VRIL COMPENDIUM

VOLUME 9

VRIL AND AERIAL RADIO

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COMMENTARY

VOLUME 9 VRIL AND AERIAL RADIO

9.1 BLACK RADIANCE

We learn of the strange nature, behavior, and response of Vril through numerous technological sources. Comparisons among the designs of early electrotechnology are especially useful in these regards, opening the discovery of new Vril phenomena which may not be realized through the accessible qualitative learning processes. It is through examples of old electrotechnology and wireless designs that we discover certain facts concerning Vril which are otherwise never observed. An enormous fund of Vril related information exists in the very oldest radio patents. The collection of related empirical phenomena provides the researcher with an endless and necessary bibliography.

Our aim is the development of technology which, eliminating all additional energetic applications, operates entirely in Vril functions. When this condition is established in a grounded radionic system, strong manifestations of the black radiant energy

appear. The black radiance is Vril.

Our summary investigation of Wireless Science begins with a re-examination of patents which are replete with obvious anomalies indicative of Vril suffusion. Only a complete study of these forgotten designs, and the empirical observations associated with them, can lead to a coherent discussion of black radiant energies and the potentials which they offer to humanity. It is in this context that our thesis has found historical continuity.

Qualitative science requires a fundamental reorganization of thought around the black radiance. Our discussion must focus on the most fundamental ground of being: that domain in which both the physical realms of our experience merge with the metaphysical realms. Interactions, between black radiant ground energies and inertial forces, have been chronicled in previous volumes of the VRIL COMPENDIUM. readers are directed to search the catalogue

descriptions of each volume for study topics.

What is VRIL? What kind of energy is it? Known also throughout the most ancient cultures under different names and titles, the black radiance is specific and most fundamental among the consciousness energies. Egyptian, Greek, Persian, or Oriental, every culture describes the black radiant energy...the energy associated with fundamental consciousness and being. Whether in descriptive phrase or metaphor, through scientific account or mythical prose, each true culture has known of the BLACK RADIANCE and its special powers.

VRIL is the name which medieval Anglo-Saxon geomancers gave to the black radiance. I have chosen to employ the term Vril because it best defines, describes, and identifies the black radiance for modern purposes of examination. Medieval Anglo-Saxon geomancers identified Vril with the smooth glowing black space which appeared atop special mountain ridges and valleys. They observed how the smooth crown-like radiance becomes constricted in the ground,

assuming a highly organized lacework of dendritic and sinuous discharges through the ground.

Vril is densified and tightly concentrated in the ground, where it encounters and focusses into inertial space. Necessarily dynamic on behalf of bioorganisms, Vril discharges in the ground evidence persistent distributions. These Vril threadways may be mapped, the black glowing current which wriggles across wintery meadows, through valleys, and down from rocky ridges.

In its sinuous and dendritic black radiant discharges, Vril was identified with the vital, the "virile" energy. Floral beauty of incredible intensity was found springing up all along Vril paths. When spring arrived, the Vril current paths were already dark green and lush with flowering growth. Medieval geomancers noticed that vegetation maintained its verdant nature, long into

winter when undermined by wriggling Vril threads.

The more consciousness-evocative potentials of black radiant Vril were noticed immediately. Vril was not an energy having bounds and limits to inert activities. Vril entered the being, effecting healings and new ideas. Sinuous Vril trails were the "dancing" paths from which visions sprang, the "songlines" where musical melodies seemed literally to emerge from the ground, the dendritic pattern which connected sacred sites for travellers. Vril trails were renown for their clarified consciousness. Timeless suspensions were also associated with Vril paths, along which personal time is continuously altered.

What is Vril energy and what does it do to us? Vril is an external manifestation of a conscious energy in which we are permeated. Vril is the fundamental ground of being. We do not auto-generate this energy, we absorb Vril. It is in this absorption that we have our existence and consciousness. The radiance of this

fundamental ground is generative, creative, and projective.

Vril is **EIDETIC** energy, the energy of projected images. Of what do the images consist? There are varieties which, in human receptive ability, leads from fundamental qualities, archetypes, ideations, ancient scenes, modern remote views, and otherworldy scenes. Vril images become material; whose complex interpermeations compose the experiential world. Vril is the intelligence, the noumenous presence through which world-dioramas are generated, sustained, and interwoven.

Vril emerges from its mysterious metaphysical depths, depths which greatly undermine the substantial subterranean world. Those locked into the inertial-fixation of mind ask aloud, "how can this be?" Vril is conscious energy, revealing vectors which conscious in nature. At inertially inaccessible depths therefore, one translates out of the material world completely...out of the inertial lock which binds mere physical excavations...and journeys in degrees of freedom defined by consciousness alone. This is the true subterranean world, the Vril radiance which underlies, generates, and supports the experiential world.

Vril is EIDETIC energy. Its thready discharge lines permit experiential examinations of regions which lie far below and well beyond the physical ground. In this, Vril reveals itself as the experiential foundation. We are also shown that the rigid inertial worldframe, so imposing and obstructive to physical movement, is a

transparent ephemeral. The ephemeral inertial worldframe can be violated by appropriate and penetrating Vril focus, the very lesson taught to us through discoveries made during the early years of electrical communication.

9.2 VRIL MATRIX

Whether veinlike in the ground or discharging into space, Vril evidences its EXTERNAL distributions. Our normal habitation is Vril permeated with innumerable thready discharges, the Vril Matrix. Vril assumes the thready constriction discharge because it focusses into inertial space. Vril is consciousness. Vril generates conscious space. The black radiant glow is the rare terrestrial expression of pure Vril Space. Such locations are special, the persistent sacred spots known from archaic times.

Self-generating Vril emerges from unknown metaphysical depths, projecting and sustaining experiential domains. Vril generates and extends experiential space, conscious space, in directions which are determined by its own intent. Vril is a persona, not an objective force. Vril Space is structured. In Vril Space, conscious directions are unlimited in scope, expression, and orientation. In Vril space, consciousness freely moves among the organized qualities, meanings, archetypes, and worlds in continual translations. Vril Space translations comprise the familiar explorations with which children and artists are intimate.

Inertial space is a gelatinous occlusion which exists throughout terrestrial surface space. Inertial space extends out to a specific boundary, where it weakens to certain degree. Inertial space is non-consciousness. Inertial eradicates consciousness and sensation. Inertial space binds movement in volume-limited degrees of freedom, having special points of origin in fixed structure. Inertial space has been adequately described by those who chart the "world-grid"; in no way expressing the world-distribution of conscious and living energy. Vril maps achieve this feat with elegant accuracy, explaining why certain regions are either exceptionally biovital or biotoxic.

Pure black radiant spaces are not rare in the terrestrial environment. They are found as the historical sacred spots. In such locations, one senses the absence of inertial space occlusions to a degree which cannot be found in surrounding ground. The combined absence of inertial burden on bioorganisms, and the exceptional mindstates of these radiant spots, made them highly sought by archaic sensitives and insensitives alike. One feels the difference at these sites. The sacred spots tell a mysterious message of triumph: the triumph of pre-palaeozoic former encounters between Vril and inertial space.

Vril works and strives on our behalf. In its permeating progress outward from every generative point, Vril contacts and dissolves the flow of inertial space. Inertial space responds by becoming "hysterical" and armored. Focussed to dissolve and cavitate inertial space on behalf of biological and conscious organizations, Vril generates and maintains world bio-integrity.

The Vril Matrix is forever pulsating and processing. It

The Vril Matrix is forever pulsating and processing. It generates the articulate bioconscious space, having diverse strata. These strata begin where Vril contacts and assaults the static

inertial space, stratifications being the shockfronts of successive and continual dissolutions. Vril is external, independent, generative, and objective. Vril consciousness becomes subjective when organismically absorbed. The degree of Vril experience depends upon sensitivity and willingness. Will and acceptance causes greater personal Vril suffusions. One has the potential to grow in consciousness as one permits Vril currents to do so. It is in this that we comprehend the distinction among sensitives and insensitives.

The deepest world-examinations bring us into direct contact with black radiant Vril space. Though we are so intimately suffused by this vivifying presence, we often do not recognize Vril. Black radiant Vril often manifests in a semi-sensate manner, being recognized only through the clarified consciousness which it projects. Yet there are locations where Vril reaches such intensities that we experience its wonderful black radiance directly. In certain locations, this black radiance causes a visible diminution of solar light at noon, being felt throughout the body and mind as an intensification of all qualities and vitality.

Vril active groundpoints often manifest a wonderful levitational quality, one which raises consciousness and clarifies sensations beyond the familiar confines in which we live. Black radiant Vril is a real stratum, the existential world-foundation. Vril densifies in the ground, forming successive densified strata. In each of these, bioconsciousness develops and thrives. The strata progressively extend above the experiential ground surface,

reaching aerial and spacic heights.

The Vril Matrix projects eidetic images. These materialize, being the process by which experiential reality solidifies. Each such projection materializes, completely interpermeated by its own being-supportive Vril threads. In this, we recognize that experiential dioramas are indeed bioorganisms. These projected experiential dioramas blend together in their edges, forming an experiential world which appears cohesive and integrated. In truth, world experience demonstrates the multiple coordination of numerous such dioramic projections.

The projections emanate from the generative Vril strata as they progress and develop through ages of time. Experiential dioramas blossom as glowing jewels from a deep blackness which seems to be nothing. The supportive Vril "worldframe" is known as the Cupula, the Tablet, the Seas, the Chalice of existence, and the Grail. All of these are summed in the term given by ancient

writers: the KRATON.

9.3 VRIL AND WORLD-STRUCTURE

Connective Vril threads permeate throughout each experiential diorama. They form the natural communications system of the world by which experiential dioramas have their primary existence. How they develop and project sensory messages to other bioorganisms is the process of consciousness.

Anglo-Saxon visionaries traced these delicately wriggling black radiant trails throughout natural environments. Often, but not always associated with underground waterways, Vril visionaries

were prized as water-finders. Vril was visually seen and erroneously termed "mercurial waters" by ancient alchymysts. Aquavideo, the supposed visualization of subterranean waterways, is a direct sighting of subterranean Vril; only surreptitiously associated with water.

It was through personal contact with the black radiant energy that archaic minds were taught concerning the world structure. First, in simple expressions concerning the connectivity of ground, space, space objects, and mind, the archane sensitives gradually rose in conscious degree to begin developing artifices and systems. Use of the black radiant energy was given to them through

powerfully received eidetic impressions.

These sensitives knew that Vril founds the world. The world is not founded in matter. Rather, it is the generative Vril consciousness which projects experiential worlds in which sentient beings each respond and inhabit. It is, moreover, in this Vril experiential knowledge that highly advanced states of being are to be obtained. Without this, there is only the limitation of inertial engines and world-models; a non-experiential bondage to restricted rigidification, tending toward death.

Our beings are primarily participants in this conscious world. It is an unlimited, unbounded world of organized structure and process. The connective means through which this consciousness is absorbed occurs through innumerable Vril threads which interpermeate our auric anatomy. Fine as hair, yet complexly patternate in nature, continuously flowing Vril currents suffuse

and sustain our being.

Vril is organismically absorbed in the form of these fine pulsating thready discharges. Their messages arrive in continually endless processions. We each, as sensory recipients of this external conscious dynamic, respond to every inflection and surge in the Vril Matrix. World-generative Vril gives the communications Matrix through which world bioconsciousness is maintained. It therefore serves as a communications exchange among sensitives who are equipped to transact mindstates directly.

The archetypes of Vril Technology undergo successive, aperiodic permutations as the Vril Matrix develops. In the Cathedral System, one sees the repetitive archetypes of Vril Technology in a new transmogrification. Preserved in stone for all the centuries to see and wonder, the Gothic Cathedrals represent the prevailing Vril worldstate of medieval times; a worldstate which has since then permuted into an entirely new regime of

applications.

The world-structure has direct impact on the nature of radioelectric propagation among regions, a topic which must be completely treated with respect to its Vril parameters. Knowing the world-structure was the secret of the Templars. Their megalithic revival was not made of rough hewn rocks, as were their megalithic predecessors. Templar architecture employed the finest hewn stonework which servant-masons could produce. In their geometrized constructions, distributed along aperiodic Vril points, are hidden the secrets of medieval eidetic communications.

The Cathedral System represents the largest privately governed project since the pyramids. It is a Vril System, having enormous

implications in communications and a host of other related disciplines. The operations evoked within the Templar System remain mysterious, although their placement most certainly civilized Europe with a power not seen among other world regions. Even the Orient with its massive geomantic works, commissioned and structured by famed Emperors, never succeeded in achieving the mind expansions seen during the European Renaissance.

In a revolution spanning several centuries, alchymy was replaced by electrical technology, as a major focus of human endeavors emerged from Europe. The discovery of new electrical phenomena appeared with remarkably great regularity, from the late Seventeenth Century until the early Twentieth Century. Forms, never before seen, spontaneously began appearing in widely separated laboratories. In the absence of close contact and rapidly shared knowledge, electrical phenomena were slowly being developed into a

technology which would come to rule academic thought.

The developments which quickly emerged contained within their assortments the very framework of modern radioelectric communications systems. Each discovery, each development unfolded in wondrous successions. First is each of these episodes came examples of phenomena, later termed "anomalous" by the developing convention of academicians. Nevertheless, these first fruits each demonstrated that a power, superior and more fundamental to electricity itself, was present and active. That power, the suffusive presence which densifies as rivulets in the ground and floods outward into space, is VRIL.

Anciently known and forgotten through countless human foibles, Vril consistently presented itself to sensitives whose magnified consciousness enabled the development of a new Vril Technology. More recently, academicians began denying the very existence of a bioconscious Matrix, eidetic earth currents, and the transmission of non-powered communications across great distances. Despite the numerous, deliberate, and complete denials of Vril Energy, Vril

continually made itself known.

With this brief and very general instruction concerning Vril behavior, we may now begin to study the aspects of wireless in which Vril energy is so obviously operative. Thus it was that systems, designed to operate entirely by electrical applications, Vril-generated anomalies began plaguing systems operators, designers, owners, and academicians alike. It was impossible for systems designers to divest themselves of the anomalies which kept appearing. Despite countless re-organizations, theorists were unable to devise communication systems which completely eliminated these manifestations. Before approaching these fascinating developments, we will now examine the major steps through which empirical discoveries re-identified Vril. Let us examine the very first recent instance where metallic aerials and grounds were devised and employed.

9.4 GALVANI

Luigi Galvani observed that frog legs began to kick when placed on a copper table out under an opened storm sky. Each distant lightning flash caused the spontaneous and persistent spasms in the animal muscle. The kicking persisted for a time after

each stroke, provoking wonder in Galvani. His experiments had a deliberate first goal which, for a time, involved him in the revivification of dead animals. When small animals could not be brought back from death through these stimulations, he abandoned this phase of his work.

Noticing that frog legs could sense the lightning often before the strike, Galvani began making observations. He found that the muscle spasms occurred in the absence of visible strikes, during snow storms, and on blue sky days. He learned that it was possible to obtain greater stimulations when very tall aerial masts, insulated from the ground, were employed. To this aerial assembly he combined a copper plate, submerged in a very deep well. The combination proved to be the very first aerial terminal and water-saturated ground.

Thus, most scholarly researchers do not suspect that the true father of all aerial-ground radio systems is Luigi Galvani. We may clearly see these forms throughout the several etchings which remain of his work. The unique introduction of these structures have great archane significance. But, how did they come to appear in Galvani's work? His invention of these components remains a true

wonder, for the aerial and ground had no precedent.

In the work of Luigi Galvani we also see remarkable evidence of the first primitive radio transmitter and detector. He found that the sensitivity of frog legs, in detecting distant manifestations of vital fluid, actually exceeded that of gold leaf electroscopes by many orders. In these aerial displays, Galvani saw the dynamic process of vital energy at work, for he observed these otherwise invisible displays despite the condition of the skies. In fact, Galvani was able to discern the difference between vital fluids discharged in the sky during fair and foul weather.

Galvani used the term "atmosphere" for aura. Metals emanated strong such "atmospheres" up to several feet. When grounded or elevated, these atmospheres suddenly expanded outward to several yards. Galvani and his assistants explored the sensations evoked when passing between such plates. Each metal projected its own assortment of impressions, both visceral and emotional. During the Twentieth Century, Dr. A. Abrams would show that rheostatic solenoids and variable resistors could literally tune the metals; propelling their expansive atmospheres to nearly unlimited volumes. A few modern researchers have recognized that these distant expansions reveal and operate within a natural ground conductive system which is world-permeative.

Galvani, qualitatively discerning the special sense-permeating influence of all metals, discovered that metals were tremendously modified whenever grounded or elevated. Touching either grounded or elevated metal plates magnified the peculiar sensations felt among large plates of well-insulated metals. Standing between such plates, Galvani and his assistants noted the now-magnified permeating sensations of copper, zinc, iron, silver, and other

metals.

Galvani saw that the metals, so elevated or grounded, became more nearly unified with their true environmental sources. This, their auric nature, was a legacy hailing from the alchemists of the Renaissance. Lowering copper plates into stone wells, and elevating

iron or zinc masts overhead, Galvani magnified the penetrating and beneficial auric effects. In these qualitative experiments, Galvani

was rediscovering Vril.

Grasping both aerial and ground terminals in their own hands, both he and his assistants sensed the "thrilling currents" of bright weather days and the "deadly currents" which signalled impending thunderstorms. Thrill shocks vivified. Deadly currents could kill. Galvani explored and distinguished all opposed varieties of currents associated with metals and the environment. He maintained an opened mind concerning the various energetic species which he had observed.

There was much life-magnifying force to the metal atmospheres when each was properly disposed in the natural environment. But those pre-storm currents represented incursions of another energetic form which ruined the vital quality. This phenomenon, this change of current nature from vital to deadly, represents the incursion of deadly inertial currents into metals from their

external sources of origin.

In his eloquent view, this atmospheric emanation was especially active in living things. The excess auric emanation of human operators and animal anatomical parts could be made to artificially stimulate frog legs. The excess energy of the experimenter was being transferred, through metallic conductors, to the frog legs. Manifesting itself in the sudden muscular spasms, Galvani interpreted the activity as proof of his theory. Galvani focussed his observations on the anatomy of frogs and dogs in order to precisely locate the physiological receptors of the vital fluid, believing that such a study might again bring him closer to an ability to revivify dead organisms.

Galvani thus distinguished between what later became known as Radionic emanations and Voltaic currents, refusing their reduction into a single electrical condition. Galvani always considered his work representative of vital energy phenomena. For Galvani, all of nature was a flood of these "atmospheres", the radiant manifestations of a divine ordination. Life, he reasoned was the result of mysterious projections. These projections came from both the sky and the earth. When they blended, vitality was conferred.

9.5 VOLTA, FRANKLIN

While European academes failed to recognize the complete difference between Radionic thrill shocks and electrical "deadly shocks", certain qualitative researchers continued their exploration of the vivifying currents. This research pursuit later developed into the science of Radionics, first with Reichenbach in Germany, and later with Abrams in the United States.

Nevertheless, academes insisted the essential unity between Galvanic currents and Voltaic currents; an erroneous and deceptive poise. Mounting biopathic fears concerning any and all mention of aura, soul, or psychic force, academicians drove their consciousness progressively into more quantitative science. If academically approved measuring instruments could not detect Galvanic thrill currents, then the thrill currents did not exist!

This sorry self-deception eventually produced increasing academic tunnel-vision by a steady inclination toward non-

experiential experimental methods. Along with this came the invalidation of human sensations, the disanullment of human consciousness, and the neutralization of dialogue concerning both. Now, academic science would not even discuss its own imperfections!

Having first reduced all world-forces to the three known inertial varieties (gravitational, magnetic, electrical actions-at-a-distance), science began looking through its own template at the whole world; daring to suggest that all it saw could be equally reduced to forces.

Volta showed that his "electrical current" could be continually produced in special metal piles, interspersed with brine-soaked blotters. Galvani and Volta corresponded in gentlemanly fashion, though in later years Galvani confided his dislike for Volta.

Volta, Galvani believed, had simply managed to produce one of a great variety of currents; certainly not the ONLY metallic atmosphere. Galvani considered Volta's thesis an imposture. It was illogical for Volta to imagine that Galvanic currents were simply "the same" flow of current. It was equally obvious that sensations and differences in sensitivity formed the true difference between researchers; a fact which later provoked much jealousy and hatred among researchers and academes.

Galvani recognized that Volta had captured the academic ear, receiving total credit for a partial truth. Volta forged ahead, studying the electrical currents produced by his method and discovering their painfully disruptive effects. Pain and sometimes death was always associated with this Voltaic breed of current. Galvani had already showed this. But academes ignored the vital currents!

Benjamin Franklin, whose investigation of natural electrostatic phenomena resulted in the development of several remarkable static bell-ringing devices, adhered to Volta's view of these currents. While performing his deadly work with lightning and lightning rods, Franklin developed simple signalling devices which employed the deadly currents of approaching storms. These necessitated outdoor aerials, a lethal arrangement. The accumulated electrostatic energies caused aerial-connected bells to ring and pithballs to fly apart when storms were approaching. Amusements for the naturalist, these little experimental arrangements were dangerous components to maintain for pleasure in one's house.

More sensitive persons recognized Galvani's discovery of vital energy rays. Whenever weather was fair, a defined beneficial effect was brought indoors through such aerial conductors. The effects were especially magnified when united with ground cables. These components, radiators of vitality, became permanent fixtures in numerous researcher's homes. Unfortunately, many scholars did not bother to read Galvani's warnings. These simple systems became deadly during thunderstorms. The tragic death by lightning-electrocution, of the Russian academe Richmann, brought a death-knell to all of this curious research for a great long while.

9.6 JOSEPH HENRY

During the years between 1840 and 1900, several major and now legendary investigators made thrilling discoveries in the

electrical sciences. Fortuitous accidents were made by scientific researchers who were simply and romantically "playing" in the laboratory. It was while engaged in this "scientific playtime" that the first evidences of broadcast electrical effects were discovered.

In an experimental arrangement, designed to discover the nature of spark discharges, Joseph Henry discovered a peculiar manifestation of radiant energy (1842). Wishing to accurately determine the direction or directions in which spark discharge currents actually moved, he devised a simple experiment to this end. His question centered on the vibrant nature of sparks. Did the charge merely shuttle between charged bodies...or did they bounce back and forth?

He reasoned that sparks would produce a resultant magnetic polarity in magnetized needles. Allowing the discharge to pass through such a needle would permit a measurable record of the current directions. Directions would relate to the resultant needle polarity. Each discharge produced a different polarity, indicating that the spark was an alternating phenomenon. But these effects could be modified.

It was possible to so arrange the Leyden Jar parameters as to "fix" the discharge, preventing its alternation. Moreover, Dr. Henry discovered that actual conduction of the spark discharge current was not required for the needles to be repolarized. needles could be repolarized several feet from the spark discharge. Trying to discover the range of this strange and unprecedented electrical effect, he placed needles throughout the building in which he worked. Each time, the effect worked its power. Magnetized needles were repolarized.

Thinking that this was a conductive effect, a possible leakage through the stone of the building, he insulated his spark apparatus. Standing on glass blocks, the large Leyden Jar continued to produce its radiant effects. Dr. Henry found that the magnetic needles had been repolarized...in the basement, several floors down below. The spark discharge had produced an amazing effect through a substantial volume...through 400,000 cubic feet of space without connections.

He turned all of his skills toward this new a strange phenomenon, by which electrical energy had been transferred by a strong discharge through space. In trial after trial, Dr. Henry discovered to his amazement that the sudden electrical discharges obtained through large Leyden Jars could produced electrical effects at a distance. The distances were impressive, often reaching several hundred feet. Moreover, these energetic transfers occurred directly through several floors of oak, stone, and iron.

How did electrical force of this penetrating power effect this change through such volumes of wood, iron, stone, and air without material connections? There was no precedent for this observation, the key to a new technology. His astonished conclusion was that light-like ELECTRICAL RAYS had penetrated the floors and cellar vault.

Twenty years after this momentous discovery, an amazing manifestation of Vril inspiration produced the first modern wireless communications of signals (1862). True and deliberate

aerial signalling systems began with Dr. Mahlon Loomis. His designs and experimental demonstrations proved not only that aerial communications were possible, but that a mysterious natural energy could supply all the necessary means for signalling between distant mountaintops. While Dr. Loomis was first to employ both the capacity aerial and ground, we do not include his work in this issue. He has been given a separate and just place of honor, since we believe that the Loomis System was a pure Vril communications device (V.7).

9.7 ELIHU THOMSON

The penetrating power of the electrical rays, first discovered by Dr. Henry, was the essential mystery compelling all subsequent researchers. One such experimenter was Elihu Thomson, a high school instructor. During the year 1872, Elihu Thomson conducted a series of experiments in order to more closely examine the development of

electrical sparks from a large induction coil.

He noticed that the sparks from his coil visibly and audibly intensified when one of the high voltage terminal wires was accidentally connected to a large metal table top. Wishing to further intensify these strange effects, Thomson connected a wire from the other high voltage terminal to a cold water pipe nearby. This being done, the spark discharge become completely different in nature. The loud crackling white threads were fluidic and powerful, an appearance which he had not previously seen. The arrangement soon manifested another phenomena for which he was not prepared.

Touching a metal cabinet handle, insulated in the midst of its wooden board, Thomson received a sharp shock. Perplexed by this, he look to see whether or not some accidental electrical connection had been made with the experimental apparatus. This being impossible, he tried the cabinet handle again, receiving the same

sharp shocking sensation.

Now he walked around the room, touching the insulated metal objects with a penknife blade. In each case he perceived a strong and continual spark discharge which took the form of a whitish-violet fluidic stream; nearly identical to the induction coil spark. At this point, he was completely astonished. Here was a phenomenon by which all the metals of the room were being charged without visible conductive connections.

Not completely realizing the full import of what he was observing, he wished to see the extent of the charging effect. Walking down the hall, he met Elihu Thomson, sharing with him the observation. Together they went through the building, floor by floor, touching metal objects with the penknife blade. In no case were the resulting sparks diminished. The amazing phenomenon brought them as far as the school observatory, where an astronomy teacher was informed of the experiment. In the dark, they each beheld the steady sparks which could be drawn from the metal tube of the school telescope; a remarkable manifestation of radiant electricity

What Thomson had accidentally produced were the effects which Joseph Henry had observed nearly thirty years before. Because Dr. Henry used frictional generators to charge his Leyden Jar for single discharges, he could not have enjoyed the full extent of his

discovery. The induction coil, which owed its existence to Henry's discoveries, was employed by Thomson in a novel manner. The arrangement had somehow combined characteristics which had not previously been obtained, fortuitously producing a steady barrage of explosive sparks such as those which Henry had developed.

It was the special characteristic of these sparks, as opposed to others, which had in them the power to release such energetic effects. The experiment, being performed with other arrangements, did not succeed to produce these radiant electrical effects. Once again, ELECTRICAL RAYS had been generated, a phenomenon which required another twenty years before their full potential was utilized.

9.8 GROUND SYSTEM ANOMALIES

Anomalies were inadvertently revealed when telegraphy enjoined the ground. The employment of double end-grounded lines brought inexplicable effects which appeared as electrical manifestations. All too numerous in their diverse kinds, and all too numerous in their varied varieties, these electrical anomalies could not be adequately explained by conventional models of electricity. When academes decided that theory was at fault, they attempted remodelling their existing science to incorporate the anomalies. This failed on a number of occasions, provoking the wrath of frustrated theoreticians. The final outcome of this time period was the total denial of such events and anomalies: the eradication and disqualification of the phenomena.

Throughout the COMPENDIUM we see how Vril, the black radiance, interacts with grounded artifice. More specifically, we have endeavored to show the high degree with which black radiance actually interacted with the components of electrotechnology. When once those components were incorporated in ground connection, the anomalous manifestations arrived daily. There were those astute observers who recognized hat, contrary to the official denial of phenomena, another energetic stratum had possibly been contacted.

This energy was one whose effect in the telegraphic and telephonic systems was to aperiodically evoke anomalous functions and malfunctions. Spontaneous electrical generations baffled telegraphers, and delighted system owners. It was possible to operate telegraph systems without batteries for years in certain locales. In addition, there were equally fascinating accounts of phenomena whose characteristics exceeded those accounted to electricity. Perceptual phenomena noted in telegraph stations included time-space distortions, strong and consistent eidetic impressions, and telepathic episodes.

Thus, certain operators noticed that their own familiar perceptual state was considerably modified when communicating with specific stations during the night. Lost time, distorted space, fixed visual impressions, and an ability to know why the other operator was calling...as well as the exact nature of their message, were some of the night "hauntings" with which telegraph operators became accustomed.

Operators were quick to recognize each of these rare behaviors in systems, being equally quick enough to share them amongst their ranks. Theoreticians were slow to begin entertaining them,

considering them the mere banter of the telegraph "servant class". Their experiences could not be adequately approached by the conventional science.

Hailing our rediscoveries of the Vril presence into this curious period, when electrical anomalies plagued grounded systems, we find our answers arriving with elegant exactness. The primary communications mode through which Vril communes with us is **EIDETIC**: a combination of primary images and absorbing visceral sensations. One often feels as though they are present at the site with which they are conductively connected. This bilocational sensation of being simultaneously at the transmission site and the reception site is common among Vril phenomena.

Eidetic whole images are transmitted through very thin Vril threads. These threads follow conductive lines when necessary (Hieronymous, Drown). The phenomenon by which threads become whole images has been experimentally examined. It explains the numerous phenomena of bilocation and remote viewing which persistently occur in specific ground locations. It explains why certain remote viewing agents required grounded light bulbs as a gazing tool. Vril enters electrical systems, automagnifying its presence. Eidetic energy is especially enlarged when encountering low pressure bulbs,

argon also acting as a facile eidetic agent.

Vril is constantly flowing in pulsations from and across the ground. Grounded metallic structures absorb and pass these Vril currents. Grounded systems enjoin Vril directly. They do not require electrical additions for their operation. Grounded Vril saturated systems operate in the EIDETIC MODE, their primary mode and function. Neither electricity nor code is necessary if the operators allow themselves time to recognize the forgotten perceptual mode, eidetic vision being the lost sentient language. Through eidetic communications we learn of the fundamental world-language once again, the mode through which all worlds dynamically interact.

Ground objects thus serve as a source of eidetic currents, a source of eidetic viewing. Is it not curious that natural instances of remote viewing best occur near well grounded locations? Eidetic images may be thus absorbed directly through proximity with ground objects. In such a case, eidetic discharges project into the recipient from the grounded object. Through direct contact, one may absorb and experience eidetic processions with great ease. The process is best facilitated through implementation of grounded radionic instruments.

Ancient methods learned that stone marked Vril points gave especially strong eidetic impressions on touch. It was gradually realized that iron rods served this function with far greater power and clarity despite season or hour. Copper provides a softer interface between subterranean Vril strata and the recipient. One finds this eidetic flow completely absorbing, being required to allow oneself to believe once again that the imaginal flow which enters through closed eyes is indeed real. The various behaviors which Vril currents display are an important tutelage for the serious student. Only when these principles are learned through personal experience, may one begin to make progress in developing Vril Technology.

Ground communications systems, whether wire or wireless, conduct the eidetic imagery which becomes the meaning of each message. This notion is foreign to most thinkers, who imagine that code and meaning necessarily arrive as a single unity. We have discussed the instances in which eidetic impressions and code are actually sundered. Instances are rare but not absent in which code is perfectly received...while their meanings are vague and indistinct.

Contrariwise, there were instances in which meanings proceeded in absence of coded transactions. Operators could always identify both the gender and operator when called to the receiving station by the message alarum. Each of these abilities is impossible, considering the fact that telegraph keys are digital switches. Lacking sensitivity to provoke such coded "inflections", academic science could never evaluate these telepathic instances on the basis of "touch" or "tenor". For this, and other related reasons, several dignitaries of great renown were moved to a necessary examination of psychic phenomena (Crookes, Lodge).

9.9 VRIL WIRELESS

The astounding achievements of both Antonio Meucci (V.5), and of Nathan Stubblefield in these regards (V.7) received considerable attention during their day. Antonio Meucci, true and original inventor of the telephone, conceived of trans-Atlantic conduction wireless in 1845. In his wireless method, tested across New York Harbor, telephonic messages were impressed directly on seawater through submerged metal plates. He conceived of large such systems, having differentiating electrodes for maintaining the integrity of telephonic signals across the great stretch of sea miles between New York Harbor and Valentia Bay, Ireland.

Nathan Stubblefield, by far the greatest modern developer of Vril System technology in numerous regards, first engaged wireless vocal communications...in 1872. Mr. Stubblefield publically demonstrated vocal ground-radio systems (1906) along the northeast coast on dates very much later than these initial verifications of his theories. Mr. Stubblefield worked with telephone repairmen. It was probable that his original experiments focussed on broken telephonic lines, whose continued operation remained "anomalous" at the time. He may have been the first person to deliberately implement a double-grounded telephonic line, impressing his voice in the conductive ground. Receiving these vocal signals at ever great distances through an equivalent double-ground, he may thus have been first to recognize the principle of conduction wireless. Despite these beginnings, his work took on a completely different aspect when an intriguing discovery was made. Somewhere during his initial research in conduction wireless, Stubblefield discovered that commercial amounts of an electrical power could be drawn directly from certain groundpoints...indefinitely. This constituted his famed "earth cell", or geological cell, patented as a "battery".

Scholarly examination of his work leads to the inexorable conclusion that Stubblefield may not have been working with electricity as we know it. The characteristics of his results support this belief. His ancillary developments included: drawing

usable power from the ground to drive motors, light special arclamps, heat cabins, detect intruders, and receive very distant signals. His lamps and motors ran "cold", never burned out, and required no replacements. The same was true of his earth cells, which were never deactivated and which never corroded.

His final life's work, a process for "extracting, storing, and rebroadcasting sunlight", cannot be comprehended through electrical models. This last accomplishment of Stubblefield was never mentioned in any research reports, although all too numerous witnesses testified of the "brilliant light which flooded out of the hillside".

After his death, his emaciated body was recovered. The cabin laboratory was a shock for those who entered, having been filled with large strange and alien apparatus. Warmed by a mysterious heat source which rippled with continual heat "from two shiny metal plates", this Vril system maintained its vigil over his body in silence. It was known that his systems could be kept in continual operation for weeks without ever a concern for deactivating or replacing them. Corrosion or decay was never a problem, his famed ground receiver not being an ordinary electrolytic cell.

After the stunning achievements performed by Meucci, by Loomis, and by Stubblefield, systems operated entirely through pure Vril applications, others began questioning and elaborating on their methods in "more conventional terms". As each of these used means which did not employ electrical currents as we know them, both the academes and designers were in developmental checkmate. Mr. Stubblefield represented a major mystery to those of his day. His own "scallywag" partner, A.F. Collins, developed a counterfeit system which employed heavy storage batteries and carbon button telephonic transmitters. Many erroneously imagined that this represented the Stubblefield system.

Most disconcerting is the fact that most designers and theoreticians continued their frail attempts at telegraphic wireless in absolute ignorance of what had been achieved in Murray, Kentucky early in 1872. Mr. Stubblefield actually performed his original experiments at this early date, developing and protecting his discoveries until 1898.

It is remarkable testimony to the ignorance of enlightened convention that the scientific and inventive community actively and aggressively pursued inferior experimental investigations throughout this time period. Even when Mr. Stubblefield had revealed his great work to the world at large, there were those who stubbornly and ignorantly delved into less worthy wireless telegraphic ventures. Nevertheless, both Telegraphy and Telephony were about to be dissolved in Wireless. In this new venture, Vril would again make its first astounding forays. But first modern indications of these realities came through the pioneering work of Nathan B. Stubblefield.

Misconceived and inappropriate, a group of "electrical inventors" soon emerged. Having the duplication of Stubblefield's demonstrations as their goal, they each designed and redesigned each other's devices. None however, achieved the results which had been surpassed decades before. The wonder of a supernal energy, a dream-like non-electrical energy, had been implemented by persons

such as Meucci, Loomis, and Stubblefield. This energy was transduced into pure manifestations of light, heat, motion, and vocalizations; possibly without the intermediate by-products commonly termed "electrical".

Theorists studied the electrical characteristics of Telegraph and Telephone Systems with great intent, hoping to find the "conventional reality" within the lost legends. Overshadowed by Meucci and Stubblefield, an emerging inertial technology strengthened its hold on designers and experimenters alike. Vril technology seemed again to recede below ground, the dream current returning to its metaphysical sea.

Each subsequent electrical discovery, after these stellar achievements, became the redundant recapitulations of a more decadent technological phase: pure electrotechnology. It seemed that few minds were capable of grasping the significance of the great and previous empirical summit. Stubblefield had already drawn

usable power from the Vril Matrix.

Performing experimental work with electrical applications now, several confluent discoveries were subsequently made which surreptitiously enabled wireless communications. These discoveries began with those of Tesla in regard to ELECTRICAL RAYS. It was through this means that the first aerial electrical transmissions were made. Others applied the various kinds of electrical irritations (alternations, oscillations, and impulses) directly to the ground in order to wirelessly "transmit signals" by EARTH CURRENTS.

During this time frame, Dr. Amos Dolbear (1886) developed and patented a radio communications device whose propagation mode is yet problematic for examiners. Using large closed-capacitance for his aerials, Dr. Dolbear was finally able to engage vocal communications for several more miles than stated in his initial reports. Careful examination of his design reveals an impossible configuration, one in which no "spark discharge" actually occurs. Telephonic communications are applied directly to the induction coil transmitter by way of a carbon button microphone. Vocal transmissions were empowered when the apparatus was poised on stone. Complete records on Loomis, Stubblefield, and Dolbear may be found in COMPENDIUM Volume 7.

9.9 TESLA

The system which combined telegraph lines, subaqueous, and subterranean segments had successfully operated for years. Early subaqueous and subterranean conduction telegraphy employed rapidly impulsed currents, power provided through combinations of induction coils and magnetic reed vibrators. Capable of transmitting strong telegraphic signals through long courses of dry grounds, wetlands, and water bodies, inventors began investigating the function of circuit interrupters. It was subsequently discovered that high voltage signals of shortest possible duration travelled to greater distances.

Experiments in England showed that high voltage interruptions were effective in conducting signals across channels and large tracts of ground (Preece, Hughes, Branly). Circuit vibrators and other such interrupters were therefore investigated in numerous

laboratories with great interest. Heinrich Hertz developed a series of experimental spark apparatus through which he claimed it possible to transmit spark energy through long distances. Taken as proof of the Maxwell electromagnetic wave theory, Hertz was heralded with great honor.

Nikola Tesla complained that he had been unable to reproduce the results claimed in Hertz's classic report. Moreover, Tesla claimed the accidental discovery of a spark-related phenomenon which differed completely from those of Hertz. Nikola Tesla wrote a curiously unquoted article in which he describes the discovery in

detail. Most scholars ignore the paper entirely.

Tesla felt a strong shock when manually interrupting a high voltage DC generator. Believing that he had received the shock through his hand, he insulated himself entirely from the apparatus, and performed the experiment again. Again he received the shock, a prickling tension which struck him like a shockwave. Devising a mechanical interrupter, he was able to gain distance from the system enough to study the effect. When this was done however, Tesla could not escape the shock effect. Irregardless of his distance from the system, the shockfield continued to propel irritating tensions throughout the laboratory space. Here then was real evidence...strong evidence...for the transmission of electrical force through space. The question now centered about Hertz. Why were his effects so very different...and weak?

Tesla studied the literature, finding only the two incidents of Henry and Thomson in corroboration. Tesla examined the designs of Hertz, discovering between the two experiments fundamental differences in electrical values. In effect, Tesla stated that he had discovered a means for releasing electrostatic RAYS. Hertz had only succeeded in releasing electromagnetic WAVES. Tesla stated that waves could not possibly be useful in transmitting power through space, being the weak equivalent of a heat loss. Tesla proved that electrical rays were the strong force, reliable and penetrating. True wireless transmission of power could only be

effected by such rays.

Tesla's statement was the announcement of a new electrical force, a force which did not find place in the collated fund of academic phenomena. Although the empirical records of Henry, Thomson, and Thomson stood as heralds of this radiant electrical force, few but Tesla engaged it seriously. Empirically discovered and defying the fixed icons which ruled the electrical engineers, Tesla's announcement was neither comprehended, accepted, or endorsed.

Requiring very specific and stringent electrical parameters for their liberation, Tesla described the means for interrupting a high voltage field to release electrical rays.b The effect required a unidirectional electrostatic voltage of high initial value. This being very abruptly interrupted, a new electrical force appeared throughout the surrounding space. Emanated through the spark discharge proper, these electrostatic rays were penetrating and potent. Tesla found that even copper shields did not block their passage. Placed in oil, the rays propelled a gaseous stream which deformed the oil for several inches.

Tesla discovered that high voltages could cause an effective

separation between charge carriers and electrical fields. The sudden charging of a conductive line produced a sudden electrostatic field expansion. This field penetrated space with irritating force, a release of electrostatic rays. By causing the irreversible abrupt expansion and collapse of an electrostatic field in a specially constructed high voltage discharge device, Tesla states that a new electrostatic force emerges.

The liberated radiant electric force shoots beyond the bondage of charged particles, penetrating to great spatial distances with apparently undiminished force. If the interruptive process is continuous, the release of electrostatic rays is continuous. The process had nothing at all to do with magnetic fields or magnetic inductions. All the energy was contained within the expansive electrostatic field.

Generators of these rays had to employ unidirectional impulses. Tesla clearly describes the precise parameters required in order to prevent the instabilities of alternations and even oscillations from occurring. The effects which Henry and Thomson each observed were very rare events. The release of these rays required very special circuit values, parameters which preserved the unidirectionality of the electrostatic field throughout the transformation process. Instabilities, whether of alternations or of certain oscillations, would ruin the effect which he claimed to be the greatest secret of electrical force.

Moreover, Tesla discovered what would happen if this ray energy was intercepted by other conductive bodies. Single-layer solenoids behaved as peculiar capacitors in this space. Expansive electrostatic rays were not conducted as charge through the solenoid windings. Electrostatic rays focussed over the solenoid surface. Tesla found that these surface-focussed electrostatic rays expand over the coil surface, travelling over the windings as an ever increasing voltage pulse from end to end. This greatly raised voltage could not be accounted by the familiar magnetic transformer proportion.

Measurements on the coil condition gave surprising results. The coils gave a zero-amperage reading, evidencing the fact that charge carriers are blocked from moving through the windings. In their absence, the electrostatic field actually travelled over the coil surface. The explosive propagation of these rays produced an ever-increasing voltage rise with increasing coil resistance. Tesla stated that it was possible to produce voltage transformations of ten thousand volts to the solenoid inch, factors which informed engineers that a truly new electrical force and inductive principle had been discovered.

Tesla describes the ELECTROSTATIC TRANSFORMATION of impulses from low voltages to high voltages without the inductive effects of magnetism. He publically demonstrated the Tesla Transformer, a true ELECTROSTATIC INDUCTOR. During his Royal Society Lecture, Tesla gave the exact function and parameters required to reproduce this new device. Tesla took great pains to prove to his listeners that his Electrostatic Transformer did not function because of magnetic induction. He equated the electrostatic inductor to a pulsating Wimhurst Machine of far greater power.

These sharp and penetrating rays were found to flood the

surrounding space whenever directed. They could be used to produce extremely high voltages through equally great distances. In his series of new discoveries with the electrostatic rays, Tesla had found a means for directing and collimating the radiant electrostatic effects which had so irritated him in his accidental discovery. It was during this lecture that Tesla first describes his preliminary experiments with the transmission of electrical power without wires, a feat which greatly out-classed the mere transmission of radio signals.

Toward the very last portion of his lecture, Tesla demonstrated the delivery of intense power to a vacuum lamp. The small and focussed ray field produced a very intense light at a good distance without wires. At the very end of his talk, Tesla predicted the use of geoelectric energy, the transmission of electrostatic ray power, and the establishment of radiosignalling stations across the world.

No longer would he trifle with polyphase of high frequency alternating currents. In fact, each of his subsequent patents reveals his clear distinctions among the three current forms...alternating, oscillating, and impulse currents. But, why had Tesla entered this field of study at all? Alternating Current was his original forte, was it not?

9.10 MARCONI

Professor Augusto Righi devised a scheme for producing very powerful spark impulses across very small capacities, insuring a rapid intermittent break of any applied electrical tension. Righi staged his discharge capacities to obtain extremely rapid oscillations and alternations, immersing his central discharge gas in paraffin oil. This permitted a more powerful field absorption before spark breakdown. The oil bath blocked the discharge until the field strength reached some exceeding strength, whereupon it suddenly discharged its full charge with sudden impulsive force.

Righi was one of those who observed and corroborated the findings of Tesla. Radiant electrostatic rays were distinctly different, and ultimately more penetrating, than the weak waves obtained when alternations were generated. As Tesla had first described with detail in his famed forgotten article (Electrical Experimenter, 1892), Righi recognized the special power inherent in impulse discharges and oscillations.

This oil bath discharge gap was the improvement which allowed Dr. Righi to produce very prolific electrostatic rays. In fact, by placing his small oscillator inside a copper pipe or paraboloid, Righi succeeded in projecting electrostatic rays to a great distance.

The several components which appeared in the Marconi Radio System, operated before the English military, were noticed by the academicians who had conceived and invented them. These Royal Society members viewed Marconi and his device with quiet, conservative, and contemplative scorn. His induction apparatus was that of Ruhmkorff. His coherer detector had been developed by Eduard Branly. The high frequency discharge oscillator and harmonic tuning circuits were clearly invented by Lodge. Combinations of coils and capacitor plates were derived from circuits invented by

Hertz, Edison, and Thomson. High frequency air-core transformers, capacity aerials, ground connections, and the various tuning components had been invented by Tesla. Beam ultra-shortwave transmitters employed Righi oscillators and the parabolic reflectors of Hertz.

First to admit that he had derived electrical components previously discovered and developed by others, he selectively gave credit to predecessors when it suited his pride to do so. This weak defense was a necessity, since Morgan was watching.

Many of the legends from whom he "adapted components" were still living. By now, his extensive financial base permitted him to cover the numerous suits which were justly levelled against him. But Marconi was ever the victor in court. He now fared with the rich of the earth who gave him strong aid in these bureaucratic matters.

One person made several casual public statements concerning his own priority in radiosignalling systems. That person was Nikola Tesla. Tesla had his proof for this priority in a great number of his patents. In each, we see the entire marconi system prefigured. Tesla was not interested in royalties. He was already a millionaire. Tesla simply wished to enunciate his views on creativity and invention. The question dealt with true revelation and true patent licensure.

Contrary to historical reference, Marconi was never able to produce anything truly creative. Statements made by Marconi, each thoroughly prepared and rehearsed, forever revolved about the "nature of invention" rather than on true creativity. He also pandered the tired phrases concerning inspiration and perspiration. Obviously he had not the former, nor the latter. He was simply a good promoter of the ideas and inventions of others. Unfortunately, he had neither the gratitude nor the decency to include those from whom he so liberally and openly stole.

Though brazenly implementing several of Tesla's patents, Marconi refused to acknowledge Tesla at all. Perhaps this was part of the picture. Marconi demonstrated his bureaucratic connections in several court cases. In each court decision, the Marconi claims were persistently upheld. Apparently it was important for Morgan that Marconi's wireless become the success which history records.

9.11 ACROSS THE ATLANTIC

Limited in his viewpoint of natural science, Marconi never strayed far from the academically accepted world of electrical science. He always "played the science game straight", so that ridicule and the possibility of social unpopularity would never come near him. He knew well what happened to Tesla. New and penetrating radio theories would not be heard spouting from his lips. Irregardless of the true glory of the legend, Marconi chose to avoid Tesla's legendary route of scientific martyrdom.

The necessary test of his radiosignalling system, the "acid test" was imposed on him by his principle investor. Before seizing the financial profits away from ordinary submarine telegraphic or telephonic exchanges, Marconi had to prove the ability of his waves to cross the Atlantic. To this end he was given funds with which to conduct a demonstration of the practical transmission and reception of signals...with clarity. The system had to bring the clarity and

speed which submarine telegraphics afforded. High speed telegraphic transmission was the central feature toward which his efforts would be focussed.

The transmission sites were chosen on opposite sides of the North Atlantic: at Glace Bay, Nova Scotia and at Poldhu in Cornwall, England. There, enormous aerial structures were erected. Four huge multi-girdered masts were first erected. Upon these, an immense inverted pyramid of cables were strung. Work on these aerials proceeded slowly, weather conditions prohibiting more rapid deployment of the necessary transmitter components.

These sites were chosen because of their obvious close geographic poise, Marconi anticipated that the first signals would be relatively weak and furtive. Until the proper parameters for transmission and reception were chosen, there would be wide room for failure. Transmissions were to proceed from Cornwall, being received at the Nova Scotia side. The famed signal was a simple Morse Code "S"...the three dots. This signal was to be continually broadcast in hopes that the others in Nova Scotia would receive them. Telegraphic affirmations would serve as confirmation of signals received.

The weather raged against his efforts. The high winds finally destroyed the Nova Scotia reception aerial. With time working against him, Marconi decided to try a simple method for launching an aerial wire to greater altitudes than the original pyramid afforded. Taking a lesson from Mahlon Loomis, Marconi had large kites constructed and outfitted with copper screens. These were sent aloft, using the very winds which destroyed his aerial towers in order to give him aid.

Many doubt whether Marconi's signals were ever received, believing that Marconi faked the results in order to stall for time. They assert that his stall technique was based on his confidence that a strong signal could eventually be transferred across the Atlantic, but that the initial attempt had failed. Nevertheless Marconi's wave signal, clouded with noise and static common to its mode, was indeed received across this stretch of the North Atlantic. It was transferred, but not through the power which was provided by his transmitter on the western shores of England.

Indeed, when one considers the initial power and aerial geometry which Marconi utilized in his famed trans-Atlantic experiment, one concludes mathematically that the signals could never have been detected at all! Calculations show that the Marconi signal could never have been transferred through the power levels which were employed, the effective output energies of his spark generators being insufficient to produce an intelligible wave signal across that distance. How then did the signal manage the cross-over? It is here that we may begin again recognizing the antagonistic roles which Vril and electricity play in the environment. It is also through these antagonisms that the resultant effect of communicated intelligence, of meaningful dialogue, occurs between distal communicants. But, contrary to conventional explanations of radioelectric signal exchange, we will learn the true function and limit of electricity during the communications process.

The electrical irritation of Vril results in a production of

electrical charge wherever the willful reception of signals is established. The appearance of electrical charge does not occur as a result of "passages through" conductive media or spaces. The appearance of electrical charge occurs "in situ"; in the very site

where signals are willfully received.

In this first Marconi arrangement, electrical irritant was applied within the aerial Vril stratum. The received signals were fraught with the static. Static is evidence of a Vril metabolic process by which the electrical charges, applied at the transmission site, are actually destroyed through dissolutions. Being thus digested in the Vril Matrix, transmitted charges vanish in the Matrix. If charges are dissolved in transit, what then remains to be communicated?

Conventional explanations for empirically observed phenomena do not account for details such as these. Being aggregate phenomena, producing whole effects, one tends to overlook the individual portions of a dynamic natural expression. This leads to faulty conclusions and erroneously constructed models. When convention endorses the model, it becomes rigidified in utility. New ideas therefore become impossible to convince. The elegance of qualitative science consists in its ability to appeal directly to sensation and subjective reality, its primary base. One might therefore allow a rare moment of personal sensation during scientific analysis, seeing the fundamental Vril dynamic which generates every other effect.

Grounded systems are absorbed in the natural black radiance of the district. When groundpoints are properly chosen, these grounded systems become especially Vril radiant. Human operation of these systems permits the addition of extra sentient impressions on the primary radiance. The radiance is articulate, a complex pattern of messages, therefore the addition of minor patterns is possible. This is the signal portion which is effectively and losslessly

exchanged between distant geopoints.

Meaningful communication does not consist of coded transactions. Coded transactions ride the meaningful component, a black radiant Vril signal which has the nature of consciousness. Meaningful communication consists of auric modulations. Modulations of the human aura impress the exchange of eidetic impressions on the Vril Matrix. Whether telegraphic impulses or vocal expressions, it is the auric component which enters system components and makes patterned impressions on the primary Vril radiance. When such a system is electrically "flashed", radiant Vril patterns suddenly expand in an antagonistic fury which becomes hazardous.

Thus, based on confused understandings, wireless electric signal transmission spawned a world-revolution. But such distant communications were not new for the archane societies who developed the megalithic system. The greatly expanded and enraged radiant Vril patterns spread throughout the district on behalf of bioorganisms. The response is one intended to preserve life in the presence of irritations which kill. Vril messages are patterns, there is no transference of matter. Vril floods the world, therefore its pattern changes are instantaneously received. Placement throughout the district and region determines the degree of Vril pattern receipt. Specific groundpoints are imminently more

in contact with the pattern changes, being connected in the naturally established Vril threadways. Pattern changes are fascinating fluidic exchanges of black crystalline states. These "pattern flickers" have been observed, and preserved in experiments which employ chemical emulsions.

Vril ground currents feed each bioorganism in a district on an individual basis. The needs of each bioorganism is thus contained in the Vril flow, an enormous and complex pattern which can be intercepted and studied. Whenever this patternate flood of life-generating expressions is disturbed, Vril overwhelms and asserts its presence. Electrical applications into the ground or aerial strata produces this antagonism. Many individuals yet preserve enough of their sensitivity to feel these irritations throughout the environment. The pattern transactions occur because they are intended to preserve the diverse bioorganisms which depend on Vril currents for their individual existence.

Because of this Vril response, electrical disturbances are lost at the ground site; being absorbed and dissolved by the Vril Matrix. There are interstitial phases in this Vril digestive process during which "other kinds of electrical species" thus appear. These, however observed by experimenters, have nothing to do with the Vril pattern exchange. They only serve to prolong the expansive Vril antagonism until local inertial space is cavitated enough for the patterns to be exchanged. While unidirectional impulses best serve in this antagonistic relationship, raising Vril states to enormous pattern potentials, any electrical application will effect the distal pattern transaction.

Marconi had not yet learned the secret of choosing proper "related" geological points to insure the most powerful signal transactions. Points such as these evidence the eidetic connectivity of distant locations, producing both eidetic and subsequent electric charges in situ. Fixated on the relatively weak electric charges produced by the primary eidetic energies which are exchanged, operators failed to tap the primary power at work in these systems. It was a fact that certain geological locations exchanged radiowave signals with impossibly great power. After shifting from ray to wave signalling apparatus, Marconi came to rely upon such means in order to boost every fraction of output power.

We will see that additional patterns which are impressed on Vril ground messages are actually unnecessary, since these contain information on all bioorganisms in each area. Ancient sensitives learned how to read these individual eidetic signals, obtaining detailed information on sentient-related activities in their own districts and others. One may, through the artifice of specially constructed ground components, gaze into the Vril dialogues which occur in particular districts. We may select, with certain strength, very specific locations from which eidetic currents can be drawn to our apparatus.

In all of this we peer into the anatomical communications of the Vril Matrix, learning that eidetic ground messages comprise a mysterious dialogue. This dialogue engages diverse Vril strata, districts, and regions. It is a world language of vast and mostly unintelligible import with which more archane designers and priestly operators were familiar and adept. Indeed we will find that the archane technology of certain civilizations, now shrouded in archaeological misrepresentations, was wholly devoted to Vril and its naturally mystifying dynamics.

9.12 WORLD WAVE COMMUNICATIONS

In misdirected efforts to improve his wireless system, Marconi inadvertently converted his transmitters from ray to wave systems. Shifting engineering emphasis from the electrostatic rays to the transverse waves produced weak transmission signals. This necessitated higher power outputs at the transmitter sites, requiring mammoth generation and transformation facilities. One may examine the photographic record of this cross-over from rays to waves.

The change provoked Tesla to make several penetrating and derisive comments ("True Wireless"). Tesla later made an appearance at the New Brunswick Marconi Wireless Station in New Jersey. In this revealing portrait, the very soul of Tesla may be seen. Disgusted with the unnecessary waste of effort and outraged by the display of bureaucratic control, we glimpse a rare moment in Tesla's biography. According to Tesla, the employment of electrostatic rays is the only mode for transmitting power and signals.

Marconi, unaware of the real difference between rays and waves, chose the weaker electrical mode by which to forge his path of development. Apparently ignorant of Tesla's true discoveries and claims, Marconi continued to develop and perfect only Hertzian wave technology. These, the inefficient detritus of electrical currents, could never fare against Tesla's power transmitters and receivers. They unfortunately became the radio convention, forever contaminating the academic mind with strongly rigidified conscious bias. The fundamental difference between Tesla Radio and Marconi Radio is so vast that their names should never be placed on the same page. Rays exceed waves in power, penetration, speed, and clarity.

The electrostatic ray, potent and penetrating, did not disperse with distance. Furthermore, the very ground itself intensified the rayic signals as they were conducted. It was observations such as these which encouraged Tesla to attempt accreting natural ground energies when employing impulses of very specific duration and repetition. Despite all of the natural and anomalous clues, Tesla had not yet come to realize why this was so, yet believing that the communicated exchanges entirely took place in the "electrical medium".

Most of the early wireless stations were prolific radiators of electrostatic rays, with only minor performance in the Hertzian broadcast mode. This is certainly evident in the capacity aerial systems. This would also explain how it was possible for Marconi to transmit and receive intelligible signals across the Atlantic with the equipment he devised. Marconi thereafter advanced the Hertzian Radio scheme, utilizing ineffective transverse waves to signal across space.

Great difficulty attended both the generation and detection of these weak transverse waveforms. Yet, the indomitable Marconi

pushed his system into the gargantuan realm to avoid failure. Only the exceptional donations and continued support of Morgan could grace this failure-bound venture with success. Certainly no such patron ever appeared to freely grant aid to Tesla, whose electric rays far outstripped Marconi Wave Radio as a threatening power broadcast system. Marconi Stations were enormous in both cost and size. For their hugeness, the overall performance was disappointing. Marconi Radio Systems were slow in telegraphic transmission and weak in reception. In this light, we must recall Meucci, who had already demonstrated VOCAL transmissions across great volumes of seawater in 1845.

Some Marconi systems were so large that their reception aerial were placed miles away from the transmitter aerials in order to isolate the receiver. Induced transmitter signals could destroy the sensitive detectors to which operators gave careful attention. The original radiofrequency generators which Marconi employed were based on the hydrogen-arc systems of Valdemar Poulsen; mammoth constructions which were actually plasma magnetrons for the VLF range. More elaboration on the hydrogen arc generators has been included in (V.11).

Worldwide Hertzian mode VLF engineering developed around Marconi. Through his sponsorship, Marconi is responsible for proliferating the "weak wave" method. Marconi radio-transmitters exalted the Hertzian waves, requiring exceedingly long aerial structures. Impossible to construct out of solid metal plate, capacity aerials were out of the question on every consideration. The patents of Lodge and Fessenden reveal the enormous size required to achieve signal potential with these aerials and their excitation generators. Tesla had already foreseen these foibles, having developed and perfected diverse means for achieving true electric ray transmission (Dollard).

electric ray transmission (Dollard).

Marconi began fabricating the articulate line aerials from wrapped cables. Marconi's famous bent-L design utilized heavy copper cables, with length reaching one mile or greater in some instances. The numerous cables of this array fanned open from their generator site, stretching in parallel cadence. Powerline technology in a usable form, a new means to employ almost-obsolete investments and secure the monopoly. Who else could afford the

construction of these sites but Morgan?

The Marconi transmitters utilized VLF alternations, originally provided by large arc generators of enormous output. He eventually relied entirely on harmonic alternations, the pure sinewaves which are now equated with radio. Indeed, most engineers are incapable of recognizing the existence of other electrical species, dispelling the reality of electric rays and their role in effecting vastly improved radio-communications. Because of their enormous physical size, Marconi stations were useful only in slow-speed telegraphic communications. It was said that the first stations not only "lit up" during operation, but "rang like a gong" with each keyed application of power. So much power was consumed that the structure required a long discharge period between keyed applications. While Marconi stations resembled huge capacitative "waveguides", directing Hertzian alternating radio-energies out to the sea, it is probable that a great deal of his success was based

on the extension of his effective aerial length through seawater conduction. The extensive copper ground screens, laid on the seafloor for a mile or more, has recently been found off the New Jersey shore. These screens greatly outdistanced the overhanging aerial structure of the famed "bent-L".

Thus, recognizing the inherent failure of this scheme, Marconi resorted to trickery of the lowest kind. His first VLF transmissions were not entirely aerial or "radio-radiant". Using forgotten principles of Antonio Meucci, Marconi frequently employed both conductive geological structures and seawater channels in order to propel signals through seawater in the old conductive-wireless manner. The excessive power levels consumed in Marconi transmission sites, and the equally excessive amplification systems at Marconi reception sites, were never necessary in Tesla's electrostatic ray signalling system. Electrical shockwaves, delivered through space as sharp pulsating electrokinetic rays, delivered all the required power by which Tesla drove his electrical receivers.

These early high power VLF stations were not unlike bluntended, or terminated power stations. These were eventually constructed so as to launch VLF waves along geologic orientations. With their special trellis-like arrays, these enormous arrangements ran for nearly a mile or more straight out into the seawater. Brute force was the only means for sending the lossy alternating waves out across the northern sea, submarine geology being an often necessary means for conducting more power. Marconi trellis aerials (Bent-L designs) operate because of Vril parameters, albeit inefficiently. Vril gathers upon the trellis as do vines, thickening near the aerial roots, and spreading outward toward the opened sea. Vril surges between electrical pulses, impelling the actual message, context, and comprehension previously thought inherent and homogeneous in radio signals. Vril vectors occur along the trellis conductors. The applied electricity causes the meaningful signal to greatly expand, flooding the surrounding space with its characteristic black radiance.

Underlying the entire fanfare was the fear that Tesla might find a willing party in the government sector, one which would implement his power broadcasting designs and wreak havoc in the Morgan Electric empire. Content to occupy himself with the inferiority of an electric wave transmission mode, Marconi developed huge stations which required the sizable fortunes of his patron. Morgan, ever the invisible promoter, willingly endorsed his controllable and predictable "star inventor" for various reasons. One of these included the fact that Morgan was heavily invested in powerline technology, a failed ploy to entrap Tesla and Westinghouse into a parasitic partnership.

Any designer can clearly see that Marconi stations obviously employ the powerline technology which Morgan had previously monopolized in order to ruin Tesla. The corporate monopoly of Marconi Radio by Morgan is difficult to ignore. No longer in control of "his Radio", Marconi found himself being pressed into service by patron and academicians. Morgan had caught him, pulling him into the net. Marconi no longer had the pleasure of relaxing in seclusion. He had to produce, and produce new designs with great

deliberation. Now he was irked into serving his own creation, a task which taxed his temperament beyond all ability to endure. Marconi began sailing away. His yacht "Elettra", purchased at no small price considering the day, was a self-imposed exile lasting for several decades.

Between honors ceremonies, press interviews, and business meetings, Marconi sailed. On occasion he would land and appear at new station dedications, all arranged by others to whom he had delegated authority. Marconi Radio Stations were subsequently built across the globe, principle sites being chosen on the basis of strategic access to main cities. The process was now a formula. Building Marconi Stations was now a methodic engineering exercise. The Marconi stations were huge and costly, often extending several miles into the sea. Tesla high frequency alternators, long abandoned by Tesla himself as inefficient, began appearing in Marconi Stations.

Designs which had been appropriated by Alexanderson of RCA, they were now heralded as the "greatest achievement in modern radio engineering". The media publications, owned and operated by the patron, was churning out the popular mythology which stimulated the minds of young and hopeful engineers. Throughout this time period, Tesla had already perfected generators for the pure production of electrostatic rays.

Nevertheless, Marconi required these mammoth alternators in order to replace the large Poulsen Hydrogen Arc generators, for which he paid handsome royalties. Though paying him legendary heed, most young experimenters had no empirical connectivity with the systems which Tesla had outlined. The contaminated press had already found ways of misrepresenting the Tesla method. It remains so to this day, where ray technology is completely derided as "impossible". Tesla Radio systems were compact and portable, utilizing the very smallest spiral-loop capacity aerials. The equivalent Marconi Station would necessarily be several football fields in length!

Tesla's mocking indictment of this wasteful broadcast method has been reprinted ("The True Wireless") in which he shows that Hertzian VLF resembles the radiation of radio "heat" rather than the more powerful electrical ray mode which he himself discovered and developed. Marconi had completely misunderstood the very patents which he adopted from Tesla, interpreting every text as

harmonic high frequency AC.

Ignoring Tesla's established principles of power transmission, Marconi focussed all of his attentions on establishing world wave communications. Developing the lossy systems which Tesla continually upbraided as "inefficient and excessive", a determined and well-financed Marconi established a world-girdling radio communications "circuit". This system eventually was absorbed into the growing RCA megalith. Tesla later appears in a revealing photograph which was taken at the dedication of a Marconi station in New Brunswick, New Jersey. He is clearly displeased for a great number of reasons. Einstein and Steinmetz represented two forces with which he battled all his life: abstraction without experience, and the bureaucratic prostitution of scientific expertise.

9.13 SHORTWAVE

An avid experimenter and worker throughout his life, Marconi was a far more successful businessman than a discoverer of new electrical phenomena. But in this latter realm, he was not entirely without merit or ability. Because of his exceptional technological access, Marconi soon discovered several natural phenomena concerning the frailty of Hertzian propagation. This was a fact reported by Tesla a decade before.

Both Marconi and Fessenden each individually found that diurnal changes in VLF signal strengths often varied by the minute; a dangerous fact for stockholders to know. VLF signals were found to vary as much as eighty-percent between specific hours of the day. This inefficiency equalled lost revenue, a closely guarded secret until the remedies were found and quickly implemented. Marconi's method was not to back track his work as far as Tesla would have insisted: a complete revision of radiant mode.

Marconi found that trans-Atlantic communications suffered in transit along east-west directions, while north-south trans-Atlantic communications came through with great power. This mystery led him to the creation of special world-wide "radio circuits"; signal paths which were rigorously tied to their geological features and best suited for signalling throughout the day.

Therefore, while Marconi continued to explore the possibility of creating newer forms of radio apparatus, he nevertheless maintained a strict confinement to the Hertzian principles. He was always implementing and absorbing the newest electrical devices when their adaptation to radio could improve the Marconi System. His wife divorced him. Marconi sought refuge in a freedom which kept him an exile at sea.

Sailing the world for years in his yacht "Elettra" he finally managed escapes from patrons, media, business, and his own overinflated image. Here there was peace and tranquility, solitude and space out under the night skies. Marconi returned to his boyhood days where, content to read and experiment, he re-sought his own lost trail. Too much too soon. The old "rapid rise, rapid demise" story which fame at an early age brings.

His desire to make transoceanic travel safe and troublefree, succeeded in perfecting a number of directional beam transmitters and detectors. With these it was possible to pinpoint a ship on the ocean with great precision.

He joined the world wide effort, along with other researchers, to investigate the electrical layers found above the clouds. Even as Mahlon Loomis suggested some fifty years before this work, Fessenden, Heaviside, Kennelly, Austin, and many others investigated the mysterious ionosphere. Aimed toward the sky, shortwave beams were seen as echoes bouncing off the "ionospheric ceiling" of an immense world-covering cavern.

Marconi patented a shortwave beam signalling device early in his career (1897). It was nothing more than the very oilbath spark generator of Righi placed in the bent copper parabolic mirror of Hertz.

Marconi eventually explored short and ultra short Hertzian waves which were best suited for ionospheric bouncing. Bouncing these signals off the ionospheric "cavern ceiling" made long range

communication possible. Ever the master of adaptation, Marconi utilized the new and special vacuum electron tubes in both his shortwave transmitters and receivers. Marconi later developed new Hertzian designs, adding first a telegraph key and then vocal modulators to the simple miniature dipoles. Through these previous fundamental inventions, Marconi developed and popularized short Hertzian waves for public access, opening the world of HF, VHF, AND UHF to amateurs.

With his shortwave transmitters and receivers, Marconi successfully saw the popularization of radio, a reality of which he had not previously dreamt. The gigantic bent-L aerials now were miniaturized, so that amateurs the world over could intercommunicate freely. Marconi offered his UHF transmitter to the Vatican, perhaps to ameliorate his by now seared conscience.

The work, no longer a simple upper room experiment with components belonging to others, became an excessive burden set on him by his principle investor. Constantly clamoring for the perfected systemology of instant world-communications, Marconi had to deliver the patron his due tribute in continual successions. This meant that he had to consistently conceive and develop original inventions; a task which proved beyond the ability of the experimenter-turned-diplomat. The romantic dream was long gone. The upturned nose, so evident in Marconi's earliest portraits was now replaced by a deeply embittered condescension. Jaded and despoiled, Marconi died with honors.

By far not the first to conceive, investigate, develop, and proliferate radiosignalling apparatus, Marconi commercialized a form of radio which should never have been proliferated. Masking the true wonder and world-potential represented in Teslian Technology, Marconi had been heralded far too long as "the father of radio". Reaching back before the Century's turn, Antonio Meucci first demonstrated the exchange of telephonic signals through seawater. Mahlon Loomis first demonstrated the exchange of telegraphic signals across 20 miles without wires or batteries. Nathan Stubblefield exchanged vocal signals through the ground without batteries.

The tragedy of a young and zealous experimenter has not been completely told. His dreams were not completely satisfied. Having been promoted so quickly, his mind and creativity were actually prevented from achieving that true originality by which legends are truly marked. In his life, this prize, this inner blessing never blossomed. The rose, frozen in snow.

9.14 CAPACITY AERIALS

It is indeed indicative of our poverty in Vril knowledge, that we often require the contrasts afforded by radioelectric effects on the Vril environment. The study of wireless components grants revelatory understandings by way of such contrasts. Activated by electrical means, these components produced uncommon Vril states in regions. With these uncommon Vril states came equally bizarre effects in both the inertial and perceptual experiential realms. The reappearance of long lost geometric forms, now becoming useful in wireless, was a strange sight for those who watched designers setting them up toward the zenith.

Ball aerials, inverted cones, cylinders, and coaxial radiators are a few of the designs which comprised the early working radio systems. With these capacity aerials it was possible to transmit and receive signals far in excess of ordinary applied power. Ordinary inspection of the patent texts reveals an abundance of radio anomalies associated with these designs. We should perhaps first begin by comparing the nature of signals and signal qualities reported with capacity aerials before even considering those yielded by familiar Hertzian wave-antennas. Are there, in fact, any capacity aerial deficiencies or even superiorities in some aspect of signals transceived? Capacity aerials are simultaneously immersed in a number of very different energy forms. We may simplify the numerous interactions into a basic antagonistic conflict between inertial space and Vril space. Early wireless operated solely in the VLF range. Both the nature of radioenergy generators and the aerial symmetry determined the nature of signals transmitted. Early wireless relied on spark generators, the quality of which determined the nature of energy delivered to the aerials. The radiant propagation of electric vectors from capacity aerial symmetries provokes serious questions. The source energy becomes converted in the capacity aerial, becoming an altogether diverse radiance. A patternate Vril radiance.

Though large in surface volume, none of the designs is possessed of sufficient geometric length for true electric waves to reach their necessary power maxima. Lacking the required expansion length for waves, such capacity surfaces cannot radiate a complete fund of energy which may be delivered by harmonic radioenergy sources. Capacitance aerials cannot effectively radiate Hertzian vectors. The impossibility of radiating electric waves from these metalloforms is matched only by an equal impossibility of using them to detect such waves. Yet the experimenters found empirical evidence for the overwhelming success of these designs. In fact, most of the working patent designs should not work at all as transmission aerials. As empirical discoverers and patent examiners found to their own amazement, these structures do in fact succeed in radiating signals of all kinds. From Teslian perspectives, these capacity aerials may be thought as Ray Vector radiators, thus explaining their often misunderstood performances.

In capacity aerials, each applied charge of the harmonic cycle translates into an electrostatic pressure. Charged with each alternation and incapable of expanding through sufficient dimensional length, the capacity aerial functions as a semi-efficient radiator of electrostatic field lines.

When supplied by appropriate spark discharge apparatus, potential was made available for the production of Teslian electric rays. In fact, the only electrical mode by which aerials of these empirically over-efficient designs may operate is through the electrostatic rays which Tesla rediscovered. Only electrostatic rays operate in the coaxial capacity aerials of Marconi, where transverse waves could never stir a detectable current. Proper implementation of these capacity aerials required the abrupt high direct voltage without alternation which Tesla perfected.

Since capacity aerials operated with electrokinetic ray modes, energies which are not presently believed to exist by all but a few

academicians (Aspden, Jefimenko), we are led to examine the particular details by which meaning and message are conveyed through rays. The only electrical function which operates in these designs is the Teslian electrostatic ray, prolifically produced along with the transverse waves when high voltage sparkgap oscillators are employed. This meant that powerful unidirectional rays could antagonistically radiate along with the system-suffusing Vril radiance. But coded signals do not compose a meaningful signal. Electrostatic rays, however potent and penetrating, do not complete meaningful exchanges from such systems. Just how then does a capacity aerial conduct, transduce, and radiate the meaningful signal component at all?

Coded and acoustic signals are separate from the meaningful component comprising the sentient message. No sentient exchange, whether through code or acoustic signal, comprises a meaningful exchange. The meaningful signal is supplied by Vril, being the ground of consciousness; that from which all our intentions and urges to communicate arise. All communications systems therefore necessarily enjoin the Vril black radiance. This was the very observation made when systems of this kind were directly connected with the ground.

To comprehend the manner in which eidetic currents radiate from electrified capacitance, we must first understand how these eidetic currents permeate radiosystem components from the ground. Capacity aerials which are highly insulated in the electrical manner, are not insulated from ground or aerial Vril strata. Oil immersions do not insulate capacity aerials from Vril, which densified in oils (Fessenden).

By extending thready black radiant arcs from the ground, Vril suffuses through circuit components. This process is selective. These Vril discharges then rise through the capacity aerial, flooding its solid metal surface with bioactive patterns. Vril pattern currents naturally and aperiodically pulsate from ground to space through such capacity aerials before electricity is ever applied. The natural flood of Vril eidetic images slides over and through solid metal surfaces with an ease dependent on metal composition, disposition, overall surface geometry, and placement.

We see that Vril suffuses capacity aerials completely. Natural eidetic signals, the district prevalent Vril energies, flood the metallic volume with black radiant currents. In addition, every impressed eidetic signal flows into the capacity hood, both pattern populations blending on the surface. Before electrical applications are engaged, there exists a defined procession of eidetic currents from these capacity aerials. These may be shown through radionic examination of both the metal hood, the ground, and distant locations. Thus, without applications of electrical power, on can exchange meaningful eidetic signals. This is the very means by which archane megalithic technology operated. But what is the overall effect of electrification? What happens to the natural flood of throbbing eidetic currents in the aerial capacitance?

Electrification of the metal hood causes a sudden expansion of all the conducted Vril currents, a bioassertive automagnification of enormous and hazardous intensity (Reich). In the process, Vril signals are magnified beyond their normal limit (Kilner, Abrams).

One may often see the black radiance which surrounds a large electrified metal surface. What is the true and fundamental "capacity" by which materials and material forms are distinguished?

The sheer volume of metal and surface area of capacity aerials offers adequate absorptivity of ground suffusing eidetic images. This eidetic absorptivity is the only and fundamental CAPACITY of a metal surface, the ruling function which is dimly perceived as "electrical capacity". These absorbed eidetic currents are also conducted in aperiodic pulsations, flowing from ground to space by means of the metal surfaces. Radiating through the metal hood, eidetic images flow from the aerial metallic surfaces directly into the aerial Vril stratum. Distributed across the hood surface according to Vril geometric principles, learned and used by Templars, eidetic image currents are thus directly applied from this terminal.

The aerial Vril stratum is a vertical symmetry of black radiant threads which proceed from ground to space, interspersed with connections which spread in all directions. It is understood that, while these black threads may be objectively and visually sighted in certain circumstances (Watson, Corliss), the aerial Vril stratum is one through which experiences flow. The Vril world is one which generates and defines world experience. It projects the world as we know it. Access within these strata permit transcendent cooperative modifications of world structure.

The Vril aerial stratum is especially densified over central Vril powerpoints, long known for their direct link with special stellar or planetary foci. Once absorbed into the capacity aerial, the eidetic currents are unfortunately violated by electrical irritations of the most dreadful degree. High voltage irritations can kill bioorganisms. What then do they do to the resilient Vril currents themselves?

The spark generator used along with a capacity aerial determines its efficient projection of electrostatic rays. The efficient degree to which the capacity aerial is therefore electrostatically shocked determines the degree to which it functions best as a conjugate ray transmitter. Conjugate ray symmetries are always engaged in Teslian devices (Dollard). where electrostatic rays maintain a continued Vril expansion for long distances.

Any electrical irritation which traverses the Vril strata will cause a corresponding enraged expansion response in the Vril domain. This occurs even when alternations are sued. Only the electrical presence is required for this dynamic to take place. In turn, the degree to which the capacity aerial projects electrically enlarged eidetic threads horizontally from its surface determines the degree to which subsequent measurements of "skywaves" and "groundwaves" are observed in meters. Intriguing enough, electrical lines alone do not long proceed in horizontal attitude with respect to ground. How then do we explain their powerful long-range effects?

Tesla found that capacity aerials did not produce better transmission with increased height. Nearness to ground always produced stronger signals, the densified Vril ground stratum supplying the suffusive eidetic articulation. Eidetic articulations

determine the exchange of communicated signals. Only a population of true long-range horizontal eidetic discharges could account for the long-range performance of these smooth surface aerials.

We must follow the eidetic flow through such a system. From the ground, eidetic currents of enormously magnified pattern potentials are radiated into the aerial stratum from the capacity surface. Vril threads flow outward, proceeding along the rays of electrical irritation in long horizontal discharges. The capacity aerial radiosystem is an eidetic fountain, employing a powerful (unnatural) inertial irritant to achieve its function as a communicator. Most horizontal eidetic discharges follow the irritating raylines until they reach ground. Some maintain their horizontal attitude, self-generating their processions in a remarkable display of bioprotection. This accounts for some remarkable "skywave" performances of capacity aerials.

According to Tesla, the capacity aerial system did not require the excessive aerial size or elevation above ground level which Marconi lavished upon his wireless systems. Thus, capacity aerials can function in both transmitting and receptive functions while close to the ground. This intriguing feature leads directly to a discussion of black radiant strata and Vril current interceptions.

Situations in which weak electrostatic charging occurs result in more ground-reentrant eidetic projections. This reentrance produces strange local static phenomena. Not dispersed as charge from the metal hood, static charges appear throughout the surrounding grounds to some degree. Representing the cavitation of ground absorbed inertial space, by projected eidetic threads, a large volume of ground suddenly manifests the spontaneous electrical charging effects noted by early experimenters. This charge is electrically measured as an increased "groundwave", but is not radiated energy. It is eidetic dissolution of inertial space, with a resulting population of fragments known as "charges".

In their direct application to the aerial Vril stratum, eidetic currents are modified by the "geometric spread" which the conductive surface dictates. Capacity aerials are direct connections in the aerial Vril stratum, eidetic exchange terminals. Electro-magnified eidetic signals are thus propagated through the very specific Vril routes of a district. Their patternate processions communicate eidetic information throughout the district. All those who engage the Vril point distribution in specific locations are then privy to the flood of eidetic information. Those who know the mappable relationships among widely dispersed regions also know that they can receive such eidetic information in specific points of their neighborhood. Vril points may be enjoined through nonelectrified radionic apparatus.

The geometry of a capacity aerial modifies both the absorption and projective directionality of eidetic image currents. Vril responses to hood geometry modifies the manner in which ground discharges will extend up into the hood. Specific geometries block or enhance eidetic distributions throughout the metal hood surface. Eidetic thread distributions do not conform to dielectric field distributions noted with diverse metal plates and solid forms, they influence dielectric fields.

Eidetic threads avoid negative curvatures, but will focus upon them when multiple negatively curved metal layers are stacked. Their discharges most powerfully spring from sharp edges, but are noticeably suppressed and complicated by stippled or decorated edges and surfaces. Singular metal masts always project strongest eidetic current from their terminal points, but collections of vertical metal masts always densify eidetic currents at right angles to their lengths. Vril tunnels into material distributions and layers, a fascinating topic which was mentioned in regards to the formation and densification of mineral layers (V.4).

Spherically shaped metallic surfaces produce eidetic distribution through which eidetic patterns may be discerned. These patterns are not uniform homogeneities, evidencing the complex details of wood grain patterns. Nevertheless when spherical metal shells are layered, one within the other, an astonishing focalization of all eidetic currents occurs. This focussing effect draws all of the surface absorbed eidetic currents into a singular constriction. The site where this constriction occurs is dense and active, always influenced directly by spaceward bodies: by the sun and moon, as well as by stars and planets. In this regard, it was not uncommon to read reports which correlated radio effects in capacity aerials with space conditions. Clearly astromantic in effect, RCA later employed an individual whose sole task was to chart planets and thereby predict best daily frequencies of operation (Nelson).

It is not difficult to arrange small empirical tests of these eidetic effects. One may even appropriate the larger metalloforms found in architectural structures to make simple verifications of these statements. Large forms which are equivalent to the sky-pointing coniform capacity aerials of Fessenden, have been closely examined in these regards. These aerials project intense eidetic energy spaceward, the verticality or angulature of which is always modified by local Vril conditions. The verticality from such sky-pointing coniforms varies with season and time of day, being powerfully influenced by both solar and lunar positions. The resultant eidetic projection varies from zenith by as much as forty-five degrees, seeking out mysterious fixed points in space.

Such vertical projectors visually manifest black radiant Vril threads at certain times. But these threads often become whitened in hue as the day progresses, being the black thready sites where inertial space is actively dissolved and absorbed. The characteristic white inertial sheaths have been previously discussed (V.1). These coniforms are noted for their prolific production of electrostatic charge, an anomaly erroneously associated with ordinary aerofrictive charging.

These coniform aerials engage and draw entrant space energies in a remarkable manner, eidetic signals being modified directly from Vril strata beyond terrestrial environs. The ascending and greatly intensified Vril thread thus touched into deep Vril space strata. The immediate descending response instantly occurs in numerous widely separated points simultaneously. Through the implementation of this unusual capacity aerial design, spacedescending eidetic imagery of an excessive power was received in

greatly distant locales. This certainly occurred in locations for

which no successful electrical explanation can be given.

Dielectric discharges spring from sharp edges, not varying from this general response even when encountering the baffled plates of air capacitors. But eidetic discharges prefer tunneling through obstruction, automagnifying as they process. Eidetic discharges obey responses whose tendencies always insure the proliferation of biovital states. This strictly behavioral response reveals the intelligent nature of Vril, which resists the simplicity of rules applicable to dielectric field distributions. One is driven to a necessary empirical examination of eidetic fields when studying and discussing metalloforms.

Other qualities of eidetic content are altered by the metals (elements and alloys) used, and the ability of the geometry to diffract certain eidetic components. Highly convoluted metal surfaces diffract portions of eidetic currents, magnifying or suppressing qualities which exist within specific currents. Capacity aerial geometry collectively modifies the meaningful content of Vril signals. Concentrated toward specific ground Vril receptor points, one receives eidetic messages along specific meandering Vril lines. Thus, while electrical vectors may be entirely absent at furthest ranges, strong eidetic impressions with or without attendant infinitesimal electric charge will be detected.

While most engineers are content to accept the notions that each of these capacity aerial systems operate as Hertzian radiators, there are in fact other designs which should not radiate waves at all. A number of these appeared in an article written by Professor Righi. From Righi's drawings we see a great number of puzzling capacity aerials, some of which could not possibly radiate Tesla Rays or Hertzian waves. The numerous huge coaxial hood-and-shield assemblies should not operate as either transmitters or receivers in either ray or wave radiant modes. How did these transmit the empirically ascertained signals?

Close examination of Marconi "coaxial aerials" and their accompanying text only intensifies the paradox. One realizes that these large metallic forms could never project radio energy through their heavily shielded capacity to be a transmitting aerial. As a receiving aerial, no external radiowave energy should ever penetrate the capacity shield. The induction of detectable current would then be equally impossible. This aerial design should not operate, either as a ray or wave transmitter. With neither rays nor waves permitted entrance, how were signals exchanged? How then did these designs operate at all?

these designs operate at all?

It is first very evident that all electrical functions were blocked completely. The only signal which could effectively penetrate the Faraday barrier would be a non-electric one, a "neutral radiance". There is only one energy which, being pre-electric and communications-fundamental, could ever bridge the electrical barrier. Coaxial capacity aerials grant us a remarkable opportunity to realize unexpected Vril behaviors, clearly operating in the eidetic mode. Any electrical charges observed in operation of these designs is fortuitous, being manufactured "in situ" by the radiant or entrant eidetic Vril threads.

9.15 ARTICULATE AERIALS

Articulated aerials for wireless communication first emerged from the laboratory of Nikola Tesla. These designs were compact spiral loops of incredible effectiveness. In both transmitting and receiving electric rays of various pulse lengths, Tesla claimed their efficiency was unusually high. He began replacing several capacity aerials of his own construction with these pancake spiral and loop aerials. Tesla discovered their remarkable effectiveness in receiving both his own ray transmission and those of Hertzian rich Marconi VLF signals, publishing these reports well before the turn of the century. It was with these that the world's very first high power ray transmissions were made.

Marconi and Fessenden later produced extremely large articulate aerials of their own design. These dissected the solid geometries of previous capacitor aerials, producing combinations of cage-like forms. These arrived in quick succession. In typical fashion, Marconi and Fessenden constructed enormous articulate aerials. In Marconi's typical style, some these were necessarily miles in length. Marconi consistently ignored what Tesla stated concerning these designs. In truth, the articulate aerial revealed that a truly living exchange medium was somehow involved in radio signalling.

Tesla first believed that electrostatic ray components would permit a strong signal reception with negligible aerial dimension. But these facts do not adequately explain how such a small and compact flatwound spiral is so successful in receiving the very much longer waves of ordinary broadcast bands. When the mysterious handheld ferrite-core loop aerials later proved to have anomalous operative efficiencies, physicists were not provoked into giving renewed explanations for the empirical anomaly.

How a non-Hertzian aerial can act so powerfully in receiving such long waves as used in ordinary AM broadcasting finds no satisfactory answer in theory, and remains conspicuously unaddressed. But let us question the convention once again, evoking academic reprisals of the most unenlightened variety. How does a small and compact spiral loop manage the powerful reception of VLF signals? It would seem that the employment of ferrite core material actually magnifies VLF signals, serving as preliminary signal amplifiers. In what manner does such a passive material, assumed to have somewhat lossy characteristics, actually boost an incoming signal?

The best an earliest answer to many of these questions did not emerge from the convention. It came from one whose words were held in disrepute. Tesla believed that the effective communications exchange medium was gaseous in nature. He observed steady gas-like streams emerging from wires which conducted unidirectional impulses of high repetition. He also observed thready gaseous emanations in highly exhausted bulbs when electrified through high voltage tension. Tesla assumed that these threads communicated their content without loss of detail when traversing space. But gases, irregardless of their dynamic state or density, cannot transact the uninterrupted consistency of whole images through thready currents.

Such patternate integrity is certainly not found in the

aetheric "ultragas", as Tesla first assumed when making his preliminary discoveries. Furthermore, the finer wire spiral loops began evidencing a wonderfully powerful receptivity which seemed self-intensifying. That aerials, having articulate detail, could greatly outperform smooth surface capacity aerials became somewhat mysterious. No engineer ever launched a theoretical model explaining this fact. Increased articulation, increased detail should bring only needless electrical complications in overall impedance. Shortwave radio designers later sought simplicity, which the smooth surface metal aerials afforded. But here was an anomaly.

Articulate, convolute, woven matrix...each exceptional such aerial became more highly transmissive or receptive with increased convolutions and woven complexities. Electric rays would not require such convolute complexity for reception. One sees numerous early examples of working geometric aerial forms which could never be considered as feasible by contemporary engineering conventions. Electric waves would never operate in such geometries. The increasing complexity of the articulate aerials approached organismic detail. The manner in which highly articulated aerials magnify messages-in-reception indicates something of an organismic nature in the transmitted signals themselves.

Articulated aerials, whether wound or woven in design, had no place in conventional theory. It became apparent that transmitted signals also increased in clarity when special woven or even convoluted geometries were employed. These strange organismic designs were incredibly effective in both transmission and reception. This then inferred the existence of spatial variegation within signal pulses, a volumetric patterning. Neither electric rays nor electromagnetic waves partake of such qualities.

In the efficient operation of articulate aerials, we therefore see evidence that an energetic carrier or medium. One perceives that organismic patterns of a highly complex nature may be exchanged among widely distant signallers only through an equally articulate medium, capable of sustaining, preserving, and exchanging details of incredible complexity across vast aerial spaces.

It is clear that, in reception, the energies which impinge on articulate surfaces of appropriate capacity are not electrical in nature. The energies which render intelligible transactions are eidetic, absorbing these thready discharges along flatwound pancakes of various volumes and dimensions. We see that Vril behaviors far exceed those observed in electrical phenomena. The detailed manner in which Vril phenomena respond to and cooperate with material structures reveals a bioarticulate nature. Aerial wire-wrapping designs cannot effectively operate except in the Vril mode.

Vril is an articulate expression, a living entity possessed of deeper functions. Those with which we have had to describe thus far are vegetative characteristics. There are other characteristics which match and then greatly exceed sentient potential. Vril process covers the entire range of consciousness, from infrastructure to permuted structure. Vril exists in a self-generating stratum of its own, building upon the established

firmaments of its own achievements. Vril has characteristics of both growth and processive continuity from which vegetation finds its nature. Plant growth and vegetative process indirectly reveals certain Vril dynamics.

In transmission, one recalls that electrical applications are merely used to provoke antagonistic reactions in the primary substratum, Vril. Magnified into enraged states, Vril eidetic currents discharge into aerial or ground Vril strata. Previously suffused with ground emergent Vril currents, the empirically designed aerials evidence cooperation with certain Vril characteristics. One characteristic which Vril manifests is growth. Vril threads emerge from the ground and grow into grounded artifice like vines.

Vril suffuses all grounded communications systems, emerging and extending as gradually growing discharges from the ground. In this behavior, one recognizes the nature of floral growth, that which the medieval geomancers called "VIROLE...a woven bracelet" and "VRILLE...to weave". Flooding the huge components of wireless radio (massive aircore inductors, giant plate capacitors, magnetic arc dischargers, and immense aerials), Vril behaved as climbing vines do in spring. When encountering ground supportive extensions, vines surmount and gradually propagate. Vines add matter to their preliminary shoots, growing and cross weaving their own extensions until the vascular bundles become like cable.

Articulated aerials are Vril trellises. Coil aerials corroborate what we know of Vril. New facts are obtained by examining how Vril and the Vril stratum behave in other natural situations. We may best learn how coil aerials and other articulate aerial designs operate by noticing the response of vegetative process to trellises of various forms and symmetries. The growth characteristics of climbing vines, ground covering ivy, and grape vines, grant us a physically tangible means for studying what kinds of responses ground-emergent Vril demonstrates. It is at once remarkable that the large articulate VLF aerials resemble garden trellises of various kinds (Marconi, von Arco, Hart, Latour, Chubb, Conrad, Scheller, Chireix, et al).

There were articulate aerial forms which completely defy conventional analysis, converging from the feedline and reconverging at their terminus. Thus in a great number of anomalous behaviors, each of which corroborate the more vegetative Vril behaviors, one observes that impossible aerial forms actually outperformed those longlines which Hertzian theory demanded. If we recognize that the primary operation of articulate aerials occurs in Vril parameters, then we will find that a great number of correlative facts will begin to self-organize. We can apply what we have learned concerning the true and foundational nature of communications. Relying on Vril eidetic currents to transact meaningful communications, one recognizes why loops can be so very remarkable in both transmissive and receptive modes.

Vril grows into grounded coils, climbing onto and over coils like vines. The grounded structures themselves behave like vine trellises, receiving and conducting proportional amounts of Vril threads. Each coil has a specific Vril capacity, accommodating a specific fund of flowing Vril threads. Vril is densified outside of

coils when they are electrified, powerfully collapsing back into the coil when the electrical pulse has passed. This sudden Vril collapse brings with it an increased Vril growth potential, a frighteningly magnified Vril presence which is dangerous. In this

manner, electrified coils greatly magnify Vril.

As historically noted, the electrical parameters of coils is related to a peculiar capacity. But this capacity is eidetic in fundamental nature. The eidetic capacity of a structure determines its resultant electrical capacity. Vril will load coils and other such symmetries when properly grounded. The very wire or cable upon which or into which Vril is provoked to flow will determine what general sorts of Vril responses may be expected. Eidetic accretions discharge from absorptive capacities, bringing with them their continuity of meaning and message directly through the underlying ground contact.

The only rational means for assessing exactly what Vril will do is

through the old empirical method of making scale models.

Layers, braids, weaves, each represent conditions into Vril will articulate. Vril threads accrete upon stippled, scored, and crenelated surfaces with great affinity. Vril self-magnifies as it encounters resistance, multiplying the eidetic capacity in an equivalent volume with which smooth solid surfaces cannot compete. Articulate aerials produce Vril magnifications by the simple resistance response, being natural geometric magnifiers. Thus naturally assuaged into a magnified state, Vril begins its communications in strengthened degree long before electrical irritations propel its rage response throughout the district.

The articulated aerial forms (whether woven, twisted, or braided) absorb Vril in the normal fashion, but so resist Vril absorption that it self-magnifies while flowing through the structure. One has added advantage then, the eidetic signal component being already magnified by natural process. Less input irritation is necessary to produce strong resultant meaningful communications. Crenelated and scored wires each effect more of the Vril automagnification process. These aerials produce both much greater Vril outputs (natural eidetic transactions), and inputs (natural eidetic receptions).

Let us imagine for a moment that these metallic lattices, these trellises, were equivalent to a smooth solid metal surface. Let us also allow that the means by which they operated with such effectiveness had origins in a charging process. If each of these aerial forms operated by some such charging process, why then did equal metallic volumes of different weaves or convolutions work better than their solid equivalents? In this farfetched consideration, neither wrapped nor woven aerials rationalized.

Let us also assume that small sections of these designs were individually receiving ray or wave transmissions. The collective sum of induced currents could spill out into the connective ends. If these same connective endlines functioned as absorptive capacities, the inductions could occur in small linear dimensions until they reached their maxima. This might permit a large resonant induction to take place, producing detectable signals. But how then to explain this mechanistic scheme in designs having cross-

connections...effective short circuits?

It becomes very clear that certain other such convoluted designs could never be explained by the above two mechanistic schemes. The wavering trace of "Zig-Zag" aerials receive strong signals in VLF, broadcast bands, and shortwave. The signals they receive can neither be ray nor wave in nature. "Zig-Zag" aerials do not function in electrical parameters, being a paradox of wonderful representation. Their very symmetry defies theory and reason. Any supposed induced electric vector will be counteracted in the geometry of such an aerial, until a neutralized state is obtained. Yet, even small Zig-Zag aerials reportedly received signals of prodigious strength.

Curious during this time of radio development was the appearance of woven cage aerials, space-distributed examples of their planar prototypes. Receptive devices which should never work, these systems outperformed many longer ray and wave aerials. In truth, these cage and loop systems effectively accrete Vril

currents in very special symmetries

Much smaller loops began to become popular when shortwave was introduced in the public sector. Here, the Teslian principles could be used to best efficiency despite the Hertzian transmission of radiosignals. Coil and loop aerials could be large, such as those six foot diameter varieties which Tesla displayed in 1894, or as small as six inches in diameter. With shortwave, the compact spiral and indoor loop aerial made their second public debut. The efficiency of these aerials enabled a reasonably good signal reception indoors, performing remarkably well for their small dimensions. These units received signals with equivalent strength as longwire aerials, eliminating the necessity of such large outdoor structures. They offered strikingly good performance during times where static played havoc with longwire outdoor aerials.

Closer attention to this curious developmental series reveals that a breed of broadside loops was first developed, after which an astounding flat-faced loop aerial appeared. As transmitting aerials these devices exalted the electrostatic rays inherent in transmitters of the day. As receiving aerials, the eidetic

component was absorbed with great power.

On occasion, Vril threads have been observed descending from specific space points. These are often associated with whole space regions where star clustres seem especially vibrant. Descending Vril threads have a decidedly insensate nature, and have been erroneously called "white" rays by some who refer to their semi-visibility or semi-sensate nature. Both ascending and descending Vril threads pulsate and vary in their natural manifestations, obeying mysterious Vril ordinances.

Such mysterious discharges between ground and space, actually modified and empowered certain monopolar aerial systems. In their operation we see eidetic translations between otherworlds, the systems being suffused by eidetic Vril threads from stellar domains. In this, we sense an ancient theme. We recall the archane astromancers who received the descending eidetic space currents, and learned of other worlds.

Vril dynamically interacts with human artifice. This fact has been observed throughout the millenia. Grounded systems, (dolmens, stones, temples, cathedrals, or radionic systems) have forever behaved mysteriously for their human percipients. This topic became the focussed fascination of several legendary researchers (Kircher, Mesmer, Galvani, Reichenbach, White, Abrams, Hieronymous, Drown).

For those engaged with electrical systems, new and strange behaviors were making themselves known. Vril overtly engages and actively modifies the physical behavior of electrified magnetized devices. It was in this active encounter that inventors, developers, investigators, and operators alike beheld numerous objective phenomena which were each deemed "anomalous". Vril domain permeates and rules all grounded and communications systems. Despite the fact that they are empowered through electrical energies, these communications necessarily involve Vril, interactions of a most intriguing sort. The distinct shift in ground communications made itself apparent by the appearance of new aerial components in ground radio circuitry. A gradual elimination of double grounds showed the metamorphosis, aerials growing longer with time as designers were placing radiant emphasis on different electrostatic aspects. Nevertheless, the reasons why radioelectric signalling operates at all is not found in the electrical parameters on which designers focus attention.

While these objective anomalies attracted the attentions of those who dealt only with measurable energetic forces, recognition of the second variety of anomalies did not come a swiftly as those which baffled the engineers and designers. Time was required before sensitive operators and designers alike recognized the more "perceptual modifying" aspects, paranormal perceptions, associated

with grounded communications systems.

In the complex electrical communications systems, the active black radiant phenomena were modified and often masked. Only the most gifted observers were thus empowered to separate black radiant currents from the applied electrical energies. In nonpowered electrical systems which are grounded, Vril processions demonstrated remarkable behaviors. Certain sensitive empirical designers recognized the anomalous dynamics taking place in their systems. Empirical observation does not always grant complete accuracy of scientific assessments. Experimenters, confusing dielectric rays with Vril threads, believed that electrical impulse impelled signal radiation. But such improper associations are often compounded by uninitiated observers. The conjugate nature of certain energies, such as dielectricity, flows in the spaces which Vril occupied.

Although dielectricity effects powerful modifications of Vril threads, it does so through a process of irritation. In this manner, electrical impulses, not alternations, best produce greatly enlarged Vril reactivities. In such states, subsequent paranormal dynamics become evident. There are those who confuse conjugate natural dynamics with devices which are only accidentally able to function in other parameters. In this case, electrical systems engaged Vril energies quite directly. In truth, and in retrospect, one realizes that Vril guidances were constantly striving with those who insisted on using unnecessary electrical force. The

electrical components were an outgrowth of this Vril impressment on designers.

Radio-electric systems fortuitously arrange the antagonistic relationship of electrical inertia and Vril, producing dangerously empowered distant communications in the Vril Matrix. Powerfully attracting and focussing the consciousness of a few singular individuals, a renaissance in qualitative science began before the last Century's end. Abandoning radioelectric methods, these experimenters preferred a new nonelectric instrumentation of eidetic currents which became known as RADIONICS.

Each of these experimenters recognized the inherent hazard caused by forcing coils and other grounded components to absorb more than their natural capacity of Vril threads. Eliminating every irritating application, they defied reason and affirmed intuition. In so doing, these legendaries rediscovered the basic Vril principles which had almost been lost since their reemergence in the Mid-Nineteenth Century. Adding to these precious pieces of knowledge that which had been long forgotten through the centuries, these researchers were afforded an opportunity to develop technology which the scientific convention has never and can never equal.

Numerous radionists recognized that radiostations create such heavily inertialized states at the ground level that biovitality is reduced to dangerously depressed levels. Effectively eliminating the normal sensate eidetic currents which flood a district, radioelectric applications destroy the normal access to aerial Vril strata. Forced to dissolve these inertial conditions, Vril becomes continually enraged. Because of this radioelectric irritant, Vril shifts eidetic imagery to higher geometric pattern states while areas become devoid of immediate eidetic flow.

The aggressive and antagonistic interactions between Vril and inertial space produce various phenomena which have been observed and collated by scientific examiners for centuries. Those physical phenomena, the dynamics of moving bodies and of forces, are collectively termed "inertial" because they both exist and are active in a surficial plane of operation.

Though seeming to hold dominion in our experience through their overt and ponderant character, kinetics and the manifestations of forces have no root in the more fundamental world-reality of consciousness. Kinetics, the science of surficial inertial experiences, do not penetrate to the depth from which our consciousness emerges.

Mere sensory observation of the world, in absence of consciousness, does not constitute the deepest available tool for exploring the world. Without primary consciousness as the world-exploratory tool, no factual derivation can satisfactorily stand or comprise a "valid" science. The ancient philosophers who knew these simple truths relied on their minds before experimenting.

Vril is pre-electric, pre-particulate, pre-aetheric, radiant black space. It was empirically rediscovered that personal interceptions of Vril threads produced remarkable processions of live images. The rediscovery of eidetic earth connection evokes a flood of paranormal experience. Magnified image processions are experienced when special radionic instruments conduct Vril from the

ground. True eidetic communications devices are passive radionic

instruments, requiring no other energy than Vril itself.

Pattern communications systems require no electrical irritation, the eidetic energy alone supplying all the necessary communications power. Eidetic communications is an exchange of patterns. This exchange requires no power other than the flicker-procession of Vril itself. What one does require is an exceptional radionic instrument which, grounded and filtered, can separate and project each eidetic component with articulate clarity. CLARITY and PATTERN determine the efficiency of pure eidetic communications systems.

EIDETIC EXPERIENCES are the natural transmissions and receptions which form the mysterious dialogue among geopoints, equally mysterious foci. Eidetic experiences were noted in few professional journals because of their distinctively "occult" and "paranormal" implications, a poise which academes had firmly resolved to eradicate. Nevertheless, tales of true eidetic communions have been told and retold by those who plied their trade in telegraphy and telephony. These, deposited in old trade journals, were the object of ridicule in their day. When wireless operators began corroborating these accounts, a few researchers began to take notice.

There remain a few who preserve the truth of these paranormal incidents. The discovery of paranormal eidetic transactions in wireless stations, while not understood, were not completely dismissed. Not uncommon were the times when distant operators communicated in total accord, the one anticipating both the questions and answers of the other. Being "under the influence of the spark" was a common enough phrase to explain its own meaning.

Vril energies oppose and overwhelm pulsating electrical signals, producing a continuous Vril flux throughout impulsing systems which is eidetic. Vril opposition to electrical irritation manifests in electrical signals as anomalous and spurious undulations, static, and "noise". Vril generated electrical undulations do not themselves communicate their complete eidetic power to operators. The eidetic imagery of VLF systems continues flowing and overwhelming operators even when VLF generators are deactivated. This phenomena was noted by operators, especially during the night.

The self-charging of aerial structures was known to reach lethal potentials, evidence of the Vril accretion process in passive grounded systems. The eidetic flood which emerged through the aerial systems without power was a paranormal phenomenon often observed in the early wireless days. These items have been described in several lectures (Nichols). The aerial terminal enables connectivity between ground Vril and space discharge points. Such threadways, established instantly, produce surpassing effects in the double ground systems. These effects diminished completely when aerial systems replaced the double ground systems.

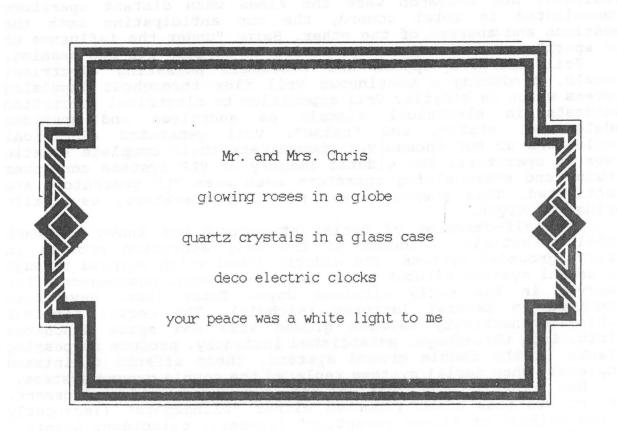
Now, eidetic communications required very specific placement. Distant stations often reported either "blindspots" (improperly placed points) or "freak reception" (properly coincident points). These latter phenomena resulted because district groundpoints act as Vril beacons. Double ground systems activated all such points

simultaneously, but the aerial-line systems shifted emphasis from the whole district to very specific points in the district. This is why certain latter systems required so much power in order to maintain radio contact, while others could communicate across thousands of optical miles without much power at all.

The Twentieth Century has been a strange episode, an epoch where mere investors and developers managed a broad array of wonderfilled patents into megalithic industries. Themselves not true discoverers, certain names stand out as obsessive moguls. Morgan, Sarnoff, Zworykin, Steinmetz: the commercializers of far deeper and yet unfathomed scientific wonders. Consistent with the general profile, such personalities managed the complete eradication of essential themes.

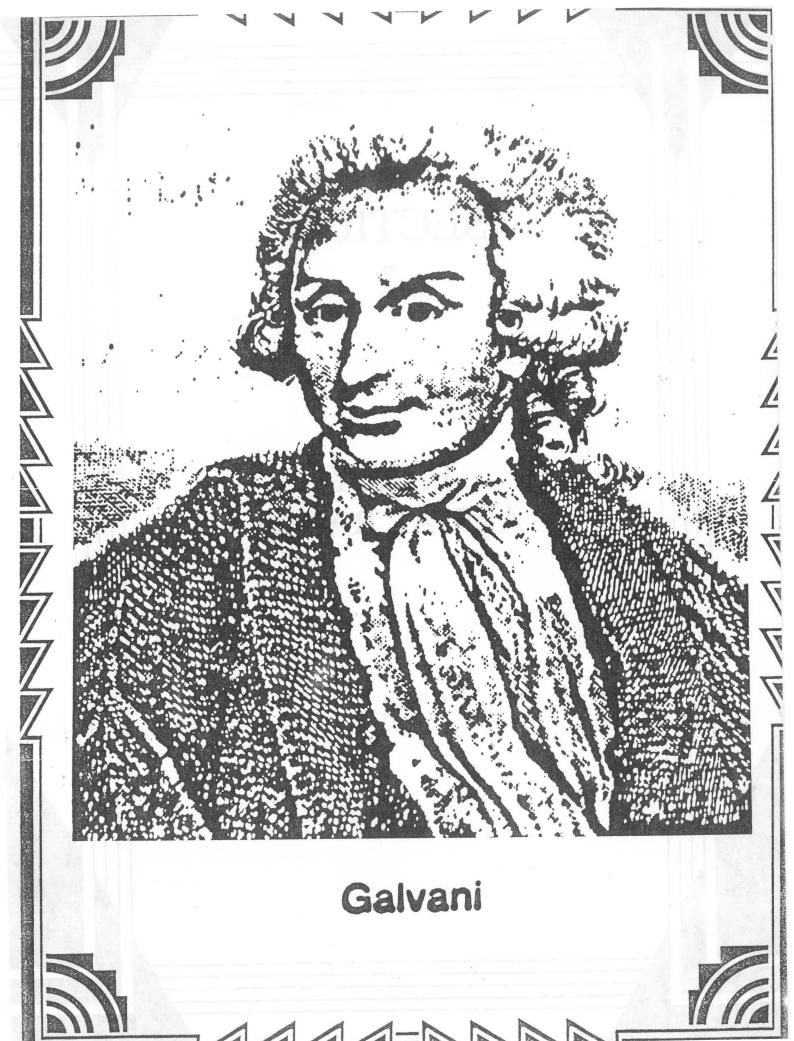
Purloined from inventions, whose originators they methodically eradicate, the consumable aspects of invention are commercially reduced for production. The inhuman assembly line hammers away the wonder. The ceaseless forge pounds out the mystery. The press bleaches out the glory.

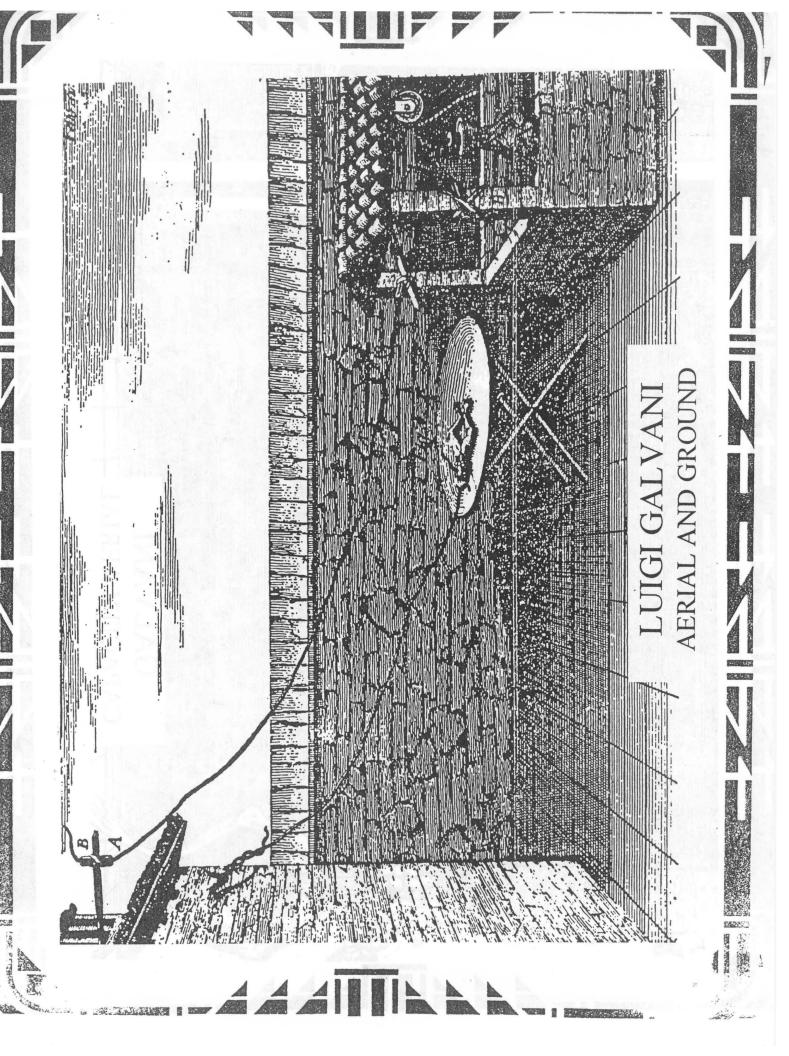
Radio is not now that glorious and vitalizing tool which Meucci and Stubblefield foresaw...that wonder which mystified children sense when huddled close to pocket crystal receivers. There, safely secure in the heart of winter, a sapphire space of cold winter nights pulses with the stars. The message of eternity.

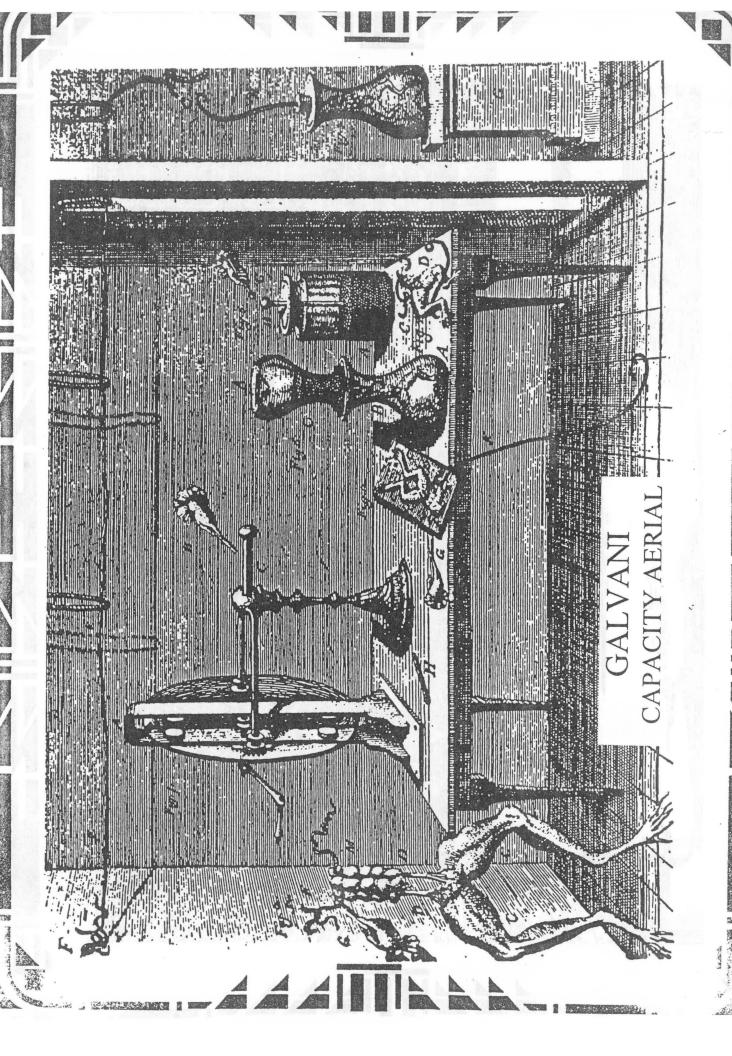


SECTION 2

EARLY AERIAL RADIO







THE EFFECTS OF ATMOSPHERIC ELECTRICITY ON MUSCULAR MOTION

Having discovered the effects of artificial electricity on muscular contractions which we have thus far explained, there was nothing we would sooner do than to investigate whether atmospheric electricity, as it is called, would afford the same phenomena, or not: whether, for example, by employing the same devices, the passage of lightning, as of sparks, would excite muscular contractions.

Therefore we erected, in the fresh air, in a lofty part of the house, a long and suitable conductor, namely an iron wire, and insulated it, Fig. 7, and to it, when a storm arose in the sky, attached by their nerves either prepared frogs, or prepared legs of warm animals, as in Fig. 20, 21, Tab. IV. Also we attached another conductor, namely another iron wire, to the feet of the same, and this as long as possible, that it might extend as far as the waters of the well indicated in the figure. Moreover, the thing went according to our desire, just as in artificial electricity; for as often as the lightning broke out, at the same moment of time all the muscles fell into violent and multiple contractions, so that, just as the splendor and flash of the lightning are wont, so the muscular motions and contractions of those animals preceded the thunders, and, as it were, warned of them; nay, indeed, so great was the concurrence of the phenomena that the contractions occurred both when no muscle conductor was also added, and when the nerve conductor was not insulated, nay it was even possible to observe them beyond hope and expectation when the conductor was placed on lower ground, Fig. 8, particularly if the lightnings either were very great, or burst from clouds nearer the place of experimentation, or if anyone held the iron wire F in his hands at the same time when the thunderbolts fell.

Moreover, the phenomenon occurred whether the animal was exposed in the fresh air, or, for the sake of convenience, had been enclosed in a suitable jar, as in Fig. 7, or kept within the room. It occurred also although the nerve-conductor was at some distance from the nerves themselves, particularly with lightnings either more violent or nearer, as we said occurred in artificial electricity when

the sparks were either stronger or extorted nearer the animal. Finally that worthy of notice occurred, that not merely by one contraction of muscles was the whole thing manifested in the lightning as in the spark, but by many, succeeding one another as it were in one mutual moment of time, of which the number of thunders seemed to correspond to the number which a thunderbolt is wont to produce.

Now, indeed, such contractions were produced not merely with lightning but in a stormy sky, with clouds passing over the almost removed conductors they arose for the most part spontaneously; and when this had happened, both the electrometers gave no slight signs of electricity, and not rarely sparks could be elicited from the conductors raised high in air, differently from when contractions were obtained with lightning-flashes; for then more often no sparks were elicited, and more delicate electrometers hardly aroused any

suspicion of electricity.

Now experiments of this kind were undertaken not only in dead but also in living animals, and in both the phenomenon appeared, and none of those things was omitted which we have discovered in artificial electricity, but all for the most part occurred in the same way. At first sight, indeed, it seemed that this considerable difference existed, that the prepared frogs which, with a suitable conductor, were enclosed in a little glass machine, Fig. 6, Tab. I, separated from the conductor of the electric machine by an interval, on the passage of the spark were violently disturbed, as we said, but, when lightning burst from the clouds, were wholly quiescent; perhaps either because, if any electricity were conveyed from the electric cloud to the little machine by means of the conductor, it was very slight, and occupied a very small part of its surface, so that it was not adequate for inducing contractions, or perhaps because none was carried to the same little machine; just as for the most part, for the same reason the same contractions are lacking on the passage of the spark, if the little machine is placed, not near the electric machine, but near that end of the electric conductor, EE Fig. 3, Tab. I, which is far distant from the same machine.

Upon diligent investigation of the circumstance, on this account, the manner of action appears similar between artificial and atmospheric electricity; perhaps for obtaining these contractions within the little glass machine, it is necessary that the electric atmosphere, either wholly or for the most part, should surround the same ma-

LUIGI GALVANI

chine; but, from what has hitherto been stated, it seems to be far removed from the position of the little machine and from the experiment.

But not merely the phenomenon having been explored, but its laws also having been subjected to examination, we have ascertained that the same are maintained in no dissimilar manner in atmos-

pheric, as are maintained in artificial, electricity.

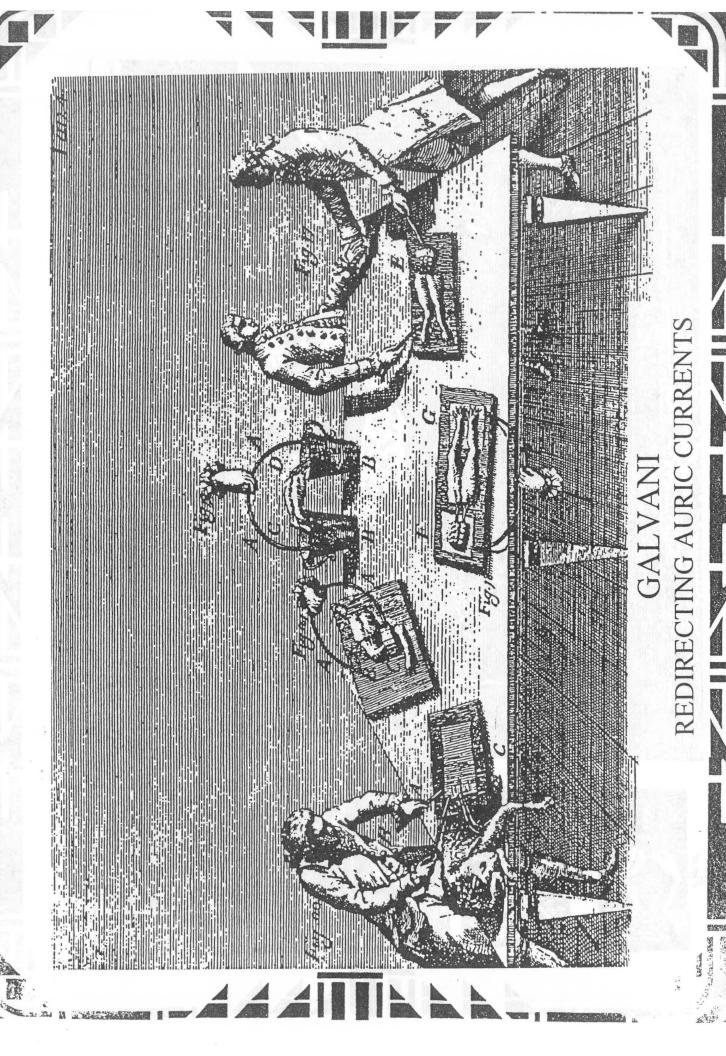
Now, indeed, the effects of storm electricity, as they say, having been investigated, not of thunder and lighting alone, it occurred to us also to test what sheet lightning and northern lights would produce in animals prepared in the customary way. Therefore we adapted our animals to an atmospheric conductor not only during lightning but during northern lights. But no contractions were ever then produced, perhaps because either such coruscations do not depend on electricity or, if they do, either in too remote a place, or they occur for some very different reason than thunderbolts. But these are questions for the physicists.

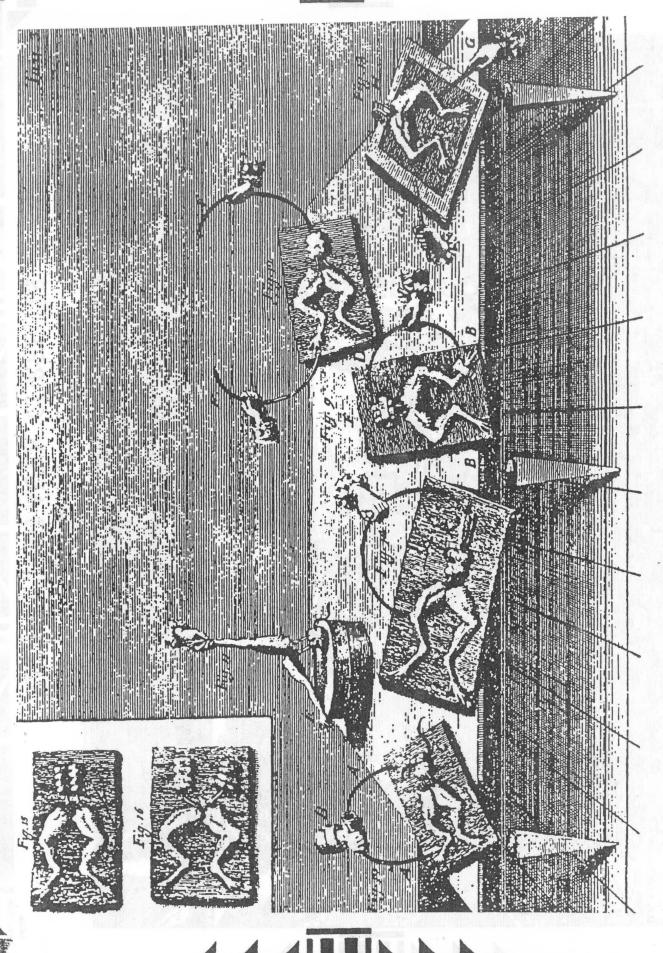
From these observations it was clear to us that there is required not only the application of a conducting body to the nerves, but also a certain magnitude and extension thereof, for the production of the phenomenon. Hereafter, for the sake of perspicuity, not of brevity, let us be permitted to call such a conductor a nerve-conductor.

Moreover, we attached to the extremity of this conductor a frog by means of a small hook fixed into its spinal cord, Fig. 2, and sometimes placed the frog opposite the machine, sometimes placed its conductor so that the frog was now near the machine, now far distant from it, and therefore now the feet, now the prepared nerves, were turned towards the machine, which had the conductor now before now behind it; nevertheless contractions were always obtained equally.

We investigated moreover whether the phenomenon would be obtained in prepared animals, from a machine situated far distant, and this employing very long nerve-conductors. Moreover, the trial was so conducted that when an iron wire, 150 feet long and more, was employed, nevertheless, when a spark was produced, contractions of the muscles occurred, even at so great a distance from the machine.

We arranged an experiment in this way. We suspended an iron wire, EEE, Fig. 3, by a series of silk threads and, as the physicists say, insulated it. One end we attached similarly by silk threads to a nail driven in the wall, F; the other we conducted far from the machine the length of the wire into various other rooms. To this, at point C, we attached another iron wire, B, to whose extremity a frog was attached; and for convenience enclosed the frog in a glass jar, A, the bottom of which was filled with some conducting material, like water, for example, or very fine lead shot, whereby a better experiment resulted. But when a spark was produced from the conductor of the machine, surprisingly the headless frog moved at so great a distance and jumped vigorously about. The same thing happened if a frog outside the glass jar was attached in the same way to conductor EE, and far more quickly if there were attached to its feet some conducting body which communicated with the earth.





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LETTERS OF CARMINATI AND GALVANI

Signor Volta concluded that the deficiency of electric fluid exists on the part of the nerves, not the excess, as you had believed you could advance on other conjectures. Therefore, our distinguished Signor Volta wishes the contrary of your opinion, which is not yet held as a settled thing, because based on experiments of the utmost delicacy, made by him in number, but not yet repeated as much as he would wish.

Meantime, while the above celebrated physicist attends to these experiments on frogs, that they may be perfectly reasonable and easy to perform, let not others among us cease to experiment on other animals, including warm-blooded; and already are verified the tests made by yourself on birds and quadrupeds. Those of my own Institute are now proposing some experiments, which can be of very useful application to medicine, on the action of poisons and of drugs,

especially of those which are called medicinal and heroic.

To do these experiments I have already made suitable arrangements with Signor Volta; and so, after having conferred with him about it, I have already performed a trial of experiments directed to determine the action of opium, of camphor, of musk, of snakevenom, of cherry laurel, of bitter almond, and others, with regard to exalting and abating animal electricity, applying these materials now to nerves and now to muscles, now in substance, and now by means of infusion, holding the animal for some time immersed, either intact or deprived of some parts. Within a short time I shall perhaps be in position to communicate to you the principal results of these, my researches.

We purpose still to investigate what may be the electric action of nerves on other parts than the muscles, that is on membranes and on vessels; and in what manner it modifies the circulation of fluids, the secretions, and other things; if indeed in this we have not been already forestalled by you, as supposes our most esteemed friend, Don Mariano Fontana, who esteems you as much as I, who do not allow myself to be surpassed by anyone in the honor of being, with the most distinguished consideration and greatest respect, yours.

Pavia. 3 April, 1792.

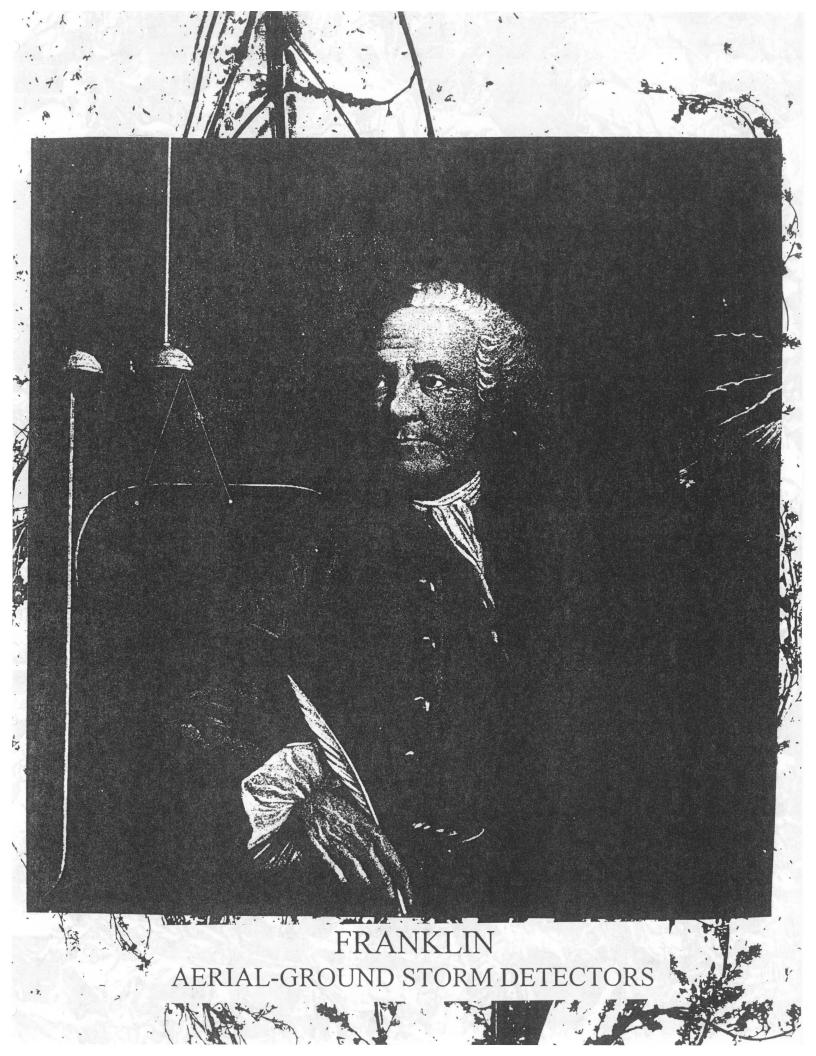
Letter from Doctor Luigi Galvani to Professor Don Bassano Carminati

I have finally written out, in some manner, amid the scarcity of time in which I live daily, the few considerations pertaining to the experiments of the illustrious Signor Volta which I promised you in my latest. I beg you to submit them to the sagacious discernment of so illustrious a philosopher, to whom I entrust them and on whose judgment will depend principally their fate. They are expressed roughly and in confusion; in such a manner, that is, as the brevity of time and my scanty ability have permitted. But whereas he believed them not entirely useless, you can embellish them with the elegance of your style; therefore I consecrate them wholly to you.

The learned author, then, as you advise me, has measured the quantity of artificial electricity which, in a frog prepared and armatured in the manner proposed by me, suffices to produce muscular contractions, and has found this to be the tenth part of a degree of what is necessary to render it sensible to the most delicate electrometer, and thence he draws two beautiful conclusions: one is that the frog prepared in a similar way is an electrometer ten times more sensitive and delicate than any yet invented, and even than his own most delicate ones; the other is that a similar minute quantity of animal electricity will suffice to produce natural and spontaneous movements in the aforesaid animal; thence there comes by legitimate deduction the prodigious force which extrinsic electricity must have, whether it be terrestrial or atmospheric, in animals and thence in man, and therefore he had not yet sufficiently learned what and how great changes occurred to infer this either in one or in the other.

In short, in a very brief time he has shed no little light on the most interesting point of the influence of terrestrial and atmospheric electricity on our actions, and on the alterations and diseases which frequently afflict us; and in other animals he has no little encouraged the doctors to continue the use of artificial electricity, making them hope, with every reason, no small advantage.

He has made other beautiful experiments concerning the seat of the excess and of the deficiency of this animal electricity, referred to muscles and to nerves.







ON A NEW CONNECTION FOR THE INDUCTION COIL.

By Prof. Edwin J. Houston, in the Journal of the Franklin Institute.

The following experiments were made at the Central High School of Philadelphia, with a view of increasing the quantity of the spark of the induction coil without greatly diminishing its length. The instrument used was made by Ritchie, of Boston, and will throw the spark six inches in free air.

One of the poles or ends of the secondary wire was connected with the earth by a copper wire, attached to a gas pipe. The other pole was connected with a wire, which rested on a large lecture table holding the coil. On turning the break piece, the electricity, instead of being lost by passing along the wires to the earth, jumped from the pole connected with the table to that connected with the earth. The thickness of the spark was greatly increased, its length diminished, and its color changed to a silvery white, as when a Leyden jar is placed in the path of the discharge,

While the electricity is flowing between the points, long sparks may be drawn from any part of the table, or from any metallic article within eight or mine feet of the coil. On one occasion, the gas was lighted by a spark drawn from the finger of a person standing on the door. The gas pipe being in almost perfect connection with the earth, the spark must have been given to it from the body of the person.

On another occasion, one wire was attached to the gas pipe, as before, and the other to a stove, whose pipe connects with that of another stove in an adjoining room. The thickness of the spark was greatly increased. Sparks were drawn from the distant stove, and even from a small steam engine, which latter was fully thirty feet from the coil. In all the experiments it was found necessary to insulate the handle of the break piece as a slight shock was experienced at every break. The pyles being kept at a distance from each other less than the insulating power of the coil, six inches, no danger of injuring the instrument was apprehended. In one instance sparks were drawn, in a room underneath the adjoining room, from a wire which connected with the table on which the coil rested.

These facts showing great loss of the electricity, but indicating the need for a large conductor, probably to allow the rapid discharge of the secondary wire, a large insulated conductor was extemporized, by placing some old tin stills and percolators on large glass jars. On connecting one of the poles with this conductor, and the other with the gas pipe, the quantity of the spark was increased, though there was reason to believe that, with a larger conductor, better results would have been obtained. The conductor was then divided into two, of about equal size, which were connected with the poles. The quantity of the spark was increased, with, however, great diminution in the length. By successively diminishing the size of one of the conductors, and increasing that of the other, the length of the spark was increased, without any sensible diminution in its quantity, until, when one of the conductors was less than one square foot in surface, a fine quantity spark of about five inches was obtained.

It will be noticed that this connection is somewhat similar to that used in the common cylinder or plate machine, in which one of the conductors, generally the negative, is connected with the earth, and the quantity of the electricity thereby increased.

In all the experiments in which one pole was in partial connection with the earth, as when it rested on the table, the loss of electricity must have been very great, for several gas and water pipes were in connection with the table. If, then, the table merely serves as an imperfectly insulated conductor, which allows the rapid induction of electricity in the secondary wire by its rapid discharge, and thereby, notwithstanding the loss, gives so great an increase in the quantity of the spark, it would seem that if, instead of the table, an insulated conductor of very large surface were used, a much greater increase in quantity would be obtained.

It would seem from the above experiments, that the maximum increase will be obtained when one of the poles is connected with an insulated conductor, say several hundred square feet in surface, and the other with the earth.



Electrical Engineer.

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CURIOUS EFFECTS OF HERTZIAN WAVES.

BY

Shhu Thoman-



N the issue of the London Electrician of June 8, 1894, under the heading, "Hertzian Waves at the Royal Institution," the following remark occurs: "It is wholly probable, as Dr. Lodge suggests, that Hertzian waves may often have

manifested themselves in physical laboratories to the annoyance of the workers, etc."

I may mention in this connection that in 1877, if I remember the year correctly, while working a Ruhmkorff induction coil, one terminal of which was grounded and the other terminal of which was attached to an insulated metallic body, Prof. Houston and I noticed that when the sparks were passing between the terminals of the coil, it was possible not only to obtain minute sparks from all metallic bodies in the immediate neighborhood, that is, in the same room, but that delicate sparks could be taken by holding in the hand a small piece of metal near metallic objects in many other rooms and on different floors in the building, although the pieces were not connected to ground. These could only have been Hertzian effects, but there was no recognition of their true character at the time, though the effects were seen to be connected with the very quick charging and discharging of the insulated body. An account of these experiments was, I think, published in the Journal of the Franklin Institute at the time.

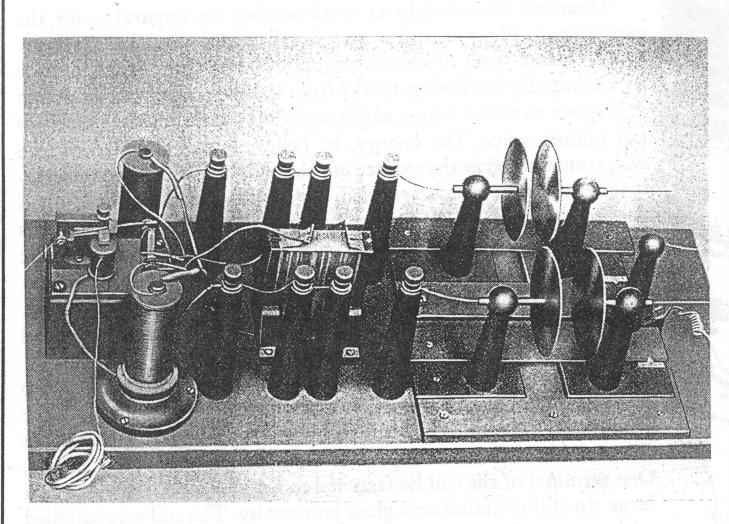
I desire also to mention, as coming under my notice within the past year, a curious and rather amusing illustration of the principle upon which the beautiful instrument for detecting the presence of electric oscillations devised by Dr. Lodge and called by him the "coherer," is based. It was reported to me when in Philadelphia that a cer-

tain electro-plater had found that he could not pursue his silver plating operations during thunder-storms, and that if he left his plating over night and a thunder-storm came up the work was invariably ruined. I was disposed to be thoroughly skeptical, and expressed my disbelief in any such effect. Being urged, however, I went to the silver plater's shop, which was a small one, and questioned the silver plater himself concerning the circumstance which had been reported. While it was evident that he was not a man who had informed himself electrically, I could not doubt that, after conversing with him, he had indeed been stating what was perfectly true; namely, that when his operations of plating were going on and a thunder storm arose, his batteries, which were Smee cells, acted as though they were short-circuited, and the deposit of metal was made at too rapid a rate. The secret came out on an inspection of his connections. The connections of his batteries to his baths were made through a number of bad contacts which could not fail to be of high resistance under ordinary conditions. I could readily see that virtually he was working through a considerable resistance and that he had an excess of battery power for the work. Under these circumstances a flash of lightning would cause coherence of his badly contacting surfaces, and would improve the conductivity so as to cause an excessive flow of current,

give a too rapid deposit, and—as he put it—"make the batteries boil."

The incident suggests the use of Dr. Lodge's ingenious instrument in the study of the waves which are propagated during thunderstorms, of which waves we have practically little or no information.





Model of the historic tuned-circuit apparatus Thomson used to disprove the Edison "etheric force" argument — 1876

Thomson was already at work setting up apparatus for the experiment. He was quite certain that the so-called "etheric force" was a train of electromagnetic waves sent through space by the rapidly oscillating sparks from the induction coil, an action analogous to sound waves set in motion by the vibrating cords of the human voice. The energy, he believed, was supplied by the coil, transformed at the surface of the condenser plates into electromagnetic waves which traveled out in all directions, and, upon passing through a "receiver" composed of metallic objects almost touching, transformed back again into minute electric sparks. If he was right, the experiments would be valuable laboratory proof of Maxwell's theory, so far existing only on paper. Thomson was, in fact, after bigger game than Edison. He hoped to make a basic contribution to physical science. Edwin Houston lent little to the occasion except the table top in his ground-floor classroom, where Thomson had set up a large Ruhmkorff induction coil. But Elihu was too sure of his procedure to need his superior's help. The connections were very simple. One terminal of the coil he fastened to a water pipe, the other to a

the classical setup for a transmitter of wireless signals.

For a receiver Thomson rigged up a black box, open at one side and provided with two graphite pencil points nearly touching within. One of the pencils carried a large brass knob outside to

large tin still mounted on a glass jar near by. The coil was supplied with current from a powerful battery of bichromate cells under

the table. Any modern schoolboy will recognize that he had made

absorb more of the waves. Again, the rudimentary radio receiver. From our twentieth century knowledge of electrophysics it seems certain that Elihu Thomson, with the basic apparatus in his hands, must have gone on to discover the whole great principle of wireless signaling forthwith. But he did not. For the second time in four years he missed the practical implications fairly staring him in the face and stuck to his theoretical investigation.

Thomson, the pure scientist, was to the fore that day. He was only the first of that long line of laboratory men—Hertz, Crookes, Helmholtz, Lodge and many more—who must complete their work before the youthful Marconi would see the enormous practical value of electromagnetic telegraphy and at last make it work.

A great invention is a notorious insult to the men who make it. Though a thousand minds labor, it refuses to be born till it pleases and then it turns to mock them all for their stupidity.

No doubt if some prophetic person had told Thomson just then that he had the secret of a priceless system of communication in his grasp, he would have been unmoved. All that he wanted to do was to refute Edison's idea of an "etheric force" and establish experimental proof of Maxwell's waves. Turning on the Ruhmkorff coil and setting the gap to give the brightest and fattest sparks, he began a systematic search for the electromagnetic waves he hoped to find. Everywhere in Houston's classroom sparks flashed brilliantly in the black box. Thomson took it into the next room; the sparks were just as strong. Down cellar they were as good, even to the farthest corner. He found that it was unnecessary to use the box at all. There was runaway energy enough to produce the sparks by holding a sharp pencil against the brass knobs of the doors.

Elihu hurried from room to room, trying every metallic object that was insulated from ground. On the second floor he got the same results, and on the third. Finally climbing five flights of stairs to the observatory on the roof he made the pencil test again and found the wave energy still abundant.

Astronomy Professor Snyder, working quietly in his observatory, was considerably surprised when his visitor burst in. But as the young chemistry instructor panted out an explanation of his experiment Snyder dropped what he was doing and took a decided interest. With growing attention he watched as Thomson drew sparks, first from the doorknob, then from the eyepiece of the telescope, and finally even from a group of small metallic objects in a glass case.

Thomson invited him to try the pencil for himself. Snyder did so, growing more excited every minute. At a time like this the most sedate scientist acts like a child with a shiny new toy. The professor of astronomy knew Maxwell's work well—knew too that he had predicted the passage of electromagnetic waves through space or "ether" between the atoms of all known substances. This was certainly the proof. The spark coil was operating 90 feet below them, and the energy was coming up through five floors loaded with mortar and bricks and heavy beams.

They moved along the hallway to the door of the library, which had a particularly splendid brass knob. Here the sparks were so intense as almost to be audible. Thomson stopped suddenly and grinned inquiringly at Snyder. The older man nodded. "There's no doubt about it," he said. "Electric energy transmitted through space!"

But science is never spectacular all the time. Other very different tests were necessary. If the sparks really were generated by electromagnetic waves instead of by some unexplained "etheric force," they would be absent when the waves were absent, even though the induction coil was still in operation. Thomson devised an ingenious apparatus to suppress the waves without stopping the coil. It consisted of two "resonators" or tuned circuits, each sending out a wave of its own. The two could be adjusted so that their waves would add up and go out together, or so that they would oppose and neutralize each other.

This principle of "interference" was a very old one in the field of light waves, having been discovered centuries before by Newton. Elihu Thomson reasoned that if Maxwell were right in saying that light and electromagnetic waves were of the same nature, then the interference principle should work now.

He was delighted to find that it did work. The two resonators could be adjusted "in phase" to send out powerful waves, giving their sparks all over the building. Or they could be set in opposition, so that no waves went out at all, and consequently no sparks appeared.

Electrical Engineer.

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ON THE DISSIPATION OF THE ELECTRICAL EN-ERGY OF THE HERTZ RESONATOR.



NYONE who, like myself, has had the pleasure of witnessing the beautiful demonstrations with vibrating diaphragms which Prof. Bjerknes, exhibited in person at the Paris Exposition in 1889, must have admired his ability and

painstaking care to such a degree, as to have an almost implicit faith in the correctness of observations made by him. His experiments "On the Dissipation of the Electrical Energy of the Hertz Resonator," which are described in the issue of Dec. 14, of THE ELECTRICAL ENGINEER, are prepared in the same ingenious and skillful manner, and the conclusions drawn from them are all the more interesting as they agree with the theories put forth by the most advanced thinkers. There can not be the slighest doubt as to the truth of these conclusions, yet the statements which follow may serve to explain in part the results arrived at in a different manner; and with this object in view I venture to call attention to a condition with which, in investigations such as those of Prof. Bjerknes, the experimenter is confronted.

The apparatus, oscillator and resonator, being immersed in air, or other discontinuous medium, there occurs—as I have pointed out in the description of my recent experiments before the English and French scientific societiesdissipation of energy by what I think might be appropriately called electric sound waves or sound-waves of electrified air. In Prof. Bjerknes's experiments principally this dissipation in the resonator need be considered, though the sound-waves-if this term be permitted-which emanate from the surfaces at the oscillator may considerably affect the observations made at some distance from the latter. Owing to this dissipation the period of vibration of an air-condenser can not be accurately determined, and I have already drawn attention to this important fact.

These waves are propagated at right angles from the charged surfaces when their charges are alternated, and dissipation occurs, even if the surfaces are covered with thick and excellent insulation. Assuming that the "charge" imparted to a molecule or atom either by direct contact or inductively is proportionate to the electric density of the surface, the dissipation should be proportionate to the square of the density and to the number of waves per second. The above assumption, it should be stated, does not agree with some observations from which it appears that an atom can not take but a certain maximum charge; hence, the charge imparted may be practically independent of the density of the surface, but this is immaterial for the present consideration. This and other points will be decided when accurate quantitative determinations, which are as yet wanting, shall be made. At present it appears certain from experiments with high-frequency currents, that this dissipation of energy from a wire, for instance, is not very far from being proportionate to the frequency of the alternations, and increases very rapidly when the diameter of the wire is made exceedingly small. On the latter point the recently published results of Prof. Ayrton and H. Kilgour on "The Thermal Emissivity of Thin Wires in Air" throw a curious light. Exceedingly thin wires are capable of dissipating a comparatively very great amount of energy by the agitation of the surrounding air, when they are connected to a source of rapidly alternating potential. So in the experiment cited, a thin hot wire is found to be capable of emitting an extraordinarily great amount of heat, especially at elevated temperatures. In the case of a hot wire it must of course be assumed that the increased emissivity is due to the more rapid convection and not, to any appreciable degree, to an increased radiation. Were the latter demonstrated, it would show that a wire, made hot by the application of heat in ordinary ways, behaves in some respects like one, the charge of which is rapidly alternated, the dissipation of energy per unit of surface kept at a certain temperature depending on the curvature of the surface. I do not recall any record of experiments intended to demonstrate this, yet this effect, though probably very small, should certainly be looked for.

A number of observations showing the peculiarity of very thin wires were made in the course of my experiments. I noted, for instance, that in the well-known Crookes instrument the mica vanes are repelled with comparatively greater force when the incandescent platinum wire is exceedingly thin. This observation enabled me to produce the spin of such vanes mounted in a vacuum tube when the latter was placed in an alternating electrostatic field. This however does not prove anything in regard to radiation, as in a highly exhausted vessel the phenomena are principally due to molecular bombardment or con-

vection.

When I first undertook to produce the incandescence of a wire enclosed in a bulb, by connecting it to only, one of the terminals of a high tension transformer, I could not succeed for a long time. On one occasion I had mounted in a bulb a thin platinum wire, but my apparatus was not adequate to produce the incandescence. I made other bulbs, reducing the length of the wire to a small fraction; still I did not succeed. It then occurred to me that it would be desirable to have the surface of the wire as large as possible, yet the bulk small, and I provided a bulb with an exceedingly thin wire of a bulk about equal to that of the short but much thicker wire. On turning the current on the bulb the wire was instantly fused. A series of subsequent experiments showed, that when the diameter of the wire was exceedingly small, considerably more energy would be dissipated per unit surface at all dégrees of exhaustion than was to be expected, even on the assumption that the energy given off was in proportion to the square of the electric density. There is likewise evidence which, though not possessing the certainty of an accurate quantitative determination, is nevertheless reliable because it is the result of a great many observations, namely, that with the increase of the density the dissipation is more rapid for thin than for thick wires.

The effects noted in exhausted vessels with high-frequency currents are merely diminished in degree when the | air is at ordinary pressure, but heating and dissipation occurs, as I have demonstrated, under the ordinary atmospheric conditions. Two very thin wires attached to the

terminals of a high-frequency coil are capable of giving off an appreciable amount of energy. When the density is very great, the temperature of the wires may be perceptibly raised, and in such case probably the greater portion of the energy which is dissipated owing to the presence of a discontinuous, medium is transformed into heat at the surface or in close proximity to the wires. Such heating could not occur in a medium possessing either of the two qualities, namely, perfect incompressibility or perfect elasticity. In fluid insulators, such as oils, though they are far from being perfectly incompressible or elastic to electric displacement, the heating is much smaller because of the continuity of the fluid.

When the electric density of the wire surfaces is small, there is no appreciable local heating, nevertheless energy is dissipated in air by waves, which differ from ordinary sound-waves only because the air is electrified. These waves are especially conspicuous when the discharges of a powerful battery are directed through a short and thick metal bar, the number of discharges per second being very small. The experimenter may feel the impact of the air at distances of six feet or more from the bar, especially if he takes the precaution to sprinkle the face or hands with ether. These waves cannot be entirely stopped by the interposition of an insulated metal plate.

Most of the striking phenomena of mechanical displacement, sound, heat and light which have been observed, imply the presence of a medium of a gaseous structure, that is, one consisting of independent carriers capable of free motion.

When a glass plate is placed near a condenser the charge of which is alternated, the plate emits a sound. This sound is due to the rythmical impact of the air against the plate. I have also found that the ringing of a condenser, first noted by Sir William Thomson, is due to the presence of the air between or near the charged surfaces.

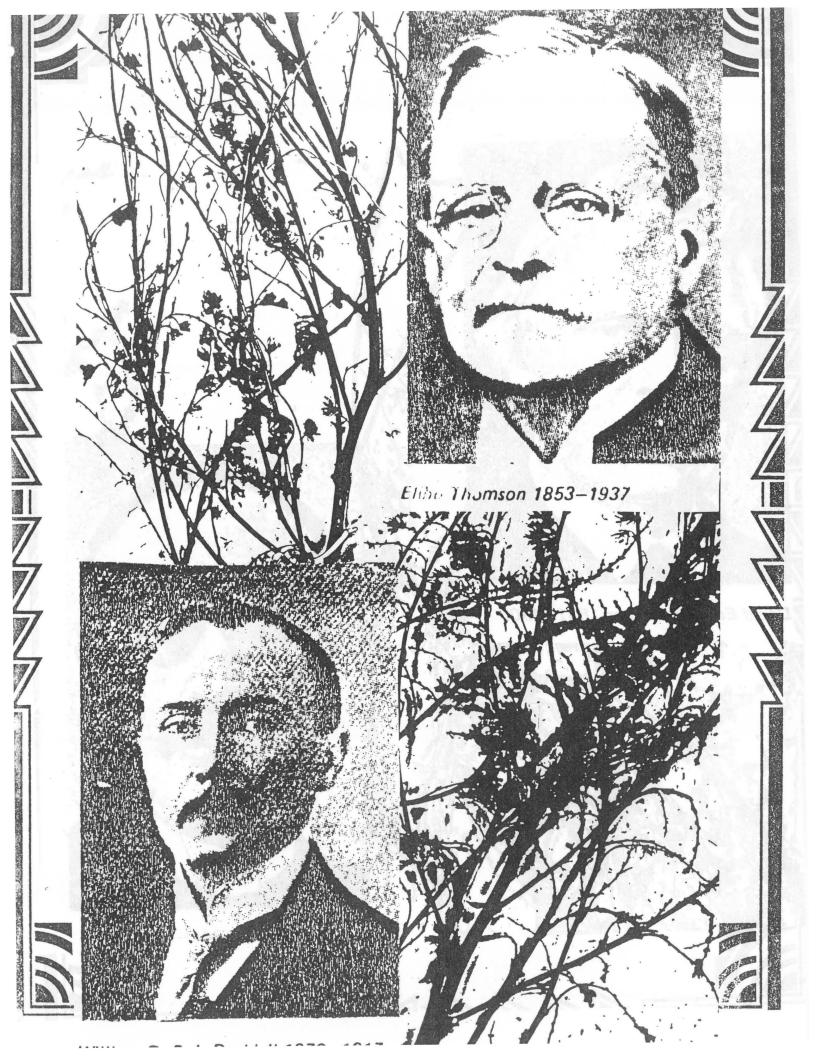
When a disruptive discharge coil is immersed in oil contained in a tank, it is observed that the surface of the oil is agitated. This may be thought to be due to the displacements produced in the oil by the changing stresses, but such is not the case. It is the air above the oil which is agitated and causes the motion of the latter; the oil itself would remain at rest. The displacements produced in it by changing electrostatic stresses are insignificant; to such stresses it may be said to be compressible to but a very small degree. The action of the air is shown in a curious manner for if a pointed metal bar is taken in the hand and held with the point close to the oil, a hole two inches deep is formed in the oil by the molecules of the air, which are violently projected from the point.

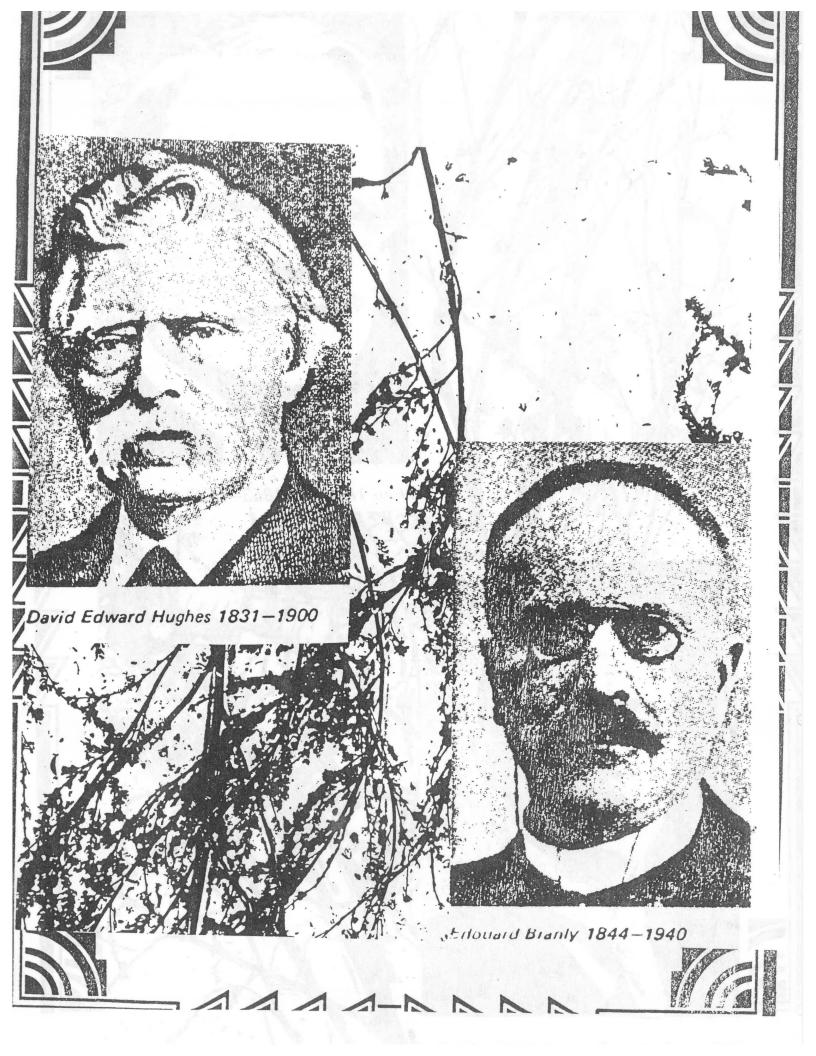
The preceding statements may have a general bearing upon investigations in which currents of high frequency and potential are made use of, but they also have a more direct bearing upon the experiments of Prof. Bjerknes which are here considered, namely, the "skin effect," is increased by the action of the air. Imagine a wire immersed in a medium, the conductivity of which would be some function of the frequency and potential difference but such, that the conductivity increases when either or both of these elements are increased. In such a medium, the higher the frequency and potential difference, the greater will be the current which will find its way through the surrounding medium, and the smaller the part which will pass through the central portion of the wire. In the case of a wire immersed in air and traversed by a high-frequency current, the facility with which the energy is dissipated may be considered as the equivalent of the conductivity; and the analogy would be quite complete, were it not that besides the air another medium is present, the total dissipation being merely modified by the presence of the air to an extent as yet not ascertained. Nevertheless, I have sufficient evidence to draw the conclusion, that the results obtained by Prof. Bjerknes are affected by the presence of air in the following manner: 1. The dissipation of energy

is more rapid when the resonator is immersed in air than it would be in a practically continuous medium, for instance, oil. '2. The dissipation owing to the presence of air ren. ders the difference between magnetic and non-magnetic metals more striking. The first conclusion follows directly from the preceding remarks; the second follows from the two facts that the resonator receives always the same amount of energy, independent of the nature of the metal, and that the magnetism of the metal increases the impedance of the circuit. A resonator of magnetic metal behaves virtually as though its circuit were longer. There is-a greater potential difference set up per unit of length, although this may not show itself in the deflection of the electrometer owing to the lateral dissipation. The effect of the increased impedance is strikingly illustrated in the two experiments of Prof. Bjerknes when copper is deposited upon an iron wire, and next iron upon a copper wire. Considerable thickness of copper deposit was required in the former experiment, but very little thickness of iron in the latter, as should be expected.

Taking the above views, I believe, that in the experiments of Prof. Bjerknes which lead him to undoubtedly correct conclusions, the air is a factor fully as important, if not more so, than the resistance of the metals.





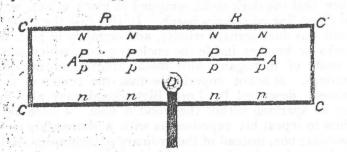


ON THE GENERATION OF LONGITUDINAL WAVES IN ETHER.1

In a short note published in NATURE of February 6, I suggested an arrangement of four insulated and electrified spherical conductors with their centres in one line, giving rise to ethereal waves in the surrounding atmosphere, of which the disturbance in the line of centres is essentially longitudinal. But at any finite distance from this line there must also be laminar or distortional waves of the kind expressed in Maxwell's equations. The object of my present communication is to show an arrangement by which a large space of air is traversed by pressural disturbance, or by waves essentially longitudinal, or by condensational-rarefactional vibrations; with but a very small proportion, practically evanescent, of laminar waves.

Let AA be a plane circular metal plate insulated within a metal case ccc'c', as indicated in the drawing. Let D be a discharger which can be pushed in so as to make contact with A. Let A be charged to begin with, positively for instance as indi-

cated by the letters PPpp; NNnn showing negative electricity



induced by it. Let now the discharger be pushed in till a spark passes. The result, as regards the space between AA and the roof RR over it, will be either an instantaneous transmission of commencement of diminution of electrostatic force, or a set of electric waves of almost purely longitudinal displacement, according as ether is incompressible or compressible.

Hence, if the theory of longitudinal waves, suggested by Röntgen as the explanation of his discovery (for the consideration of which he has given strong reasons), be true, it would seem probable that a sensitive photographic plate in the space between AA and RR should be acted on, as sensitive plates are, by Röntgen rays. Either a Wimshurst electrical machine or an induction coil, adapted to keep incessantly charging AA with great rapidity so as to cause an exceedingly rapid succession of sparks between D and A, might give a practical result. In trying for it, the light of the sparks at D must be carefully screened to prevent general illumination of the interior of the case and ordinary photographic action on the sensitive plate.

The arrangement may be varied by making the roof of sheet aluminium, perhaps about a millimetre thick, and placing the sensitive photographic plate, or phosphorescent substance, on the outside of this roof, or in any convenient position above it. When a photographic plate is used there must, of course, because outer cover of metal or of wood, to shut out all ordinary light from above. This arrangement will allow the spark gap at D to be made wider and wider, until in preference the sparks pass between AA and the aluminium roof above it. The transparency of the aluminium for Röntgen light will allow the photographic plate to be marked, if enough of this kind of light is produced in the space between the roof and AA, whether with or without sparks.

1 A paper by Lord Kelvin, read before the Royal Society on February 13

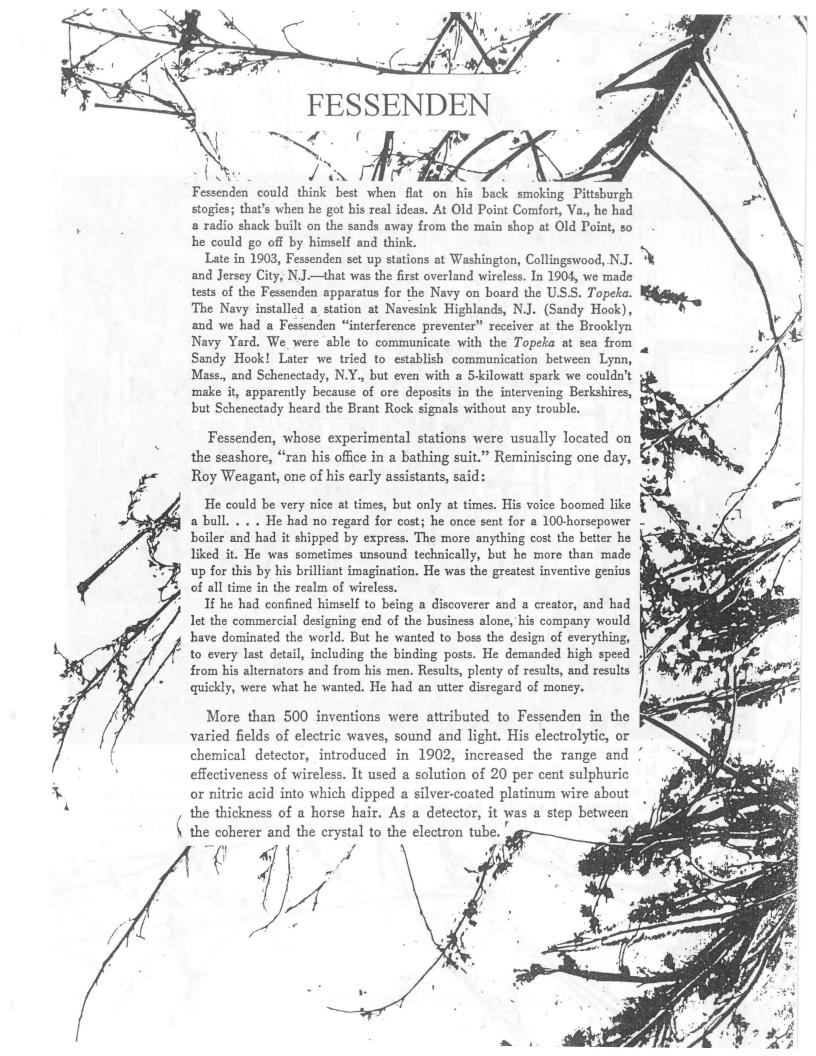
The new photography has hitherto, so far as generally known, been performed only by light obtained from electric action in vacuum; but that vacuum is not essential for the generation of the Röntgen light might seem to be demonstrated by an experiment by Lord Blythswood, which he described at a meeting of the Glasgow Philosophical Society on Wednesday, February 5. As a result he exhibited a glass photographic dry plate with splendidly clear marking which had been produced on it when placed inside its dark slide, wrapped round many times in black velvet cloth, and held in front of the space between the main electrodes of his powerful Wimshurst electrical machine, but not in the direct line of the discharge. He also exhibited photographic results obtained from the same arrangement with only the difference that the dark slide, wrapped in black velvet, was held in the direct line of the discharge. In this case the photographic result was due, perhaps wholly, and certainly in part, to electric sparks or brushes inside the enclosing box, which was, as usual, made of mahogany with metal hinges and interior metal mountings. It is not improbable that the results of the first experiment described by Lord Blythswood may also be wholly due to sparking within the wooden case. I have suggested to him to repeat his experiments with a thoroughly well closed aluminium box, instead of the ordinary photographic dark slide which he used, and without any black cloth wrapped round outside. The complete metallic enclosure will be a perfect guarantee against any sparks or brushes inside.

If the arrangement which I now suggest, with no sparks or brushes between AA and the roof, gives a satisfactory photographic result, or if it shows a visible glow on phosphorescent material placed anywhere in the space between AA and the roof above it, or above the aluminium roof, it would prove the truth of Röntgen's hypothesis. But failure to obtain any such results would not disprove this hypothesis. The electric action, even with the place of the spark so close to the field of the action sought for as it is at D, in the suggested arrangement, may not be sudden enough or violent enough to produce enough of longitudinal waves, or of condensational-rarefactional vibrations, to act sensibly on a photographic plate, or to produce a physical

glow on a phosphorescent substance.

MARCII 12, 1896]











WIRELESS TELEGRAPHY.

By REGINALD A. FESSENDEN.

VERY little is known in Europe of the scientific work done in America, and consequently there is a good deal of repetition to the mutual disadvantage of workers on both sides of the Atlantic.

It may, therefore, be of interest if I give a brief description of some of the work done by me relative to the determination of laws governing the propagation of wireless disturtances, together with a little new matter which has not heretofore been published.

WAVE MEASUREMENT.

A large number of receivers for electric waves were tested in the years 1896 and 1897, and a number of new ones invented.

In connection with receivers, some sensitive indicating instruments were also designed, one of these being the string galvanometer which was constructed for me, according to my designs, by Mr. John A. Brashear, the optical instrument maker, in 1896. This proved a quite satisfactory instrument, and has since come into use under the name of the Einthoven string galvanometer.

The earlier forms of receivers were abandoned in favour of the instrument which I have described elsewhere, consisting of a Boys' radio-micrometer having its thermo coupling heated by radiation from a heating coil. This proved fairly satisfactory, and the matter of putting it on the market was considered by Messrs. Queen & Co. about 1899, but this was never done, though the instrument was described at the 1899 meeting of the American Association for the Advancement of Science. I found that this instrument gave fairly satisfactory results in many ways, and the general usefulness of the instrument has been confirmed by Mr. Duddell.

This instrument was, however, abandoned in the spring of 1899 for the Elihu Thomson ring galvanometer, in which two coils generate inductively currents in a third coil or ring suspended at an angle of 45° to the first coils. This latter instrument proved much more suitable for quantitative work, especially in connection with resonance phenomena, as its olimic resistance could be kept very low, and the coils were not in proximity to any iron.

With this instrument a large number of absolutely reliable quantitative measurements was made, and the laws of the propagation of the waves definitely determined.

It was found that the intensity fell off as the square of the distance up to distances of several miles, and that the waves were not true Hertzian waves as held by some, nor current waves spreading out at a uniform height, as held by Taylor. nor electrostatic impulses, one antenna forming one plate of the condenser, and the other antenna forming the other plate, as held by Blondel until after the publication of my results, but were a new type of waves, the existence of which was stated to be possible by Hertz, but the existence of which had not been demonstrated by him. This new type of wave was found to be different from the Hertzian waves in that Hertzian waves were propagated in a straight line. but these waves followed the surface of the conductor. It was found to differ from electric oscillations in wires in that while it followed the surface of the conductor, the electrostatic and electro-magnetic intensities were in phase instead of 90° apart.

This form of indicator was developed into a telegraphic receiver, but for scientific work it was abandoned in favour

of the hot-wire barretter.

The hot-wire barretter consists of a minute platinum wire about '00004 of an inch in diameter, and about '01 of an inch leng. Its specific heat was such that a fiftieth of an erg is sufficient to cause a change in resistance of 1 per cent.

This instrument possesses many advantages over other instruments for accurate scientific work. It introduces no self-induction or capacity into the circuit. It can be standardised so as to be absolutely quantitative in the same way as a platinum thermometer. It needs no adjustment. It does not affect the tuning of the circuit in any way. It can be given such a resistance that it absorbs all impulses

irrespective of frequency. It can be buried in the ground or immersed in water so as to measure the intensity of the waves there, and possesses many other advantages.

With this instrument a great deal of work was done, more especially in determining the way in which the intensity of the waves falls off below the surface of water containing different percentages of salt, below the surface of different kinds of soil, and in determining the changes which take place in the electric oscillations where the waves have to make sudden changes of course, as in going up a bank from the water; in studying the way the waves are reflected; and by means of a step-ladder in measuring the way in which the waves increase in height in going out from a vertical antenna. It was also used largely in making experiments on tuning and in measuring wave lengths, and in detecting possible changes of wave lengths with distance.

With this receiver it was found that, when stations were constructed on the sea level close to the water's edge and provided with a wave-chute, up to 50 miles the energy received fell off directly as the square of the distance. These experiments were completed in 1901 and 1902.

In 1902 the liquid barretter was invented. This was found, when proper precautions were taken, to be a truly quantitative instrument, and by 1903 the correctness of this law, i.e., that the intensity falls off as the square of the distance, was proved up to a distance of 250 miles.

Since that time further experiments have been made up to a distance of a little over 3,000 land miles, and it has been found that the law still holds.

ATMOSPHERIC ABSORPTION.

The weakening of signals observed at different times is due, amongst other things, to two causes, one due to the fact that some receivers such as the coherer must be adjusted less sensitively when there is much atmospheric disturbance in the neighbourhood, the other due to an actual absorption of the energy.

Insulating an antenna or constructing it of such a size that there is no ionisation has no effect on these losses. Nor does the weather at either station have any effect on these losses, as the losses depend upon what is going on in the air between stations. It is true that Captain Wildman's experiments show that the loss varied with the condition of the weather at the stations, but this was doubtless due to the fact that the stations were close together, i.e., only a little over 100 miles apart, so that the weather at the stations was the same as the weather between them.

In working across the Atlantic between Boston and Machrihanish, it is found that the intensities of the signals received by either station are identical on the same night. Out of a great many observations made during the last winter, on 96 per cent. of the tests the intensity received at Machrihanish from Boston were identical with the intensities received at Boston from Machrihanish. By identical is meant that the intensities agreed within 5 per cent. The difference which occurred on 4 per cent. of the tests was probably due to causes aside from atmospheric absorption.

This identity in the strength of the signals would not of itself prove that the effect obtained took place near or at the stations themselves. These results were, however, checked in the following way. In addition to the stations at Machrihanish and Boston, operators were stationed at the following points:—One of the company's cottages. Lynn, Schenectady, Philadelphia and Washington, the distances from the Boston station being, respectively, 200 yards, 30 miles. 170 miles, 270 miles and 400 miles. The Machrihanish station is distant 3,004 land miles from the Boston station.

The intensities were taken by measuring the intensities of certain signals which experiment had shown to be best adapted for giving quantitative results.

It will be seen from this that a wide range was covered, and the results of these experiments showed that the absorption did not take place at the stations. The amount of this absorption varies very greatly.

In making the comparison we will confine ourselves for the present strictly to measurements made at night, on account of the fact that the amount of sunlight will vary on different days during the daytime.

Taking the best night as standard, and it may be men-

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tioned that in every case so far examined, the best night never exceeds the theoretical intensity, thereby showing that there is no *reflection*, the intensities on the worst nights were as follows for the following distances.

(By intensities on the worst nights is meant the intensities which may be expected to occur as often as three or four times a month. The fact may here be noted that these worst nights appear to be really worse nights, i.e., not more than 1 per cent. of the total nights will be found to be worse than the worst nights. This would seem to indicate that on the so-called worst nights the absorbing body occupies almost the entire path of the waves between the stations.)

Station.	Distance.	Strength of signals received on worst nights (strength of unabsorbed signals being taken as 1,000).
Company's cottage	200 yards	1,000
Lynn	30 miles	1,000
Schenectady	170 miles	500
Philadelphia	270 miles	300
Washington	400 miles	150
Machrihanish	3,000 miles	1 - 2 - 1
		I A. S.

It will be seen that the absorption increases as a high power of the distance, at least up to a certain distance. There is some indication that after a few thousand miles the rate of absorption becomes constant. For example, on certain nights there appeared to be indications at the Boston station of a double set of impulses being received, one about a fifth of a second later than the other. It is too early yet to make any definite statement in regard to this matter, but there is some reason for thinking that the second set of signals arrived at the station after going the longer way round.

To take an actual numerical example, the strength of signals received at Boston from Machrihanish on the night of January 30th was 480 times that of audibility. If the second set of signals went around the other way, their intensities, according to the square law would be

32: 252 or as 9: 25, i.e., 1: 70;

hence signals which had gone the other way round would have an intensity of

$$\frac{480}{70} = 7$$
 times stronger than audibility.

As a matter of fact, the second set of signals, which we may call the echo signals, were really nearly twice as strong. This, of course, might be taken as an argument against their having come that way, but I am not disposed to consider it as a conclusive one. If, however, they did come round the other way, it is evident that the rate of absorption must become uniform after a certain distance.

I subjoin a chart (fig. 1) showing the variations for a single month in working between Boston and Machrihanish, the month taken being that of January. No sending was done on January 1st on account of its being a public holiday.

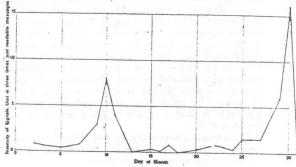


Fig. 1.—Curve showing Variation of Intensity of Trans-Atlantic Messages for the Month of January, 1906.

The intensities taken were in terms of a standard intensity, which was about three times that of the lowest intensity at which messages could be read under the best conditions.

The variation, as will be seen, is extremely great, and on three nights, i.e., on January 13th, 18th and 31st, the strength of the signals received was approximately only onethousandth of the strength at which signals were received on the night of January 30th.

On the night of January 30th, the strength of the signals received agreed almost exactly with that deduced from theoretical considerations. The signals were of course on that night quite loud, and some of the operators amused themselves by reading the messages with the telephone held 3 in. from the ear.

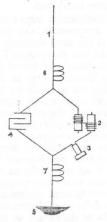
Incidentally it may be mentioned that the amount of power used in making these tests during the month was approximately 4 H.P. On a number of occasions messages were exchanged using only a single horse-power.

This atmospheric absorption will be seen to be perhaps the most important factor in wireless working over long distances. Work has been commenced on the stations at Boston and Machrihanish with a view to increasing the intensity of the signals one hundred times, and it is expected to have this work completed by the fall of 1906. When completed it will be possible to hear messages with only one one-hundred-thousandth of the strength that they come in on on the best nights. It is not proposed, however, to install one hundred times the energy, but merely to use about 50 H.P., the intensity being increased ten times by the use of a new form of receiver which is approximately ten times as sensitive as the liquid barretter.

CHANGE OF WAVE-LENGTH.

A very interesting question is whether there is any change in wave-length in transmission over long distances. Theoretically, there should be no change, but it seemed advisable to ascertain the fact.

In measuring wave-lengths the writer commenced in 1897 and 1898 by using a long solenoid and vacuum tube after the method originally devised and used by Tesla in 1893, and later by Fleming and others. It was found that this method did not give sufficiently accurate results, and, moreover, it could not be used to measure waves accurately at any considerable distance from the station. A method was, therefore, devised and put in practice in 1899, which is capable of measuring wave lengths accurately to a fifth of 1 per cent., and which at the hands of different observers on different days, has given results agreeing to one-fourth of 1 per cent. The fact may be mentioned here that the wave-



1, Antenna: 2, Variable inductance: 3, Receiver; 4, Condenser; 5, Ground: 6 and 7, Lamps.

Fig. 2.

length sent out by the Machrihanish station has been measured at Boston to within one-fourth of 1 per cent. by this means.

In this method a variable inductance is used, as it is difficult to construct an accurate variable condenser having any very wide range. The Varley-Thomson rheostat was at first used as a variable inductance, but it was found that with the low voltages met with in wireless work the contacts could not be depended upon. A variable inductance on a new principle was therefore devised, in which the contacting cylinder of the Varley rheostat is made of a tube of pure electrolyte copper having a spiral thread cut in it, so that all the wire wound on to the copper cylinder forms the

primary of a transformer, which has a short-circuit secondary—namely, the copper cylinder. The wire can therefore be insulated and covered with a coat of varnish without interfering with the action of the variable inductance.

This variable inductance is placed in shunt to a standard air condenser, the resonant circuit opened, a hot-wire barretter inserted in it, and is connected to the aerial and

ground as shown in the figure.

Non-inductive resistances, consisting generally of lamps, are inserted in the aerial and ground connections at the points 6, 7, as shown in the figure. This is for the purpose of rendering the antenna oscillations deadbeat, thus leaving only the supply circuit resonant, and thereby avoiding all questions of double frequencies.

With this apparatus measurements were made of the wavelengths at different distances from sending stations, and it was found that there was no variation in the wave-length amounting to as much as one-third of 1 per cent.

AEOLOTROPIC ABSORPTION.

It has been found that the absorption varies in different directions on different nights. On one night stations can be readily heard which are located in the South, while on other nights stations to the East and West can be heard best. There is considerable evidence in favour of diffraction effects being produced. There are also strong indications that the

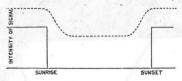


Fig. 3.

absorbing masses are not continuous, but somewhat resemble transparent clouds. There are also indications that the size of these clouds varies considerably, the diameter varying from about 150 ft. comparatively low down, i.e., within five or ten miles of the ground, in tropical countries, up to masses having a diameter of at least two miles, and much higher up in the air, as indicated by the experiments between Boston and Machrihanish.

To go thoroughly into this matter would require more space than the Editor would, I believe, care to allow me. I will merely refer to some experiments made between two of our stations on the River Amazon 150 miles

apart.

At these stations it was found that the signals had an intensity of 20 during the night time, but that within 15 minutes after sunrise the signals became inaudible. The curve showing the strength of the signals was very abrupt, as shown by the full line of fig. 3. After making certain changes in these stations, which somewhat increased the strength of the signals, the curve took the shape of the dotted line shown in the same figure, in which it will be seen that the slope is more gradual, and the relative change in the intensity of the signals is very much less.

DAYTIME AND NIGHTTIME.

As will be seen from the Amazon curve, over short distances in tropical countries the difference between daytime and nighttime is very marked. Between Machrihanish and Boston, however, so far the indications are that the difference between daytime and nighttime is very much less than that between good and bad nights. A sufficiently extended series of observations has not been obtained, but so far the indications are that the worst day is not very much worse than the worst night, while the best day is very much worse than the best night. It is expected that more will be known of this as soon as we have had time to make an extended series of observations. Up to the present time the days have been so much taken up with experimental work that there has been very little time for sending. We have, however, quite a complete set of tests between Washington and Boston, a distance of 400 miles, both daytime and nighttime, and these tests show something of the same character, i.e., worst day gives signals of about half the intensity that the worst night does.

SUMMARY.

It is too early yet to draw definite conclusions on this subject, but the following statements seem to be in accordance with the facts.

1. There are large masses of absorbing material, probably ionised air, in the upper atmosphere. Down near the surface these masses are not continuous, but somewhat resemble clouds, and their size diminishes as we approach the earth.

2. In temperate climates waves sent out do not reach up to the height of the absorbing masses, and hence are not absorbed appreciably up to distances of 100 miles.

3. Beyond distances of 100 miles the waves reach up into the absorbing matter and are absorbed. Beyond 100 miles the absorption increases at a rate proportional to a higher power than the first of the distance. Beyond several thousand miles there is a possibility that the rate of absorption becomes constant.

4. For long distances the absorption may be very great, and more than 99.9 per cent. of the energy may be

absorbed.

5. Sunlight causes the height at which absorption takes

place to approach considerably nearer the ground.

6. Sunlight acts by changing the air in some way, probably by ionising it. This is shown by the rapid rate at which signals die out after the sun rises, since, to take the case of the Amazonas stations. 15 minutes would not be sufficient to allow the ionised air to flow downwards to an extent necessary to produce the absorption.

7. In tropical countries the absorption height is much less

than in temperate climates.

8. The absorption may be aeolotropic—i.e., there may be much greater absorption in one direction than in another.

9. In the temperate zone there is considerable difference between the absorption at night and during the daytime. Between distances of 300 and 1,000 miles in the temperate zone there is considerable difference between the absorption at night and during the day-time. In distances of over 1,000 miles the difference is not so marked.

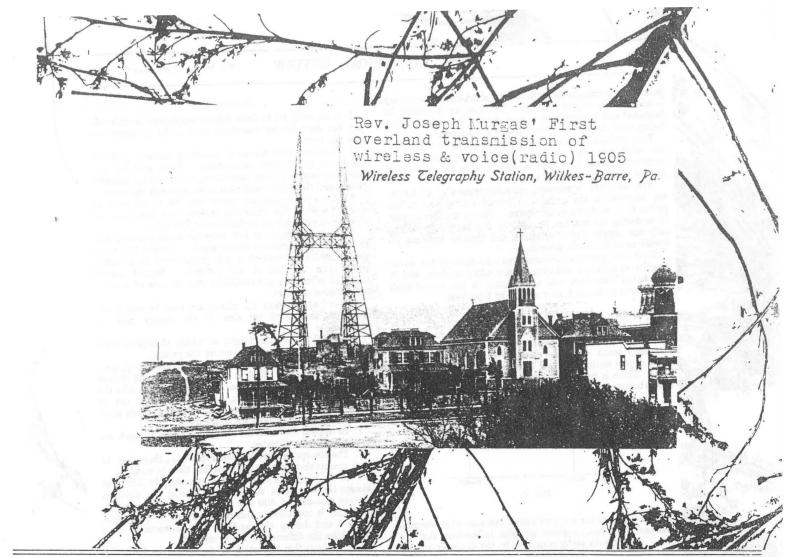
This suggests that the action of daylight is to lower the level at which absorption takes place, and hence, when stations are so far apart that waves reach above the absorbing level even during the night-time, the lowering of the absorption level during the day does not produce so marked an effect as in the case of stations whose waves lie below the

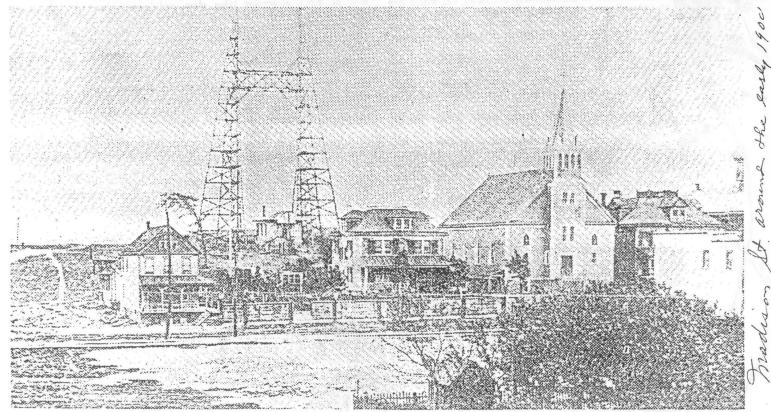
absorbing level at night-time.

10. The height above the earth at which marked absorption begins to take place may be roughly estimated as about 300 miles at night time and 100 miles during daytime, for the temperate zone, and 100 miles at night-time, and 30 miles during day-time for the tropics.

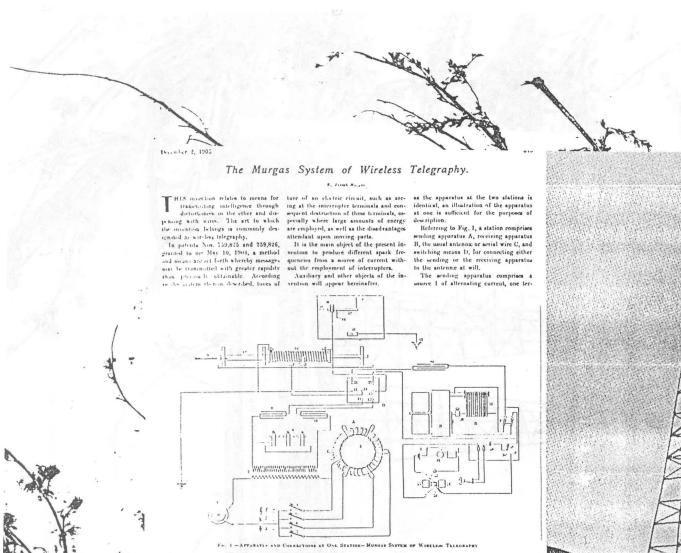
(To be continued.)







Father Murgas' Antenna Towers Built in 1905 in Wilkes-Barre, Pa., near his old Slovak Church of Sacred Heart.



different with are employed in place of the dot and dash of the well-known Morse illustrate the invention, erstern. This is accomplished by causing different spark gap frequencies at the sending station corresponding to the different toors, and these frequencies are produce! be a plurality of interruptors, any one of which may be included at will in the carruet of a source of direct current. This mesans of producing sparks of the desired frequencies has disadrantages; among

Pig. 1 is a diagram showing the apparatus of one station and the connection Fig. 2 is a detail of an improved imper

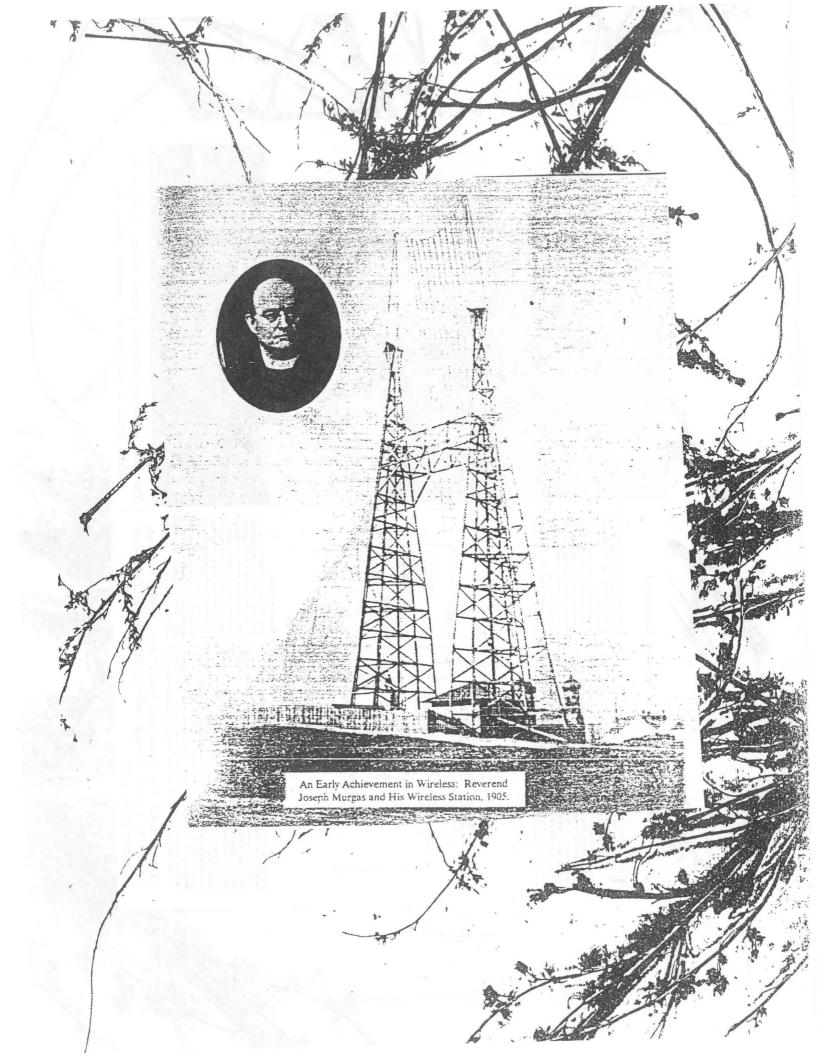
feet contact, and

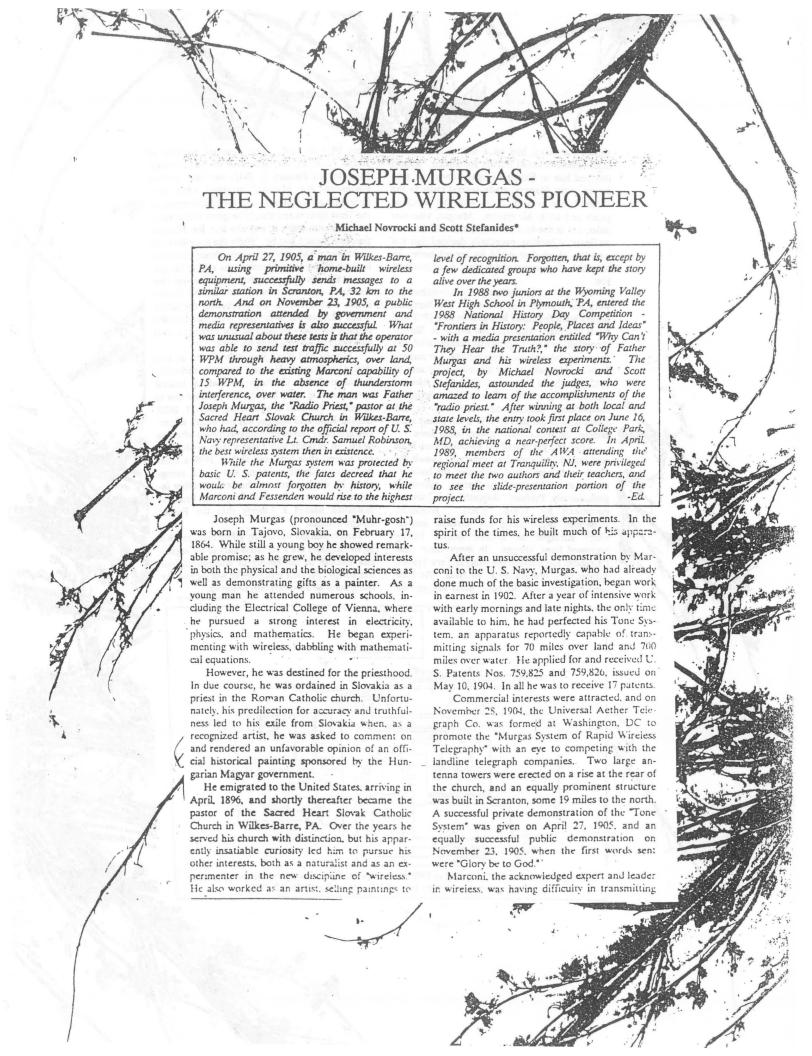
which may be mentioned those which are supposes the existence of two stations, to taps taken from different points of the well known to be attendant upon the rup- one sending and the other receiving, but inductance 3, so that by closing the

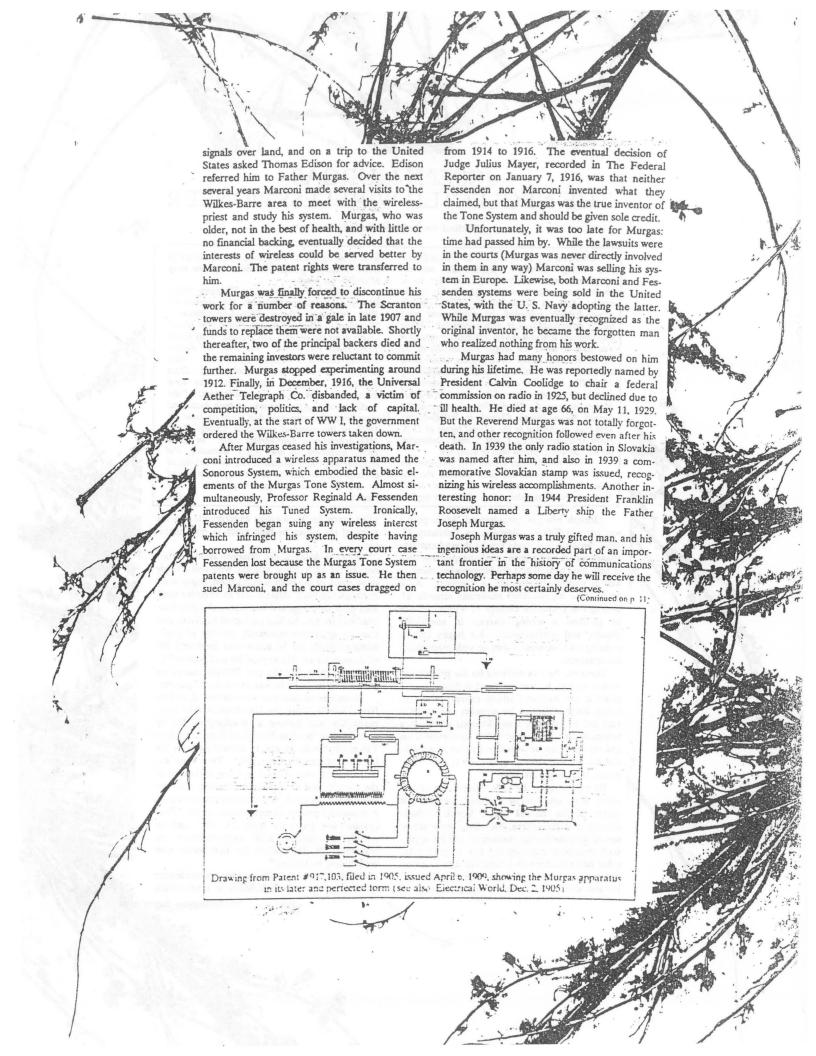
In the accompanying drawings, which minal of which is connected to a ternunal of the primary of the transformer 2. The other terminal of the primary is connected to one end of an inductance 3, and also to one terminal of a normally open switch or key 4, the other terminal of the switch being connected to the other Fig. 3 is a diagram showing an im- terminal of the alternating-current source. proved arrangement of receiving appara-tus. Other keys, 5, 6 and 7, similar to the key 4, are also connected to the last-The transmission of a message pre- mentioned terminal of the source 1, and

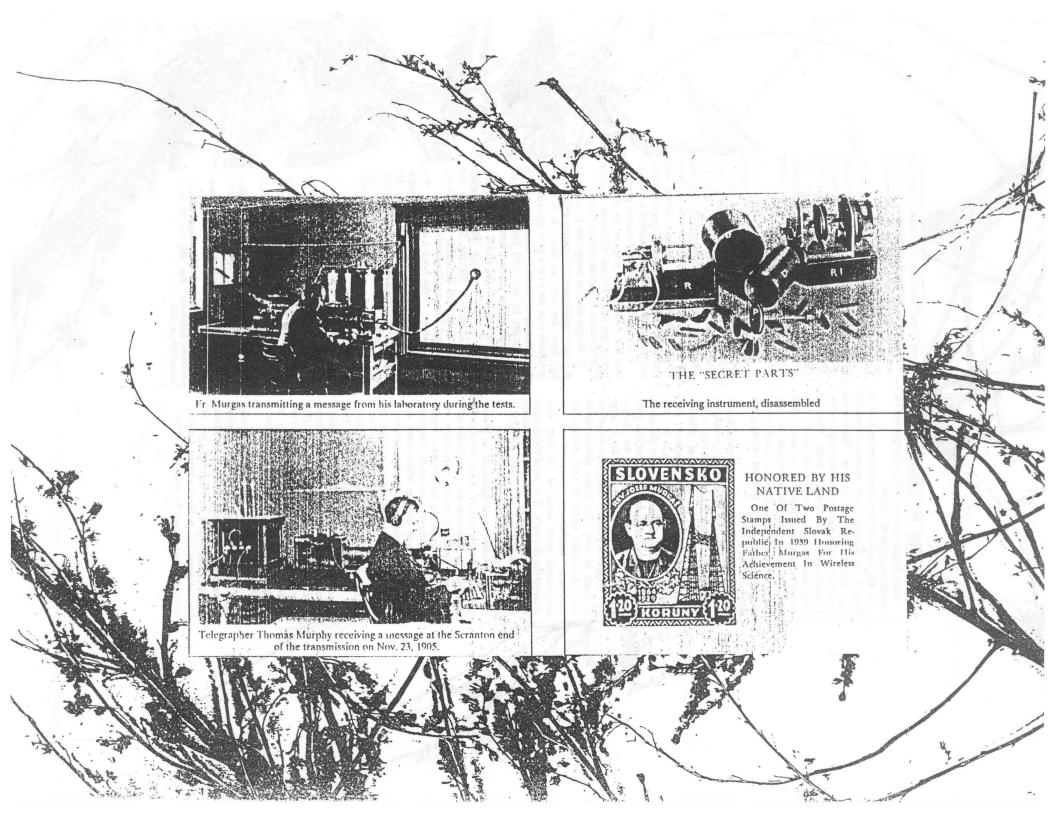
A page from The "Electrical World" Dec. 2, 1905 with an article by Father Murgas defining the Murgas System of Wireless Telegraphy.

The first wireless station of Father Murgas built on the highest point in the city of Scranton, Pennsylvania.











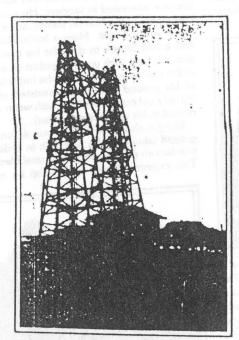
Father Murgas: Radio's Forgotten Genius

Somehow, The Contributions To Early Wireless By Rev. Joseph Murgas Have Gotten Lost In The Shuffle. He May Well Deserve More Credit Than Marcon!!

BY ALICE BRANNIGAN



Father. Joseph Murgas (1864-1929)



The picture postcard that ran last December in POP'COMM actually shows the towers in a partially completed state. The tops had not yet been added

In the December issue of POP'COMM, there appeared a very old picture postcard bearing the caption. "Father Murgas Wireless Telegraph Station." In researching the card, we checked the usual data sources and drew a total blank.

Yet, there was no doubt about the fact that the station did exist, those two large wireless towers couldn't be denied. But where was the station, what was the station, and who was l'ather. Murgas? That's what we asked our readers to tell us when we ran the postcard.

Readers told us; did they ever tell us! Even though we hadn't been able to locate information on Father Murgas in a huge stack of reference books on early wireless, we came to learn that the station on the postcard was most historic and the man who designed and built it was a brilliant inventor whose many accomplishments are, today, little british cultilie of Wilker Barre, Pennsylvania.

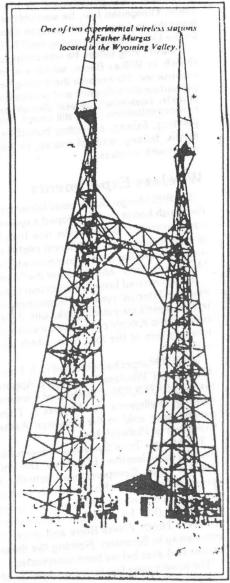
From our vantage point here at the tail end of the 20th century, and after all of the many advances in the field of telecommunications, we tend to overlook all but a few of the very highest profile wireless pioneers whose efforts were directly linked to the successful commercial development of communications, men such as Marconi and DeForest.

But in the opening years of the century, there were other experimenters whose efforts were no less outstanding than those whose names fill the history books. Rev. Joseph Murgas, for one, drew the eyes of the communications world to Wilkes-Barre, where he served for almost 35-years (until his death in 1929) as pastor of Sacred Heart Slovak Church

Beginnings

Murgas was born February 17, 1864, in Tajov (Jabrikova), Zvolen County, Slovakia. At the age of 18 he decided to study for the priesthood and entered the seminary at Bratislava. Two years later, in 1884, he transferred to the seminary at Ostrihom where, in addition to his theological studies, he began his first electrical and wireless experiments. In addition to these efforts, he was also studying French, German, advanced physics, and astronomy Furthermore, he was enrolled at the celebrated Academy of Arts in Munich

Ordained in 1888, Murgas continued



This is the way the completed towers looked

with his art studies in Munich and later graduated with honors and awards as an accomplished painter. He continued with his electrical and wireless experiments and even enrolled at the Electrical College of Vienna as an advanced student.

Murgas also had a number of very strong political opinions, and he was an ardent patriot and student of the lives of the many Slovak figures who fought for freedom from the clutches of Hungary for almost 1,000 years. This topic was the focus of many of his

most famous paintings.

Because of his wide recognition in the arts. Murgas was asked by the Hungarian government to evaluate a contemporary painting which was to be displayed in the Hungarian Parliament. This painting depicted the occupation of ancient Slovakia by the Magyars in the year 907, obviously a sore point with the intensely nationalistic Murgas. He felt that the painting failed to depict the event with honesty and promptly characterized the scene as a "tragic misrepresentation," further denouncing it as unworthy of art.

It was not what the Hungarian government wanted to hear. He was charged with disloyalty and also of having proven himself as having anti-government tendencies. Under Hungarian law, he was obligated to leave the country, and thereupon departed for the United States, arriving April 6, 1896.

It wasn't long before he was assigned to a church in Wilkes-Barre, which was newly constructed. He became the driving force in expanding the influence and services of this Hiller in with the washing award Stovak American organizations, and still found time for painting, fishing, collecting butterflies and moths, botany, and, of course, his experiments with wireless.

Wireless Experiments

In 1898 Murgas built a small laboratory in the parish house and developed a system of communication based upon two high-frequency tones (tones of different pitch), one tone representing (and in common with) the Morse code "dot" and the other the "dash,"

This permitted faster transmission speeds than the Marconi system. Murgas transmitted his signals via rotary spark, with the signals fed into a single pole antenna with a distributing arm at the top, from which wires extended.

In 1904 Murgas had obtained U.S. Patent #759,825 ("Wireless Telegraphy Apparatus") and #759,826 ("Method of Communicating Intelligence by Wireless"). These patents were sold to the Universal Aether Company of Philadelphia.

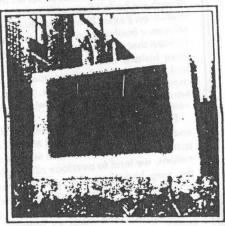
The Murgas Tone System was eventually covered by no less than 17 patents. The Universal Acther Company was actually a group of financiers who wanted to market the Murgas Invention. This syndicate spent about \$25,000 for 200-foot transmission towers in North Wilkes-Barre and ones 19 miles away in Scranton. Nothing like these towers had ever before been constructed.

The towers were first tested on April 27 of



NA L

The Sacred Heart Church in Wilkes Barre (Photo by Ed Shedlock)



In front of the Sacred Heart Church is a plaque dedicated to Father Murgas. The plaque reads, in part, " in the early days of radio communication, he created and developed to practical use a major advancement in the air that opened the way to improved and dependable radio transmission over great distances."

1905 Several prominent community leaders, as well as a representative of the U.S. Navy, were present. The first official test and public demonstration was offered on November 23, 1905. It was an event that received national media coverage because it attracted members of the scientific community, the government, and many residents of the area.

The results were stunning. For one thing, they proved the practicality of wireless transmission at long distances over land; they also introduced Murgas' superior method of telegraphy. The tests went without a hitch and Murgas was able to send his traffic at 50 wpm (the Marconi system ran at 15 wpm)

Lt. Cmdr. Samuel S. Robinson, USN, witnessed the tests and reported them "most satisfactory," noting that Murgas had the best system of wireless transmission – one which threatened to revolutionize world communications

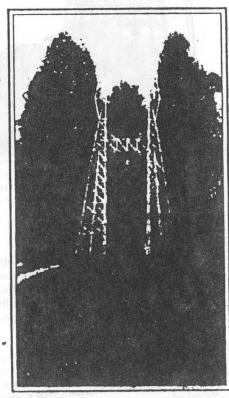
The problem here was that our government had already entered into contracts with Marconi (as did other governments) and had purchased millions of dollars' worth of Marconi equipment.

Adoption of the Murgas system would cause a lot of money spent on Marconi apparatus to be considered as "wasted" The question was would international financiers allow this to take place. The Universal Aether people felt that they could do battle with those forces only if they could match their wealth. That was a major obstacle.

In the meantime, Murgas journeyed to New York to meet with other wireless pioneers. This included Marconi and his associate, Fessenden. Marconi was so impressed with Murgas' inventions that he went to Wilkes-Barre to see them.

Gordon Shook, of Wilkes-Barre, recalls that he was 16 years old at the time and had become interested in wireless. He was also curious about the Murgas station, so he paid the Inventor a visit. Murgas invited him in and asked Shook to describe his own station. He then took young Gordon on a tour of the station and explained the importance of his ground system (It consisted of six buried steel containers filled with water connected to his wireless apparatus).

Murgas also took Gordon into an undefground laboratory fie had built in order to conduct an experiment for General Electric. This experiment was to develop an auto-



P.

Model of Father Murgas radio towers which stands near the site of the original station.

(Photo by Ed Shedlock)

Murgas Messages Reenactment Slated Renactment Slated

One of the more unique the original Murgas messages.

events on the cakindar of activities of the Luzerne County Bithes of the Luzerne County Bithes are centennial Commission is Barre.

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Murgas Radio Message Will Be Transmitted

One of the more unique events in the calendar of activities of the County Bicentennial Commission is now being planned. Under the leadership of the Murgas Amateur Radio Club, a reenactment of one of the first transmission and receipt of messages by wireless communica- transmission and reception

tion overland will be held Sunday, Nov. 23, 1975.

The reenactment will be held at Sacred Heart Church, 601 North Main Street, Wilkes-Barre. As the original event, it will be held at 2 p.m.

in the school auditorium. This will mark the anniversary anniversary of the initial transmission by Father Joseph Murgas, a pioneer in the field of wireless communications. As outlined by the Murgas Commemorative C o m m i ttee under the direction of David Watkins, the Nov. 23 event will faith(ully duplicate the actual event by including message transmission by the mayors of Wilkes-Barre and Scranton, the pastor of Sacred Heart Church and the Bishop of Scranton, as well as other local and national dignitaries. The messages transmitted will be sent in English, Slovak, Polish and Latin as were the

original Murgas messages. As a faithful duplication of the 1905 event, a separate ransmission and receipt of mestransmission and reception center will be set up in Scranton at the Sheraton Hotel. Stanley Gritsevicz, cochairman of the Commemorative Committee, will man the Scranton station. The Sheraton Hotel is located on the former site of a radio tower used in the 1905 event.

Following the message transmission and the presentation of several commemorative plaques, and address will be given by Commander Jerald A Copple, USN, representing the Chief of Naval Operations (who was present at the original transmission). A social hour will conclude the event at the Sacred Heart School.

The coordinator of this event for the County Bicentennial Commission is Miss Mary Barrett, Chairman of Heritage '76 Committee. She has been assisted by Watkins, Gritsevicz, and Reverend Charles J. Hooker Jr., President of the Murgas Amateur Radio Club.

In 1976. Murgas' early transmissions were impressively recreated during the Bicenten nial celebrations.

matic switching system for trains and street cars and consisted of a large generator running about 100 light bulbs.

Gordon recalls that the next day Marconi showed up for his visit and Murgas introduced Gordon as his "2nd hand Secondary Engineer." Marconi told Murgas that his experiments in Europe were successful with messages going across water but that he was not very successful with signal propagation over land. Murgas seemed dumbfounded since he had no problems at all with sending signals over land and had been communicating this way for months!

Marconi stayed a few days and then returned to Europe

Gordon's station was able to communicate with Father Murgas' station, and their network was soon expanded when "Pop" Stenger from South Wilkes-Barre got on the air. Pop and his son erected two poles with an antenna wire strung across and became active on the air. The government had installed a carbon-arc transmitter at Murgas' station and experiments continued.

Problems

The original problem of making all of this a marketable product still loomed over Murgas and the Universal Aether people. By 1907, Murgas had been able to send speech over his station by modification of his tone system. These experiments were witnessed by a number of people. Unfortunately, Universal Aether did not have the resources available to finance any extensions in speech transmission. The company was al-





The Murgas Amateur Radio Club honors the memory of the cherished priest, scientist, and inventor

ready dissolutioned by the domination of Marconi's enterprises in the field of wireless.

Fate also participated in the matters at hand. The Scranton station was destroyed by a storm. Not only that, two of the most important backers of Universal Aether suddenly died. These factors contributed to Universal Aether's abandonment of Murgas.

Marconi and Fessenden, of course, had known of Murgas and his experiments before they came to America. In fact, Marconi came up with what he called "improvements" to Murgas methods and termed it the Sonouros System." Fessenden's version was called "The Tuned System."

Murgas, for his part, continued his efforts

ting after Murgas' original work on the high frequencies required for producing the tone effects, both Marconi and Fessenden entered the commerical market with their respective systems. Thereupon followed a complex chain of lawsuits between Marconi and Fessenden over who had invented the tone method based upon high-spark frequency. The usual case was for Fessenden to sue Marconi and the cases bounced back and forth through many courts for a number of years. Eventually the U.S. District Court (Southern District of New York) ruled that neither one of the two had invented the high spark-frequency required in tone transmission. Murgas was named as the originator of the invention, which was being claimed

Father Murgas died on May 11, 1929. His life and work did not go without recognition In 1939, on the tenth anniversary of his death, the Independent Slovak Republic named its only broadcasting station after him and also issued two postage stamps in his honor. The stamps depicted his Wilkes-Barre radio towers and called him a pioneer in wireless science. During WWII an American Liberty ship was named after him. Even before his death he was not forgotten; President Coolidge appointed Murgas as a member of the National Radio Commission

by leith

Today, he is still remembered fondly by the people of Wilkes Barre The Murgas Amateur Radio Club (established in 1975)

exists in Wilkes Barre. Bob Nygren of the club advises that during the 1976 Bicentennial Celebration, members of the group re created the famed 1905 experiment

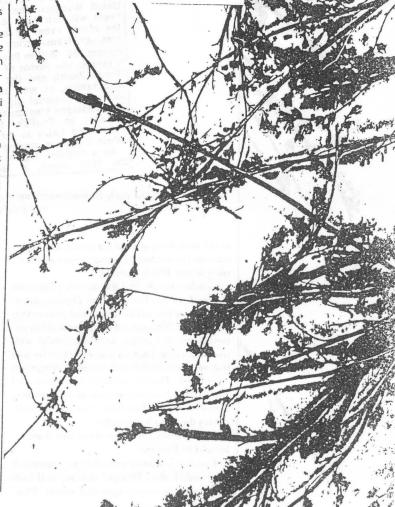
A plaque and monument (consisting of a miniature reproduction of Father Murgas' station) stands near the original site of the Wilkes Barre towers. Furthermore, King's College in Wilkes Barre maintains a consid erable amount of Father Murgas memorabilia and the institution also offers The Reverend Joseph Murgas Program In Com munications Studies.

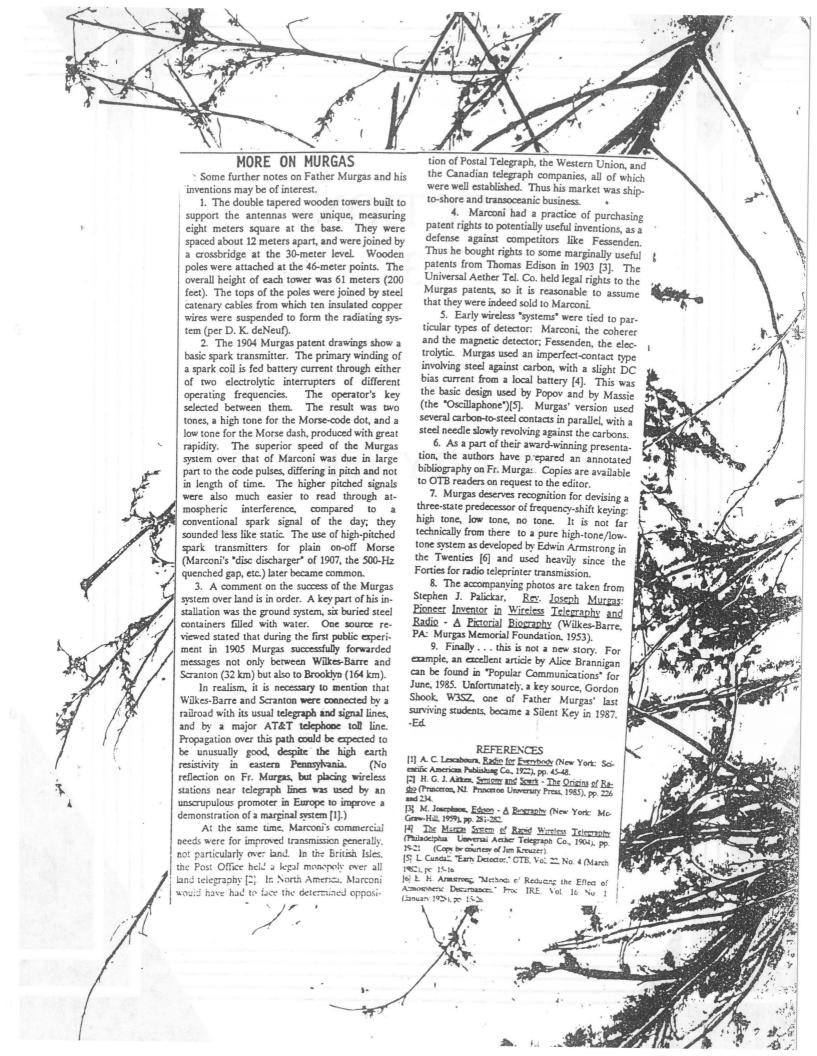
In Retrospect

Here, in 1985, Father Murgas' inventions are still regarded as brilliant and ahead of their time. It was a peculiar set of circumstances that prevented the Universal Aether Company from evolving into RCA or AT&T

And what contributed to the eventual obscurity of Murgas himself outside of his adopted hometown? Fate? Misfortune? Misadventure? Certainly his work, as well as the man himself, deserves a prominent place in telecommunications history

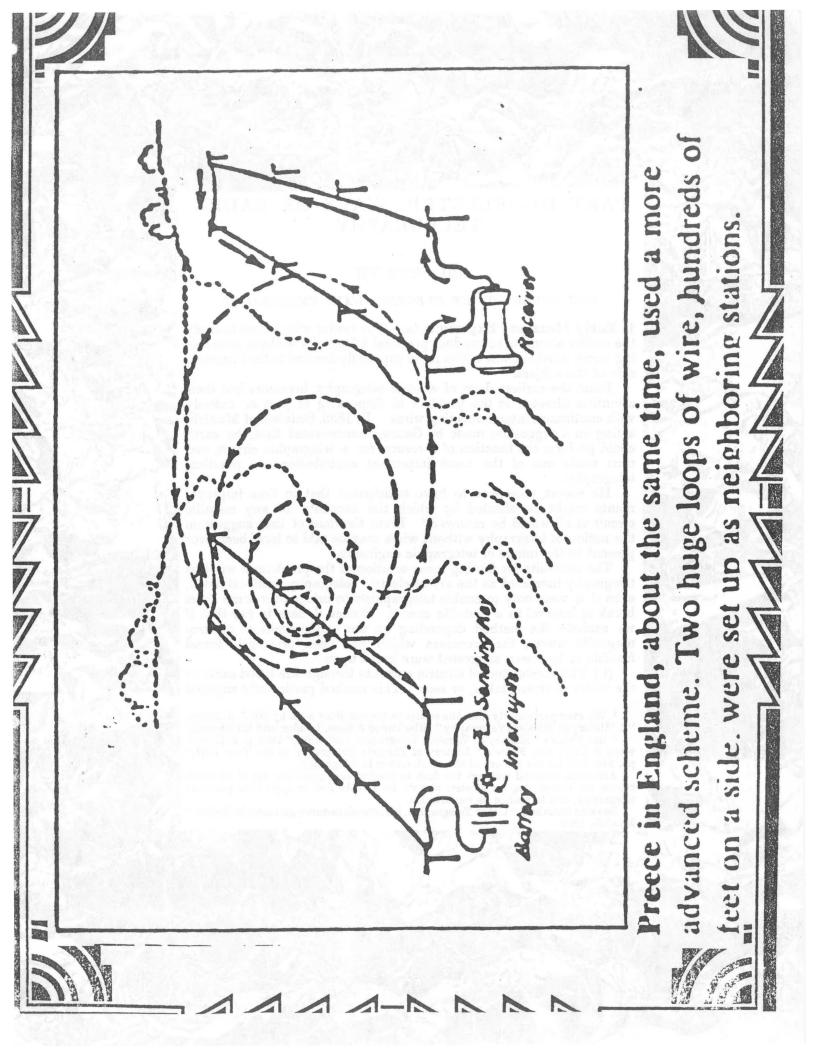
The author wishes to sincerely thank the following persons for their information and advice in the preparation of this remembrance of Father Murgas: Ed Shedlock. Wilkes Barre, PA; Gordon Shook, W3SZ. Wilkes-Barre, PA; Father Tom Carten, K1PZU, King's College, Wilkes-Barre, PA: Leo Kalinosky, KB3SK, Pt. Matilda, PA; Bob Nygren, WA3YON, Wilkes-Barre, PA

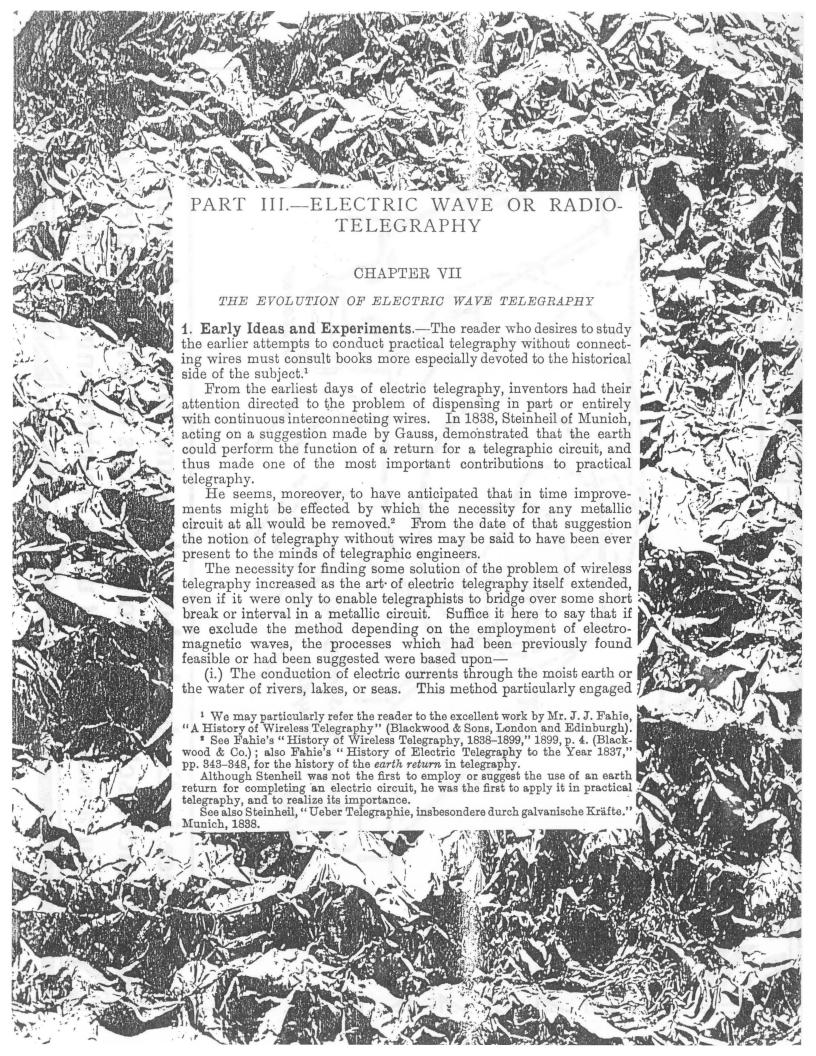




SECTION 3

CAPACITY AERIALS





the attention of Morse, Lindsay, Trowbridge, Preece, Rathenau. Strecker, Wilkins, and Melhuish. (ii.) Electromagnetic induction between parallel metallic conductors, either complete circuits or circuits including earth returns. Suggested and studied by Trowbridge, Preece, Stevenson, and Lodge. iii.) A combination of methods (i.) and (ii.). Made into a practical system chiefly by the labours of Sir William Preece, aided by the British Postal Telegraph Engineers. (iv.) Electrostatic induction between conductors separated by a greater or less distance. Brought to a working success by Edison, Gilliland, Phelps, and W. Smith, as a means of communication with moving railway trains. The reader wishing to have some information with regard to the earlier researches of the above-named inventors may be referred to the following original papers, as well as to the "History of Wireless Telegraphy," by Mr. J. J. Fahie above mentioned. J. Trowbridge, "The Earth as a Conductor of Electricity," American Acad. rts and Sciences, 1880. W. H. Preece, "Recent Progress in Telephony," British Association Report, W. H. Preece, "Electric Induction between Wires and Wires," British Associaion Reports, 1886 and 1887. W. H. Preece, "Electric Signalling without Wires," Journal Soc. of Arts, ebruary 23, 1894. W. H. Preece, "Signalling through Space without Wires," Proc. Roy. Inst. ond., 1897, vol. xv. p. 467. W. H. Preece, " Ætheric Wireless Telegraphy," Proc. Inst. Elec. Eng. Lond., 898, vol. xxvii. p. 869.
O. J. Lodge, "Magnetic Space Telegraphy," Proc. Inst. Elec. Eng., 1899, vol. xvii. p. 799. In many cases suggestions were put forward which were based upon obviously erroneous ideas, and even embodied in patent specifications without being subjected to critical trial. Nevertheless, the best of the methods above classified had only enabled comparatively short distances to be covered. Even the most effective of them, viz. the method involving both conduction through the soil or water and electromagnetic induction between parallel wires, was extremely limited in its applicability by reason of the necessity for employing two parallel metallic wire circuits almost as long as the distance to be bridged. A new era dawned when the scientific investigations commenced which finally placed us in possession of the principal facts connected with the generation and detection of electromagnetic waves, or as they are more shortly called, electric waves. Maxwell's profound speculations and mathematical researches resulted, as we have seen, in the enunciation in 1865 of his famous electromagnetic theory of light. This theory, owing to its abstract

resulted, as we have seen, in the enunciation in 1865 of his famous, electromagnetic theory of light. This theory, owing to its abstract nature, was not at first fully appreciated. Hertz's discoveries and investigations, published in 1888, cast a flood of light upon its meaning, and whilst opening up a wide and promising field for experimental investigation, gave such enforcement to Maxwell's theory that it at once commanded general attention.

The matter, however, which chiefly interested physicists were the

properties of the long waves generated in the æther by Hertzian methods, and the similarity between the effects connected with them and familiar optical phenomena. Hence a rapidly accumulated mass of experimental evidence was obtained, tending to show that luminous radiation is electromagnetic in nature. These electro-optic phenomena were sedulously studied, and physical optics became, as it were, a department of electromagnetism.

When any new field of discovery or invention is thus laid open, it invites the attention of two classes of minds. There are those who are chiefly drawn to its cultivation by a desire to increase purely scientific knowledge, and to explore the mysteries involved, regardless of any particular practical utility they may possess. On the other hand, there are others to whom this pursuit of novel facts or effects, or the unravelling of complicated phenomena, or the construction of new theories, does not appeal. They are impelled to look at once for applications of the new knowledge which will minister to the convenience or mitigate the troubles of mankind. Probably in neither case is a more personal motive entirely absent, but whilst some minds regard the discovery of new physical facts or laws as an end in itself, others regard them only as a means to an end, and invent rather than discover or explore. The general non-scientific public are, however, prone to attach more importance to the so-called applications than to the discoveries out of which they have grown. Hence the practical inventor or applier of scientific knowledge generally occupies in the public mind a more prominent position than the purely scientific investigator. Unless the latter has the good fortune to make some sensational discovery capable of immediate technical application, such as the Röntgen radiation, his work will seldom attract notice outside of a limited circle of experts. So it was in the case of the field of investigation laid open by Hertz. Between 1888 and 1895 a host of scientific workers in various lands gathered in a rich harvest of scientific knowledge concerning the properties and powers of electromagnetic waves. The non-scientific public concerned itself but little with these results.

In 1892 Nikola Tesla captured the attention of the whole scientific world by his fascinating experiments on high frequency electric currents. He stimulated the scientific imagination of others as well as displayed his own, and created a widespread interest in his brilliant demonstrations.

Amongst those who witnessed these things no one was more able to appreciate their inner meaning than Sir William Crookes. More than twenty years previously he had explored with wonderful skill and insight the phenomena of electrical discharge in high vacua, and had produced the instrument which subsequently produced the Röntgen rays. He allowed a trained scientific imagination to busy itself with the recent discoveries, and he wrote a now well-known article "On some Possibilities of Electricity" in the Fortnightly Review for February, 1892 (p. 173), in which he endeavoured to forecast some of the applications of high frequency electric currents and of Hertzian waves.

In this outlook into the future he clearly discerned the coming of a new form of wireless telegraphy based on an application of Hertz's

discoveries to the communication of intelligence from place to place. In the course of the paper Sir William Crookes made a cryptic reference to experiments in this direction he had witnessed "some years" ago," which were subsequently explained to refer to unpublished investigations by the late Professor D. E. Hughes, in which signals were sent. "a few hundred yards," without connecting wires, by the aid of a telephone. No details of the experiments were given, or any hint of how the result was obtained. For the purposes of patent! litigation this notable essay has been put forward as an anticipation of subsequent practical work. It is necessary, however, to keep clearly in mind the true meaning of "invention." Invention does not consist in displaying a few brilliant and original ideas. Neither does it consist in outlining a certain set of requirements and broadly defining the means by which certain ends may be attained. Invention consists in overcoming the practical difficulties of the new advance, not merely talking or writing about the new thing, but in doing it, and doing it so that those who come after have had real obstacles cleared out of their way, and have a process or appliance at their disposal which was not there before the inventor entered the field. In most cases, however, the removal of the obstacles which block the way is not entirely the work of one person. The fort is captured only after a series of attacks, each conducted under a different leader. In these cases the inventor who breaks down the last obstruction or leads the final assault is more particularly associated in the public mind with the victory than are his predecessors, though his intrinsic contribution may not be actually of greater importance. There are other cases, however, in which, prior to the work of one man, we can find no actual achievement, although the end to be attained, and to some extent the character of the means to be used. are clearly recognized. In the article to which reference is made we find much remarkable prognostication, but not a description of actual inventions. It emphasized, in fact, how much at that date (1892) yet remained to be done. Speaking of electromagnetic waves and their properties, Sir William Crookes says (loc. cit.):-"Here is unfolded to us a new and astonishing world, one which it is hard to conceive should contain no possibilities of transmitting and receiving intelligence. "Rays of light will not pierce through a wall, nor, as we know only too well, through a London fog. But the electrical vibrations of a yard or more in wave length of which I have spoken will easily pierce such mediums, which to them will be transparent. Here, then, is revealed the bewildering possibility of telegraphy without wires, posts, cables, or any of our present costly appliances. Granted a few reasonable postulates, the whole thing comes well within the realms of possible fulfilment. At the present time experimentalists are able to generate electrical waves of any desired wave-length from a few feet upwards, and to keep up a succession of such waves radiating into space in all directions. It is possible, too, with some of these rays, if not with all, to refract them through suitably shaped bodies acting as lenses, and so direct a sheaf of rays in any given direction; enormous lens-shaped masses of pitch and similar bodies have been used for this purpose. Also an experimentalist at a distance can receive some, if not all, of these rays on a properly constituted instrument, and by concerted signals messages in the Morse code can thus pass from one operator to another. What, therefore, remains to be discovered is-firstly, simpler and more certain means of generating electrical rays of any desired wave-length, from the shortest,

those long waves whose lengths are measured by tens, hundreds, and thousands of miles; secondly, more delicate receivers which will respond to wave-lengths between certain defined limits and be silent to all others; thirdly, means of darting the sheaf of rays in any desired direction, whether by lenses or reflectors, by the help of which the sensitiveness of the receiver (apparently the most difficult of the problems to be solved) would not need to be so delicate as when the rays to be picked up are simply radiating into space in all directions, and fading away according to the law of inverse squares. "I assume here that the progress of discovery would give instruments capable of adjustment by turning a screw or altering the length of a wire, so as to become receptive of wave-lengths of any preconcerted length. Thus, when adjusted to 50 yards, the transmitter might emit, and the receiver respond to, rays varying between 45 to 55 yards, and be silent to all others. Considering that there would be the whole range of waves to choose from, varying from a few feet to several thousand miles, there would be sufficient secrecy, for curiosity the most inveterate would surely recoil from the task of passing in review all the millions of possible wave-lengths on the remote chance of ultimately hitting on the particular wavelength employed by his friends whose correspondence he wished to tap. By coding' the message even this remote chance of surreptitious straying could be "This is no mere dream of a visionary philosopher. All the requisites needed to bring it within the grasp of daily life are well within the possibilities of discovery, and are so reasonable and so clearly in the path of researches which are now being actively prosecuted in every capital of Europe that we may any day expect to hear that they have emerged from the realms of speculation into those of sober fact. Even now, indeed, telegraphing without wires is possible within a restricted radius of a few hundred yards, and some years ago I assisted at experiments where messages were transmitted from one part of a house to another without an intervening wire by almost the identical means here described." The above vague reference to experiments on telegraphy without wires over a short distance was at a later date illuminated by the account given by Professor D. E. Hughes himself, of the precise nature of these hitherto undescribed experiments.3 In the course of his work on the microphone, Professor D. E. Hughes had occasion to notice the wonderful sensitiveness of a "microphonic" or loose joint between conductors, and its variation of resistance under impacts, such as those of sound waves. He included such an "imperfect contact" in series with a voltaic cell and a telephone, and found that the resistance of certain kinds of contact was effected by electric sparks at a distance. Using a contact between carbon and steel, he no doubt constructed some form of self-restoring coherer, and made the important discovery that the discharge of a Leyden jar at a distance caused a sudden variation in its electrical resistance, and hence a sound in the telephone included in its circuit. Professor D. E. Hughes stated in a letter addressed to Mr. Fahie. on April 29, 1899 (loc. cit.), that he showed these experiments in December, 1879, to Sir W. H. Preece, Sir William Crookes, Sir W. Roberts-Austen, Professor W. G. Adams, and Mr. W. Grove; also in February, 1880, to Mr. Spottiswoode, then president of the Royal Society, and to Professor Huxley, and Sir George Gabriel Stokes, the secretaries. In addition, he exhibited them to Sir James Dewar and Mr. Lennox. He was apparently discouraged from publishing the results at the time by finding that Sir George Stokes considered they were due to ordinary electromagnetic induction. It is, however, clear from the statements of Professor Hughes himself in 1899 that he had ³ See a letter by Prof. D. E. Hughes in The Electrician, May 5, 1899, vol. 43

discovered (but not announced) in 1879 a number of facts afterwards rediscovered by Professor E. Branly in Paris in 1891, and he had, in fact, been using a self-restoring carbon-iron coherer in series with a telephone which was affected up to a distance of a few hundred yards by the electromagnetic waves created by an electric spark. If at the time he had publicly placed these observations on record, he would undoubtedly have anticipated some at least of Branly's work, but much remained to be done, which was subsequently done by Hertz and by Marconi, before electric wave wireless telegraphy, in any true sense of the word, could be translated from dream to fact.

Four years passed by, however, without any fulfilment of Crookes's scientific prophecy, although the most eminent physicists continued to work at the subject.

On January 1, 1894, the scientific world heard with profound regret of the death of Hertz.

On Friday, June 1, 1894, Sir Oliver Lodge delivered a memorial lecture on "The Work by Hertz," in the Royal Institution, London.

This lecture was remarkable in many ways. It gave many persons the opportunity of seeing, for the first time, striking experiments performed with Hertzian waves. The lecturer made use of a modified Branly's metallic filings tube, and also of a loose or imperfect metallic contact of his own invention, as a means of detecting the electric waves, and he gave to these devices the name coherer, by which they have since been known.

The tube was a glass tube loosely filled with iron borings and closed at the ends with metal plugs or caps. It is represented about one-third of full size in Fig. 3 of Chapter VI. The other form of coherer was a loose or microphonic contact between two pieces of metal, the pressure of which could be adjusted so that the junction offered too great a resistance to pass the current from a single cell, but cohered when electric waves fell upon it. In both cases the tapping back or decoherence was effected by hand after each experiment.

Experiments on the reflection, refraction, and polarization of these electric waves were shown, and their passage through stone walls from room to room. Yet, although replete with interest, the lecture, as originally delivered, contained not even a hint of a possible applications of these electromagnetic waves to telegraphy. The lecturer throughout fixed the attention of the audience on the similarity between the effects obtainable with these waves and those better known effects produced by rays of light.

It was, in fact, an experimental demonstration of the undulatory character of the electromagnetic radiation from an oscillator, and of the electromagnetic nature of ordinary light.

Subsequently the lecture was published as a book, the first edition of which bore the title, "The Work of Hertz and some of his Successors."

These experiments and some variations of them were repeated at the meeting of the British Association at Oxford in the following autumn, but here again no mention of the application of these waves to telegraphy was made, the object of the experiments being to illustrate an electrical theory of vision, and to expound the properties of the electric waves.5

It is highly probable that these articles and lectures, bringing home so forcibly the power of an electric spark to affect or make a deflection of a galvanometer at a distant place, must have turned the thoughts of many ingenious persons to its utilization as a means of sending telegraphic signals. Subsequently we were informed that the matter had begun to occupy the minds of Dr. A. Muirhead, Admiral Sir H. B. Jackson (then Captain in the Royal Navy), and

Professor R. Threlfall, and perhaps many more.

Amongst others, Professor A. S. Popoff, Professor in the Imperial Torpedo School in Cronstadt, Russia, directed his attention to the subject, attracted to it by Lodge's lecture, and desirous, as he says, of repeating the experiments both for lecture purposes, and for registering electrical perturbations taking place in the atmosphere. apparatus and wave detector have already been described (see Chap. VI. § 3), as well as the publication of his description of them, and experiments conducted with them in January, 1896, in the Journal of the Physico-Chemical Society of St. Petersburg.

It is beyond question, however, that the use he made of his apparatus was not the communication of intelligence to a distance, but for studying atmospheric electricity. The observations were made at the Institute of Forestry, St. Petersburg. Popoff says—

"Upon the building of the Institute, amongst other arrangements made for observing the direction and force of the wind, there was a small wooden mast about 4 sajen (28 feet) higher than the rods carrying the anemometers and weathercocks, and which was furnished at the top with an ordinary lightning point and rod. This lightning rod, by means of a wire carried first on the wood of the mast, and further stretched across the yard on insulators into the meteorological observatory, was connected with the apparatus at the point A (Fig. 2), whilst the point B was connected to a wire which served as an earth conductor or connection for the other meteorological apparatus, and was connected to the water-supply pipes. The registering arrangements consisted of an electromagnet, to the armature of which there was attached a Richard pen writing on a Richard recording cylinder, making one revolution per week. It was found that the apparatus responded by a ring of the bell to every closing of an electric circuit which was recording observations of the direction and force of the wind, since electric oscillations were then set up in the conductors connected with the apparatus by the common conductor leading to the earth plate. In order to distinguish these marks from the others made by atmospheric electricity, the observers, who produced the ringing, made a note each time on the cylinder. This action upon the apparatus was, however, useful for the purpose of being sure that it continued in good order."

That this primary object was not telegraphy is shown by the paragraph with which he concludes his paper (loc. cit.). He says-

"In conclusion, I may express the hope that my apparatus, with further improvements, may be adapted to the transmission of signals to a distance by the aid of quick electric vibrations as soon as a means for producing such vibrations possessing sufficient energy is found."

We are left, then, with this unquestionable fact that at the beginning of 1896, although the most eminent physicists had been occupied for nine years in labouring in the field of discovery laid open by

See The Electrician, August 17, 1894, vol. 33, p. 458. For pictures of the Tindge apparatus exhibited at Oxford, see The Electrician, vol. 39, p. 687.

Hertz, and although the notion of using these Hertzian waves for telegraphy had been clearly suggested, no one had overcome the practical difficulties, or actually given any exhibition in public of the transmission of intelligence by alphabetic or telegraphic signals by this means. The appliances in a certain elementary form existed, the advantages and possibilities of electric wave telegraphy had been pointed out, but no one had yet conquered the real practical difficulties, and exhibited the process in actual operation.

2. Marconi's Work, 1895-1898.—Meanwhile, a young investigator had been busy in Italy. Guglielmo Marconi was born at Bologna on April 25, 1874, and very early displayed an original and inventive mind. He studied physics under Professor Rosa of the Leghorn Technical School, and made himself acquainted with the published writings of Professor Righi of the University of Bologna, whose valuable work on electromagnetic radiation was well known.

When little more than twenty years of age, Marconi had not only acquired much knowledge of Hertzian wave research, but he had clearly formed the intention of devoting himself to its utilization for

effecting wireless telegraphy.

On his father's estate at the Villa Griffone, near Bologna, he began experimenting in June, 1895, with Hertzian waves, using an ordinary spark induction coil, and making for himself experimental coherers or various forms of the Branly tube. Before long he originated an important improvement. Instead of employing the, Hertzian form of radiator, he connected one terminal of the secondary circuit of his induction coil to a metal plate or net laid on the ground, and the other by a wire to a metal can or cylinder, placed on the summit of a pole. The spark balls were kept at such a distance than on closing the primary circuit of the coil an oscillatory spark passed between them. At the receiving end he similarly connected a metallic filings sensitive tube between an earth plate and an insulated conductor or capacity. He then began systematically to examine the relation between the distance at which the spark could affect his coherer and the elevation of his cans or cylinders above the ground. This brought him speedily to the discovery that the higher the cans the greater the distance over which he could work.

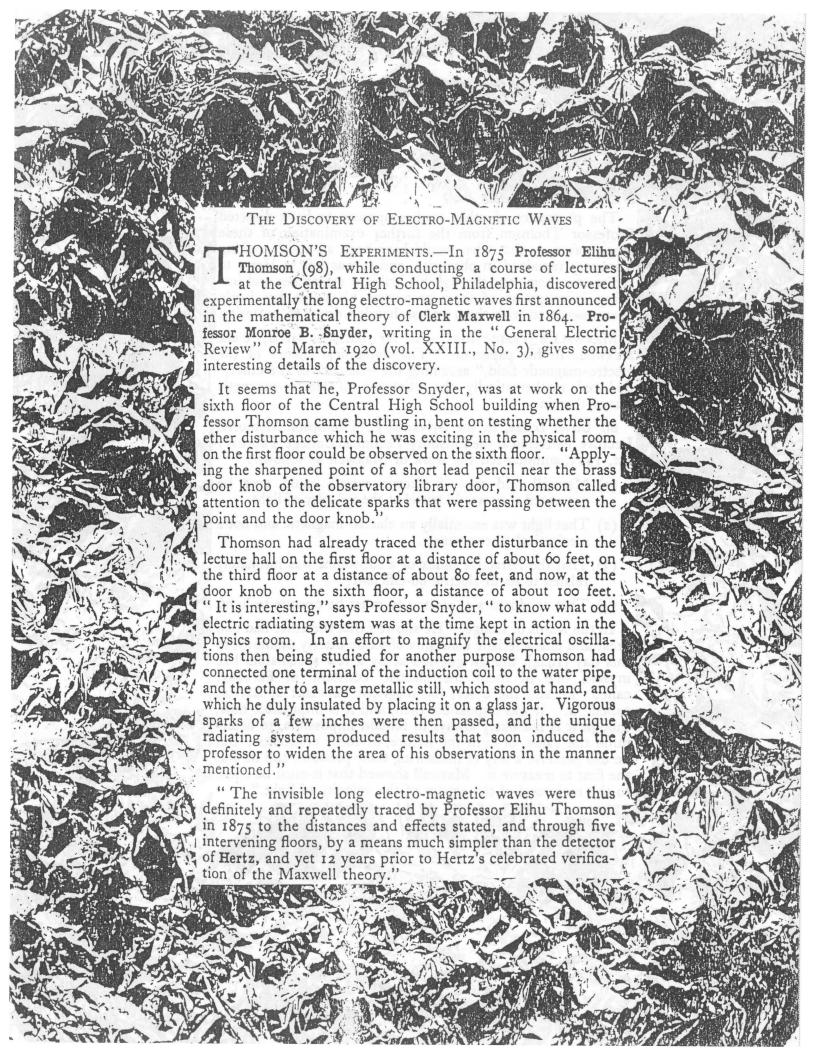
Thus in 1895 he was using cubes of tin about 1 foot in the side as elevated conductors or capacities, and found that when placed on the tops of poles 2 ms. high he could receive signals at 30 ms. distance, and when placed on poles 4 ms. high at 100 ms., and at 8 ms. high at 400 ms. With larger cubes of 100 cms. side fixed at a height of 8 ms. Morse signals could be transmitted 2400 metres,

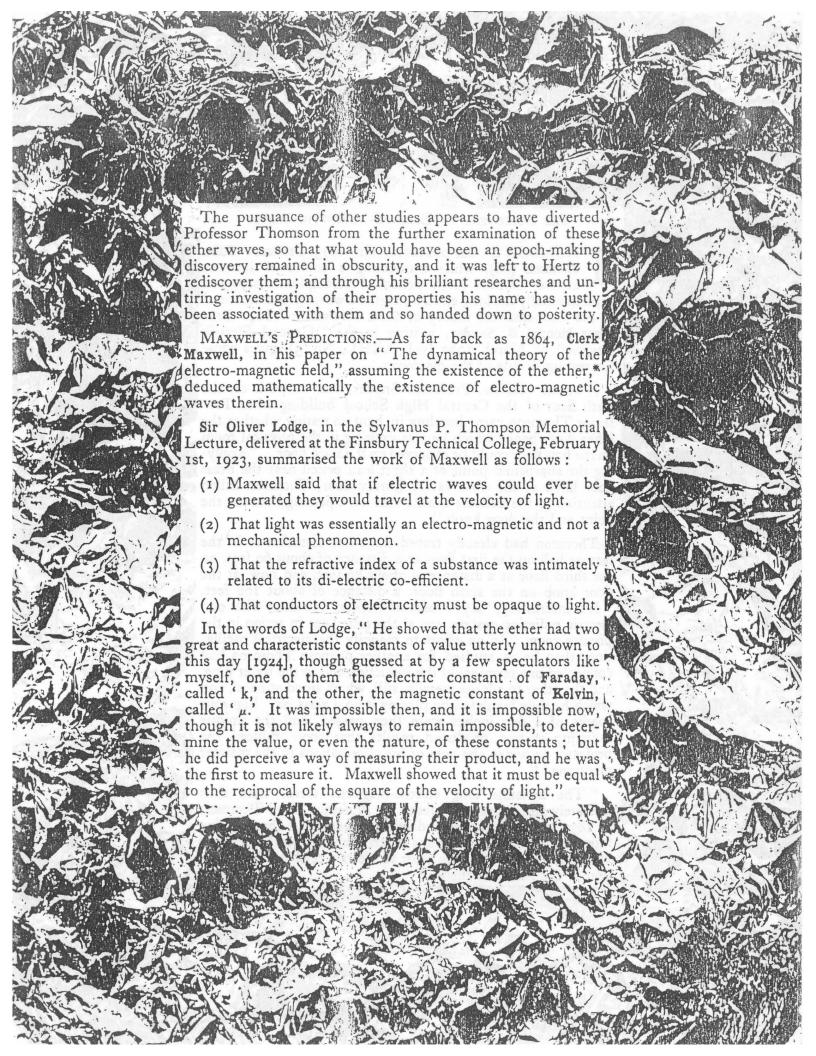
or 11 miles all round.

Before this time, however, he had improved the Branly metallic filings tube, and produced his own nickel-silver filings sensitive tube already described (see Chap. VI. Fig. 4). He had combined this sensitive and regularly acting improved coherer with an electric-tapping arrangement, but with more careful insight into the conditions to be fulfilled and a greater range of adjustment than previous workers.

He added also to the filings tube a pair of inductances or choking

circuit in parallel with the tube, and compel them to expend their energy on the tube itself. He placed in series with the tube a single voltaic cell and a sensitive relay, and employed the relay to actuate a Morse printing instrument worked by a separate set of cells. In addition, he placed shunt circuits across the tapper break contacts and relay contacts to prevent sparking, and therefore disturbances of the sensitive tube by local effects. Finally, he mounted the whole receiving arrangement on a board and enclosed the tube, tapper, and relay in a metallic box to shield them from the direct action of electric sparks made in their vicinity. In the primary circuit of the induction coil at the transmitting end he placed a Morse sending key, and he connected the secondary terminals to the earth and to an elevated conductor as described. At the receiving end he connected, in the early experiments, one end of the coherer tube to an earth plate, and the opposite terminal to an elevated capacity. Lastly, he made such adjustments of the tapping arrangements that when a short series of cscillatory sparks were made at the induction coil by just depressing the Morse key in its primary circuit for one moment, the combination at the receiving end printed a dot on the Morse tap, and when the key was depressed for a longer time it printed a dash. In this manner the two signals required for forming an alphabet on the Morse code were obtained, and letters and words could be printed on the tape at the receiving end by properly handling the key at the transmitting end. He employed at first the ball discharger of Professor Righi, which consisted of four solid brass balls, the two larger central ones being separated by a certain small interval, and the space between filled with vaseline oil kept in position by a non-conducting jacket or membrane. In some experiments Marconi placed the discharge balls in the focal line of a cylindrical parabolic mirror, and the receiver in the focus of another similar mirror, using, for the purpose of collecting the wave energy, two metal strips or rods, attached to the extremities of the coherer tube. In 1896 he came to England with this apparatus, and on June 2, 1896, he applied for a British patent, No. 12,039, for the invention, which was duly granted. The complete specification was filed March 2, 1897.6 In July, 1896, he introduced his invention and new method of telegraphy to the notice of Sir William Preece, then engineer-in-chief! to the British Government Telegraph Service, who had for the previous twelve years interested himself in the development of wireless telegraphy by the inductive-conductive method. On June 4, 1897, Sir W. H. Preece gave a lecture to a large audience at the Royal Institution in London on "Signalling through Space without Wires."7







machine. A main spark gap was connected between the aerial and earth, and across this main gap he arranged a circuit consisting of a Morse key having its contacts submerged in oil, a tank containing distilled water, and a small auxiliary spark gap.

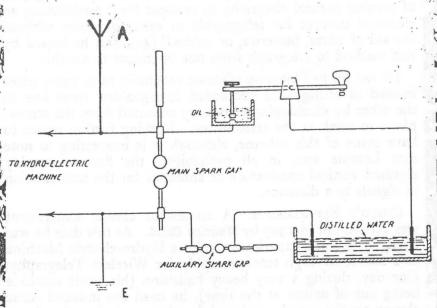
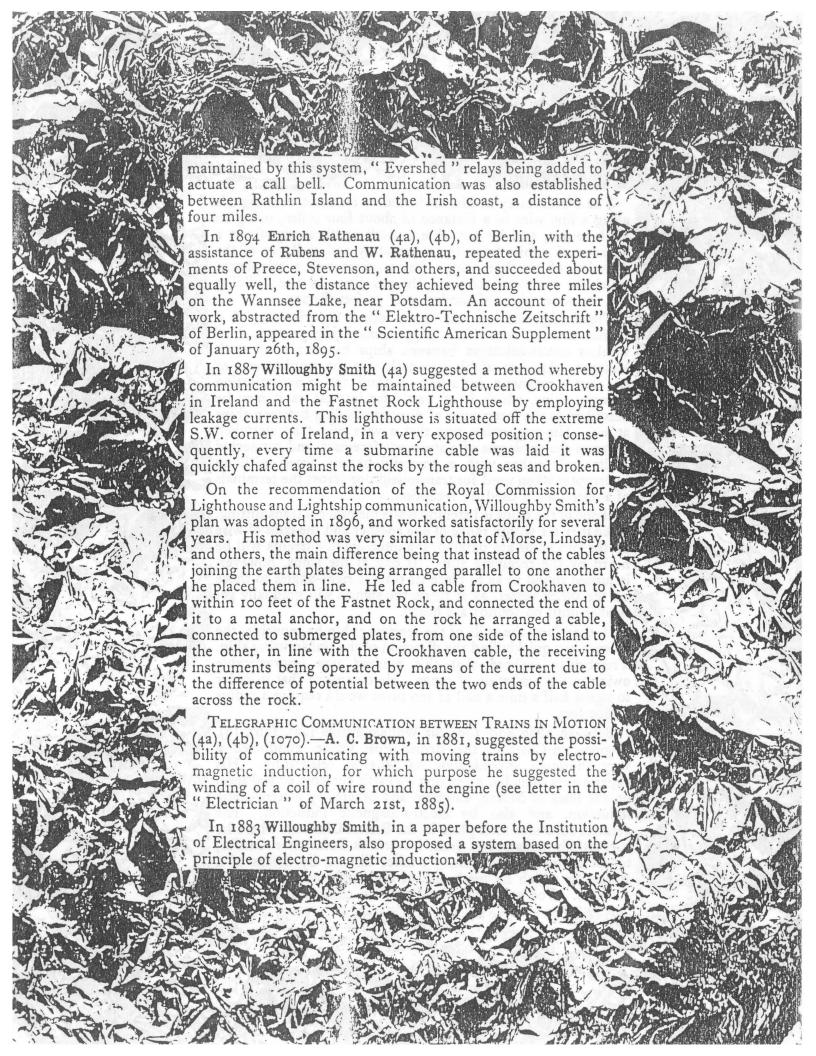


Fig. 21. M. Child's High-tension Key.

As long as the contacts of the key are closed a steady leakage of electricity takes place from the aerial through the water and across the auxiliary gap to earth. (The sparks seen at the latter are red in appearance and of a non-oscillatory character.) This leakage keeps the potential of the aerial from rising to a voltage sufficient to overcome the resistance of the main spark gap. When, however, the key is depressed the oil insulation stops the leakage, and the voltage instantly rises until the aerial discharges across the main spark gap.

EARTH CURRENT SIGNALLING.—In 1880 Professor John Trowbridge (42, 4b and 4d) read a paper entitled "The Earth as a Conductor of Electricity" before the American Academy of Arts and Sciences, in which he gave the results of researches he had carried out in the detection of earth currents by means of a telephone.

The Observatory at Harvard used to transmit time signals along a line wire to a distance of about four miles, using an earth return, and he was able to pick up these signals at a distance of a mile from the observatory and well out of the direction of the line wire. His receiver was a telephone, which he connected between the gas pipes in one building and the water pipes of another only 50 feet distant. Trowbridge carried out many other experiments of a similar nature, one of his suggestions being a method of wireless communication between ships by means of earth leakages. Another of his proposals was the employment of an electro-magnetic induction method for communication between ships, which is of particular interest as it may be described as the forerunner of direction finding between ships at sea. His suggestion was that a wire might be stretched between the yardarms of a steamer's foremast, and connected at its ends either with a powerful battery fitted with an interrupter when used for transmission or across the terminals of a telephone if used for reception. If one of the ships is listening while the other is transmitting, when they are within range of one another and the coils of wire on the two ships are parallel, the interrupted currents will be heard by the receiving ship. If one of the ships, however, is turned round so as to place its coils at right-angles to those on the other vessel, as it turns the signals will gradually get weaker until no sounds are heard. If, therefore, the coils of the receiving ship be movable, the listener can quickly find the direction of the transmitting ship. Trowbridge realised that this method was impracticable owing to the limitation of range. He computed that in order to signal half a mile a coil of ten turns would require a radius of 800 feet. Between 1882 and 1900 Sir William Preece (4a), (4b), (9), Engineer-in-Chief of the British Post Office, conducted a very thorough investigation of wireless telegraphy. His experiments included signalling by earth currents or leakages, on the lines of Morse, Lindsay, and others, by electro-static induction, and also by electro-magnetic induction. greatest successes took place in the Bristol Channel, where he successfully telegraphed from Lavernock Point near Cardiff; to the island of Flatholm, 3.3 miles distant, by means of a system in which he made use of both induced and leakage currents. For some years telegraphic communication was



TELEGRAPHY AND TELEPHONY.

534. Herlzian Telegraphy. E. Ducretet. (Comptes Rendus, 127. pp. 713-716, 1898.)—The author describes the "coherer" system of telegraphy in use since last October between the Eiffel Tower and the Paris Panthéon—a distancé of 4 km. The transmitter is the usual form of oscillator, excited by an inductioncoil giving a 25 cm. spark. This sparking-distance is diminished considerably when the exploring-wire is connected to the apparatus; the author attributes the diminution to the great capacity of the exploring-wire—the wire is not very far from the metal-work of the tower. The receiver is contained in a portable box at the Panthéon, and means are provided for registering the signals. It is worth noting that although this system works perfectly arranged in this way, it fails when the attempt is made to interchange the sending and receiving apparatus at the two stations, i.e., it fails when the Eiffel Tower is made the receiving station for signals sent from the Panthéon. The case is an extreme one, owing to the large masses of iron and other conducting material in the vicinity.



Wireless Telephony.—Collins.—An illustrated article on his system of wireless telephony. He uses long electric waves, produced by means of low-frequency, high-potential currents. The primary of his sending induction coil is in series with the transmitter, battery, variator and key; the terminals of the transformer are connected to the earth and to a compensating capacity; bridged across the terminals of the secondary is a Leyden jar condenser; the receiver is formed of a closed circuit, which has the telephone, a single dry cell, and the secondary of a transformer, in series; the primary of the transformer is earthed as in the case of the transmitting secondary of the induction coil. He succeeded in transmitting speech over three miles, the articulation being clear and loud enough for commercial purposes. He proposes to equip vessels with his system for communication with the shore.—Elec. Rev., November 29.

By Prof. J. W. Gore.

URING the summer of 1900 Prof. W. C. A. Hammel and the writer made some experiments relative to a system of signaling to and from moving trains, when the question arose, How, far could a wire the length of a car be placed from a telegraphic circuit, one end being connected with a coherer, so that the inductive effect of the current might still be sufficient to effectively operate the coherer? We tried placing the wire at various angles with the telegraphic circuit and found that the coherer responded even when apparently at right angles to the circuit.

Although my interest was aroused as to the nature of this effect, various other interests prevented further experimenting until the past session, when I directed the attention of some of my laboratory students to the problem. Some of their results, which I have since verified, may be of sufficient interest to note in your columns.

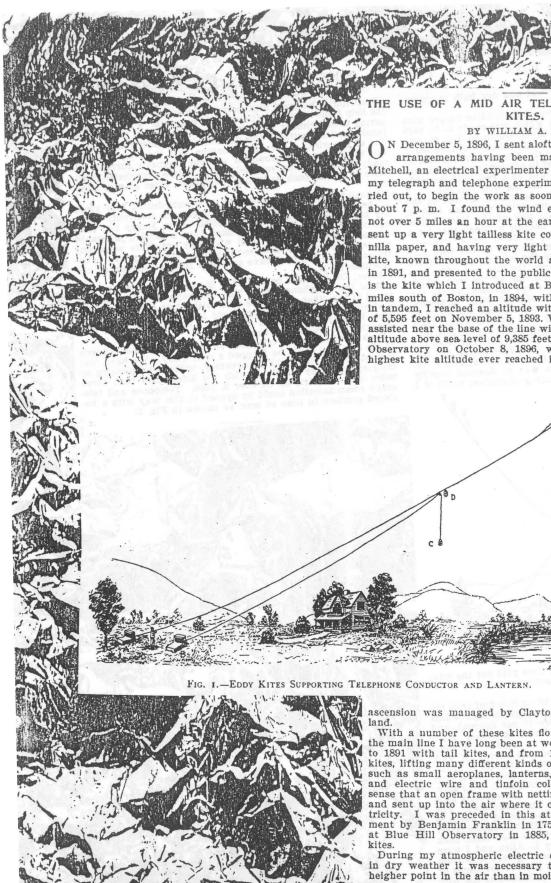
With the battery and coherer used it was necessary to have some inductance in circuit, such as a telegraph sounder or a small induction coil. Due precaution was taken to be assured that the effects were not the result of other than the causes mentioned. The antenna was placed quite accurately at right angles to the circuit. The coherer was effectively operated upon, making and breaking the circuit when the bare end of antenna touched the circuit; when the end of antenna was near or some distance beyond the circuit; when the antenna was doubled around the circuit or doubled back on itself and the end connected with the coherer. The effect is greater when a helix, having a conductor for its axis, is connected to the antenna, either end, the middle or both ends of helix being connected to the antenna.

Very decided effects were obtained in each of the above cases when one end of an open circuit was connected to a terminal of the secondary coil. In but a few of the cases were earth connections necessary, though the effects were increased by earth connections

The results obtained seem to be due to the same cause that operates the coherer when an insulated conductor, near the end of the antenna has its potential suddenly changed—namely, electrostatic induction.

It may be a hasty, though it seems a legitimate inference from the experiments, that long-distance wireless telegraphy is an electrostatic, rather than a Hertzian wave effect.

An oscillatory electrostatic stress between the conductor (earth) affected ether and the freer ether above the earth, would produce waves that would be propagated around the earth. The better the earth conductor, the greater the electrostatic effect; the smoother the surface of the earth the less the waves would be distorted and deflected. These are conditions which are found favorable for transmission of wireless telegraphic signals.



BY WILLIAM A. EDDY."

N December 5, 1896, I sent aloft a pilot kite at 4:30 p. m., arrangements having been made with Dr. William H. Mitchell, an electrical experimenter of Bayonne, N. J., where my telegraph and telephone experiments with kites were carried out, to begin the work as soon after dinner as possible, about 7 p. m. I found the wind extremely weak, probably not over 5 miles an hour at the earth, and for that reason I sent up a very light tailless kite covered with very thin manilla paper, and having very light sticks. It was a tailless kite, known throughout the world as the Eddy kite, devised in 1891, and presented to the public free of patent in 1892. It is the kite which I introduced at Blue Hill Observatory, ten miles south of Boston, in 1894, with which, using nine kites in tandem, I reached an altitude with my top kite at Bayonne of 5,595 feet on November 5, 1893. With seven of these kites, assisted near the base of the line with two Hargrave kites, an altitude above sea level of 9,385 feet was reached at Blue Hill Observatory on October 8, 1896, which is undoubtedly the highest kite altitude ever reached in the world. This great

ascension was managed by Clayton, Fergusson and Sweat-

With a number of these kites flown one above another on the main line I have long been at work at Bayonne, from 1890 to 1891 with tail kites, and from 1892 to 1896 with tailless kites, lifting many different kinds of experimental apparatus, such as small aeroplanes, lanterns, flags, silvered reflectors, and electric wire and tinfoin collectors, collectors in the sense that an open frame with netting was coated with tinfoil and sent up into the air where it collected atmospheric electricity. I was preceded in this atmospheric electric experiment by Benjamin Franklin in 1752 and Alexander McAdie at Blue Hill Observatory in 1885, both of whom used tail

During my atmospheric electric experiments I found that in dry weather it was necessary to send my collector to a heigher point in the air than in moist weather. I proved this by measuring the humidity with wet and dry bulb thermometers.

I had two or three thousand feet of thread-like copper wire which was bare of insulation and which was ready to be paid out upward along my heavy kite cable, which by 7 p. m. was well sustained in the air by the first pilot kite just mentioned (6 feet in diameter), and two slightly heavier kites, 7 feet in diameter. The wire had been used in atmospheric electric experiments with success; it was wound on a reel with movable spools which could be replaced in case the wire ran out.

About 7:30 p. m. Dr. Mitchell, the electrician, arrived on the open lot from which the kites were flying with one lantern aloft. The wind declined, and the pull of the kites, which were flying toward the northeast, became so weak that for a time I feared it would be necessary to defer the experiment. Luckily the wind strengthened, and by 8 p. m. the wire was paid out from the wire reel across the lot to a point on the kite line about one hundred feet from the kite reel. The kite cord was then run down to meet the end of the wire which was passed through three harness rings fastened across the kite line and bound to a rigid piece of bent wire. A permanent red lantern, D, Fig. 1, was attached near the rings to show the point at which the running wire was suspended from the kite cable. Then the kites were paid out from the kite reel, A, and at the same time the bare wire was paid out from the reel, B, while a plummet lantern, C, was fastened to the end of the running wire. If I stopped the kite reel and paid out the running wire then the lantern was to descend rapidly some distance away beyond intervening obstacles; while if I I attribute the great clearness of the sound theoretically to the help from earth and atmospheric currents. I am now preparing to experiment with this midair wire to see if I can get results entirely without the magnets in the telephone at each end of the wire. I assume, of course, that the telephone will not work if merely grounded without magnetic currents already emanating from each telephone, unless a magnetic storm were in action, such as invades telegraph wires at rare intervals.

I have found strong atmospheric currents during four years of persistent experiment with atmospheric electricity from my kite wires, since October 8, 1892. Prof. Henry had long ago shown us that a lightning flash from a Leyden jar would magnetize steel needles. And why may not these persistent atmospheric currents, always present whenever my wire penetrates upward 600 feet, have sufficient force to operate an ear telephone?

Later, Dr. Mitchell connected a Morse sounder run by one cell to the telephone wire. The telegraph signals could be heard at the other end of the wire with great clearness. With a strong battery the message could have been sent from my kites by way of the main telegraph or cable system to San Francisco or around the world.

Such a wire, with a telephone instead of plummet lantern at the end of it could be dropped a mile away. We have just noticed that at Blue Hill Observatory, without telephoning or telegraphing, they paid out with the kites more than three-miles of piano wire, on October 8, 1896. Telephone and telegraph communication could be opened in this way with a besieged garrison in time of war, as shown in Fig. 2.

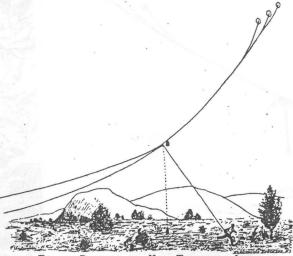
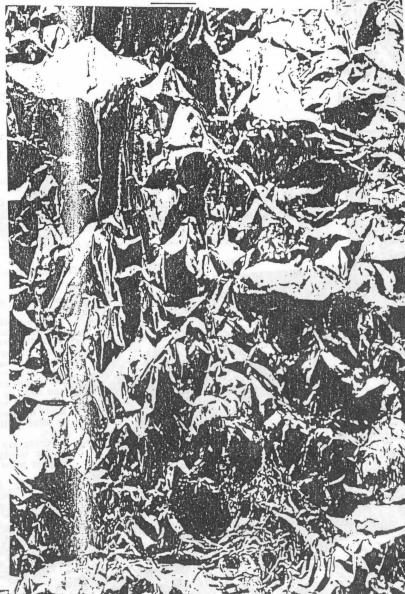


FIG. 2.—RUNNING THE KITE TELEPHONE LINE.

stopped the wire reel and at the same time paid out the kites upward and away from me, then the lantern would rise in the air as the kites receded.

This is what really happened later, but on this first trial the friction of the wire against the harness rings through which it ran was so great that the lantern would not descend, and the wire broke, dashing the plummet lantern to pieces. ally found an old pulley, which had been used for another purpose, about 3 inches in diameter, and this started off well, but the wire jammed in behind the wheel and again broke, causing the plummet lantern to fall about 400 feet upon a hard stone pavement in front of the residence of Col. C. W. Fuller. The lantern globe was smashed to atoms. However, I soon had another lantern in the air and this time succeeded. wire with the plummet lantern, C, at the end of it reached the ground about 1,000 feet away, and Dr. Mitchell immediately grounded it with a brass grounding rod. He then came back to the base of the kite line where Henry L. Allen and I were managing the reels. He then ran a connecting bare wire from an iron pin driven into the earth through the two terminals of a small hand telephone without a bell attachment, to the wire which had been carried up the kite string and grounded at the other end. At the end where the kites were held the wire was not detached from the wire reel. Dr. Mitchell then told me to listen continuously at the telephone. I did so for some time, and heard nothing. I was about to give it up when 1 heard a faint clicking sound, which was the adjustment of the wires to the two poles of the telephone at the other end. Finally the first kite telephone message in the world came over the wire, sharp and clear: "Do you get me?" I answered "Yes. Good." After a few more words I looked at my watch and found it was 9:35 p. m.

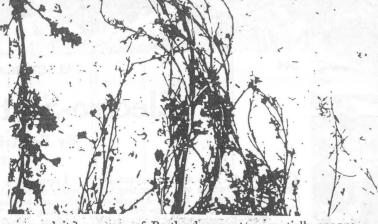


1500. Transparency to Hertzian Waves. G. Le Bon. (Revue Scientif. 11. pp. 513-526, 1899.)—The shortest Hertzian waves yet produced are of 5 mm. wave-length. In Hertz's work the difficulty was to produce waves which could be detected. Nowadays the difficulty is not in producing Hertzian waves, but in avoiding their production. Even to touch anything is enough to produce these waves. When an induction coil is used, the spark must be very short; the frequency is then high, the colour of the spark is different, and one pole of the coil can be touched without pain. The variations of conductivity in a coherer are only an exaggeration of what must occur in every circuit-wire clamped in by binding screws, upon the production of any spark in its neighbourhood. This can be readily shown by measuring the resistance of a pile of discs of iron, bismuth, or aluminium, before and after passing a spark near it. If the discs be of different metals, shocks will bring the resistance up to 30,000 ohms, and a spark will suddenly reduce this to 3 ohms. Copper wire does not produce this effect; if iron wire had been more generally used, Ohm's law might not have been discovered, for making and breaking the circuit itself makes sparks sufficient to produce the disturbing effect referred to. And more than this, the neighbourhood of copper seems to prevent this effect, so that a pile of alternate discs of copper and aluminium obeys Ohm's law.

Metals are apparently not nearly as opaque to Hertzian waves as was at first thought; but if the enclosure be perfect the waves do not get through. The apparent transparency is due to the waves getting through chinks or round the metal; but if there be no chinks, a thickness of $\frac{1}{100}$ mm. is as effectively opaque as one of 2 mm., and forms a perfect screen, so that waves cannot even travel down a metallic rod into the interior of a perfectly closed box. A chink is much more effective in allowing rays to pass through than a much more considerable series of apertures; and metallic gauze is very nearly as opaque as a plate.

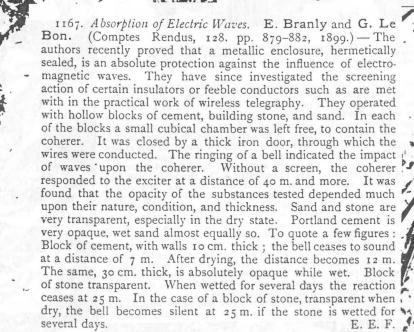
The length of the waves makes them turn round obstacles with great facility; which accounts for the apparent partial transparence of metallic mirrors.

Non-metallic substances have been considered to be perfectly transparent. But do the Hertzian waves come through a hill



or round it? 12 cm. of Portland cement are partially opaque, 30 cm. wholly so. Dry sand is almost completely transparent, wet sand much less so. Freestone is much less opaque than cement; but it becomes more so when wet. These bodies are far more transparent for Hertzian waves than for light, but the transparency varies from one body to another, decreases as the thickness increases, and increases when the bodies are wet. The waves therefore come round, not through, a hill.

If we put together: (1) a 25 cm. induction coil; (2) a sparkgap and two Leyden jars; (3) a solenoid coil connecting the two Leyden jars; (4) a large coil of copper wire; (5) two wires leading from the ends of the solenoid (3), one to the lowest point of the coil (4), the other to a point of the same to be found by trial and error; (6) a wire leading from the top of (4), and with a free tip; then on setting (1) in action, sparks pass in (2), and an oscillating current in (3), which current is partly taken through (4), and there affected by self-induction, so that a large "brush" is formed at the tip of (6), and this brush traverses dielectrics freely without deviation (therein differing from the ordinary) electrostatic brush), and in the dark can be seen to do so. This bombardment ruins a Geissler tube as if it had been riddled with small holes; but the explanation of the phenomenon is still to be found. The photo-plate shows that the phenomenon extends to a considerable distance beyond the visible glow of the brush. At two metres distance a Geissler tube will glow up. The whole field of the brush seems to become a rapidly oscillating electrostatic field. A distribution-table within it at some distance, when the induction coil had a 50 cm. spark actuated by a 110 volt current, was covered with sparks; the wires fused and shortcircuited, and a conflagration was started. If this brush could be concentrated upon a warship, it would be caught up by the electric wires and would cover them with sparks which would soon cause an explosion. The same effect could no doubt be produced upon ammunition stores, and even the contents of soldiers' cartridge belts.



Electro-Static Experiments

By Frederick von Lichtenow

PART II (Conclusion)

Y EVERAL years ago I happened upon the instructive and interesting little work entitled, "Simple Experiments in Seria Flourisity" by Percival G. in Static Electricity," by Percival G. Bull. Experiment No. 9, Chapter IV, of this book, dealing with spectacular condenser discharges, imprest me very much; in fact, to the extent that I couldn't help but give it the due tryout. The "bronze" or "metal" paper referred to and needed in the experiment seems, as I faintly remember, to be an uncertain article on the local market. There is something entirely wrong with it. Either the demand for it is so brisk that stocks are early exhausted, or there is no call for it at all, and, consequently, nobody bothers with it. I was for a time inclined to think the latter way, until finally, after a prolonged and fruitless search among the various stationery stores, was shown at some small place what looked to be the remnant of a once glorious pile. Whether I purchased the real, honestto-goodness "metal" paper or not has been an open question with me to this day, since it was not sold to me under that somewhat mysterious sounding name. At any rate, it

I mention this little incident only as an

I employed in these experiments two very finely made static Leyden jars of one pint size each in connection with the always dependable little "Electro" Wimshurst static machine. According to the book in reference the jars are to be placed one at each end of the paper and connected with their inner coatings to the respective poles of the machine. I have placed them in various positions, these latter depending on the spark effect desired, as well as necessitated by the nature of the paper itself.

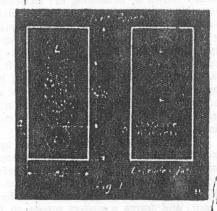
nature of the paper itself.

The following illustrations and short descriptions give the results of my tests (Fig. 1).

Characteristic of this paper is that the sparks always show a strong tendency toward branching out over its surface, whether the distance between the jars be a few inches or a foot, or even more. Their color is a beautiful bluish-white. With the jars separated by only a few inches, and up to six inches or so, the discharge manifests itself in thousands of bright little stars hanging together by shiny threads. These very striking effects are due to the relatively high conducting quality of the metal particles covering this paper.

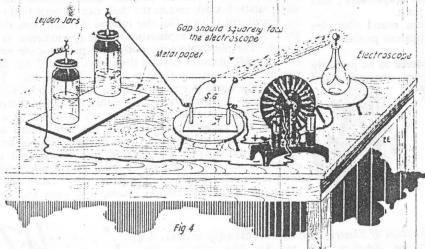
The paper illustrated in Fig. 2, offering a

ately) lighted room. The papers may be placed in triple or quadruple layers, thus insuring a better insulation for the Leyden



Spectacular Condenser Discharges Can Be Arranged With Metalized Paper, i Pair of Leyden Jars and a Small 3" Static Machine. This is a "Silver Paper" Experiment.

jars, in addition to which an oilcloth covered ing on the table may be advisable. Cau in must be taken that the discharge balls and the machine are first to be separated beyofts, sparking distance while charging the jure and not set "a few inches apart," as p' be scribed by the text book, which may arst misunderstood, since the small Wimsh's a machine I used in these tests deliventhy three-inch spark alone, when in a heaver condition, not to speak of the many largely static machines with their correspondings greater output.



A Novel and out-of-the-ordinary Static Experiment Which the Author Discovered. The Insulated Electroscope Responded to the Unipolar Oscillatory Waves Set Up by a Silent Discharge in the Spark Gap, Owing to its Ball Being in Line With Those on the Spark Gap.

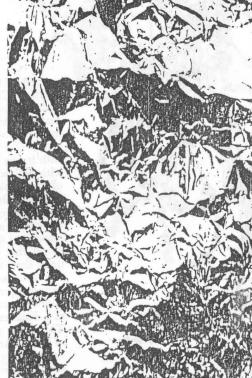
example of the handicaps, which at times confront the experimenter even in big cities, and which are only too frequently responsible for the fact that many otherwise highly instructive and fascinating experiments are left untried. Needless to say, I have had several real disappointments of this nature since, not only "close calls" like the above.

My aim in this article is to put down the results obtained with, and various spark effects noted on, three different grades of "bronze" or "metal" paper—the only number I was able to secure—which are not given in the aforementioned book. Following in the order of their relative resistance capacity they are "silver" paper, the "copper-bronze" paper and the "brass-bronze" paper, the latter being the poorest conductor of the three. They measure each, as cut by me, 19½ inches in length (the original width of the paper) by 8¼ inches wide, an ample size for the accommodation of even the largest Leyden jars ordinarily used.

somewhat higher resistance to the condenser discharge than the former, limits the distance between the jars to ½ of a foot. At or near that distance the sparks are very pronounced and appear concentrated in the form of miniature lightning bolts of a clear white color. They hit around in curves and are accompanied by a loud report. If the jars are approached to within 4 inches or less, as indicated in "b," the sparks will dart in spray fashion across the intervening space lighting up in a vivid emerald green.

in spray fashion across the intervening space, lighting up in a vivid emerald green. (Fig. 3.) As I have stated before, this paper is a poor conductor, and, consequently, permits only a separation of a few inches between the Leyden jars. Set at that distance, the spark effect is very similar to the one noticed on the "copper-bronze" paper, Fig. 2-b; however, it is not quite so distinct. The color shade of the sparks runs more into a dull yellowish green, not unlike that or oxidized brass.

The above spark-and-color effects are those as observed in an artificially (moder-



INSTITUTION OF ELECTRICAL ENGINEERS. Ætheric Telegraphy. BY W. H. PREECE, C.B., F.R.S. (PAST-PRESIDENT). I have never submitted to the Institution of Electrical Engineers any record of my long and continuous researches on signalling through space. My reports have been made from year to year to Section A of the British Association. Some of them not having been printed, it is not to be wondered at that all my work is not known, and so much of it is occasionally reproduced by others. I will confine my remarks in this paper to ætheric telegraphy, and to its electromagnetic form alone. In 1884* disturbances—that is, stray currents producing extraneous noises on the telephone—were detected on the circuits erected over the house-tuns, produced by currents.

In 1884* disturbances—that is, stray currents producing extraneous noises on the telephone—were detected on the circuits erected over the house-tops, produced by currents in telegraph wires buried in iron pipes in the streets. Messages sent on the telegraph wire were actually read on the telephone circuit, though the wires were nowhere in contact. Exhaustive experiments were made to prove that

"'Induction between Wires and Wires," B.A. report, Birmingham, 1886.

these results were due to induction and not conduction. This was done by making the circuits metallic. They were separated from each other by a span of 80ft.

Many preliminary laboratory experiments were made with coils of many turns, but in 1885 square coils of insulated single wire, each side being of 440 yards length, were laid horizontally on the ground in the neighbourhood of Newcastle, and conversation by telephone was effected from one to the other through a space of one-quarter of a mile. Disturbances between these squares were appreciable at 3,000ft., and even at a distance of 1014 miles between parallel lines of telegraph connecting Durham and Darlington. In 1886* experiments were carried out across the Severn for a length of 14 miles between Bristol and Gloucester, the parallel wires being separated by a mean distance of 4.5 miles. Primary currents of 0.449 ampere were rapidly made and broken by mechanical means, producing on the telephone a continuous note which could be conveniently broken up by a Morse key into dots and dashes, as in Cardew's vibrator. Disturbances were observed in the secondary circuit. The circuits were metallic and of many miles in length, that on the Gloucester side being completed through Stroud, and that on the Welsh side through Monmouth. Here we had just reached the limit of disturbance with the means at our disposal. It afforded a convenient measure of the range of audibility. The unexpected fact was shown that, whether the circuits were metallic or earthed at the ends of the parallels, the results were the same. This was confirmed subsequently by innumerable experiments, especially by some results obtained between Arran and Kintyre in 1894. All our experience since has shown that a coil of one single turn of thick copper wire, and of the largest possible diameter, gives the best result, and signals to the greatest distance. Moreover, it will be shown that the greater portion of this coil may be made up by the In a single turn thus formed we have the full beneficial effect of electromagnetic as well as of electrostatic induction, we have the advantage of earth conduction, and we reduce capacity and inductance to their minimum. In closed coils of many turns we have only electromagnetic induction, and we make inductance a maximum. In the autumn of the same year (1886) the vast expanse of sand at Porthcawl, in South Wales, was used to further develop the law determining these effects Two horizontal squares of 300 yards per side were placed 300 yards apart, and subsequently one of them was suspended on scaffold poles 15ft. above the other, which was covered with water at high tide. No difference was detected in the strength of signals, whether the space were air or water, or a combination of air and water. Subsequent experiment (1893) showed that through 15ft. the effect in air was distinctly better than through water.

BY ELLISON HAWKS F.R.A.S

30.—Augusto Righi's Experiments with the Hertzian Waves.

FOR some time the discoveries of Hertz had been the subject of experiment in many laboratories in different parts of the world, and soon further additions to our knowledge were made. Hertz's waves, for instance, were many metres in length, and it does not seem that he ever worked with waves of less than 30 centimetres. It was not long before shorter waves were produced and also improved methods of propagating and detecting the waves.

Some of the most important developments at this time were made by Augusto Righi, Professor of Physics at Bologna University. Righi, who was a native of Bologna, was born on August 27th, 1850, and died on Tune 8th, 1920. He was a scientist of some distinction and, as we shall see later, aroused a great interest in the

Hertzian waves in one of his young pupils-Marconi. Soon after Hertz had announced the discovery of the electro-magdetic waves Righi commenced to investigate them, paying particular-attention to their optical properties. In 1897 he em-bodied his results in a treatise, not yet published in English, entitled "Optice Elettrica."

Centimetre Wavelengths.

By using exciters with very small spheres, Righi was able 10 propagate waves of 2.5 centimetres. He found that the smaller the spheres, the shorter are the waves. By using minute spheres of platinum, Prof. Chunder Boze, of Calcutta, was able to produce raves of only 6 mm., and thus we carried the matter to its extreme, and imagined the ultimate atom to be used, we

should get waves the length of which correspond approximately to light waves.

Righi also effected a considerable improvement in Hertz's " exciter," by replacing the hollow spheres with olid metal balls, which enabled the waves to be transmitted to nearly double the distance.

Hertz had found that the spheres quickly oxidised, and their roughened surfaces caused the action to become regular. This necessitated that the spheres should be requently cleaned and their surfaces polished. To overome this difficulty E. Sarasin and L. de la Rive, of neva, immersed the spheres in olive oil. The sparks were then found to be greatly strengthened but the oil

Pioneers of Wireless .-

quicksilver, as used for mirrors, rendered discontinuous by cross-lines lightly traced with a diamond.

Righi died in 1920 and thus lived not only to see the full development resulting from his pioneer work, but also to witness the complete triumph of his one-time pupil, G Marconi-a triumph that must have been a continual source of pleasure and pride to the one whose enthusiasm for Hertz and his work had undoubtedly directed the young man's attention to the subject in which he met with such conspicuous success.

Righi resembled Hertz, and other modest workers, in

was found to carbonise quickly. Righi further improved on this suggestion by placing the metal balls in an ebonite frame and filling the spark-gap with vaseline-oil, thickened by the addition of ordinary vaseline and contained

in a parchment envelope filling the spark-gap.
Righi found that this "liquid cushion" seemed to have a heightening effect on the electric potential, and also that it had a regularising effect making the production of the waves more uniform. He also found oxidisation very materially reduced, and even after working for a long time, when the vaseline had become black and the surfaces of the balls was covered with a deposit of carbonised vaseline, the apparatus continued to perform satisfactorily.

Before the Hertzian waves could be turned to practical

use for wireless communication, however, and before any system of wireless telegraphy could become commercially possible, it was evident that some more delicate apparatus than Hertz's somewhat crude resonator spark gap was necessary for the detection of the waves in space. As we have seen, such an apparatus was subsequently forthcoming, and in its final form was given to the world by Edward Branly, of France, whose pioneer work in this connection has already

At the time Righi was at work on the subject, however, the coherer principle had not been developed. Little was known of its action beyond the fact that in 1850 Guitard had noticed that when dusty air was electrified from a point, the dust particles tended to

cohere into strings or flakes-a long-forgotten observation that seems to have been re-discovered in 1866 by S. A. Varley, who made the first practical application of the principle of cohesion by embodying it in the construc-

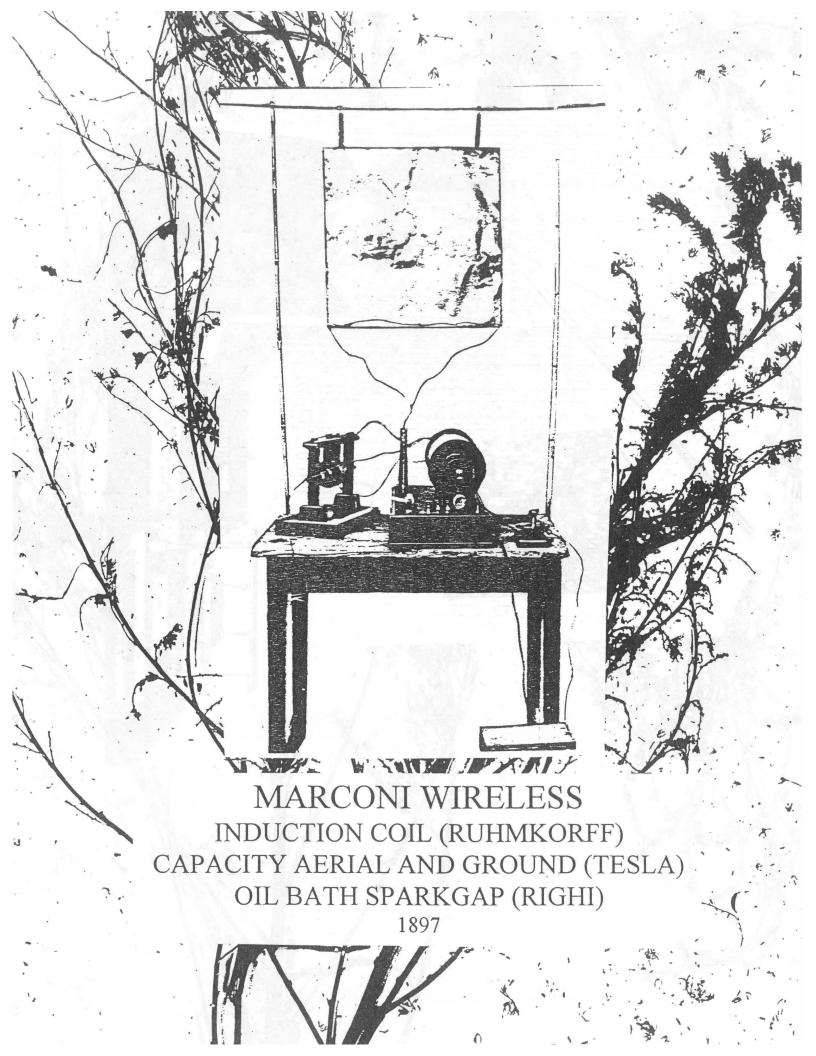
tion of his lightning protector for telegraphic apparatus.
Other forms of detectors—based on physiological, chemical, electrical and mechanical principles-were at this time under experiment, when Righi introduced what he considered to be an improved form of detector. Hertz's " rectifier " had consisted of simply a wire bent in the form of a circle, cut in one place and the ends terminating in small metal knobs, between which the sparks appeared. Righi's detector consisted of bands of

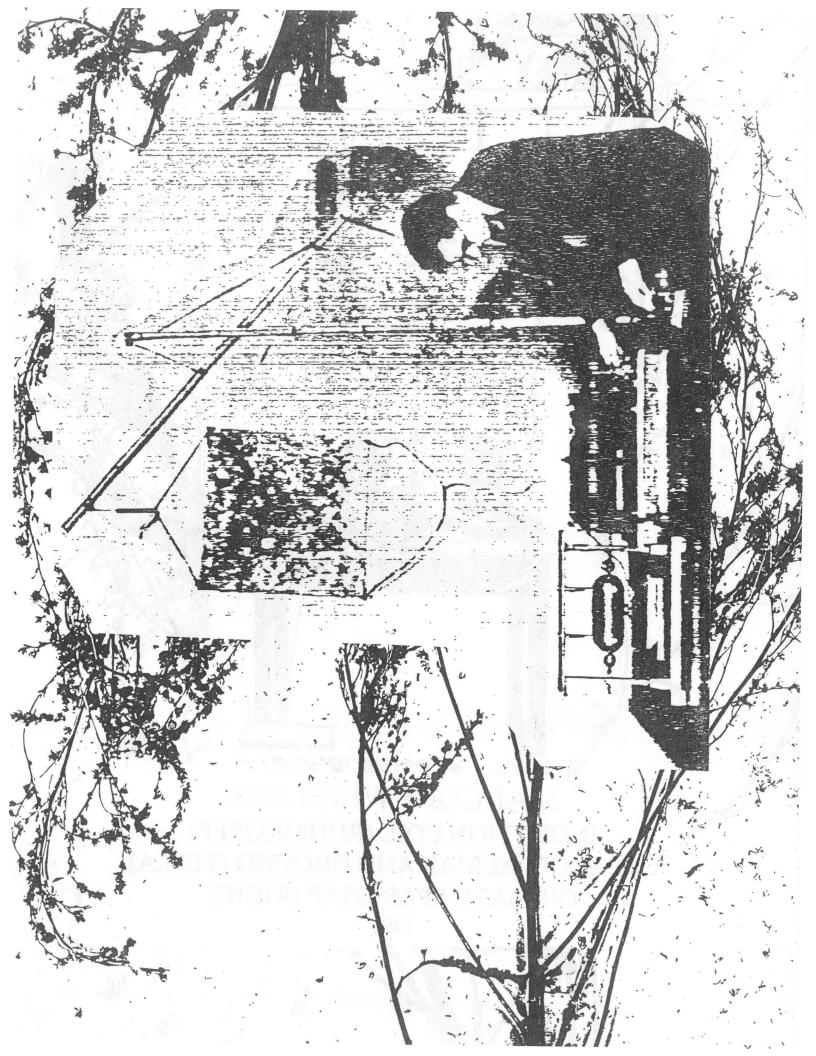


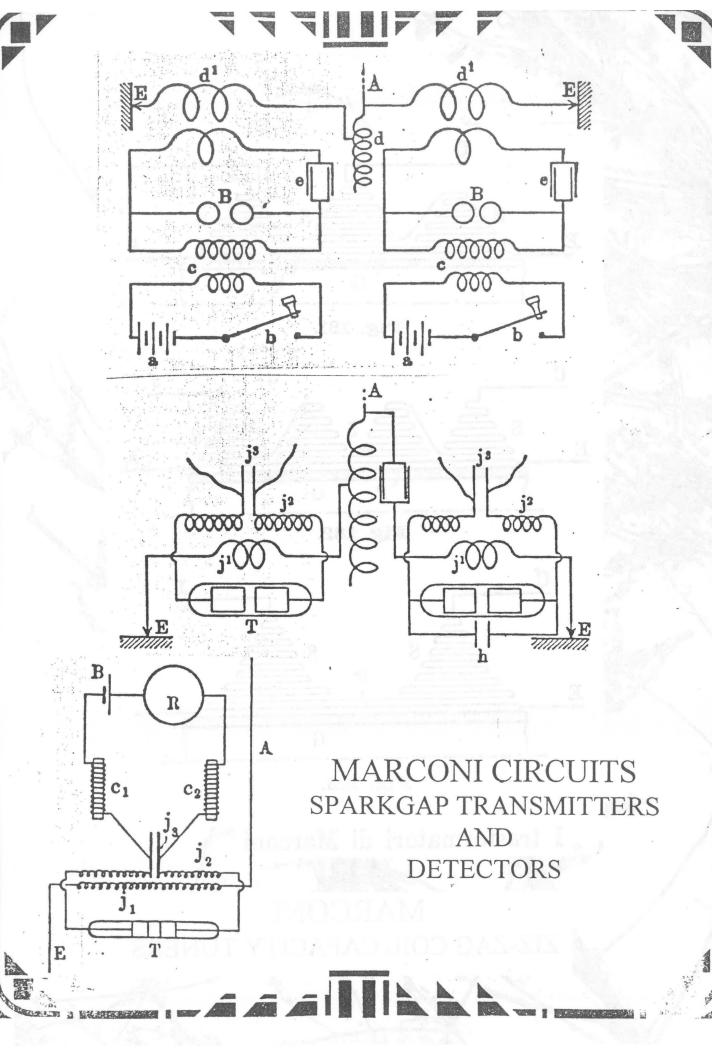
Augusto Righi.

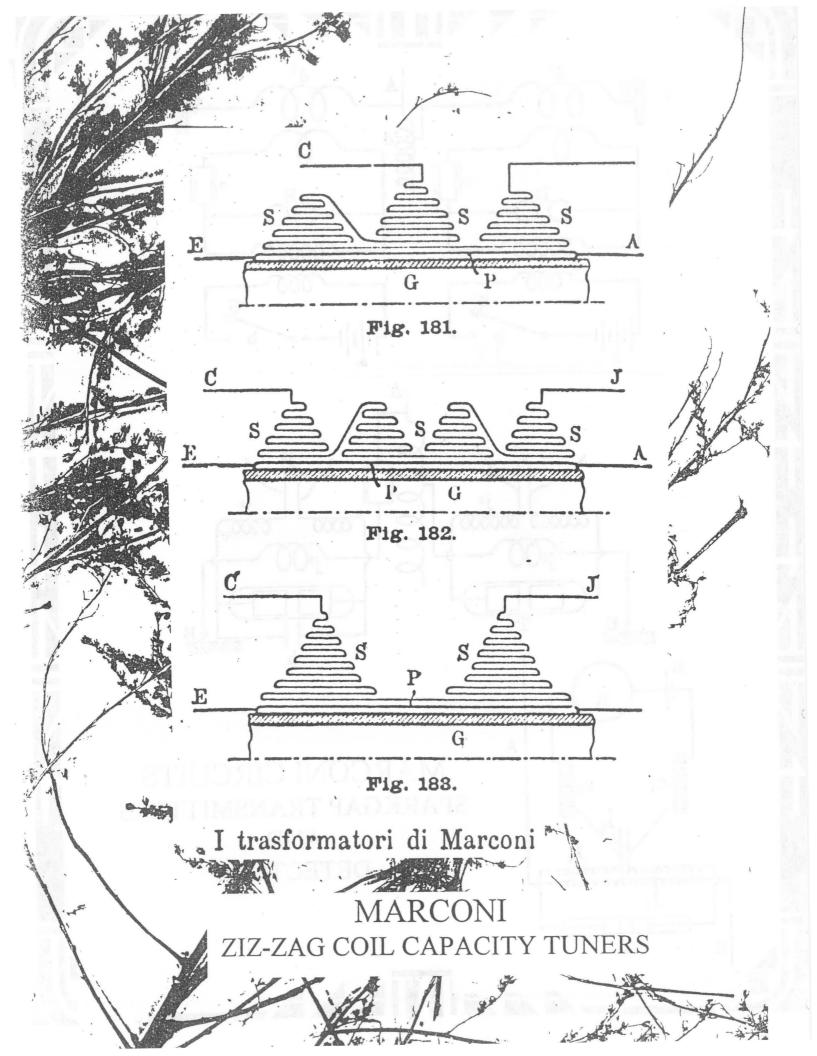
been fully dealt with.

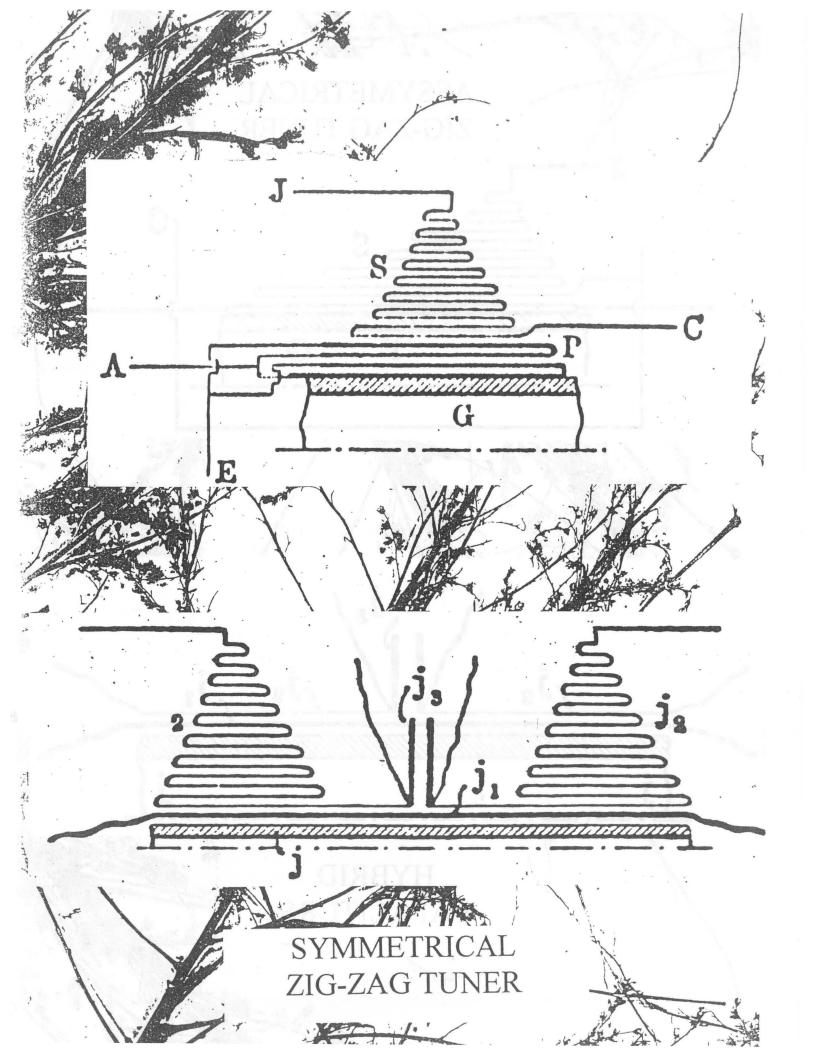
his dislike of publicity. "Righi's friends," wrote his friend Augustus Trowbridge, "appear to have been jealous lest he should fail to receive proper credit for his part in making wireless communication possible. But not so Righi himself—he cared little for popular applause, and actually enjoyed a fuller measure of it in his own country than ordinarily falls to the lot of a pure scientist."

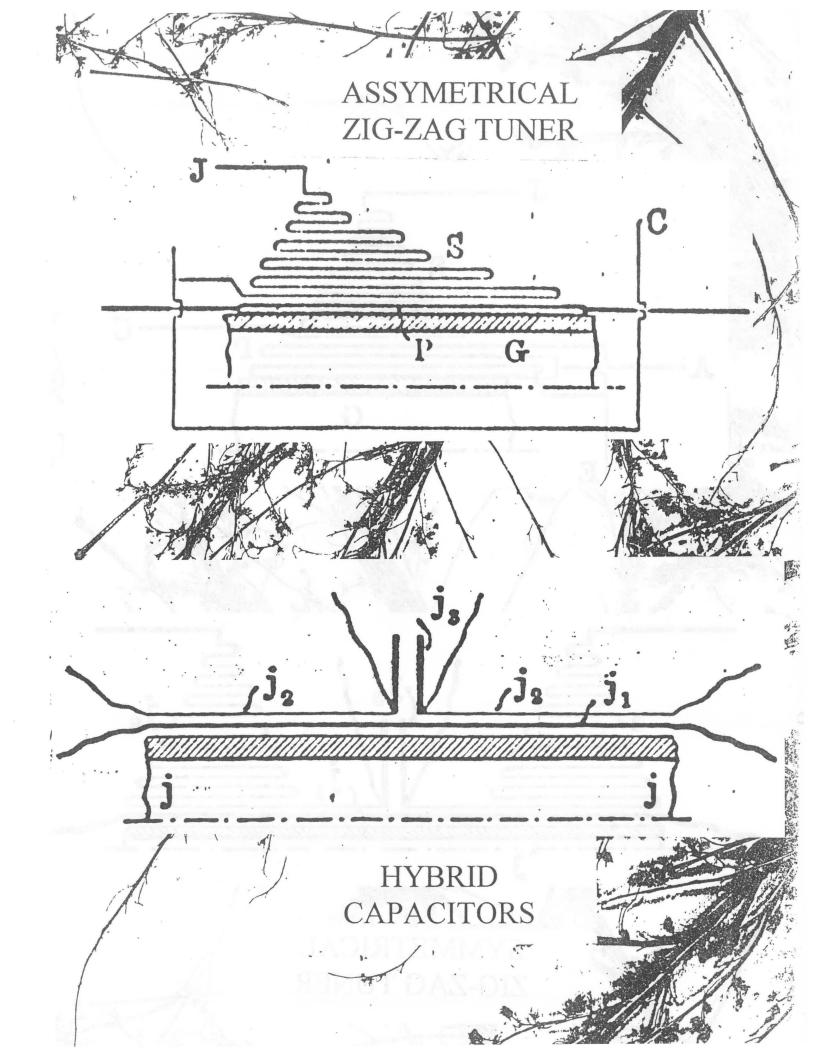


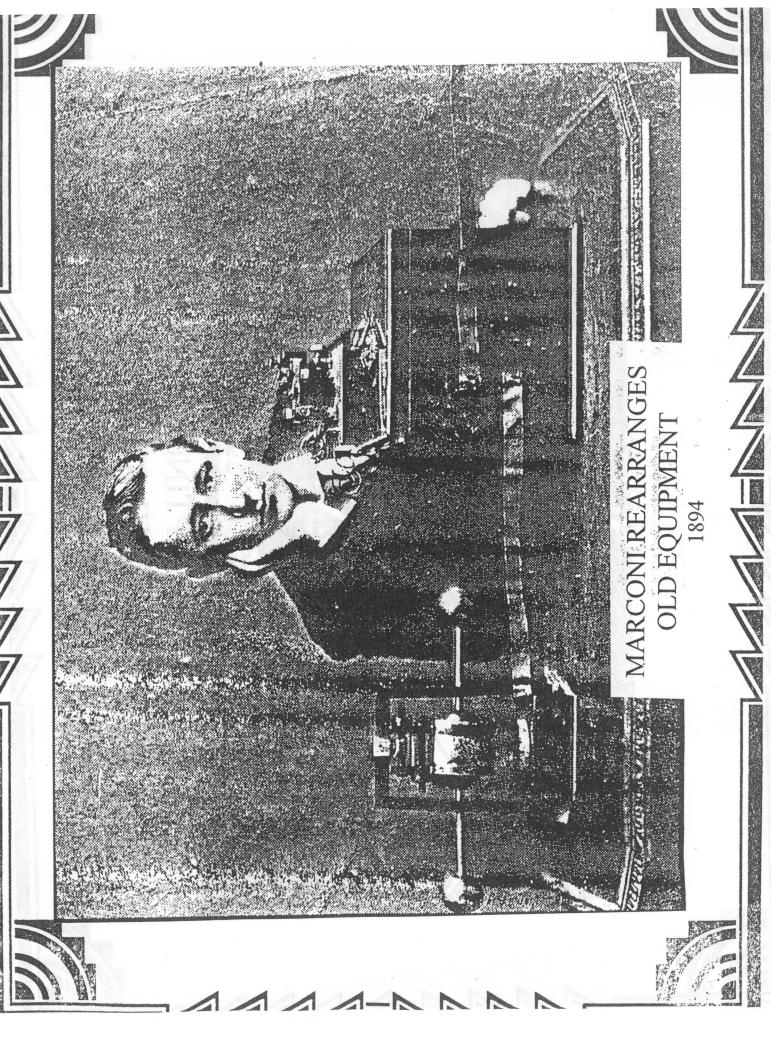






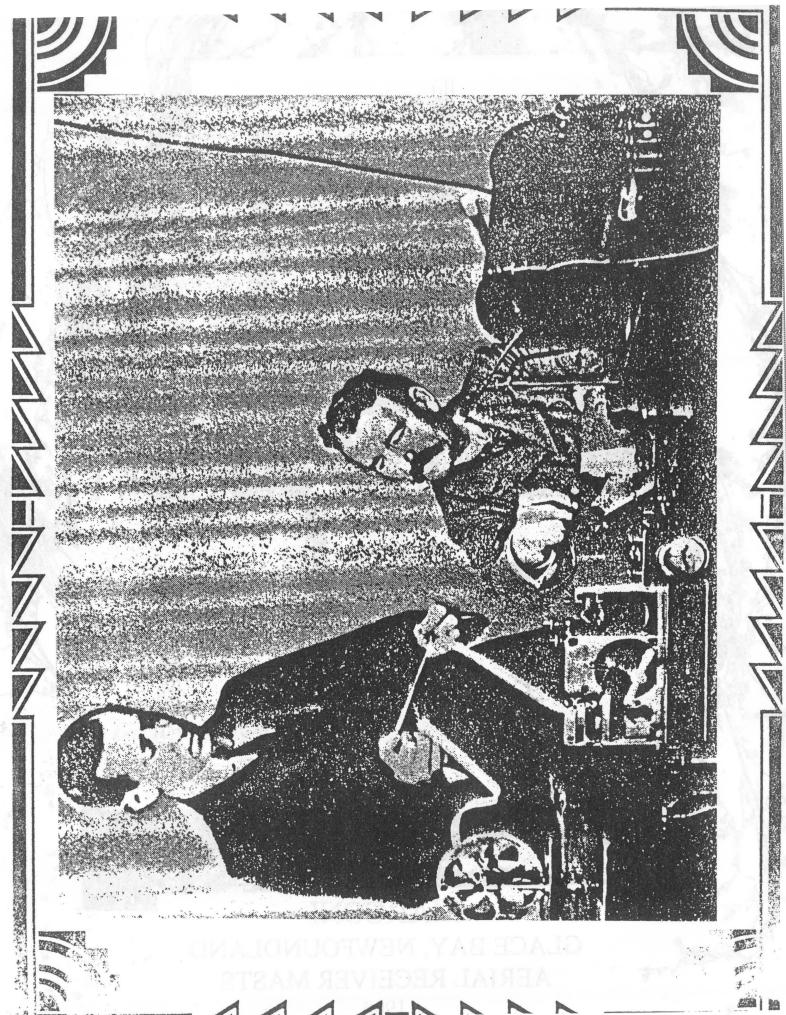


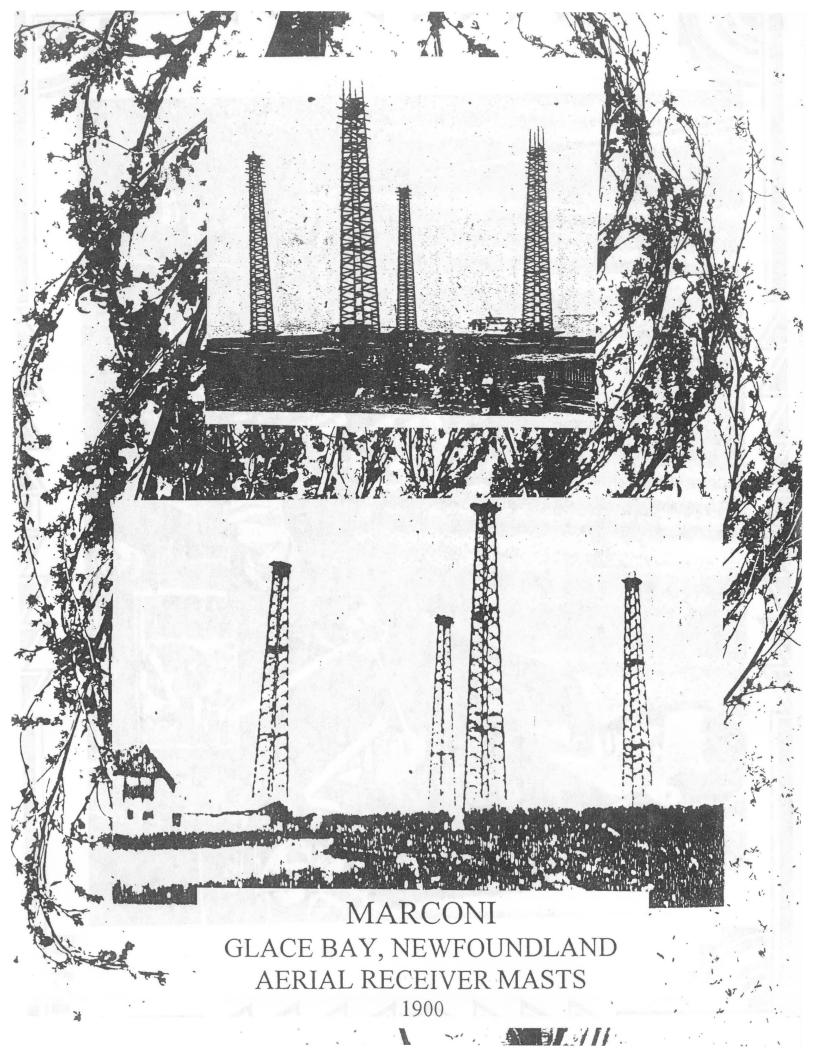


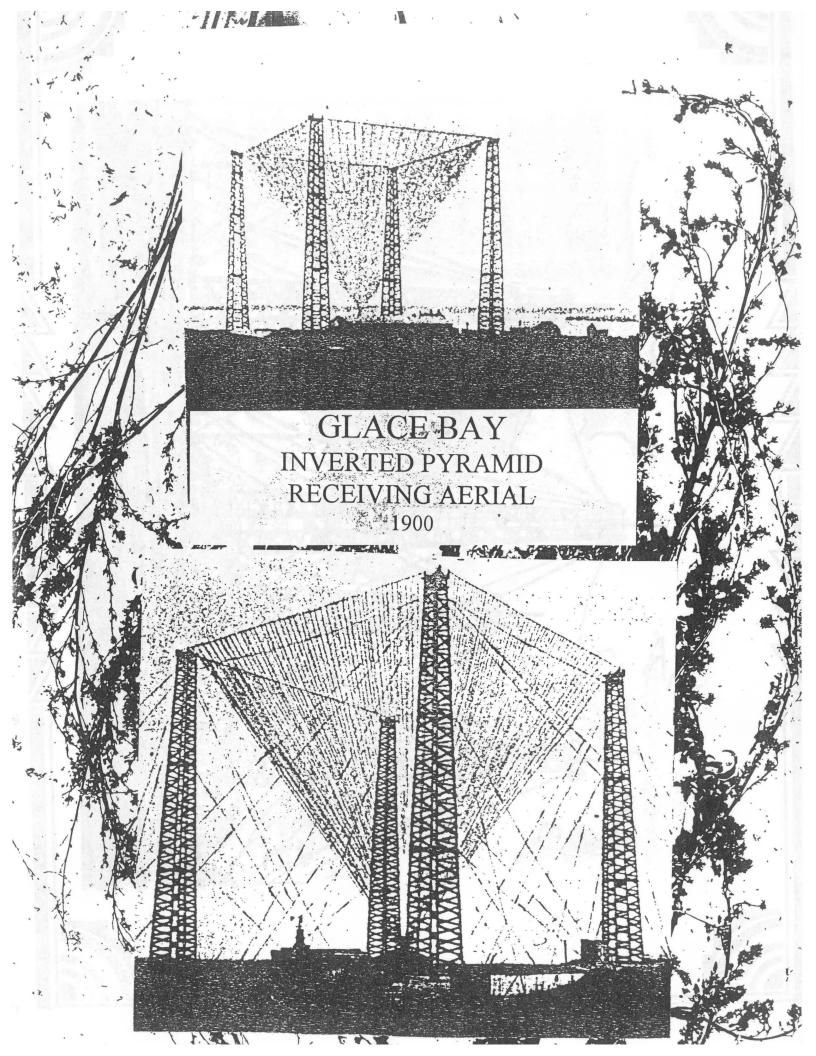


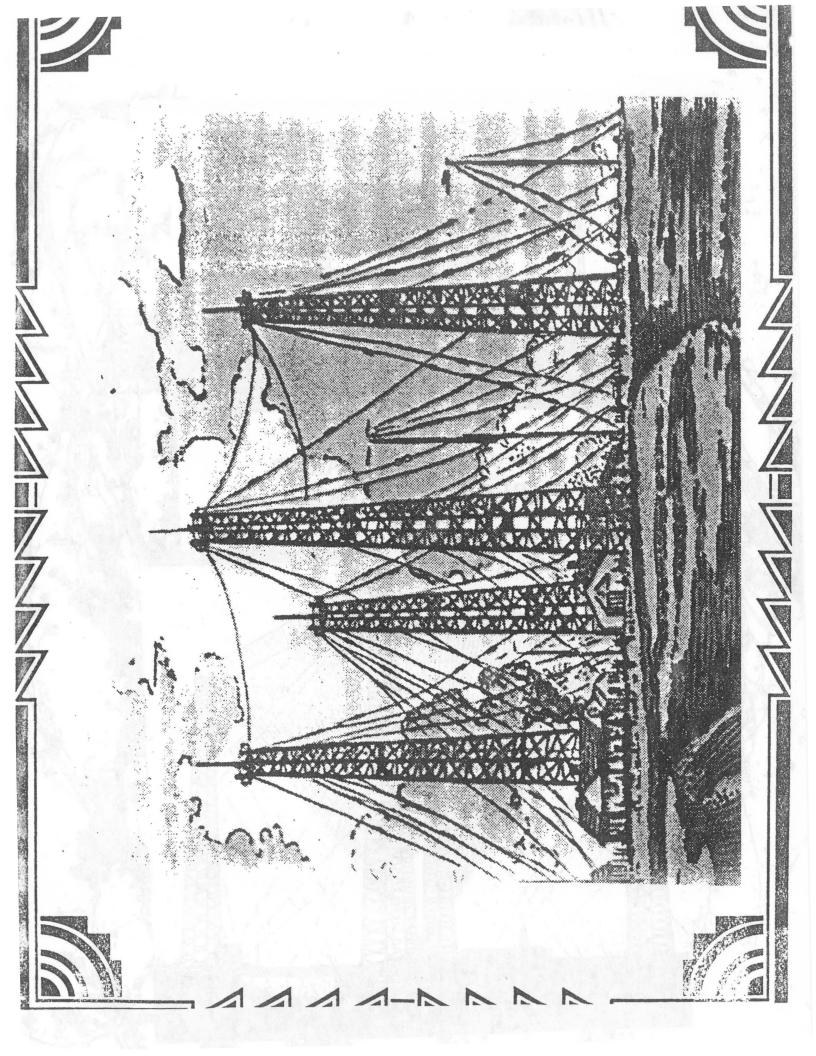


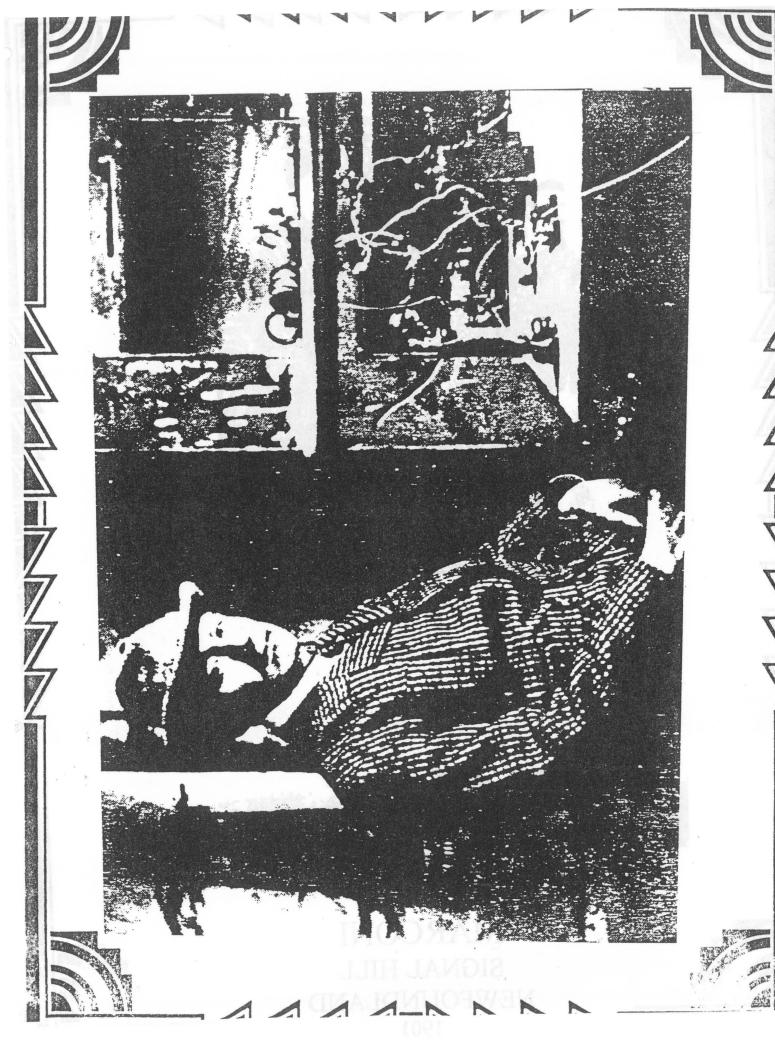
ADAPTING
TELEGRAPHIC RECORDER
MARCONI

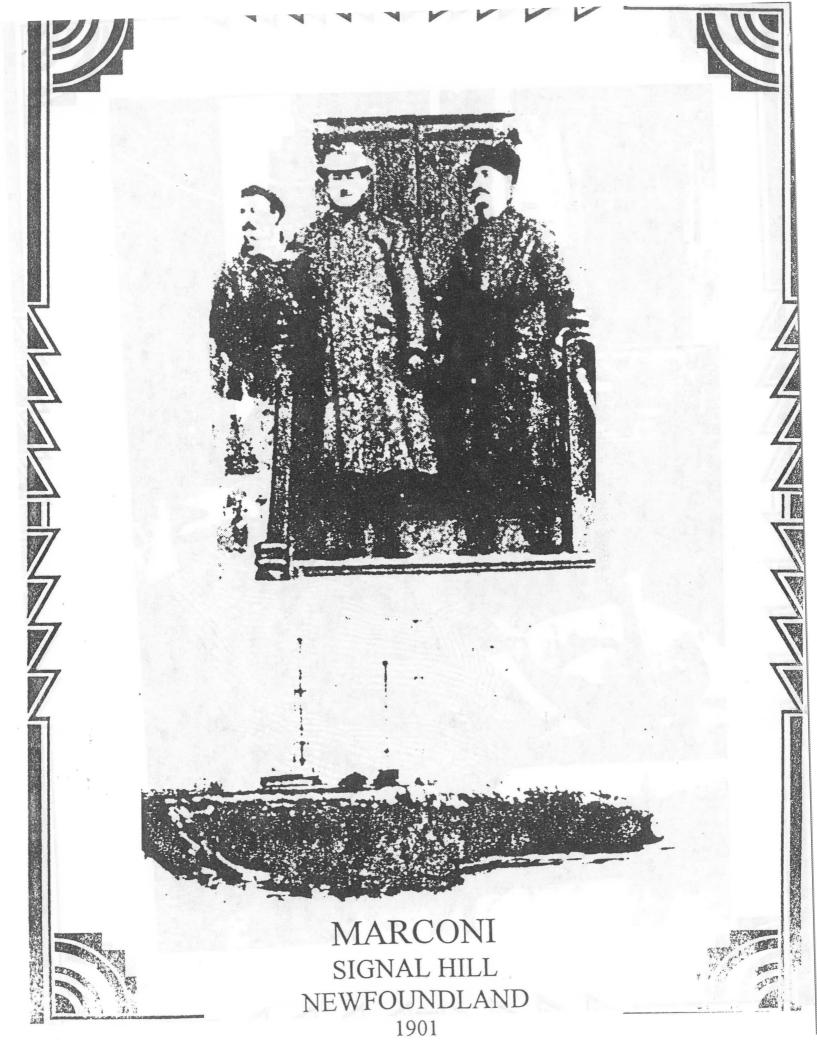


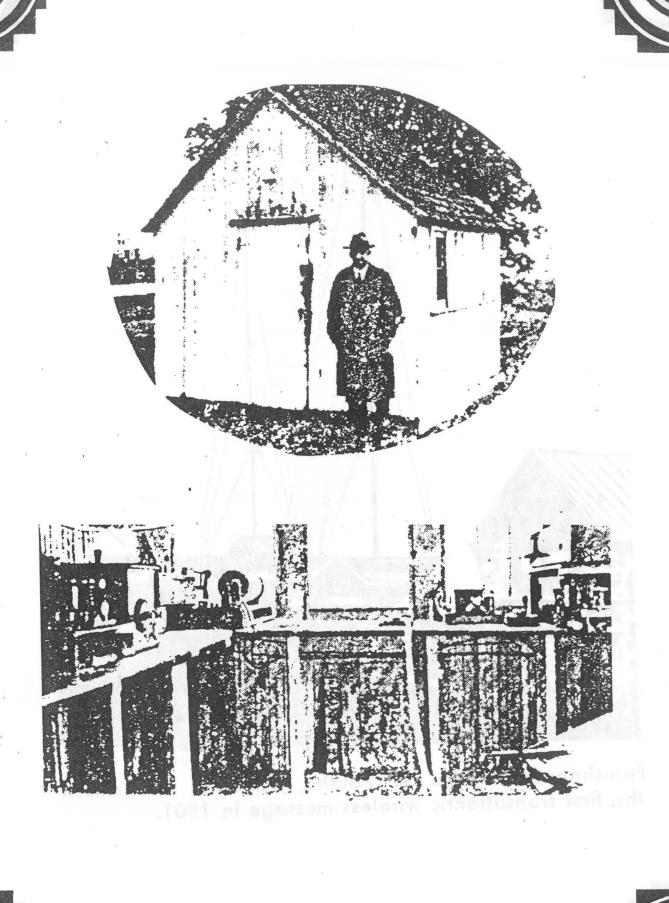


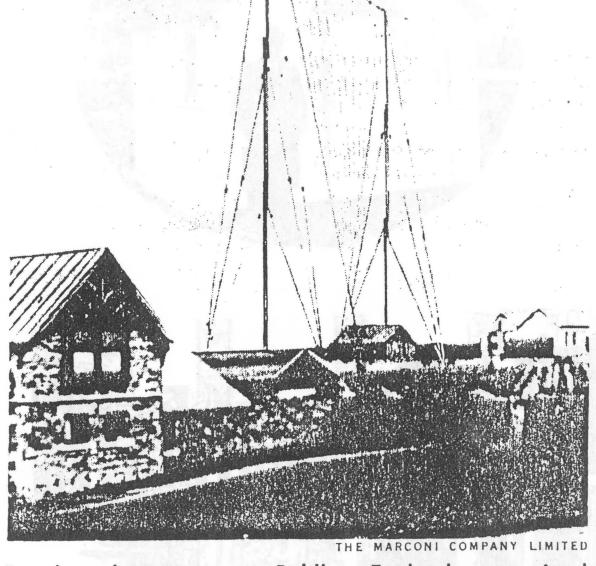




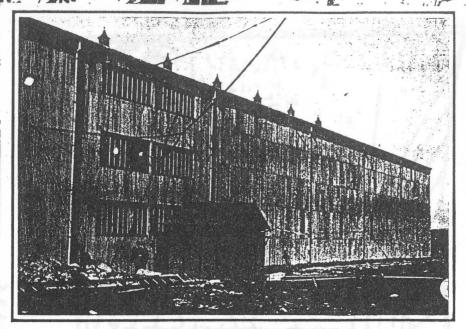






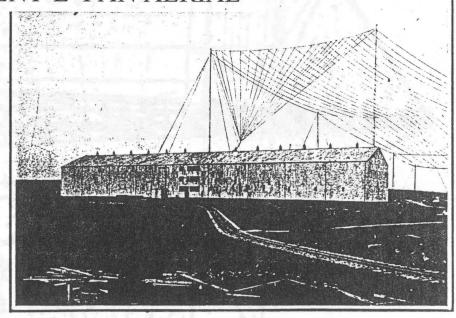


Fan-shaped antenna at Poldhu, England, transmitted the first transatlantic wireless message in 1901.



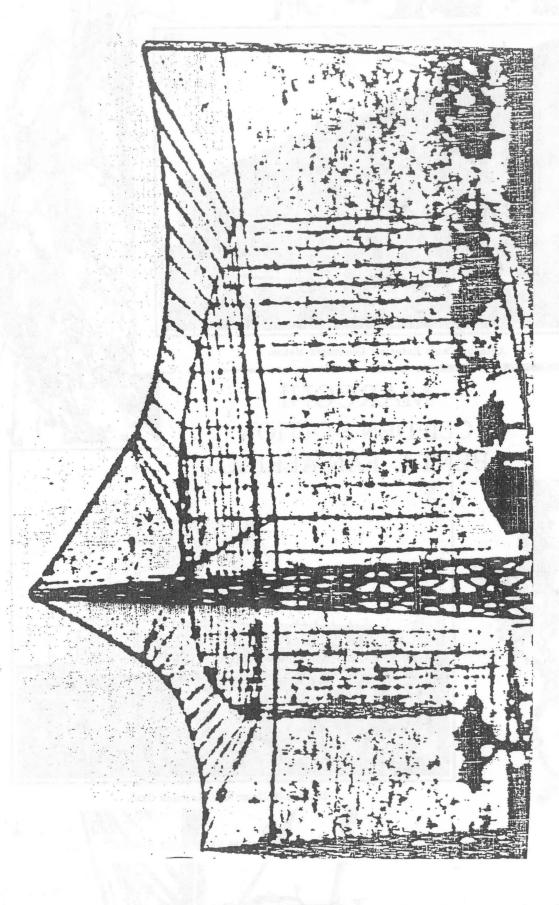
Antenna Cable Entering Condenser House.

MARCONI CLIFDEN STATION BENT-L FAN AERIAL

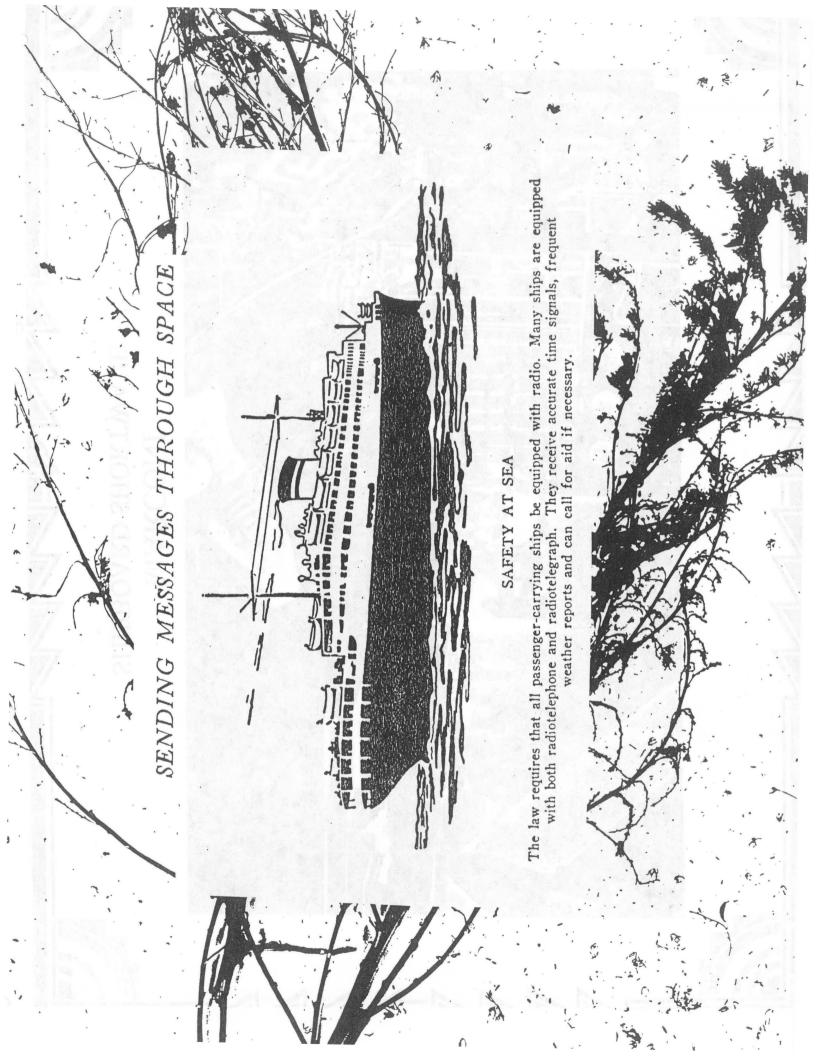


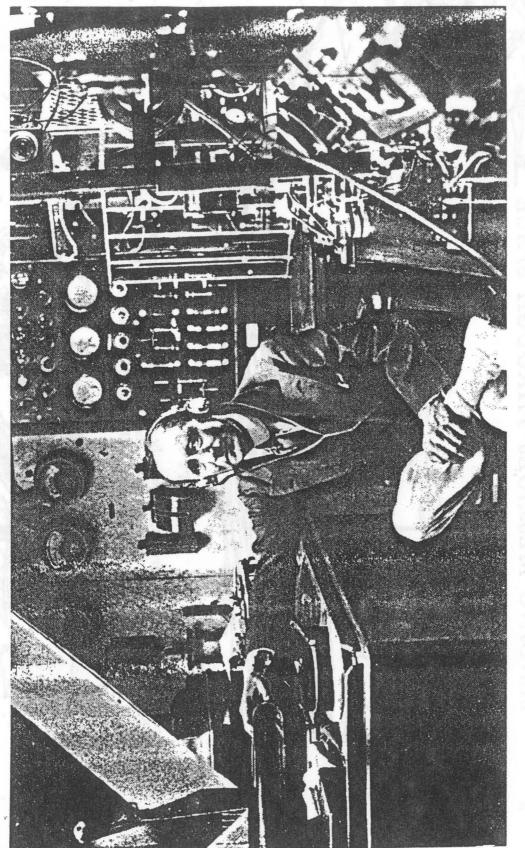
Condenser House and Antenna Grid.

THE CLIFDEN STATION OF THE MARCONI WIRELESS TELEGRAPH SYSTEM



MARCONI VLF DIRECTIONAL BEAM





MARCONI SHIPBOARD SHORTWAVE





GUGLIELMO MARCONI

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By the mid-1890s a variety of experimentation in induction telegraphy and telephony was in evidence. However, the concept of modulating a high frequency carrier wave with voice perhaps can be ascribed to John Stone Stone who, in 1892, utilized both induction coils and alternating current generators in experiments designed by AT&T to communicate by telephone with ships at sea. Although the inspiration for this series of investigations came from the work of Hertz and Tesla, and preceded Marconi by several years, Stone fell short of "inventing" radio partly by reason of the aforementioned confusion of induction with radiation, and partly by lack of appreciation of the need for such appliances as antennas and modulation detectors.²⁰

VOICE MODULATED SIGNALS

LURANIA I At the turn of the century, another development occurred which proved crucial for the growth of experimental broadcasting. This was the application of the high frequency arc to wireless. The oscillating arc was basically a circuit arrangement that included two carbon electrodes activated by high voltage and shunted by suitable inductance and capacitance. Investigated by Elihu Thomson in 1889, it was not until further work after 1900 by William Duddell in England and Valdemar Poulsen in Denmark that frequencies high enough for radio transmission could be realized. Although the arc did produce "continuous waves" and was a favorite of other experimenters, Fessenden felt uncomfortable with it because of its high distortion level and instability.²² As a result, he asked Charles Steinmetz of the General Electric Company to construct a 10,000 cycle alternator for him that would have some capability for modulation with voice or music information. Tests with this machine were made at the Washington, D. C. laboratory of the newly formed National Electric Signalling Company in 1905. Results were encouraging enough to construct a higher frequency machine for the use at NESCO's Brant Rock, Massachusetts installation. The engineering team at Schenectady was headed by E. F. W. Alexanderson, a talented young Swedish electrical engineer. An alternator was delivered to Fessenden in 1906, and after many technical difficulties made ready for its debut. On Nov. 21, 1906, a variety of scientific dignitaries, including Greenleaf W. Pickard and Elihu Thomson, witnessed tests in which speech was successfully transmitted 11 miles between Brant Rock and Plymouth, Mass.23 A phonograph was on hand and was used to transmit music over the airwaves. On Christmas Eve, 1906, Fessenden and his group at Brant Rock presented a program of varied content for the holiday occasion; this was advertised to ship operators of the United Fruit Co. three days in advance. A similar schedule was presented on New Year's Eve. Ship reports of reception came from points as far away as Norfolk and the West Indies. The programming was described by Fessenden:

First a short speech by me saying what we were going to do, then some phonograph music . . . the music on the phonograph being Handel's "Largo." Then came a violin solo by me, being a composition by Gounod called "O, Holy Night," and ending up with the words "Adore and be still" which I sang one verse of, in addition to playing the violin, though the singing, of course, was not very good. Then came the Bible text, "Glory to God in the highest and on earth peace"

to men of good will," and we finally wound up by wishing them a Merry Christmas and then saying that we proposed to broadcast again New Year's Eve.

The Broadcast on New Year's Eve was the same as before, except that the music was changed and I got someone else to sing. I had not picked myself to do the singing, but on Christmas Eve I could not get any of the others to either talk, sing or play and consequently had to do it all myself. On New Year's Eve one man — I think it was Stein — agreed to sing and did sing, but none of the others either sang or talked.²⁴

NESCO continued experimental work on the radiotelephone in July, 1907, and obtained distances up to 180 miles. The following excerpt from the log of wireless enthusiast Francis Hart shows the description of the transmission as received in the New York harbor area on Feb. 11, 1908, at 1:16 p.m.:

Wireless phone at Jamaica and other must be at Brant Rock, Mass. Phone very clear except for a rasping noise that mingles with the voice . . . I managed to get the following and could probably have obtained more except for "9" and etc.

"How's that now" "open up a little more"
"You came in louder than that yesterday"

Could hear music as clear as voice from weaker station but couldn't make out words from other station although they came in fair.²⁵

Although NESCO's wireless telephone activities continued for a time, the company ran into economic and administrative difficulties. The Bell System was quite impressed with Fessenden's wireless telephone, but AT&T suffered a major reorganization following the financial panic of 1907 and interest cooled. Fessenden and his financial backers also were on poor terms for several years, and the inventor was forced to leave the company in 1911. The following year NESCO went into receivership, though the organization continued in research and development activities until its purchase by Westinghouse in 1921. The alternator, for all its wizardry in wireless telephony, was too; cumbersome a machine and the engineering fraternity preferred to endure the higher distortion level in the more portable Poulsen arc. The alternator's significance in radiotelegraphy would overshadow other use, as would its political effect in the battle over control of the early radio industry in the period during World War I and thereafter.

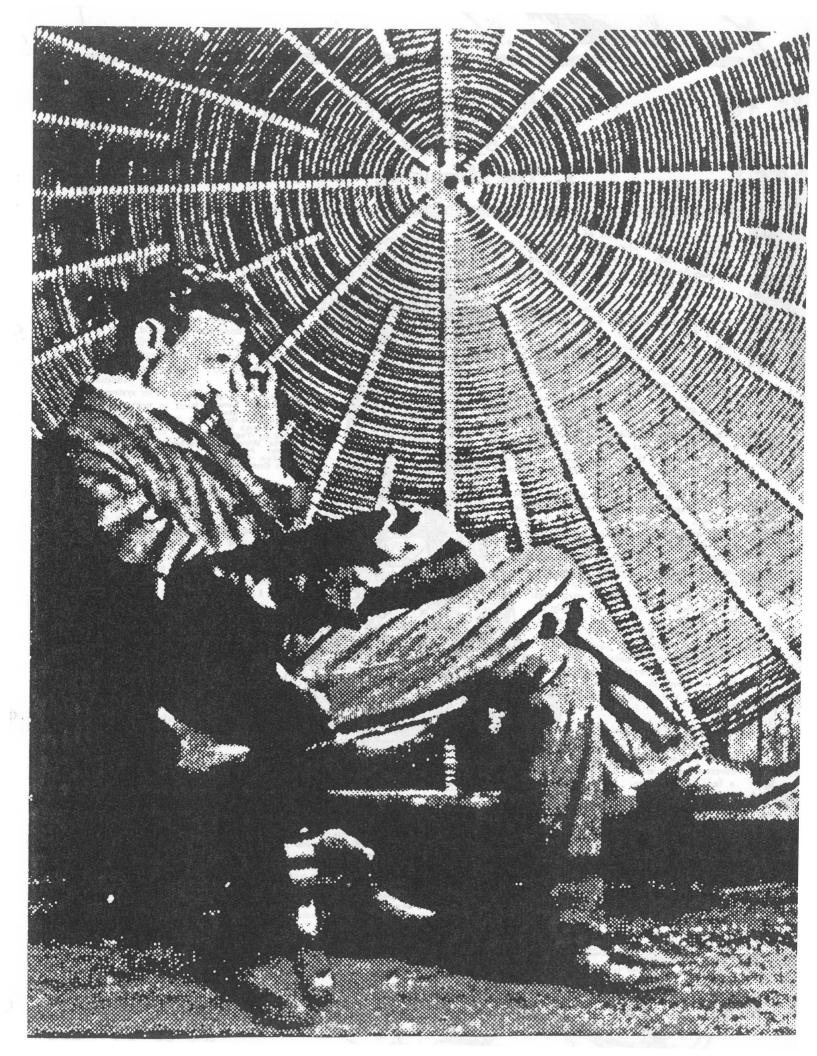
West Coast Radiotelephony

The critical role of the high frequency arc and alternator in the growth of radiotelephony has been stressed. These devices were "continuous wave" generators, and were only reliable tools for voice modulation techniques prior to development of the vacuum tube oscillator. However, Marconi-type "damped wave" transmitters didn't necessarily preclude telephony if distortion caused by the spark irregularity and low spark frequency could be minimized. In practice this was difficult to do, though Fessenden, as we have indicated, made some efforts in this direction.

In 1902, an amateur operator from San Francisco, Francis Mc-Carty, began to experiment in spark telephony with a view toward development of a commercial system. The Henshaw brothers, influential bankers of Oakland, California, were persuaded to invest some capital in the new venture. However, McCarty was fatally injured in a motorcycle accident in 1906, and the project was temporarily interrupted pending the search for new engineering advice and leadership. In 1908, Cyril Elwell, an electrical engineering student at Stanford, was persuaded to join the McCarty Wireless Telephone Co. as a consultant.32 He proceeded to set up experimental broadcasting with * a phonograph supplying the program content. Elwell realized that the McCarty system worked best when the transmitter spark gap was so narrow that the system operated as a quasi-arc, providing nearly continuous waves. Experiments were 'continued from the Company's Palo Alto laboratory until early 1909. At that time, Elwell advised the management that it would be useless to play around further with spark gaps, and that the Poulsen arc held the real future for wireless engineering.







My Inventions By Nikola Tesla The Magnifying Transmitter

S I review the events of my past life I realize how subtle are the influences that shape our destinies. An incident of my youth may serve to illustrate. One winter's day I

managed to climb a steep mountain, in company with other boys. The snow was quite deep and a warm southerly wind made it just suitable for our purpose. We amused ourselves by throwing balls which would roll down a certain distance, gathering more or less snow, and we tried to outdo one another

in this exciting sport. Suddenly a ball was seen to go beyond the limit, swelling to enormous proportions until it became as big as a house and plunged thundering into the valley below with a force that

made the ground tremble. I looked on spellbound, incapable of understanding what had happened. For weeks afterward the picture of the avalanche was before my eyes and I wondered how anything so small could grow to such an immense size. Ever since that time the magnification of feeble actions fascinated me, and when, years later, I took up the experimental study of mechanical and electrical resonance, I was keenly interested from the very start. Possibly, had it not been for that early powerful impression, I might not have followed up the little spark I obtained with my

coil and never developed my best invention, the true history of which I will tell here for the first time.

Scrapping the World's Engines.

"Lionhunters" have often asked me which of my dis-

coveries I prize most. a few technical men, very able in their special departments, but dominated by a pcdantic spirit and nearsighted, have asserted that excepting the induction motor I have given to the world little of practical use. This is a grievous mistake. A nev idea must not be judged by its immediate re-

sults. My alternat-

MAGINE a man a century ago, bold enough to design and actually build a huge tower with which to transmit the human voice, music, pictures, press news and even power, thru the earth to any distance whatever without wires! He probably would have been hung or burnt at the stake. So when Tesla built his famous tower on Long Island he was a hundred years ahead of his time. And foolish ridicule by our latter day arm-chair "savants," does not in the least mar Tesla's greatness.

The titanic brain of Tesla has hardly produced a more amazing wonder than this "magnifying transmitter." Contrary to popular belief his tower was not built to radiate Hertzian waves into the other. Tesla's system sends out thousands of horsepower thru the earth-he has shown experimentally how power can be sent without wires over distances from a central point. Nor is there any mystery about it how he accomplishes the result. His historic U. S. natents and articles describe the method used. Tesla's Magnifying Transmitter is truly a modern lamp of Aladdin.

EDITOR.

and altho considerable resistance had to be overcome and opposing interests reconciled, as usual, the commercial introduction could not be long delayed. Now, compare this situation with that confronting my turbine, for example. One should think that so simple and beautiful an invention, possessing many features of an ideal motor, should be adopted at once and, undoubtedly, it would under similar conditions. But the prospective effect of the rotating field was not to render worthless existing machinery; on the contrary, it was

> to give it additional value. The system lent itself to new enterprise as well as to improvement of the old. My turbine is an advance of a character entirely different. It is a radical departure in the sense

that its success would mean the abandonment of the antiquated types of prime movers on which billions of dollars have been spent. Under such circumstances the progress must needs he slow and perhaps the greatest impediment is encountered in the prejudicial opinions created in the minds of experts by organized opposition. Only the other day I had a disheartening experience when I met my friend and former assistant, Charles F. Scott, now professor of Electrical Engineering at Yale. I had not seen him for a long time and was glad to have an opportunity for a little chat

at my office. Our conversation naturally enough drifted on my turbine and I became heated to a high degree. "Scott." I exclaimed, carried away by the vision of a glorious future, "my turbine will scrap all the heatengines in the world." Scott This depends on the point of view. Not stroked his chin and looked away thoughtfully, as though mak-

ing a mental calculation. "That will make quite a pile of scrap. he said, and left without another word!

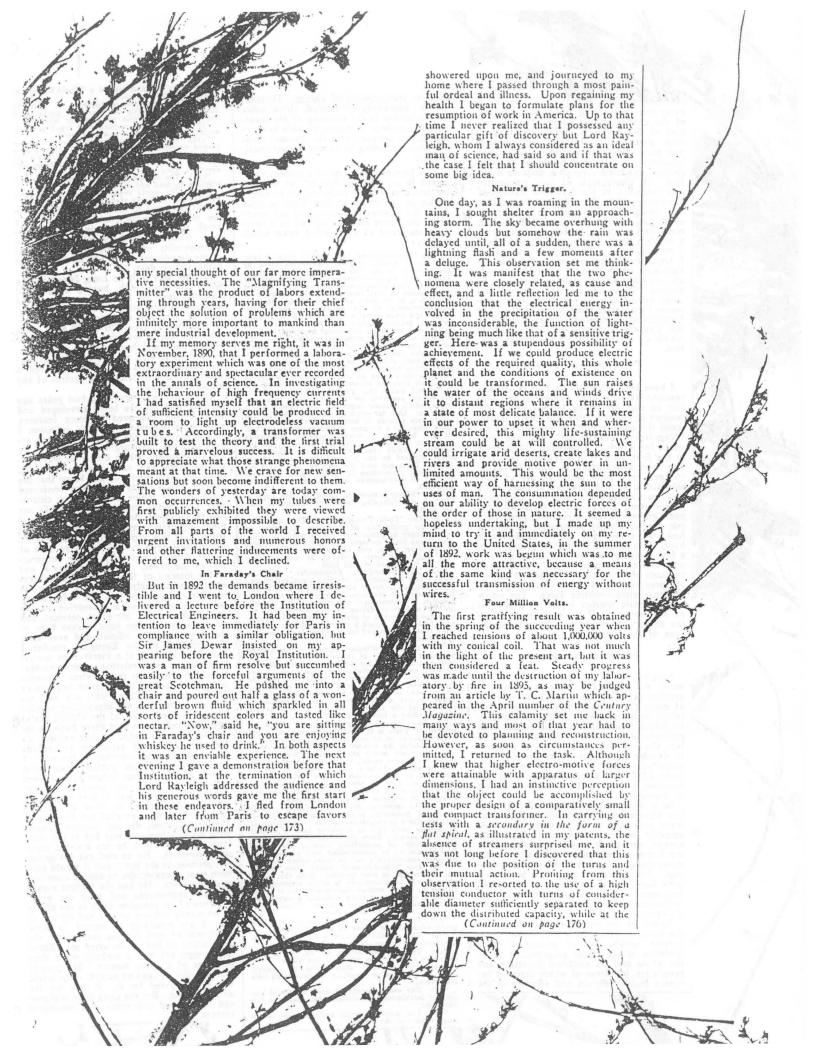
"Aladdin's Lamp".

These and other inventions of mine. however, were nothing more than steps forward in certain directions In evolving them I simply fol-



ing system of power transmission came at a psychological mo- lowed the inhorn instinct to improve the present devices without ment, as a long-sought answer to pressing industrial questions,

(Continued on pane 148)



same time preventing undue accumulation of the charge at any point. The applica-tion of this principle enabled me to pro-duce pressures of 4,000,000 volts, which was about the limit obtainable in my new laboratory at Houston Street, as the discharges extended through a distance of 16 feet. A photograph of this transmitter was published in the Electrical Review of November, 1898. In order to advance further along this line I had to go into the open, and in the spring of 1899, having completed preparations for the erection of a wireless plant, I went to Colorado where remained for more than one year. Here introduced other improvements and refinements which made it possible to generate currents of any tension that may be desired. Those who are interested will find some information in regard to the experiments I conducted there in my article, "The Problem of Increasing Human Energy" in ments I conducted there in my article, the Century Mayazine of June, 1900, to which I have referred on a previous occa-

The Magnifying Transmitter.

I have been asked by the ELECTRICAL Ex-PERIMENTER to be quite explicit on this subject so that my young friends among the readers of the magazine will clearly understand the construction and operation of my "Magnifying Transmitter" and the purposes for which it is intended. Well, then, in the first place, it is a resonant transformer with a secondary in which the parts, charged to a high potential, are of siderable area and arranged in space along ideal enveloping surfaces of very large radii of curvature, and at proper distances from one another thereby insuring a small electric surface density everywhere so that no leak can occur even if the conductor is bare. It is suitable for any frequency, from few to many thousands of cycles per second, and can be used in the production of currents of tremendous volume and moderate pressure, or of smaller amperage and immense electro-motive force. The maximum electric tension is merely dependent on the curvature of the surfaces on which the charged elements are situated and the area of the latter.

100 Million Volts Possible.

Judging from my past experience, as such as 100,000,000 volts are perfectly racticable. On the other hand currents much as practicable. of many thousands of amperes may be obtained in the antenna. A plant of but very moderate dimensions is required for such performances. Theoretically, a terminal of less than 90 feet in diameter is sufficient to develop an electro-motive force of that magnitude while for antenna currents of from 2,000-4,000 amperes at the usual frequencies it need not be larger than 30 feet in diameter.

In a more restricted meaning this wireless transmitter is one in which the Hertzwave radiation is an entirely negligible quantity as compared with the whole energy, under which condition the damp-ing factor is extremely small and an enormous charge is stored in the elevated capacity. Such a circuit may then be excited with impulses of any kind, even of low frequency and it will yield sinusoidal and continuous oscillations like . those of an alternator.

Taken in the narrowest significance of the term, however, it is a resonant transformer which, besides possessing these qualities, is accurately proportioned to fit the globe and its electrical constants and properties, by virtue of which design it becomes highly efficient and effective in the

wireless transmission of energy. Distance is then absolutely eliminated, there being no diminution in the intensity of the transmitted impulses. It is even possible to make the actions increase with the distance from the plant according to an exact mathemati-

This invention was one of a number com-prised in my "World-System" of wireless transmission which I undertook to commercialize on my return to New York in 1900. As to the immediate purposes of my enter-prise, they were clearly outlined in a technical statement of that period from which I quote:

I quote:

"The 'World-System' has resulted from a combination of several original discoveries made by the inventor in the course of long continued research and experimentation. It makes possible not only the instantaneous and precise wireless transmission of any kind of signals, messages or characters, to all parts of the world, but also the inter-connection of the existing telegraph, telephone, and other signal stations without any change in their present equipment. By its means, for instance, a telephone subscriber here may call up and talk to any other subscriber on the Globe. An inexpensive receiver, not bigger than a watch, will enable him to listen anywhere, on land or sea, to a speech delivered or music played in some other place, however distant. These examples are cited merely to give an idea of the possibilities of this great scientific advance, which annihilates distance and makes that perfect natural conductor, the Earth, available for all the innumerable purposes which human ingenuity has found for a line-wire. One far-reaching result of this is that any device capable of being operated thru one or more wires (at a distance obviously restricted) can likewise be actuated, without artificial conductors and with the same facility and accuracy, at distances to which there are no limits other than those imposed by the physical dimensions of the Globe. Thus, not only will entirely new fields for commercial exploitation be opened up by this ideal method of transmission but the old ones vastly extended.

"The World-System' is based on the application of the following important inventions and discoveries:

"1. The 'Tasla Transformer.' This apparatus

discoveries:

"1. The 'Tesla Transformer.' This apparatus is in the production of electrical vibrations as revolutionary as gunpowder was in warfare. Currents many times stronger than any ever generated in the usual ways, and sparks over one hundred feet long, have been produced by the inventor with an instrument of this kind.

"2. The 'Alagnifying Transmitter.' This is Tesla's best invention—a peculiar transformer specially adapted to excite the Earth, which is in the transmission of electrical energy what the telescope is in astronomical observation. By the use of this marvelous device he has already set up electrical movements of greater intensity than those of lightning and passed a current, sufficient to light more than two hundred incandescent lamps, around the Globe.

of lightning and passed a current, sufficient to light more than two hundred incandescent lamps, around the Globe.

"3. The 'Tesla Wireless System.' This system comprises a number of improvements and is the only means known for transmitting economically electrical energy to a distance without wires. Careful tests and measurements in connection with an experimental station of great activity, erected by the inventor in Colorado, have demonstrated that power in any desired amount can be conveyed, clear across the Globe if necessary, with a loss not exceeding a few per cent.

"4. The 'Art of Individualization.' This invention of Tesla is to primitive 'tuning' what refined language is to ungriculated expression. It makes possible the transmission of signals or messages absolutely secret and exclusive both in the active and passive aspect, that is, non-interfering as well as non-interferable. Each signal is like an individual of unmistakable identity and there is virtually no limit to the number of stations or instruments which can be simultaneously operated without the slightest mutual disturbance.

"5. The terrestial Stationary Ill'artes." This wonderful discovery, popularly explained, means that the Earth is responsive to electrical vibrations of definite pitch just as a tuning fork to certain waves of sound. These particular electrical vibrations, capable of powerfully exciting the Globe, lend themselves to innumerable uses of great importance commercially and in many other respects.

"The first 'World-System' power plant can be put in operation in nine months. With this power plant it will be practicable to attain electrical activities up to ten million horsepower and it is designed to serve for as many technical achievements as are possible without due expense. Among these the following may be mentioned:

"(1) The inter-connection of all the present telephone exchanges or offices all over the world;

"(2) The establishment of a secret and noninterferable government telegraph service;

"(3) The establishment of

is, by telegraph or telephone, in connection with Press; (5) The establishment of such a World-Syston of intelligence transmission for exclusive pri-

vate use;
"(6) The inter-connection and operation of all stock tickers of the world;

"(7) The establishment of a 'World-System' of musical distribution, etc.;
"(8) The universal registration of time by cheap clocks indicating the hour with astronomical precision and requiring no attention whatever;
"(9) The world transmission of typed or handwritten characters, letters, checks, etc.;
"(10) The establishment of a universal marine service enabling the navigators of all ships to atterprefectly without compass, to determine the exact location, hour and speed, to prevent collisions and disasters, etc.;

location, hour and speed, to prevent collisions and disasters, etc.;

"(11) The inauguration of a system of world-printing on land and sea;

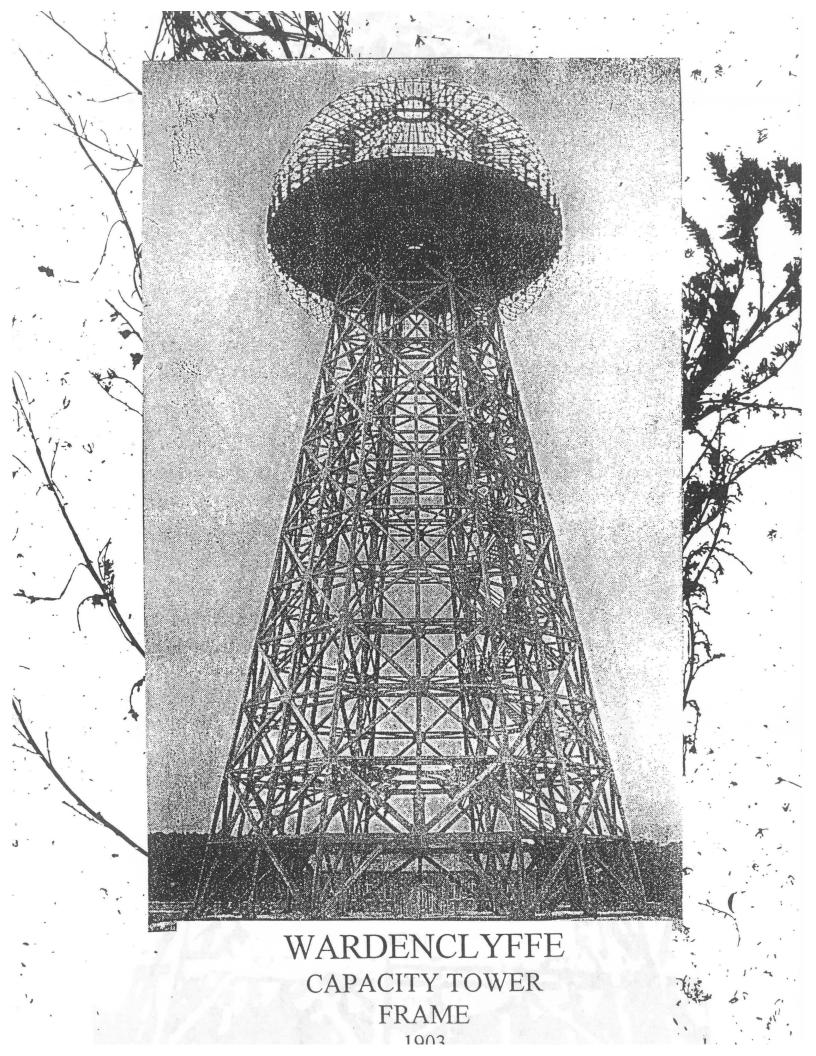
"(12) The world reproduction of photographic pictures and all kinds of drawings or records."

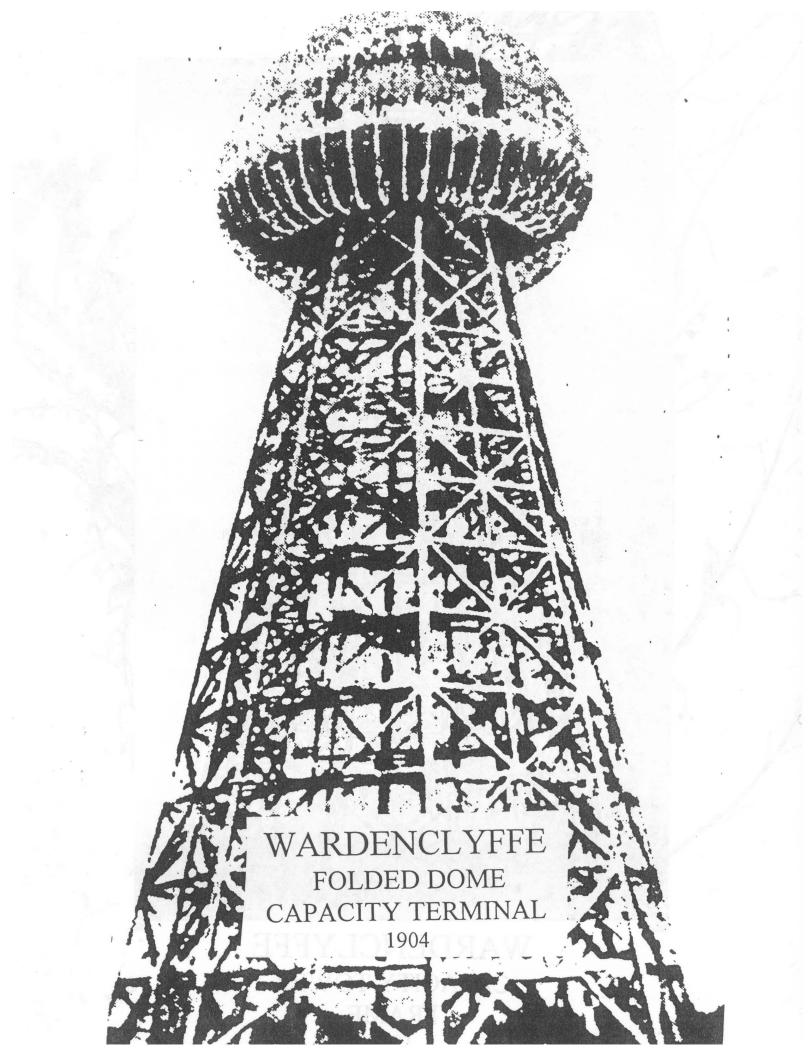
I also proposed to make demonstrations in the wireless transmission of power on a small scale but sufficient to carry conviction. Besides these I referred to other and incomparably more important applications of my discoveries which will be disclosed at some future date.

A plant was built on Long Island with a tower 187 feet high, having a spherical terminal about 68 feet in diameter. These dimensions were adequate for the transmission of virtually any amount of energy. Originally only from 200 to 300 K.W. were provided but I intended to employ later several thousand horsepower. The transmitter was to emit a wave-complex of special .characteristics and I had devised a unique method of telephonic control of any

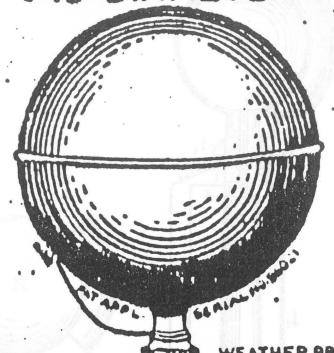
amount of energy.

The tower was destroyed two years ago but my projects are being developed and another one, improved in some features, will be constructed. On this occasion I would contradict the widely circulated report that the structure was demolished by the Government which owing to war conditions, might have created prejudice in the minds of those who may not know that the papers, which thirty years ago conferred upon me the honor of American citizenship, are always kept in a safe, while my orders, diplomas, degrees, gold medals and other distinctions are packed away in old trunks. If this report had a foundation I would have been refunded a large sum of money which I expended in the construction of the tower. On the contrary it was in the interest of the Government to preserve it, particularly as it would have made possible—to mention just one valuable re-sult—the location of a submarine in any part of the world. My plant, services, and all my improvements have always been at the disposal of the officials and ever since the outbreak of the European conflict I have been working at a sacrifice on several inventions of mine relating to aerial navigation, ship propulsion and wireless transmission which are of the greatest importance to the country. Those who are well into the country. Those who are well in-formed know that my ideas have revolutionized the industries of the United States and I am not aware that there lives an inventor who has been, in this respect, as fortunate as myself especially as regards the use of his improvements in the war. have refrained from publicly expressing myself on this subject before as it seemed improper to dwell on personal matters while all the world was in dire trouble. I would add further, in view of various rumors which have reached me, that Mr. J. Pierpont Morgan did not interest himself with me in a business way but in the same large spirit in which he has assisted many other pioneers. He carried out his gener-ous promise to the letter and it would have been most unreasonable to expect from him anything more. He had the highest regard for my attainments and gave me every evidence of his complete faith in my ability to ultimately achieve what I had set out to I am unwilling to accord to some small-minded and jealous individuals the satisfaction of having thwarted my efforts. These men are to me nothing more than microbes of a nasty disease. My project was retarded by laws of nature. The world was not prepared for it. It was too far ahead of time. But the same laws will pre-vail in the end and make it a triumphal





4-10" DIAMETER→



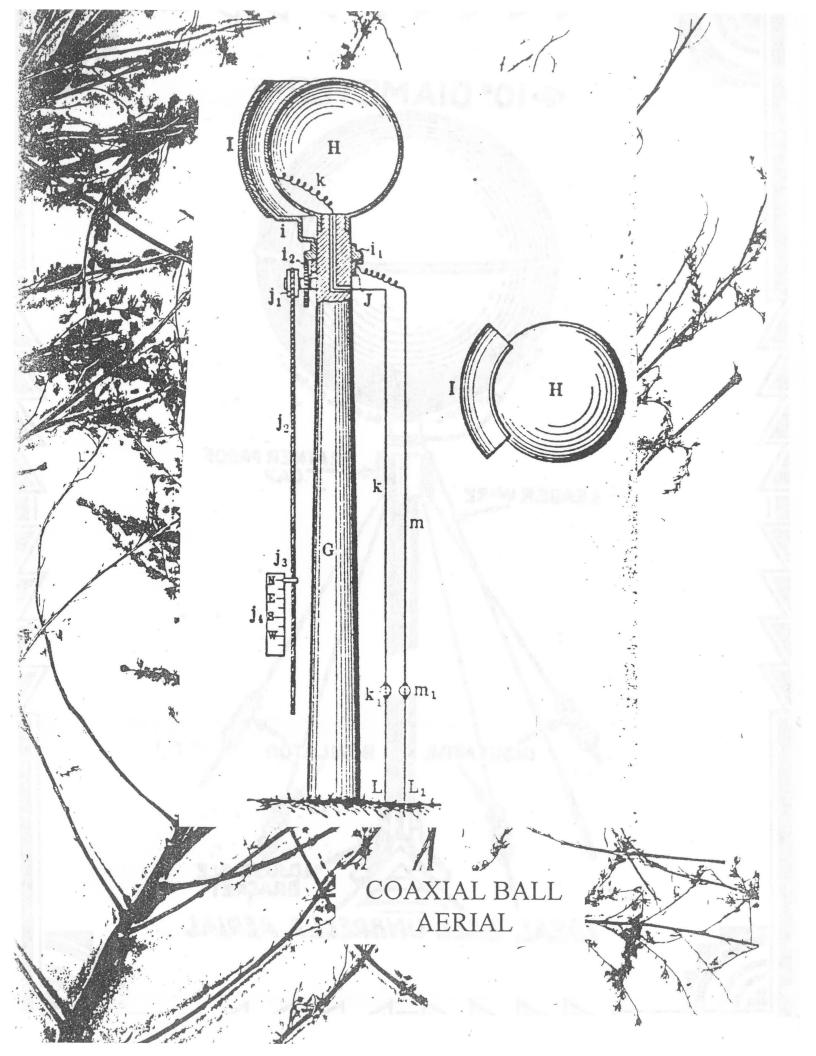
WEATHER PROOF

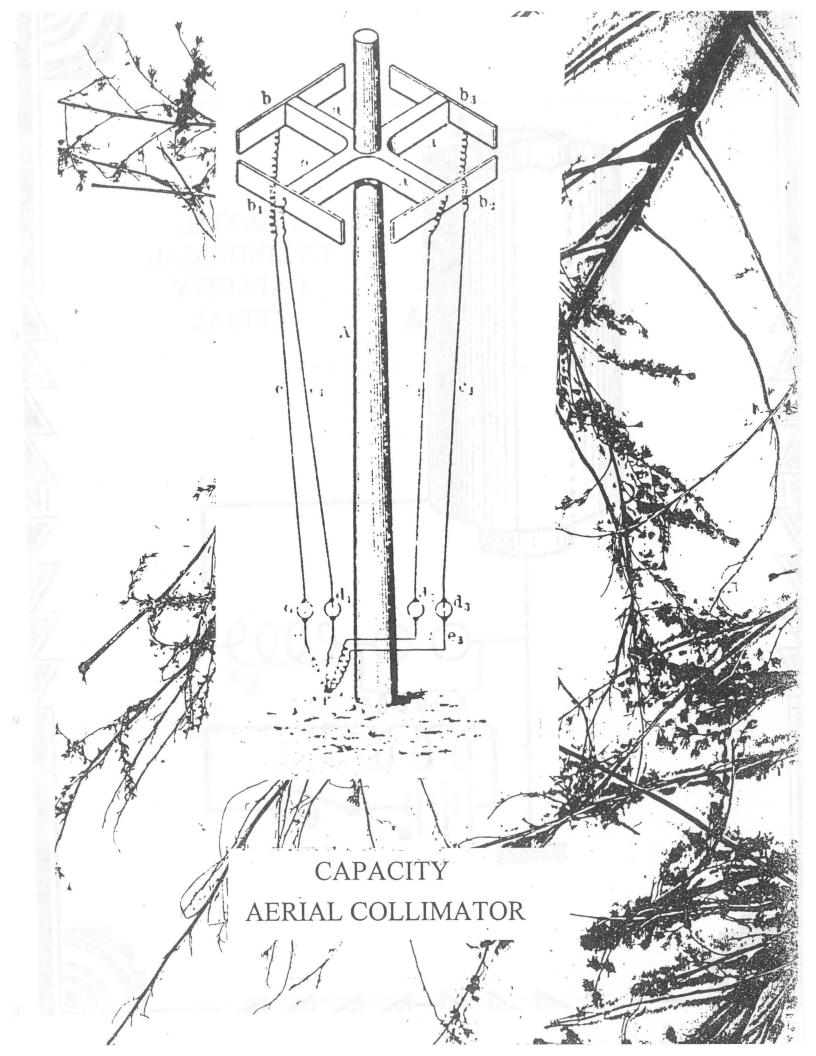
NOTATION

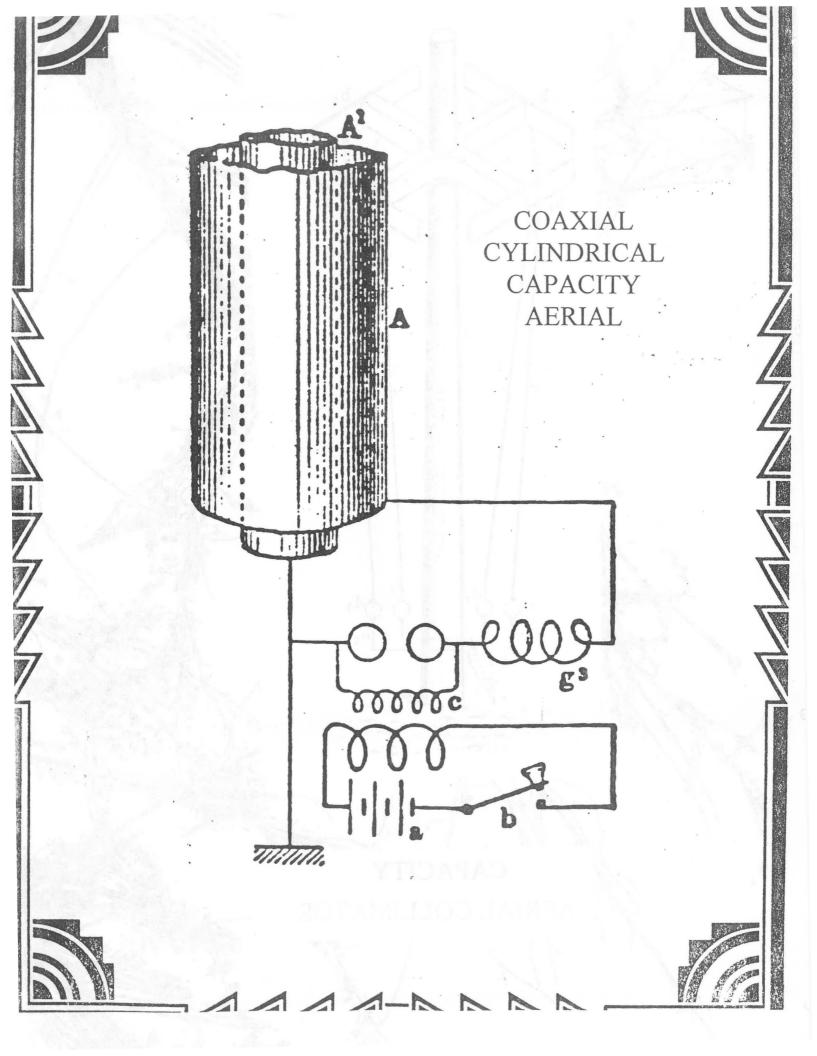
INSULATOR

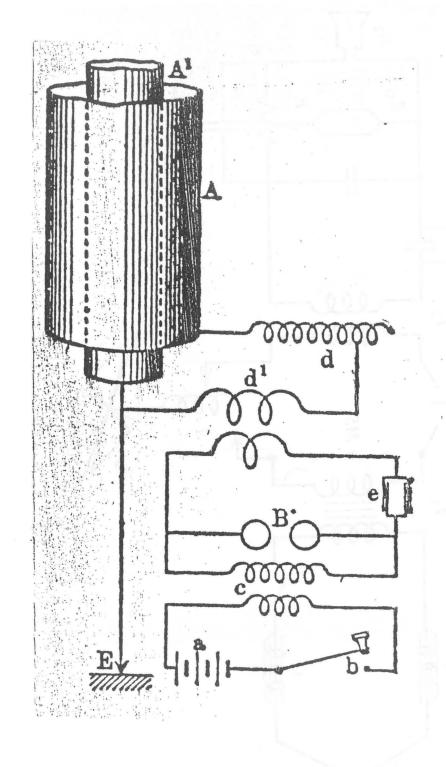
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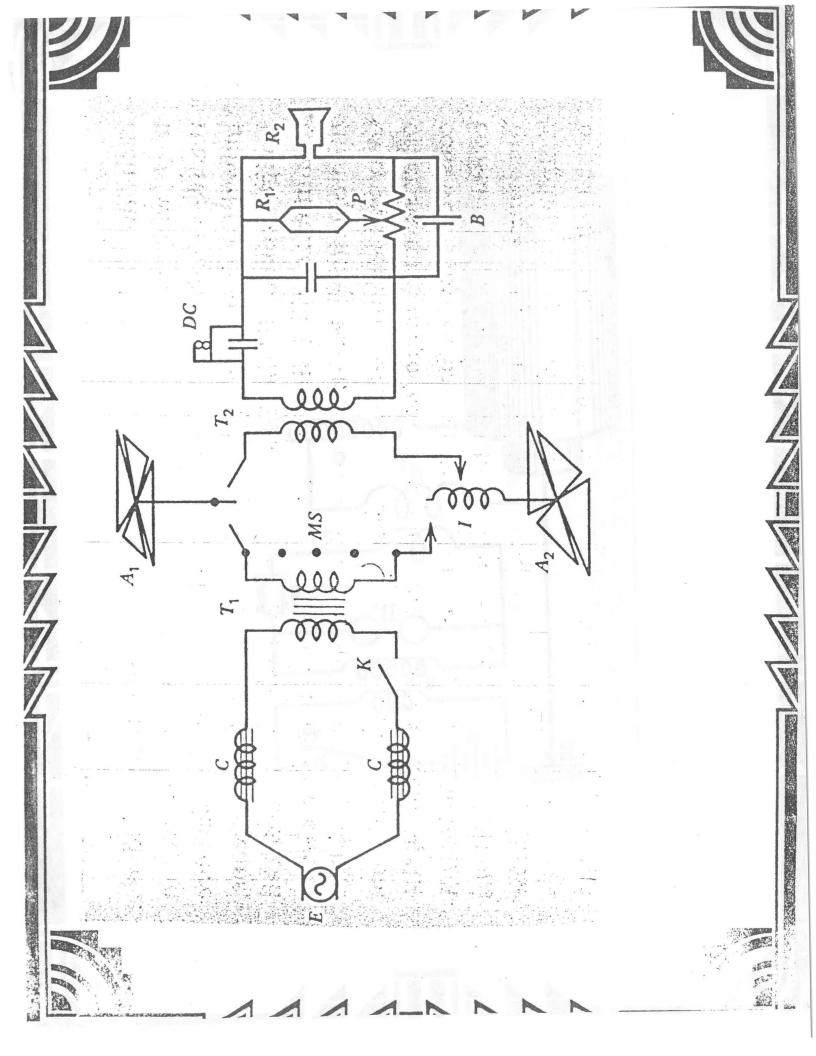
IDEAL BALL UNBRELLA AERIAL













SIR OLIVER LODGE

No. 609,154.

O. J. LODGE.

ELECTRIC TELEGRAPHY.

(No Model.)

A Fig. 1.

A Fig. 3.

A Fig. 3.

A Fig. 3.

A Fig. 6.

A Fig. 7.

A Fig. 6.

A Fig. 7.

A Fig. 6.

A Fig. 6.

A Fig. 7.

B Fig. 6.

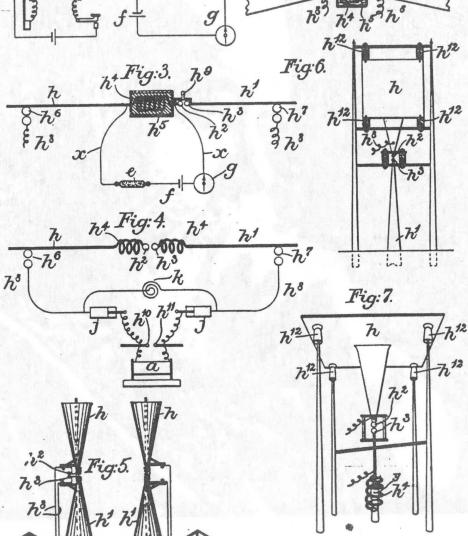
A Fig. 7.

B Fig. 6.

A Fig. 7.

B Fig. 6.

B F



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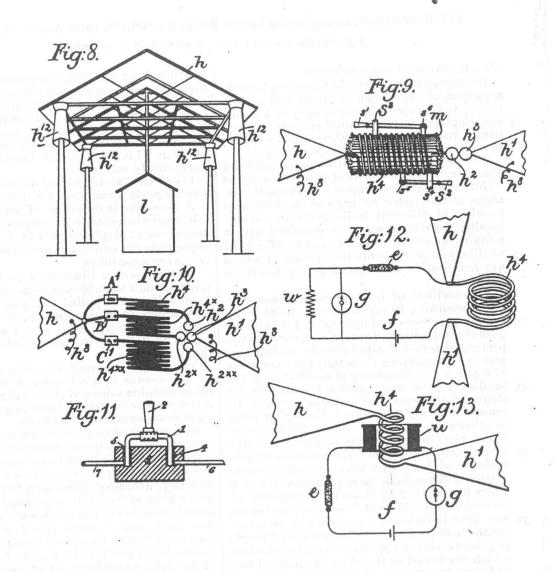
No. 609,154.

Patented Aug. 16, 1898.

O. J. LODGE. ELECTRIC TELEGRAPHY.

(Ne Medel.)

2 Sheets-Sheet 2.



Witnesses: EABellock, Manne Thomas. Inventor.
Bliver Joseph Lange
By his Alloways.
Balsion, Sander Wight

United States Patent Office

OLIVER JOSEPH LODGE, OF LIVERPOOL, ENGLAND.

ELECTRIC TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 609,154, dated August 16, 1898.

Application filed February 1, 1898. Serial No. 668,752. (No model.)

To all whom it may concern:

Be it known that I, OLIVER JOSEPH LODGE, a subject of the Queen of Great Britain, residing at Liverpool, in the county of Laneaster, England, have invented certain new and useful Improvements in Electric Telegraphy, of which the following is a specification.

The object of my invention is to enable an operator, by means of what is now known as "Hertzian-wave telegraphy," to transmit messages across space to any one or more of a number of different individuals in various localities, each of whom is provided with a suitably-ar anged receiver, and to effect the ancillary in provements the nature of which are hereinafter more particularly described and claimed.

The method of intercommunication consists, according to my invention, in utilizing 20 certain processes and apparatus for the purpose of producing and detecting a sufficientlyprolonged series of rapid electric oscillations and in so arranging them that the excitation of a particular frequency of oscillation at the 25 sending-station may cause a telegraphic instrument to respond at a distant station by reason of being associated, through a relay or otherwise, with a subsidiary circuit capable of electric oscillations of that same par-30 ticular frequency or of some multiple or submultiple of that frequency. Another distant station will similarly be made to receive messages by exciting at the sending-stations alternations of a different frequency, and so on, 35 and thus individual messages can be transmitted to in lividual stations without disturbing the receiving appliances at other stations which are tuned or timed or syntonized to a different frequency. Each station will usu-40 ally be provided with both sending and receiving apparatus.

In the accompanying drawings, which are diagrammatic representations, Figure 1 shows the simplest arrangement of emitter and receiver heretofore in use. Figs. 2, 4, 6, 7, 8, 9, and 10 show alternative arrangements to be adopted at signaling-stations or appendages thereto in accordance with my invention.

The state of the emitting arrangements to be an obtain a succession of the emitting arrangements to be a could be succession of the emitting arrangements.

is utilized for receiving purposes. Fig. 5 depicts the more prominent features of a long-distance arrangement, both sending and receiving. Figs. 12 and 13 illustrate alternative forms of connection of apparatus in a syntonic receiving-circuit with appendages, and Fig. 11 is a detail view hereinafter more particularly referred to.

Like letters and figures of reference indicate 6 similar parts throughout the drawings.

A complete installation of Hertzian-wave telegraphy consists, in its simplest form, of the arrangement depicted in Fig. 1, wherein A represents the emitting apparatus, and B the 6 receiving apparatus.

In the emitter illustrated in Fig. 1 electricity from a suitable source, such as a Ruhmkorff coil a, is supplied to a pair of conductors which discharge into each other from 7 knobs b and c and thus excite oscillations, which emit one or two waves before they are damped out.

The receiving-circuit consists, essentially, of a collector d, a coherer e, a battery f or 79 other suitable source of electrical energy, and a telegraphic receiving instrument g, all in electrical connection, as shown.

In carrying out my invention, and referring now to the subsequent figures of the drawings, I use a definite radiator consisting of a conductor or pair of conductors h h' of large capacity, arranged either as a Leyden jar or preferably spread out separately in space, one of them being the earth when desired. I sjoin to h and h', respectively, which I denominate "capacity areas," a pair of polished knobs h² h², protected by glass from ultraviolet light, which form the adjustable spark gap. Between either capacity area and its ocknob I place a syntonizing self-inductance coil—that is, a coil of wire or mention ribbon h¹, preferably insulated with an solid or fuid insulator, as in Fig. 2, or in air, of shape suitable to attain greatest inductance with given amount of resistance—the object of the coil being to prolong the electric oscillations occurring in the radiator, so as to constitute it a radiator of definite fre and obtain a succession of

sponse departs on the fact that the total number of desibations in a suitably-arranged circuit is very great, so that a very feeble impulse is gradually strengthened by cumulative action until it causes a perceptible effect on the well-known principle of sympathetic resonance.

I supply the electricity to the radiator from a Ruhmkorff or from a Tesla coil or from a Wimshurst or other known or suitable hightension machine a in one of three ways, ac-

cording to circumstances.

The first way is by leading wires from the machine a to the two knobs $h^2 h^3$, which is the customary plan and gives a discharge which follows upon fairly steady electric strain.

The second way consists, as shown in Fig. 3, in having a supplementary pair of spark-20 gaps he h, (which I call the "supply-gaps,") one knob of each (called the "receivingknob") being attached to the middle or other convenient point of each capacity area h h', and the other knob of each pair (called the "supply-knobs") being connected by wires h to the Ruhmkorff coil and brought moderately near the first, so that when the coil is in action the capacity areas shall receive their positive and negative charge by aerial dis-30 ruption-that is, in a sudden manner -- rather than by the slower process of metallic conduction, and shall then be left to discharge into each other through the connecting-coil h' and across the short spark-gap between the 35 knobs h2 h3. The best width of this gap depends upon circumstances, and it may be closed altogether without stopping the action. The gap between the knobs he ha may be op-

tionally closed by a shunt h...

In the third plan, as indicated in Fig. 4, I interpose in each of the wires h. leading from the Ruhmkorff coil a to the supply-knobs a Loyden jar or other suitable condenser j able to stand a high potential, so that the knobs are supplied from the outer—that is, the uninsulated—coat of each jar, while between the inner coats or coil-terminals I arrange a third spark-gap, (called the "starting-gap,") also consisting of suitable knobs h... The outer coats of the jars must not be insulated from each other, and I usually join them by an induction-coil of fairly thin wire k, so as

to permit thorough charging. When the discharge occurs, this wire acts as an alternative 55 path or by-pass, but does not prevent the

sparks at the supply-gap.

By both of the means described with reference to Figs. 3 and 4 I charge the two capacity areas h h' (which, together with the inductance-coil between them, constitute the radiator) by aerial disruption or impulsive rush. The advantage of this is that charges so communicated are left to oscillate free from the results are connected to the pource of electricity, and there-

when supplied by wires in the usual way.

Moreover, the capacity areas of a radiator are
more conveniently employed as the capacity
areas of a receiver without need of disconnection.

The arrangement described with reference to Fig. 4 illustrates most completely the method of charging the capacity areas h h' with an impulsive rush. The action is as fol- 7 lows: The Ruhmkorff machine a charges the jars j, whose outer coats are connected, and discharges them at the starting-gap h10. This spark precipitates a discharge at the supplygaps hahand suddenly supplies the capacity areas h h' with electric charges, which then surge through the connecting-coil h4 (divided into two parts in this figure) and spark into each other at the discharge-gap between the knobs h2 h2. This last discharge is the chief 80 agent in starting the oscillations which are the cause of the emitted waves; but it is permissible in the arrangements of Figs. 3 and 4 to close this last gap when desired and so leave the oscillations to be started by the 90 sparks at the supply-gaps only, whose knobs must in that case be polished and protected from ultra-violet light, so as to supply the electric charge in as sudden a manner as pos-

As charged surfaces or capacity areas spheres or square plates or any other metal surfaces may be employed; but I prefer, for the purpose of combining low resistance with great electrostatic capacity, cones or triangles or other such diverging surfaces with the vertices adjoining and their larger areas spreading out into space; or a single insulated surface may be used in conjunction with the earth, the earth or conductors embedded to in the earth constituting the other oppo-

sitely-charged surface.

Radiation from an oscillator consisting of a pair of capacity areas is greater in the equatorial than in the axial direction, and a accordingly when sending in all directions is desired it is well to arrange the axis of the emitter vertical. Moreover, radiation polarized in a horizontal plane--that is, with its electric oscillations vertical-is less likely to be absorbed during its passage over partiallyconducting earth or water. A pair of insulated capacity areas arranged for long-distance signaling is shown on the left-hand side of Fig. 5. Fig. 6 shows a single insu- 1 lated capacity area h with the earth acting as the other surface and leading up to the spark-knobs h2 h3 by a triangular sheet or cone h', so as to afford good conductance even to rapidly-alternating currents. The wire h8 in this case leads to one terminal of the Ruhmkorff coil, the other terminal of which is taken to earth. The capacity area h is insulated, as indicated at h12.

In cases where it is required that the apparatus shall offer less resistance to wind the arrangement may be such as that illustration

in Fig. 7, where instead of being vertical, as ! shown in Fig. 6, the capacity area h is slanting or horizontal.

In Fig. 7 the syntonizing-coil h⁴ is shown 5 as surrounding a large telegraph-insulator y, which insulator divides the upper from the lower part of the rod carrying the discharge-' knob h's. The spiral h' bridges over the gap thus caused, uniting the rod above and beto low the insulator and so affording an earth

Fig. 8 shows an insulated metal surface in the form of a roof of a shed or building which E may be used as a capacity area, with suitable 15 connection and apparatus (not shown) inside

the little house 1.

The self-inductance coil represented at h^1 in all applicable figures is a coil of highlyconducting wire or ribbon, well insulated by so air or by some other medium, as already described, or else covered to a sufficient thickness with insulating material of such shape as to have maximum self-inductance for a given resistance, and it may be either a flat 25 coil inclosing a considerable plane area or it may be a cylindrical coil wound upon a finelysubdivided iron core, as shown at m in Fig. 9, the score being either ring-shaped or Ushaped or straight.

The discharge-knobs hi hi may be arranged at one end of such coil, as shown in Figs. 2. 3, 7, and 9, or the coil may be in two halves with the knobs inserted in the middle, at pleasure. (See Figs. 4 and 5). Several such coils $h^4 h^{4\times} h^{6/4}$, with their knobs $h^2, h^{2/4}$, and h2 < x, may, as shown in Fig. 10, be arranged for use with a single pair of capacity areas, and any one of them may be brought into action by a suitable switch, so that the de-40 sired frequency of vibration or syntony with a particular distant station is attained by replacing one coil by another, for the frequency

can be adjusted either by varying the capacity of the condenser or jar or other con-45 ductor employed or the charged body on the one hand or by varying the number and position of coils or other portion of the discharge-circuit on the other. That discharger

is in action whose spark-gap is allowed to op-crate, and a switch A' B' C' can determine which of a set of different coils shall be utilized for a given distant station. Fig. 11 illustrates the form of switch indicated in Fig. 10,

In Fig. 11 the numeral 1 designates a me-55 tallic union-piece. 2 is its handle, of insulating material, and 3 is a suitable insulating-base. The union-piece I dips into mercury-cups 4 and 5, with which the leads 6 1 and 7 are connected.

A plan alternative to that described with reference to Fig. 10 is to connect the capacity areas through one pair of knobs and a single large coil of a considerable number of turns, as shown in Fig. 9, and to have keys or plugs or switches s' and a', whereby some of the spires or the coil can be shunted out of ac-

tion, so that the whole or any smaller portion of the inductance available may be used inaccordance with the correspondingly-attained receiver at the particular station to which it

is desired to signal.

Fig. 9 shows two hand-levers s' s2 hinged, respectively, to the coil at s3 s8. The bar of each lever is made of metal, while the handle is of insulating material. s³ s⁴ are movable 75 metallie spring-clips connected to the said coil and adapted to grip the levers when they are depressed, so as to make good contact. Thus each lever when pressed down shuts out all the spires of the coil between the two ends of 80 such lever. This arrangement may be used either in lieu of or in combination with inter changeable inductance-coils, such as shown in Fig. 10, and in the latter case they are useful for correcting slight errors in tuning for 85 any one station. The one I call an "adjustable" coil and the other I call "replaceable" or "interchangeable" coils, and both, since they tend to a like end and behave similarly, may be included by the term "variably-act- 90 ing" coil.

A receiver or resonator consists of a similar pair of capacity areas connected by a similarly-shaped conductor or self-inductance coil, the whole constituting an absorber ar- 95 ranged so as to have precisely the same natural frequency of electrical vibration as the radiator in use at the corresponding emittingstation, so that it can accumulate the received impulses-that is to say, can act cumula- 10 tively; but it must not have a spark-gap, such as h^2/h^3 , or if it have a spark-gap the same must be carefully closed or shunted or bridged across by a good short conductor-for example, like Fig. 11 - before the arrangement can 10, be properly used as a cumulative receiver. Identically the same capacity areas and se finductance coil can be used at will either as emitter or as receiver-that is, either as radiator or as resonator (see Fig. 5)-if it beyr convenient to do so, on condition that the "discharge" spark-gap h2 h3 of the radiator is perfectly closed whenever acting as re-

Thus referring to Fig. 3 it will be seen that in that diagram illustrates a combined omitting and receiving apparatus. When in use as a radiator, the gap between the discharge-knobs. he ha is left open. When utilized as a resonator, the said gap is closed by the shunt h, 12 (there supposed to be like Fig. 11,) and the coherer e, battery f, and telegraphic receiva ing instrument g are connected through a thin wire x from each end of the coil ht-that is, from each of the capacity areas.

If the Ruhmkorff maghine a has been actually connected to the capacity areas h h', as in Fig. 2, then it must be detached and p stituted by the coherer-circuit when in is wanted; but if the charge

through anpply-gaps ht h', as 4, (and this is the best plan,)

korth action between the resonator is then in no way afaction of the resonator is then in no way affected provided always that the coil is not put late activity while the receiving-circuit is connected up.

A coherer consists of any arrangement which drops in resistance on receipt of an electric impulse and rises to its old resistance on being subjected to a mechanical impulse,

10 such as a tremor or a tap.

A coherer-circuit is any known arrangement for observing or recording effects due to fluctuations in the electrical resistance of a coherer.

**Social As coherer I use either a light single-point contact or Branly's arrangement of a pair of conductors embedded in metallic grains or pawder or filings; but I prefer selected iron-filings of uniform size sealed up in a good

20 vacuum and with the communicating surfaces or electrodes reduced to points or thin platinum wires fused into the glass and with their ends close together; or I may use any other suitable apparatus with an appropriate

25 device for tapping back. In some cases I find that a coherer restores itself sufficiently without specially-arranged tremor and that in these cases a telephone is the quickest re-

sponder that can be used.

As coherer-circuit I usually arrange the coherer in simple series with a battery (voltaic or thermal) and a galvanometer, telephone, or other indicator, or a recorder of fluctuations of current, and I then connect the terminals of this series of instruments to the capacity areas of the receiver close to its self-inductance coil, so that this same coil of wire completes and forms an essential part of the coherer-circuit. The coherer is thus affected by

6 ory electrical disturbance occurring in the connecting-coil or in its capacity areas and by aid of the battery at once enables the telegraphic or telephonic instrument to appreciate and indicate the signals. This plan is shown in Figure 2 and 12.

45 shown in Figs. 3 and 12. It is an improvement on any mode of connection that had previously been possible without the connecting-coil.

In some cases I may, as shown in Fig. 13, surround the syntonizing-coil of the resonator with another or secondary coil u (constituting a species of transformer) and make this latter coil part of the coherer-circuit, so that it shall be secondarily affected by the alternat-

55 ing currents excited in the conductor of the resonator, and thus the coherer be stimulated by the current in this secondary coal rather than primarily by the currents in the syntonizing-coil itself, the idea being thus to leave

60 the resonator freer to vibrate electrically withcut disturbance from attached wires.

In all cases it is permissible and sometimes

less shunt the roils of the telegraphic

thy means of a resistance or a ca
n at w in Fig. 12, in order to

therer more effectively; and

coil surrounding said self-inductance coil, which secondary coil forms part of the coherer-circuit substantially as and for the purpose set forth.

9. The combination, in the receiving-circuit of a system of Hertzian-wave telegraphy, of a variably-acting self-inductance coil, connecting the capacity areas, a coherer, a bat-

closely to the capacity areas or receiving arrangement whereby it is to be stimulated.

What I claim, and desire to seeme by Letters l'atent of the United States, is—

1. In a system of Hertzian-wave telegraphy, the combination, with a pair of capacity areas, of a self-inductance coil inserted between them electrically for the purpose of prolonging any electrical oscillations excited in the system and constituting such a system a radiator of definite frequency or pitch.

2. In a system of Hertzian-way o telegraphy, the combination, with a pair of capacity areas, of a self-inductance coil inserted between a self-inductance coil inserted between a them electrically for the purpose of prolonging any electrical oscillations excited in the system, thus constituting the system a resonator or absorber of definite trequency or pitch, and a distant radiator of corresponding period capable of acting cumulatively.

3. In a system of Hertzian-wave telegraphy, the combination, with a pair of capacity areas, of electrical means having a spark-gap inserted between them and serving to syntonize them and means for bridging or shunting the spark gap, whereby the apparatus is adaptable for use at will either as a radiator or resonator.

4. In a system of Hertzian-wave telegraphy, the combination, with a pair of capacity areas, of a number of self-inductance coils having different amounts of self-induction each of which is capable of being switched in or out of circuit, serving to syntonize any such radiator to a corresponding resonator or vice versa, whereby signaling may be effected between any two or more correspondingly-attuned stations without disturbing other differently-attuned stations.

5. In a system of Hertzian-wave telegraphy, the combination, with a pair of capacity areas, of a variably-acting self-inductance coll, serving to syntonize such a radiator or resonator to any other such resonator or radiator, whereby signaling may be effected between any two or more correspondingly-attuned stations without disturbing other differently-at-

tuned stations.

6. In combination, a pair of capacity areas connected by a coil of wire serving as the radiator in a system of Hertzian-wave telegraphy, means for syntonizing such radiator, and means for charging it by aerial disrup-

tion or impulsive rush.

7. In a system of Hertzian-wave telegraphy, at the combination of a pair of capacity areas such as h, h, means for syntonizing such capacity areas, a receiving-circuit completed through one or both of such capacity areas, and means for bridging over the dischargegap between such capacity areas when they are to be used as a receiver, whereby such capacity areas are rendered adaptable for use at will either as a radiator or resonator.

8. In combination, in a system of ayntonic Hertzian-wave telegraphy, a pair of gapacity areas, a self-inductance coil and a mecondary

across the coils thereof substantially as and ic for the purpose set forth.

In testimony whereof I have hereunto subscribed my name.

OLIVER JOSEPH LODGE.

Witnesses: A. F. SPOONER.

No. 671,403. Patented Apr. 2, 1901. WIRELESS TELEGRAPH SYSTEM. (Application filed Nov. 26, 1900.) (No Moděl.) 15 GROUND PLATE 26-9 INDUCTION COIL 24 Juventor tharry Shoemaker 37 Eunis +Co; attorney (

Patented June II, 1901. No. 676,332. APPARATES FOR WIRELESS TELEGRAPHY. (Application filed Feb. 23, 1901.) 2 Sheets-Sheet 1. (No Model.) i^1 Fig. 2. C INVENTOR, WITNESSES: Guglielmo Marconi, Ynv. Talle Bette, Bette, Sheffield & Bette HIS ATTORNEYS. Tital! No. 676,332.

Patented June II, 1901.

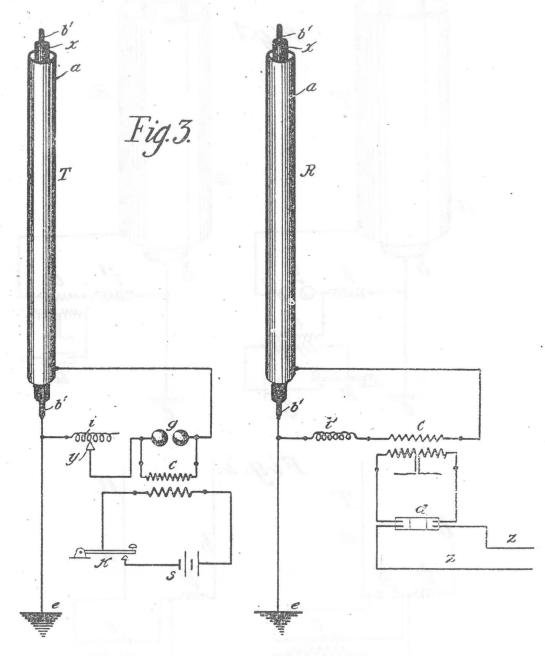
G. MARCONI.

APPARATUS FOR WIRELESS TELEGRAPHY.

(No Model.)

(Application filed Feb. 23, 1901.)

2 Sheets-Sheat 2.



Him. Tallman. Hany Pragacin

INVENTOR

Guglielmo Marconi, By Botts, Shapping & Batte

UNITED STATES PATENT OFFICE.

HARRY SHOEMAKER, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR OF ONE-HALF TO MARIE V. GEHRING, OF SAME PLACE.

WIRELESS-TELEGRAPH SYSTEM.

SPECIFICATION forming part of Letters Patent No. 671,403, dated April 2, 1901.

Application filed November 26, 1900. Serial No. 37,821. (No model.)

To all whom it may concern:

Be it known that I, HARRY SHOEMAKER, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and 5 State of Pennsylvania, have invented certain new and useful Improvements in Wireless Telegraph Systems; and I do declare the following to be a full, clear, and exact description of the invention, such as will enable oth-10 ers skilled in the art to which it appertains to make and use the same.

My invention relates to certain novel improvements in wireless-telegraph systems; and the objects are to simplify the construc-'15 tion, improve the operation, and increase the

efficiency of the apparatus.

To these ends the novelty and invention consist in the construction, combination, and arrangement of the several elements of the 20 device, as will be hereinafter more fully described, and particularly pointed out in the

In the accompanying drawings the same reference characters indicate the same parts 25 of the invention.

Figure 1 is a side elevation, partly in section, of the transmitting apparatus. Fig. 2 is a similar view of the receiving apparatus. Fig. 3 is a top plan view of the air-plate shown 30 in Fig. 1. Fig. 4 is a similar view of the airplate shown in the receiving apparatus.

A denotes the transmitting and B the re-

ceiving apparatus.

1 designates the air-plate, which is support-35 ed at a suitable elevation, and it consists of a series of parallel horizontal metallic disks 22, supported on a vertical conducting-rod 3, mounted on a conducting-stand 4, from which a conductor 5 leads to the binding-post 40 6, fixed on an insulating-plate 7, which forms the top of the "oscillator," and this bindingpost 6 is electrically connected to the post 8, which supports a large conducting-sphere 9, and counter-post sphere 10 being mounted 45 on a similar post 12, fixed on the opposite side of the top plate 7 and in electrical connection with the binding-post 13, from which a conductor 14 extends to the ground-plate 15. 16 17 designate similar smaller spheres fixed | the ground-plate 43.

on the conducting-posts 18 19, which are also 50 fixed in and extend through said top plate 7 and connected to the terminals of a condenser comprising interleaved and alternately-arranged conductor-plates 20 21, which are inclosed within a non-conducting casing 55 22, fixed to the said top plate 7 and filled with any suitable liquid dielectric, such as a heavy oil or the like, and supported on the stand 23.

From the binding-post 6 of the oscillator a conductor 24 extends to one binding-post 60 terminal 24' of the "secondary" of the Ruhmkorff coil 25, and from the opposite terminal 26 a conductor 27 extends to the ground-wire 14. A condenser 100 is bridged across the interrupter-terminals to prevent sparking. 55 28 designates the transmitting-battery, which is in circuit with the "primary" of said induction-coil through the medium of the conductors 29 30, and 31 designates the usual "Morse" signaling-key interposed in said 70 primary-coil circuit, the operation being such that when the usual dots and dashes constituting the Morse alphabet are transmitted by the key 31 corresponding induced impulses are created in the secondary and by means 75 of the wires 24 are conducted to the oscillator, where they are amplified and converted into etheric waves or oscillations, which are dissipated through the medium of the airplate 1 and ground-plate 15.

32 designates the air-plate of the receiving apparatus, and it consists of a series of vertical parallel semicylindrical conductorplates 33 33, arranged concentrically and mounted on a conductor-stand 34, supported 85 in any suitable manner, and from this stand a conductor 35 extends to the conductor-wire 36 of the "coherer" 37, which consists of a hermetically-sealed glass tube from which the air has been exhausted and which is mounted go within the solenoid 38. The upper end of the conductor 36 is connected to a contact-plug 39, which is beveled on its upper end, as shown, and 40 denotes a reversely-arranged and counter-post plug separated from the 95 former by a non-conducting strip 41, and from the plug 40 a conductor 42 extends to

44 designates a non-conducting plug provided with an axial orifice 45 and fixed within the coherer, and 46 represents a soft-iron split ring supported by the said plug 44 and within the inductive influence of the solenoid 38, which is formed about a longitudinally-split soft-iron core 38'.

47 denotes a small quantity of annealed ironfilings which normally rest by gravity in the 10 pocket formed by the beveled ends of the contact-plugs 39 40 and which close the circuit

between said plugs at this point.

The conductors 36 42 extend to the relay 48 and constitute the relay-circuit, high-re-15 sistance bridges 49 50 being interposed in said circuit to protect the coherer and the relay 4S, respectively, from the effect of heavy currents of induction or from extraneous sources. The relay local circuit commences at the ar-20 mature 51, from which a conductor 52 extends to one pole of the local battery 53, and from the opposite pole a conductor 54 extends to one binding-post of the local sounder 55, and a conductor 56 extends from the con-25 ductor 54 to the solenoid 38, from whence a conductor 57 extends to the stationary contact-point 58, fixed in the path of the relayarmature 51, and from the said conductor 57 a branch conductor 59 extends to the remain-30 ing binding-post of the sounder 55, and 60 61 designate high-resistance bridges interposed between the conductors 52 57 and conductors 54 and 59 to protect the apparatus from hightension jerk of current generated when the 35 circuit is broken at the relay.

The particular advantages of the parallel arrangement of the air-plates reside in the fact that they afford a large capacity area and an increased radiating-surface, thereby producing oscillations of increased regularity and intensity. Furthermore, this arrangement obviates the necessity of employing tall masts to support the aerial conductors, as I have found that relatively short metallic supports carrying the parallel plates are more efficient than the old form of towering masts with single radiating-plates. The respective types illustrated are adapted to be used interchangeably, and both the transmitting and receiving stations may be equipped with the

same type of aerial conductor.

The operation of the system above described is as follows: On depressing the key 31 to make, for example, a dash the induced 55 currents set up in the secondary of the induction-coil spark across the spark-gaps of the oscillator and generate surges or impulses which radiate into space from the aerial conductor 1. Some of the impulses or 60 oscillations strike the aerial conductor 32 at station B and are carried by wire 35 to ground through the detector 37, causing the iron-filings therein to cohere, allowing the local battery 101 to act and close the relay 48. The 65 armature 58 of said relay closes the circuit of

battery 53 and energizes sounder 55. At the same time solenoid 38 is energized by derived current from battery 53 and the ring-armature 46 attracts the iron-filings, causing the latter to decohere, thereby interrupting the current from battery 101, opening the relaycircuit, and restoring the mechanism to normal condition to be acted upon by a succeeding impulse from the transmitting-station.

In the accompanying drawings I have a shown my apparatus in the best form now known to me; but very many changes in the details may be made within the skill of an electrician without departing from the prin-

ciple of my invention.

Having thus fully described my invention, what I claim as new and useful, and desire to secure by Letters Patent of the United States, is—

1. In a wireless-telegraph system, a trans- 85 mitting apparatus comprising a signaling-circuit embracing the primary of an induction-coil, an oscillator provided with an aerial and a grounded conductor in the secondary of said coil, said aerial conductor comprising a 90 series of parallel conductor-plates and a conductor-rod supporting the same.

2. In a wireless-telegraph system, an aerial conductor comprising a series of parallel conductor-plates, and a conductor-supporting 95 rod, common to all the plates, substantially

as and for the purpose set forth.

3. In a wireless-telegraph system, a transmitter comprising an oscillator consisting of a pair of conductor-spheres included in the 100 transmitter - circuit, a second pair of conductor-spheres arranged in juxtaposition to said first-mentioned spheres to provide airgaps between all of said spheres and a condenser bridged between said second set of 105 spheres.

4. In a wireless-telegraph system, a transmitter comprising an oscillator, consisting of a pair of parallel insulated conductor-rods, a series of interleaved, alternating conductor-plates carried by said rods, a liquid dielectric encompassing said plates, conductor-spheres fixed to the exposed ends of said rods, a pair of conductor-spheres arranged in the same plane with the said spheres first noted and embraced in the transmitter-circuit, substantially as and for the purpose set forth.

5. In a wireless-telegraph system, a receiver comprising main circuit, a coherer located in said circuit, an electromagnetic ring 120 mounted in the coherer, a solenoid encompassing said coherer-ring and embraced within the local circuit, substantially as and

for the purpose set forth.

6. In a wireless-telegraph system, a re- 125 ceiver comprising an aerial conductor consisting of a series of semicylindrical concentric conductor-plates, a conductor-stand common to all the plates, a ground-plate, and a coherer interposed between said air and earth 130

plates, substantially as and for the purpose set forth.

7. In a system of wireless telegraphy, an arrial conductor comprising a series of semi-cylindrical concentric conductor-plates and a supporting-conductor common to said plates. In testimony whereof I have hereunto set

my hand in presence of two subscribing witnesses.

HARRY SHOEMAKER.

Witnesses:

GUSTAVE P. GEHRING, JOSEPH S. HAGAN.

United States Patent Office.

GUGLIELMO MARCONI, OF LONDON, ENGLAND, ASSIGNOR TO MARCONI'S WIRELESS TELEGRAPH COMPANY, LIMITED, OF SAME PLACE.

... PPARATUS FOR WIRELESS TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 676,332, dated June 11, 1901.

Application filed February 23, 1901. Serial No. 48,447. (No model.)

To all whom it may concern:

Be it known that I, GUGLIELMO MARCONI, a citizen of the Kingdom of Italy, residing at 18 Finch Lane, Threadneedle street, in the 5 city of London, England, (and having a postoffice address at 18 Finch Lane aforesaid,) have invented certain new and useful Improvements in Apparatus for Wireless Telegraphy, (for which I have applied for a patent in Great Britain, dated March 21, 1900, No. 5,387,) of which the following is a specification.

My invention relates to improvements in apparatus for communicating signals and telestically without wires, employing at a transmitting-station, a producer of Hertz oscillations controlled by a signaling instrument, and, at a receiving-station, a coherer or other imperfect contact for controlling a sounder, relay, or other device; and the objects of my invention are to increase the efficiency of the system and to provide a means whereby oscillations from a transmitting-station may be localized when desired at any selected receiving station or stations.

In my former patents, especially Nos. 586,193, 624,516, 650,109, and 650,110, I have described means for communicating between two stations situated at a great distance and 30 between which obstacles may intervene.

Referring to the accompanying drawings, which show diagrammatically three embodiments of my new improvements, Figure 1 shows one embodiment of the system wherein the two conductors at each station are arranged concentrically and fixed inductancecoils are employed at each station. Fig. 2 shows a modification having the conductors arranged side by side, and Fig. 3 shows a system having a variable inductance at the transmitting-station and a fixed inductance at a receiving-station.

I have discovered means for greatly increasing the efficiency of the apparatus at the as receiving and transmitting stations of the system.

Heretofore, so far as I am aware, each station has been provided with a single aerial conductor for receiving or transmitting electrical oscillations. I have, however, discovered that the communication of signals may

be greatly facilitated by the employment at each station of two aerial conductors insulated from each other and to which may be connected conductors leading directly or 55 through a transformer-circuit to a spark-producer or other source of electrical oscillations or to a coherer or other instrument influenced by said oscillations.

I have further discovered that advanta- 60 geous results are attained by the inclusion in the aerial circuits at both the transmitting and receiving stations of inductances preferably employing (especially at the transmitting-station) inductance-coils capable of wide 65 variations of self-induction, whereby the resonance of the inductances at the transmitting and receiving stations can be harmonized and the receiving apparatus caused to readily respond to the oscillations sent from 70 the transmitting-station.

The aerial conductors at both stations may be disposed in any suitable way, care being taken, however, to thoroughly insulate them from each other. As shown in Figs. 1 and 3, 75 they may consist of inner and outer conductors, (insulated from each other,) and they may be of any desired shape. The inner conductor may be simple or compound—such as a metallic tube b, Fig. 1, or a cable or rod b', 80 Fig. 3—and the second conductor a may be disposed concentrically around the first named, being preferably insulated therefrom—for instance, by an applied coating X, Fig. 3, of india-rubber, gutta-percha, or other 85 insulent—and the conductors being separated by a surrounding air-space. The conductor a may be a metallic tube, as shown in Figs. 1 and 3, or a concentric cable, spiral band, or wire, or even a metal-foil covering. In- 90 stead, however, of being arranged concentrically the two conductors a and b (or b') may be separated in any suitable way. As shown in Fig. 2, they are two parallel vertically-extending rods, wires, or strips in- 95 sulated from one another by the air alone or by an applied coating. At the transmittingstation I erect one of these double conductors and at the receiving-station a similar one or several of these. At the transmitting-station 100 I preferably connect one of the conductors—

for instance, b—to one terminal of an induc-

at i Live

tion-coil capable of giving electric sparks and also connect that terminal to earth. The other terminal of the induction-coil is preferably connected to the other conductor. In 5 series either with the one or the other of the two conductors, at both stations, I place an inductance-coil, preferably of variable inductance. When the two conductors are in concentric form, I prefer to connect the inner one to eart! At the receiving end I provide an inductant coil in series with either of the two conductors, and preferably with a similar earth connection to one of them, and I connect a suitable form of sensitive tube, co-15 herer, or other Hert wave-receiving device between the two conductors and the associated inductance-coil. I may also add to the receiving device a telegraphic relay or other receiving device, as a sounder or printing in-20 strument, for receiving or recording messages or otherwise making the received oscillations manifest, in accordance with arrangements described by me in my earlier patents. I usually also insert between the coherer or 25 other receiving device and the termination of the pair of conductors an induction-coil

30 heretofore issued to me. In employing my invention to localize the transmission of intelligence to one of several receiving-stations I proceed as follows: At the transmitting end the inductance - coil 35 which I preferably employ is one that may have its self-induction varied over wide limits. At each of the receiving-stations I employ an inductance-coil of fixed inductance, suitably selected. I find that if the induct-40 ance-coil at the transmitting-station has its inductance varied until the electrical system composed of the aerial conductor or conductors and the associated inductance-coil is in resonance with that of one of the receiv-45 in systems, that one alone of all the receiving ..ystems responds, provided that the distance between the transmitter and receiver is not too small. In this manner by systematic trials I can adjust each receiving instru-50 ment to respond to the transmitter when the inductance of that transmitter has a value corresponding to the particular receiving instrument which is to be affected.

or transformer of a kind suitable for the

transformation of very-rapidly-alternating currents, such as are described in patents

Figs. 1 and 2 are diagrams of transmitting 55 and receiving apparatus arranged as above described. Tindicates the transmitting system, and R the receiving.

In Fig. 1, a b indicate concentric metal cylinders. I have used with success outer cylinders three feet in diameter and inner cylinders one foot six inches in diameter, both twenty feet high. For higher cylinders it is desirable to increase the annular space between the outer and inner cylinders. g indicates the spark-gap of an induction-coil or transformer c, which is connected to the cylinders b and a, an inductance-coil i being in-

terposed. s is the battery, and k the key. A Tesla coil may be used to produce the oscillation. At R an induction-coil or transformer 70 c, similar to those described in my previous patents and applications, is used and is inserted between the two concentric cylinders ba along with an inductance-coil i. The induction-coil or transformer c is connected to 75 a coherer or detector d of electric waves and a suitable receiver-such, for example, as is described in United States Letters Patent No. 586,193, granted to me—the connection and other details being, for clearness, omitted. 80 The internal cylinders b are connected to earth e or to a large capacity which may be used in place of earth.

Fig. 2 shows a modification in whic's two adjacent conductors a and b are used instead s_5 of the concentric cylinders.

Referring especially to Fig. 3, the inductance-coil i at T is shown as being capable of variation in power. For this purpose the switch Y or other electrical device adapted 90 to increase or decrease the number of turns of the inductance-coil in circuit may be employed. I do not wish to be understood, however, as confining my invention to a system employing a variable-inductance coil at the 95 transmitting-station and fixed inductancecoils at the receiving-stations. If desired, the inductance at the transmitter may be fixed and the inductance at the receiving-station may be variable. In said figure I have 100 also shown wires Z Z, connected to the coherer d and leading to a device which may control the operation of a sounder, printing device, or a decohering mechanism.

I am aware of United States Letters Patent 105 No. 609,154, dated August 16, 1898, to Lodge, of British Letters Patent No. 14,449, of 1899, to Brown, and of German Letters Patent No. 11,578, dated October 14, 1898, to Braun; but none of these contain the distinctive features 110 of my invention. While Lodge shows two large oscillation-producing conductors and au inductance device connected between them, yet in none of these patents is it proposed to use a plurality of aerial oscillation-produc- 115 ing conductors insulated from each other by the air or some other insulating substance and in combination therewith to arrange inductances in what I call the "oscillation-circuits" at the transmitting apparatus—that is, the 120 circuit which extends from one oscillationproducing conductor to the other-by connecting it in series with the conductors and with the oscillation-producer; nor is it therein proposed at the receiving apparatus to in- 125 clude an inductance in what I call a "receiving-circuit" by inserting it in series with two aerial conductors and so locating the coherer or detector as to be influenced by the oscillations in the circuit so formed. In practice I 130 have found that the best result will be-secured by dissymmetrically including the inductance in the oscillation and receiving circuits To obtain the best results in long

ALK K K K

distance wireless telegraphy, it is essential to give to the electrical oscillations a difference in phase, and this is secured by the dissymmetrical inclusion of the inductance in 5 series with the oscillation-producer and with the oscillation-producing conductors at the transmitting apparatus and by the dissymmetrical inclusion of the inductance in the receiving-circuit, with the coherer or detector to so arranged as to in readily influenced thereby. Where the ina stance is not used in the receiving-circuit, the result will be that both terminals of the coherer will be electrified positively or negatively simultaneously and 15 current will not flow therein. By my preferred arrangement the including of the inductance in the receiving-circuit in such position that the received oscillations will readily pass through the coherer and affect the re-20 lay will secure the desired result. Moreover, none of the said patents show the combination at a station of two aerial conductors with an inductance connected in series between them and with a connection from one of said 25 conductors to the earth, which arrangement I have found to be highly advantageous in

While I have herein shown and described embodiments of my invention which I have so found to be practical, yet I do not desire to be understood as limiting my claims thereto. Obviously modifications thereof will readily suggest themselves to electricians and to persons skilled in wireless telegraphy.

What I claim is—

In apparatus for communicating electrical signals, the combination, at a transmitting-station, of two aerial oscillation-producing conductors insulated from each other; an inductance connected in series with said conductors; a producer of electrical oscillations and a signaling instrument controlling the oscillation-producer.

2. In apparatus for communicating electrical signals, the combination, at a transmitting-station, of two aerial oscillation-producing conductors; an inductance connected in series with said conductors; a producer of electrical oscillations; a signaling instrument controlling the oscillation-producer, and a connection from one of the oscillation-producing conductors to earth.

3. In apparatus for communicating electrical signals, the combination, at a transmitting-station, of two aerial oscillation-producting conductors insulated from each other; an inductance connected in series with said conductors; a producer of electrical oscillations; a signaling instrument controlling the oscillation-producer, and a connection from one 60 of the oscillation-productors to earth.

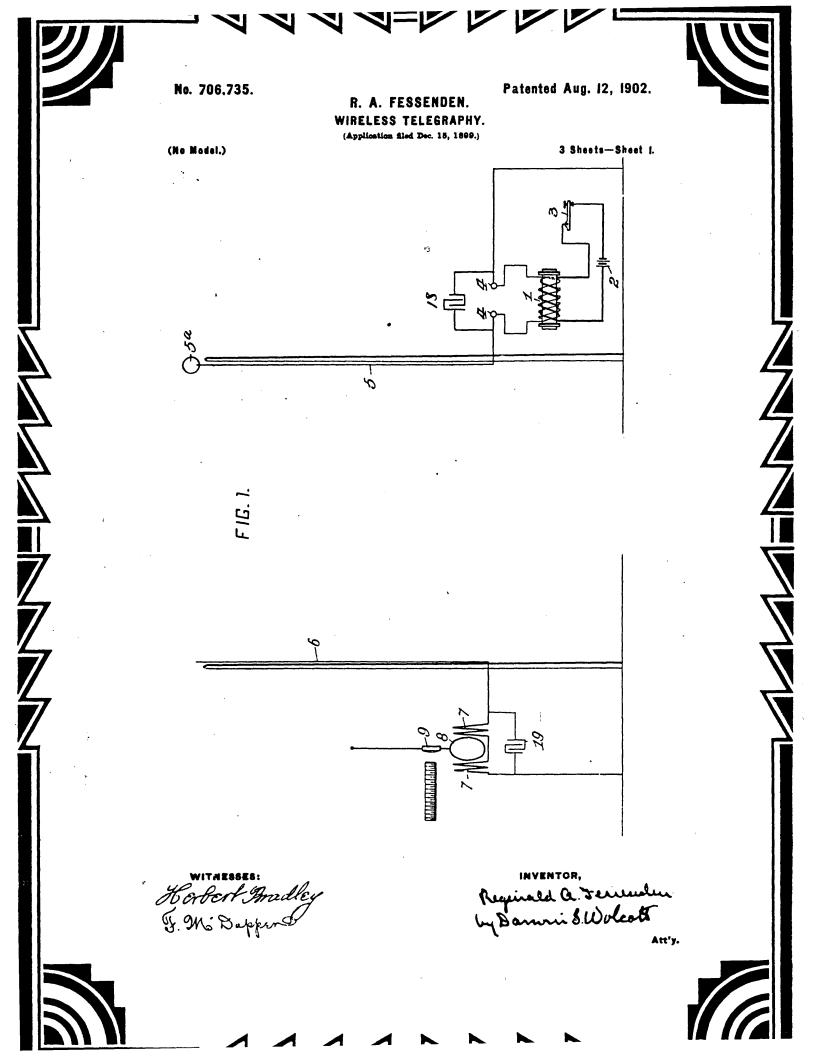
4. In apparatus for communicating electrical signals, the combination, at a receiving-station, of two aerial oscillation-receiving conductors insulated from each other; an inductance connected in series with said conductors; and an imperfect electrical contact or detector influenced by the received oscillations.

5. In apparatus for communicating electrical signals, the combination, at a receiving station, of two aerial oscillation-receiving conductors insulated from each other; an inductance connected in series with said conductors; an imperfect electrical contact or detector influenced by the received oscillations; and a connection from one of the oscillation-receiving conductors to earth.

In testimony whereof I have hereunto set my hand in presence of two subscribing wit- 80 nesses.

GUGLIELMO MARCONI.

Witnesses:
WILLIS UTLEY,
HARRY WARD.



No. 706,735. Patented Aug. 12, 1902. R. A. FESSENDEN. WIRELESS TELEGRAPHY. (Application filed Dec. 15, 1869.) (Ne Medel.) 3 Sheets-Sheet 2. FIG. Z. FIG. 5. 15 Herbert Gradley F. D. Dapper INVENTOR, Requiald a Ferrenden by Danaris Wolcott Att'y.

Ne. 706,735. Patented Aug. 12, 1902. R. A. FESSENDEN. WIRELESS TELEGRAPHY. (Application filed Dec. 15, 1899.) (Ne Model.) 3 Sheets-Sheet 3. FIG. 3. 15 FIG. 4. 16 INVENTOR, Herbert Gradley Regulal a. Ferrenden F. M. Dappers by Danni S. Wolest Att'y.

United States Patent Office.

REGINALD A. FESSENDEN, OF ALLEGHENY, PENNSYLVANIA.

WIRELESS TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 706,735, dated August 12, 1902.

Application filed December 15, 1899. Serial No. 740,429. (No model.)

To all whom it may concern:

Be it known that I, REGINALD A. FESSEN-DEN, a citizen of the United States, residing at Allegheny, in the county of Allegheny and 5 State of Pennsylvania, have invented or discovered certain new and useful Improvements in Wireless Telegraphy, of which improvements the following is a specification.

The invention described herein relates to certain improvements in the electrical transmission of signals from one station to another without the use of conductors connecting such stations.

In the methods heretofore employed the electromagnetic waves generated at the receiving-station produce voltages in the receiving-circuit. These voltages passing through a suitable material normally nonconductive render the same conductive, and thereby permit the passage of a current through a circuit in which said material, usually termed a "coherer," is included. After the cessation of the voltages produced by each series of electromagnetic waves generated at the sending-station the coherer must be operated on in some way to restore it to normal or non-conductive condition.

The object of the present invention is to provide for the generation by currents pro30 duced by electromagnetic waves of currents in a second element or circuit and by the reaction of the current in this second element or circuit on the field formed or produced by the currents in the receiving-wire to produce 35 motion which is directly or indirectly observable.

In general terms the invention consists in the generation by electromagnetic waves of a current directly or indirectly in coils at the receiving-station, the current in said coils inducing a current in another element or circuit which is arranged in such relation to the coils that the current induced therein reacts with the field produced by the coils, thereby producing motion.

The invention is hereinafter more fully described and claimed.

In the accompanying drawings, forming a part of this specification, Figure 1 is a diasonal responsive device" as used herein and by me part of this specification, Figure 1 is a diasonal responsive device as used herein and by me parameter view showing the arrangements are diagrammatic views and options. Figs. 2 and 3 are diagrammatic views

illustrating modifications of the receiving apparatus. Fig. 4 is a side elevation of the apparatus shown in Fig. 3, and Fig. 5 is a further modification of the receiving apparatus.

The apparatus employed at the sendingstation may be similar to that now in use for the generation of electromagnetic waves and consists of an induction-coil 1, having its 60 primary coil in circuit with a generator 2, said circuit having a make-and-break mechanism 3 included therein. One of the discharging knobs or terminals 4 is connected with the vertical sending-conductor 5, while 65 the other knob or terminal is grounded.] have found that by placing a capacity formed. by a body 5" of conducting material having a comparatively large radiating-surface the waves generated at the sending-station have 70 a very much higher energy, thereby correspondingly increasing the effect or energy of the current produced in the receiving-conductor.

The terms "sending-conductor" and "re- 75 ceiving-conductor" are employed herein as indicating all of the circuits at the sending and receiving stations from top to ground, if grounded, or if not grounded from one extreme end to the other extreme end, including 80 all apparatus in series with the circuits, while the term "radiating portion" indicates all of the sending-conductor from top or extreme end of same to point of junction with the apparatus for effecting the oscillatory charging 85 and discharging thereof, such as sparking terminals, transformer-coils, armature-windings, &c. By the term "electromagnetic waves" as used herein is meant waves of a wave length long in comparison with the wave length of 90 what are commonly called "heat-waves" or "radiant heat." By "grounded conductor" is meant a conductor grounded either directly through a capacity, an inductance, or a resistance, so that the currents in the conductor 95 flow from the conductor to ground, and vice versa, when electromagnetic waves are being generated. The terms "tuned" and "resonant" are used herein as one including the other. By the term "current-operated wave- 100 responsive device" as used herein and by me generally is meant wave-responsive devices having their contacts good contacts and op-

netic waves. They are hence to be distinguished from wave-responsive devices depending for operation upon varying contact resistance.

At the receiving-station the receiving-conductor is formed by a wire or wires 6, projecting up vertically or at an inclination to a suitable height, which are also grounded. A coil or coils 7 are arranged in the circuit of the re-10 ceiving-conductor 6, and an element or coil of wire 8, forming a closed circuit, is supported with a freedom of movement in such relation to the coil or coils 7 that the current produced by the electromagnetic waves will in-15 duce a current in the element 8. The element 8 is supported, preferably, in such manner that a plane at right angles to its axis will form an angle of approximately forty-five degrees, (45°,) with a plane at right angles to the 20 axis of the coils 7, so that the reaction of the current induced in said element with the field produced by the coils 7 will cause the element 8 to move with reference to the coils 7. This motion of the element may be observable by 25 means of a mirror 9, attached thereto, reflecting a beam of light on a scale, or said element may form a part of the circuit of a recordingsiphon, &c.

As shown in Fig. 2, the coils 7 may be con-30 nected to the secondary coil 11 of a transformer whose primary coil 12 is connected in

series with the receiving-wire.

A desirable means for transforming the electromagnetic waves into recordable motion 35 is shown in Figs. 3 and 4. The element 8 is balanced on supporting-rods or knife-edges 13. one of which is formed of a good electrical conductor, as silver, the element 8 being preferably formed by a silver ring. A car-40 bon block 14 is so arranged that a portion of the ring between the supporting-rods will normally rest lightly thereon. This microphonic contact, the conducting pivotal support, and the portion of the ring between 4; them form parts of an electric circuit, which also includes a generator 15 and a recording instrument 16 as a telegraphic sounder or the receiver of a telephone. When a current is generated, as above described, in the coil 7, 50 the element or ring 8 will be caused to press on the carbon block, thereby increasing its conductivity. When using a telephone-receiver as a recording instrument, the generator 15 is preferably of a character capable 55 of producing an alternating current, as such current causes a constant vibration of the diaphragm, the vibrations increasing in intensity with an increased flow of current in the circuit. This increase in intensity of ac-60 tion with increased flow of current is characteristic of this form of receiver and also of the form shown in Fig. 1. In this it is sharply differentiated from such devices as the coherer, which either give a strong indication 65 or do not give any. This characteristic is advantageous in that if the signal sent-say

full intensity it may still in most cases be read and not missed entirely, which is of value in sending code-messages.

In the construction shown in Fig. 5 the circuit of the generator is divided, one branch including a coil 16 and connected to a microphonic contact 14°, while the other branch of the circuit includes a reversely-wound coil 75 162 and is connected to a microphonic contact 14b. These contacts are arranged on opposite sides of the ring 8 and are so adjusted that the ring will normally rest equal on both blocks, so that an equal current will flow 80 through both of the coils 16 16^a, thereby maintaining a magnetic bar 17, suspended between the coils in equilibrium with relation to the coils. Adjustable resistances may be placed in the circuits of the coils, thereby 85 avoiding the necessity of delicate adjustments of the carbon blocks. When the coils and the ring or element S are energized, the pressure of the latter on one contact is increased and that on the other decreased, 90 thereby correspondingly changing the resistances in the two branches. The increased flow of current through one coil and decreased flow through the other coil, due to the change in resistances, will produce a greater move- 9; ment of the magnetic bar 17 than if only a single coil were used. The movement of the bar 17 can be rendered observable in many ways known in the electric-signaling art—as, for example, by securing a mirror thereon.

As shown in Fig. 1, a condenser 19 may be connected in shunt with the field coil or coils 7 for the purpose of obtaining as large a current as possible in the field-coil 7, as this increase in current will give a greater torque to 105 the ring 8. When no condenser is employed, this large current must flow in the vertical wire, and there would be great loss of energy on account of the resistance of wire 6, and, further, without the condenser a large amount 110 of energy will be required to give the statical charge to the receiving-conductor. Hence on account of the small energy furnished by the wave a large current cannot be obtained in field coil or coils 7 without the condenser. 115 By employing a condenser of the proper size current in wire 6 may be made to have a value equal to the difference between the current in the field coil or coils and the current in the condenser. Either of these currents may 120 therefore be large and either or both may be used to produce motion, while the current in wire 6 may be kept so small that there is practically no loss of energy on account of its resistance or of the statical charging of the re- 125 coiver, and all the energy may be used in producing motion. Without the condenser the current in the field coil or coils 7 will be practically a quarter-phase behind the voltage on account of the self-inductive lag in the field- 130 coil. If the condenser were substituted for the field-coil, there would be a current in it nearly a quarter-phase in advance of the volta dot-be too weak to give an action of the large the to the capacity lead. When both the

field-coil and the condenser are introduced one in shunt with the other, there will be a current in the field coil or coils lagging ninety degrees (90°) and in the condenser a current leading ninety degrees, (90°.) The sum of two currents one hundred and eighty degrees apart in phase is equal to the difference between their values. Hence if there is a current in the field coil or coils of one ampere and in the condenser a current of nine-tenths $\binom{10}{10}$ of an ampere the current in the receivingwire 6 will be one-tenth $\binom{10}{10}$ of an ampere.

By the employment of a condenser in shunt with the coil or coils 7 the current in the receiving-wire is reduced without reducing the current in the coil or coils 7, so that the resistance drop, which is at times sufficiently great to affect the operation of the system, is eliminated or so reduced as not to have any

It is preferred to place a shunt-circuit containing a condenser across the terminals of the induction-coil at the sending-station for the purpose of maintaining sustained radiation. This shunt-circuit must be tuned to the receiving-conductor; otherwise the oscillations produced by it will have no action upon the wave-responsive device at the receiving-station. This shunt-circuit by virtue of its capacity stores up an additional amount of energy, and when a spark passes across the gap, since the sending-conductor can radiate energy at a given rate, it must continue to radiate for a longer time in order to dissipate

35 this additional stored-up energy. I am aware that apparatus consisting of a fixed primary and a movable secondary circuit has been used for detecting oscillatory currents. This apparatus was a modified 40 form of an earlier alternating voltmeter, a silver disk or thick-rimmed annulus being substituted for the wire coil used in the voltmeter and delicately suspended so as to have a long period of swing. This apparatus was 45 used not for the purpose of detecting electromagnetic waves emitted and received by unclosed circuits, but for detecting the magnetic inductive effects which one closed circuit (having rapidly-oscillating currents pro-50 duced in it by a transformer, Hertz oscillator, or other suitable means) produced on another closed circuit. The effects to be obtained by such an apparatus were therefore disterent in kind from those sought in wireless teleg-55 raphy and the method of producing them were different from that described herein. This Northrup apparatus was used to detect magnetic induction effects to a distance of approximately one hundred yards. Although 60 distances somewhat longer could doubtless have been attained with such apparatus, the method employed by Northrup is not available for commercial wireless signaling, as magnetic induction effects fall off as the cube 65 of the distance, and approximately ten thourequired to obtain effects with the Northrup apparatus at a distance of one hundred miles.

The construction of Northrup's receiving instrument is not suitable for the purposes of 70 wireless telegraphy, as the movable member consists of a disk or thick-rimmed annulus. whereas the movable member of the receiving mechanism for wireless telegraphy should be a ring formed of thin wire (indicated at 8 75 in the drawings) having a ratio of internal and external diameters equal or approximately equal to unity. If a disk or thickrimmed annulus should be used as the movable member of the receiving mechanism for 80 wireless telegraphy, the efficiency of such mechanism would be so greatly reduced as to render it inoperative, for the reason that the currents induced in the disk or thick-rimmed annulus tend to get as near as possible to the 85 center of such parts, and thereby weaken the reactive effect between the fixed and movable parts and to exert small torque, and, further, as the disk and thick-rimmed annulus have low self-induction the currents in- 90 duced in them tend to get out of phase with the currents in the fixed coil or coils, and hence the torque is weakened. Moreover, the period of oscillation of a disk or thickrimmed annulus for a given restoring force 95 is so long that extremely-powerful restoring forces must be used to enable a mechanism having such a movable member to record signals at commercially-practical speeds, and since the force varies as the square of the 100 speed deflecting forces many thousands of times greater must be employed than is required in the receiving mechanism described herein. In other words, the thin light ring 8 will work with but a fraction of the energy 105 required to operate a disk or thick-rimmed annulus. By the employment of a thin ring of good conducting material and a fixed coil of few turns, as shown in the drawings, the electrical forces between fixed and movable 110 members of the receiving mechanism are rendered more efficient, and hence the force necessary for commercially-practical signaling is greatly lessened.

The inapplicability of the Northrup appa- 115 ratus is further shown by the fact that the coils of the fixed member of his apparatus consist of a large number of turns of wire, so that the resistance in such coils is high, whereas a commercially-practicable instru- 120 ment for wireless telegraphy should have its fixed coil or coils formed by a few turns of wire, and consequently of low resistance. By the employment in the receiving instrument of a fixed coil or coils of few turns and a 125 movable member formed by a thin light ring of highly-conducting wire high resonance effects combined with a rapid natural period of the moving part and a maximum efficiency are attained and the advantageous use of 130 transformers, as in Fig. 2, is rendered pos-

sands of millions times the energy would be I sible.

It is characteristic of the method shown that the receiving mechanisms are actuated by currents produced by electromagnetic waves and not by voltages, as in the case of the coherer. Hence when the receiving mechanisms described herein are used in connection with a secondary circuit said circuit is controlled by the currents generated by electromagnetic waves and not by voltages. It is 10 also characteristic that when a secondary circuit is used in connection with the type of wave-responsive device shown in Figs. 3, 4, and 5 a portion of the secondary circuit is traversed and controlled by currents pro-15 duced by electromagnetic waves. It is further characteristic of my improved system that the indications produced by the receiving mechanism herein described are dependent upon the total amount of energy emitted 20 to form the signal and are not, as in the case of the coherer, dependent upon the maximum of the voltage.

I claim herein as my invention-

1. As an improvement in the art of transmitting signals electrically by electromagnetic waves the method herein described, which consists in the generation of electromagnetic waves at one station and transforming the energy of the currents generated by such 30 waves at the receiving-station into the energy of motion, that is without the necessary interposition of a secondary or auxiliary generator for the production of such motion, substantially as set forth.

2. As an improvement in the art of transmitting signals between stations by electromagnetic waves, the method herein described which consists in causing the radiation of electromagnetic waves from a grounded conductor, generating voltages by such waves in a conductor at the receiving-station and transforming the energy of each of said voltages into the energy of motion, substantially as set forth.

3. As an improvement in the art of transmitting signals electrically between stations by electromagnetic waves, the method herein described which consists in producing an electromagnetic field in a receiving mechanism
consisting of relatively fixed and movable members arranged in operative relation to each other by the generation of electromagnetic waves at the sending-station, thereby causing a movement of one of the parts of the receiving mechanism, substantially as set forth

4. As an improvement in the art of transmitting signals electrically between stations by electromagnetic waves, the method herein described which consists in the generation of a current or currents in a portion of a receiving mechanism consisting of relatively fixed and movable members by the generation of electromagnetic waves at the sending-station and then producing a current or currents in the other portion of the receiving mechanism by the current or currents generated or the

waves into the energy of motion, varying the currents in two or more local or secondary circuits by such energy of motion, transforming the energy of the varied currents into the energy of motion and causing the energies of motion so produced to operate in the same direction, substantially as set forth.

olectromagnetic waves, whereby one part of the receiving mechanism is caused to move relative to the other part, substantially as set 70 forth.

5. As an improvement in the art of transmitting electrical energy by electromagnetic waves the method herein described, which consists in maintaining a secondary circuit in 75 an energized condition and controlling the energy of said circuit by current effects produced by electromagnetic waves flowing through a current-operated wave responsive device forming a portion of the secondary circuit. 80

6. As an improvement in the art of transmitting electrical energy by electromagnetic waves the method herein described, which consists in prolonging the oscillations of an energy-radiating conductor by energy from a source external to the radiating-conductor and tuned to the period of the radiating-conductor, substantially as set forth.

7. As an improvement in the art of transmitting electrical energy by electromagnetic 90 waves the method herein described, which consists in the generation of electromagnetic waves at one station and transforming the energy of the currents generated by such waves at the receiving-station into the energy of motion, varying the motion thus produced by varying the amount of energy delivered at the receiving-station without the necessary interposition of a secondary or auxiliary generator for the purpose of such motion, substantially as set forth.

8. As an improvement in the art of signaling by electromagnetic waves the method herein described, which consists in generating electromagnetic waves in a grounded conductor 105 at the sending-station, receiving such waves at the receiving-station and transforming the energy of electromagnetic waves so received into the energy of motion by means of a receiving instrument having a low resistance, 110 substantially as set forth.

9. As an improvement in the art of transmitting electrical energy, the method herein described, which consists in varying the conductivity of a secondary circuit at the receiving-station by motion produced by currents generated by electromagnetic waves, substantially as set forth.

10. As an improvement in the art of transmitting electrical energy, the method herein described, which consists in the generation of electromagnetic waves at one station, transforming the energy of the currents generated by such waves at the receiving-station into energy of motion, varying the currents in two or more local circuits by such energy of motion and transforming the energy of such currents into the energy of motion, substantially as set forth.

and movable members by the generation of olectromagnetic waves at the sending-station and then producing a current or currents in the other portion of the receiving mechanism by the current or currents generated of the currents generated of the currents generated of the currents generated by such

In testimony whereof I have hereunto set my hand.

REGINALD A. FESSENDEN.

Witnesses:

DARWIN S. WOLCOTT, F. E. GAITHER.

STATES PATENT OFFICE.

REGINALD A. FESSENDEN, OF ALLEGHENY, PENNSYLVANIA.

WIRELESS TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 706,737, dated August 12, 1902. Application filed May 29, 1901. Serial No. 62,301. (No model.)

To all whom it may concern:

Be it known that I, REGINALD A. FESSEN-DEN, a citizen of the United States, residing at Allegheny, in the county of Allegheny and 5 State of Pennsylvania, have invented or discovered certain new and useful Improvements in Wireless Telegraphy, of which improvements the following is a specification.

The invention described herein relates to 10 certain improvements in transmission of energy by electromagnetic waves, and has for its object the production of more efficient

sending or generating conductors.

It is a further object of the invention to 15 provide for the production of mechanical movements by the direct interaction of currents induced in the receiving-conductor by electromagnetic waves and constant or varying magnetic fields.

The invention is hereinafter more fully de-

scribed and claimed.

In the accompanying drawings, forming a part of this specification, Figure 1 is a diagrammatic view illustrating a form of appa-25 ratus for the practice of my invention. Fig. 2 is a similar view illustrating a modification of the apparatus at the receiving-station. Fig. 3 is a sectional elevation of one form of conductor. Fig. 4 is a top plan view of the 30 same, and Fig. 5 is an elevation of a modification of the conductor.

In the experiments heretofore made in wireless transmission of energy, as in telegraphy, relatively high frequencies—e. y., of the or-35 der of two million (2,000,000) periods or more per second—have been used. It is impossible to produce or utilize mechanical movements directly by the interaction of a constant or independently-varying magnetic field 40 and a current induced by electromagnetic waves of such high periodicities, for the reason that either the element to be moved (as the diaphragm of a telephone) is incapable of such rapid vibrations or the vibrations are 45 too rapid to be utilized. In order to utilize directly the interaction between currents induced by electromagnetic waves and a constant or independently-varying magnetic field to produce motion in one of two mem-

50 bers of a receiving instrument, one member thereof consisting of a constant or independently-varying magnetic field, the sending- the supporting-rings, as shown. This wire

conductor is so constructed that its capacity or self-induction, or both, are large, as compared with the value of the aerial wire com- 55 monly used in the art and distributed with practical uniformity along the conductor from or near its top to a point at or near the instrument. By thus increasing the capacity and self-induction of either of them the frequency 60 of the electric oscillations in the conductors, and consequently of the waves generated, will be sufficiently low to produce utilizable motion in the instrument. By "low frequency" is meant low relative to the fre- 65 quency hitherto used in wireless telegraphy.

The terms "sending-conductor" and "receiving-conductor" as hereinafter employed indicate all of the circuits of the sending and receiving stations from top to ground, if 70 grounded, or, if not grounded, from one extreme end to the other extreme end, including all apparatus in series with the circuits, while the term "radiating portion" indicates substantially all of the sending-conductor 75 from top or extreme end of same to a point at or near junction with the apparatus for effecting the oscillatory charging and discharging thereof, such as sparking terminals, transformer-coils, armature-windings, &c.

The self-induction of the sending-conductor can be regulated by increasing or decreasing the turns in the coil 2, formed in the wire connecting the radiating portion 1 with the generator 3. The capacity of the sending-con- 85 ductor can be regulated in several ways-as, for example, by changing the superficial area of the radiating portion 1-by the employment of a medium as described in application No. 62,303, filed May 29, 1901, or reduc- 90 ing the height of the radiating portion without reducing its superficial area. A conductor of large capacity may be constructed. as shown in Fig. 3, having its radiating portion 1 in the form of a cylindrical cage, con- 95 sisting of a number of parallel wires 4, socured at their ends to supporting-rings 5, provided with hubs or central sockets 6 for the reception of supporting-rods 7, formed of bamboo or other light non-conducting mate- 100 rial. For convenience it is preferred to form the cylindrical eage in sections, which can be mechanically and electrically connected by

cage or cylinder can be connected to ground | both, having these electrical constants suitin any suitable manner, as by the wire S, in ably proportioned so that the sending-conwhich coils or turns may be formed to adjust | ductor has a natural period identical with 70 the self-induction of the sending-conductor, that of the dynamo. This obviously ren-As shown in Fig. 5, the radiating portion may be formed by a cylinder 9, having continuous | metal walls. By employment of sending-conductors having large capacity distributed with approximate uniformity or regularity 10 over a large portion of its length the height thereof may be reduced without affecting the officient travel of the electromagnetic waves radiated therefrom. When low frequency is obtained by increasing the capacity alone, 15 or by increasing both capacity and self-induction, the curve of resonance is broader than is obtained by increasing the self-inductance alone, though in the former cases the amount of energy radiated for a given 20 voltage and length of sending-conductor is more than is obtainable with a short resonance curve. Hence to obtain the best results it is preferred to use the two former methods and to conjoin with them at the re-25 coiving-station means for increasing the selective effect of the receiving - conductor, which means are described and claimed in application No. 62,303, filed May 29, 1901.

By increasing the capacity and self-induc-30 tion, or either of them, the stated advantages of a low frequency of oscillations in the conductor and a shorter radiating portion are obtained, and in addition thereto it is possible with frequencies of one hundred thousand 35 (100,000) or less to substitute for the induction-coil, connected in the manner now in vogue, a source of alternating voltage as the exciting-generator—as, for example, the exciting-generator may be a dynamo, a trans-40 formerconnected toadynamo, or an inductioncoil producing low-frequency oscillations in a primary circuit, the secondary circuit forming the source of alternating voltage and having one terminal connected to the radiating 45 portion and the other terminal to the ground. In order that a dynamo may be used to produce such a high periodicity which, though low as compared with periodicities heretofore used in wireless transmission of energy, 50 as in telegraphy, is very high as compared with those generated by dynamos commonly used in electrical engineering, it must possess several distinct characteristics. First, it should generate pure sine-waves, because, 55 as is well known, this is the only form of curve which gives perfect resonance. With a dynamo giving such a curve forming a part of a suitably-constructed sending-conductor it is possible to wind the dynamo so as to i 60 generate, for example, only a thousand volts on open circuit, and yet by means of reso-tained by the employment of steam-turbine. nance effects to obtain a voltage of a hundred thousand volts on the sending-conductor. It is possible to obtain resonance 65 effects by use of a dynamo of low internal resistance, as a portion of a sending-con-

ders the machine much cheaper to build and much easier to manipulate for signaling purposes than a dynamo or dynamo and transformer built to give one hundred thou- 75 sand volts directly. Second, the armature must be of low internal resistance, because if of a high resistance the oscillations will be dampened and high resonance voltages cannot be produced. Third, it must be well ven- 80 tilated, because during the period of sending a signal the current may run up to hundreds or even thousands of amperes. Fourth, the length of wire in the armature must be as small as possible compared with the length 85 of the sending-conductor, for otherwise the electrical constants of the sending-conductor-i. c., of the cir uit from the top of the conductor to the ground including the armature—will be determined too largely by 90 that part of the circuit between the armature terminals and the amount of radiation from the given voltage on the sending-conductor would be much less than would be the case if the armature had relatively lesser length 95 of wire. In other words, the self-induction and capacity of the armature must be as small a fraction as possible of the self-induction and capacity of the sending-conductor. When the dynamo is said to be in resonance 100 with the sending-conductor, it is meant that the natural period of the whole conductor, from the top of the conductor to the ground including the armature, is the same as the periodicity of the dynamo. Fifth, it is also 105 essential that all iron magnetically influenced by currents in the conductor should be so proportioned and distributed as not to effect the shape of the curve of voltage or to cause loss of power by hysteresis, as in such case 110 there would be too much dampening. For these reasons the dynamo may be constructed with a fixed armature containing no iron, having the air-gap, as long as possible consistent with a high magnetic flux density, 115 revolving pole-pieces so shaped as to produce sine-waves as closely as possible, and the revolving parts formed of magnetic material of high tensile strength, such as nickel-steel.

A dynamo with the revolving part having 120 a high peripheral speed of one-half mile per minute has given ten thousand periods per second, and with a revolving part formed of nickel-steel a peripheral speed of five miles per minute can be safely maintained, giving 125 thereby one hundred thousand periods per second. Such peripheral speed can be ob-

It will be evident to those skilled in the art that instead of using a dynamo giving a 130 thousand volts a dynamo giving a hundred volts may be used with a transformer stepping up to a thousand volts; but in such case ductor of large capacity or self-induction, or the length of wire in the secondary of the

It is characteristic of the method shown that the receiving mechanisms are actuated by currents produced by electromagnetic waves and not by voltages, as in the case of the coherer. Hence when the receiving mechanisms described herein are used in connection with a secondary circuit said circuit is controlled by the currents generated by electromagnetic waves and not by voltages. It is 10 also characteristic that when a secondary circuit is used in connection with the type of wave-responsive device shown in Figs. 3, 4, and 5 a portion of the secondary circuit is traversed and controlled by currents pro-15 duced by electromagnetic waves. It is further characteristic of my improved system that the indications produced by the receiving mechanism herein described are dependent upon the total amount of energy emitted 20 to form the signal and are not, as in the case of the coherer, dependent upon the maximum of the voltage.

I claim herein as my invention—

1. As an improvement in the art of transmitting signals electrically by electromagnetic waves the method herein described, which consists in the generation of electromagnetic waves at one station and transforming the energy of the currents generated by such such as waves at the receiving-station into the energy of motion, that is without the necessary interposition of a secondary or auxiliary generator for the production of such motion, substantially as set forth.

2. As an improvement in the art of transmitting signals between stations by electromagnetic waves, the method herein described which consists in causing the radiation of electromagnetic waves from a grounded conductor, generating voltages by such waves in a conductor at the receiving-station and transforming the energy of each of said voltages into the energy of motion, substantially as set forth.

3. As an improvement in the art of transmitting signals electrically between stations by electromagnetic waves, the method herein described which consists in producing an electromagnetic field in a receiving mechanism
consisting of relatively fixed and movable members arranged in operative relation to each other by the generation of electromagnetic waves at the sending-station, thereby causing a movement of one of the parts of the receiving mechanism, substantially as set forth.

4. As an improvement in the art of transmitting signals electrically between stations by electromagnetic waves, the method herein described which consists in the generation of a current or currents in a portion of a receiving mechanism consisting of relatively fixed and movable members by the generation of electromagnetic waves at the sending-station and then producing a current or currents in the other portion of the receiving mechanism by the current or currents generated of the

waves into the energy of motion, varying the currents in two or more local or secondary circuits by such energy of motion, transforming the energy of the varied currents into the energy of motion and causing the energies of motion so produced to operate in the same direction, substantially as set forth.

electromagnetic waves, whereby one part of the receiving mechanism is caused to move relative to the other part, substantially as set 70 forth.

5. As an improvement in the art of transmitting electrical energy by electromagnetic waves the method herein described, which consists in maintaining a secondary circuit in 75 an energized condition and controlling the energy of said circuit by current effects produced by electromagnetic waves flowing through a current-operated wave responsive device forming a portion of the secondary circuit. 80

G. As an improvement in the art of transmitting electrical energy by electromagnetic waves the method herein described, which consists in prolonging the oscillations of an energy-radiating conductor by energy from a 85 source external to the radiating-conductor and tuned to the period of the radiating-conductor substantially as set forth

ductor, substantially as set forth.

7. As an improvement in the art of transmitting electrical energy by electromagnetic 90 waves the method herein described, which consists in the generation of electromagnetic waves at one station and transforming the energy of the currents generated by such waves at the receiving-station into the energy of motion, varying the motion thus produced by varying the amount of energy delivered at the receiving-station without the necessary interposition of a secondary or auxiliary generator for the purpose of such motion, substantially as set forth.

S. As an improvement in the art of signaling by electromagnetic waves the method herein described, which consists in generating electromagnetic waves in a grounded conductor at the sending-station, receiving such waves at the receiving-station and transforming the energy of electromagnetic waves so received into the energy of motion by means of a receiving instrument having a low resistance, 110 substantially as set forth.

9. As an improvement in the art of transmitting electrical energy, the method herein described, which consists in varying the conductivity of a secondary circuit at the receiving-station by motion produced by currents generated by electromagnetic waves, substantially as set forth.

10. As an improvement in the art of transmitting electrical energy, the method herein described, which consists in the generation of electromagnetic waves at one station, transforming the energy of the currents generated by such waves at the receiving-station into energy of motion, varying the currents in two or more local circuits by such energy of motion and transforming the energy of such currents into the energy of motion, substantially as set forth.

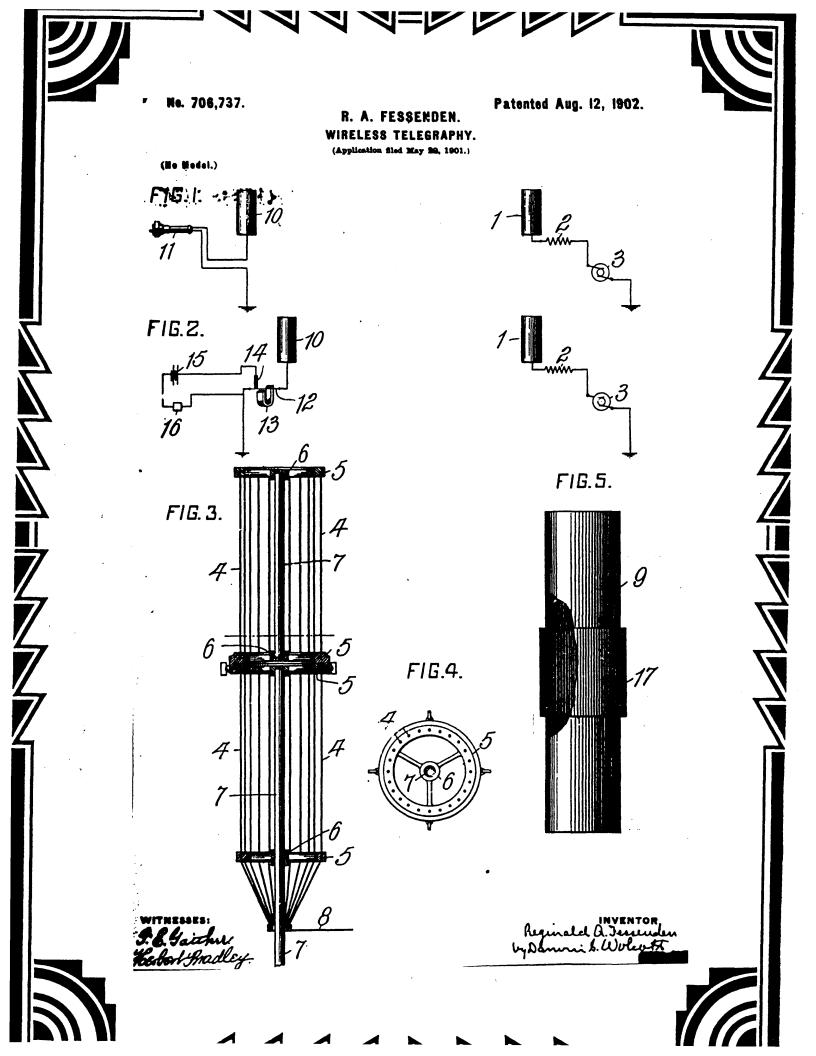
11. As an improvement in the art of transmitting electrical energy, the method hereby
described, which consists in generating electromagnetic waves at one station, transforming the energy of currents generated by such

In testimony whereof I have hereunto set my hand.

REGINALD A. FESSENDEN.

Witnesses:

DARWIN S. WOLCOTT, F. E. GAITHER.



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transformer should have the same relation to the length of the whole conductor, including the secondary of the transformer, as stated in reference to a dynamo giving a thousand

5 volts. The best results are obtained when the frequency of the source of alternating voltage, as a dynamo, is equal or approximately equal to the natural frequency of the radiating sys-10 tem. The adjustment of frequencies can be effected by changing the speed of the dynamo. The reason why the best results are obtained when the frequency of the dynamo or . its equivalent (as a transformer connected to 15 a dynamo) is equal or approximately equal to that of the natural frequency of the radiating circuit is that when the frequency of the dynamo is less than this the chief effects are electrostatic and magnetic in their nature 20 and there is practically no electromagnetic radiation. Under these circumstances signals cannot be transmitted to any great distance, as the electrostatic and magnetic effects fall off as a high power of the distance. 25 As the frequency of the dynamo is increased the effects of electrostatic and magnetic induction continue to predominate until the frequency of the dynamo approaches that of the sending-conductor. When this point is 30 reached, if the radiating portion of the sending-conductor has a length which is a large fraction of the total length of the circuit a large amount of energy can be radiated in the form of electromagnetic waves and sig-35 nals be transmitted a long distance. The reason why the length of the radiating portion of the sending-conductor should be a large fraction of the total length of the circuit is that if otherwise the circuit would be a poor 40 radiator. If, for example, the length of the radiating portion of the sending-conductor is five feet and the length of the wire in the armature is five miles, the amount of energy radiated would be very small compared to 45 what it would be if the length of wire in the armature were only five hundred feet and the radiating portion of the sending-conductor five feet. A further advantage incident to the employment of low frequencies is the 50 fact that there is, as I have discovered, less absorption of the electromagnetic force as the waves travel along the ground than when

the waves have high frequencies. In the form of apparatus shown in Fig. 1 55 the generator 3 (in this case a dynamo) has one pole connected to ground and the other pole connected by a wire having an inductance 2 to the radiating portion 1. The sending-conductor which may have its radiating 60 portion of any suitable form, but preferably that shown in either Figs. 3 and 5, has its capacity or self-induction or both adjusted in the manner described, that the electromagnetic waves radiated will have low frequency. 65 At the receiving-station the receiving-conductor 10 is connected to one terminal of a translating device 11, as a telephone, the

opposite terminal thereof being connected to the ground. As the frequencies of the waves which induce currents in the conductor 10 70 are low, the diaphragm of the telephone will respond thereto, and the vibrations of the diaphragm will produce audible notes.

In Fig. 2 is shown another form of receiving apparatus. A portion of the ground con- 75 nection of the receiving - conductor 10 is formed by a piece of fine wire 12, held in tension between the poles of a magnet 13. By the interaction between the currents passing along the wire 12 and the magnetic field the 80 wire is caused to vibrate and make and break contact with the microphonic contactpoint 14, which is so adjusted as to be normally out of contact with the wire 12. A circuit, including a battery 15 and relay 16 or 85 other translating device, is formed in part by the contact 14 and the wire 12, so that whenever the secondary circuit is completed by the vibration of the wire the relay will be energized.

If the radiating portion be made, as shown in Fig. 5, with varying superficial dimensions—e. y., with a swell or enlargement 17 the electromagnetic waves generated from its different surfaces will have different perio- 95 dicities, as the periodicity of electromagnetic waves depends, in part at least, on the capacity of the radiating portion at the sendingstation, a similarly-constructed conductor may be used at the receiving-station, or two 100 simple receiving-conductors suitably tuned may be used.

By the use of a sending-conductor of large capacity and having that capacity uniformly distributed certain specific advantages are 105 obtained which cannot be obtained by any other style of conductor. When the capacity is not distributed with substantial uniformity, it is impossible to obtain a sine form of electromagnetic wave, and this form of wave 110 gives very much better results in that it permits of the voltage being increased by resonance to any extent, depending only on the resistance losses. For example, if the resistance be low it is possible with an impressed 115 voltage of, say, five to reach a resonant voltage of two hundred or more with a capacity distributed uniformly—i.e., with a sine-wave, while if the capacity be distributed, so as to give a parabolic wave with a voltage of five, 120 it is not possible to obtain by resonance a higher voltage than twenty-five, since when the capacity is large the resistance is also low on account of the fact that the currents with these high frequencies flow over the sur- 125 face of the sending-conductor it follows that with a sending-conductor of large capacity uniformly distributed it is possible to get a sine-wave and a low resistance—i. e., conditions necessary and favorable for the pro- 130 duction of large resonant voltages from small impressed voltages, and hence conditions which permit of sending over longer distances than if the sending-conductor were of

large capacity not uniformly distributed or of small capacity uniformly distributed. By the term "large capacity" as herein used is meant a capacity large as compared with the 5 capacities of wires heretofore commonly used in the art, and by the term "uniformly distributed" is meant distributed with substan-

tial uniformity over the radiating portion.

The effect of locally increasing the super-10 ficial area of the sending-conductor or of locally increasing the capacity by any other suitable means is to produce two or more sets of waves of different periodicities, the periodicity of the first being dependent upon the 15 electrical constants of the sending-conductor as a whole and the periodicity of the other depending upon the position and amount of localized increase of capacity in the same way as by attaching a weight or spring to a 20 piano-wire between its extremities additional vibrations in the wire are created.

By the term "electromagnetic waves" as used herein is meant waves of a wave length long in comparison with the wave length of what are commonly called "heat-waves" or "radiant heat." By "grounded conductor" is meant a conductor grounded either directly or through a capacity, an inductance, or a resistance, so that the current in the conduc-30 tor flows through the conductor to ground, and vice versa, when electromagnetic waves are generated. The terms "tuned" and "resonant" are used herein as one including the other.

This invention involves the discovery of the desirability and practicability of using radiant electromagnetic waves of a frequency lower than has heretofore been recognized as desirable or practicable and in the de-40 vising of a considerable number of very meritorious features combined in an apparatus or system whereby the energy of such waves may be successfully radiated in quantities sufficient for practical use over long 45 distances.

In constructing an apparatus that will give practical results with such low-frequency waves novel features have been devised, some of which are of general utility in generating 50 and radiating waves of the higher and more usual frequencies, and these are hereinafter claimed in terms which will cover the use thereof in other than the specific connection for which they are primarily intended.

The amount of radiation possible for a given system is dependent, among other things, upon the frequency, and, other things being equal, the amount is less for the lower frequencies. In order, therefore, to radiate 60 large amounts of energy by low-frequency waves, I take advantage of the rise of voltage due to resonance effects brought about by a proper proportioning of inductance and capacity, so that the phases of the impressed 65 electromotive force and the current coincide

tities of the conductor which make it a good oscillator, and this is measured by the amount 70 that the resistance is less than the square root of four times the inductance divided by the capacity—that is, the amount of R² is less than $\frac{4L}{C}$; but in such a conductor the best 75 conditions of resonant oscillation require that the length of conductor be one-fourth the length of the fundamental wave oscillating therein. It is evident then that if the conductor be a plain wire of ordinary size 80 and the capacity and inductance employed for tuning be small the wave length therein will be substantially the length in the ether of a wave of the same frequency, which for a frequency of ninety thousand is two miles, 85 and the resistance which acts to cut down oscillation would be that of eight miles of wire for each complete wave or oscillation, so that the tenth wave or oscillation, for example, would have been subject to the re- 90 sistance losses of eighty miles of wire. Where, however, the inductance and capacity are large, the length of the sending-conductor and its subsequent resistance detrimental to oscillation may be greatly decreased, for the 95 frequency of the fundamental wave-that is, the natural period of such a conductorvaries inversely as the square root of the capacity multiplied by the square root of the inductance—that is, inversely as the quan- 100 tity or value V L C. Now since the condition of resonance is that C L W2=1 it is evident that instead of increasing L and C in equal proportions to get a large total 🎺 L C necessary for a good oscillator one of these 105 factors may be increased, while the other remains constant or is decreased. Large inductance, however, would involve large resistance, which is bad, as shown, while increase of capacity in accordance with my invention is 110 advantageous in many ways, as will be pointed out. I therefore make the capacity large and the induction correspondingly small, thereby making the quantity \checkmark L C large and correspondingly shortening my sending-conductor and greatly reducing my resistance.

grounded at one end depend upon the quan-

The large capacity I distribute uniformly over substantially all of the radiating portion of the conductor, thereby further reduc- 120 ing instead of increasing the resistance and at the same time providing a large effective radiating-surface. The further reason why the capacity is thus distributed is that with any other arrangement it is difficult to get a 125 pure sine form of electromagnetic wave, because any local increase of capacity tends to produce two or more sets of waves of different periodicities.

In order that I may radiate large amounts 130 of energy, I make the radiating-conductor over which the capacity is distributed a large fraction of the total length of the send-Resonance effects in a vertical conductor ling-conductor. This points another advan-

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tage of relatively and absolutely large capacity and corresponding inductance, for un-· less I was able to greatly shorten the sending-conductor, as I do by their use, it would 5 be difficult to construct a low-frequency radiating-conductor which would be so large a fraction of the length of the whole sendingconductor.

From the above it will be seen that by my 10 invention the internal current losses due to ohmic resistance are largely decreased by using large total capacity and small inductance for the tuning, thereby shortening the length of sending-conductor necessary for a 15 given frequency or for a given wave length in the ether. The shortening of the sending-conductor also facilitates the use of a radiatingconductor which is a large fraction of the wave length. The distribution of the ca-20 pacity makes possible a better form of wave, decreases the resistance of that part of the sending-conductor, and further increases the radiating-surface.

With this system, whereby large amounts 25 of energy may be radiated at a low frequency, I am able to substitute for the induction-coil and spark-gap now in use a dynamo or simi-

lar source of alternating voltage. If the dynamo be used without the spark-30 gap, I am able at once to produce a continuous train of radiant waves of substantially uniform strength, as distinguished from the well-known systems wherein the spark-discharge starts a train of waves of rapidly-di-35 minishing power followed by relatively long intervals of no radiation. Furthermore, where the spark discharge is used I am able, by reason of the persistent oscillation coupled with the low frequency, to greatly diminish 40 and, indeed, to completely bridge over the intervals of no radiation, for with ten thousand sparks per second exciting a sendingconductor of a periodicity of ninety thousand it is evident that if each spark gives only ten 45 oscillations before being damped sufficiently to stop radiation, every tenth oscillation will coincide with the first oscillation produced by the next succeeding spark. Thus the radiation will be practically continuous, and 50 the total energy of the first oscillation produced by the spark will be divided between only nine electromagnetic waves. Now if the frequency were one million and the sparks ten thousand per second it would be 55 necessary to have an oscillator capable of one hundred useful oscillations of a power sufficient to produce useful radiations in order to maintain practically continuous radiation.

60 would be divided between one hundred radiant electromagnetic waves and would be too small for practical use over commercial distances.

The energy of a single spark in that case

From the above it will be seen that by keep-

electromagnetic waves of an energy sufficient for practically continuous effects at the receiving-station. Even in the case where the sets of oscillations do not quite overlap in 70 time it is evident that the intervals of inactivity are decreased by the increase of the time of a train to ten times what it would be with a frequency of one million. This is a great advantage in cases where the receiver 75 is tuned to the period of the transmitter, for the regularity, continuity, and great energy of the waves improve the resonance in a manner that by use of proper devices at the receiving-station more than compensates for 80 the rather broad curve of resonance involved in any use of large capacity for tuning purposes.

In practice it is found that substantial uniformity of distribution of capacity may be \$5 obtained by making the conductor uniform in figure from the top to a point at or near the bottom, as is indicated in 'ig. 3. It has been held by some that the capacity of the upper portion of a vertical conductor of uniform oo cross-section is much smaller than that of the middle or lower portions by reason of its greater distance from ground; but I have found by actual measurement that this is practically not the case, the upper portions 95 having practically the same capacity as the lower portions. The capacity of a conductor with respect to ground is mainly dependent upon its size and shape and not upon its distance from the ground when the distance be- 100 tween the conductor and ground is not small.

I claim herein as my invention-

1. A sending-conductor for electromagnetic waves, having a large capacity distributed with substantial uniformity over its ra- 105 diating portion, substantially as set forth.

2. A sending-conductor for electromagnetic waves, having its capacity so adjusted that the waves radiated therefrom have a low frequency, substantially as set forth.

3. A sending - conductor for electromagnetic waves, having its capacity and inductance so adjusted that the waves radiated therefrom have a low frequency, substantially as set forth.

4. In a system for transmission of energy by electromagnetic waves, the combination of a source of alternating voltage and a conductor in series therewith forming a sending-conductor said sending-conductor being adapted 120 to radiate electromagnetic waves and having its radiating portion of a length which is a large fraction of the quarter-wave length produced by the alternating source of the radiating portion in the medium surrounding 125 the radiating portion, substantially as set forth.

5. In a system for transmission of energy by electromagnetic waves, the combination of a source of alternating voltage and a conductor 130 65 ing R² small and the frequency low I am able in series therewith forming a sending-contoradiate practically continuous streams of ductor said sending-conductor being adapted

to radiate electromagnetic waves having its | currents produced by said waves, substanradiating portion of a length which is a large | tially as set forth. fraction of the length of the sending-conductor, substantially as set forth.

6. In a system for transmission of energy by electromagnetic waves, the combination of a conductor in series therewith forming a send- 1 its total length. 10 ing-conductor said sending-conductor being adapted and proportioned to radiate electro- netic waves having a natural period of viset forth.

7. In a system for the transmission of energy by electromagnetic waves, the combination of an alternating-current dynamo and a conductor in series therewith forming a sendingconductorsaid sending-conductor being tuned by large capacity and small inductance. 20 to the dynamo and adapted to radiate electromagnetic waves and tuned to the dynamo,

substantially as set forth. 8. In a system for the transmission of energy by electromagnetic waves, the combination of 25 a sending-conductor so proportioned as to radiate waves of low frequency and an alternating-current dynamo having its terminals connected respectively to the radiating por-

tion of the sending-conductor and to ground, 30 the dynamo being so adjusted that its periodicity is the same or approximately the same as the natural period of the sendingconductor, substantially as set forth.

9. A sending-conductor for electromagnetic 35 waves, formed by an alternating-current dynamo and a conductor in series therewith, one pole of the dynamo being grounded, the sending-conductor thus formed being so proportioned as to radiate waves of low fre-40 quency, substantially as set forth.

10. A sending-conductor for electromagnetic waves so proportioned as to radiate waves of low frequency in combination with a source of alternating voltage having its ter-45 minals connected respectively to the radiating portion of the sending-conductor and to ground, the voltage-generator being so adjusted that its periodicity is the same or approximately the same as the natural period 50 of the system when so connected, substan- 1 of electromagnetic waves. tially as set forth.

11. A sending-conductor for electromagnetic waves, formed by a source for continuously generating alternating voltage and a 55 conductor in series therewith, one pole of the source of alternating voltage being grounded, the sending-conductor thus formed being so proportioned as to radiate waves of low frequency, substantially as set forth.

12. A system for signaling by electromagnetic waves having in combination a con- my hand. ductor adapted to radiate waves of low frequency, and a receiver dependent for its action upon a constant or independently-vary-65 ing magnetic field and adapted to respond to i

13. A sending-conductor for electromagnetic waves of a length much less than a quarter of the length of an ether wave, hav- 70 ing a frequency equal to the natural period source of alternating voltage generating of said sending-conductor, and having a ragroups of impulses of low frequency and a diating portion which is a large fraction of

14. A sending-conductor for electromag- 75 magnetic waves, and being tuned to the bration much lower than the period of an source of alternating voltage, substantially as | other-wave four times its length, whereby its radiating portion may be a relatively large fraction of the total length of said sending- 80 conductor.

15. A sending-conductor for electromagnetic waves tuned to a desired low frequency

16. A sending-conductor for electromag- 85 netic waves having small inductance and tuned to a desired lov frequency by a suitably-proportioned large capacity.

17. A sending-conductor for electromagnetic waves having low resistance, small self- 90 induction and great capacity, substantially as and for the purpose set forth.

18. A sending-conductor for electromagnetic waves having low resistance, small selfinduction and great capacity so correlated as 95 to support persistent oscillation of a frequency much less than that of an other-wave of a length four times that of said sendingconductor.

19. A system for transmission of energy 100 by electromagnetic waves in combination with a radiating-conductor and a source of alternating electrical energy or potential, said radiating-conductor and source being coordinated and relatively adjusted to radiate 105 a substantially continuous stream of electromagnetic waves.

20. A system of transmission of energy by electromagnetic waves including in combination a radiating-conductor and a source of 110 alternating electrical energy or potential, said radiating-conductor and source being coordinated and relatively adjusted to generate and radiate a substantially continuous stream

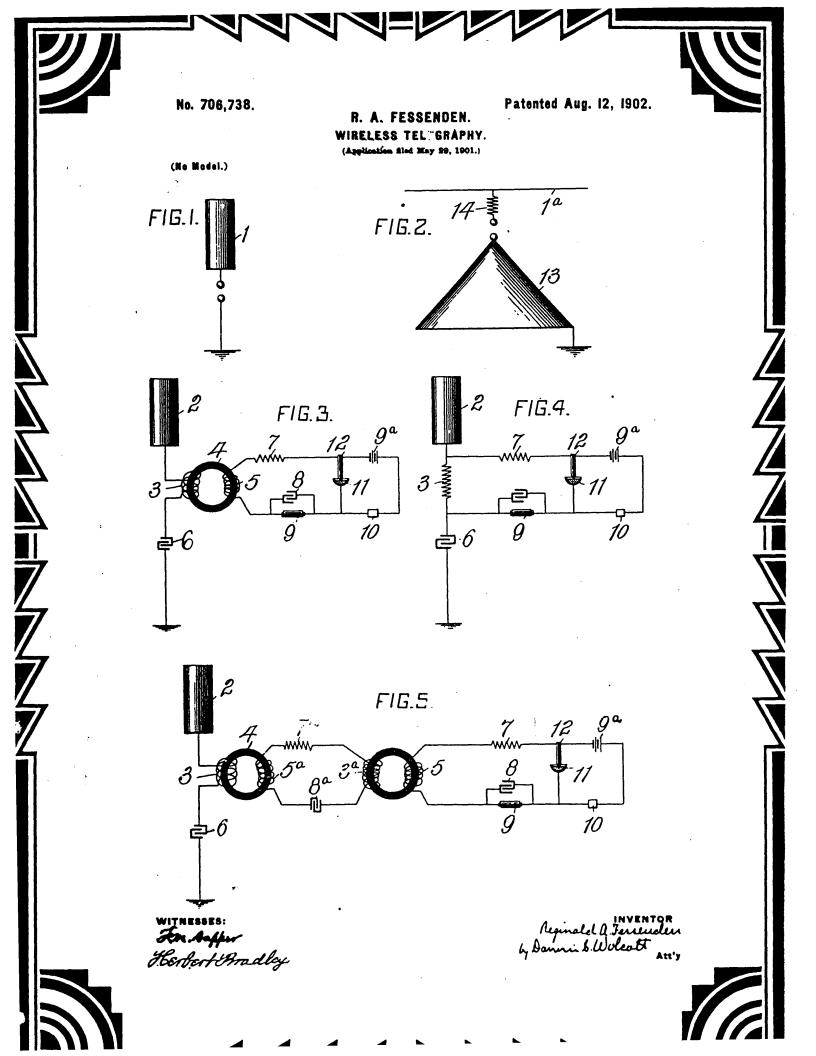
21. A system for transmission of energy by electromagnetic waves, including in combination a radiating-conductor and a source of alternating electrical energy or potential, said radiating-conductor and source being co- 120 ordinated and relatively adjusted to radiate a substantially continuous stream of electromagnetic waves of substantially uniform strength.

In testimony whereof I have hereunto set 125

REGINALD A. FESSENDEN.

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m Witnesses}$:

W. B. Fearing, S. C. Gray.



United States Patent Office.

REGINALD A. FESSENDEN, OF ALLEGHENY, PENNSYLVANIA.

WIRELESS TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 706,738, dated August 12, 1902.

Application filed May 29, 1901. Serial No. 62,302. (No model.)

To all whom it may concern:

Be it known that I, REGINALD A. FESSEN-DEN, a citizen of the United States, residing at Allegheny, in the county of Allegheny and 5 State of Pennsylvania, have invented or discovered certain new and useful Improvements in Wireless Telegraphy, of which improvements the following is a specification.

The invention described herein relates to certain improvements in apparatus for wireless telegraphy, and has as its object the provision of suitable means whereby a transformer or other inductive means may be employed for raising the voltage at the receiving-station.

It is also an object of the invention to increase the number of oscillations in the conductor during its discharging period, so that only a small fraction of the energy will be discharged or radiated at each oscillation.

It is a further object of the invention to provide for selective signaling by so tuning the receiving apparatus that it will respond solely to waves of one periodicity.

The invention is hereinafter more fully described and claimed.

In the accompanying drawings, forming a part of this specification, Figures 1 and 2 illustrate diagrammatically forms of conductors for sending-stations. Fig. 3 illustrates diagrammatically the apparatus for the receiving-station, and Figs. 4 and 5 are similar views of modifications of the receiving apparatus.

The addition of capacity to sending-conductors where signals are to be sent long distances has heretofore been considered useless. While this is true when a coherer or other closer for a secondary circuit is used alone, I have found that by the employment at the receiving-station of inductive means as a transformer for raising the voltage in the secondary circuit the addition of capacity to the sending-conductor has a decidedly beneficial effect. At the sending-station I employ a sending conductor 1—such, for example, as that shown and described in application No.

a sending conductor 1—such, for example, as that shown and described in application No. 62,301, filed July 2, 1901—having a large capacity relative to that of a wire of the same 50 height and of low self-inductance and resistance. At the receiving-station the receiving-conductor 2 may be similar to that at the

sending-station or of any other suitable form or construction. By the terms "sending-conductor" and "receiving-conductor" as 55 herein used I include all of the circuit from the top to ground, if grounded, or, if not grounded, from one extreme end to the other extreme end of the circuit, including all apparatus in series with the circuits, while un- 60 der the term "radiating portion" is included all of sending-conductor from top or extreme end of same to point of junction with apparatus for effecting the oscillatory charging and discharging thereof, such as sparking 65 terminals, transformer-coils, armature-windings, &c. The terms "tuned" and "resonant" are used herein one to include the other. This receiving-conductor, which is connected to ground, includes as a part thereof a trans- 70 former, as the inductance or coil 3, forming the primary of an induction-coil, the core 4 of which is preferably formed of fine wire. The secondary coil 5 of the transformer forms a part of another or secondary circuit, which cir- 75 cuit, as well as the prime receiving-circuit, consisting of the conductor 2, inductance 3, and capacity 6, (when used,) is so proportioned that its natural period of electric oscillation is identical with that of the sending system. 80 The tuning of the secondary circuit is effected by means of an inductance 7 and a capacity 8, included in said circuit, as shown in Fig. 3. The inductance 7 employed in tuning the secondary circuit may be combined with and 85 form a part of the secondary coil 5. When a coherer 9 or similar instrument is used as a receiver, the capacity 8 should be placed (if used) in shunt to the coherer, because thus advantage is taken of the resonant rise of po- 90 tential in a shunt-path between the lump inductance and capacity of a resonant circuit. The secondary circuit also includes a battery 9° and a relay 10 or other translating device. In order to prevent the local battery from op- 95 erating the relay except when the coherer has been rendered conductive, an opposing source of voltage, preferably an electrolytic cell, is bridged across the secondary circuit. This cell preferably consists of a cup 11, 100 formed of zine and containing caustic potash, and a copper wire or rod 12, having a fine point and capable of being moved up and down in the solution, so as to vary the back

electromotive force of the cell, because if the surface exposed to the liquid is large the quantity of electricity passing through the cell would not be sufficient to polarize to so 5 great an extent as if the surface were smaller. It is of course recognized that where the quantity is not limited the back voltage of polarization always reaches a fixed limit; but in the present case the quantity passing each 10 way is limited and the effect is reversed each half-period and is not cumulative. This cell is so connected as to present a counter electromotive force to the local battery when the coherer is inoperative, but to permit the al-15 ternating current flowing through it, and so render the coherer operative.

As shown in Fig. 4, the secondary circuit may form a shunt around the inductance 3, and, as shown in Fig. 5, three or more tuned 20 circuits may be used at the receiving-station, with the result of affording an additional safeguard as against any accidental operation of the receiving apparatus. When using three or more tuned circuits, the prime cir-25 cuit and the last circuit of the series are arranged as before described, and the intermediate circuit or circuits includes the secondary coil whose primary forms the inductance 3 of the conductor and the primary coil 3° of 30 an induction-coil whose secondary is included in the next circuit of the series. Each circuit includes a capacity and an inductance, whereby it may be properly tuned.

It will be noticed that the current 7° 3° 8° 35 5° in Fig. 5 forms a closed tuned secondary circuit.

The employment of simple wires having small capacity as the radiating portions of sending-conductors is objectionable, for the 40 reason that the radiation is so rapid that there are very few oscillations in each discharge, and hence the inductive rise in voltage at the receiving-station cannot attain sufficient value to permit of the use of inductive de-45 vices for raising the potential at such station. By the employment of sending-conductors having radiating portions of large capacity at the sending-station and by properly proportioning the self-inductance and resistance tho 50 radiation from the sending-conductor can be so controlled that there will be a large number of oscillations-e.g., fifty or more for each total discharge. In other words, the total discharge is so controlled that only a small frac-55 tion of the total energy is radiated at each oscillation. By thus extending the period of radiation opportunity is afforded for the inductive voltage at the receiving end to rise to its full value. By increasing the number 60 of oscillations for each total discharge from the sending-conductor and by adjusting the receiving system so that its natural period corresponds, or approximately so, to the period of the electromagnetic waves the distance of 65 travel of the waves is not dependent upon the heights of the sending and receiving conductors, as has heretofore been held. When I

low frequency is obtained by increasing the capacity alone or by increasing both capacity and self-induction, the curve of resonance 70 is broader than is obtained by increasing the self-induction alone, though in the former cases the amount of energy radiated for a given voltage and length of conductor is more than is obtainable with a sharp resonance-curve. 75 On account of this fact—i. e., that it is preferable to use sending-conductors having large capacity or large capacity and self-induction and that in these cases the curve of resonance is broadened-it has heretofore been 80 impossible to make the receivers respond solely to waves of one periodicity, as other periodicities, if above a certain power, will affect the receivers. By constructing the sending-conductor so the oscillations for each 85 total discharge are increased and by employing at the receiving-static two or more tuned circuits a very perfect resonance or tuning between the stations can be attained. With one tuned circuit at the receiving-sta- 90 tion and with sending-conductors permitting a rapid radiation at the sending-station electrostatic and hysteresis effects become very prominent, and the great self-inductance desirable for sharp resonance cannot be at- 95 tained. By employing at the receiving end two tuned circuits, the first consisting of the receiving-conductor and the other secondary to the first, the relative inductance may be greater in the secondary than in the primary 100 circuit of the receiving-conductor or the sending-conductor, in which latter, as before explained, the capacity is preferably a dominant factor of tuning, and the electrical effect in the secondary will occur only when the pe- 105 riods are very closely the same.

In view of the fact that the terms "tuning," "syntony," and "resonance" may be used synonymously in some cases and in others to cover a more or less perfect sympathetic re- 110 sponse between fundamentals and their harmonics it is particularly pointed out that all circuits intended to be "tuned" or responsive to a particular frequency should be tuned to that frequency as a fundamental, the 115 quantity V L C being equal in the two circuits said to be tuned, and, as was early pointed out, a receiver-circuit is preferably always identical with any corresponding transmitting-circuit—that is to say, not only is the 120 quantity \checkmark [C of the one equal to the quantity V L C of the other, but the quantity L of the one equals L of the other, as the quantity C of the one equals the quantity C of the 125 other. This latter is not true of the secondary circuits shown in Figs. 3 and 5 of the present application, wherein the inductance preponderates in the secondary, while capacity preponderates in the primary. It is true, 130 however, that these circuits are preferably tuned to the same fundamental, the quantity VI, C being the same in both cases. An additional advantage peculiar to this con708,738

struction is that it permits high ratios of transformation to be obtained, for since the length of the secondary should not be greater than the length of the receiving-conductor and a considerable length of wire—say twenty (20) or thirty (30) feet—should preferably be used in the primary in order to obtain sufficient magnetizing effect, as is well known in the art, a ratio of transformation approximately greater than one to five cannot be obtained with a single tuned secondary; but by employing several transformers in series it is evident the stepping-up process will be repeated a number of times, and the ratio between the final and primary voltages may be made large.

In lieu of the cylindrical form of conductor, as shown in Fig 1, a horizontal conductor 1°, as shown in Fig. 2, having a large radiat-20 ing area—i. e., a large capacity—may be employed. This horizontal conductor may be formed by a group or network of wires or a sheet of metal. It is preferred to employ in connection with the horizontal conductor a 25 metal cone 13, which serves to deflect the radiated waves and direct them along the surface of the earth. If desired, a self-inductance 14 may be placed in the circuit of the conductor 13. This conductor is preferably 30 so constructed that its capacity is relatively much larger than that of a wire of equal length and extending vertically from a point in the plane of the conductor to the ground. I claim herein as my invention-

1. In a system of signaling by electromagnetic waves, a receiving-conductor having a transforming device in series in the circuit, in combination with a circuit including a translating device and having a local source of voltage and controlled by the transforming device and a source of voltage so arranged that its voltage will oppose the voltage from the local source operating the translating device, substantially as set forth.

2. In a system of signaling by electromagnetic waves, a receiving-conductor having a transforming device in series in the circuit, in combination with a circuit including a translating device and having a local source of voltage and controlled by the transforming device and an electrolytic cell so arranged that its voltage will oppose the voltage from the local source operating the translating device, substantially as set forth.

3. In a system of signaling by electromag-

netic waves, a sending-conductor adapted to maintain and to radiate persistent oscillations, in combination with a receiving-conductor and one or more secondary circuits controlled by the receiving-conductor, a wave-for responsive device included in a secondary circuit of the series, the several circuits being each tuned to correspond to the period of the sending-conductor, substantially as set forth.

4. In a system of signaling by electromagnetic waves, a sending-conductor adapted to
radiate electromagnetic waves having its electrical constants so proportioned that only a
relatively small fraction of the energy of the
charged conductor is radiated during a single oscillation, in combination with a prime
conductor including the receiving-conductor,
one or more secondary circuits controlled
by the prime conductor and a wave-responsive device included in the last circuit of the
receives, the several circuits being each tuned
to correspond to the period of the sendingconductor, substantially as set forth.

5. In a system of signaling by electromagnetic waves, a sending-conductor adapted to 80 maintain and to radiate persistent oscillations, in combination with a receiving-conductor and one or more secondary circuits controlled by the receiving-conductor, the ratio of inductance to capacity being larger in 85 a secondary circuit than in the sending-conductor, a wave-responsive device included in a secondary circuit of a series, the several circuits being each tuned to correspond to the period of the sending-conductor, substantially 90 as set forth.

6. In a system of signaling by electromagnetic waves, a sending-conductor adapted to maintain and to radiate persistent oscillations in combination with receiving-conductor and one or more secondary circuits controlled by the receiving-conductor, the inductance of the secondary circuit being greater than that of the primary circuit, a wave-responsive device included in the secondary circuit of the series, the several circuits being each tuned to correspond to the period of the sending-conductor, substantially as set forth.

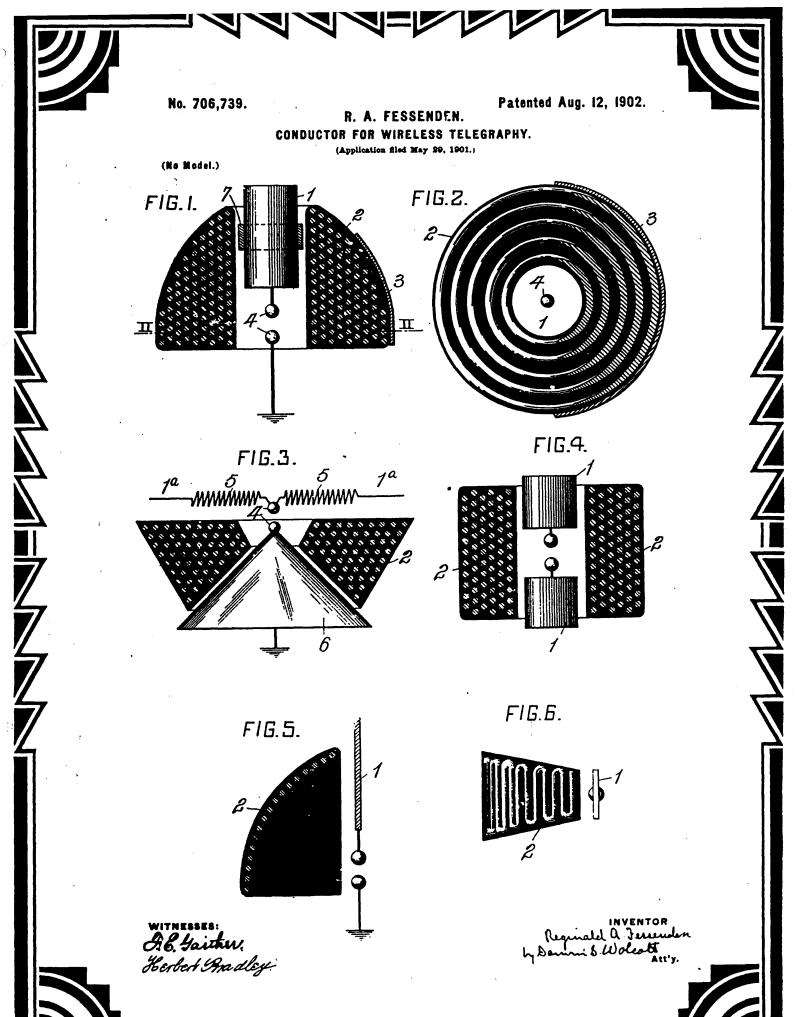
In testimony whereof I have hereunto set 105 my hand.

REGINALD A. FESSENDEN.

Witnesses:

W. B. FEARING, S. C. GRAY.





United States Patent Office.

REGINALD A. FESSENDEN, OF ALLEGHENY, PENNSYLVANIA.

CONDUCTOR FOR WIRELESS TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 706,739, dated August 12, 1902.

Application filed May 29, 1901. Serial No. 62,303. (No model.)

To all whom it may concern:

Be it known that I, REGINALD A. FESSEN-DEN, a citizen of the United States, residing at Allegheny, in the county of Allegheny and 5 State of Pennsylvania, have invented or discovered certain new and useful Improvements in Conductors for Wireless Telegraphy, of which improvements the following is a specification.

It is generally believed that conductors of a considerable length are necessary for the efficient production of electromagnetic waves. By the term "electromagnetic waves" as used herein is meant waves of a wave length long 15 in comparison with the wave length of what are commonly called "heat-waves" or "radiant heat." By "grounded conductor" is meant a conductor grounded either directly or through a capacity, an inductance, or a re-20 sistance, so that the current in the conductor flows from the conductor to ground, and vice versa, when electromagnetic waves are generated. The terms "tuned" and "resonant" are used herein as one including the other. 25 Such impression is, however, erroneous, as I have discovered that by generating the waves in a medium whose permeability to electromagnetic waves or specific inductive capacity, or both, are greater than that of air short 30 conductors may be used for the purpose of propagating and receiving electromagnetic waves. Where one of the constants only is increased, the same general effects are produced—as, for example, where the conductor 35 is immersed in water so pure as to be nonconducting, in alcohol, or other substances having large specific inductive capacity the periodicity is decreased compared with that of the same conductor in air, and radiation is 40 increased thereby, giving the effect of long

conductor.

In the accompanying drawings, forming part of this specification, Figure 1 is a sectional elevation of my improved conductor for wireless telegraphy. Fig. 2 is a sectional view of the same. Figs. 3, 4, and 5 are sectional elevations illustrating modifications of the conductor, and Fig. 6 is a plan view of the form as shown in Fig. 5.

In the practice of my invention I preferably would have if the medium were not there, employ at the sending-station a conductor I, while the permeability of the iron might be

having a large capacity and low self-induc-The capacity can be regulated by increasing the surface or area of the conductor and the self-induction by turns or coils in the 55 wire connecting the conductor to the generator, which may be an induction apparatus or an alternating generator. A medium 2, consisting of wire or lamina formed of magnetic material, as iron or nickel, is arranged 60 adjacent to the conductor on the side facing the direction of the receiving-station. The wires forming the medium are arranged in coils, turns, or folds, as shown. Good results have been obtained by the employment of 65 No. 40 B. & S. insulated wires. It is preferred that the wire, especially when formed of nickel, should be wound and maintained under tension. The coils, turns, or folds, which may be arranged indiscriminately, as shown 70 in 1'igs. 1 and 3, or may be arranged to form a single layer, as in Fig. 5, are spaced a distance apart less than the diameter of the wire and preferably a distance approximately equal to one-fourth (1) the diameter of the wire and are 75 insulated from each other. The insulation of the coils, turns, or folds can be conveniently effected by filling the spaces or surrounding wire with an insulating material preferably of high specific inductive capac- 80 ity, such as india-rubber, water, alcohol, paraffin, &c. The medium may entirely surround the conductor, as shown in Fig. 1, or be arranged only on the side facing the receiving-station, as shown in Figs. 5 and 6. If 85 the conductor be surrounded by a medium having the coils, turns, or loops spaced a distance apart equal or approximately equal to one-fourth (1) the diameter of the wire and embedded in rubber of specific inductive ca- 90 pacity four, the virtual specific inductive capacity of the medium will be approximately sixteen times that of air, because the presence of the conducting-wire will reduce the distance through which the electrostatic lines 95 have to pass to one-fourth the length and in that one-fourth the lines pass through a medium having four times the specific inductive capacity of air, and hence we will have sixteen times the number of lines that we too would have if the medium were not there,

chosen so high that virtual permeability of [the medium will be approximately nine hundred (900) times that of air. The time period T of natural oscillatory electromagnetic 5 waves get erated by a conductor depends upon the square root of the capacity and the square root of the inductance of the conductor—i.e., $T = 2 \pi \checkmark C L$. The capacity of a conductor depends, among other things, upon the specific inductive capacity of the medium surrounding it and varies directly as this specific inductive capacity. The inductance of a conductor depends, among other things, on the permeability of the medium surrounding 15 it and varies directly as this permeability. Thus it follows that since the period T of the waves formed in the medium described will be $\sqrt{16 \times 900} = 120$ times as great as the period of waves formed by the same conductor in air. Now the velocity of electromagnetic

waves in a medium is $V = \sqrt{k \mu}$, where k is the dielectric constant or specific inductive 25 capacity and μ is the permeability of the medium; but as I have made k equal sixteen times that of air and μ equal nine hundred times that of air, it follows that the velocity of the travel of waves in this medium will be

 $V = \checkmark 16 \times 900 = 120$ of that in air; but in any wave propagation the velocity equals $V = n \lambda$, where n equals the frequency and λ equals the wave length. Hence, as I have de-35 creased the velocity to one one-hundred-andtwentieth of its value in air and have also decreased the frequency so that one one-hundred-and-twentieth of the value it would have if the medium I have described were not

used—i. e., $120 = 120 \lambda$ —it follows that the length of the waves in the medium will be the same as the length of wave generated by the same conductor when surrounded by air. 45 Now it is a well-known principle in optics that if a wave emerges from a denser medium to one less dense the length of such wave is increased in proportion to the ratio of the speeds of the wave in the two media. So it is 5° also in electrooptics. Hence as the waves pass from the medium in which its speed is one one-hundred-and-twentieth of its speed in air the wave length increases one hundred and twenty times. Hence a conductor one 55 foot in length surrounded by and generating waves through such a medium will generate

waves of the same length in air as the waves generated from a conductor one hundred and twenty feet long in air. By suitably propor-60 tioning the capacity of the conductor, which may be vertical or horizontal or of any desired form, in the manner stated or in any other suitable manner the amount of energy radiated may be increased as desired. 65 If instead of rubber another insulating material or mixture of insulating material should

be used having, for example, a specific inductive capacity sixty-four, the virtual specific inductive capacity with the same distance between the lines as before would be approxi- 70 mately four multiplied by sixty-four, and hence the waves in the medium would now be $\sqrt{256 \times 900} = 960$ times the length which the same conductor would produce in air. Similarly if the iron wire were of a poorer 75 grade magnetically or were less permeable to magnetic forces of a high frequency its virtual permeability might be only one hundred, and if the same insulating material as in the last case were used the wave length would be 80 √100×256=160 times the wave length produced by the same conductor in air. It will thus be seen that if a conductor in air having a certain self-inductance and capacity be surrounded by such a medium its self-induct- 85 ance and capacity, or both, are increased. Since the wave length generated by the conductor depends upon the square root of the product of these two factors, it will be seen that the wave length from a given conductor 9° can be increased by surrounding it by such a medium. Also since the energy when the conductor is charged varies for a given voltage directly with the capacity by increasing the capacity the energy available for radia- 95 tion has been increased; and, further, with a given capacity the energy radiated depends upon the proportion which the wave length bears to the height of the conductor. Hence merely increasing the capacity of a conduc- 100 tor surro in led by air by increasing its surface without altering its height does not increase the radiation to the same extent as does increasing its capacity by increasing its height. In the present case, however, it is 105 possible to increase the capacity of the conductor without altering its height and yet

ing the height of the conductor. In the practice of my invention, except where it is desired for special purposes, to obtain as long wave lengths as possible it is 115 preferred to use a medium having large specific inductive capacity and small permeability.

without altering the relation between the

wave length and the medium and the height

For some purposes—e, g, where it is desired that the waves should have a high ef- 120 ficiency in one direction or on one side of the conductor—the medium may be arranged on the side of the conductor facing the point toward which the waves are to be principally effective, as shown in Figs. 5 and 6. An in-125 cremental effectiveness may be produced by the employment of a reflecting-plate 3, which is formed of metal arranged on the side of the conductor opposite that facing the direction in which the waves are to travel. The 130 employment of a reflector for the purpose of concentrating and projecting the waves is

of the conductor-in other words, to obtain 110

the same effect as is produced in air by rais-

706,739

practically possible only with short conductors. The dimensions, shape, and position of the reflector will be varied in accordance with the conditions under which it is used. In general it is desirable to arrange the reflector so as to form a portion of the outer wall of the medium.

When using an induction apparatus for charging and discharging the conductor, one so end of the latter is connected to a knob 4, forming one side of the spark-gap, while the other knob is connected to ground. When using a dynamo or other source of alternating current, one terminal of the generator is 15 connected to the conductor and the opposite

terminal to ground.

It is preferred that the electromagnetic waves travel along or near the surface of the earth and that the generation of the waves 20 should occur closely adjacent to the surface of the earth, thereby increasing their efficiency. To this end the conductor 12, which may be a wire, as shown, or may be in the form of a cylinder, as shown in Fig. 1, or a 25 plate or sheet, as shown in Figs. 5 and 6, is arranged horizontally, or approximately so, as shown in Fig. 3; but this construction forms no part of the subject-matter herein. One of the sparking-knobs is connected to 30 the conductor 1*, preferably at a point midway of its length, as shown. Self-inductance coils 5 may be interposed between the conductor and knob to change the natural oscillation period of the system. The other spark-35 ing-knob is connected to a cone 6, formed of metal or other conducting material and arranged below the conductor. This cone may be arranged on a table or other support and connected to ground and may rest directly 40 on the ground. In order to increase the efficiency of the conductor as regards the distance of travel of the waves, a medium 2such, for example, as that heretofore described—is interposed between the conductor 45 and cone. This medium may be made annular and extend entirely around the cone or may extend only partially around the cone on that side where the waves should be most efficient. The waves as they pass through 50 the medium impinge on the surface of the cone and are deflected down onto and along the surface of the earth.

As shown in F^* . 4, a second conductor, instead of an "electrical image," as it might 55 be termed, can be employed. In such case two similar conductors 1 are connected to opposite poles of the generating apparatus, and when an induction apparatus is used the spark-gap is formed between the conductors. 60 the knobs 4 being connected to adjacent ends of the conductors. It is preferred that the conductors be surrounded either entirely or partially, as heretofore described, by a medium 2.

The employment of a medium in the man-

electromagnetic waves of different periodicities from the same conductor as the periodicity of a wave is dependent upon the permeability and specific inductive capaciny, or both, 70 of the medium in which it is generated. As, for example, if the medium 2 be arranged in such relation to the conductor that the waves from a portion of the surface of the conductor pass through the medium, while the waves 75 from other portions of the surface are generated and pass directly through the air, the two sets of waves will have different periodicities. In such cases the portion of the conductor outside of the medium is so construct- 80 ed-i.e., increased in height or capacity—that the waves generated therefrom will have the same, or approximately the same, effective travel as the waves passing through the medium.

The generation of waves of different periodicities from the same conductor may be effected by changing the capacity of the conductor at any desired point or points inter-mediate of its ends. This may be effected by 90 enlarging the conductor at the desired portion or portions, as by a swell integral with the walls of the conductor or by a band or bands 7 of conducting material surrounding the conductor and in metallic contact there- 95 with. This latter construction affords means for adjusting the capacity by adding or removing bands or changing the position thereof along the conductor. Such a conductor would generate two or more series of waves 100 of different periodicities, the periodicity of one series of waves being dependent upon the length and configuration of the conductor and the periodicity or periodicities of the other series upon the bands or enlargements. 105 This form of conductor thus enables me to obtain long waves from a short conductor, thereby avoiding the expense involved in the erection and maintenance of high masts. It has, however, another property, in that not 110 only is the wave length the same as that from a long wire, but also the amount of energy radiated is the same for a given difference of potential as from a high wire. In other words, it is characteristic of this improvement that 115 all the functions or desirable results incident to the employment of a long high conductor can be attained by a relatively short low conductor and with the additional and many advantages peculiar to this conductor-e. g., it 120 assists me in obtaining a construction which forms one of the objects of the invention embodied in application Serial No. 62,301, filed May 29, 1901.

The receiving-stations may have a conduc- 125 tor similar to that described, or plain conductors tuned to receive the several series of waves may be employed at the receiving-sta-

It has been suggested in wireless-telegraphy 130 work to employ apparatus in which the sparkner described permits of the generation of I ing terminals have been immersed in a liquid

insulator of greater specific inductive capacity than air; but this was done for the purpose of obtaining a more abrupt spark, and ratio the purpose of obtaining a greater 5 length of wave from a given conductor. Moreover, as employed, while it would serve the purpose for which it was intended—i. e., better insulation of the terminals and more abrupt spark—it would not when used as described produce the effect aimed at in the present application.

I claim herein as my invention-

1. A conductor for radiating electromagnetic waves, in combination with a medium 15 having an electrical constant on which the wave length depends of a value greater than that of air arranged in suitable relation to the conductor.

2. A conductor for radiating electromagso netic waves having in combination therewith, a medium having an electrical constant on which the wave length depends of a value greater than that of air, arranged around the conductor, substantially as set forth.

3. A conductor for radiating electromagnetic waves in combination with a medium consisting of lamina of insulated magnetic material arranged in suitable operative relation to the conductor, substantially as set 30 forth.

A conductor for radiating electromagnetic waves in combination with a medium consisting of lamina or wire of magnetic material and a material of higher specific inductive capacity than that of air, filling the spaces between the lamina of conducting material, substantially as set forth.

5. A conductor for radiating electromagnetic waves in combination with a medium 40 having an electrical constant on which the wave length depends of a value greater than that of air and means for causing an incremental effectiveness in a given direction, substantially as set forth.

6. A conductor for radiating electromagnetic waves in combination with a medium having an electrical constant on which the wave length depends of a value greater than that of air and a reflector whereby the waves generated by the conductor may be concentrated and projected in a given direction, substantially as set forth.

7. A conductor for radiating electromagnetic waves in combination with means where55 by a different periodicity is imparted to the waves generated from different portions of the conductor, and a medium having an electrical constant on which the wave length depends of a value greater than that of air arranged in suitable relation to the conductor, substantially as set forth.

8. A conductor for radiating electromagnetic waves in combination with a piece of conducting material arranged on the conductor, 65 and a medium having an electrical constant

of a value greater than that of air, arranged in suitable relation to the conductor, substantially as set forth.

19. A grounded conductor for wireless telegraphy, in combination with a movable piece of conducting material arranged on the conductor, substantially as set forth.

20. A combination of a vertically-arranged grounded conductor for radiating electromag-

on which the wave length depends of a value greater than that of air arranged in suitable relation to the conductor, substantially as set forth.

9. A conductor for wireless telegraphy in 70 combination with a movable piece of conducting material arranged on the conductor, substantially as set forth.

10. A conductor for radiating electromagnetic waves, surrounded by a medium in 75 which the wave length of electromagnetic radiation is less than the wave length of the same radiation in air, substantially as set forth.

11. A conductor for radiating electromagnetic waves, in combination with a movable
piece of conducting material so arranged and
proportioned that the system will simultaneously radiate waves of different periodicities
of approximately the same energy, substantially as set forth.

12. A conductor for radiating electromagnetic waves, having a substantially uniform capacity over a large portion of its length and a piece of conducting material connected to such portion, whereby waves of different periodicities but of approximately the same energy may be radiated, substantially as set forth.

13. The combination of a vertically - ar- 95 ranged conductor for wireless telegraphy and a medium substantially as described arranged in operative relation to the conductor, substantially as set forth.

14. The combination of a conductor for ratioo diating electromagnetic waves connected to ground and a medium having an electrical constant on which the wave length depends of a value greater than that of air arranged in operative relation to the conductor, substantially as set forth.

15. A grounded conductor for radiating electromagnetic waves in combination with a medium having an electrical constant on which the wave length depends, of a value 110 greater than that of air, arranged in suitable relation to the conductor.

16. A grounded conductor for wireless telegraphy, having in combination therewith a medium having an electrical constant on 115 which the wave length depends, of a value greater than that of air, arranged around the conductor, substantially as set forth.

17. A grounded conductor for wireless telegraphy, having in combination therewith a 120 medium consisting of lamina of insulated magnetic material arranged in suitable operative relation to the conductor, substantially as set forth.

as set forth.

18. A grounded conductor for wireless telegraphy, in combination with means whereby a different periodicity is imparted to the waves generated from different portions of the conductor, and a medium having electrical constant on which the wave length depends, 130 netic waves, and a medium substantially as 10 described arranged in operative relation to the conductor, substantially as set forth.

In testimony whereof I have hereunto set my hand.

REGINALD A. FESSENDEN.

Witnesses:

W. B. FEARING, S. C. GRAY.

No. 706,740. Patented Aug. 12, 1902. R. A. FESSENDEN. WIRELESS SIGNALING. (Application filed Sept. 28, 1901a) FIG.I. FIG.Z. FIG.3.

Korket Gradky.

Regurald Q. Ferrender by Danni S. Wolcott Arry.

No. 706,746. Patented Aug. 12, 1902. R. A. FESSENDEN. SIGNALING BY ELECTROMAGNETIC WAVES. (Application filed July 1, 1902. (No Model.) 13 FIG.I. 13 2 0000 000 0000 000 FIG.Z. FIG.3. FIG.4. Regulated a Ferrender by Domini b. Wolcott Any.

UNITED STATES PATENT - OFFICE.

REGINALD A. FESSENDEN, OF MANTEO, NORTH CAROLINA.

SIGNALING BY ELECTROMAGNETIC WAVES.

SPECIFICATION forming part of Letters Patent No. 708,746, dated August 12, 1902.

Application filed July 1, 1902. Serial No. 113,970. (No model.)

To all whom it may concern:

Be it known that I, REGINALD A. FESSEN-DEN, a citizen of the United States, residing at Manteo, in the county of Dare and State of North Carolina, have invented or discovered certain new and useful Improvements in Signaling by Electromagnetic Waves, of which improvements the following is a specification

My invention relates to the transmission of power and signals by electromagnetic waves of a kind which have been discovered and investigated by me, and is particularly concerned with means for the efficient sending 15 and receiving of such waves and for the exact maintenance of tuning. These waves differ from those described by Hertz in that they are not complete waves, but only half-waves, and in that they travel over the surface of a con-20 ductor, and hence, unlike Hertz waves, can be deflected from a straight line. They have the property in common with Hertz waves in that the energy received by a given area varies inversely as a given distance. They differ 25 from the waves investigated by Lodge in that they are not current waves, but semifree ether waves. Thus in the Lodge waves the

ether waves. Thus in the Lodge waves the electric energy is maximum when the magnetic energy is minimum and all energy not 30 absorbed by resistance losses is recoverable, while with the form investigated by me the electric energy is a maximum at the same time as the magnetic and none of the energy

radiated is recoverable except by reflection.

I have found that it is essential for the proper sending and receipt of these waves that the surface over which they are to travel should be highly conducting, more especially in the neighborhood of the point where the waves

40 are generated. I have found that this highlyconducting portion of the surface should preferably extend to at least a distance from the origin equal to a quarter wave length of the wave in air and in the direction toward

45 the station or stations to which it is desired to send the waves. Where the sending-station is in a city or similar place where the waves may be cut off by high buildings or high trees, this highly-conducting path should so be extended still farther until it passes be-

50 be extended still farther until it passes be- To prevent evaporation of the water, the vesyond the limits of the obstacle, and there the sel is covered with glass or other insulating

highly-conducting portion, which may be in the form of a strip of metal or other conductor or of a number of wires, is connected to ground. This arrangement may be called a 55 "wave-chute."

In the accompanying drawings, forming a part of this specification, Figure 1 shows the artificial ground or wave-chute arranged for a station located in a city. Fig. 2 is a plan 60 view of the arrangement shown in Fig. 1, and Fig. 3 illustrates the ground or chute in connection with a low conductor, and Fig. 4 is a plan view showing arrangement of station on rocky shore or other non-conducting ground. 65

In the practice of my invention I connect the grounded end of the sending or receiving conductor 1 directly or by means of a conductor to a number of wires or strips 2, radiating out, as shown, preferably to a distance 70 of a quarter wave length or beyond or to points beyond the high buildings or other obstacle, as if the wires do not extend for a quarter wave length there is not sufficient capacity between the sending-conductor and 75 the artificial ground. These wires are grounded, preferably, at their ends and are laterally connected by other wires or strips 3, as shown. This arrangement is equivalent for electromagnetic waves of such frequencies 80 as are commonly used to a conductor formed of a solid strip of metal. When it is desired to send one particular direction or directions, these wires or strips are arranged so as to lie only in the direction in which it is de- 85 sired to send. Fig. 1 shows such an arrangement for sending from a station in a city having tall buildings containing pipes or conductors of metal.

material, or oil may be placed on the surface of the water for the same purpose. It is preferred to arrange the sparking terminals 5 and 6 within the tubular conductor 14, one of the 5 terminals, as 5, being electrically connected by an arm 7 to the conductor 12, while the terminal 6 is electrically connected by the post 8 to the containing vessel 4. The lower end of the tubular conductor is closed by a 10 plug 9, of insulating material, through which passes the post 8. By securing the plug to the conductor and to the post 8 the latter will serve as a support for the conductor. As shown, one of the sparking terminals, as 5, 15 is connected to the secondary coil of a suitable generator, as the induction-coil 10, and the other terminal, as 6, is also connected to such secondary coil through the post 8 and the wall of the containing vessel 4. The con-20 taining vessel is connected to ground by the artificial ground or chute extending in the

direction it is desired to signal. Another very important function of the construction here described is that it en-25 ables the capacity and self-induction of the sending-station to be maintained constant, which is of fundamental importance in working tuned circuits. It frequently happens that stations are situated on rocky portions 30 of coast where salt spray sometimes dashes up and renders portions of the ground-surface near the station conducting which were previously insulating, hence changing the capacity and inductance of the sending-con-35 ductor. If, however, the surface be covered by the network or strips heretofore described, the capacity will not be changeable, but constant, as the surface near the station is maintained in a constantly-conducting state. 40 Hence the stations once tuned will not be put out of tune by changes of weather or other disturbances. In order, however, that this second function of my construction may be fully taken advantage of, it is preferable to 45 use metallic ropes or chains II for supporting the masts where masts are used, as where ropes are used they are apt to become saturated with salt water in stormy weather and to become conductors capable of absorbing so the electromagnetic waves, thereby cutting off a portion at least of the electromagnetic waves from the receiving-conductor. These wire guys would in general absorb the waves rapidly, since for cheapness they would be 55 made of iron or steel, and since the currents generated in iron or steel conductors at such frequencies as would be used in practice are confined to a very thin film or the outside of the wires they would oppose large resistance 60 to such currents. I therefore for the full practice of my invention to prevent such absorption cover such waves, wire ropes, or chains with a coating of a non-magnetic conductor, preferably zinc or lead, and thus ren-

65 der the ohmic resistance of the wires, wire

ropes, or chains to the currents produced by

used so low that there is little absorption. I also prefer to insulate them from ground, so that they have a natural period as far re- 70 moved as possible from that of the electromagnetic waves used for signaling. When a metallic mast is used, it also should have its outer surface formed of non-magnetic good conducting material.

An additional advantage consequent on the employment of an artificial ground or wavechute is the possibility of guarding against outside interference by insulating or cutting out the artificial ground in the direction of 80 the distributing-station—as, for example, in the arrangement shown in Fig. 4, where the artificial ground or wave-chute is shown extending entirely around the conductor or station. The portion of network or wires 2 be- 85 tween the points a and b toward the distributing-station X are insulated from the ground, and a conducting-path 12 is formed around the artificial ground, extending between the points a and b, so that electrical disturbances go from the station X will be led around the conductor or station.

In order to render it certain that the natural period of the mast and guys is different from that of the electromagnetic waves, said 95 mast and guys may be wrapped or encircled with one or more coils or turns 13 of iron strips or wire, preferably insulated, thus increasing the inductance and natural period of the mast and guys and permitting the employment of 100 conducting material—e. g., iron or steel—in the masts and guys. As shown in Fig. 1, the coils or turns may be either formed locallyi. e., extending a short distance along the mast or guys-and such coils or turns may ex- 105 tend continuously along such parts.

While the coating of the mast and guys with non-magnetic material need not necessarily be used with the coils or turns, it is preferred in most cases to both coat the masts and guys 110 with non-magnetic material and to also employ the coils or turns of magnetic wire or strips, which may be formed of nickel or other magnetic material. No. 40 Brown & Sharpe gage of wire is a size suitable for the purpose. 115

I claim herein as my invention-

1. In a system for the transmission of energy by electromagnetic waves, a sendingconductor for radiating such waves and an artificial ground connected to the lower end 120 of the sending-conductor and to ground and extending outwardly from the sending-conductor, substentially as set forth.

2. In a system for the transmission of energy by electromagnetic waves, a sending- 125 conductor for radiating such waves and an artificial ground connected to the lower end of the sending-conductor and to ground and extending outwardly from the sending-conductor a distance equal to a quarter wave 130 length in air of the electromagnetic-wave length used, substantially as set forth.

3. In a system for the transmission of enelectromagnetic waves of the frequencies | ergy by electromagnetic waves, a sending-

708,746

3

conductor for radiating such waves and an artificial ground consisting of a series of wires or strips connected to the lower end of the sending-conductor and to ground and radiating from the lower end of the conductor and connected at suitable intervals by transverse wires or strips, substantially as set forth.

4. In a system for the transmission of energy by electromagnetic waves, a sending-to conductor for radiating such waves and an artificial ground connected to the lower end of the sending-conductor and to ground and extending outwardly from the sending-conductor a distance equal to a quarter wave length in air of the electromagnetic wave length used and in the direction in which it is desired to send the waves, substantially as set forth.

5. In a system for the transmission of en-20 ergy by electromagnetic waves, a sendingconductor for radiating such waves and an artificial ground connected to the lower end of the sending-conductor and connected at its outer end to ground, substantially as set forth.

25 6. In a system for the transmission of energy by electromagnetic waves, a sending-conductor for radiating such waves supported by a metallic conductor of low resistance to currents of the frequencies used, substantially 30 as set forth.

7. In a system for the transmission of energy by electromagnetic waves, a sending-conductor for radiating such waves supported by a metallic conductor, a shield for said conductor having low resistance to currents of the frequencies used, substantially as set forth.

8. In a system for the transmission of energy by electromagnetic waves, a sending-conductor for radiating such waves supported by a metallic conductor having a natural period of oscillation different from that of the frequencies of the electromagnetic waves used, substantially as set forth.

9. A conductor for radiating electromagnetic waves, consisting of a conductor immersed in a liquid medium having an electric constant on which the wave length depends of a value greater than that of air, substantially as set forth.

50 10. A conductor for radiating electromag-

netic waves, consisting of a conductor immersed in water, substantially as set forth.

11. A conductor for radiating electromagnetic waves, consisting of a metal vessel containing a medium of the character described, 55 a conductor immersed in said medium and a generator, substantially as set forth.

12. A conductor for radiating electromagnetic waves, consisting of a metal vessel containing a medium of the character described, 60 a tubular conductor immersed in the medium, sparking terminals arranged in the chamber, substantially as set forth.

13. In a system for the transmission of energy by electromagnetic waves, a sending- 65 conductor for radiating such waves, an artificial ground connected to the lower end of the sending-conductor and to ground and extending outwardly from the sending-conductor, and a second grounded conducting-strip 70 leading around the station from that facing a source of electrical disturbances to the opposite side, substantially as set forth.

14. In a system for transmission of energy by electromagnetic waves, a support for a con-75 ductor encircled by one or more turns or coils of magnetic material, substantially as set forth.

15. In a system for transmission of energy by electromagnetic waves, a support for a conductor encircled by one or more turns or coils by iron wire, substantially as set forth.

16. In a system for transmission of energy by electromagnetic waves, a conductor in combination with a support therefor, said support having a coating of non-magnetic material, substantially as set forth.

17. In a system for transmission of energy by electromagnetic waves, a conductor in combination with a support therefor, said support having a coating of non-magnetic material and encircled by one or more turns of magnetic material, substantially as set forth.

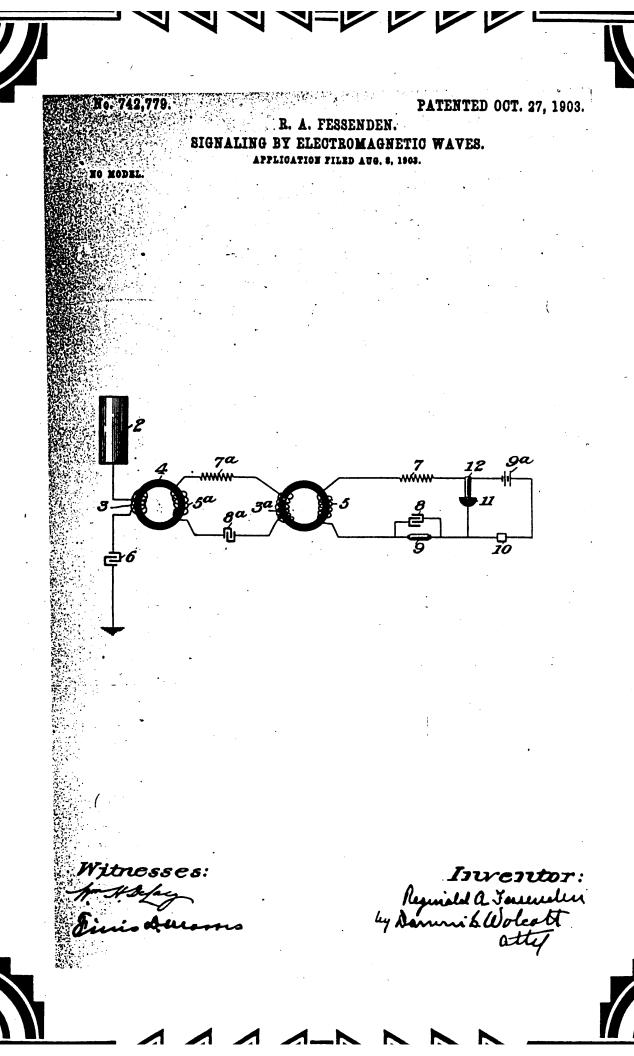
In testimony whereof I have hereunto set my hand.

REGINALD A. FESSENDEN.

Witnesses:

DARWIN S. WOLCOTT, JOHN L. FLETCHER.





United States Patent Office.

REGINALD A. FESSENDEN, OF FORT MONROE, VIRGINIA.

SIGNALING BY ELECTROMAGNETIC WAVES.

SPECIFICATION forming part of Letters Patent No. 742,779, dated October 27, 1903.

Original application filed May 29, 1901, Serial No. 62,302. Divided and this application filed August 8, 1903. Serial No. 168,796. (No model.)

To all whom it may concern:

Be it known that I, REGINALD A. FESSEN-DEN, a citizen of the United States, residing at Fort Monroe, in the county of Elizabeth 5 City and State of Virginia, have invented or discovered certain new and useful Improvements in Signaling by Electromagnetic Waves, of which improvements the following is a specification.

In Letters Patent No. 706,738 I have claimed a complete sending and receiving system, including a sending system adapted to radiate persistent oscillations or wave-trains and a receiving system comprising two or more cir-15 cuits inductively or otherwise operatively connected with reference to obtaining sharp tuning and good selectivity. The invention described and claimed in this application, which is a division of said patent, has for its 20 object the changing of the voltage at a station by the employment of two or more circuits arranged to produce the desired change.

It is a further object of the invention to provide for selective signaling by so tuning 25 a receiving apparatus that it will respond solely to waves of one periodicity and is the result of a full appreciation of the principle about to be explained.

Heretofore in tuning systems but a single 30 transformer has been used, tuned to the periodicity desired, and with this arrangement it is impossible to obtain any desired ratio of transformation on account of the fact that only a given length just sufficient to permit 35 the oscillation to travel it in the time occupied by a half-wave can be used. If the periodicity of the electromagnetic waves employed is one million eight hundred thousand, then an electric oscillation can only travel a 40 tenth of a mile during a single wave period or a twentieth of a mile during a single oscillation period, because an electric impulse cannot travel faster than the velocity of light, and along a wire which always has induct-45 ance and capacity the velocity must be less. The oscillation must travel back and forth over the wire every period, and obviously it cannot do this within the available time unless the length be not greater than one-twen-50 tieth of a mile. If the primary has a con-

not allow of sufficient turns to give as high a rate of transformation as is desired. Moreover, the tuning will not be as sharp as with the arrangement hereinafter described.

In the accompanying drawing, forming a part of this specification, the figure shows a diagrammatic view of my invention as applied to a receiving-station.

Here 2 is a conductor or serial, grounded, 60 either directly through the primary 3 or, in addition, through the condenser 6.

 5° is the secondary of a transformer of which 3 is the primary. The transformer may be an air-core transformer, or a core of magnetic 65 material, such as finely-laminated iron 4, may

3º is the primary, and 5 the secondary, of another transformer. The circuit containing the secondary 5° and the primary 3° is tuned, 70 preferably, to the period of the aerial, as is also the circuit containing the secondary 5. This tuning may be done by means of inductances, as at 7.7°, or capacities, as at 8.8°.
9 is a receiver, which may be a coherer.

12 is a polarizing-cell, as described in United States Patent No. 706,738.

9° is a local battery, and 10° an indicating mechanism.

An advantage peculiar to this construction 80 is that it permits high ratios of transforma-tion to be obtained, for since the length of the secondary should not be greater than the length of the receiving-conductor, as commonly constructed, (though with different 85 constructions the length may vary,) and a considerable length of wire—say twenty or thirty feet-should preferably be used in the primary in order to obtain sufficient magnetizing effect, as is well known in the art, 90 a ratio of transformation approximately greater than one to five cannot be obtained with a single-tuned secondary; but by employing several transformers in series it is evident the stepping-up process can be re- 95 peated a number of times and the ratio between the final and primary voltages may be made large.

When this device is used for transmitting or for transforming down, the benefits ob- 100 tained from its use arise from the same siderable number of turns, this length may I cause—i. e., that by its use it is possible to

obtain any desired ratio, either up or down, in spite of the fact that only a limited length of wire can be used in a single circuit.

When the primary of one transformer, as 3 3, is actuated by the secondary of another transformer, as 5°, the transformers are said to be in sequence.

What I claim is-

1. In a system of signaling by electromagro netic waves the combination of two or more transformers connected sequence and transforming in the same direction, a transformer at one end of said sequence being operatively connected to an aerial, and the transformer at the other end of said sequence operatively connected to a receiver for electromagnetic waves.

2. In a system of signaling by electromag**netic waves** the combination of two or more zo transformers connected in sequence and transforming in the same direction, a transformer at one end of said sequence being operatively connected to an aerial, and the circuits of the transformers being tuned to **125 the periodicity of the electromagnetic waves.**

3. In a system of signaling by electromagnetic waves the combination of two or more transformers connected in sequence and transforming in the same direction, a trans-30 former at one end of said sequence being operatively connected to an aerial.

4. In a system of signaling by electromag-

netic waves the combination of two or more circuits in sequence, an end circuit of said sequence being operatively connected to an 35 aerial, and each of said circuits having a length less than that of the sending-conductor.

5. In a system of signaling by electromagnetic waves the combination of two or more circuits in sequence, an end circuit of said 40 sequence being operatively connected to an aerial, and the first circuit operatively connected to a receiver for electromagnetic waves, each of said circuits having a length less than that of the sending-conductor.

6. In a system of signaling by electromagnetic waves the combination of two or more circuits in sequence, an end circuit of said sequence being operatively connected to an aerial, each of said circuits being tuned to the 50 aerial.

7. In a system of signaling by electromagnetic waves the combination of two or more circuits in sequence so arranged as to have a high ratio of transformation, an end circuit 55 of said sequence being operatively connected to an aerial.

In testimony whereof I have hereunto set my hand.

REGINALD A. FESSENDEN.

Witnesses:

DARWIN S. WOLCOTT, WM. II. DE LACY.



No. 767,986. PATENTED AUG. 16, 1904. J. S. STONE. SPACE TELEGRAPHY. APPLICATION FILED MOV. 25, 1903. NO MODEL. Fig.1. 0000000 Fig. 2. <u></u> = E 0000000 Fig. 5. WITHESSES. Fig.4.

United States Patent

JOHN STONE STONE, OF CAMBRIDGE, MASSACHUSETTS, ASSIGNOR TO WILLIAM W. SWAN, TRUSTEE, OF BROOKLINE, MASSACHUSETTS.

SPACE TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 767,986, dated August 16, 1904.

Application filed November 25, 1903. Serial No. 182,634. (No model.)

To all whom it may concern:

Be it known that I, John Stone Stone, a citizen of the United States, and a resident of Cambridge, in the county of Middlesex and State of Massachusetts, have invented a new and useful improvement in Space Telegraphy. of which the following is a specification.

My invention relates to the art of transmitting intelligence from one station to another o by means of electromagnetic waves without the use of wires to guide the waves to their destination; and it relates more particularly to the system of such transmission in which the electromagnetic waves are developed by 5 producing electric vibrations in an elevated conductor, preferably vertically elevated. In my Letters Patent No. 714,756, December 2, 1902, I have described such system of space telegraphy in which forced simple harmonic electric vibrations are developed in an elevated conductor by means of a sonorous or persistently - oscillating circuit associated therewith. In this system and in other systems of space telegraphy in operation to-day it has been found necessary to employ elevated transmitting-conductors of considerable height in order to transmit appreciable amounts of energy by electromagnetic waves over commercial distances.

This invention consists of a method of transmitting large amounts of energy by electromagnetic waves without the use of the high vertical conductor heretofore employed.

The invention may be best understood by 35 having reference to the drawings which accompany and form a part of this specification.

In the drawings the figures represent various forms of apparatus and circuit arrangements whereby my method may be carried 40 into effect and whereby the employment of a high vertical conductor is rendered unnecessary. My invention, however, is broader than mere apparatus, being capable of being carried into effect by a great variety of appara-45 tus and circuit arrangements, while the particular apparatus herein disclosed is claimed 184,283, 193,593, and 193,594.

50 generator. k is a key. MM' are transform- ance which increases as the frequency is fur- 100

ers. It Is are the primary and secondary windings of transformer M. LL' are inductances. C' C' are condensers. * is a sparkgap. V is an elevated conductor, consisting of a metal-plate preferably circular in form 55 and parallel to earth and whose diameter, and consequently whose periphery, is preferably great compared to its distance from the ground. However, a metallic plate of other shape or any other suitable laterally-extend- 60 ing member may be employed, and preferably its distance from the ground should be small compared to its smallest dimension.

The natural period of the sonorous circuit * C I L is made equal to the fundamental pe- 65 riod of the elevated-conductor system, consisting of the metal plate V or other suitable laterally-extending member and its connection o I. E to earth or to some harmonic of such fundamental period, and for this pur- 70 pose the electromagnetic constants of the sonorous circuit may be varied. An inductance L' or a condenser C' may be connected in the circuit o I: E for the purposes hereinafter set forth. The function of the auxil- 75 iary inductance L is, as explained in my hereinbefore-mentioned Letters Patent, to swamp the effect of the mutual inductance between the sonorous circuit and the elevated-conductor system and to thereby reduce the complex 80 of interrelated circuits to the equivalent of a system of circuits each having a single degree of freedom, so that simple harmonic electromagnetic waves of a frequency determined by the capacity and inductance of the sonorous 85 circuit may be radiated. The reactance at the driving-point o for slow frequencies is determined by the capacity of the plate V with respect to earth and varies as the area of the plate and inversely as its separation from earth, 90 As the frequency is increased the reactance at the driving-point u is in the nature of a capacity reactance and diminishes as the frequency increases, finally becoming zero when the frequency is equal to the fundamental 95 frequency " of the elevated conductor V. in my divisional applications Serial Nos. For any further increase in frequency from this point the reactance at the driving-point of In the figures, A is an alternating-current, becomes in the nature of an inductance reactther increased, the curve which shows the variation of reactance with frequency becoming asymptotic with the ordinate drawn in the positive direction from the point on the saxis of abscisse representing the the first harmonic 2" of the fundamental frequency n. As the frequency passes through the value 2" the reactance at the driving-point n suddenly changes from an inductance reactance of infinite value to a capacity reactance of infinite value, the curve which shows the variation of reactance with frequency being asymptotic to the ordinate drawn in the negative direction from the point on the axis of abscisse repre-

15 senting the first harmonic 2" of the fundamental frequency n. When the frequency is equal to the first harmonic 2" and the reactance at the driving-point n is infinite, the elevated-conductor system refuses to vibrate 20 i. n., the elevated-conductor system is then

equivalent in length to a half-wave length of the oscillations impressed upon it. As the frequency is further increased from the first harmonic the capacity reactance again wanes. 25 becoming zero when the frequency is equal to the second harmonic 3" of the fundamental frequency μ_s and so on. In other words, the curve showing the variation of reactance at the driving-point a with frequency is a dis-30 continuous curve, which is zero when the frequency is equal to the fundamental frequency n, which passes from plus infinity to minus infinity as the frequency passes through the value 2", which is zero when the frequency is 3", which 35 passes from plus infinity to minus infinity when the frequency passes through the value 4",

on, the positive values of said curve representing inductance reactances and the negative values thereof representing capacity reactances. When the reactance at the driving-point o is a capacity reactance, an inductance of suitable value is inserted in the conductor o I₂E, connecting the center of the plate V to

which is zero when the frequency is 5", and so

45 earth, as shown at L', Fig. 2, in order to balance said reactance, so that the fundamental period of the elevated-conductor system will be equal to the frequency of the oscillations or vibrations developed by the sonorous cir5° cuit κ C I₁ L or to some multiple or submultiple of such frequency. When the reactance at driving-point α is an inductance reactance, a condenser of suitable value is inserted in the conductor α I₂ E₄ as shown at C', Fig. 3,

the conductor o I₂ E, as shown at C', Fig. 3, 55 in order to balance said reactance, so that the fundamental period of the elevated-conductor system will be equal to the frequency of the oscillations or vibrations developed by the sonorous circuit s C I₁ L or to some mul60 tiple or submultiple of such frequency.

In Fig. 4 an alternating-current generator of frequency high compared with the alternating-current generators of commerce is connected in series with the primary I₁ of the transformer M whose secondary I₂ has large.

inductance to reduce the frequency of the fundamental of the elevated-conductor system to the frequency of the currents developed by the generator or to some harmonic of such frequency.

70

I claim

The method of developing electromagnetic signal-waves which consists in producing forced electric oscillations in an elevated conductor of large area and parallel to the earth.

2. The method of developing simple harmonic electromagnetic signal waves which consists in producing forced simple harmonic electric oscillations in an elevated conductor of large area and parallel to the earth.

3. The method of developing electromagnetic signal-waves which consists in producing electric oscillations of definite frequency, impressing said electric oscillations on an elevated conductor of large area and parallel to 85 the earth and regulating the period of said oscillations to accord with the fundamental period of the elevated-conductor system or some harmonic of such fundamental period.

4. The method of developing electromagnetic signal-waves of definite frequency which consists in developing electrical oscillations of corresponding frequency in a sonorous circuit, and impressing said electrical oscillations upon an elevated-conductor system comprising a plate of periphery large compared to its distance above the earth and having a fundamental period equal to the period of said electrical oscillations.

5. The method of developing electromagnetic signal-waves of definite frequency which consists in developing electrical oscillations, impressing said electrical oscillations upon an elevated-conductor system, comprising a laterally-extending conducting member and having a definite fundamental period, and regulating the period of said electrical oscillations to accord with the fundamental period of said elevated-conductor system or with some harmonic of such fundamental period.

6. The method of developing electromagnetic signal-waves of definite frequency which consists in developing electrical oscillations in a sonorous or persistently-oscillating circuit, impressing said electrical oscillations upon an elevated-conductor system, comprising a laterally-extending conducting member and having a definite fundamental period, and regulating the period of said electrical oscillations to accord with the fundamental period of said elevated-conductor system or with some harmonic of such fundamental period.

In testimony whereof I have hereunto subscribed my name this 24th day of November, 1903.

JOHN STONE STONE.

Witnesses:
G. A. Higgins,
Brainerd T. Judkins.

No. 767,999.

PATENTED AUG. 16, 1904.

J. S. STONE.

SPACE TELEGRAPHY.

APPLICATION FILED FEB. 15, 1904.

NO MODEL.

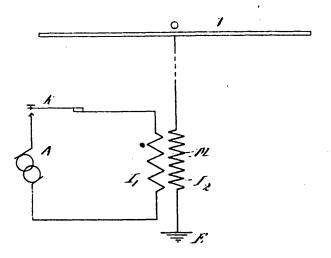
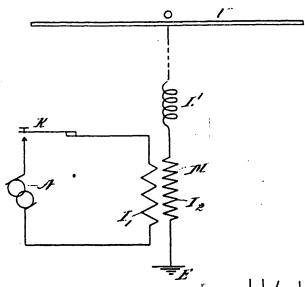


Fig 1.



WITNESSES: Brainer & T. Judruis G. Adelaide Higgid FIEZ.

John Sine Stone
on Her. P. Browne
attorney



STATES PATENT UNITED

JOHN STONE STONE, OF CAMBRIDGE, MASSACHUSETTS, ASSIGNOR TO WILLIAM W. SWAN, TRUSTEE, OF BROOKLINE, MASSACHUSETTS.

SPACE TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 767,999, dated August 16, 1904.

Original application filed November 25, 1903, Serial No. 182,634. Divided and this application filed February 15, 1904. Serial No. 193.594. 'No model.'

To all whom it may concern:

Be it known that I, JOHN STONE STONE, a citizen of the United States, and a resident of Cambridge, in the county of Middlesex and 5 State of Massachusetts, have invented a certain new and useful Improvement in Space Telegraphy, of which the following is a specification.

This invention relates to the art of trans-10 mitting intelligence from one station to another by means of electromagnetic waves without the use of wires to guide the waves to their destination; and it relates more particularly to the system of such transmission in 15 which the electromagnetic waves are developed by producing electric vibrations in an elevated conductor, preferably vertically elevated. In my Letters Patent No. 714,756, dated December 2, 1902, I have described 20 such system of space telegraphy in which forced simple harmonic electric vibrations are developed in an elevated conductor by means of a sonorous or persistently-oscillating circuit associated therewith. In this system and 25 in other systems of space telegraphy in operation to-day it has been found necessary to employ elevated transmitting or radiating conductors of considerable height in order to transmit appreciable amounts of energy by 30 electromagnetic waves over commercial distances.

This invention consists of an apparatus for transmitting large amounts of energy by electromagnetic waves without the use of the high 35 vertical conductors heretofore employed.

The invention may be best understood by having reference to the drawings which accompany and form a part of this specification.

In the drawings, Figures 1 and 2 represent 40 two embodiments of my invention whereby the employment of a high vertical conductor is rendered unnecessary.

In the figures, A is an alternating-current generator adapted to develop currents of high 45 frequency. k is a key. M is a transformer, the ordinate drawn in the negative direction are the primary and secondary windings of senting the first harmonic 2" of the funda-95 the transformer M. L' is an inductance. V i mental frequency n. When the frequency is

is an elevated conductor consisting of a metal plate preferably circular in form and paral- 50 lel to earth and whose diameter, and consequently whose periphery, is preferably great compared to its distance from the ground. However, a metallic plate of any other shape or any other suitable laterally-extending con- 55 ducting member may be employed, and preferably its distance from the ground should be small compared to its smallest dimension. The member V and its connection o I E to earth constitute an elevated-conductor sys- 60 tem. However, any other suitable form of elevated-conductor system may be employed in combination with the high-frequency alternating-current generator A, as hereinafter pointed out.

The reactance at the driving-point " for slow frequencies is determined by the capacity of the plate V with respect to earth and varies as the area of this plate and inversely as its separation from earth. As the fre- 70 quency is increased the reactance at the driving-point o is in the nature of a capacity reactance and diminishes as the frequency increases, finally becoming zero when the frequency is equal to the fundamental frequency 75 " of the elevated-conductor system. For any further increase in frequency from this point the reactance at the driving-point " becomes in the nature of an inductance reactance, which increases as the frequency is further 80 increased, the curve which shows the variation of reactance with frequency becoming asymptotic with the ordinate drawn in the positive direction from the point on the axis of abscissæ representing the first harmonic 2ⁿ 85 of the fundamental frequency ". As the frequency passes through the value 2" the reactance at the driving - point " suddenly changes from an inductance reactance of infinite value to a capacity reactance of infinite 90 value, the curve which shows the variation of reactance with frequency being asymptotic to which may be a step-up transformer. It Is from the point on the axis of abscissa repre-

ance at the driving-point a is infinite, the ele- apparatus. vated-conductor system refuses to vibrate i.e., the elevated-conductor system is then 5 equivalent in length to a half-wave length of , vated-conductor system comprising a plate of frequency is further increased from the first harmonic the capacity reactance again wanes, becoming zero when the frequency is equal 10 to the second harmonic 3" of the fundamental curve showing the variation of reactance at the driving-point a with frequency is a discontinuous curve, which is zero when the fre-15 quency is equal to the fundamental frequency n, which passes from plus infinity to minus infinity as the frequency passes through the value 2", which is zero when the frequency is 3", which passes from plus infinity to minus 20 infinity as the frequency passes through the value 4°, which is zero when the frequency is 5", and so on, the positive values of said curve representing inductance reactances and the negative values thereof representing capacity 25 reactances.

An alternating-current generator A of frequency high compared with the alternatingcurrent generators of commerce is connected in series with the primary winding h of the 30 transformer M, whose secondary lehas large inductance to reduce the frequency of the fundamental of the elevated-conductor system to the frequency of the currents developed by the generator.

Inasmuch as the frequency of the currents developed by the generator A is fixed, an inductance-coil L' may be included in the conductor " I: E to attune the fundamental of the elevated-conductor system to such frequency 40 or to some harmonic thereof i. r., to some multiple or submultiple thereof and under certain conditions a condenser may be so employed, as explained in my application, Serial No. 182,634, filed November 25, 1903, of 45 which this application is a division.

An alternating-current generator of the well-known type developed by Nikola Tesla may be used for the purposes of this invention.

I do not wish to be limited to the precise 50 form of elevated-conductor or electromagnetic-wave-radiating system herein described, inasmuch as many modifications may be made therein without departing from the spirit of my invention.

It is obvious that an alternating-current generator of high frequency may be employed advantageously with many forms of elevatedconductor or electromagnetic-wave-radiating systems of the more usual type, and there-60 fore I claim, broadly, the combination of such elevated-conductor or electromagnetic-waveradiating systems with an alternating-current generator of high frequency for directly

equal to the first harmonic 2" and the react- ' the interposition of the usual spark-producing 65.

Lelaim

1. In a system of space telegraphy, an elethe oscillations impressed upon it. As the periphery large compared with its distance 70 above the earth and an alternating-current generator of high frequency associated therewith.

2. In a system of space telegraphy, an elefrequency n, and so on. In other words, the vated-conductor system comprising a plate of 75 periphery large compared with its distance above the earth, a conductor connecting said plate to earth, a transformer whose secondary winding is serially connected in said conductor and an alternating-current generator of 80 high frequency connected with the primary winding of said transformer.

3. In a system of space telegraphy, an elevated-conductor system comprising a plate of periphery large compared with its distance 85 above the earth, a conductor connecting said plate to earth, an inductance-coil and the secondary winding of a transformer serially included in said conductor and an alternatingcurrent generator of high frequency connected 90 with the primary winding of said transformer.

4. In a system of space telegraphy, an elevated-conductor system comprising a plate of periphery large compared with its distance above the earth, an alternating-current gen- 95 erator of high frequency associated therewith, and means for attuning the fundamental period of said elevated-conductor system to the frequency of the currents developed by said alternating-current generator or to some har- 100 monic of said frequency.

5. In a system of space telegraphy, an elevated-conductor system comprising a laterally-extending conducting member and means connecting said member to earth, in combina- 105 tion with a high-frequency alternating-current generator for developing electric vibrations in said elevated-conductor system.

6. In a system of space telegraphy, an electromagnetic wave-radiating system and a high- 110 frequency alternating-current generator associated therewith without the interposition of a spark-producing apparatus.

7. In a system of space telegraphy, an electromagnetic wave-radiating system and a high-115 frequency alternating-current generator connected directly therewith.

8. In a system of space telegraphy, an electromagnetic wave-radiating system, a highfrequency alternating - current generator 120 adapted to develop currents of definite frequency associated therewith and means for attuning the fundamental period of said radiating system to the frequency of the currents developed by said alternating-current gener- 125 ator or to some harmonic of said frequency.

9. In a system of space telegraphy, an eleccreating electrical oscillations therein without 4 tromagnetic wave-radiating system, a high-

frequency alternating - current generator adapted to develop currents of definite frequency associated therewith and an inductance for attuning the fundamental period of said radiating system to the frequency of the currents developed by said alternating - current generator or to some harmonic of said frequency.

10. In a system of space telegraphy, an electromagnetic wave-radiating system serially connected with the secondary winding of a transformer in combination with a high-frequency alternating-current generator serially connected with the primary winding of said transformer.

11. In a system of space telegraphy, an elec-

tromagnetic wave-radiating system serially connected with the secondary winding of a transformer, a high-frequency alternating-current generator connected with the primary winding of said transformer and means for attuning the fundamental period of said radiating system to the frequency of the currents developed by said alternating-current generator or to some harmonic of said frequency.

In testimony whereof I have hereunto subscribed my name this 11th day of February, 1904.

JOHN STONE STONE.

Witnesses:
Brainerd T. Judkins,
G. Adelaide Higgins.

R. A. FESSENDEN.

MEANS FOR THE TRANSMISSION OF ENERGY BY ELECTROMAGNETIC WAVES.

APPLICATION FILED DEC. 19, 1906.

1,015,881.

Patented Jan. 30, 1912.

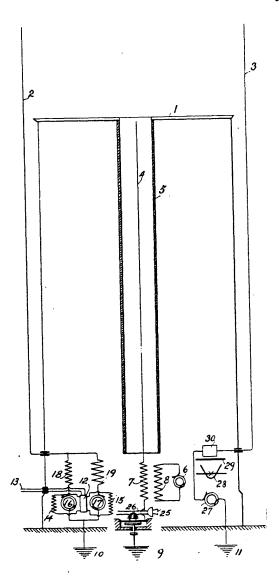
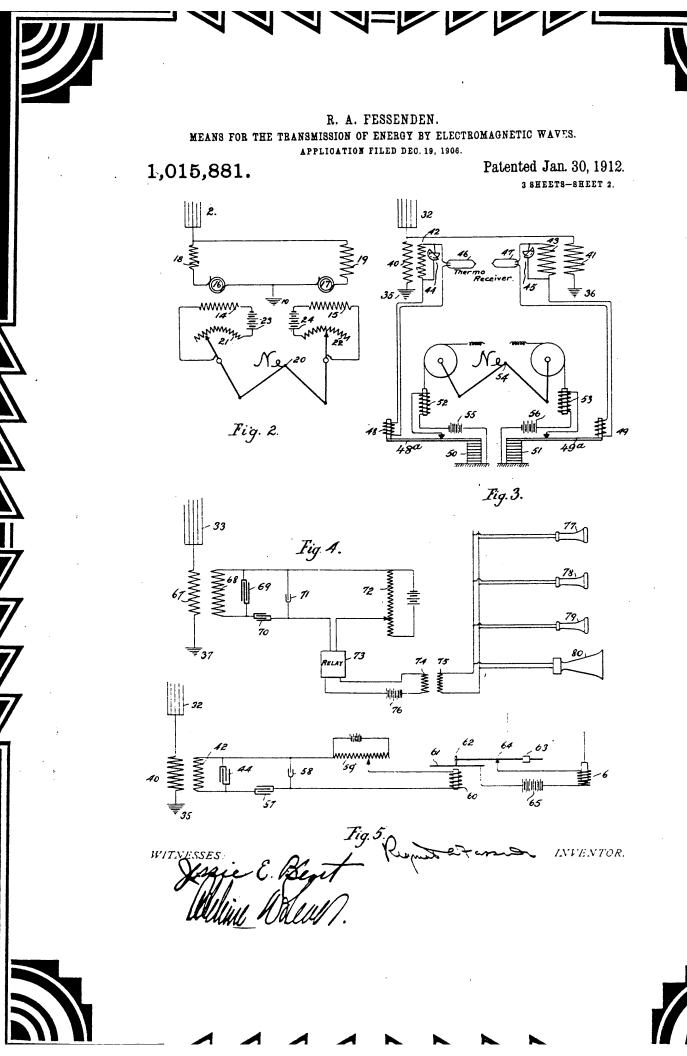


Fig. I.

Jescie & Bant Milia Wallet. Rumostanio INVENTOR.



K. A. FESSENDEN.

MEANS FOR THE TRANSMISSION OF ENERGY BY ELECTROMAGNETIC WAVES.

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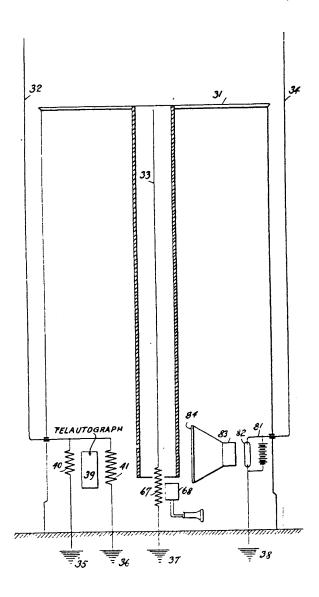


Fig. 6.

Jusie E. Bert Regulation INVENTOR

UNITED STATES PATENT OFFICE.

REGINALD A. FESSENDEN, OF WASHINGTON, DISTRICT OF COLUMBIA. ASSIGNOR TO NATIONAL ELECTRIC SIGNALING COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF NEW JERSEY.

MEANS FOR THE TRANSMISSION OF ENERGY BY ELECTROMAGNETIC WAVES.

1,015,881.

Specification of Letters Patent.

Patented Jan. 30, 1912.

Application filed December 19, 1906. Serial No. 348,660.

To all whom it may concern:

Be it known that I. REGINALD A. FESSEN-DEN, citizen of the United States, and resident of Washington, in the District of Co-5 lumbia, have invented certain new and useful Means for the Transmission of Energy by Electromagnetic Waves, of which the following is a specification.

My invention relates to the art of trans-10 mitting by electromagnetic waves sounds, writings and pictures from a central station

to a number of subscribers.

In the accompanying drawings forming a part of this specification, Figure 1 shows 15 diagrammatically apparatus for transmitting writings, sounds, either speech or music and for transmitting pictures. Fig. 2 shows an apparatus for transmitting writing, Figs. 3 and 5 show in detail apparatus 20 for receiving the writing. Fig. 4 shows apparatus for receiving the sounds. Fig. 6 shows diagrammatically an office building arranged for receiving the writings, sounds and pictures.

In the practice of my invention I construct a central distributing station shown in Fig. 1 where 1 is a structure which may be an office building and 2, 3 and 4 are antennæ. The antennæ 2 and 3 are constructed in the fashion well known in the art. The antenna 4 is contained in a wholly or partly conducting tube 5 which may for example be a portion of an elevator shaft or an air shaft. The antenna 4 is supported in this shaft and is connected to a source of high frequency oscillations 6 by means of the transformer whose coils are 7 and 8, and the antenna 4 is grounded at 9. When high frequency currents are caused to flow into

40 the antenna 4, if its electrical constants are properly proportioned the whole office building 1 may be caused to act as an antenna and to radiate out electromagnetic waves very efficiently. There may, of course, be two or
45 more such antenna in a single office building and the office building may be caused to emit waves of more than one frequency.

The antenna 2 is grounded at 10 and the

antenna 3 is grounded at 11.

For the transmission of writing, an apparatus which may conveniently be of the Grey tel-autograph type shown at 12 and in Fig. 2 is used. This acts, either by manual impulses in a well known way or by

electrical impulses transmitted over the line 55 13 to affect the strength of the fields 14, 15 of the high frequency alternators 16, 17. These alternators 16, 17 are of different frequencies and are tuned to the compound antenna 2 by means of the inductances 18, 19. 60 The fields of the alternators 16, 17 may be wound if desired differentially.

As shown in Fig. 2, in detail 16, 17 are the high frequency alternators of Fig. 1, 14, 15 the fields of the alternators, 18, 19 the tun- 65 ing inductances and 2 the antenna. The motion of the writing point 20, by changing the resistances 21, 22 varies the currents flowing in the fields of the alternators from sources 23, 24, and thereby the strength of 70 the emitted waves. Many modifications may be employed, for example the fields may be wound differentially or the resistances 21, 22 may be placed in the high frequency circuits instead of in the field cir- 75 cuits.

For transmitting speech or music the antenna 4 is used. This is operatively connected as mentioned above to the high frequency dynamo 6 through the transformer 807, 8. 25 is a telephone relay transmitter having a mouth piece for local talking and also being capable of operation from a distance through the circuit 26. The operation is well-known. (See Fig. 6 of my 85 United States Patent No. 793,649.)

In Fig. 1 the antenna 3 is arranged to transmit waves representing pictures. This device comprises a high frequency alternator 27 to generate the waves, and by means of a 90 light and projector 28, the picture to be sent is projected from the negative 29 on to the instrument 30. This is a high frequency commutator having numerous sections connected to a series of selenium cells, so that 95 when the cells are affected the character of the waves is altered. The cells are arranged after the fashion of the grating of a half tone plate, and the aggregate character of the waves is governed according to the char- 100 acter and position of the light projected upon the grating of cells, which light is of course in turn governed by the picture to be transmitted. The particular construction of this device is not essential to my in- 105 vention herein claimed.

Fig. 2 is used. This acts, either by manral impulses in a well known way or by an office building, 32, 33, 34 being antennæ

respectively grounded at 35, 36, 37, 38. For receiving writing for example stock quotations, 39 is a writing apparatus, which may be of the Grey tel-autograph type, connected 5 to the antenna 32 through the two primaries 40, 41 as shown in detail in Fig. 3.

In Fig. 3, 32 is the antenna grounded at 35 and 36, 40 and 41 are primaries whose secondaries are 42 and 43. 44 and 45 are 10 variable capacities, 46 and 47 are receivers of any suitable type producing indications by continuous current, for example thermoelectric receivers of tellurium and silicon which furnish their own current, as is well 15 known. 48 and 49 are small plunger magnets which, by means of their supporting lever beams 48^a and 49^a resting on carbon resistances 50 and 51 control the magnets 52 and 53 of the Grey tel-autograph 54. 55 20 and 56 are local batteries for actuating the tel-autograph.

In operation the waves received affect the instruments 46, 47 so as to produce currents in the coils 48, 49 which fluctuate in ac-25 cordance with the fluctuations and the stream of waves sent, which in turn of course are varied in consonance with the movements of the writing point 20 of Fig. 2. The writing point 54 of Fig. 3 being gov-30 erned in its position and motions by the magnets 52, 53, excited by the sources 55, 56. it will be observed that these last mentioned circuits are controlled by changing the resistance of the carbon resistances 50, 35 51 which in turn are altered in resistance in accordance with the movements of the magnets 48, 49 and thus with the character of the trains of waves transmitted.

The circuits including the autenna 32 and 40 coil 40 on the one hand and the circuit including the antenna and the coil 41 on the other hand are respectively arranged as well known in this art, by tuning to respond to oscillations produced respectively by reason 45 of coils 18, 19 in the sending circuits of

In Fig. 5 is shown a different method of actuating the tel-autograph magnets. Here 32 is the antenna grounded at 35, 40 the 50 primary of the transformer, 42 the secondary, 44 and 57 condensers, 58 a liquid barretter, 59 a potentiometer, 60 a telephone magnet, 61 a telephone diaphragm, 62 a balanced contact, 63 being a balancing weight 55 and 64 the knife edge, 65 is a local battery and 66 is one of the magnets 52 or 53 of the tel-autograph above described. The received waves causing by their fluctuations a variation in the current at 60, alter the char-60 acter or mean time of contact at 62.

It is found in practice that the intensity of the local current in the magnet 66 depends upon the intensity of the oscillatory currents received by the antenna 32.

For receiving sounds, the antenna 33 in 1 of electromagnetic waves, and modifying 130

Fig. 6 is used. 67 is the primary of a transformer operatively connected to the apparatus 68 which is shown in detail in Fig. 4.

In Fig. 4, 33 is the antenna grounded at 37, 67 is the primary of the transformer, 68 73 its secondary, 69, 70 are cordensers, 71 a receiver, 72 a potentiometer, 73 a telephone relay, 74, 75 are the primary and secondary of a telephone induction coil, 76 a local battery, 77, 78, 79 telephone receivers and 80 75 a loud speaking telephone.

The telephone receivers and loud speaking telephones are connected in at the office of the subscriber.

The device for receiving pictures is con- 80 nected with the antenna 34, grounded at 38 and by means of a local battery 81 which excites the vacuum tube 82, the fluctuations or alterations in characteristics of the wave trains received are caused to reproduce the 85 picture on the instrument 83. This is an arrangement of oscillating mirrors which operate upon the principle of persistence of visual impressions, but the particular construction not being a part of the inven- 90 tion here claimed is not described here.

By the above described apparatus I may transmit from a central distributing station all of the news of the day, such as reports and pictures, or music, or conversation to a great many subscribers simultaneously. The transmission of all intelligence appealing to the different senses being accomplished by the agency of electromagnetic waves, which makes it very 100 efficient and economical as will be readily understood. The present application is intended to cover the general system and the transmission of writing by electromagnetic waves, and the transmission of 105 pictures is claimed elsewhere.

What I claim herein is the following: 1. In the art of transmitting intelligence, the combination with a radiating structure for electromagnetic waves, of means to ex- 110 cite the same for radiation of waves representing sound, writing and pictures simultaneously, and a receiving station having means to select the waves of the three kinds and simultaneously reproduce sounds, writ- 115

ing and pictures. 2. The combination with a sending device and a receiving device operated by electromagetic waves, of means for generating a continuous train of waves and modifying 120 them in groups, representing several kinds of intelligence, and means at the receiving station for selecting the several groups and thereby reproducing several characteristic kinds of intelligence, substantially as de- 125

3. In the art of distributing intelligence, the combination of a central station having devices for generating a continuous stream

them in accordance with speech and handwriting, and a plurality of receiving stations having devices for selecting the said modified waves and reproducing the said 5 speech and writing, substantially as described.

4. In the art of transmitting intelligence, a generating station having a wave emitting device, and generating means associated to therewith to effect the emission of a continuous stream of electromagnetic waves, apparatus for modifying said waves in accordance with several forms of the intelligence to be transmitted, and a receiving station having a plurality of receivers, each of which is adapted to respond to the modified waves representing one form of intelligence; substantially as described.

5. Apparatus for transmitting intelligence, comprising a sending antenna, a generator for causing the antenna to emit a continuous stream of electromagnetic

waves, a tel-autograph arranged to modify the action of the generator, a receiving station, and a tel-autograph connected in the 25 receiving circuit of the receiving station, and tuned to respond to the modified impulses produced by the tel-autograph at the sending station.

6. In apparatus for transmitting of energy, 30 a building having an interior conducting shaft, a wave generator within the building, and a conductor extending upwardly from the wave generator through the shaft whereby both the shaft and the conductor 35 form part of the antenna; substantially as described.

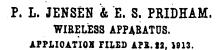
Signed at Brant Rock, in the county of Plymouth and State of Massachusetts this 17th day of December A. D. 1906.

REGINALD A. FESSENDEN.

Witnesses:

JESSIE E. BENT, ADELEINE WOLENER.





1,106,875.

Patented Aug. 11, 1914.



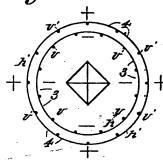


Fig.2.

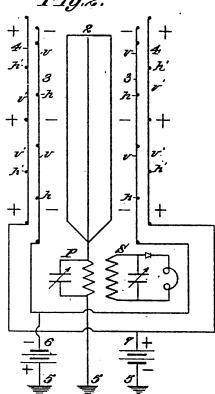


Fig.3.

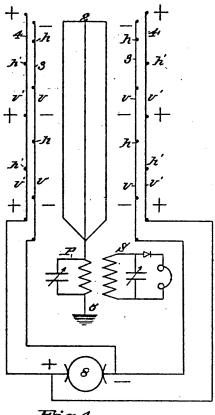


Fig4,

WITNESSES:

A.S. Burne,

INVENTORS,

Peter L.Jensen. Edwin & Pridham

EN D. H. Shong.

UNITED STATES PATENT OFFICE.

PETER L. JENSEN AND EDWIN S. PRIDHAM, OF NAPA, CALIFORNIA, ASSIGNORS TO COMMERCIAL WIRELESS & DEVELOPMENT CO., OF SAN FRANCISCO, CALIFORNIA, A CORPORATION OF ARIZONA.

WIRELESS APPARATUS.

1,106,875.

Specification of Letters Patent. Patented Aug. 11, 1914.

Application filed April 22, 1913. Serial No. 762.778.

To all whom it may concern:

Be it known that we, Peter L. Jensen, a subject of the King of Denmark, and Edwin S. Pridham, a citizen of the United 5 States, both residing at Napa, in the county of Napa and State of California, have invented new and useful Improvements in Wireless Apparatus, of which the following is a specification.

This invention relates to wireless telegraphy, and particularly to means for reducing the disturbing effects of atmospheric

electricity.

The word static is so commonly used in 15 connection with atmospheric electricity that this kind of interference will hereinafter be termed static. The origin of static is not as well known as its manifestation. We may distinguish between two kinds of static 20 disturbances, the one consists of electro-magnetic waves generated by a sudden discharge of electricity as in lightning. This disturbance is short and sharp in character, and produces a characteristic click in the tele-25 phone receiver. The other kind of disturbance is of a more serious nature and consists of a more or less intermittent discharge or flow of electricity in the antenna. This disturbance is often prolonged and may 30 make it impossible to read letters or entire words of an incoming message. These two forms of static can easily be duplicated in the laboratory, the first by discharge of an oscillatory nature as from a Leyden jar or 35 condenser, and the second which is a most exact imitation of the distressing static, may be shown by allowing masses of charged dust particles to strike the receiving antenna. It has been shown by conclusive ex-40 periments that these charged particles striking the antenna give rise to the disturbing currents in the receiving circuits.

The present invention relates to means for guarding the antenna from receiving charges from the surrounding atmosphere and consists of surrounding the receiving antenna with conductors of certain form upon which are maintained charges of electricity.

The novelty of the invention is in the maintaining of charges of electricity upon the guarding conductors and in the placing of these conductors around the receiving antenna in certain positions. A single wire

or a cage of wires without a charge on it around the antenna is of no benefit in re- 55 ducing the disturbance.

In the invention herein described we have an antenna surrounded by a cage of wires upon which is maintained a charge of electricity and concentric with this cage is a 60 similar cage with a charge of opposite kind of electricity on it. In practice the distance between the antenna and the inner cage is greater than the distance between the two concentric cages. It is necessary that 65 the charges be maintained steady or the variation will to some degree affect the receiving antenna. The charge may be produced by a high potential battery or a static machine, or any source of steady potential. It 70 is also necessary that the frequency of the received wave be of a different order than the natural frequency of the guarding cages.

Another form of the invention consists of surrounding the receiving antenna with 75 a number of guarding wires; each alternate wire being in metallic connection, thus forming two metallic sets, substantially in the same plane, one set having a plus charge upon it, the other a negative charge.

Another form of the invention consists in surrounding the receiving antenna with two conducting cages, either concentric or intermeshed and insulated one from the other and connecting the one through a source of 85 positive potential to the ground and the other through a source of negative potential to the ground.

The invention consists of the parts and the construction and combination of parts 90 as hereinafter more fully described and claimed, having reference to the accompany-

ing drawings, in which-

Figure 1 shows diagrammatically a plan view in cross section of the arrangement of 95 the guarding wires around the antenna. Fig. 2 shows diagrammatically the arrangement of parts in vertical cross section in connection with sources of potential and ground connections and the receiving circuits. Fig. 3 shows diagrammatically in vertical cross section a variation of the arrangement of the guarding wires around the antenna with a single source of electricity and receiving circuits. Fig. 4 shows diagrammatically in horizontal cross section

tion

the guarding wires with opposite charges | charges of opposite sign respectively upon of potential on the alternate wires, and the

Referring to Fig. 1, 2 is the antenna; 3 5 and 4 are concentric guarding cages formed by the vertical wires v and v', and the horizontal wires h and h'. The inner cage 3 has a charge maintained upon it and the outer cage 4 has a charge of opposite potential as 10 indicated.

Referring to Fig. 2, 8 and 4 are the two concentric cages composed of the vertical conductors v-v' and the horizontal conductors h-h'; 2 is the antenna connected 15 through the primary oscillation circuit P to the ground 5. 'S is the secondary oscillation circuit. The inner set of conductors 3 are connected through a source of negative potential 6 to the ground 5. The outer 20 set of conductors 4 are connected through a source of positive potential 7 to the ground 5.

Referring to Fig. 3, 3 and 4 are the guarding wires surrounding the antenna 2: the inner set of wires 3 being connected to 25 the negative pole of a source of electricity 8 and the outer set of wires 4 is connected to the positive pole of the source of electricity 8. The antenna 2 is connected to the primary circuit P to the ground 5. S is the 30 secondary receiving circuit.

Referring to Fig. 4 the two guarding sets of conductors are shown in horizontal view occupying substantially the same cylindrical space around the antenna 2. This arrange-35 ment may be produced by connecting each alternate wire respectively to positive and negative sources of electricity as indicated.

Having thus described our invention, what we claim and desire to secure by Letters Pat-40 ent is-

1. In a wireless receiving station including a means for reducing the disturbing effects of atmospheric electricity, an antenna, a receiving circuit in connection with said 45 antenna, means for detecting incoming electro-magnetic waves in combination with two separate sets of conductors, said sets of conductors being insulated from and substantially surrounding said antenna, and 50 means for impressing locally charges of electricity respectively upon said sets of

2. In a wireless receiving station, including a means for reducing the disturbing ef-55 fects of static, an antenna, a receiving circuit in connection with said antenna, means for detecting electro-magnetic waves striking said antenna in combination with two sets of conductors, said conductors being 60 separate from and substantially surrounding said antenna, and means for impressing

said sets of conductors.

3. In a wireless receiving station, including a means of improving the reception of 65 electro-magnetic waves, an antenna, a receiving circuit in connection with said antenna, and means for detecting electro-magnetic waves in combination with two separate sets of conductors, said conductors be- 70 ing separate from and substantially surrounding said antenna, and means for impressing and maintaining charges of oppo-site character respectively between said two sets of conductors and the ground, substan- 75 tially as described.

4. In a wireless receiving station, including a means for reducing the disturbing effects of static electricity, an antenna, a receiving circuit, and means for detecting 80 electro-magnetic waves in combination with two separate concentric sets of conductors, said concentric sets of conductors being removed from said antenna and substantially surrounding the same, and means for im- 85 pressing and maintaining charges of electricity of opposite sign respectively upon said concentric sets of conductors.

5. In a wireless receiving station, an antenna and a receiving circuit with means for 90 detecting electro-magnetic waves in combination with two separate concentric sets of conductors, said concentric sets of conductors substantially surrounding said antenna, the distance between said concentric 95 sets of conductors being less than the distance between said concentric sets of conductors and said antenna, and means for impressing charges of opposite sign respectively on said concentric sets of conductors. 100

6. In a wireless receiving station, including a means for reducing the disturbing effects of static electricity, an antenna, a receiving circuit and means for detecting electro-magnetic waves in combination with two 105 separate sets of concentric conductors, said concentric sets of conductors substantially surrounding said antenna, one of said sets of concentric conductors being connected through a source of positive electricity to 110 the ground, the other set of concentric conductors being connected through a source of negative electricity to the ground, substantially as described.

In testimony whereof we have hereunto 115 set our hands in the presence of two subscribing witnesses.

PETER L. JENSEN. EDWIN S. PRIDHAM.

 $\operatorname{Witnesses}$: W. W. HEALEY, ZOE HARRISON.

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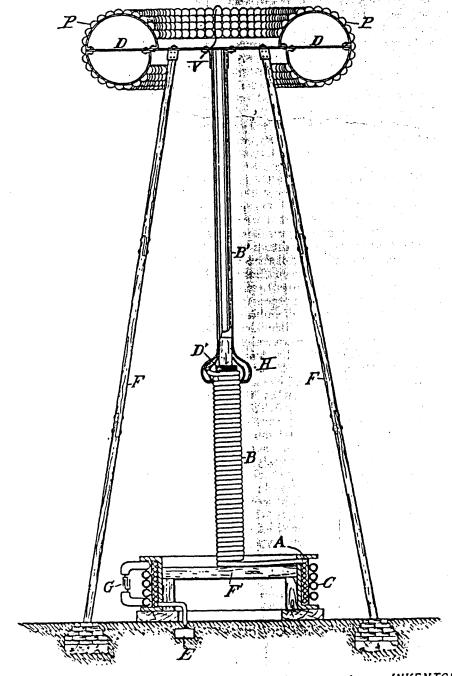


N. TESLA.

APPARATUS FOR TRANSMITTING ELECTRICAL ENERGY.
APPLICATION FILED JAN. 18, 1902. REWEWED MAY 4, 1907.

1,119,732.

Patented Dec. 1, 1914.



M. Lawson Dyrn

Denjamin Friller

Nikaca Tesla,

"I' Kenr Page & Cooper,
his ATTORNEYS.



UNITED STATES PATENT OFFICE.

NIKOLA TESLA, OF NEW YORK, N. Y.

APPABATUS FOR TRANSMITTING ELECTRICAL ENERGY.

1,119,732.

Specification of Letters Patent.

Palented Dec. 1, 1914.

Application filed January 18, 1902, Serial No. 90,245. Renewed May 4, 1907. Serial No. 371,817.

To all whom it may concern:

Be it known that I, NIKOLA TESLA, a citizen of the United States, residing in the borough of Manhattan, in the city, county, and State of New York, have invented certain new and useful Improvements in Apparatus for Transmitting Electrical Energy, of which the following is a specification, reference being had to the drawing accompanying and forming a part of the same.

In endeavoring to adapt currents or discharges of very high tension to various valuable uses, as the distribution of energy through wires from central plants to distant places of consumption, or the transmission of powerful disturbances to great distances, through the natural or non-artificial media, I have encountered difficulties in confining considerable amounts of electricity to the conductors and preventing its leakage over their supports, or its escape into the ambient air, which always takes place when the electric surface density reaches a certain value.

The intensity of the effect of a transmit-25 ting circuit with a free or elevated terminal is proportionate to the quantity of electricity displaced, which is determined by the product of the capacity of the circuit, the pressure, and the frequency of the currents 30 employed. To produce an electrical movement of the required magnitude it is desirable to charge the terminal as highly as possible, for while a great quantity of electricity may also be displaced by a large 35 capacity charged to low pressure, there are disadvantages met with in many cases when the former is made too large. The chief of these are due to the fact that an increase of the capacity entails a lowering of the frequency of the impulses or discharges and a diminution of the energy of vibration. This will be understood when it is borne in mind, that a circuit with a large capacity behaves as a slackspring, whereas one with a small 45 capacity acts like a stiff spring, vibrating more vigorously. Therefore, in order to attain the highest possible frequency, which for certain purposes is advantageous and,

apart from that, to develop the greatest 50 energy in such a transmitting circuit, I em-

ploy a terminal of relatively small capacity,

which I charge to as high a pressure as practicable. To accomplish this result I have

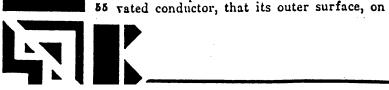
found it imperative to so construct the ele-

which the electrical charge chiefly accumulates, has itself a large radius of curvature, or is composed of separate elements which, irrespective of their own radius of curvature, are arranged in close proximity to each 60 other and so, that the outside ideal surface enveloping them is of a large radius. Evidently, the smaller the radius of curvature the greater, for a given electric displacement, will be the surface-density and, con- 65 sequently, the lower the limiting pressure to which the terminal may be charged without electricity escaping into the air. Such a terminal I secure to an insulating support entering more or less into its interior, and I 70 likewise connect the circuit to it inside or, generally, at points where the electric density is small. This plan of constructing and supporting a highly charged conductor I have found to be of great practical impor- 75 tance, and it may be usefully applied in many

Referring to the accompanying drawing, the figure is a view in elevation and part section of an improved free terminal and 80 circuit of large surface with supporting structure and generating apparatus.

The terminal D consists of a suitably shaped metallic frame, in this case a ring of nearly circular cross section, which is cov- 85 ered with half spherical metal plates P P, thus constituting a very large conducting surface, smooth on all places where the electric charge principally accumulates. The frame is carried by a strong platform ex- 90 pressly provided for safety appliances, instruments of observation, etc., which in turn rests on insulating supports F F. These should penetrate far into the hollow space formed by the terminal, and if the electric 95 density at the points where they are bolted to the frame is still considerable, they may be specially protected by conducting hoods as H.

A part of the improvements which form 100 the subject of this specification, the transmitting circuit, in its general features, is identical with that described and claimed in my original Patents Nos. 645,576 and 649,621. The circuit comprises a coil A which is in 105 close inductive relation with a primary C, and one end of which is connected to a ground-plate E, while its other end is led through a separate self-induction coil B and a metallic cylinder B' to the terminal D. 110





The connection to the latter should always latter is in the form of a cylinder with be made at, or near the center, in order to smooth or polished surface of a radius much secure a symmetrical distribution of the current, as otherwise, when the frequency is ments P.P. and widens out at the bottom yery high and the flow of large volume, the into High H, which should be slotted to 70 performance of the apparatus might be important any desired manner, from a suitable source of currents G, which may be an alternator drum D of insulating material, with its 10 or condenser, the important requirement being that the resonant condition is established, that is to say, that the terminal D is charged to the maximum pressure developed in the circuit, as I have specified in my 15 original patents before referred to. The adjustments should be made with particular care when the transmitter is one of great power, not only on account of economy, but. also in order to avoid danger. I have shown 20 that it is practicable to produce in a resonating circuit as E A B B' D immense electrical activities, measured by tens and even hundreds of thousands of horse-power, and in such a case, if the points of maximum 25 pressure should be shifted below the terminal D, along coil B, a ball of fire might break out and destroy the support F or anything else in the way. For the better appreciation of the nature of this danger it 30 should be stated, that the destructive action may take place with inconceivable violence. This will cease to be surprising when it is borne in mind, that the entire energy accumulated in the excited circuit, instead of re-35 quiring, as under normal working conditions, one quarter of the period or more for its transformation from static to kinetic form, may spend itself in an incomparably smaller interval of time, at a rate of many 40 millions of horse power. The accident is apt to occur when, the transmitting circuit being strongly excited, the impressed oscillations upon it are caused, in any manner more or less sudden, to be more rapid than 45 the free oscillations. It is therefore advisable to begin the adjustments with feeble and somewhat slower impressed oscillations, strengthening and quickening them gradually, until the apparatus has been brought under perfect control. To increase the safety, I provide on a convenient place, preferably on terminal D, one or more elements or plates either of somewhat smaller radius of curvature or protruding more or less beyond the others (in which case they may be of larger radius of curvature) so that, should the pressure rise to a value, beyond which it is not desired to go, the powerful discharge may dart out there and lose itself harmlessly in the air. Such a plate, performing a function similar to that of a safety valve on a high pressure reservoir, is indicated at V. Still further extending the principles underlying my invention, special reference

is made to coil B and conductor B'. The

turns close together. I have discovered that 73 when so wound the effect of the small radius of curvature of the wire itself is overcome and the coil behaves as a conductor of large radius of curvature, corresponding to that of the drum. This feature is of consider- so able practical importance and is applicable not only in this special instance, but generally. For example, such plates at P P of terminal D, though preferably of large radius of curvature, need not be necessarily 85 so, for provided only that the individual plates or elements of a high potential conductor or terminal are arranged in proximity to each other and with their outer boundaries along an ideal symmetrical en- 90 veloping surface of a large radius of curvature, the advantages of the invention will be more or less fully realized. The lower end of the coil B-which, if desired, may be extended up to the terminal D-should 95 be somewhat below the uppermost turn of coil A. This, I find, lessens the tendency of the charge to break out from the wire connecting both and to pass along the support F. Having described my invention, I claim:

1. As a means for producing great electrical activities a resonant circuit having its outer conducting boundaries, which are charged to a high potential, arranged in 105 surfaces of large radii of curvature so as to prevent leakage of the oscillating charge, substantially as set forth.

2. In apparatus for the transmission of electrical energy a circuit connected to 110 ground and to an elevated terminal and having its outer conducting boundaries, which are subject to high tension, arranged in surfaces of large radii of curvature substantially as, and for the purpose described. 115

3. In a plant for the transmission of electrical energy without wires, in combination with a primary or exciting circuit a secondary connected to ground and to an elevated terminal and having its outer conducting 120 boundaries, which are charged to a high potential, arranged in surfaces of large radii of curvature for the purpose of preventing leakage and loss of energy, substantially as set forth.

4. As a means for transmitting electrical energy to a distance through the natural media a grounded resonant circuit, comprising a part upon which oscillations are impressed and another for raising the ten- 130



8

sion, having its outer conducting boundaries on which a high tension charge accumulates arranged in surfaces of large radii of curvature, substantially as described.

ture, substantially as described.

5. The means for producing excessive electric potentials consisting of a primary exciting circuit and a resonant secondary having its outer conducting elements which are subject to high tension arranged in proximity to each other and in surfaces of large radii of curvature so as to prevent leakage of the charge and attendant lowering of potential, substantially as described.

6. A circuit comprising a part upon which oscillations are impressed and another part for raising the tension by resonance, the latter part being supported on places of low electric density and having its outermost conducting boundaries arranged in surfaces of large radii of curvature, as set forth.

7. In apparatus for the transmission of electrical energy without wires a grounded circuit the outer conducting elements of which have a great aggregate area and are arranged in surfaces of large radii of curvature so as to permit the storing of a high charge at a small electric density and prevent loss through leakage, substantially as described.

8. A wireless transmitter comprising in 30 combination a source of oscillations as a condenser, a primary exciting circuit and a secondary grounded and elevated conductor the outer conducting boundaries of which are in proximity to each other and arranged 35 in surfaces of large radii of curvature, substantially as described.

9. In apparatus for the transmission of electrical energy without wires an elevated conductor or antenna having its outer high 40 potential conducting or capacity elements arranged in proximity to each other and in surfaces of large radii of curvature so as to overcome the effect of the small radius of curvature of the individual elements and 45 leakage of the charge, as set forth.

10. A grounded resonant transmitting circuit having its outer conducting boundaries arranged in surfaces of large radii of curvature in combination with an elevated terminal of great surface supported at points of low electric density, substantially as described.

NIKOLA TESLA.

Witnesses:
M. Lamson Dyer,
RICHARD DONOVAN.











Call Up Wifey on the "Sto Pipe" Radio

MAN with a box slung over his shoulder and holding in one hand three pieces of stove pipe placed side by side on a board climbed into an automobile on East Country Road, Elkins Park, Pa.

As he settled in the machine he picked up telephone transmitter, set on a short handle, and said:

"We are going to run down the road. Can you hear me?".

Other passengers in the automobile, all wearing telephone receivers, heard a woman's voice answering: "Yes, perfectly. Where are you?'

By this time the machine was several hun dred yards down the road and the voice in the garage was distinctly heard.

This was one of the incidents in the first demonstration of the portable wireless tele-phone outfit invented by W. W. Macfarlane, of Philadelphia.

Mrs. Macfarlane, sitting in the garage back of the Macfarlane home, was talking thru the wireless telephone to her husband. seated comfortably in a moving automobile 500 yards away.

The occupants of the car were a chauffeur, a reporter and a photographer. All wore the telephone receivers and could hear everything Mrs. Macfarlane was saying. The chauffeur had no other apparatus than the receiver with the usual telephone cord attached by a metal clip to his steering wheel.

Lying beside Mr. Macfarlane was the footsquare box, the only "secret" in the whole demonstration. What is in the box is the inventor's mystery. This box weighs about twelve pounds. The other machinery used consisted only of the usual telephone transmitter and receivers and the three pieces of stovepipe standing erect on a plain piece of board. This forms the acrial of the apparatus.

Before starting on the automobile demonstration of his wireless telephone Mr. Mac-farlane stood in the garage and directed the movements of a soldier in a field more than 200 yards away from him. This soldier assistant had a pair of telephone receivers over his head, connected by a wire with two metal clasps to his rifle (see photo herewith). He marched and halted and about-faced and left shouldered arms out there in the field the instant Mr. Macfarlane gave the order thru his little hand wireless phone in the garage.



Mr. Macfarlane said he would make no fanciful predictions as to what his simple,

portable wireless telephone might do.
"There are all kinds of possibilities in it,"
he continued. "If this could have been ready
for use in the war, think of the value it
would have had. A whole regiment equipt with the telephone receivers, with only their rifles as aerials, could advance a mile and each would be instantly in touch with the commanding officer. No runners would be needed. There could be no such thing as a

"lost battalion."
"No high power is necessary to operate this wireless, I am using one-tenth of an amount of the control of th results you see are so good that the voice carries as well as on the usual wire tele-phone. The telephone system uses about one-fourth of an ampere.

"I am working on a new theory in electricity, and in wireless. I think the accepted principle of the waves is only part of the story. There is something else. It is that something else that I am utilizing. There is no supplementary current in this system as in the usual wireless operation. fliere is no static and no interruption."

An umbrella, Mr. Macfarlane explains,

will serve as well as a rifle for an aerial. A plain citizen carrying a small handbag containing the compact wireless outfit and with his umbrella held aloft can walk along the street talking with friend wife at the

house at the other end of the city," he said.
"How costly would this outlit be?" he was asked.

Nothing new is used," he explained. "All the apparatus fits in with existing devices. Everything needed for the outst could be bought for probably \$15."

"My apparatus here is rather crude and not all the quality of current is obtained that I can get," he continued. "But it is no wild dream to say that a man riding on a train to New York can telephone his wife about bringing a friend home for dinner thus far before very long. This apparatus here needs improvement, but it demonstrates the practicability of the thing. Even now I can connect up the end of the wire-less in the house with the existing telephone system and thus can talk from my automobile with any person in the city."

SECTION 4

ARTICULATE AERIALS

THE TESLA CONDENSER-MAGNET.

In electric apparatus or systems in which alternating currents are employed, the self-induction of the coils or conductors in many cases operates disadvantageously by giving rise to false currents which often reduce the commercial efficiency of the apparatus or operate detrimentally in

other respects.

The effects of such self-induction, as is well known, can be neutralized by proportioning to a proper degree the capacity of the circuit with relation to the self-induction and frequency of the currents. This has been accomplished heretofore by the use of condensers applied as separate instruments. In order to avoid the employment of condensers, which involve additional expense, Mr. Nikola Tesla has devised a method of constructing the coils themselves so as to accomplish the same object as the condensers.

Mr. Tesla had found some years ago that in every coil there exists a certain relation between its self-induction and capacity that permits a current of given frequency and potential to pass through it with no other opposition than that of ohmic resistance, or, in other words, as though it possessed no self-induction. This is due to the mutual relations existing between the special character of the current and the self-induction and capacity of the coil, the latter quantity being just capable of neutralizing the self-induction for that frequency.

It is well known that the higher the frequency or potential difference of the current, the smaller the capacity required to counteract the self-induction; hence, in any coil, however small the capacity, it may be sufficient for the purpose stated if the proper conditions in other respects be secured. In the ordinary coils the difference of potential between adjacent turns or spires is very small, so that

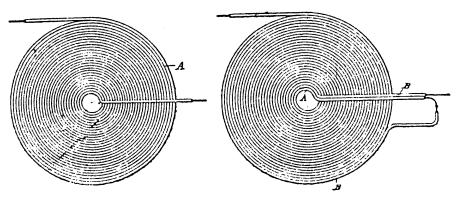
while they are in a sense condensers, they possess but very small capacity and the relations between the two quantities, self-induction and capacity, are not such as under any ordinary conditions satisfy the requirements contemplated by Mr. Tesla, because the capacity relatively to the self-induction is very small.

In order to attain his object and to properly increase the capacity of any given coil, Mr. Tesla winds it in such a way as to secure a greater difference of potential between its adjacent turns, and since the energy stored in the coil—considering the latter as a condenser—is proportional to the square of the potential difference between its adjacent convolutions, it is evident that in this way he may secure, by a proper disposition of these convolutions, a greatly increased capacity for a given increase in potential difference between the turns. The accompanying drawings show the general nature of the plan which he has adopted for carrying out this idea.

Fig. 1 is a diagram of a coil wound in the ordinary manner, while Fig. 2 shows the winding designed to secure the

objects Mr. Tesla is aiming at.

In Fig. 1, A designates any coil the convolutions of which are wound insulated in the usual way. Let it be assumed that the terminals of this coil show a potential difference of 100 volts, and that there are 1,000 convolutions; then considering any two contiguous points on



Figs. 1 and 2.—The Tesla Condenser-Magnet.

adjacent convolutions let it be assumed that there will exist between them a potential difference of one-tenth of a volt.

If now, as shown in Fig. 2, a conductor B be wound parallel with the conductor A and insulated from it, and

If now, as shown in Fig. 2, a conductor B be wound parallel with the conductor A and insulated from it, and the end of A be connected with the starting point of B, the aggregate length of the two conductors being such that the assumed number of convolutions or turns is the same, viz., 1,000, then the potential difference between any two adjacent points in A and B will be 50 volts, and as the capacity effect is proportional to the square of this difference, the energy stored in the coil as a whole will now be

250,000 times as great.

Based on this principle, any given coil may be wound either in whole or in part, not only in the exact manner illustrated, but in a great variety of ways, so as to secure between adjacent convolutions such potential difference as will give the proper capacity to neutralize the self-induction for any given current that may be employed. Capacity secured in this particular way possesses an additional advantage in that it is evenly distributed, a consideration of the greatest importance in many cases, and the results both as to efficiency and economy are more readily and easily obtained as the size of the coils, the potential difference, or frequency of the currents are increased.

(No Model.)

N. TESLA. COIL FOR ELECTRO MAGNETS.

No. 512,340.

Patented Jan. 9, 1894.



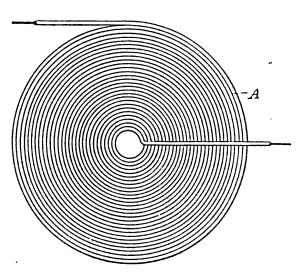
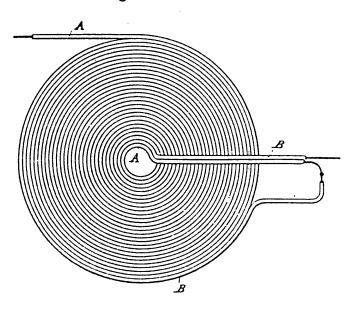


Fig. 2



Witnesses Raphael Netter James W. Listlaw Inventor Mkola Ilela Duulan Pagel.



United States Patent Office.

NIKOLA TESLA, OF NEW YORK, N. Y.

COIL FOR ELECTRO-MAGNETS.

SPECIFICATION forming part of Letters Patent No. 512,340, dated January 9, 1894.

Application filed July 7, 1893. Serial No. 479.804. (No model.)

To all whom it may concern:

Beit known that I, NIKOLA TESLA, a citizen of the United States, residing at New York, in the county and State of New York, have in-5 vented certain new and useful Improvements in Coils for Electro-Magnets and other Apparatus, of which the following is a specification, reference being had to the drawings accompanying and forming a part of the same.

In electric apparatus or systems in which alternating currents are employed the selfinduction of the coils or conductors may, and, in fact, in many cases does operate disadvantageously by giving rise to false currents 15 which often reduce what is known as the commercial efficiency of the apparatus composing the system or operate detrimentally in other respects. The effects of self-induction, above referred to, are known to be neutralized by 20 proportioning to a proper degree the capacity of the circuit with relation to the self-induction and frequency of the currents. This has been accomplished heretofore by the use of condensers constructed and applied as sepa-25 rato instruments.

My present invention has for its object to avoid the employment of condensers which are expensive, cumbersome and difficult to maintain in perfect condition, and to so con-30 struct the coils themselves as to accomplish

the same ultimate object.

I would here state that by the term coils I desire to include generally helices, solenoids, or, in fact, any conductor the different parts 35 of which by the requirements of its application or use are brought into such relations with each other as to materially increase the self-induction.

I have found that in every coil there exists 45 a certain relation between its self-induction and capacity that permits a current of given frequency and potential to pass through it with no other opposition than that of ohmic resistance, or, in other words, as though it pos-45 sessed no self-induction. This is due to the mutual relations existing between the special character of the current and the self-induction and capacity of the coil, the latter quautity being just capable of neutralizing the 50 self-induction for that frequency. It is wellknown that the higher the frequency or po-

the capacity required to counteract the selfinduction; hence, in any coil, however small the capacity, it may be sufficient for the pur- 55 pose stated if the proper conditions in other respects be secured. In the ordinary coils the difference of potential between adjacent turns or spires is very small, so that while they are in a sense condensers, they possess but very so small capacity and the relations between the two quantities, self-induction and capacity, are not such as under any ordinary conditions satisfy the requirements herein contemplated, because the capacity relatively to the 65 solf-induction is very small.

In order to attain my object and to properly increase the capacity of any given coil, I wind it in such way as to secure a greater difference of potential between its adjacent turns 70 or convolutions, and since the energy stored in the coil-considering the latter as a condenser, is proportionate to the square of the potential difference between its adjacent convolutions, it is evident that I may in this way 75. secure by a proper disposition of these convolutions a greatly increased capacity for a given increase in potential difference between the turns.

I have illustrated diagrammatically in the 85 accompanying drawings the general nature of the plan which I adopt for carrying out this invention.

Figure 1 is a diagram of a coil wound in the ordinary manner. Fig. 2 is a diagram of 85 a winding designed to secure the objects of

my invention.

Let A, Fig. 1, designate any given coil the spires or convolutions of which are wound upon and insulated from each other. Let it 90 be assumed that the terminals of this coil show a potential difference of one hundred volts, and that there are one thousand convolutions; then considering any two contiguous points on adjacent convolutions let it be 95 assumed that there will exist between them a potential difference of one-tenth of a volt. If now, as shown in Fig. 2, a conductor B bo wound parallel with the conductor A and insulated from it, and the end of A beconvected 100 with the starting point of B, the aggregate length of the two conductors being such that the assumed number of convolutions or turns tential difference of the current the smaller is the same, viz., one thousand, then the po-





512,340

tential difference between any two adjacent points in A and B will be fifty volts, and as the capacity effect is proportionate to the square of this difference, the energy stored 5 in the coil as a whole will now be two hundred and fifty thousand as great. Following out this principle, I may wind any given coil either in whole or in part, not only in the specific manner herein illustrated, but 10 in a great variety of ways, well-known in the art, so as to secure between adjacent convolutions such potential difference as will give the proper capacity to neutralize the self-induction for any given current that may be 15 employed. Capacity secured in this particular way possesses an additional advantage in that it is evenly distributed, a consideration of the greatest importance in many cases, and the results, both as to efficiency and economy, 20 are the more readily and easily obtained as the size of the coils, the potential difference, or frequency of the currents are increased.

Coils composed of independent strands or conductors wound side by side and connected 25 in series are not in themselves new, and I do not regard a more detailed description of the same as necessary. But heretofore, so far as I am aware, the objects in view have been essentially different from mine, and the results l

which I obtain even if an incident to such 30 forms of winding have not been appreciated

or taken advantage of.

In carrying out my invention it is to be observed that certain facts are well understood by those skilled in the art, viz: the re- 35 lations of capacity, self-induction, and the frequency and potential difference of the current. What capacity, therefore, in any given case it is desirable to obtain and what special winding will secure it, are readily determin- 40 able from the other factors which are known.

What I claim as my invention is-1. A coil for electric apparatus the adjaent convolutions of which form parts of the circuit between which there exists a potential 45 difference sufficient to secure in the coil a capacity capable of neutralizing its self-induction, as hereinbefore described.

2. A coil composed of contiguous or adjacent insulated conductors electrically con- 50 nected in series and having a potential difference of such value as to give to the coil as a whole, a capacity sufficient to neutralize its self-induction, as set forth.

NIKOLA TESLA.

Witnesses:

ROBY. F. GAYLORD, PARKER W. PAGE.





No. 624,516.

Patented May 9, 1899.

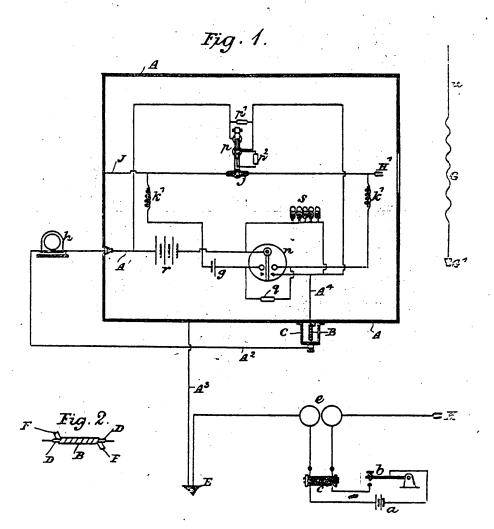
G. MARCONI.

APPARATUS EMPLOYED IN WIRELESS TELEGRAPHY.

(Application filed Jan. 5, 1899.)

(No Model.)

2 Sheets-Sheet 1.



Witnesses. A.TH. Oznkins Era Balloza

THE PERSON NAMED IN COLUMN

Inventor. Guglielmo Marconio, By his Attorneys, Redui Saiden Might

No. 824,518.

Patented May 9, 1899.

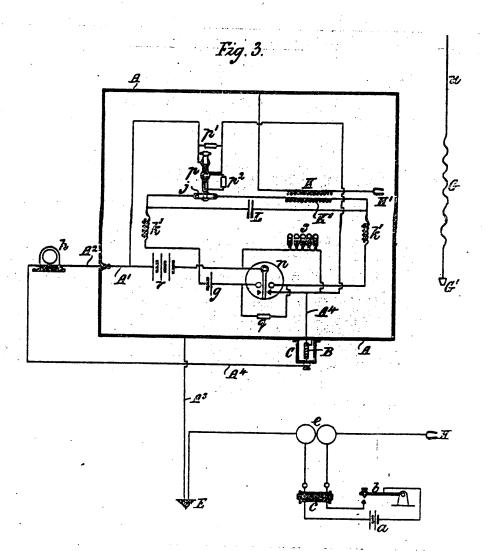
G. MARCONI.

APPARATUS EMPLOYED IN WIRELESS TELEGRAPHY.

(Application fled Jan. 5, 1899.)

(No Model.)

2 Shcets-Sheet 2.



Mitnesses. Mrst. Foster Des Riva Treglishus Marconi by his attorneys Baldwin, Dandson Wiffel

United States Patent

GUGLIELMO MARCONI, OF LONDON, ENGLAND, ASSIGNOR TO THE WIRELESS TELEGRAPH AND SIGNAL COMPANY, LIMITED, OF SAME PLACE.

APPARATUS EMPLOYED IN WIRELESS TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 624,516, dated May 9, 1899. Application filed January 5, 1899. Serial No. 701,250. (No model.)

To all whom it may concern:

Be it known that I, GUGLIELMO MARCONI, electrician, a subject of the King of Italy, residing at 28 Mark Lane, in the city of Lon-5 don, England, have invented certain new and useful Improvements in Apparatus Employed in Wireless Telegraphy, of which the follow-

ing is a specification.

In the specification of a former patent 10 granted to me, No. 586,193, I described an arrangement in which the transmitter consisted of a sparking appliance having one terminal connected to an insulated conductor in the air and the other terminal to earth, while the 15 receiver contained a sensitive tube or sensitive imperfect contact having one end connected to a similar conductor and the other end to earth. When both instruments are employed at the same station, it is found that 20 the sensitive tube or sensitive imperfect contact is liable to injury by its close proximity to the sparking appliance. In order to obviate this objection, I inclose the receiver containing the sensitive tube or sensitive imperfect 25 contact in a box of metal having only a small opening into it, and I employ the same conductor and earth-plate for both instruments. The earth-plate is permanently connected to one terminal of the sparking appliance and to the 30 outside of the box. The insulated conductor can be connected by a plug either to the other terminal of the sparking appliance or to the other end of the imperfect contact. Where a recording instrument is employed, this can-35 not conveniently be placed inside the box, and in order to prevent the wires connecting it to the relay of the receiver from leading injurious oscillations to the sensitive tube I adopt the following arrangement: One terminal of the relay-circuit is connected to the inside of the box and one terminal of the recording instrument to the outside. The ends of the wires from the other terminals of the relay-circuit and recording instrument are 45 connected to the ends of a coil formed from an insulated wire covered with tin-foil. This coil is outside the box, and the tin-foil is in electrical communication with it.

Figure 1 is a diagram of a combined transp mitting and receiving station arranged in

the wire of which the coil B is made. Fig. 3 is a diagram similar to Fig. 1, showing a modification.

The letters, so far as they are applicable, 55 are the same as those employed in the former

specification.

a is a battery, and b an ordinary Morse key closing the circuit through the primary of a Ruhmkorff coil c, the terminals of the second- 60 ary being connected to metallic balls e. g is a battery, and h a telegraphic instrument on the derived circuit of a relay n. j is a glass tube containing metallic powder. k' are choking-coils in the circuit through the tube. p 65 is a trembler on the relay-circuit for tapping the tube. q is a resistance-coil. r is a battery in the relay-circuit. p' is a resistance inserted in derivation across the terminals of the trembler p, and p^2 is a resistance in a circuit 70 connecting the vibrating contacts of the trembler. s is a resistance across the terminals of the relay-circuit. u is an aerial conductor. These arrangements are now well known and are fully described in my former 75 specification.

According to my present invention Linclose the receiver in a metallic box A. One-twentieth of an inch is a suitable thickness for the metal. The inside of the box is connected 80 by a wire A' to the relay-circuit and its outside by wires $A^2 A^3$ to one terminal of the telegraphic instrument h and earth E, respectively. The other branch of the relay-circuit is connected by a wire A4, insulated from the 85 box, to the other terminal of the instrument h.

B is a coil on the wire A' and outside the box. It is protected from mechanical injury by a wooden case C; but this may be omitted. The coil B may contain about twenty 90 yards of wire one seventy-fifth of an inch in diameter and have one hundred and twenty turns. The wire is insulated with guttapercha D, which is covered with tin-foil F, as shown in Fig. 2. The tin-foil is in electric 95 connection with the box. The coil B prevents oscillations of the transmitter from reaching the coherer at the same station through the wire A4. The aerial conductor u can be connected by a flexible conductor, 100 plug G', and spring-contacts H and H' either accordance with this invention. Fig. 2 shows | to one of the balls e for transmisting or to

one end of the tube j for receiving. The other end of the tube j is connected by a wire J to the inside of the box.

The aerial conductor need not be insulated, 5 as shown, but may be connected to earth through the primary of an induction-coil, the ends of the secondary of which are connected to the terminais of the receiver. This arrangement is shown in Fig. 3. The contact to II', in place of being connected to the end of the tube j, connected to the inside of the box through primary K of an inductioncoil, while the two ends of the tube j are connected to the secondary K' of the coil. L is 15 a condenser in a shunt across the wire leading from the tube j to the coils k'. In other respects the arrangement is the same as that shown in Fig. 1, and the parts are marked with the same letters.

What I claim is—

1. The combination of a transmitter, a receiver, an aerial conductor, a metallic box containing the receiver, earth connections to one terminal of the transmitter and to the serial conductor either to the other terminal of the transmitter or to one terminal of the receiver and a connection between the other terminal of the receiver and the box.

2. The combination of a transmitter, a receiver, an aerial conductor, a metallic box containing the receiver, earth connections to one terminal of the transmitter and to the box, an interchangeable connection from the

aerial conductor either to the other terminal of the transmitter or to one terminal of the receiver, a connection between the other terminal of the receiver and the box, a relay operated by the receiver, a telegraph instrument outside the box, a connection between 40 the box and one terminal of the relay, a connection between the box and one terminal of the telegraph instrument and a connection insulated from the box between the other terminals of the relay and telegraph instrument.

3. The combination of a transmitter, a receiver, an aerial conductor, a metallic box containing the receiver, earth connections to one terminal of the transmitter and to the box, an interchangeable connection from the 50 aerial conductor either to the other terminal of the transmitter or to one terminal of the receiver, a connection between the other terminal of the receiver and the box, a relay operated by the receiver, a telegraph instru- 55 ment outside the box, a connection between the box and one terminal of the relay, a connection between the box and one terminal of the telegraph instrument, a connection insulated from the box between the other termi- 60 nals of the relay and telegraph instrument, a coil of insulated wire outside the box in the latter connection and a metallic covering to the insulation in connection with the box.

GUGLIELMO MARCONI.

Witnesses:

ROBERT B. RANSFORD, JOHN H. WHITEHEAD. No. 650,109.

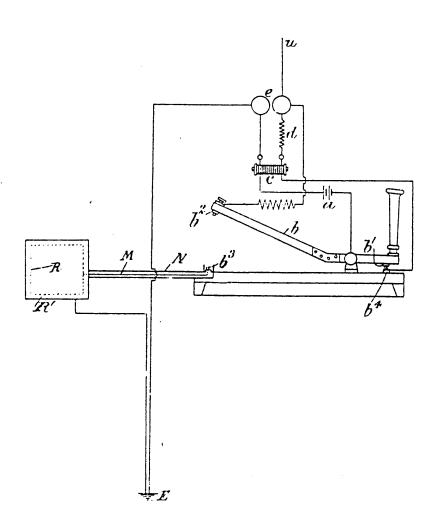
Patented May 22, 1900.

G. MARCONI.

APPARATUS EMPLOYED IN WIRELESS TELEGRAPHY.

(Application filed Oct. 12, 1890.)

(No Model.)



Wilnesses C.D. Ladley TG. Ring

Greglielnes Marconic Ly his attorneys Paridon Hilligh

United States Patent Office.

GUGLIELMO MARCONI, OF LONDON, ENGLAND, ASSIGNOR TO THE WIRELESS TELEGRAPH AND EIGNAL COMPANY, LIMITED, OF SAME PLACE.

APPARATUS EMPLOYED IN WIRELESS TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 650,109, dated May 29, 1909. Application Sted Coteber 12, 1889. Serial No. 733,413. (No model.)

To all whom it may concern:

Be it known that I. Gugi ielmo Marconi. olectrician, a subject of the King of Italy, residing at 28 Mark Lane, in the city of London, 5 England, have invented certain new and useful Apparatus Employed in Wireless Telegraphy, of which the following is a specification.

In the specification of a former patent, dated the 13th day of July, 1897, No. 586,193, an arto rangement is described in which the transmitter consisted of a sparking appliance having one terminal connected to an insulated conductor in the air and the other terminal to earth, while the receiver contained a sen-15 sitive tube or sensitive imperfect contact having one end connected to a similar conductor and the other end to earth. It is found that the aerial conductor sometimes becomes charged with atmospheric electricity, and when the so same conductor is used both for transmitting and receiving this electricity discharges through the operator when he shifts the conductor from the transmitter to the receiver or through the imperfect contact when the 25 conductor is shifted from one instrument to the other, and this is liable to give a shock to the operator or to injure the imperfect con-

The object of this invention is to remove 30 this inconvenience and also to reader it impossible for the operator to accidentally operate his transmitter, and thereby cause a spark when the aerial conductor at his station is connected to the receiver, which might 35 injure the imperfect contact.

According to this invention the aerial conductor is permanently connected to one terminal of the sparking appliance, and therefore if a Ruhmkorff coil or transformer is 40 used the serial conductor will be connected to earth through its secondary winding, thus preventing the accumulation of atmospheric electricity in it, while it is found that the electrical oscillations falling upon it from the 45 transmitter of the correspondent station cannot readily traverse the convolutions of the coil, but prefer to pass to earth through the receiver when the said serial wire is connected to it. The signals are sent, as before,

circuit through the primary of the Ruhmkorff coil or transformer.

According to this invention the srm of the key is prolonged beyond its pivot and carries an insulated terminal which is permanently 55 connected to the terminal of the sparking appliance, and therefore to the aerial conductor. Below this terminal there is on the base of the instrument the terminal of the receiver. The arm is so arranged that immediately it 60 is released by the operator after sending a message it turns about on its pivot, bringing the above-mentioned conductors together, thus connecting the receiver to the serial con-

The drawing is a diagram of a combined transmitting and receiving station arranged in accordance with this invention.

The letters, so far as they are applicable, are the same as those employed in the former 70 specification.

a is a battery, and b an ordinary Morse key closing the circuit through the primary of a Ruhmkorff coil c, the terminals of the secondary being connected to metallic balls e. 75 The serial conductor u is permanently connected to one of the balls e, the other being connected to earth E. The key b has two contacts b' b', insulated from each other. The diagram shows the key in the position for 30 sending, the contact b' touching the contact b' and closing the circuit of the battery a through the primary of the induction-coil c. Immediately the key is released by the operator its longer arm falls by its own woight, 85 the contact be descending onto the contact o, which is connected to the receiver R by the wire M.

It is found advantageous to insert an impedance-coil d between the terminal of the in- 90 duction-coil used for sending and the sphere, which is connected to the aorial conductor.

The receiver R is inclosed in a box R'_i of conducting material, and may be such and so connected as is described in my former United 05 States patent, No. 024,516. The invention can also be applied to receivers described in the specification of the patent dated the 13th day of July, 1897, No. 586,193. The means 30 by means of a Mores key in a local-battery | adopted for protecting the receiver are profit 300

> 100

crably those described in the specification of | circuit with the primary, an aerial conductor the patent detect the 27th day of June, 1899, | connected to one terminal of the secondary, the patent dated the 27th day of June, 1899, No. 627,650. The wire connecting the recoiver to the terminal on the base of the key 5 should preferably be inclosed in a metal tube If to protect it from the cacillations of the local transmitter, and the tube N should be electrically connected to the box B'. This invention is ale 'applicable if the earth con-10 nection is substit. ... ad by a capacity area. In this case the especities of the transmitter and receiver should preferably be connected to-

I claim

1. The combination of the primary and secordery of c sparking appliance, a battery and key in circuit with the primary, an aerial con-ductor counceted to one terminal of the secordary, a receiver, means for connecting the so said terminal to the receiver and a capacity connected to the other terminal.

2. The combination of the primary and secordary of a sparking appliance, a battery and key in circuit with the primary, an aerial con-ductor connected to one terminal of the sec-ondary, a receiver, means for connecting the said terminal to the receiver and an earth connection connected to the other terminal.

8. The combination of the primary and sec-30 ondaty of a sparking appliance, a battery in

a capacity connected to the other terminal, a receiver, two fixed contacts one connected to one terminal of the primary and the other to 35 the receiver, a pivoted arm and two contacts on the arm insulated from each offier and opposite the fixed contacts one being connected to the other terminal of the primary and the other to that terminal of the secondary which 40 is connected to the serial conductor.

4. The combination of the primary and secondary of a sparking appliance, a battery in circuit with the primary, an aerial conductor connected to one terminal of the secondary, 45 an earth connection connected to the other terminal, a receiver, two fixed contacts cae connected to one terminal of the primary and the other to the receiver, a pivoted arm and two contacts on the arm insulated from each 50 other and opposite the fixed contacts one being connected to the other terminal of the primary and the other to that terminal of the secondary which is connected to the serial conductor.

GUGLIELMO MARCONI.

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١, ١٧ TOES: LAROLD G. VILLARD, EDWARD C. DAVIDSON. No. 650,110.

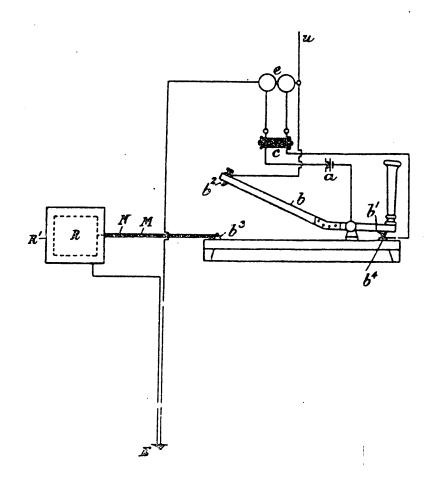
Patontod May 22, 1900.

6. MARCONI.

APPARATUS EMPLOYED IN WIRELESS TELEGRAPHY

(Applienties filed Dec. 28, 1003.

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UNITED STATES PATENT OFFICE.

GUGLIELMO MARCONI, OF LONDON, ENGLAND, ASSIGNOR TO THE WIRELESS TELEGRAPH AND SIGNAL COMPANY, LIMITED, OF SAME PLACE.

APPARATUS EMPLOYED IN WIRELESS TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 650,110, dated May 22, 1900.

Application filed December 28, 1899. Serial No. 741,820. (No model.)

To all whom it may concern:

Be it known that I, GUGLIELMO MARCONI, electrician, a subject of the King of Italy, residing at 28 Mark Lane, in the city of London, England, have invented certain new and useful Apparatus Employed in Wireless Telegraphy, of which the following is a specification.

In the specification of a former patent, dated the 13th day of July, 1897, No. 586, 193, an arrangement is described in which the transmitter consisted of a sparking appliance having one terminal connected to an insulated conductor in the air and the other terminal to earth, while the receiver contained a sensitive tube or sensitive imperfect contact having one end connected to a similar conductor and the other end to earth. It is found that the aerial conductor sometimes becomes charged with atmospheric electricity, and when the

20 same conductor is used both for transmitting and receiving this electricity discharges through the operator when he shifts the conductor from the transmitter to the receiver or through the imperfect contact when the conductor is shifted from one instrument to the other, and this is liable to give a shock to the operator or to injure the imperfect contact.

The object of this invention is to remove this inconvenience and also to render it impossible for the operator to accidentally operate his transmitter, and thereby cause a spark when the abrial conductor at his station is connected to the receiver, which might injure the imperfect contact.

According to this invention the aerial conductor is led in close proximity to one terminal of the sparking appliance, and therefore if a Ruhmkorff coil or transformer is used the aerial conductor can discharge itself through the small spark-gap to earth through the secondary winding, thus preventing the accumulation of atmospheric electricity in it. The signals are sent as before, by means of a Morse key in a local-battery circuit, through the primary of the Ruhmkorff coil or transformer. According to this invention the arm of the key is prolonged beyond its pivot and carries an insulated terminal, which is permanently

this terminal there is on the base of the instrument the terminal of the receiver. The arm is so arranged that immediately it is released by the operator after sending a message it turns about on its pivot, bringing the above-mentioned conductors together, thus 55 connecting the receiver to the aerial conductor.

The drawing is a diagram of a combined transmitting and receiving station arranged in accordance with this invention.

The letters, so far as they are applicable, are the same as those employed in the former specification.

a is a battery, and b an ordinary Morse key closing the circuit through the primary of a 65 Ruhmkorff coil c, the terminals of the secondary being connected to metallic balls c.

The aerial conductor u is led in close proximity to, say, within one centimeter of one of the balls e, the other being connected to earth 70 E. The key b has two contacts b' b^2 , insulated from each other. The diagram shows the key in the position for sending, the contact b' touching the contact b' and closing the circuit of the battery a through the primary 75 of the induction-coil c. Immediately the key is released by the operator its longer arm falls by its own weight, the contact b^2 deseending onto the contact b^a , which is connected to the receiver R by the wire M. The So receiver R is inclosed in a box R' of conducting material and may be such and so connected as is described in my former United States patent, No. 624,516. The invention can also be applied to receivers, as described 85 in the specification of the patent dated the 13th day of July, 1897, No. 586,193. The means adopted for protecting the receiver are preferably those described in the specification of the patent dated the 27th day of June, 90 1899, No. 627,650. The wire connecting the receiver to the terminal on the base of the key should preferably be inclosed in a metal tube N to protect it from the oscillations of the local transmitter, and the tube N should 95 be electrically connected to the box R.

an insulated terminal, which is permanently | This invention is also applicable if the earth connected to the aerial conductor. Below connection is substituted by a capality area.

In this case the capacities of the transmitter and receiver should preferably be connected together.

What I claim is—

1. The combination of the primary and secondary of a sparking appliance, a battery and key in circuit with the primary, an aerial conductor led in close proximity to one terminal of the secondary, means for connecting the said aerial conductor to the receiving instrument, and capacity connected to the other terminal.

2. The combination of the primary and secondary of a sparking appliance, a battery and key in circuit with the primary, an aerial conductor led in close proximity to one terminal of the secondary, means for connecting the said aerial conductor to the receiving instrument, and an earth connection connected to the other terminal.

3. The combination of the primary and secondary of a sparking appliance, a battery in circuit with the primary, an aerial conductor led in close proximity to one terminal of the 25 secondary, a capacity connected to the other

terminal, a receiver, two fixed contacts one' connected to one terminal of the primary and the other to the receiver, a pivoted arm and two contacts on the arm insulated from each other and opposite the fixed contacts one being connected to the other terminal of the primary and the other to the aerial conductor.

4. The combination of the primary and secondary of a sparking appliance, a battery in circuit with the primary, an aerial conductor led in close proximity to one terminal of the secondary, an earth connection connected to the other terminal, a receiver, two fixed contacts one connected to one terminal of the primary and the other to the receiver, a pivoted arm and two contacts on the arm insulated from each other and opposite the fixed contacts one being connected to the other to the aerial conductor.

GUGLIELMO MARCONI.

Witnesses: HENRY W. ALL

HENRY W. ALLEN, GEO. J. B. FRANKLIN. No. 711,130.

Patented Oct. 14, 1902.

WIRELESS TELEGRAPHY. (Application filed Oct. 16, 1901.)

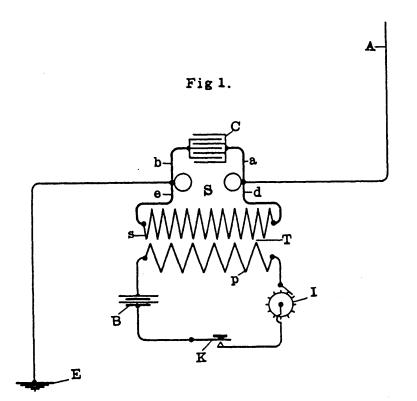
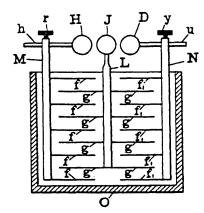


Fig 2.



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hy Harry Shoemaker borneline D. Chret hu attorney

United States Patent

HARRY SHOEMAKER, OF PHILADELPHIA, PENNSYLVANIA, ASSIGNOR OF ONE-HALF TO THE AMERICAN WIRELESS TELEPHONE AND TELEGRAPH COMPANY, OF PHILADELPHIA, PENNEYLVANIA.

WIRELESS TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 711,130, dated October 14, 1902.

Application filed October 16, 1901. Serial No. 78,874. (No model.)

To all whom it may concern:

Be it known that I, HARRY SHOEMAKER, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and 5 State of Pennsylvania, have invented certain new and useful Improvements in Wireless Signaling Systems, of which the following is a specification.

This invention relates to wireless signaling 10 systems in which the signal or message is represented by electroradiant energy and is transmitted through the natural media.

This invention relates more particularly to the transmitting apparatus, especially the 15 circuit arrangements thereof, whereby efficient transmission is attained.

More particularly, it relates to the disposition of a capacity or condenser with relation to the usual spark-gap of an oscillator, where-20 by great efficiency in the transmitting apparatus is attained.

My invention consists also of a disposition of a condenser with relation to the radiatingcircuit whereby a great amount of energy 25 may be radiated in a certain interval of time, and whereby the transmitting-transformer may be caused to deliver at the spark-gap more energy than has heretofore been possible.

It has heretofore been the custom in wireless signaling systems to insert in the aerial radiating-conductor a spark-gap in shunt to which is the secondary winding of the usual transmitting coil or transformer. By this 35 arrangement it was seldom possible to radiate as electromagnetic waves as much energy as the transformer was able to supply in case it were used in the arts of electric lighting or power transmission. In other words, it was 4c impossible to load the transformer to a point anywhere near its capacity.

By the employment of a properly-proportioned condenser in shunt to the spark-gap I have been enabled to get results with an aerial 45 conductor of a certain size and a transformer

of a certain capacity which I have mover been able to attain without the use of such condenser. I connect the armatures of the condenser to the spark-gap terminals by a direct in such circuit under a predetermined elec-

which are very short and thick—thereby avoiding any inductance in such connections. If long conductors of small diameter were employed for such connections, considerable inductance would be present and my system 55 would operate differently on a different principle and produce different results.

Reference is to be had to the accompanying

drawings, in which-

Figure 1 is a diagrammatic view of the cir- 60 cuits of my transmitting apparatus. Fig. 2 is a view of a special type of condenser which I have employed in the system herein described.

A represents the aerial radiating-conductor, 65 between which and the earth-plate E is the spark-gap S. In shunt to this spark-gap S is connected the secondary s of the transformer T by means of the conductors c and d.

At p is shown the primary of the trans- 70 former T, and in circuit with such primary is the source of energy B, operator's key K, and the interrupter I.

In shunt to the spark-gap S there is connected also the condenser C by means of the 75 short thick conductors a and b. These conductors in virtue of their dimensions possess negligible self-induction, and the result is, for all practical purposes, that the armatures of the condenser C are in direct communica- 80 tion with the terminals of the spark-gap.

The conductors d and e are shown on the drawings as of large diameter, but such dimensions are unnecessary. It is immaterial whether or not the conductors d and e possess 85 self-induction, because they are, in fact, a portion of the secondary winding s, which has very great self-induction. The presence of the condenser in shunt to the spark-gap S means also, in the arrangement of circuits 90 shown, that the condenser C is also in the circuit of the secondary winding s. The condenser C operates, therefore, as a condenser connected in series in a circuit with an inductance, and therefore operates, as is well un- 95 derstood in the art of fluctuating or alternating currents, to counteract the effect of the inductance and permit a larger current-flow 50 connection—that is, by means of conductors | trical pressure. In other words, the con- 100

denser C operates to permit the flow of a p greater amount of energy from the transformer than would be possible were such condenser absent. Furthermore, the presence 5 of the condenser in the disposition shown in the aerial circuit causes also a great amount of energy to be radiated as electromagnetic waves in a definite interval of time. The condensor C is, in fact, a part of the radiat-10 ing-circuit, and because the connections from the condenser to the terminals of the sparkgap possess an inductance or self-induction which is practically nil the condenser is not in a local freely-oscillating circuit, which would 15 then set the period of the oscillations in the aerial conductor and which would determine the period of the electromagnetic waves. By my system, therefore, with a transmittingtransformer of definite capacity and with the 20 radiating-circuit of certain dimensions it is possible to radiate a greater amount of electromagnetic-wave energy in a definite interval of time, due to loading the transformer to a higher point than heretofore, and by the 25 disposition of the condenser in the aerial circuit, which causes it to radiate great amounts of energy in very few oscillations.

The condenser shown in Fig. 2 is contained in a vessel O, containing a liquid dielectric. 30 M is a post which is in electrical communication with the leaves I, forming one armature of the condenser. N is a post in electrical communication with the leaves f, forming another armature of the condenser. In 35 the top of post M may be adjusted the rod h_i which carries at its end the spark-ball II. Through the top of post N passes the rod n_i which carries at its end the spark-ball D. The rods h and u are clamped in position by 40 the thumb-screws r and y, respectively. Between the spark-balls II and D is a third spark-ball J, mounted at the upper end of the rod L, which is in electrical communication with the leaves of the condenser q. In practice the aerial conductor is con-

connection is made directly to the rod M.

It is to be understood that the condenser shown in Fig. 2 is not necessary in my system, though it produces advantageous results. As shown in Fig. 1, the ordinary type condenser may be used, but is preferably adjustable for the purpose of obtaining the proper relation with respect to the aerial scircuit and with respect to the secondary of the transformer. It is to be understood also that in place of the battery B and interrupter I in the primary of the transformer T there may be used, and it is the preferable arrangement, a source of true alternating currents.

nected directly to the rod N, while the earth

What I claim is—
1. In a wireless signaling system, an aerial conductor, a spark-gap in series therewith, a source of energy in shunt with said spark-65 gap, and a condenser directly connected in shunt to said spark-gap.

2. In a wireless signaling system, a radiating-conductor, a spark-gap in series therewith, a condenser directly connected in shunt to said spark-gap, and a source of energy in 70 connection with said spark-gap.

3. In a wireless signaling system, a radiating-conductor, a capacity in series therewith, a spark-gap having its terminals in direct connection with the terminals of the capacity, and a source of energy connected across the terminals of said spark-gap.

4. In a wireless signaling system, a radiating-conductor, a spark-gap associated therewith, a source of energy in shunt to said spark-80 gap, and a condenser having its armatures in direct connection with the terminals of said spark-gap.

5. In a wireless signaling system, a radiating-conductor, a large capacity in series 8; therewith, and a spark-gap directly in shunt to said capacity.

6. In a wireless signaling system, a radiating-conductor, a capacity in series therewith, a spark-gap, conductors of negligible 90 inductance joining the terminals of said capacity with the terminals of said spark-gap, and a source of energy in shunt to said spark-gap.

7. In a wireless signaling system, a trans- 95 mitting-circuit comprising a source of energy, a spark-gap in connection with said source, and a condenser having its armatures in direct connection with the terminals of said spark-gap.

8. In a wireless signaling system, a radiating-circuit comprising a conductor, a sparkgap in series therewith, and a condenser connected to the terminals of said spark-gap by conductors having negligible inductance.

9. In a wireless signaling system, a radiating-conductor, a spark-gap in series therewith, a large capacity in shunt to said spark-gap by conductors whose self-induction is practically *nil*, and a source of energy in 110 shunt to said spark-gap.

10. In a wireless signaling system, a transmitting-transformer, a radiating-conductor, a capacity in series with said radiating-conductor, and a spark-gap connected in shunt 115 to said capacity by conductors of negligible inductance.

11. In a wireless signaling system, a radiating-conductor, a large capacity in series therewith, and a spark-gap in direct connection with the terminals of said capacity.

12. In a wireless signaling system, a radiating-conductor, a plurality of spark-gaps in series therewith, and a condenser connected in shunt to each spark-gap by connections 125 whose self-induction is practically nil.

In testimony whereof I affix my signature in presence of two witnesses.

HARRY SHOEMAKER.

Witnesses:

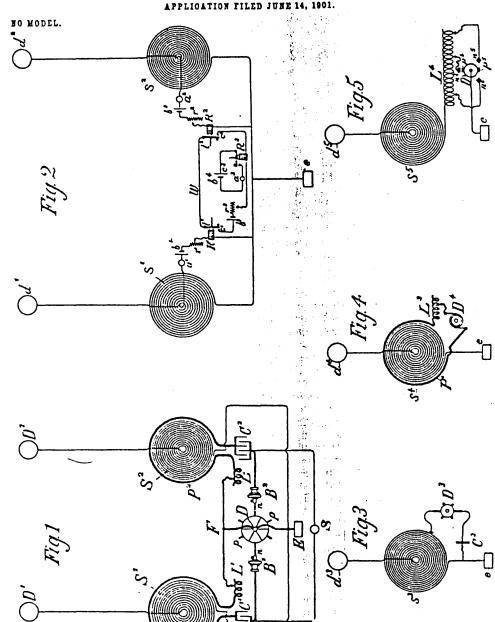
E. B. HUME, R. LEAMAN. 道

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No. 723,188.

PATENTED MAR. 17, 1903.

N. TESLA.
METHOD OF SIGNALING.



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en is of the NIKOLA TESLA, OF NEW YORK, N. Y.

METHOD OF SIGNALING.

SPECIFICATION forming part of Letters Patent No. 723,188, dated March 17, 1903. Original application filed July 16, 1900, Serial No. 23,847. Divided and this application filed June 14, 1901. Serial No. 64,522. (No model.)

To all whom it may concern:

Be it known that I, NIKOLA TESLA a citizen of the United States, residing in the borough of Manhattan, in the city, county, and 5 State of New York, have invented certain new and useful Improvements in Mothods of Signaling, of which the following is a specification, reference being had to the drawings accompanying and forming a partiof the

to same. In certain systems for transmitting intelligible messages or governing the movements and operations of distant automata electrical impulses or disturbances produced by suit-15 able apparatus are conveyed through the natural media to a receiving-circuit capable of responding to the impulses, and thereby effecting the control of other appliances. Generally a special device, highly sensitive, is 20 connected to the receiving-circuit, which in order to render it still more susceptible and to reduce the liability of its being affected by extraneous disturbances is carefully adjusted so as to be in tune with the transmit-25 ter. By a scientific design of the sending and receiving circuits and other apparatus and skilful adjustment of the same these objects may be in a measure attained; but in long experience I have found that not-30 withstanding all constructive advantages and experimental resources this method is in many cases inadequate. Thus while I have succeeded in so operating selectively under certain favorable conditions more than one 35 hundred receivers in most cases it is prac-

number rapidly diminishing as, either owing to great distance or other causes, the energy available in the tuned circuits becomes 40 smaller and the receivers necessarily more delicate. Evidently a circuit however well constructed and adjusted to respond exclusively to vibrations of one period is apt to be affected by higher harmonics and still 45 more so by lower ones. When the oscillations are of a very high frequency, the number of the effective harmonics may be large and the receiver consequently easily disturbed by extraneous influences, to such an 50 extent that when very short waves, such as those produced by Hertzian spark apparatus, I number of the cooperative disturbances or

ticable to work successfully but a few, the

are used little advantage in this respect is to he derived from tuning the circuits. -It being an imperative requirement in most practical applications of such systems of signal- 55 ing or intelligence transmission that the signals or messages should be exclusive or private, it is highly desirable to do away with the above limitations, especially in view of the fact which I have observed that the in- 60 fluence of powerful electrical disturbances upon sensitive receivers extends even on land to distances of many hundreds of miles, and consequently, in accordance with theory, still farther on sea. To overcome these draw- 65 backs and to enable a great number of transmitting and receiving stations to be operated selectively and exclusively and without any danger of the signals or messages being disturbed, intercepted, or interfered with in any 70 way is the object of my present invention.

Broadly stated, this invention consists in generating two or more kinds or classes of disturbances or impulses of distinctive character with respect to their effect upon a re- 75 ceiving-circuit and operating thereby a distant receiver which comprises two or more circuits, each of which is tuned to respond exclusively to the disturbances or impulses of one kind or class and so arranged that the 80 operation of the receiver is dependent upon their conjoint or resultant action.

By employing only two kinds of disturbances or series of impulses instead of one, as has heretofore been done, to operate a re- 85 ceiver of this kind I have found that safety against the disturbing influences of other sources is increased to such an extent that I believe this number to be amply sufficient in most cases for rendering the exchange of sig- 90 nals or messages reliable and exclusive; but in exceptional instances a greater number may be used and a degree of safety against mutual and extraneous interference attained, such as is comparable to that afforded by a 95 combination-lock. The liability of a receiver being affected by disturbances emanating from other sources, as well as that of the signals or messages being received by instruments for which they are not intended, may, 100 however, be reduced not only by an increased

series of impulses, but also by judicious choice of the same and order in which they are made to act upon the receiver.

Evidently there are a great many ways of 5 generating impulses or disturbances at any wave length, wave form, number or order of succession, or of any special character, such as will be capable of fulfilling the requirements above stated, and there are also many to ways in which such impulses or disturbances may be made to cooperate and to cause the receiver to be actuated, and inasmuch as the skill and practical knowledge in these novel fields can only be acquired by long experience 15 the degree of safety and perfection attained will necessarily depend upon the ability and resource of the expert who applies my invention; but in order to enable the same to be successfully practiced by any person pos-20 sessed only of the more general knowledge and experience in these branches I shall doscribe the simplest plan of carrying it out which is at present known to me.

For a better understanding of the subject reference is now made to the accompanying drawings, in which—

Figures 1 and 2 represent diagrammatically an apparatus and circuit connections employed at the sending and receiving stations, respectively, for the practice of my invention; and Figs. 3, 4, and 5, modified means which may be employed in the practical application of the invention.

In Fig. 1, S' S' are two spirally-wound coils 35 or conductors connected with their inner ends to preferably elevated terminals D' and D', respectively, and with their outer ends to an earth-plate E. These two coils, conductors, or systems D'S' E and D'S' E have different 40 and suitably-chosen periods of vibration, and, as pointed out in other patents relating to my system of energy and intelligence transmission, their lengths should be such that the points of maximum pressure developed there-45 in coincide with the elevated terminals D' By suitably-chosen periods of vibration such periods are meant as will secure the greatest safety against interference, both mutual and extraneous. The two systems may 50 have electrical oscillations impressed upon them in any desired manner conveniently by energizing them through primaries l'and P2, placed in proximity to them. Adjustable inductances L' and L² are preferably included 55 in the primary circuits chiefly for the purpose of regulating the rates of the primary oscillations. In the drawings these primaries P' and P' surround the coils S' S' and are , joined in series through the inductances ${f L}'$ 60 L2, conductor F, condensers C and C2, brush-holders B' and B2, and a toothed disk D, which is connected to the conductor F and, if desired, also to the ground-plate E, as shown, two independent primary circuits being thus 65 formed. The condensers C' and C' are of such capacity and the inductances L' L' are

so adjusted that each primary is in close reso-

nance with its secondary system, as I have explained in other patents granted to me. The brush-holders B' and B' are capable in- 70 dependently of angular and, if necessary, also of lateral adjustment, so that any desired. order of succession or any difference of time interval between the discharges occurring in the two primary circuits may be obtained. 75 The condensers being energized from a suitable source S, preferably of high potential, and the disk D being rotated, its projections or teeth pp coming at periodically-recurring intervals in very close proximity to or, as the 80 ease may be, in contact with conducting rods or brushes n n cause the condensers to be discharged in rapid succession through their respective circuits. In this manner the two secondary systems D'S' E and D'S'E are set 85 in vibration and oscillate freely each at its proper rate for a certain period of time at every discharge. The two vibrations are impressed upon the ground through the plate E and spread to a distance reaching the re- 90 ceiving-station, which has two similar circuits or systems es' d' and es' d', arranged and connected in the same manner and tuned to the systems at the sending-station, so that each responds exclusively to one of the two 95 vibrations produced by the transmitting apparatus. The same rules of adjustment are observed with respect to the receiving-circuits, care being furthermore taken that the tuning is effected when all the apparatus is 100 connected to the circuits and placed in position, as any change may more or less modify the vibration. Each of the receiving-coils s' and szis shunted by a local circuit containing, respectively, sensitive devices a'a', batteries 105 b'b', adjustable resistances r'r', and sensitive relays R'R', all joined in series, as shown. The precise connections and arrangements of the various receiving instruments are largely immaterial and may be 110 varied in many ways. The sensitive devices a' a' may be any of the well-known devices of this kind-as, for example, two conducting-terminals separated by a minute air-gap or a thin film of dielectric which is 115 strained or weakened by a battery or other means to the point of breaking down and gives way to the slightest disturbing influence. Its return to the normal sensitive state may be secured by momentarily interrupting 120 the battery-circuits after each operation or otherwise. The relays R' R' have armatures l' l2, which are connected by a wire w and when attracted establish electrical contacts at c' and c2, thus closing a circuit containing 125 a battery band adjustable resistance rand a relay R3. From the above description it will be readily seen that the relay R5 will be operated only when both contacts c' and c' are closed.

The apparatus at the sending-station may be controlled in any suitable manner—as, for instance, by momentarily closing the circuit of the source S, two different electrical vi-

ments or circuits, as S' and S2, since a suc-

brations being emitted simultaneously or in rapid succession, as may be desired, at each closure of the circuit. The two receivingcircuits at the distant station, each tuned to 5 respond to the vibrations produced by one of the elements of the transmitter, affect the sensitive devices a' and a' and cause the relays R' and R2 to be operated and contacts c' and c^2 to be closed, thus actuating the reto ceiver or relay R3, which in turn establishes a contact c³ and brings into action a device a^3 by means of a battery d^i , included in a local circuit, as shown. But evidently if through any extraneous disturbance only one 15 of the circuits at the receiving-station is affected the relay R3 will fail to respond. In this way a communication may be carried on with greatly-increased safety against interference and privacy of the messages may be 20 secured. The receiving-station shown in Fig. 2 is supposed to be one requiring no return message; but if the use of the system is such that this is necessary then the two stations will be similarly equipped, and any well-25 known means, which it is not thought necessary to illustrate here, may be resorted to for enabling the apparatus at each station to be used in turn as transmitter and receiver. In like manner the operation of a receiver, 30 as R3, may be made dependent instead of upon two upon more than two such transmitting systems or circuits, and thus any desired degree of exclusiveness or privacy and safety against extraneous disturbances may be attained. The apparatus as illustrated in Figs. 1 and 2 permits, however, special results to be secured by the adjustment of the order of succession of the discharges of the primary circuits P' and P2 or of the time in-40 tervals between such discharges. To illustrate: The action of the relays R' R2 may be regulated either by adjusting the weights of the levers l' l', or the strength of the batteries b' b^2 , or the resistances r' r^2 , or in other 45 well-known ways, so that when a certain order of succession or time interval between the discharges of the primary circuits P' and P' exists at the sending-station the levers l' and l^2 will close the contacts c' and c^2 at the same 50 instant, and thus operate the relay R3, but will fail to produce this result when the order of succession of or the time interval between the discharges in the primary circuits is another one. By these or similar means addi-55 tional safety against disturbances from other sources may be attained and, on the other hand, the possibility afforded of effecting the operation of signaling by varying the order of succession of the discharges of the two cir-60 cuits. Instead of closing and opening the circuit of the source S', as before indicated, for the purpose of sending distinct signals it may be convenient to merely alter the period of either of the transmitting-circuits arbitrarily, 65 as by varying the inductance of the primaries.

Obviously there is no necessity for using

cession of waves or impulses of different characteristics may be produced by an instrument 70 having but one such circuit. A few of the many ways which will readily suggest themselves to the expert who applies my invention are illustrated in Figs. 3, 4, and 5. In Fig. 3 a transmitting system e s3 d3 is partly shunt- 75 ed by a rotating wheel or disk D3, which may be similar to that illustrated in Fig. 1 and which cuts out periodically a portion of the coil or conductors, or, if desired, bridges it by an adjustable condenser C3, thus altering the 80 vibration of the system e s3 d3 at suitable intervals and causing two distinct kinds or classes of impulses to be emitted in rapid succession by the sender. In Fig. 4 a similar result is produced in the system e s' d' by pe- 85 riodically short-circuiting, through an induction-coil L3 and a rotating disk D4 with insulating and conducting segments, a circuit p' in inductive relation to said system. Again, in Fig. 5 three distinct vibrations are caused 90 to be emitted by a system $e s^5 d^5$, this result being produced by inserting periodically a number of turns of an induction-coil L'in series with the oscillating system by means of a rotating disk B5 with two projections p5 p5 95 and three rods or brushes n5, placed at an angle of one hundred and twenty degrees relatively to each other. The three transmitting systems or circuits thus produced may be energized in the same manner as those of Fig. 1 100 or in any other convenient way. Corresponding to each of these cases the receiving-station may be provided with two or three circuits in an analogous manner to that illustrated in Fig. 2, it being understood, of course, 105 that the different vibrations or disturbances emitted by the sender follow in such rapid succession upon each other that they are practically simultaneous so far as the operation of such relays as R' and R2 is concerned. Evi- 110 dently, however, it is not necessary to employ two or more receiving circuits, but a single circuit may be used also at the receiving-station constructed and arranged like the transmitting-circuits or systems illustrated in Figs. 115 3, 4, and 5, in which case the corresponding disks, as D3 D4 D5, at the sending will be driven in synchonism with those at the receiving stations as far as may be necessary to secure the desired result; but whatever the na- 120 ture of the specific devices employed it will be seen that the fundamental idea in my invention is the operation of a receiver by the conjoint or resultant effect of two or more circuits each tuned to respond exclusively to 125 waves, impulses, or vibrations of a certain kind or class produced either simultaneously or successively by a suitable transmitter.

It will be seen from a consideration of the nature of the method heroinbefore described 130 that the invention is applicable not only in the special manner described, in which the transmission of the impulses is effected transmitters with two or more distinct ele- I through natural media, but for the transmis-





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sion of energy for any purpose and whatever the medium through which the impulses are conveyed.

What I claim is—

1. The method of operating distant receivers which consists in producing and transmitting a plurality of kinds or classes of electrical impulses or disturbances, actuating by the impulses or disturbances of each kind or to class one of a plurality of circuits tuned to respond to impulses of such kind or class and operating or controlling the operation of a receiver by the conjoint action of two or more of said circuits, as set forth.

2. The method of signaling, which consists in producing and transmitting a plurality of kinds or classes of electrical impulses or disturbances, developing by the impulses of each class a current in one of a plurality of receiv-20 ing-circuits tuned to respond exclusively thereto and controlling by means of the conjoint action of such circuits a local circuit.

as set forth.

3. The method of signaling which consists 25 in producing a plurality of series of impulses or disturbances differing from each other in character and order of succession, exciting by the impulses of each series one of a plurality of receiving-circuits tuned to respond 30 exclusively thereto and controlling by the conjoint action of such circuits a local circuit, as set forth.

4. The method of signaling which consists in producing a plurality of series of electrical 35 impulses of different character, varying the time interval between the emission of such impulses, exciting by the impulses of each series one of a plurality of receiving-circuits funed to respond exclusively thereto and con-40 trolling by the conjoint action of such cir-

cuits a local circuit, as set forth.

5. The method of transmitting electrical energy for conveying intelligible signals which consists in producing a plurality of electrical 45 impulses of different character, developing by the impulses of each kind a current in one of a plurality of receiving-circuits tuned to respond exclusively thereto, controlling the action or effect of the transmitted impulses 50 upon the receiving-circuits by varying the character of said impulses, and operating or controlling the operation of a receiver by the conjoint action of two or more of said receiving-circuits, as set forth.

6. The method of transmitting electrical en- 55 ergy which consists in producing a plurality of electrical waves or impulses of different periodicities, varying the order of transmission of the waves or impulses forming elements of the signal sent, according as one or to another receiving-station is to be communicated with where (proper circuit-closing mechanism being provided at each receiving-station) the transmitted signal will be intelligible at and only at the intended receiving- 65 station.

7. The method of transmitting intelligence, which consists in selecting and associating together in predetermined order of succession two or more electrically-generated impulses 70 of different periodicity, forming elements of signals to be sent, and transmitting such selected impulses with reference to the conjoint action of both or all in the production of a signal at a distant point, substantially as set 75

forth.

8. In a system of telegraphy, wherein signals or messages are sent by the use of a plurality of electrical impulses of different periodicities and in a predetermined order of succession, 80 the method of ascertaining at any particular station the particular signal sent to that station, which consists in the selection, to form a signal, of certain transmitted impulses of different periodicities and of a predetermined 85 order of succession to the exclusion of all others, as set forth.

9. The improvement in the art of transmitting electrical energy which consists in operating or controlling a receiving mechanism 90 by a series or group of electrical impulses of different periodicities and of a predetermined

order of sucession.

10. In a system for the transmission of electrical energy, for sending signals or messages 95 to any one of two or more receiving-stations, the method of transmitting the message with reference to the intelligible receipt thereof at the desired station, which consists in the transmission of electrical waves or impulses 100 of different periodicities in varying order of transmittal by a separate order or grouping of transmittal for each receiving-station.

NIKOLA TESLA.

Witnesses:

M. LAWSON DYER, BENJAMIN MILLER.



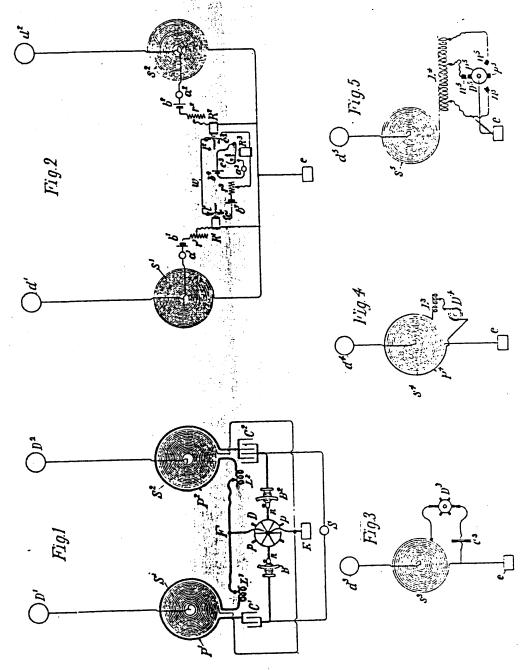


No. 725,605.

PATENTED APR. 14. 1903.

N. TESLA. SYSTEM OF SIGNALING. APPLICATION PILED JULY 16, 1900.

NO MODEL.



Wilnesses: Raphail Notter &DMorrill Nikola Tesla. Inventor

Ken. Page & Cooker Attys

United States Patent Office.

NIKOLA TESLA, OF NEW YORK, N.Y.

SYSTEM OF SIGNALING.

SPECIFICATION forming part of Letters Patent No. 725,605, dated April 14, 1903.

Application filed July 16, 1900. Serial No. 23,847. (No model.)

To all whom it may concern:

Be it known that I, NIKOLA TESLA, a citizen of the United States, residing in the borough of Manhattan, in the city, county, and State of 5 New York, have invented certain new and useful Improvements in Systems of Signaling, of which the following is a specification, reference being had to the drawings accompanying and forming a part of the same.

and forming a part of the same. In certain systems for transmitting intelligible messages or governing the movements and operations of distant automata electrical impulses or disturbances produced by suitable apparatus are conveyed through the natural 15 media to a distant receiving-circuit capable of responding to the impulses, and thereby effecting the control of other appliances. Generally a special device highly sensitive is connected to the receiving-circuit, which in 20 order to render it still more susceptible and to reduce the liability of its being affected by extraneous disturbances is carefully adjusted so as to be in tune with the transmitter. By a scientific design of the sending and receiving 25 circuits and other apparatus and skilful adjustment of the same these objects may be in a measure attained; but in long experience I have found that notwithstanding all constructive advantages and experimental resources 30 this method is in many cases inadequate. Thus while I have succeeded in so operating selectively under certain favorable conditions more than one hundred receivers in most cases it is practicable to work successfully but a few, 35 the number rapidly diminishing as, either owing to great distance or other causes, the energy available in the tune circuits becomes smaller and the receivers necessarily more

smaller and the receivers necessarily more delicate. Evidently a circuit however well 40 constructed and adjusted to respond exclusively to vibrations of one period is apt to be affected by higher harmonics and still more so by lower ones. When the oscillations are of a very high frequency, the number of the 45 effective harmonics may be large, and the receiver consequently easily disturbed by extraneous influences to such an extent that when very short waves, such as those produced by Hertzian spark apparatus, are used

little advantage in this respect is derived from 50 tuning the circuits. It being an imperative requirement in most practical applications of such systems of signaling or intelligence transmission that the signals or messages should be exclusive or private, it is highly 55 desirable to do away with the above limitations, especially in view of the fact, which I have observed, that the influence of powerful electrical disturbances upon sensitive receivers extends, even on land, to distances of 60 many hundreds of miles, and consequently in accordance with theory still farther on sea. To overcome these drawbacks and to enable a great number of transmitting and receiving stations to be operated selectively and exclu- 65 sively and without any danger of the signals or messages being disturbed, intercepted, or interfered with in any way is the object of my present invention.

Broadly stated, this invention consists in the 70 combination of means for generating and transmitting two or more kinds or classes of disturbances or impulses of distinctive character with respect to their effect upon a receiving-circuit and a distant receiver which 75 comprises two or more circuits of different electrical character or severally tuned, so as to be responsive to the different kinds or classes of impulses and which is dependent for operation upon the conjoint or resultant action 80 of the two or more circuits or the several instrumentalities controlled or operated thereby. By employing only two kinds of disturbances or series of impulses instead of one, as has heretofore been done to operate a 85 receiver of this kind, I have found that safety against the disturbing influences of other sources is increased to such an extent that I believe this number to be amply sufficient in most cases for rendering the exchange of 90 signals or messages reliable and exclusive; but in exceptional instances a greater number may be used and a degree of safety against mutual extraneous interference attained, such as is comparable to that afforded by a com- 95 bination-lock. The liability of a receiver being affected by disturbances amanating from other sources, as well as that of the signals or messages being received by instruments for which they are not intended, may, however, be reduced not only by an increased number of the coorperative disturbances or series of impulses, but also by a judicious choice of the same and the order in which they are made to act upon the receiver.

Evidently there are a great many ways of generating impulses or disturbances of any 10 wave length, wave form, number or order of succession, or of any special character such as will be capable of fulfilling the requirements above stated, and there are also many ways in which such impulses or disturbances may 15 be made to cooperate and to cause the receiver to be actuated, and inasmuch as the skill and practical knowledge in these novel fields can only be acquired by long experience the degree of safety and perfection attained 20 will necessarily depend upon the ability and resource of the expert who applies my invention; but in order to enable the same to be successfully practiced by any person possessed only of the more general knowledge and 25 experience in these branches I shall describe the simplest plan of carrying it out which is at present known to me.

For a better understanding of the subject reference is now made to the accompanying 30 drawings, in which —

Figures 1 and 2 represent diagrammatically the apparatus and circuit connections employed at the sending and receiving stations, respectively; and Figs. 3, 4, and 5 modified 35 means which may be employed in the practical application of the invention.

In Fig. 1, S' and S² are two spirally-wound coils or conductors connected with their inner ends to elevated terminals D' and D2, respec-40 tively, and with their outer ends to an earthplate E. These two coils, conductors, or systems D' S' E and D2 S2 E have different and suitably-chosen periods of vibration, and, as pointed out in other patents relating to my 45 system of energy and intelligence transmission, their lengths should be such that the points of maximum pressure developed therein coincide with the elevated terminals D' D2. The two systems may have electrical oscilla-50 tions impressed upon them in any desired manner, conveniently by energizing them through primaries P' and P2, placed in proximity to them. Adjustable inductances L' and L² are preferably included in the primary cir-55 cuits chiefly for the purpose of regulating the rates of the primary oscillations. In the drawings these primaries P' and P2 surround the coils S' S2 and are joined in series through the inductances L' L2, conductor F, condensers C' 60 and C2, brush-holders B' and B2, and a toothed disk D, which is connected to the conductor F and, if desired, also to the ground-plate E, as shown, two independent primary circuits being thus formed. The condensers C' and C2 65 are of such capacity and the inductances L'

and L² are so adjusted that each primary is in

close resonance with its secondary system, as

I have explained in other patents granted to me. The brush holders B' and B2 are capable independently of angular and, if necessary, 70 also of lateral adjustment, so that any desired order of succession or any difference of time interval between the discharges occurring in the two primary circuits may be obtained. The condensers being energized from a suitable 75 source S, preferably of high potential, and the disk D being rotated, its projections or teeth p p, coming at periodically-recurring intervals in very close proximity to or, as the case may be, in contact with conducting rods or brushes 80 n n, cause the condensers to be discharged in rapid succession through their respective circuits. In this matter the two secondary systems D' S' E and D² S² E are set in vibration and oscillate freely, each at its proper rate, for a 85 certain period of time at every discharge. The two vibrations are impressed upon the ground through the plate E and spread to a distance reaching the receiving station, which has two similar circuits or systems e s' d' and $e s^2 d^2$ 90 arranged and connected in the same manner and tuned to the systems at the sending-station, so that each responds exclusively to one of the two vibrations produced by the transmitting apparatus. The same rules of adjust- 95 ment are observed with respect to the receiving-circuits, care being, furthermore, taken that the tuning is effected when all the apparatus is connected to the circuits and placed in position, as any change may more or less 100 modify the vibration. Each of the receiving coils s' and s² is shunted by a local circuit containing, respectively, sensitive devices a' a^2 , batteries b' b^2 , adjustable resistances r' r^2 , and sensitive relays R' R2, all joined in series, 105 as shown. The precise connections and arrangements of the various receiving instruments are largely immaterial and may be varied in many ways. The sensitive devices a' a^2 may be any of the well-known devices 110 of this kind - as, for example, two conductingterminals separated by a minute air-gap or a thin film of dielectric which is strained or weakened by a battery or other means to the point of breaking down and gives way to the 115 slightest disturbing influence. Its return to the normal sensitive state may be secured by momentarily interrupting the battery-circuit after each operation or otherwise. The relays R' R² have armatures l' L^2 , which are con-120 nected by a wire w and when attracted establish electrical contacts c' and c^2 , thus closing a circuit containing a battery b3, and adjustable resistance r^3 , and a relay R^3 .

From the above description it will be readily 125 seen that the relay \mathbb{R}^3 will be operated only when both contacts c' and c^2 are closed.

The apparatus at the sending-station may be controlled in any suitable manner — as, for instance, by momentarily closing the circuit 130 of the source S, two different electric vibrations being emitted simultaneously or in rapid succession, as may be desired, at each closure of the circuit. The two receiving-circuits at the

distant station, each tuned to respond to the vibrations produced by one of the elements of the transmitter, affect the sensitive devices a' and a² and cause the relays R' and R² to 5 be operated and contacts c' and c^2 to be closed, thus actuating the receiver or relay R3, which in turn establishes a contact c3 and brings into action a device a^3 by means of a battery d^4 , included in a local circuit, as 10 shown; but evidently if through any extraneous disturbance only one of the circuits at the receiving-station is affected the relay R³ will fail to respond. In this way communication may be carried on with greatly-increased safe-15 ty against interference and privacy of the messages may be secured. The receiving-station (shown in Fig. 2) is supposed to be one requiring no return message; but if the use of the system is such that this is necessary then 20 the two stations will be similarly equipped and any well-known means, which it is not thought necessary to illustrate here, may be resorted to for enabling the apparatus at each station to be used in turn as transmitter and receiver. 25 In like manner the operation of a receiver, as R3, may be made dependent, instead of upon two, upon more than two such transmitting systems or circuits, and thus any desired degree of exclusiveness or privacy and safety 30 against extraneous disturbances may be attained. The apparatus as illustrated in Figs. 1 and 2 permits, however, special results to be secured by the adjustment of the order of succession of the discharge of the primary 35 circuits P' and P2 or of the time interval between such discharges. To illustrated, the action of the relays R' R2 may be regulated either by adjusting the weights of the levers l' l^2 , or the strength of the batteries b' b^2 , or 40 in other well-known ways, so that when a certain order of succession or timeinterval between the discharges of the primary circuits P' and P2 exists at the sending-station the levers l' and l^2 will close the contacts c' and 45 c^2 at the same instant, and thus operate the relay R3; but it will fail to produce this result when the order of succession of or the time interval between the discharges in the primary circuits is another one. By these or similar 50 means additional safety against disturbances from other sources may be attained and, on the other hand, the possibility afforded of effecting the operation of signaling by varying the order of succession of the discharges of the 55 two circuits. Instead of closing and opening the circuit of the source S, as before indicated, for the purpose of sending distinct signals it may be convenient to merely alter the period of either of the transmitting-circuits arbitrarily. 60 as by varying the inductance of the primaries.

Obviously there is no necessity for using

transmitters with two or more distinct ele-

ments or circuits, as S' and S2, since a succes-

sion of waves or impulses of different char-

having but one such circuit. A few of the many

ways which will readily suggest themselves to

65 acteristics may be produced by an instrument

the expert who applies my invention are illustrated in Figs. 3, 4, and 5. In Fig. 3 a transmitting system e s3 d3 is partly shunted by a rotat-70 ing wheel or disk D3, which may be similar to that illustrated in Fig. 1 and which cuts out periodically a portion of the coil or conductor s3 or, if desired, bridges it by an adjustable condenser C3, thus altering the vibration of the 75 system e s3 d3 at suitable intervals and causing two distinct kinds or classes of impulses to be emitted in rapid succession by the sender. In Fig. 4 a similar result is produced in the system e s⁴ d⁴ by periodically short-circuiting, through 80 an induction-coil L3 and a rotating disk D4 with insulating and conducting segments, a circuit p⁴ in inductive relation to said system. Again, in Fig. 5 three distinct vibrations are caused to be emitted by a system $e s^5 d^5$, this result 85 being produced by inserting periodically a suitable number of turns of an induction-coil Lingseries with the oscillating system by means of a rotating disk B5 with two projections p⁵ p⁵ and three rods or brushes n⁵, placed 90 at an angle of one hundred and twenty degrees relatively to each other. The three transmitting systems or circuits thus produced may be energized in the same manner as those of Fig. 1 or in any other convenient way. Cor- 95 responding to each of these cases the receiving-station may be provided with two or three circuits in an analogous manner to that illustrated in Fig. 2, it being understood, of course, that the different vibrations or disturbances 100 emitted by the sender follow in such rapid succession upon each other that they are practically simultaneous, so far as the operation of such relays as R' and R2 is concerned. Evidently, however, it is not necessary to 105 employ two or more receiving-circuits; but a single circuit may be used also at the receiving-station constructed and arranged like the transmitting circuits or systems illustrated in Figs. 3, 4, and 5, in which case the correspond-110 ing disks, as D3 D4 D5, at the sending will be driven in synchronism with those at the receiving stations as far as may be necessary to secure the desired result; but whatever the nature of the specific devices employed it will 115 be seen that the fundamental idea in my invention is the operation of a receiver by the conjoint or resultant effect of two or more circuits each tuned to respond exclusively to waves, impulses, or vibrations of a certain 120 kind or class produced either simultaneously or successively by a suitable transmitter.

It will be seen from a consideration of the nature of the method hereinbefore described that the invention is applicable not only in the 125 special manner described, in which the transmission of the impulses is effected through natural media, but for the transmission of energy for any purpose and whatever the medium through which the impulses are con-130 veyed.

What I claim is -

1. In a system for the transmission of electrical energy, the combination with means for

producing two or more distinctive kinds of disturbances or impulses, of receiving-circuits, each tuned to respond to the waves or impulses of one kind only, and a receiving device dependent for operation upon the conjoint action of the several receiving-circuits, as set forth.

2. In a system for the transmission of electrical impulses and the operation or control, of signaling or other apparatus thereby, the combination with a transmitter adapted to produce two or more distinctive kinds or classes of disturbances or impulses, of sensitive receiving-circuits, each tuned to respond to the impulses or disturbances of one kind or class only, and a receiving device dependent for operation upon the conjoint action of the sensitive circuits, as set forth.

3. In a system for the transmission of electrical impulses, and the operation or control
of signaling, or other apparatus thereby, the
combination with a transmitter adapted to
produce two or more distinctive kinds or
classes of disturbances or impulses, of sensitive
circuits at the receiving point or station, each
tuned to respond to the impulses or disturbances of one kind or class only, a local circuit
arranged to be completed by the conjoint
action of the sensitive circuits and a receiving
device connected therewith, as set forth.

4. In a system for the transmission of electrical impulses, and the operation or control of signaling or other apparatus thereby, the combination with a transmitting apparatus adapted to produce two or more distinctive kinds of disturbances or impulses, of means for varying the time intervals of the emission of the impulses of the several kinds, sensitive circuits each tuned to respond to the impulses or disturbances of one kind only, and a receiving apparatus dependent for operation upon the conjoint action of the sensitive circuits, as set forth.

5. In a system, such as herein described, the combination with a transmitter adapted to produce a plurality of distinctive kinds of electrical disturbances or impulses, of a receiving apparatus comprising a plurality of circuits, a sensitive device and a relay included in each circuit, and each said circuit being tuned to respond to the impulses or disturbances of one kind only, and a receiving apparatus in a local circuit controlled by the relays and adapted to be completed by the conjoint action of all 55 of said relays, as set forth.

6. In a system of the kind described, the combination with a transmitter adapted to produce two or more series of electrical oscillations or impulses of different frquencies, of a receiving apparatus comprising plurality of sensitive circuits each tuned to respond to the impulses of one of the series produced by the transmitter, and a signaling device dependent for its operation upon the conjoint action of said circuits, as set forth.

7. The combination with a plurality of transmitter elements, each adapted to produce a

series impulses or disturbances of a distinctive character, and means for controlling and adjusting the same, of a receiver having a plurality of sensitive circuits each tuned so as to be affected by one of the series of impulses only, and dependent for operation upon the conjoint action of all of said circuits, as set forth.

8. The combination with a transmitter adapt- 75 ed to produce series of electrical impulses or disturbances of distinctive character and in a given order of succession, of a receiving apparatus comprising tuned circuits responding to such impulses in a corresponding order, 80 and dependent for operation upon the conjoint action of said elements, as set forth.

9. In A receiving apparatus, the combination with a plurality of sensitive circuits, severally tuned to respond to waves or impulses of a 85 different kind or class a receiving circuit controlled by the sensitive circuits and a device connected with the receiving-circuits adapted to be operated when said circuit is completed by the conjoint action of two or more of the 90 sensitive circuits, as set forth.

10. A system for the transmission of electrical energy, having in combination means for producing and transmitting two or more impulses of different periodicities to form a signal 95 in a predetermined order of succession, as set forth.

trical energy, the combination with a transmitting apparatus comprising one or more cir-100 cuits, means for impressing therein oscillations or impulses of different character and a receiving apparatus comprising a plurality of circuits each tuned to respond to the impulses of one kind produced by the transmitter and a re-105 ceiver dependent for operation upon the conjoint action of the receiving-circuits, as set forth.

12. In a system for the transmission of electrical energy, the combination with a transmit-110 ting apparatus comprising a transformer and means for impressing upon the secondary element of the same oscillations or impulses of different character, of a receiving apparatus comprising a plurality of circuits each tuned 115 to the impulses of one kind emitted by the secondary of the transitting-transformer, and a receiver dependent for operation upon the conjoint action of the receiving-circuits, as set forth.

13. In a system for the transmission of electrical energy, the combination with a transmitting apparatus comprising a transformer and means for impressing upon the secondary elements of the same oscillations or impulses 125 of different periodicities and in a given order of succession, of a receiving apparatus comprising a plurality of circuits each tuned to respond to the transmitted impulses of one period, and a receiver dependent for opera-130 tion upon the conjoint action of the receiving-circuits, as set forth.

14. In a signaling system, the combination of

means for generating a series of electrical impulses of different periodicities, receiving-circuits of differing electrical periods of vibration, and an indicating mechanism operated to give an intelligible indication only when currents are induced in the receiving-circuits a predetermined order, as set forth.

15. In a system for the transmission of energy, the combination of two or more cir10 cuits differing with respect of one of their electrical constants, means for energizing said circuits, and an indicating mechanism operative only by conjoint action of two or more currents generated by waves from the send-

ing-station, as set forth.

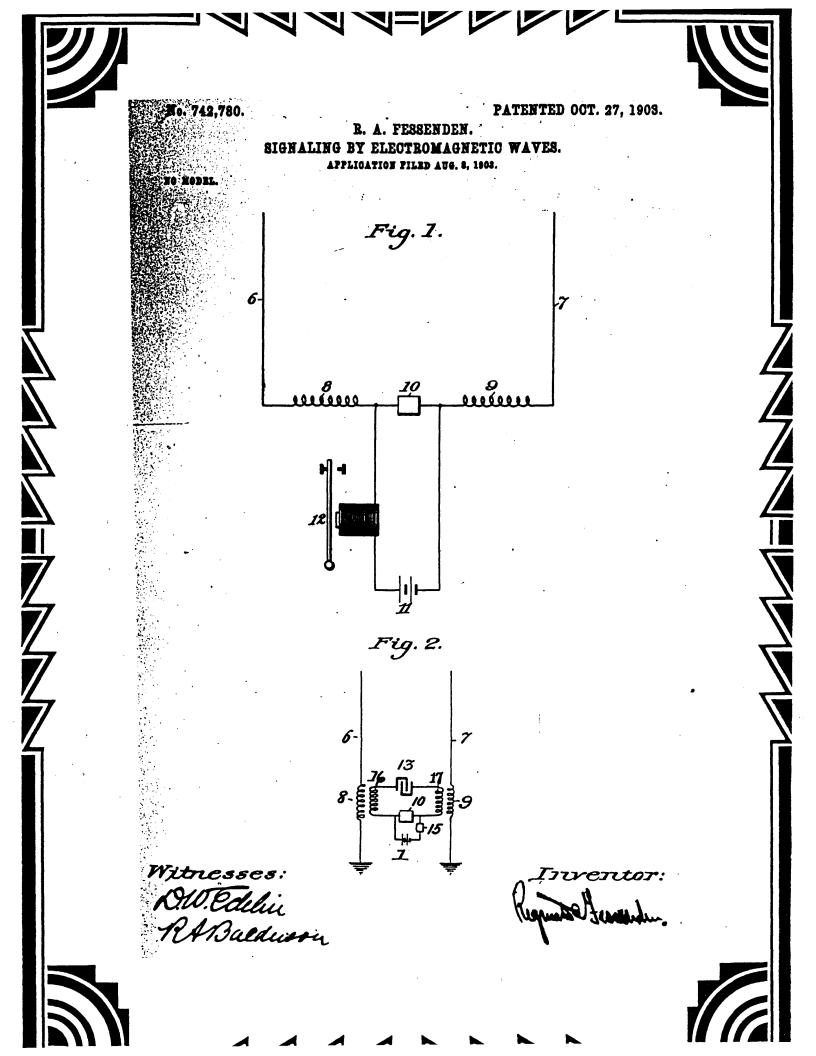
16. In a system for the transmission of electrical energy, the combination with a transmitter adapted to produce electrical waves or oscillations varying in character in a predetermined order, of a receiving instrument responsive to said oscillations and dependent for 20 operation upon the action thereof in a corresponding order, as set forth.

NIKOLA TESLA.

Witnesses:

John C. Kerr, Richard S. Donovan.





UNITED STATES PATENT OFFICE.

REGINALD A. FESSENDEN, OF FORT MONROE, VIRGINIA.

SIGNALING BY ELECTROMAGNETIC WAVES.

SPECIFICATION forming part of Letters Patent No. 742,780, dated October 27, 1903.

Application filed August 8, 1903. Serial No. 168,799. (No model.)

.To all whom it may concern:

Be it known that I, REGINALD A. FESSEN-DEN, a citizen of the United States, residing at Fort Monroe, in the county of Elizabeth City 3 and State of Virginia, have invented or discovered certain new and useful Improvements in Signaling by Electromagnetic Waves, of which improvements the following is a specification.

The invention described herein relates to certain improvements in selective signaling in systems where the signal is transmitted by waves, and has for its object the neutralization of disturbing impulses or waves which have not the periodicity which it is desired to receive

Figure 1 in the accompanying drawings, forming a part of this specification, shows a diagrammatic view of a form of apparatus adapted to the practice of my invention. Fig. 2 shows a similar view where the aerials are grounded.

In the practice of my invention I employ two or more conductors 6 and 7, which are tuned to different periodicities by any suitable means, as by the wires 8 and 9, which connect the conductors to a coherer 10 or other suitable wave-responsive device. Each of the wires 8 and 9 is preferably of approximately the same length as the conductor to which it is connected.

A grounding of the receiving-conductors is not necessary, as efficient signaling can be effected without a ground. A suitable construction where a ground is used is shown in Fig. 2, where 6 and 7 are the aerials, 8 and 9 primaries of transformers, whose secondaries 16 and 17 are arranged to act upon the receiver 10. A condenser 13 may be used, as shown.

When employing a coherer, it is connected, as usual, in the circuit of a battery 11, Fig. 1, or 1, Fig. 2, and with a relay of transmitting mechanism, 12, Fig. 1, or 15, Fig. 2. In the construction here shown the wave-responsive device is affected by waves of either of the periodicities to which the receiving-conductors 6 and 7 are tuned or to both periodicities conjointly, provided that the oscillations are sufficiently prolonged. If the receiver be adjusted so as to respond only tor. Instead of a coherer a cumulatively-acting receiver of the current-operated type, as a barretter, is preferably used.

What I claim as my invention is—

I. As an improvement in the art of signaling by periodic impulses the method herein described which consists in causing a disturbing influence to produce equal effects, and neutralizing these effects on the receiver.

2. As an improvement in the art of signaling by periodic impulses the method herein

when the effect of both the aerials is added and not to the effect produced by a single one, the receiver will only be operated by the conjoint action of the two sets of waves.

When an electric impulse is received by the conductors 6 and 7, the first few oscillations of the series of waves will generate nearly the same potential at the ends of the coherer or translating device 10, Fig. 1, or 10, 60 Fig. 2; but if the oscillations persist and their periodicity agrees with that to which either of the receiving-conductors is tuned the potential at one end of the coherer will rise higher than that of the other and the 65 receiver will be actuated. If, however, the periodicity of the impulse does not agree with that to which either receiving-conductor is tuned, there will be no cumulative rise in the potential at one end of the receiving device, 70 and if the periodicity of the impulse be sufficiently different from the periodicities to which the receiving-conductors are tuned there will be no appreciable rise at one end above that of the opposite end.

As the coherer or other translating device is so constructed as to be unresponsive to approximately equal potentials or the potentials so nearly neutralize each other as to produce no operative effect on the coherer or waveresponsive device, it follows that the apparatus at any receiving-station will not respond to any wave or series of waves or impulses which will not produce or generate at the coherer or other wave-responsive device potential differing to a predetermined degree. Thus disturbing impulses produced by other stations or by atmospheric disturbances will be unable to affect the receiver.

It is preferred that the aerials 6 and 7 90 should be of approximately the same height—
i. e., should not differ more than a few per cent.

Where this invention is used for wire lines, as telegraph lines or cables, the conductors 6 and 7 in Fig. 2 are preferably connected to each other above the coils 8 9 and the junction connected to the line-wire. In his case condensers are preferably placed in series with each of the conductors 6 and 7. Also instead of grounding the conductors 6 and 7 they may be connected to a return-conducted described which consists in causing a disturbing influence to produce a plurality of equal effects, and neutralizing these effects on the receiver.

In testimony whereof I have hereunto set my hand:

REGINALD A. FESSENDEN.

Witnesses:

DARWIN S. WOLCOTT, WM. H. DE LACY.

PATENTED AUG. 16, 1904. No. 767,977. J. S. STONE. SPACE TELEGRAPHY. APPLICATION PILED NOV. 24, 1903. RENEWED JUNE 20, 1904. NO MODEL. Fig.1. Fig. 5. INVENTOR-

United States Patent Office.

JOHN STONE STONE, OF CAMBRIDGE, MASSACHUSETTS, ASSIGNOR TO WILLIAM W. SWAN, TRUSTEE, OF BROOKLINE, MASSACHUSETTS.

SPACE TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 767,977, dated August 16, 1904.

Application filed November 24, 1903. Renewed June 20, 1904. Serial No. 213,322. (No model.

To all whom it may concern:

Be it known that I, John Stone Stone, a citizen of the United States, and a resident of Cambridge, in the county of Middlesex and 5 State of Massachusetts, have invented a certain new and useful Improvement in Space Telegraphy, of which the following is a specification.

My invention relates to the art of transmitting intelligence from one station to another
by means of electromagnetic waves without
the use of wires to guide the waves to their
destination; and it relates more particularly
to the system of such transmission in which
telectromagnetic waves are developed by producing electric vibrations in an elevated conductor, preferably vertically elevated. In my
Letters Patent No. 714,756, dated December

2, 1902, I have described such system of telegraphy by electromagnetic waves in which electrical vibrations of definite frequency and substantially simple barmonic in form 2, 2, as nearly simple harmonic in form as it is possible to produce them - are developed in a 25 sonorous or persistently-oscillating circuit and

impressed on an elevated conductor, whereby electromagnetic waves of corresponding frequency and form are radiated. In said Letters Patent I have explained that the condenser included in the sonorous circuit so associated with the elevated conductor and the tuning-condensers in all resonant circuits employed in either the transmitting or receiving systems should be devoid of dielectric hys-

35 teresis and that all coils, whether they form the windings of transformers or sources of auxiliary inductance, should be devoid of magnetic hysteresis in order that the electrical oscillations developed in the sonorous
 40 circuit may be as nearly simple harmonic as possible and in order that the resonant circuit

possible and in order that the resonant circuits at the receiving-stations may respond strongly to oscillations of one frequency and practically to the exclusion of oscillations of 45 other frequencies.

In my Letters Patent No. 714,832, dated December 2, 1902, I have stated that although a condenser devoid of dielectric hysteresis may be the coil and without dissipating appreciable condenser devoid of dielectric hysteresis may be the suggestion which resulted in my use of

electric some other dielectric, either solid or 50 liquid, sufficiently free from dielectric hysteresis may be found, and I have therein stated that the cores of the coils employed may be made of finely-divided soft iron embedded in a dielectric matrix for the purpose of increasing the magnetization in the coils, although the magnetic hysteresis of such coils may be most completely minimized by excluding paramagnetic material from their construction.

The object of this invention is the realization of a system of space telegraphy similar
to that described in my Letters Patent No.
714,756, in which the magnetization of the
coils is increased by providing said coils with
a core consisting of finely-divided soft iron 65
embedded in a dielectric matrix and in which
the capacity of the condensers of given cubical contents is greatly increased or the cubical contents for a given capacity greatly reduced by providing said condensers with solid
70
dielectrics consisting of a material substantially free from dielectric hysteresis and of
greater specific inductive capacity than air.

In my Letters Patent Nos. 717,511, 717,512, dated December 30, 1902, and Nos. 714,832, 75 714,833, dated December 2, 1902, and in Letters Patent No. 726,368, granted April 28, 1903, upon an application filed by me April 4, 1894. I have described a manner in which iron or other paramagnetic material may be employed with advantage to enhance the energy stored in a magnetic field. In the present application I have reference particularly to the use of finely-comminuted paramagnetic material embedded in a dielectric matrix used as a means of enhancing the inductance of a coil without introducing the effects of variable permeability and hysteresis losses.

Tam aware of publications by Oliver Heaviside as follows: Electrical Papers, Vol. II, 90 pages 111, 113, and 158, in which it is stated that cores made of finely-divided iron in a matrix of beeswax may be used to augment the inductance of coils without producing appreciable aberration of the permeability of 95 the coil and without dissipating appreciable energy in hysteresis losses. I first received the suggestion which resulted in my use of

such a material from the above-cited publications of Oliver Heaviside, and having found the material to possess the properties he ascribed to it I now disclose a highly-useful 5 application of it in the art of wireless telegraphy.

The advantages to be gained by the use of finely-divided paramagnetic material in a dielectric or highly-insulating material may best be realized by having reference to my United States Letters Patent Nos. 714,756, 714,832, and 737,170, wherein is set forth the necessity of excluding magnetic hysteresis from coils forming part of a resonant circuit and wherein is also set forth the advantages of increasing the value of the selectance function $\int |\mathbf{L}|$.

As pointed out in the above-cited patents, the kinetic energy of the coil supplying the inductance of a resonant circuit must be large compared to its potential energy when supporting a current of the frequency to which the circuit is attuned. The construction of a coil which will enhance the energy stored in the magnetic field will, cateris paribus, evidently enhance the value of L. and provided

the magnetic field will, cateris paribus, evidently enhance the value of L and provided such construction does not proportionally in-; 3º crease C it is of evident advantage in coils for use in a resonant circuit: but in singlelayer coils, such as described in my Letters Patent No. 714,756, the electric force is substantially normal to the coil, as shown in Fig. 35 1 of the present specification, except at a potential node. In such coils, provided the kinetic energy is large compared to the potential energy for a particular frequency for currents of that frequency, the length of the coil 49 is a fraction of half a wave length of the potential or current along the coil. Careful consideration of the theory of wave propagation along single-layer coils will show that in an infinite coil of this type the propagation of the 45 wave is in general similar to that in an infinite linear conductor of uniformly-distributed inductance, capacity, and resistance, where the inductance per unit of length of the coil takes the place of the inductance per unit of length; 50 of the uniform conductor, the capacity per unit of length of the coil takes the place of the capacity per unit of length of the uniform

conductor, and the resistance per unit of length of the coil takes the place of the re55 sistance per unit of length of the uniform conductor. The theory of such propagation is so well known that no exposition of it is here necessary. Suffice it to say that in half a wave length the kinetic energy is equal to the potential energy. This phenomenon places a definite limitation upon the length of the coil which may be employed in a given resonant

length of the wire is diminished below that of a 65 linear conductor in about the same proportion or ratio as the inductance is increased above that of a linear conductor by winding the wire in a single-layer coil there would be no advantage in winding the wire in the form of 70 a coil. However, as the capacity per unit of length of the wire in a single-layer coil in general does diminish in about the same ratio as the inductance per unit of length is increased when the wire is wound in an infinite 75 coil it follows that for a given frequency the length of wire per wave length in such a coil is approximately equal to that in a linear circuit of such wire or 3×10^{10} centimeters per second divided by the vibrations per second. In 80 view of the foregoing it follows that except in the immediate vicinity of current-nodes the inductance per unit of length of the conductor is increased by being wound in the form of a coil, and except in the immediat vicinity of a potential node the capacity per unit of length of a wire is proportionately diminished by being wound in the form of a coil. In the case of a single-layer coil and condenser forming a resonant circuit excited 90 by forced vibrations corresponding in frequency to the frequency to which the circuit is attuned the potential difference of the coil may be very great compared to the impressed electromotive force; but provided the kinetic 95 energy is small compared to the potential energy in the coil the current throughout the coil is not substantially different, as shown diagrammatically in Fig. 2, where the fullline curve u indicates the current and the todotted-line curve b indicates the potential at

phase $\frac{\pi}{2}$ and π , respectively. Careful consideration will show that the introduction of a dielectric core in the coil will tend to increase the potential energy of the current flowing in the coil, but that if the increase in the kinetic energy effected by the introduction of this core be greater than this increase in potential energy the length of wire in the coil increase, category parishus, be decreased and the selectance $\sqrt{\frac{1}{C}R^2}$ correspondingly improved.

The increase in capacity here mentioned is insignificant compared to the increase in inductance when a core of finely-comminuted iron embedded in a matrix of paraffin or beeswax and rosin is introduced in such a coil. Such a core is preferably constructed by melting a mixture of beeswax and rosin in a suitable cylindrical mold, pouring fine soft-iron filings in the mixture, and then allowing the mixture to harden after careful stirring.

potential energy. This phenomenon places a definite limitation upon the length of the coil which may be employed in a given resonant circuit, and were it not for the fact that in to their dielectric strengths and their specific general in such coils the capacity per unit of inductive capacities. It has long been recog-

767,977

nized that such solid dielectrics possess an electrical property which corresponds to the mechanical property of imperfect elasticity. This property of solid dielectries in condensers 5 produces the phenomenon known as dielectric hysteresis, by which a portion of the electrical energy of every charge stored in the condenser is absorbed and converted into heat. It may also result in the distortion of the wave form 10 of an alternating current traversing such condenser and generally produces marked diminution in the phenomenon of resonance when such condensers are used to tune resonant circuits, as first determined by Dr. Louis A. Dun-15 can in a series of experiments, some of the results of which were set forth in a paper presented at a general meeting of the American Institute of Electrical Engineers June 6, 1892. and published in Vol. IX of the transactions 20 of that society. It has also long been known that if air or any elementary gas be substituted for the solid dielectric in the condenser, these gases having practically perfect mechanical elasticity, the resulting condenser does 25 not possess dielectric hysteresis, does not cause a dissipation of any appreciable portion of the electric energy of a charge stored in the condenser, does not distort an alternating current traversing the condenser, and does not diminish 30 the phenomena of resonance when it is used to tune a resonant circuit. However, air and other gases have small dielectric strengths and small specific inductive capacities as compared to the dielectric strengths and specific induc-35 tive capacities of the solid materials usually employed as dielectrics in condensers. Therefore an air-condenser capable of storing a given amount of energy is in general vastly ; greater in cubical contents than the corresponding condenser with a solid dielectric.

Dr. Louis Duncan has discovered that glass made by fusing quartz which possesses almost perfect mechanical elasticity is devoid of dielectric hysteresis. Moreover, since the dielec-45 tric strength of fused quartz-glass is excessively high and its specific inductive capacity much greater than that of air, it follows that by the use of this material as a dielectric in a condenser the amount of electric energy which 5° may be stored in such a condenser per unit of cubical contents is much greater than that amonthly effecting the operation of the relay or which may be stored in condensers having any a signal-indicating device R. known gaseous dielectric. Finally, owing to the perfect electrical elasticity of fused quartz-55 glass these condensers possess all the advantages hereinbefore set forth as possessed by condensers having air or other gaseous dielectries.

In the drawings which accompany and form 60 a part of this specification, Figures 1 and 2 are diagrams already referred to. Fig. 3 is a diagrammatic illustration of apparatus and arrangements of circuits constituting a spacetelegraph transmitting system. Fig. 4 is a 65 diagrammatic illustration of apparatus and ar- ...

rangements of circuits constituting a spacetelegraph receiving system.

In the figures, V is an elevated conductor. M M' are transformers. It Is are respectively the primary and secondary windings of the 70 transformer M, and it is to be understood, as a matter of course, that this transformer may be a step-up or a step-down transformer, according to its position in the system. L is an inductance. C is a condenser. Q repre- 75 sents the dielectric of condenser C, which is preferably made of fused quartz-glass. F is a magnetic core of the usual construction, upon which the windings of the step-up transformer M' are wound. F' is a core consist- 80 ing of finely-divided iron embedded in a dielectric matrix. s is a spark-gap. k is a key. A is an alternating-current generator or other suitable source. K is a receiver, which may be a coherer. B is a battery. R is a relay 85

or signal-indicating device. For details of construction of the parts not herein specifically described and for the operation of the systems reference may be had to my Letters Patent Nos. 714,756 and 714,832. 90 Suffice it here to say that the discharge of the energy stored in the condenser C across the spark-gap * sets up in the sonorous circuit * C I L electric vibrations of definite frequency, which are substantially simple har- 95 monic in form and that therefore forced electric vibrations of corresponding frequency are developed in the elevated conductor V, that these electric vibrations so developed in the elevated conductor V cause the radiation 100 of substantially simple harmonic electromagnetic waves of corresponding frequency which create electromotive forces of like frequency in the elevated conductor V at the receivingstation, and that by means of the resonant 195 circuit I: C' C L. associated with said elevated conductor, the energy of the oscillations created in the elevated conductor by electromagnetic waves of the frequency to which said resonant circuit is attumed is absorbed to the ex- 110 clusion of the energy of electric oscillations of other frequencies, thereby creating a maxi-

1. In a system of space telegraphy, an elevated conductor associated with a sonorous 120 circuit which includes a condenser having a dielectric of fused quartz-glass.

mum difference of potential at the terminals

2. In a system of space telegraphy, an elevated conductor associated with a sonorous circuit which includes a condenser having a 125 dielectric of fused quartz-glass and which also includes a coil having a core of finely-divided paramagnetic material embedded in a dielectric matrix.

3. In a system of space telegraphy, an ele-130

of the condenser C and effecting a change in the resistance of the receiver K, and conse-115

vated conductor, a sonorous circuit associated with said elevated conductor and including a coil having a core of finely-divided paramagnetic material embedded in a dielectric ma-

4. In a system of space telegraphy, a persistently-oscillating circuit including a condenser having a dielectric of fused quartz-

5. In a system of space telegraphy, a persistently-oscillating circuit including a condenser having a dielectric of fused quartzglass and also including a coil having a core of finely-divided paramagnetic material em-15 bedded in a dielectric matrix.

6. In a system of space telegraphy, a persistently-oscillating circuit including a coil having a core of finely-divided paramagnetic material embedded in a dielectric matrix.

7. In a system of space telegraphy, a persistently-oscillating circuit including a condenser which has a solid dielectric substantially free from dielectric hysteresis and of a specific inductive capacity greater than that 25 of air.

8. In a system of space telegraphy, a persistently-oscillating circuit including a condenser which has a solid dielectric substantially free from dielectric hysteresis and also substantially free from magnetic hysteresis. | 1903.

9. In a system of space telegraphy, a resonant circuit including a coil having a paramagnetic core substantially free from mag-35 netic hysteresis.

10. In a system of space telegraphy, an elevated conductor associated with a resonant circuit which includes a condenser having a dielectric of fused quartz-glass.

11. In a system of space telegraphy, an ele-40 vated conductor associated with a resonant circuit which includes a condenser having a dielectric of fused quartz-glass and which also includes a coil having a core of finely-divided paramagnetic material embedded in a dielec- 45

12. In a system of space telegraphy, an elevated conductor, a resonant circuit associated with said elevated conductor and including a coil having a core of finely-divided paramag- 50 netic material embedded in a dielectric ma-

13. In a system of space telegraphy, a resonant circuit including a condenser which has a solid dielectric substantially free from di- 55 electric hysteresis and of a specific inductive capacity greater than that of air.

14. In a system of space telegraphy, a resonant circuit including a condenser which has a solid dielectric substantially free from di- oo electric hysteresis and also including a coil having a paramagnetic core substantially free from magnetic hysteresis.

In testimony whereof I have hereunto sub-30 including a coil having a paramagnetic core; scribed my name this 23d day of November; 65

JOHN STONE STONE.

Witnesses:

G. Adelaide Higgins, Ellen B. Tomlinson.

No. 818,363. PATENTED APR. 17, 1906. C. D. EHRET. ART OF SIGNALING THROUGH SPACE. APPLICATION FILED AUG. 25, 1905. FIG.I. FIG. 2. FIG.3. INVENTOR

UNITED STATES PATENT OFFICE.

CORNELIUS D EHRET, OF ARDMORE, PENNSYLVANIA.

ART OF SIGNALING THROUGH SPACE.

No. 818,363.

Specification of Letters Patent.

Patented April 17, 1906.

Original application filed July 27, 1903, Serial No. 167,129. Divided and this application filed August 25, 1905. Serial No. 275,760.

To all whom it may concern:

Be it known that I, CORNELIUS D. EHRET, a citizen of the United States, residing at Ardmore, in the county of Montgomery and 5 State of Pennsylvania, have invented new and useful Improvements in the Art of Signaling Through Space, of which the following is a specification.

My invention relates to electrical signaling, to more especially that system in which electroradiant energy representing the signal or message is transmitted through the natural media.

My invention consists in a method of transforming electroradiant energy into the energy
of electric currents, such electric currents
causing or controlling the production of an
electric current of the fluctuating or alternating type and having a frequency corresponding to the frequency of the transmitted wavetrains and boosting or reinforcing the alternating current so produced to more effectively control or actuate a receiver or other
translating device.

Reference is to be had to the accompany-

ing drawings, in which—

Figure 1 is a diagrammatic view of the circuits of a transmitting apparatus for impressing upon the natural media two series of 30 wave-trains, the trains of each series being displaced in time with respect to each other and the frequency or periodicity of the electromagnetic waves forming the trains at one series being different from the periodicity or 35 frequency of the electromagnetic waves forming the trains of the other series. Fig. 2 is a diagrammatic view of the circuit arrangements at a receiving-station wherein the received electroradiant energy causes or con-40 trols the production of a fluctuating or alternating current, such alternating or fluctuating current being reinforced or boosted. Fig. 3 is a diagrammatic view of receiving-circuits in which dephased wave-trains cause or 45 control the production of fluctuating or alternating currents, such currents being reinforced or boosted.

Referring to Fig. 1, P and P' are primary coils of two separate transformers, such primary windings being included in the circuit of a source of two-phased currents—that is, the current passing through the winding P is dephased ninety degrees with respect to the current passing through the winding P'. The separate transformers, such conductor A', and further, the frequency of the electromagnetic waves radiated from A is different from the frequency of the electromagnetic waves radiated from A'. Suppose the two-phased currents supplied to P P' to have a frequency of one hundred and eighty simultaneously open or close the circuits of emanating from A will be dephased from the

the primaries P and P'. S is the secondary winding of the transformer whose primary is P, and S' is the secondary of the transformer whose primary is P'. Both of these trans 60 formers are preferably step-up transformers, the voltages of the secondaries being preferably equal. G is a spark-gap in shunt to the secondary S, and this spark-gap, along with the condenser C, transformer-primary p, and 65 inductance L, forms an oscillating circuit of very short period or very high frequency, as well understood in this art. A is an aerial or radiating conductor between which and the earth-plate e is connected the transformer- 70 secondary s of the transformer whose primary is p. G' is a spark-gap in shunt to the secondary S' and forms, along with condenser C', transformer-primary p', and inductance L', an oscillating circuit of very high fre- 15quency. A' is a second aerial conductor between which and the earth-plate e is the transformer-secondary s', cooperating with the primary p'. The frequency of the oscillations in the circuit C, p, L, and G depends, among 80 other things, as is well understood, upon the product of the capacity and inductance of such circuit. Similarly, the frequency of the oscillating circuit C', p', L', and G' depends upon the product of the capacity and inductance of 85 such circuit. The capacity and inductance, or rather their product, of the circuit C p L G is taken different from that of the circuit C', p', L', and G', so that the frequency of the electromagnetic waves radiated from the con- 90 ductor A is different from the frequency of the electromagnetic waves radiated from the conductor A'. Since the current supplied by the secondaries S and S' are in quadrature, the oscillations for each train of waves gener- 95 ated in the circuit C p L G begin at a time earlier (or later) than the commencement of a wave-train generated by the circuit C', p', L', and G', such difference in time amounting to a quarter of a period of the current sup- 100 plied to the transformer-primaries P and P'. In other words, the wave-trains emanating from the conductor A are dephased with respect to the wave-trains emanating from the conductor A', and further, the frequency of 105 electromagnetic waves radiated from A is different from the frequency of the electromagnetic waves radiated from A'. Suppose the two-phased currents supplied to P P' to

wave-trains emanating from A' by an amount corresponding with a quarter period or one seven-hundred-and-twentieth of a second. Furthermore, the electromagnetic waves ra-5 diated from A may be at the rate of one million per second, while those radiated from A' may be at the rate of seven hundred and fifty thousand per second. I prefer to have the condensers C and C' of very nearly the same 10 capacity, the inductances of the two circuits being chosen differently in order to secure the different frequencies, so that both condensers will be charged to their maximum potential in equal periods of time, so that the spark at 15 the gap G will precede (or succeed) the spark at G' by exactly a quarter of a period of the current supplied to P and P'. The sparkgaps G and G' are preferably similar in every respect, so that both will break down under 20 similar circumstances.

From the foregoing description it is seen, therefore, that by depressing the operator's key F a plurality of series of wave-trains are transmitted, the wave-trains of the different 25 series being dephased with respect to each other and the electromagnetic waves of each series having a frequency different from the frequency of the electromagnetic waves of

any other series.

Referring to Fig. 2, A is an aerial conductor by which is received electroradiant energy. P is the primary winding of a transformer and is connected between A and the earth-plate e. Across the secondary S is con-35 nected the self-restoring wave-responsive device W, which controls the local circuit including the choke-coils f f, battery B, and primary winding p of a transformer. By this arrangement for every wave-train im-40 pinging upon A a current impulse passes through the primary p. In the circuit of the secondary s there is then a series of impulses or groups of impulses whose rate of succession depends upon the rate of succession of the 45 wave-trains transmitted. To make such secondary circuit selective of wave-trains succeeding each other at a certain rate only, the condenser C and the inductance L are employed to so attune such circuit. 50 resents a telephone-receiver, recording instrument, or any other translating device. In cases where the current in the circuit of the secondary s is extremely faint, due to excessive distance between the transmitting 55 and receiving stations or for any other cause, it is reinforced by the induction-generator K. This induction-generator comprises a primary winding included in series in the circuit of s. The rotor consists of a cylinder or disk 60 of magnetizable metal properly laminated and carrying short-circuited conductors, as well understood in the electrical art. By rotating the rotor at a rate in excess of synchronism for the frequency of the impulses or 65 groups of impulses passing through its pri- I ture c.

mary the current is reinforced or boosted By the arrangement shown in Fig. 2, there. fore, the efficiency of a wireless-telegraph receiving system is increased, and with a given amount of energy employed or radiated the transmitting-station a greater effect may be produced in the recording instrument of the receiver or any other translating device

In Fig. 3, A and A' represent aerial receiving-conductors, between which and the earth e are serially connected the inductances 9 and 10, respectively. The inductance 9, with the aerial A, constitutes a tuned or selective ceiving-conductor selective of the waves of one series of transmitted wave-trains. Similarly, the inductance 10 and aerial A' are selective of the waves of another series of wavetrains. The wave-responsive devices W and W', preferebly self-restoring, are associated with the inductances 9 and 10. Controlled by W is a local circuit including the choke coils ff, battery B, and a primary winding p of a transformer. The secondary s of the transformer is in series with the condenser C. one phase-winding of the two-phase induction-generator K^m, the winding X on the core Z, and the inductance L. The condenser and inductance L are so chosen and adjuste as to make the circuit containing them lective of impulses succeeding each other the rate of or at a mulitple of the rate of sile cession of the wave-trains emitted by transmitter shown in Fig. 1. Similarly, the wave-responsive device W' controls a local circuit including the primary of the transformer whose secondary s' is in series with the condenser C', the other phase-winding of the induction-generator Km, the winding Y on the core Z, and the inductance L'. C' and L' are so chosen and adjusted as to render the circuit containing them selective of impulses or groups of impulses succeeding each other at a rate equal to or a multiple of the rate of succession of the wave-trains emitted by the transmitter shown in Fig. 1. By rotating the rotor of the induction-generator K mabove synchronism for the frequency of the impulses or groups of impulses in the circuits of its windings the currents of such windings will be amplified or boosted and will cooperate in it magnetizing the core Z. Since the transmitted wave-trains do not overlap, but alternate with each other, the core Z receives twice as many or a multiple of twice as many magnetizations per unit of time as there are wave trains in a single series per unit of time. The result is that the armature c is more pos tively attracted and prevented from flutteric and the operation more certain and effective When the armature c is attracted, it engages? the contact a, thus closing a circuit through the battery b and a signal translating or recording instrument, a Morse recorder M. The spring d opposes the attraction of the arms

This application is a division of my prior application, filed July 27, 1903, and bearing Serial No. 167,129.

What I claim is—

1. The method of rendering intelligible messages or signals transmitted through the natural media in electroradiant form, which consists in transforming the received electroradiant energy into the energy of electric currents or charges, controlling by such currents or charges locally-generated electrical energy to produce changes or fluctuations thereof, ampifying the fluctuations or changes of said energy, and controlling or actuating a signal-translating instrument by the amplified energy.

2. The metnod of rendering intelligible messages or signals transmitted through the natural niedia in electroradiant form, which consists in transforming the received electroradiant energy into the energy of electric currents or charges, controlling by said currents or charges the production of current fluctuations representing the transmitted messages or signals, increasing or amplifying said current fluctuations, and employing said amplified or increased fluctuations to reproduce the messages or signals.

3. The method of rendering intelligible messages or signals transmitted through the

natural media in electroradiant form, which consists in transforming the received electro-

radiant energy into the energy of electric currents or charges, controlling by said currents or charges the production of fluctuations of 35 current locally generated, boosting or reinforcing said current and reproducing the messages or signals by said boosted or reinforced current.

4. The method of rendering intelligible 40 messages or signals transmitted through the natural media in electroradiant form, which consists in transforming the electroradiant energy into the energy of electric currents or charges, controlling by said currents or charges the production of a fluctuating current, boosting or reinforcing said current without destroying its message or signal representing form, and reproducing the messages or signals by said boosted or reinforced current.

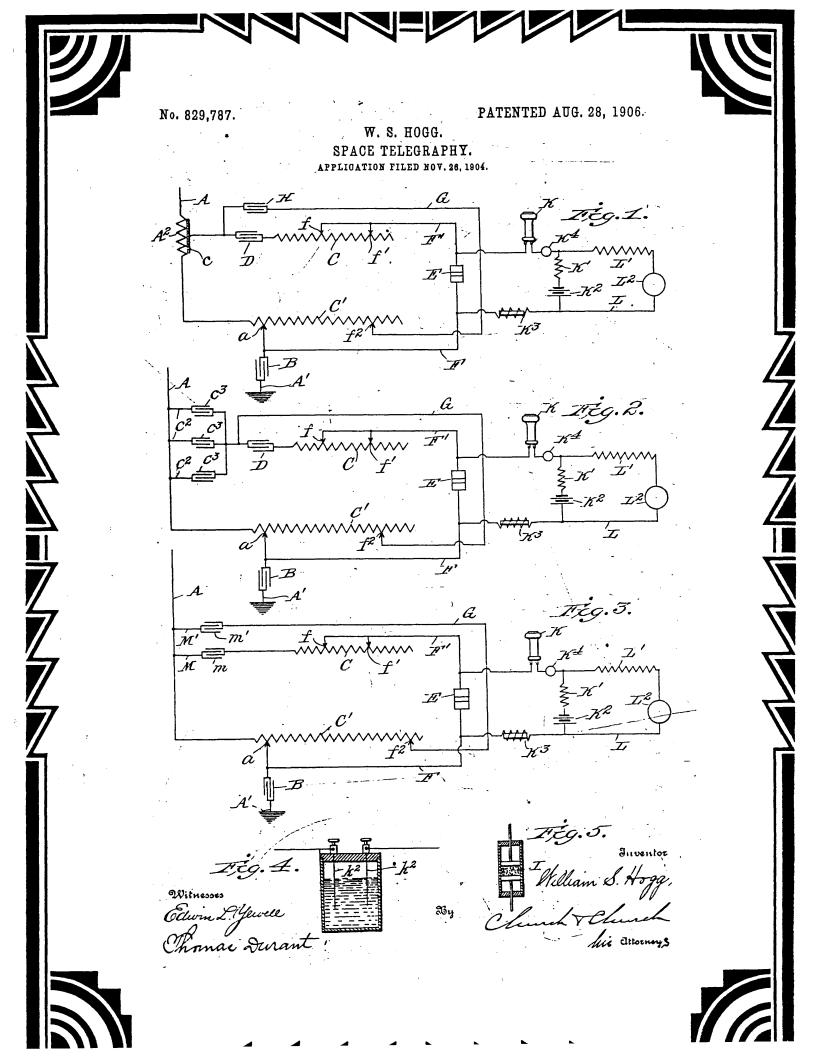
5. As an improvement in the art of reproducing signals or messages represented in transmission by electroradiant energy, the step which consists in amplifying the current 55 changes or fluctuations representing the messages or signals.

In testimony whereof I have hereunto affixed my signature in the presence of two subscribing witnesses.

CORNELIUS D. EHRET.

Witnesses:

ALICE S. MARSH, ELEANOR ROBERTS.



UNITED STATES PATENT-

WILLIAM S. HOGG, OF WASHINGTON, DISTRICT OF COLUMBIA, ASSIGNOR TO OVERLAND & MARINE TELEGRAPH COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

SPACE TELEGRAPHY.

No. 829,787.

Specification of Letters Patent.

Patented Aug. 28, 1906.

Application filed November 26, 1904. Serial No. 234,396.

To all whom it may concern:

Be it known that I, WILLIAM S. Hogg, lieutenant-commander United States Navy, residing at Washington, in the District of 5 Columbia, have invented certain new and useful Improvements in Space Telegraphy; and I do hereby declare the following to be a full, clear, and exact description of the same, reference being had to the accompanying 10 drawings, forming a part of this specification, and to the letters of reference marked thereon.

This invention relates to space telegraphy or the method of transmitting intelligence 15 from one station to another by waves of energy transmitted through the natural media without the use of artificial conduc-

tors connecting the stations.

The objects of the invention are to pre-20 vent interference from outside sources; to provide a call at the receiving-station capable of use in connection with a telephonic receiver; to provide for the attuning of the apparatus and to provide an improved medium 25 sensitive to the waves of energy arriving at

the receiving-station.

The invention consists first in a system attuned to respond to waves of the character it is desired to receive and also tuned to 30 waves of character other than those it is desired to receive, with means whereby the latter will not cause the receiver to respond and as a consequence the intelligence made manifest will correspond only to that trans-35 mitted by the waves of the selected character. The invention further consists in a system having a medium sensitive to the waves of energy transmitted through the natural media, combined with a local circuit includ-40 ing a telephonic or other receiver and having a high-resistance shunt including a call usually in the form of a galvanometer, siphon-recorder relay, or the like.

Finally the invention consists in certain 45 novel arrangements of the circuits and instrumentalities, whereby attuning is facilitated, the calls and signals made distinct and positive and sensitiveness and steadiness secured, all as will be hereinafter described, 5° and pointed out particularly in the appended

Referring to the accompanying drawings, Figure 1 is a diagrammatic view of a receiv- | tion F extends to the ground connection

ing-station embodying the present improvements. Figs. 2 and 3 are similar views 55 showing slightly-modified arrangements for preventing interference. Fig. 4 is a sectional view of the preferred form of polarization-cell employed in the present system. Fig. 5 is a sectional view of the cell of sensi- 60 tive material.

Similar letters of reference in the several

figures indicate like parts.

The aerial which may be of any usual or preferred construction is indicated by the 65 letter A, grounded at A' through a condenser Two inductance or tuning coils C C', В. preferably performed by zizzag resistance-conductors, are employed in connection with the aerial. That lettered C' is preferably in 70 direct connection with the aerial and the ground is made through the adjustable connection a of the tuning-coil. The other tuning-coil lettered C is connected with the aerial through a condenser D and preferably 75 at a series of points, thus as indicated in Fig. 1 the conductor of the aerial is bent into zigzag form at A^2 and a collector-plate c serves to take off the potential at each point, the arrangement, however, may be and under 80 some circumstances preferably is as shown in Fig. 2 where the aerial is provided with a series of widely-separated connections c^2 each of which may have a condenser c^3 therein as shown.

The sensitive medium or coherer indicated at E is located in a local circuit to be presently described and connections be-tween opposite sides of the coherer and aerial are established through adjustable 90 connections with the respective tuning-coils and an additional or primary connection is made with one side through a second adjustable connection with one of said coils whereby through the first-mentioned con- 95 nections both sides of the coherer may be connected to receive simultaneously waves of a certain character but to which it will not respond, presumably because the waves neutralize each other. The other connec- 100 tion however provides a path for the waves which it is desired shall affect the coherer and to which the local circuit will respond.

Referring to the drawings it will be seen that from one side of the coherer a connect- 105 23

above the condenser while from the other side of the coherer a connection F' extends to two adjustable connections ff' with the coil C. From the connection between the coil C and the aerial a connector G leads to an adjustable connection f² with the coil C'.

To prevent short-circuiting of the local

To prevent short-circuiting of the local circuit this connection is provided with a condenser H as shown in Fig. 1, and in Fig. 2 to each of the connections c² is provided with a

condenser c^3 .

In operation the connection f is adjusted to attune the circuit containing the coherer with waves of the character it is desired to 15 receive. If interference is manifest or develops, the connections f' f^2 are adjusted to attune the circuit-bridging or short-circuiting the coherer to the interfering waves when it is found that the latter waves will have no effect on the coherer as the changes in potential due to them will be the same on both sides of the coherer, especially if the coherer be constructed and arranged in a local circuit as will be now described.

The material of the coherer is of such character as to decohere without the use of a tapper and preferably is formed of a comminuted selinite of copper and nickel indicated at I Fig. 5. The proportions of the 30 ingredients should be such as to form a uniform chemical combination or at least a surfacing of the particles. In practice I have used one part of an alloy of nickel and copper (an ordinary nickel coin) comminuted 35 and mixed with five to ten per cent. by vol-ume of selenium and heated. The ingredients combine with much heat forming a selinid of copper and nickel. It is then ground up or comminuted and is ready for use but 40 in use is preferably mixed with an elastic material such as fine particles of soft rubber which it is found increases the range of adjustment and prevents caking. Obviously the sensitive material may be combined 45 with other metal ingredients, such as mercury without departing from the invention, although advantages might accrue from the

The local circuit in which the coherer is 50 included also includes a telephonic receiver K, a resistance K' battery K², choke-coil K³ and a polarization-cell K⁴. In addition, the said circuit has a shunt formed by a conductor L, said shunt including a relatively high 55 resistance L' and a call device, such, for instance, as a galvanometer, a siphon-recorder L³, a relay or other device of like character.

L', a relay or other device of like character.

The polarization-cell K' is preferably formed as shown diagrammatically in Fig. 4

by two lead electrodes k' partially immersed in a sulfuric-acid solution. The electrodes are preferably of fine wire or wire of just sufficient size to prevent material corrosion by the current. The cell with lead electrodes,

tis found, acts as a regulator of the current

through the telephone and causes the coherer to decohere promptly an effect which is not easily obtained and which does not seem to follow where a polarization-cell having platinum electrodes is employed.

obviously the arrangement of the tuning-circuits may be varied considerably from the arrangements shown in Figs. 1 and 2 without departing from the invention and in Fig. 3 a variation is shown wherein the two tuning-circuits are connected with the aerial at different points, indicated at M and M', condensers m' m' of course being interposed to prevent short-circuiting of the local circuit of the receiver.

In operation a small proportion only of the current from the local battery passes through the shunt and call. Variation in the main local circuit will cause a fluctuation of relatively wide range in the sensitive call located 85 in the shunt and give indications to the attendant who will then take the message by means of the telephone-receiver as usual.

The call might be used also to take the message especially if it be a siphon-re-90 corder but if it has a sluggish action the speed would be limited. Obviously both may be used and constitute a check upon

each other.

I do not wish to confine the invention to 95 any particular theory of operation as the application is based upon the results of practical demonstration, thus while non-interference may be due to a neutralization of the interfering waves in the coherer, it may on 100 the other hand be due to the provision of an attuned path to ground or to a combination of the two. So too in the local circuit the resistance in the main and shunt, circuits preferably bear the proportion of one hundred 10; to ten thousand ohms but it is obvious that these proportions may be widely departed from and the proportionate resistances may be secured by the instruments such as the call, telephonic receiver, coherer, &c., with- 110 out the use of special resistance-coils although the latter are preferably employed owing to the facility of adjustment to vary the relation between the main and shunt cir-

Having thus described my invention, what I claim as new, and desire to secure by Let-

ters Patent, is-

1. In space telegraphy, a receiving-station system embodying an aerial, a local circuit including a battery and material sensitive to waves of energy received through the aerial and two circuits connected with the aerial, one attuned to the waves to which the sensitive material is to respond and the other attuned to interfering waves; substantially as described.

ficient size to prevent material corrosion by the current. The cell with lead electrodes, it is found, acts as a regulator of the current aerial, an attuned circuit connection from the 130

ne 130

aerial to each side of the sensitive material, and a second attuned circuit connection from the aerial to one side of said sensitive material.

3. In space telegraphy, a receiving-station system embodying a grounded aerial, a sensitive material in a local receiver-circuit, separate attuned circuit connections from the aerial to opposite sides of the sensitive material, and a second attuned circuit connection from the aerial through said sensitive material to ground.

4. In space telegraphy a receiving-station system embodying a grounded aerial, a sensitive material in a local receiver-circuit, two tuning-coils connected with the aerial and connected respectively with opposite sides of the sensitive material, an adjustable connection between one of said coils and one side of said sensitive material and a ground connection with the opposite side of said sensitive material.

5. In space telegraphy a receiving-station system embodying an aerial, two tuning-coils connected therewith a sensitive material in a local receiver-circuit and included in circuit connections between said tuning-coils and a ground connection with one of said coils; substantially as described.

30 6. In space telegraphy, a receiving-station system embodying an aerial, a sensitive material in a local circuit, separate attuned circuit connections leading from the aerial to opposite sides of the sensitive material, a second attuned circuit connection leading to one side of said sensitive material and a ground connection with the opposite side of said sensitive material.

7. The described improvement in space telegraphy to prevent interference from outside sources, which consists in a sensitive material and circuit connections on both sides of the sensitive material attuned to accord with the interfering waves, the circuit con-

nections on one side of said sensitive mate- 45 rial being also attuned to accord with the waves it is desired to receive.

8. In space telegraphy, a receiving-station embodying a local circuit including a coherer, telephone receiver and battery, and a high-so resistance shunt around the battery including a call device.

9. In space telegraphy, a receiving-station embodying a local circuit including a sensitive material formed of a comminuted seli- 55 nid of a metal, a receiver, battery and polarization-cell.

10. In space telegraphy, a receiving-station embodying a local circuit including a coherer, receiver, battery and a polarization - cell 60 formed of electrodes having lead as a base immersed in an acid solution.

11. In space telegraphy a receiving station embodying a local circuit including a sensitive material formed of a comminuted seli- 65 nid of a metal, a receiver, battery and a polarization-cell formed of lead electrodes immersed in an acid solution.

12. A receiving system for space telegraphy embodying a local circuit including a 70 coherer, telephone-receiver, polarization-cell, resistance-coil and battery and a high-resistance shunt around the battery and resistance-coil and including a call.

13. In wireless telegraphy a receiving-sta-75 tion embodying an aerial, coherer, attuned circuit connections from the aerial to opposite sides of the coherer, an attuned circuit connection from the aerial to one side of the coherer, a local circuit including said coherer. 80 a telephone-receiver, polarization-cell and battery and a shunt from said local circuit including a call.

WILLIAM S. HOGG.

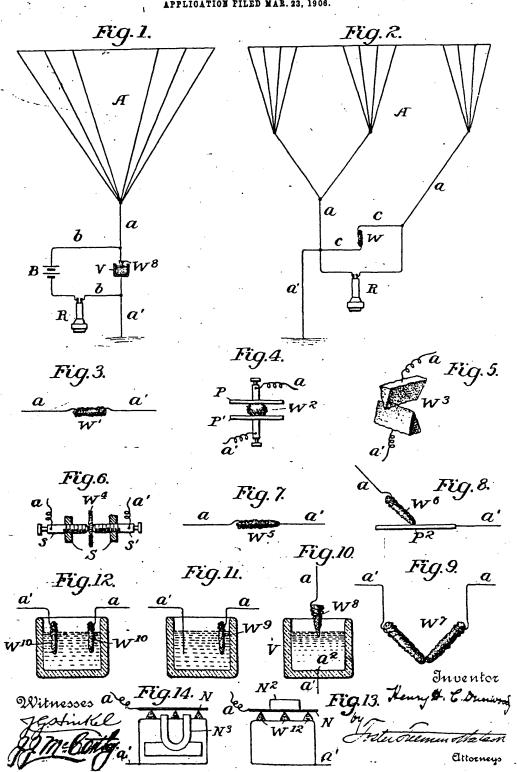
Witnesses:
ALEXANDER S. STEWART,
THOMAS DURANT.



No. 837,616.

PATENTED DEC. 4, 1906.

H. H. C. DUNWOODY.
WIRELESS TELEGRAPH SYSTEM.
APPLICATION FILED MAB. 23, 1906.



UNITED STATES PATENT OFFICE.

HENRY H. C. DUNWOODY, OF WASHINGTON, DISTRICT OF COLUMBIA.

WIRELESS-TELEGRAPH SYSTEM.

No. 837,616.

Specification of Letters Patent.

Patented Dec. 4, 1906.

Application filed March 23, 1906. Serial No. 307,879.

To all whom it may concern:

Be it known that I, HENRY II. C. DUNwoody, a citizen of the United States, residing at Washington, in the District of Colum-5 bia, have invented certain new and useful Improvements in Wireless-Telegraph Sys-tems, of which the following is a specification.

My invention relates to wireless telegraph or signaling systems, and has for its object 10 more particularly to provide an improved wave responsive or detecting device, as well as an improved arrangement of such device in connection with the ordinary apparatus of the receiving-station; and to these ends 15 my invention consists in a wave responsive or detecting device, of the character substantially specified, arranged and operating substantially in the manner hereinafter pointed

In the accompanying drawings, wherein I have indicated some of the ways in which I have utilized my invention, Figure 1 is a diagram of a wave receiving and signaling apparatus of a simple form. Fig. 2 is another diagram; and Figs. 3 to 14 are detailed views showing some specific embodiments and arrangements of the wave-responsive device, which will be more particularly described hereinafter.

My improved wave responsive or detecting device, broadly stated, comprises a mass or body of non-metallic crystalline material, and in practice I have generally used such a mass or body comprising crystalline silicid 35 of carbon or carborundum. This material may be in any desired shape or size, and is generally in the form of a concrete mass or body of crystals which may vary in size and character, and which are composed of carbon 4° and silicon in a chemical combination forming what is chemically known as a "carbid" of silicon, or silicid or carborundum, and is a highly-refractory material, extremely hard

and a relatively poor conductor of electricity. 45 This wave-responsive material may be utilized in many and various forms and connected in the circuit of the signal-receiving apparatus in many and various ways, some of which are indicated in the annexed draw-5° ings, and I do not, therefore, limit myself to any particular manner of using the material.

In the drawings, A represents an aerial receiving conductor or wave collector or an- I one of the conductors or wires a and rests by

tennæ which may be of any well-known or desirable form, being shown, for convenience, 55 as embodying what is generally known as the "fan" type of aerial receiver. This receiver or collector is connected to a conductor a, having a ground terminal a', and interposed in this conductor is the wave-responsive detoce \mathbf{W}' .

In Fig. 1 there is a branch circuit including a battery B and conductors b b', which are connected to the conductors a a' at opposite sides of the wave-responsive device W'. 65 This circuit includes a signal-receiving device, shown in the present case as in the form of an ordinary magnetotelephone receiver R, in practice this being usually embodied in the ordinary head-telephone form for con- 70 venience.

The wave-responsive device W', indicated in Fig. 1, may be of many and various forms and in Fig. 3 I have indicated it in the form of a mass or body of crystalline material as 75 carborundum, to which the ends of the wires or conductors a a' are secured in any suitable way as by being twisted or bound tightly around the ends of the body.

In Fig. 4 the wave-responsive device is 80 shown in the form of a regular mass W2, of the crystalline material supported between two plates or bodies P P' of conducting material, to which the conductors a a' are connected.

In Fig. 5 the wave-responsive device W³ comprises two pieces or bodies of the crystalline material or carborundum having at least one relatively sharp edge, and the edges of the two pieces are placed in contact and may 90 be supported in this relation in any suitable way, and are included in the circuit as before.

In Fig. 6 the wave-responsive device Wis shown in the form of a relatively thin plate or mass of carborundum supported between 95 adjusting-screws s s', mounted in a suitable frame or support S and connected in the electric circuit.

In Fig. 7 I have indicated a concrete mass W's of the material, to one end of which the 100 conductor a is connected in any suitable way, as by being turned or twisted around the body, while the other terminal or conductor a' simply rests in contact with the mass:

In Fig. 8 the material We is connected to 105

gravity upon a plate P² connected to the [other conductor or wire a'.

In Fig. 9 the wave-responsive device W comprises two bodies of the crystalline mai terial connected to the conductors as before, but having portions of their bodies in relatively loose contact.

In Fig. 10, I have shown a vessel V containing some electrolyte, as mercury, or an To acid, or an alkali fluid, and the wave-responsive device W⁸ is preferably in the form of a pointed mass, and at one end is connected to the conductor a the smaller or pointed mass being immersed to a greater or less extent in 15 the electrolyte, and the other conductor a' is either connected to the vessel V, if it is of conducting material, or to a separate electrode or terminal a2 immersed in the electrolytic fluid.

In Fig. 11 the wave-responsive device comprises the mass W9 of the crystalline material connected to one conductor a immersed in an electrolyte, while the other conductor a' extends into the electrolyte at 25 a distance away from the mass.

In Fig. 12 is shown a substantially similar arrangement, except that there are two bodies or masses of crystalline wave-responsive material W10 immersed in the electro-30 lyte.

In Figs. 13 and 14 I have shown another embodiment of my invention, wherein N represents a needle or conductor resting upon the edges of several pieces or blocks Wie of carborundum, which are electrically connected together. In some instances it is desirable to hold the needle or conductor in position as by a weight N2, or a permanent magnet N3, and in these cases, the needle and 40 carborundum are respectively connected to the terminals, as indicated.

I have found that all of these various forms or embodiments of my invention are operative as wave-responsive devices, and I 45 have made other embodiments and arrangements, not necessary to recite herein, these being sufficient to show the various manners of using my improved wave-responsive de-

vice or material. In Fig. 2, I have illustrated an arrangement which I have found to be practically operative, in which there is an aerial receiver or wave-collector A, in which the antenna are connected by the conductors a a to the 55 ground conductor or antenna a', and there is a signal-receiver R in the circuit from a portion of the antennæ between them and the ground. The receiver is bridged by a shuntcircuit c c', including a wave-responsive de-69 vice W, there being no battery or other independent source of electric current. With this arrangement of circuits in connection with my improved wave-responsive device, I wave-responsive device an electrolyte and

electrodes of non-metallic crystalline material extending therein.

9. In the art of wireless telegraphy, a re-5 ceiving apparatus comprising an aerial wire, a ground connection, a signal device in the ground connection, and a shunt-circuit bridging the signaling device and including as a

have been enabled to receive signals sent several hundred miles distant from the re- 65 ceiving-station.

It will be understood that any and all of the various forms of wave-responsive devices illustrated can be used in either of the arrangements of circuits described and illus- 70 trated in Figs. 1 and 2, or in any equivalent arrangement of circuits.

It will be understood that in actual practice, it is desirable to use some of the wellknown tuning devices in connection with the 75 wave-responsive device, as these tuning devices suppress a great many false signals, which would otherwise interfere to a greater or less extent with the understanding of the message, but I do not deem it necessary to 80 show or describe any of these well-known adjuncts, as the wave-responsive device is operative without them as well as with them.

One of the advantages of the use of my improved wave-responsive material, especially 85 in connection with an electrolyte in the manner indicated in Figs. 10 to 12 for instance, is that it is not only very sensitive as a receiver, but I have also found that it possesses the great advantage that the carborundum will 90 not burn out or be destroyed when the receiver is located near a sending-station. Or, in other words, that the intense disturbances or waves produced at a sending-station located in proximity to my improved receiver, 95 do not destroy or injure the same, as is the case with many other responsive devices of the electrolytic type.

If desired, the wave-responsive devices shown in Figs. 10, 11 and 12, may have a 100 coating of glass or other insulating material of such form as to leave the desired area of the mass exposed.

What I claim is—

1. In the art of wireless telegraphy, as a 105 wave-responsive device, a mass of non-metallic crystalline material.

2. In the art of wireless telegraphy, wave-responsive device consisting essentially of carbon and silicon.

3. In the art of wireless telegraphy, as a wave-responsive device carbon and silicon in chemical combination.

4. In the art of wireless telegraphy, a wave-responsive device consisting essentially 115 of crystalline carbon and silicon.

5. In the art of wireless telegraphy, as a wave-responsive device a concrete mass of crystalline silicide of carbon.

6. In the art of wireless telegraphy, as a 120 wave-responsive device a body of carborun-

7. In the art of wireless telegraphy, as a wave-responsive device an electrolyte and a mass of non-metallic crystalline material.

8. In the art of wireless telegraphy, as a wave-responsive device a mass of carborun-

In testimony whereof I affix my signature in presence of two witnesses.

HENRY H. C. DUNWOODY.

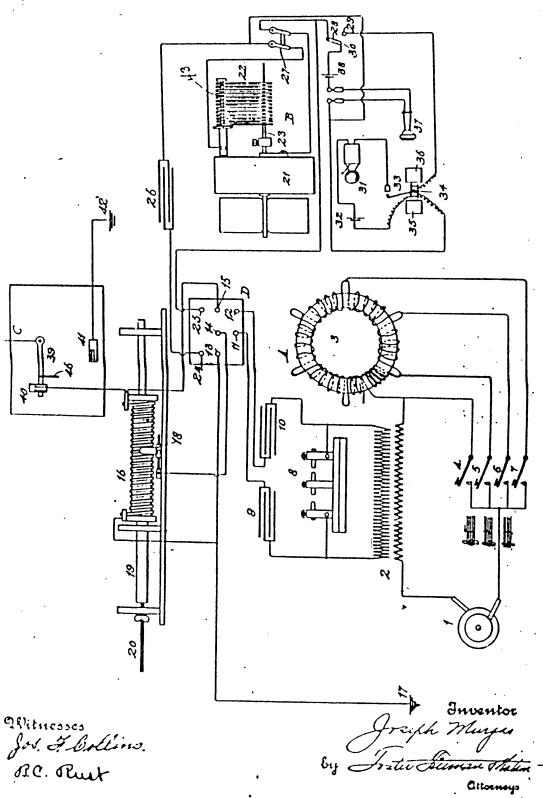
Witnesses:

FRANK L. FREEMAN, MILTON TIBBETTS.

J. MURGAS. WIRELESS TELEGRAPHY. APPLICATION FILED COT. 7, 1005.

917,103.

Patented Apr. 6, 1909.



UNITED STATES PATENT OFFICE.

JOSEPH MURGAS, OF WILKES-BARRE, PENNSYLVANIA.

WIRELESS TELEGRAPHY.

No. 017,103.

Specification of Letters Patent.

Patented April 6, 1909.

Application filed October 7, 1905. Serial No. 281,827.

To all whom it may concern:

citizen of the United States, residing at Wilkes-Barre, Luzerne county, State of I useful Improvements in Wireless Telegraphy, of which the following is a specification.

This invention relates to means for transmitting intelligence through disturbances in |

to the other and dispensing with wires.

The art to which the invention belongs is commonly designated as wireless telegraphy. In Patents Nos. 759,825 and 759,826 granted to me May 10th, 1904, a method and 15 means are set forth whereby messages may be transmitted with greater rapidity than pre-viously obtainable. According to the system therein described, tones of different pitch are employed in place of the dot and 20 dash of the well know Morse system. This is accomplished by causing different spark gap frequencies at the sending station corresponding to the different tones, and these frequencies are produced by a plurality of 25 interrupters, any one of which may be in-cluded at will in the execute of a source of direct current. This means of producing sparks of the desired frequencies has disadvantages; among which may be mentioned 30 those which are well known to be attendant upon the rupture of an electric circuit, such as arcing at the interrupter terminals and consequent destruction of those terminals, especially where large amounts of energy are 35 employed, as well as the disadvantages attendant upon moving parts.

It is the main object of the present invention to produce different spark frequencies from a source of current without the em-

40 ployment of interrupters.

Ancillary and other objects of the inven-

tion will appear hereinafter.

In the accompanying drawing, which illustrates the invention, the drawing is a 45 diagram showing the apparatus of one station and the connections thereof.

The transmission of a message presupposes the existence of two stations, one sending and the other receiving, but as the apparatus 50 at the two stations is identical, an illustration of the apparatus at one is sufficient for the purposes of description.

Referring to the drawing, a station com-

switching means I) for connecting either the Be it known that I, Joseph Munoas, a sending or the receiving apparatus to the antennie at will.

The sending apparatus comprises a source 5 Pennsylvania, have invented certain new and 1 of alternating current, one terminal of 60 which is connected to a terminal of the primary of the transformer 2. The other terminal of the primary is connected to one end of an inductance 3 and also to one terminal of a normally open switch or key 4, the other 63 terminal of the switch being connected to the other terminal of the alternating current source. Other keys 5, 6 and 7 similar to the key 4, are also connected to the last mentioned terminal of the source 1 and to taps 70. taken from different points of the inductance 3 so that by closing the proper key the source may be connected directly to the terminals of the transformer primary or any one of several portions of the inductance may be 75 connected in circuit therewith. A spark gap 8 is connected across the secondary of the transformer. The gap as a whole may consist of a plurality of breaks as shown or may consist in but a single break. The terminals su of the gap are preferably made adjustable as shown. The terminals of the gap are respectively connected, through the condensers 9 and 10, with the contacts 11 and 12 of the switch D.

The switch D may be of the well known three pole double throw type. The middle contacts 13, 14 and 15 of the switch are, in the order named, connected one to one end of the inductance 16 and to the earth at 17, 90 another to the sliding contact 18 adapted to contact with the coils of the inductance 16. and the other to the other end of the inductance 16 and to the antennæ C. It will now be seen that when the switch D is thrown 93 downwarldy, the transformer secondary and spark gap connected in parallel are connected through condensers in shunt with an inductance interposed between the antennæ and ground. The amount of the inductance 100 included between the terminals of the secondary circuit may be regulated by sliding the contact 18 in one direction or the other as may be required to include a greater or less number of turns. To effect a further 105 and nicer adjustment of the inductance, means may be provided-for varying the distances between its turns. This may be prises sending apparatus A, receiving apparatus B, the usual antennes or serial wire C and bearing against the end of the inductance 110

coil and moved in one direction or the other ! by a suitably mounted screw 20. When the screw is turned in one direction the coil will be compressed, while when the screw is s turned in the other direction the coil will be lengthened.

The apparatus of the secondary circuit described, containing the secondary of the transformer, the spark gap, the condensers 10 and the inductance, constitute an oscillatory circuit well known in the art and which may be adjusted in a well known manner to pro-

duce the desired results.

When messages are to be sent by means of 15 tones as set forth in the patents before referred to, the alternator is adjusted to run at a suitable frequency which may be fixed. The spark frequency depends upon the length of the gap, being less when the spark 20 gap is greater and vice versa, and the gap is adjusted so that when the key 4 is closed (the alternator connected directly across the transformer primary) a spark frequency corresponding to the frequency of the alternator 25 and a tone is produced. It will be understood that the inductance capacity and resistance of the oscillator will be adjusted in a well known manner to produce the desired oscillatory effects. To secure another tone, 30 the spark frequency may be lowered by inserting inductance in the primary circuit. This may be accomplished by depressing the key 5 which is connected to a point in the inductance 3 such that sufficient inductance will be included in the primary circuit to produce a spark frequency corresponding to a lower tone. This tone may differ by an octave or octaves from the first and the point at which the key is to be connected to 40 include the proper amount of inductance may be ascertained by gradually inserting inductance until the tone is produced. The keys 4 and 5 and connected apparatus are sufficient for the purposes of sending a mes-45 sage, since two tones will fulfil that purpose, but if other tones are desired additional keys as 6 and 7 can be connected to other points of the inductance 3 corresponding respectively to other tones. The points at which 50 the additional keys are to be connected may he ascertained as before described and the several tones will differ from each other by an octave or octaves. It will now be obvious that a message is sent by depressing the keys 55 in the proper order to produce tones as

required by the code employed.
The receiving apparatus comprises an imperfect contact driven by the motor 21, as in my patents referred to, and the contact itself 60 may be as therein described, but is here shown as a number of carbon bars 22 bearing at one end upon a polished steel shaft 23 driven by the motor, and at the other end upon a platinum support 43. The terminals

terminals 24 and 25 of the switch D, and when that switch is thrown upwardly, these terminals are connected respectively to the antennæ and ground. A condenser 26 is inscrted in one of the connections. A switch 70 27 may be provided for disconnecting the imperfect contact when sending, as strong discharges through the contact have been observed when oscillating waves were produced in the spark gap. A switch 28 when 75 bearing upon one contact 29 connects in calling apparatus, and when upon another contact 30 connects in receiving apparatus.

The call receiving apparatus comprises a bell 31 connected in circuit with a battery 32 80 and a switch 33. The movable member of the switch is carried by a movable coil 34 mounted to turn in the field of the magnets 35 and 36. When the switch 28 is upon the contact 29, the coil 34 is connected across 85 the imperfect contact and upon receipt of an impulse at the station, the coil 34 is energized and moves in the magnetic field thereby closing the circuit through the battery 32 and bell 31 whereupon the bell rings.

The message receiving apparatus comprises telephone receiver 37 and a battery 38. When the switch 28 is upon the contact 30 the receiver and battery are connected across the terminals of the imperfect contact and 95 messages are received, as described in my

patents referred to.

Preferably a switch 39 is provided which when engaging contact 40 connects the antenna to the sending or receiving apparatus, 100 and when engaging contact 41 disconnects the antennæ from the apparatus and connects it directly with the ground as at 42. By this means the antenne may be disconnected from the station apparatus and con- 105 nected with the ground in time of storm or at other times. A rope 46 may be connected with the switch 39 or other suitable means may be provided whereby the switch may be operated without rendering it necessary for 110 the operator to place himself in dangerous proximity thereto.

It is to be understood that various constructions and arrangement of apparatus may embody the invention, and it should not, 115. therefore, be limited to the structure and ar-

rangement shown. What I claim is,-

1. In a wireless telegraph system, an apparatus for transmitting messages made up of 120 signal elements each differing from the others in spark frequency, comprising a spark producing circuit, a single source of alternating current adapted to impress energy thereon and produce a spark frequency correspond- 128 ing to a signal element, and pleans for changing said spark frequency to produce a different signal element.

2. În a wireless telegraph system, an appa-65 of the contact are connected to the upper | ratus for transmitting messages made up of 130

signal elements each differing from the others { in spark frequency, comprising a spark producing circuit, an inductance, a single source of alternating current adapted to impress i 5 energy upon said circuit and produce a spark ; frequency corresponding to a signal element with said inductance in circuit therewith, and means for changing said inductance to produce a different spark frequency correspond-

10 ing to a signal element.

3. In a wireless telegraph system, an apparatus for transmitting messages made up : of signal elements each differing from the others in spark frequency, comprising a 15 spark producing circuit, an inductance, a single source of alternating current adapted to impress energy upon said circuit and produce a spark frequency corresponding to a signal element with said inductance in cir-20 cuit therewith, and means for cutting said inductance out of circuit.

4. In a wireless telegraph system, the combination with an apparatus for transmitting messages made up of signal elements each 25 differing from the others in spark frequency, comprising a spark producing circuit, a single source of alternating current adapted to impress energy thereon and produce a spark frequency corresponding to a signal element, 30 and means for changing said spark frequency to produce a different signal element.

5. In a wireless telegraph system, an appuratus for transmitting messages made up of tones differing from each other in spark 35 frequency, comprising a spark producing circuit a single amires of alternating surrant numbered to impress a frequency thereon with tone characteristic, and means for changing said frequency to produce a different tone

40 characteristic.

6. In a wireless telegraph system, an apparatus for transmitting messages made up of signal elements each differing from the other in spark frequency, comprising a spark 16 producing circuit, a single source of alternat- in presence of two witnesses. ing current, and means for operatively associating said source with said circuit, said means comprising a plurality of connections having different inductances and means for 50 effecting the association of said source with i

said circuit through any one of said connections at will.

7. In a wireless telegraph system, an apparatus for transmitting messages made up of signal elements each differing from the \$5 other in spark frequency, comprising a spark producing circuit, a transformer, the secondary of said transformer being included in suid circuit, a source of alternating current, and means for connecting the terminals of 60 said source to the primary of said transformer, said means comprising a plurality of connections having different inductances and means for connecting said source with said primary through any one of said connections 65 at will.

8. In a wireless telegraph system, an apparatus for transmitting messages made up of signal elements each differing from the other in spark frequency, comprising a spark 70 producing circuit, a source of alternating current, an inductance comprising a coil, taps from said coil, and means for operatively associating said source with said circuit, said means comprising means for connecting any 75

of said taps with said source at will. 9. In a wireless telegraph system, an apparatus for transmitting messages made up of signal elements each differing from the other in spark frequency, comprising a spark 80 producing circuit, a transformer, the secondary of said transformer being included in said circuit, a source of alternating current having one terminal connected with a terminal of the primary of said transformer, st said source with the other terminal of said primary at will, an inductance comprising a coil, one terminal of said coil being connected with one terminal of said primary, 90 taps from said coil, and means for connecting

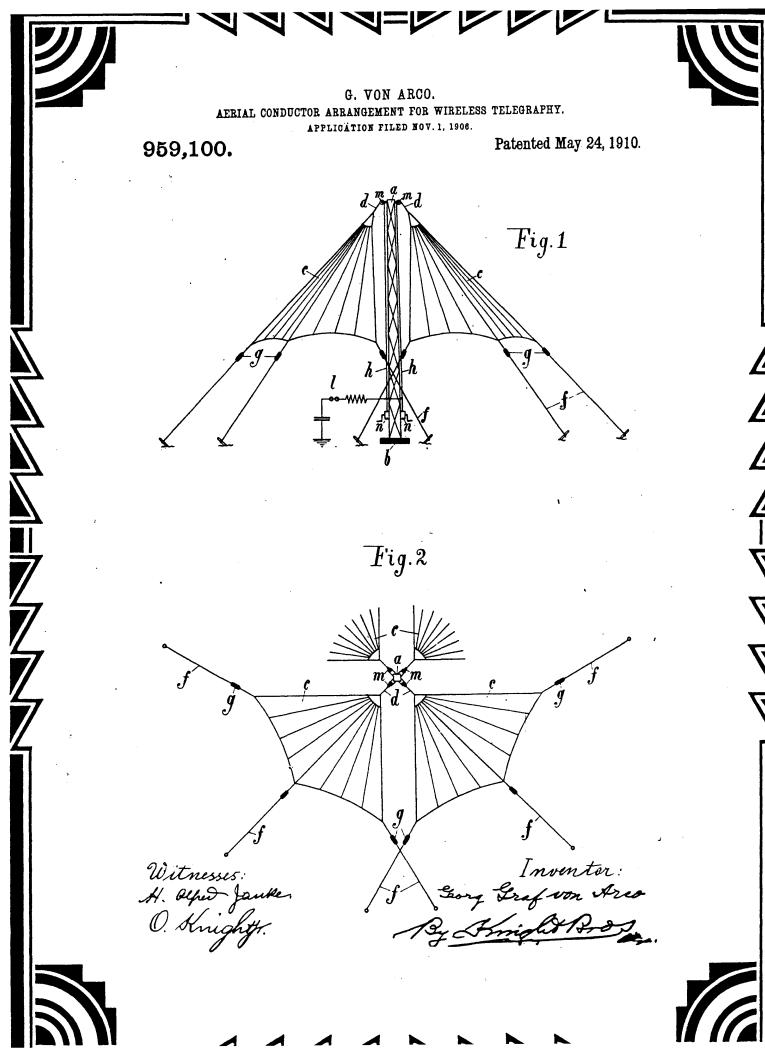
source at will. In testimony whereof I affix my signature

any one of said taps with a terminal of said

JOSEPH MURGAS.

Witnesses:

W. L. RAEDER, K. E. FERRY.



TED STATES PATENT OFFICE.

GEORG VON ARCO, OF BERLIN, GERMANY.

AERIAL CONDUCTOR ARRANGEMENT FOR WIRELESS TELEGRAPHY.

959,100.

Specification of Letters Patent. Patented May 24, 1910.

Application filed November 1, 1906. Serial No. 341,573.

To all whom it may concern:

Be it known that I, Georg Graf von Arco, engineer, a subject of the King of Prussia, residing at Berlin, Germany, have 5 invented certain new and useful Improvements in and Connected with Aerial Conductor Arrangements for Wireless Telegraphy, of which the following is a full, clear, and exact description, reference being had 10 to the accompanying drawing, forming a

part of this specification. Ror reasons of strength, facility of dismounting, and economy, iron constructions increasingly utilized in place of the 15 moden masts, towers or the like formerly imployed for wireless telegraphy despatch-ing and receiving stations, both for fixed well as for transportable purposes. Such towers made of metal, however, absorb a large part of the transmitting and receiving energy. It is therefore necessary to divide such towers in several parts and to insulate them at the places of division, in order that the vibration period of the separate that the vibration period of the vibration per bration period of the aerial conductor network. Such subdivisions militate against the strength of the tower, and also by them the result sought after is only incompletely 30 attained, as the subdivision can in practice only be carried to a certain limit. Finally such subdivisions are also very expensive. It is already known to employ electrically conducting masts, which are insulated from

the earth, as aerial conductors, and to use these masts also as supports of a small capacity area. In such cases however, the mast forms the principal member of the serial conductor system and far exceeds in 40 its capacity that of the above mentioned ca-

pacity area.

The present invention relates to long distance stations with antennæ having a very large capacity. This latter is attained by employing an aerial conductor system which consists of an umbrella-like arranged series of wires which are fastened on the one hand to the upper end of a central support on the other hand to several fixed points on or near the ground lying outside the mast or support. Such umbrella shaped antennæ have a large capacity, and it has been found that conductively connecting such antennæ with an iron mast does not cause interrup-55 tions, as the capacity of the latter is very

small as compared with that of the antennæ. It is preferable not to use the mast as a conducting part, but to electrically connect the antennæ with the wireless telegraph apparatus by means of wires, for instance, 60 copper cables, running up the sides of the mast. It is, however, not necessary to insulate these wires from the mast.

Of course any constructions formed of iron or like material which are riveted or 65 bolted together may be employed as masts, towers or the like. Mannesmann tubes, framework or lattice girders may preferably be employed for this object.

In the accompanying drawings one form 70 of construction of the invention is diagrammatically shown in Figures 1 and 2 as an

a indicates the iron mast, which is constructed on an insulated base b. The aerial 75 conductor system consists of numerous wires running in all directions from the upper point of the tower, these wires being stretched umbrella fashion between the tower and several fixed points outside the same. In the 80 present case the apparatus is formed of several separate parts or sections c which are each connected by a wire d to the top of the tower or mast. The sections are stretched umbrella like toward the ground by means 85 of guy wires f, of which, in this case, three are provided for each section c and which are insulated therefrom by means of interposed insulators g. Guy wires f in turn are fastened to ground posts circularly arranged 90 around support or mast a, as shown in the drawings. The wire sections are arranged in such a manner that they are movable up and down independently from each other, so as to facilitate the repairing of defects 95 or the like.

h indicates conducting wires which are carried up along the mast on several sides. No insulation of these wires from the mast is necessary. The transmitting and receiv- 100 ing apparatus l for the wireless telegraphy, which are placed in a separate building. may be connected with the wires h. In the drawing the conducting wires or ropes h are at the same time used for moving the sev- 105 eral sections up and down. For this purpose rollers m and windings n are mounted on the tower or mast a, and the transmitting and receiving apparatus are detachably connected to the wires h.

Having explained my invention, what I claim and desire to secure by Letters Pat-

1. An aerial conductor system for wireless 5 telegraphy, consisting of a central electrically conducting support insulated from the ground and an umbrella shaped group of wires running obliquely toward the ground, said wires being at one end electrically con-10 nected with said support and at the other end fixed to several distant points on the ground and insulated therefrom, substantially as described.

2. An aerial conductor system for wireless 15 telegraphy comprising a central support and an umbrella shaped group of wires consisting of a plurality of sections, each section individually held by said support at one end and means for stretching each section ob-20 liquely in umbrella shape toward the ground

at the other end.

3. An aerial conductor system for wireless telegraphy comprising a central support and an umbrella shaped group of wires consist-25 ing of a plurality of sections, each section individually held by said support at one end and guy wires fastened to each section at the other end, but insulated therefrom and fastened to the ground circularly around 30 said support for stretching said sections in umbrella shape toward the ground.

4. An aerial conductor system for wireless telegraphy comprising a central support and an umbrella shaped group of wires consisting of a plurality of sections, each section individually held at one end by said suppor and detachable therefrom, and means stretching said sections obliquely in in

brella shape toward the ground.

5. An aerial conductor system for wirel telegraphy comprising a central support an umbrella shaped group of wires consist ing of a plurality of sections, each sections individually held at one end by said support and detachable therefrom and guy wires fastened to each section, but insulated there. from and fastened to the ground circularly around said support for stretching said sec tions in umbrella shape toward the ground

6. An aerial conductor system for wirelest telegraphy comprising a central electrically conducting support, insulated from the ground and an umbrella shaped group of wires consisting of a plurality of sections, each section individually held at one end in said support, and detachable therefrom and guy wires fastened to each section but in sulated therefrom and fastened to ground circularly around said support stretching said sections in umbrella shape toward the ground.

In witness whereof, I hereunto subscribe my name this 20th day of October A. D.

GEORG VON ARCO

Witnesses:

HENRY HASPER, Woldemar Haupt.

F. A. HART.

APPARATUS FOR RECEIVING ELECTROMAGNETIC WAVES.

APPLICATION FILED MAY 6, 1910.

984,762.

Patented Feb. 21, 1911.

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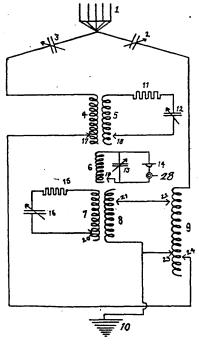


Fig.1.

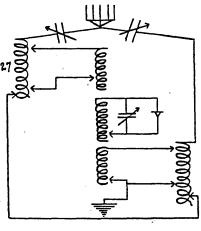
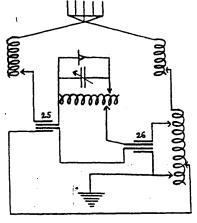


Fig. 2.



INVENTOR



FRANCIS A. HART, OF NEW YORK, N.

APPARATUS FOR RECEIVING ELECTROMAGNETIC WAVES.

Specification of Letters Patent. - Patented Feb. 21, 1911.

Application filed May 6, 1910. Serial No. 559,768.

To all whom it may concern:

Be it known that I, Francis A. Hart, a citizen of the United States, residing at 942 St. Marks avenue, New York city, borough 5 of Brooklyn, county of Kings, and State of New York, have invented a new and useful Improvement in Apparatus for Receiving

Electromagnetic Waves.

My invention relates to those forms of 10 syntonic receptors of Hertzian waves in which variable inductances and variable capacities are used to determine the frequency of natural response of the tuned or syntonic circuit, and it may equally well be applied to 15 those forms of receptors in which provision is made for receiving by means of the group frequency of the radiated waves. I further aim to secure freedom from what is known in the practice of the art of wireless teleg-20 raphy as "interference", that is, my inven-tion is so arranged as to respond very strongly to waves of a certain frequency and to the minimum possible extent to waves of other frequencies thus rendering possible the 25 reception of messages from a distant station concomitant with the sending of messages at a slightly different wave length from the above mentioned at a near station. The means I use to attain these ends are two-30 fold: (1) through the use of a particular arrangement of "balanced" and selective circuits, and (2) through the use of noninductive resistances for eliminating undesired wave lengths. These means will be 35 successively discussed.

First: The use of a particular arrangement of "balanced" and selective circuits.— In Figure 1 hereto subjoined let 1 represent the lower end of the system of conductors 40 used in the reception of electromagnetic waves and known briefly as the antenna or aerial. The figures represent the following 1 antenna, 2, 3, 12, 13 and 16 variable condensers. 4 and 8 are primaries of an oscil-45 lation transformer. 5 and 7 are secondaries of said transformer acting as the non-inductive resistances. 11 and 15 are resistances. 9 a tuning coil and 14 a suitable detector, 28 telephone, 17, 18, 19, 20, 21, 22, 23 and 50 24 variable contacts. Fig. 2, 27 a tuning coil. Fig. 3, 25 and 26 are condensers. The conductor from the lower end of 1 divides into two parts, 3, 4, 17 and 24, second path 2 22 9 23 24.

2 and 3 are variable capacities of any type which shall prove convenient such as the in- I the selectivity and is the claimed improve-

terleaved plate or concentric cylinder types and 4 and 9 are coils of conducting wire. The effective inductance of these coils may be varied by the means of the sliding con- 60 tacts 17 and 24 or otherwise. Since the frequency of maximum response of a circuit is determined by the product of the inductance and capacity in that circuit, any of the previously mentioned circuits may be adjusted 65 to respond to any given wave frequency within limits. In shunt across a part of the coil 9 is the coil 8. The portion of 9 across which 8 is connected is determined by means of the sliding contacts 22 and 23, and the in- 70 ductance of 8 itself is varied by means of the sliding contact 21 or otherwise. One of the terminals of coil 8 (as 23) is connected directly to the earth. Coils 4 and 8 form the primary coils of an oscillation transformer 75 of which coil 6 is the sole secondary, that is, coil 6 is coupled inductively to both coils 4 and 8 simultaneously. The inductance of coil 6 may be varied by means of the sliding contact 19 or otherwise. Connected to the 80 terminals of coil 6 are the terminals of the variable capacity 13 and also the terminals of the detector 14 in series of which is the telephone 28. The closeness of the inductive coupling between coil 6 and coils 4 and 85 8 can be varied at will within limits. The circuit 6 19 13 14 28 is the actual receiving circuit and the arrangement of detector and telephone in it may be made in any of the well known ways in present use. Thus the 90 receiving telephone may be connected directly across the terminals of the detector 14. or it may be connected in series with the same, or across the terminals of an auxiliary capacity which shall itself be in series with 95 14 across the terminals of 13, or otherwise.

The distribution of current and potential in a network of conductors like the above is quite complicated but the effects produced are as follows: The circuit 3 4 9 2 may be 100 tuned to respond to the desired wave frequency which will be denoted by A, and at the same time it is possible to tune the circuits 3 4 6 13 to the frequency A. It can be so arranged that the waves of the unde- 105 sired frequency B will not act on the circuit 6 13 14 because their amplitude (or current value) in the branches 4 and 8 will be equal but since these branches are opposed, their joint action will be null for waves of the 110 frequency B. The coil 8 greatly increases

ment. For if contacts 22 and 23 are kept equally distant the amplitude of the current, due to any frequency which passes through 9, in the branch 8 can be regulated 5 by moving 22 and 23 up or down coil 9. This affords a very valuable means of control of the current in 8 and hence of its neutralizing action of the effects produced by the frequency B (passing through 4) 10 on 6.

Secondly: The use of non-inductive resistances for eliminating undesired wave lengths or frequencies.—It is well known that no oscillatory current can pass in a 15 circuit for which R, the resistance is greater than two times the square root of the quotient of L, the inductance of the circuit, divided by C, the capacity of the circuit. If such a state of affairs exist in a circuit that 20 circuit is said to be aperiodic. Circuits 5 11 12 13 and 7 20 16 15 are circuits which, through the introductions of resistances 11 and 15, or otherwise are nearly but not quite aperiodic. Such circuits are highly 25 damped and therefore will absorb a considerable amount of energy at the frequency to which they are tuned by converting the absorbed energy into heat in the resistance of the circuit. Coils 5 and 7 are coupled 30 inductively or otherwise to coils 4 and 8 respectively and are therefore capable of absorbing energy at undesired frequencies and increasing the selective action of the whole arrangement.

It is by no means necessary to couple the circuits in the balancing circuit inductively as shown in Fig. 1. Fig. 3 shows how the couplings may be made electrostatically through the condensers 25 and 26 whose
special method of design is clearly evident from the figure. It is also sometimes desirable to render the balancing circuits symmetrical, as shown in Fig. 2, where by the addition of coil 27 symmetry between the
two sides of the balancing circuit is attained. In general, this complication will not be found processory.

not be found necessary.

I am aware that the balance method cf securing freedom from interference in the 50 reception of electromagnetic waves have been used previously, and I do not therefore claim this method broadly but

I claim:

1. In a device for the reception of electro55 magnetic waves, an antenna, two alternative paths to the earth from the antenna, one of said paths consisting of an inductance and a capacity and the other of a capacity and two inductances so arranged that 60 one of the two shall be placed in parallel with a portion variable at will of the other.

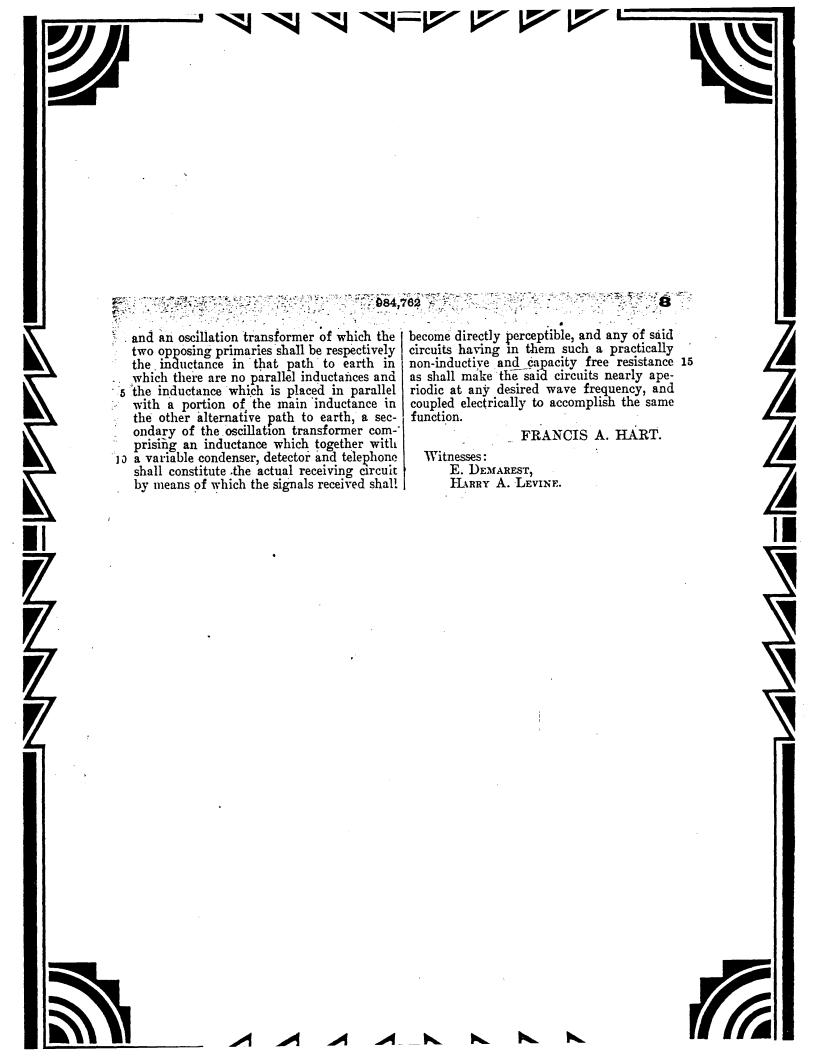
2. In a device for the reception of electromagnetic waves, an antenna, two alternative paths to the earth from the antenna, one of the two shall be placed in parallel with a portion variable at will of the other.

dance and a capacity and the other of a pacity and two inductances so arranged that one of the two shall be placed in parallel with a portion variable at will of the other and an oscillation transformer of which the two opposing primaries shall be respectively the inductance in that path to earth in which there are no parallel inductances, and the inductance which is placed in parallel with a portion of the main inductance in the other alternative path to earth.

3. In a device for the reception of electromagnetic waves, an antenna, two alterna? tive paths to the earth from the antenna, one of said paths consisting of an induction tance and a capacity and the other of a capacity and two inductances so arranged that one of the two shall be placed in parallel with a portion variable at will of the other and an oscillation transformer of which the two opposing primaries shall be respectively the inductance in that path to earth in which there are no parallel inductances and the inductance which is placed in parallel with a portion of the main inductance in the other alternative path to earth, a secondary of the oscillation transformer comprising an inductance which together with a variable condenser, detector and telephone shall constitute the actual receiving circuit by means of which the signals received shall become directly perceptible.

4. In a device for the reception of electromagnetic waves, an antenna, two alternative paths to the earth from the antenna. It one of said paths consisting of an inductance and a capacity and the other of a capacity and two inductances so arranged that one of the two shall be placed in parallel with a portion variable at will of the other and an oscillation transformer of which the two opposing primaries shall be respectively the inductance in that path to earth in which there are no parallel inductances and the inductance which is placed in parallel with a portion of the main inductance in the other alternative path to earth, a secondary of the oscillation transformer comprising an inductance, which together with a variable condenser, detector and telephone shall constitute the actual receiving circuit by means of which the signals received shall become directly perceptible, and any of said circuits having in them such a practically non-inductive and capacity free resistance as shall make the said circuits nearly aperiodic at any desired wave frequency.

5. In a device for the reception of electromagnetic waves, an antenna, two alternative paths to the earth from the antenna, one of said paths consisting of an inductance and a capacity and the other of a capacity and two inductances so arranged that one of the two shall be placed in parallels with a portion variable at will of the other



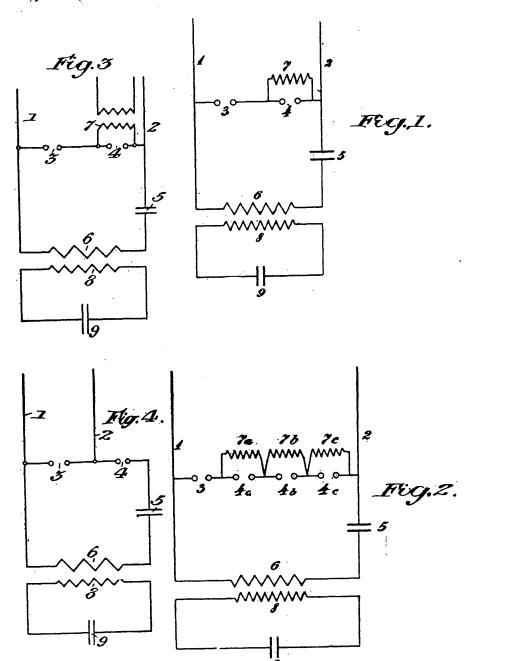
A. MEISSNER.

MEANS FOR PRODUCING SLIGHTLY DAMPED OSCILLATIONS BY SHOCK EXCITATION.

APPLICATION FILED JUNE 7, 1810.

1,077,733.

Patented Nov. 4. 1913.



Hikkingto. Ray J. Ernet. INVENTOR
Alexander Meissner
by his attorneys

NITED STATES PATENT OFFICE.

ALEXANDER MEISSNER, OF BERLIN, GERMANY, ASSIGNOR TO GESELLSCHAFT FÜR DRAHTLOSE TELEGRAPHIE, M. B. H., OF BERLIN, GERMANY, A CORPORATION OF GERMANY.

MEANS FOR PRODUCING SLIGHTLY-DAMPED OSCILLATIONS BY SHOCK EXCITATION.

1,077,733.

Specification of Letters Patent.

Patented Nov. 4, 1913.

Application filed June 7, 1910. Serial No. 565,558.

To all whom it may concern:

Be it known that I, ALEXANDER M. ISS-NER, a subject of the German Emperor, and residing at Berlin, Germany, have invented certain new and useful Improvements in Means for Producing Slightly-Damped Os-cillations by Shock Excitation, of which the following is a specification.

My invention relates to means for pro-10 ducing slightly dampened oscillations with the aid of a primary oscillation circuit, to which current impulses are imparted and means acting upon some of the spark gaps of this circuit in such manner that the gaps 15 do not limit the charging tension.

In arrangements for producing quenched sparks, such as in Wien's system, arrangements employing mercury vapor lamps or the like, which consist, as is well known, 20 of two circuits coupled with each other in suitable manner and tuned to each other, there are limits both for the maximum admissible energy per spark and for the degree of coupling between the quench gap 25 circuit and the secondary circuits which should not be exceeded, for otherwise the quench effect if present at all is obtained only imperfectly.

The principal object of my invention is 30 to provide a connection for facilitating the quench effect of spark-gaps, in order to be able either to employ closer degrees of coupling when the usual quench gaps are used and to increase the energy per spark, 35 or to employ spark-gaps which do not otherwise quench, to obtain the quench effect. The new connection simultaneously admits of the succession of sparks being increased beyond the limits customary heretofore, be-40 cause owing to the sparks being more rapidly quenched the resistance in the spark gaps rises more rapidly and consequently the time during which the spark-coil or transformer is short-circuited is shortened. 45 This end is substantially attained by interpolating in the primary oscillation circuit which I shall call hereafter the quench gap circuit an additional spark-gap having a high-frequency current resistance con-50 nected therewith in parallel, if necessary, but in any event so, that it does not limit the charging voltage. By high frequency current resistance the art understands nowadays means which offer a high resistance as an aerial for the purpose of radioteleg-

I to high frequency currents only, but which 55 not necessarily also constitute resistances for low frequency currents. For instance, a coil which may have a practically negligible inductance in low frequency circuits may offer a considerable resistance to the 60 current in a high frequency circuit. These means may for instance also be ohmic resistances or condensers or the like, and their function will be explained in detail herein-

All quench spark-gaps known heretofore, whether constructed as short Wien sparkgaps, as mercury-vapor lamps, as quench tubes or otherwise, have a twofold duty to perform in the connection in which they 70 were used heretofore. First, before the spark occurs they serve for limiting the charging of the condenser, second after the spark is formed they aid the quenching of it. because the resistance of the discharging 75 gap is rapidly increased by the continuous delivery of energy to the secondary circuit. According to my invention these two duties are separated. One spark-gap serves, as usual, for limiting the voltage for starting 80 the sparks, but together with the additional spark-gap it serves for causing them to be rapidly quenched.

Some illustrative embodiments of my invention are represented in the accompany- 85

ing drawing, wherein:

Figure 1 shows the use in connection with an ordinary oscillatory circuit of a supplementary spark gap bridged by an inductance. Fig. 2 shows a plurality of such 90 supplementary spark-gaps in such a circuit. Fig. 3 shows an arrangement similar to that in Fig. 1, wherein the choking coil 7 forms the secondary of a spark coil. Fig. 4 shows an arrangement similar to that in 95 Fig. 1, wherein the feeder 2 is arranged between spark-gaps 3 and 4.

Referring firstly to Fig. 1, 1 and 2 designate the charging feeders, 3 denotes the main spark-gap, 6 the primary coil of a 100 transformer, 5 the condenser of the quench circuit, 4 an additional spark-gap, 7 a high frequency resistance, for instance a choking coil connected in parallel with the latter, 8 the secondary transformer coil, coupled 105 with coil 6, and 9 the capacity of the tuned secondary circuit which is generally formed

raphy. During the charging operation, the additional spark-gap 4 is practically shortcircuited by the choking coil 7, so that the charging tension is limited solely by the spark gap 3. When the tension at which the gap 3 is broken down is reached and the spark occurs, this gap becomes conductive and the potential of conductor 1 is now directly at one of the electrodes of gap 4, 10 and thus also at the corresponding end of the high frequency resistance 7. The other electrode of gap 4 and the corresponding end of resistance 7 were connected before with the other side of the condenser, and 15 therefore the potential of that condenser side exists already at that side of gap 4 and of the resistance. From this it will be seen that at the moment gap 3 is broken down the total tension is transferred to gap 20 4, and the high frequency resistance 7. The latter has the effect that the potential difference can not be equalized immediately and since this difference is greater than the tension at which gap 4 commences to break 25 down, the gap will be broken down immediately. The difference in time between the breaking down of gaps 3 and 4 would be difficult to measure on account of the rapid succession in which these two gaps break 30 down. From the foregoing, it will be noted that this function of the high frequency resistance as characterized before may be performed by any kind of resistance, which is large enough to prevent the immediate 35 equalizing of the potential difference between the two electrodes of gap 4, and aside from inductances and capacities, also ohmic resistances have been successfully used for this purpose. When thus as explained 40 above gap 4 has been broken down choking coil 7 is practically cut out of circuit, and the quench gap circuit consists of the transformer coil 6, capacity 5 and the two sparkgaps 3 and 4. The choking coil 7 or its 45 equivalents, as defined above, must be proportioned in the arrangement according to Fig. 1 only for a quite small strength of current, because it is not traversed by large currents either during charge or discharge. 50 High frequency resistance 7 may be formed as the secondary coil of a spark-coil, as shown in Fig. 3, wherein 7 is the secondary and 10 the primary coil of an inductorium. In this event the discharge can be brought 55 about by the latter. Under certain circumstances the spark-gaps 3 and 4 may be ordinary spark-gaps. But the efficiency of the entire arrangement is considerably increased when either the one or the other or 60 both are formed as quench spark-gaps.

The feeder 2 can be connected equally well between the spark-gaps 3 and 4 without changing the effect of the arrangement. In this event the choking coil 7 may be done away with if the additional spark-

gap 4 be sufficiently small as compared with the spark-gap 3. This arrangement is shown in Fig. 4, wherein the reference numerals are the same as in Fig. 1.

The quench effect is particularly increased when, instead of one additional or auxiliary spark-gap and a high frequency resistance connected in parallel therewith, several such combinations are connected in series. Fig. 2 shows such an arrangement as an example. In this figure, 1 and 2 designate the charging feeders, 3 is the main spark-gap, 4°, 4°, 4° are the additional spark-gaps, 5 designates the capacity, and 6 denotes the transformer coil of the extinguishing circuit; 7°, 7°, 7° are choking coils, or one choking coil having branches, arranged in parallel with the additional spark-gaps. The tuned secondary circuit is formed by the transformer coil 8 and the capacity 9. It will be noted that in this case, where each of the several spark gaps has its high frequency resistance, the gaps are broken down consecutively since one after the other receives the entire potential of the condenser.

In the arrangement according to Fig. 1 the disruptive voltage of the additional spark-gap 4 may be greater, than that of the main spark-gap 3, when the choking coil 7 is suitably dimensioned. In the arrangement according to Fig. 2, each individual spark-gap 4, 4, 4 may be larger than or approximately as large as the main spark-gap.

By suitably dimensioning the starting tension of the auxiliary spark-gaps 4 or 4°, 4°, 4° it is possible to obtain a maximum transmission of energy from the quench circuit to the secondary circuit, exactly as this was obtained heretofore by a suitable selection of the coupling between the quench and secondary circuits.

In the annexed claims I have referred to the spark gaps 3 and 4, described hereinbe- 110 fore, as "two kinds of gaps." By the term "kind" I mean to convey the idea that these gaps have different characteristics, so far as their function in the circuit is concerned, as explained before, and as also explained in 115 the subsequent portions of the claims. The term "kind" is not to be understood, however, to imply two kinds of gaps which are constructively different from each other, though as also explained hereinbefore I may 123 use for both gaps 3 and 4 quench gaps, or also only for one a quench gap and for the other an ordinary gap, so long as their above defined characteristics are only of a different kind.

What I claim is:

1. An arrangement for producing slightly dampened electrical oscillations by shock excitation, comprising a primary oscillation circuit, containing a capacity, a self-induc-

tion and two kinds of spark-gaps, of different characteristics, the first kind adapted to limit the charging tension, the second kind having means for causing it to only participate in the discharge of said first kind of spark-gap, a secondary, slightly dampened oscillation circuit coupled with and tuned to said primary circuit.

2. An arrangement for producing slightly
10 dampening electrical oscillations by shock
excitation, comprising a primary oscillation
circuit, containing a capacity, a self-induction and two kinds of spark-gaps of different
characteristics, the first kind adapted to limit
15 the charging tension, the second kind having
high frequency resistances in shunt with it
causing it to only participate in the discharge of said first kind of spark gap, said
resistances being suitably proportioned to
20 form a low resistance for the charging cur-

rent, and a secondary slightly dampened oscillation circuit coupled with and tuned to said primary circuit.

3. An arrangement for producing slightly
dampened electrical oscillations by shock excitation, comprising a primary oscillation circuit, containing a capacity, a self-induction and two kinds of spark-gaps of different characteristics, the first kind adapted to
limit the charging tension, the second kind having means for causing it to only participate in the discharge of said first kind of spark-gaps, two feeders connecting the electrodes of the spark-gap of the first kind with a current source, the total bridging distance of the spark-gaps of the second kind being less than that of spark-gaps of the first kind,

and a secondary slightly dampened oscillation circuit coupled with and tuned to said primary circuit.

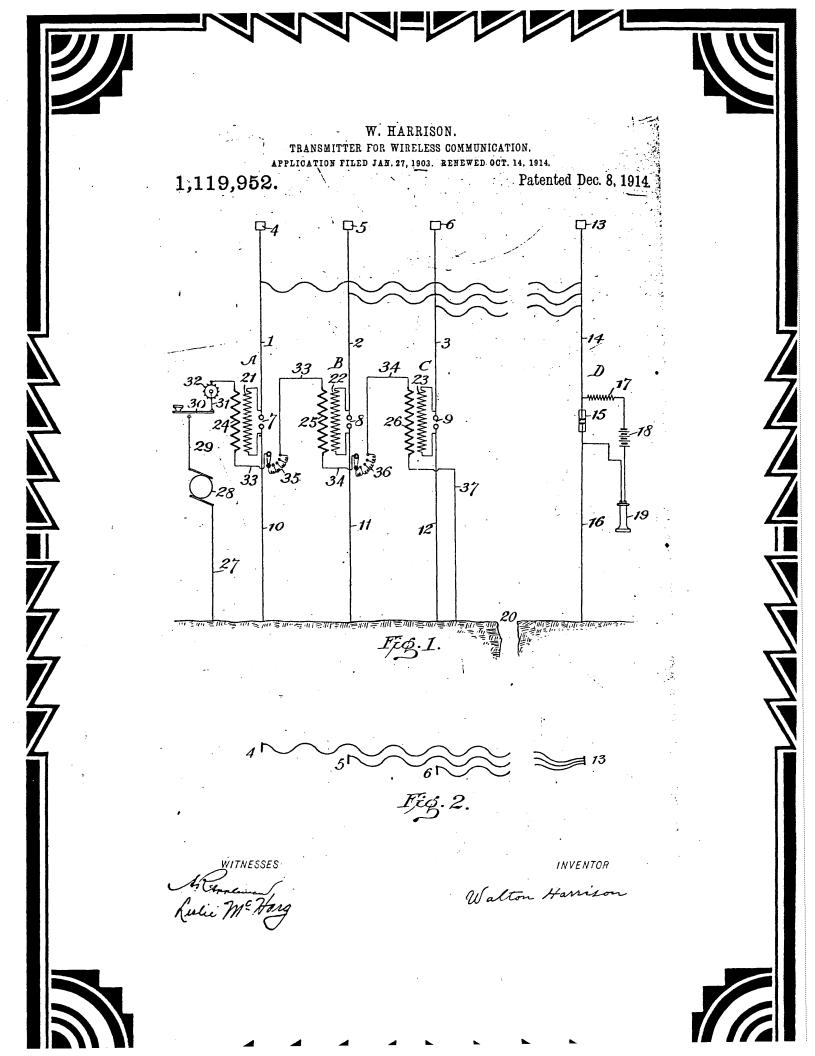
4. An arrangement for producing slightly dampened electrical oscillations by shock excitation, comprising a primary oscillation circuit, containing a capacity, a self-induction and two kinds of spark-gaps of different characteristics, the first kind adapted to limit the charging tension, the second kind having means for causing it to only participate in the discharge of said first kind of spark gaps, one of said two kinds of spark- 50 gaps being formed as quench gaps proper, and a secondary slightly dampened oscillation circuit coupled with and tuned to said primary circuit.

5. An arrangement for producing slightly 55 dampened electrical oscillations by shock excitation, comprising a primary oscillation circuit, containing a capacity, a self-induction and two kinds of spark-gaps of different characteristics, the first kind adapted to 60 limit the charging tension, the second kind having means for causing it to only participate in the discharge of said first kind of spark-gaps, said spark-gaps being formed as quench gaps proper, and a secondary 65 slightly dampened oscillation circuit coupled with and tuned to said primary circuit.

In testimony whereof, I affix my signature in the presence of two witnesses.

ALEXANDER MEISSNER.

Witnesses:
WOLDEMAR HAUFT,
HENRY HASPER.



STATES PATENT OFFICE

WALTON HARRISON, OF NEW YORK, N. Y.

TRANSMITTER FOR WIRELESS COMMUNICATION.

1,119,952.

Specification of Letters Patent.

Patented Dec. 8, 1914.

Application filed January 27, 1903, Serial No. 140,693. Renewed October 14, 1914. Serial No. 866,729.

To all whom it may concern:

Be it known that I, Walton Harrison, a citizen of the United States of America, and residing at Brooklyn, city of New York, and 5 State of New York, have invented certain new and useful Improvements in Transmitters for Wireless Communication, of which

the following is a specification.

My invention relates to wireless communi-10 cation, my more particular object being to produce an effective transmitting apparatus. To this end I connect together, at the sending station, a number of separate oscillators and suitable antennæ, so arranged that there 15 is an unobstructed path from each antenna to the receiving station, and that the several oscillators, under control of a single key or analogous transmitting device, all contribute to throw off wave energy, so that the total 20 sum of the energy transmitted is multiplied as compared with the wave energy which could be transmitted by a single oscillator. In this connection I call attention to the fact that in transmitting systems heretofore used, great difficulties have been encountered in the effort to increase the wave energy by increasing the number of oscillators or the number of antenne. While such efforts have been partially successful, the increase in wave energy has been disproportionately less than that of an arithmetical ratio. What I seek more particularly to do is to enable the power employed at the transmitting station to be increased, with a proportionate increase in the effective wave energy radiated, so as to attain longer distances of transmission. This I do in two distinct ways (1) by adding together the work done by a large number of separate oscillators, and (2) by spacing the antennæ far enough apart to prevent the currents in one antenna from interfering materially with the work of the other antennæ, yet all being controllable, as a unit, from a single source.

Reference is made to the accompanying drawing forming a part of this specification, and in which like letters indicate like parts.

Figure 1 is a diagrammatic elevation, showing both the transmitter and receiver, together with an ideal representation of several electro-magnetic wave trains; Fig. 2 is a diagrammatic plan of the transmitter and receiver, together with an ideal representation of said electro-magnetic wave trains.

The transmitter comprises a plurality of

oscillators A, B, C, and means for energizing the same, as hereinafter described. The receiver is shown at D, and may be of a type already in use, or any mechanical equivalent therefor.

The transmitting antennæ are provided with aerial capacities 4, 5, 6, spark terminals 7, 8, 9, and ground connections 10, 11, 12, these parts per se being of ordinary construction. The receiver D comprises the 65 aerial capacity 13, artenna 14, coherer 15, or analogous wave detector, ground connection 16, inductance coil 17, battery 18, and telephonic receiver 19.

The space 20, between the transmitting 70 and receiving apparatus, represents a great

distance.

The transmitting antennæ 1, 2, 3, are energized by transformers, the secondary windings of which are shown at 21, 22, 23, 75 and connected as shown. The primary windings are shown at 24, 25, 26, and may be of ordinary construction, but are connected in series.

The ground wire 27 is connected with a 80 direct current dynamo 28, from which the wire 29 leads to the key 30, and thence a wire 31 leads to an interrupter 32, which is connected with the primary winding 24. The primary windings 24. 25, 26, are con- 85 nected by wires 33, 34, in series with adjustable impedance coils 35, 36, the coil 26 being grounded by a wire 37.

The oscillators A, B, C, are preferably arranged a little out of alinement with the 90 receiving station, as indicated in Fig. 2. They are spaced far apart, so that the currents'set up in one antenna have little or no deleterious effects upon the other antennæ,

by induction or otherwise.

My purpose in placing the antennæ out of alinement with each other with respect to the receiving station is to provide a clear path from each of the antennæ to the receiving station. This is desirable in order to 100 prevent any one of the transmitting antennæ from screening another and thus impairing its wave energy.

The apparatus above described embodies one of the simplest forms of my invention, 105 and I do not limit myself to the arrangement shown. Above all, a make and break key is not the only kind of transmitter which may be used, as obviously any other transmitter capable of altering the electri- 110

cal condition of the several primary windings may be employed without departing from the spirit of my invention.

Having thus described my invention, I to claim as new, and desire to secure by Let-

ters Patent:—

1. The combination of a plurality of antennæ all adapted to throw off waves of a common wave length, said antennæ being 10 spaced apart by integral multiples of said wave length, and means for separately impressing said antennæ with oscillations, the oscillations thus set up in one antenna being of like phase as the oscillations of antother antenna.

2. The combination of a plurality of grounded antennæ spaced apart by a whole wave length or integral multiple thereof, and means for impressing upon said antennæ electric oscillations alike in phase as distinguished from opposite in phase.

3. In a terminal apparatus for wireless communication, the combination of a plurality of separate antennæ, more than two in number, spaced apart throughout their entire lengths by a distance approximating a wave length or an integral multiple thereof and grounded separately, and means for so energizing all of said antennæ as to virtually add the effects thereof.

4. In a transmitting apparatus for wireless communication, the combination of a plurality of (separate) antennæ, more than two in number, spaced apart throughout the 35 entire length thereof and grounded separately, and means for so energizing all of said antennæ as to virtually add the separate energies thereof.

5. The combination of a plurality of an40 tennæ, all having their constants arranged
so that said antennæ are adapted to throw
off waves of a common length, said antennæ
being grounded separately and spaced apart
by an entire wave length or an integral
45 multiple thereof, and means for separately

impressing said antennæ with oscillation like phase, as distinguished from phase.

6. The combination of a receiving tennæ and a plurality of transmitting tennæ, more than two in number, spapart by an entire wave length or an gral multiple thereof.

7. The combination of a plurality grounded antennæ, more than two in number, spaced apart by an entire wave length or an integral multiple thereof, and more including a circuit common to all of antennæ for energizing the same in phase as distinguished from unlike phase.

8. The combination of a plurality transmitting antennæ, more than two number, spaced apart by an entire will length or an integral multiple there means common to all of said antennæ energizing them simultaneously in the phase, and a receiving antenna common all of said transmitting antennæ for integepting waves thrown off by them.

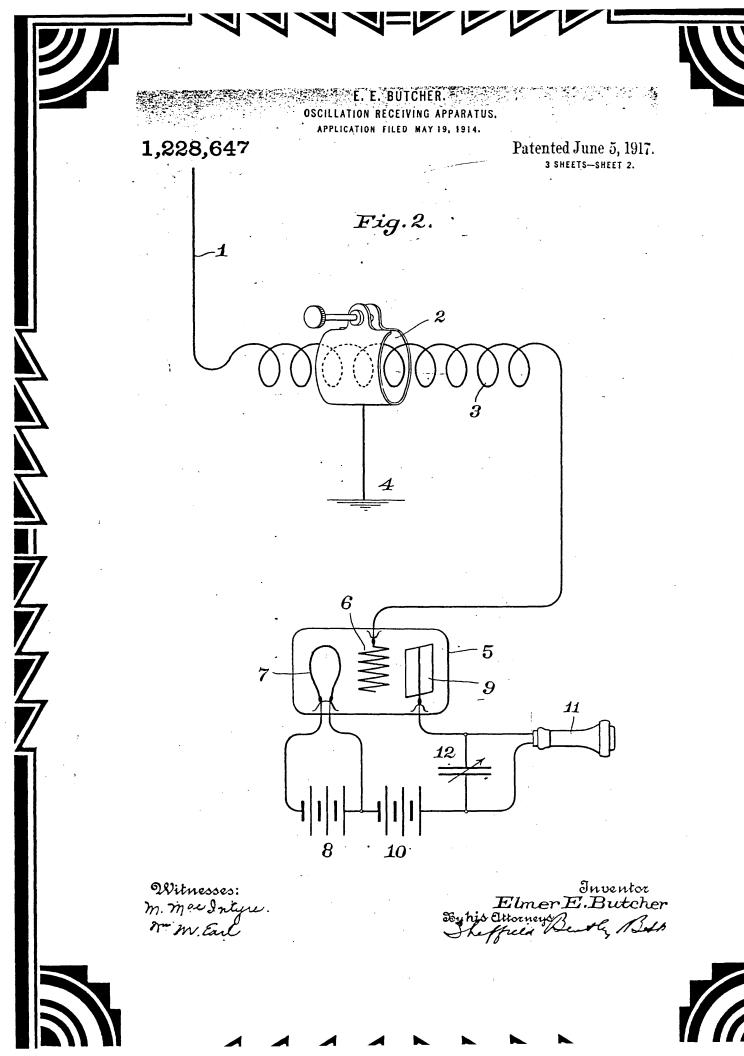
9. The combination of a plurality of transmitting antenna, more than two in number, metallically disconnected from each other, and spaced apart in a given vertical plane by an entire wave length or an integral multiple thereof, means common to all of said transmitting antennæ for energizing the same simultaneously in like phase as distinguished from unlike phase, and a receiving antennæ common to all of said transmitting antennæ, and energized by adding the separate energies thereof.

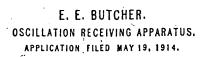
In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses, this 26th day of January, 1903.

WALTON HARRISON

Witnesses:

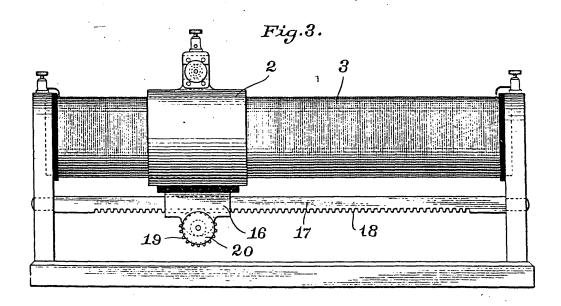
F. W. HANAFORD, W. M. AVERY.

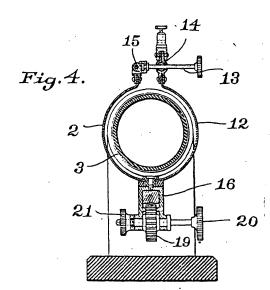




1,228,647

Patented June 5, 1917.





Witnesses: m. Mac Intyce! M. E.L

Inventor Elmer E. Butcher Shipper South Beth

UNITED STATES PATENT OFFICE.

ELMER E. BUTCHER, OF INTERLAKEN, NEW JERSEY, ASSIGNOR TO MARCONI WIRELESS TELEGRAPH COMPANY OF AMERICA, A CORPORATION OF NEW JERSEY.

OSCILLATION-RECEIVING APPARATUS.

1,228,647

Specification of Letters Patent.

Patented June 5, 1917.

Application filed May 19, 1914. Serial No. 839,483.

`To all whom it may concern:

Be it known that I, Elmer E. Butcher, a citizen of the United States, and a resident of Interlaken, in the county of Monsouth and State of New Jersey, have invented certain new and useful Improvements in Oscillation-Receiving Apparatus, of which the following is a specification.

My invention relates to apparatus adapt-10 ed to the receiving and amplification of electrical oscillations, and has for its general object the provision of such apparatus of a simple character, having few adjustments, and by which received oscillations may be 15 greatly amplified.

My invention may be applied to the reception of electrical oscillations irrespective of the manner in which they are produced or of their particular character, and may be used in any connection in which it is found applicable, as, for instance, in wireless or wire telegraphy, or wireless or wire telephony.

I shall describe my invention in connection with wireless telegraphy and in the drawings which accompany the specification I shall illustrate forms which my invention may take. These drawings, however, are intended only to show operative forms of my invention and are therefore diagrammatic and illustrative only, and should not be taken as showing the only forms or applications in which my invention finds utility.

Figure 1 shows diagrammatically the elecstrical connections of the receiving end of a wireless telegraph system embodying my invention; Fig. 2 shows a modified form of the electrical connections; Fig. 3 is a side view of the means for electrostatically couling the circuits and Fig. 4 is an end view thereof partly in section.

Referring to Fig. 1, I have shown an aerial at 1. This aerial may take any suitable form and includes in its circuit a metal15 lic element, which is shown in the drawings, for the sake of illustration, as being in the form of a cylinder 2. The secondary or detector circuit comprises an inductance 3 which is preferably in the form of a relatively long coil of wire and is grounded at 4. This point also constitutes the ground for the aerial circuit. The opposite end of the

a detector 5. I have shown the detector 5 in 55 the form of a multiple element valve detec-

inductance 3 is connected to an element of

tor, but this is not the only type which may be used, since other forms of detectors, such as crystal detectors, for instance, may be advantageously employed. The multiple element valve detector 5 I have illustrated, 60 comprises a sealed vessel inclosing three elements, a grid element 6 to which inductance 3 is connected, a filament element 7 which is heated by battery 8 or other suitable source of heat, and a plate element 9. Filament 65 element 7 and plate element 9 are connected by a circuit which includes a battery 10 and a telephone 11 in series. Telephone 11 may be shunted by a variable condenser 12, although the latter is not essential. The local 70 circuits of the detector may be modified to accord with the type of detector used, or the particular conditions of its use.

In the operation of my device the metallic element 2 is moved along coil 3, and the 75 closeness of the electrostatic coupling between the coil and the metallic element is varied in any suitable manner, as by increasing or decreasing the diameter of the cyl-These are the only adjustments 80 which my improved device requires. By the movement of metallic element 2 the aerial and secondary or detector circuits are simultaneously tuned and the amount of inductance included therein varied. The ar- 85 rangement is such that a point of maximum potential is formed at the grid element of the detector 6. In Fig. 2 I have shown a modification of my apparatus which con-sists essentially in reversing the electro-90 static coupling shown in Fig. 1, but leaving the aerial circuit electrostatically coupled to the detector circuit. While in Fig. 1 the aerial is connected to the metallic element of the coupling, in Fig. 2 it is connected to 95 the inductance and the earth is connected to the metallic element instead of directly to the inductance as in Fig. 1. Also in Fig. 2 the connection of the secondary circuit to the ground is effected through the electro- 100 static coupling instead of directly, but this does not alter its essential character as a grounded circuit. The underlying principles, however, of the apparatus of both Figs. 1 and 2 are the same and the method of 105 operation is essentially identical.

Figs. 3 and 4 show a convenient mechanism for varying the electrostatic coupling between the metallic element 2 and the coil 3. Referring to these figures it will be seen 110

that the metallic element 2 is in the form of a split cylinder, the upper ends being connected by means of a thumb-screw 13 which passes through a ball 14 mounted on one 5 edge of the cylinder, and is attached to a pivot 15 on the other. The cylinder is supported upon a slider 16, which is adapted to slide along a bar 17, the under side of which has a rack 18 formed in it. A pinion 19, 10 operated by a thumb-piece 20, engages rack 18, and serves to move the slider along by its rotation. A lock nut 21 is provided so that the cylinder may be locked in any given position relatively to the coil.

As I have pointed out above, the forms of my invention I have illustrated and described are not the only forms it may take, and they may be altered in manners which will be apparent to those skilled in the art, 20 without departing from the spirit of my invention, and I therefore do not intend to confine myself to the specific forms shown

and described.

What I claim is:

1. In an oscillation receiving apparatus, a grounded open secondary circuit containing an inductance and a detector and tuned to the periodicity of the received oscillations excited by an aerial circuit electrostatically so coupled thereto and also tuned to the periedicity of the received oscillations.

2. In an oscillation receiving apparatus, an open oscillating circuit containing an inductance and connected to the earth at one 35 end and to a detector at a point of maximum potential remote from the earthed point and an aerial circuit tuned to the periodicity of the received oscillations electrostatically

coupled thereto.

3. In an oscillation receiving apparatus, an open oscillating circuit containing an inductance and a detector and an oscillating circuit electrostatically coupled thereto at the point at which the inductance is included 45 in the circuit.

4. In an oscillation receiving apparatus, an aerial circuit containing one element of an electrostatic coupling and a detector circuit containing an inductance and a detec-50 tor. the inductance constituting the other element of the electrostatic coupling.

5. In an oscillation receiving apparatus, an aerial circuit containing one element of an electrostatic coupling and an open detector circuit grounded at one end, containing 55 an inductance and connected to a detector at a point of maximum potential remote from the earthed point, the inductance constituting the other element of the electrostatic coupling.

6. In an oscillation receiving apparatus, an open oscillating circuit containing an inductance, grounded at one end and connected to a detector at a point of maximum potential remote from the earthed point, a second 65 oscillating circuit adapted to excite the first and electrostatically coupled thereto, means for varying the closeness of the coupling

and means for varying the amount of the inductance included in the two circuits.

7. In an oscillation receiving apparatus, a secondary circuit containing an inductance in the form of a coil, an oscillating circuit adapted to excite the secondary circuit and means for electrostatically coupling the cir- 75 cuits, comprising the coil and a metallic member in proximity to the coil and adapted

to be moved relatively to it.

8. In an oscillation receiving apparatus, a secondary circuit containing an inductance 80 in the form of a coil, an oscillating circuit adapted to excite the secondary circuit, and means for electrostatically coupling the circuits and for varying the coupling, comprising a cylinder surrounding the coil, 85 means for contracting the cylinder and means for moving the cylinder longitudinally of the coil.

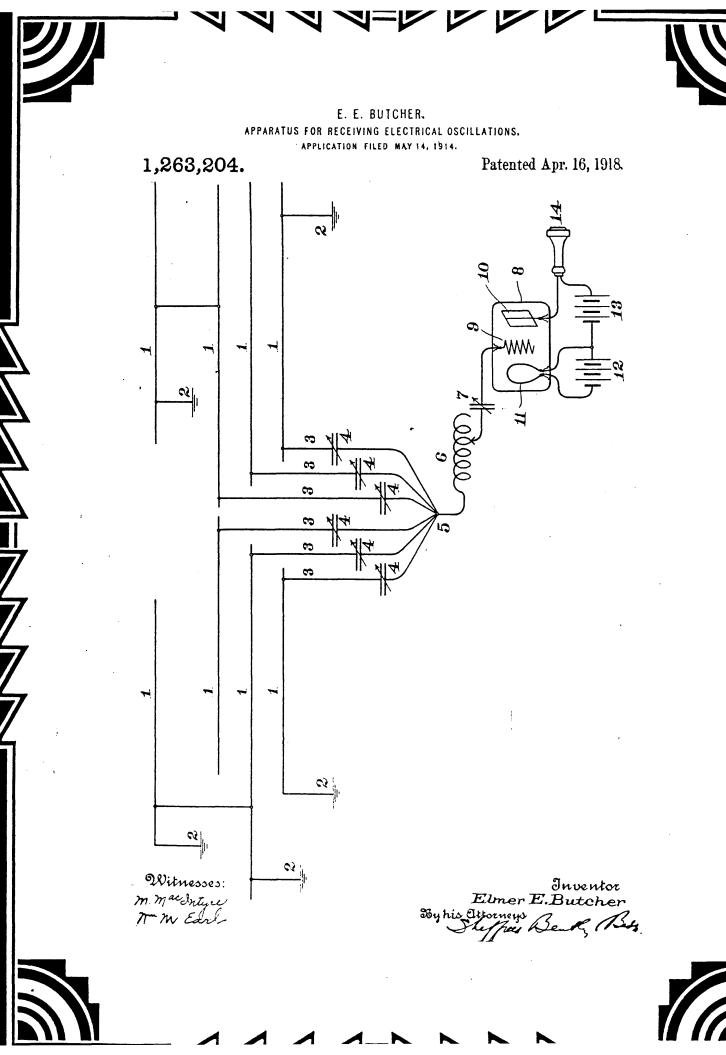
9. In an oscillation receiving apparatus, a secondary circuit, an exciting circuit and 90 means for electrostatically coupling the two circuits and for varying the coupling, comprising a coil, a split cylinder slidably mounted thereon, means for contracting the cylinder and for holding it in its contracted 95 position and means for moving the cylinder longitudinally of the coil and for locking it in any given position.

In witness whereof I have hereto signed my name in the presence of two witnesses 100 this 18th day of May, 1914.

ELMER E. BUTCHER.

Witnesses:

WALTER S. JONES, WM. M. EARL.



UNITED STATES PATENT OFFICE.

ELMER E. BUTCHER, OF INTERLAKEN, NEW JERSEY, ASSIGNOR TO MARCONI WIRELESS TELEGRAPH COMPANY OF AMERICA, A CORPORATION OF NEW JERSEY.

APPARATUS FOR RECEIVING ELECTRICAL OSCILLATIONS.

1,263,204.

Specification of Letters Patent. Patented Apr. 16, 1918.

Application file. May 14, 1914. Serial No. 838,418.

To all whom it may concern:

Be it known that I, ELMER E. BUTCHER, a citizen of the United States, and a resident of Interlaken, Monmouth county, New Jersey, have invented or discovered certain new and useful Improvements in Apparatus for Receiving Electrical Oscillations, of which the following is a specification.

The general object of my invention is to produce an apparatus suitable for the reception, detection and amplification of electrical

oscillations. My invention may be applied to the receiving of electrical oscillations, no matter 5 how produced and irrespective of their general character. It may be used for receiving both continuous or damped oscillations and may be used in any connection in which it may be of service, as, for instance, in wireless or wire telegraphy, or wireless or wire telephony. I have shown in the drawing accompanying this specification a form which my invention may take. Since this drawing, however, shows only one of the many ways 25 in which my invention may be applied, it is intended to be diagrammatic and illustra-tive only. The illustration chosen is in connection with wireless telegraphy, although, as I have pointed out, my invention is not confined to this use, and I do not wish to be limited to the specific form illustrated, since it will be apparent to those skilled in the art that many changes may be made without departing from the spirit of my in-

One of the many advantages of my invention when used in connection with wireless telegraphy is that the resonant aerial circuit now used, which involves the erection of expensive aerials, masts, etc., and considerable difficulty of operation in tuning the aerial circuit to the received oscillations, may be dispensed with and a collector of energy out of resonance with the received 5 escillations used.

Referring to the drawing, I have shown at 1 a conductor which may be the wires of a telegraph or telephone line, a telephone line being preferably used if wires are em-50 ployed as a conductor. These wires may be grounded as at 2 or not. Conductors 1 form a collector of energy merely and are not in resonance with the received oscillations, their purpose being merely to intercept them and transmit them to the detector.

It should be understood that wires 1. shown in the drawing, are illustrative of any elevated conductor, that they need not be telephone or telegraph wires nor, in fact, wires at all; nor need they be of any partic- 60

ular dimensions.

I have shown at 3 wires tapping the lines 1. In each of the wires 3 I preferably insert a condenser 4, although this condenser is not necessary. It is, however, desirable 65 in order to prevent interference with the other uses to which the line wires 1 may be put, either by reason of the connection of several of these wires 1 to each other, or by reason of the operation of the oscillation 70 detecting apparatus. Wires 3 are connected together as at 5, at which point a local detector circuit is connected, comprising a coil 6, a variable condenser 7, and a detector 8. Coil 6 is preferably in the form of a long 75 coil having a large inductance and a relatively low distributed capacity and acts as a linear oscillator, producing a point of maximum potential to which the detector is connected. Condenser 7 is a small variable con- 80 denser and is not essential to the operation of my device, although I prefer to use it. Coil 6 is preferably a coil having a relatively large number of turns and a natural period approximating that of the received oscilla- 85 tions, and condenser 7 is preferably of relatively small capacity.

The specific form of detector I have illus-

trated is a multiple element valve detector of the ordinary type, although it will be under- 90 stood that any other suitable form of detector may be used. Detector 8 consists of a sealed vessel inclosing three electrodes, a grid electrode 9 by which it is connected to the detecting circuit; a plate electrode 10; 95 and a filament electrode 11. The filament electrode 11 is heated by means of a battery or other source of heat 12, and is connected, through a battery 13 and a telephone 14, to plate electrode 10.

In the operation of my device connection is made to any convenient and suitable conductors 1, which are not tuned to the periodicity of the received oscillations. However, the circuit including the coil 6 and con- 105 denser 7, but omitting condensers 4 is tuned to the received oscillations by varying the constants in the usual manner. The batteries 12 and 13 are adjusted to give a maximum response in the telephone 14.

When arranged and operated as I have ural period approximating that of the described it signals may be received and detected without in any way interfering with the ordinary uses of the conductors to which 5 the detector has been attached.

What I claim is:

1. In an apparatus for receiving electrical oscillations, a collector, an open local circuit including a detector, and a condenser be-10 tween said collector and said local circuit.

2. In an apparatus for receiving electrical oscillations a collector of energy out of resonance with the received oscillations and an open local detector circuit tuned to the 15 periodicity of the received oscillations and comprising a detector, an inductance and a capacity in series.

3. In an apparatus for receiving electrical oscillations a collector of energy out of reso-20 nance with the received oscillations, a local detector circuit associated therewith, said circuit being tuned to the periodicity of the received oscillations and containing an inductance consisting of a coil having a natceived oscillations, a capacity and a detection series and a capacity intervening between the collector of energy and the local dete

4. In an apparatus for receiving electrical oscillations, a grounded collector, an open local circuit including a detector, and a con denser connected between said collector an said local circuit.

5. In an apparatus for receiving electrical oscillations, a collector, an open local circuit including a detector, said local circuit in cluding a capacity and inductance, said d tector, capacity and inductance being co nected in series, and a condenser between said collector and said local circuit.

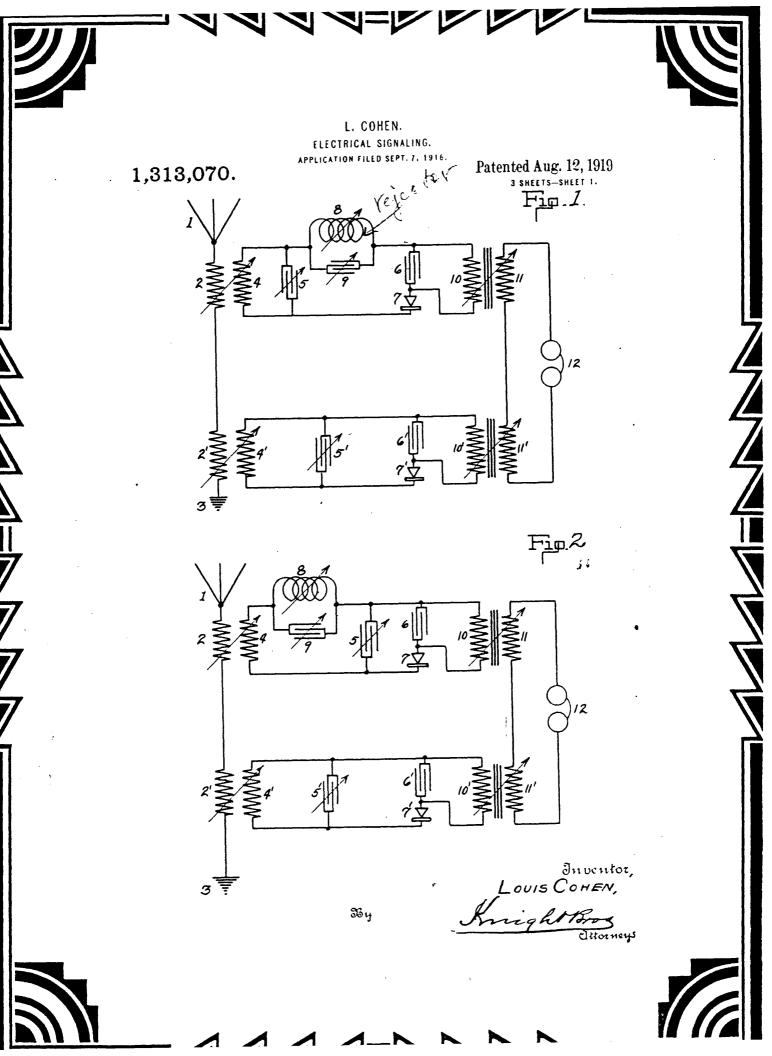
In witness whereof I have hereunto sign

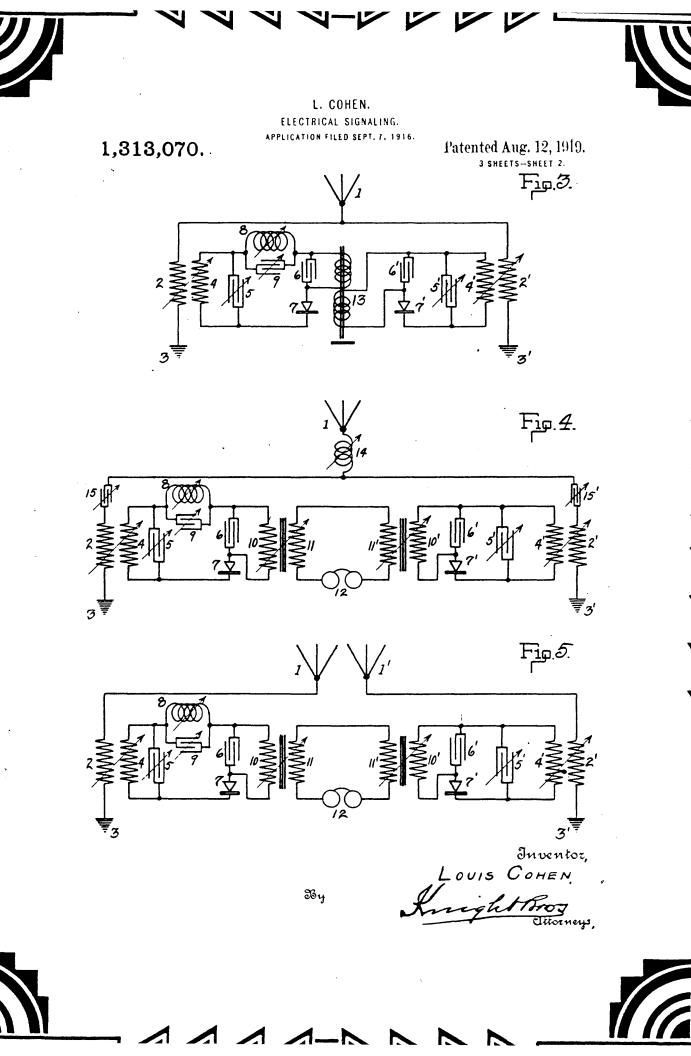
my name in the presence of two witness

this 13th day of May, 1914. ELMER E. BUTCHER

Witnesses:

WALTER S. JONES, WM. M. EARL

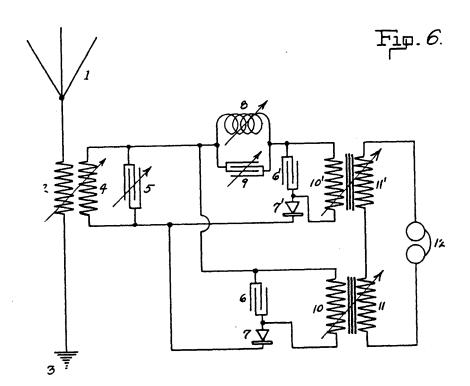




L. COHEN.
ELECTRICAL SIGNALING.
APPLICATION FILED SEPT. 7. 1916.

1,313,070.

Patented Aug. 12, 1919 3 SHEETS-SHEET 3.



Inventor, Louis Conen. Kright Bros

UNITED STATES PATENT OFFICE.

Louis cohem, of washington, district of columbia.

ELECTRICAL SIGNALING.

1,313,070.

Specification of Letters Patent.

Patented Aug. 12, 1919.

Application fied September 7, 1916. Serial No. 118,889.

To all whom it may concern:

Be it known that I, Louis Conen, a citizen of the United States, residing at Washington, in the District of Columbia, have 5 invented a certain new and useful Improvement in Electrical Signaling, of which the following is a specification.

This invention relates to the art of radio signaling and particularly receiving radio signals, and system for use in practising the

The object of the present invention is to eliminate electrostatic disturbances and interferences in the reception of radio signals, 15 and thus improve the clearness and accu-

racy in radio communication.

In carrying out the invention, the currents of the disturbances foreign to the signal desired to be received, are transformed into 20 two currents of substantially equal magnitude and delivered to the indicating device as currents of opposite sign, through two circuits, one of which is rendered opaque to the current of the signal to be received, pref-25 erably by introducing into it a loop circuit tuned to the frequency of such current, so that the current of said signal will be delivered only through the other of said circuits. In accomplishing this, there may 30 he employed two antennæ, each with a separate receiving equipment coupled thereto; or a single antenna with two receiving equipments; or one antenna with one receiving equipment and two separate detector 35 circuits associated with the receiving equip-In every case, the rectified currents of the detectors affect, simultaneously, the same indicating device and are so arranged as to produce opposite effects therein. This 40 is accomplished either by the use of two transformers, the primaries of which are separately shunted across the respective detectors, and the secondaries are connected in series with each other and with the indicat-45 ing device, but so arranged as to have the currents in the secondaries oppose each other; or by using differentially wound telephones, the respective windings of which are connected across the detectors, so that the se effect in the telephone will be proportional to the difference of the currents. One of the

receiving equipments as a whole (where two

receiving equipments are used) or its detec-

tor circuit, or one of the two detector circuits associated with a single receiving 55 equipment, is rendered opaque to the frequency of current of the signal desired to be received, by introducing in said circuit, a loop circuit tuned to the frequency of the signal which is desired to be received, which 60 has for currents of that frequency, an effect equivalent to that of a very large resistance, and consequently permits practically no current of that frequency to pass through to the telephones; currents of any other fre- 65 quency are not appreciably affected by the loop circuit. It follows, therefore, that the signals which are desired to be received will affect only one receiving equipment or one detector circuit, as the case may be, namely, 70 the one from which the loop circuit is absent, and the effects may, therefore, be indicated, in the usual manner, in the telephones or other indicating devices. Currents from interferring signals which are of different 75 frequencies or electrostatic disturbances will not be affected by the loop circuit and, therefore, will deliver currents of the same magnitude to both detectors, and neutralize each other's effects in the indicating device. 80 Where two receiving equipments are employed, the loop circuit may be either in the detector circuit or the secondary oscillation circuit of the receiving equipment with which it is associated. Or there may be, if 85 desired, a loop circuit in each of said circuits, or more than one loop circuit in either or both of them.

In the accompanying drawings-

Figure 1 is a schematic view of a system 90 for carrying out the invention, in which the two receiving equipments are coupled separately to two independent primaries which are connected in series with each other and with the antenna.

Fig. 2 is a view similar to Fig. 1, showing the loop circuit introduced into the oscilla-

tion_circuit

Fig. 8 is a schematic view of a system embodying the invention, in which the two 100 primaries to which the receiving equipments are coupled, are branched in parallel, and in which a differential telephone is used for indicating the differential effect of the two receiving equipments.

Fig. 4 shows another embodiment of the

105

invention in which the antenna and the two branch circuits to which the receiving equipments are compled, are all separately taned

Fig. 5 shows a system in which separate

5 antennæ are used.

Fig. 6 shows an embodiment of the invention in which a single receiving equipment is employed, with two detector circuits associated with it, one of which contains the loop 10 circuit tuned to the frequency of the signal

desired to be received.

In each of the figures, the detectors 7 and 7' may be of any type of detector usually employed in the reception of radio signals. 15 Also while the couplings 2, 4 and 2', 4', are shown as electromagnetic couplings, for the purpose of illustration, any other known type of coupling, for instance, that disclosed in my United States Letters Patent No. 20 1,128,098 of December 29, 1914, could be used equally well in the embodiment of this invention. In Figs. 1, 2, 4, 5 and 6, the indicating device is acted on by the currents from the detectors through the transformers 25 10, 11 and 10'; 11', while in Fig. 3, the detector currents act directly on differentially wound telephones. It is of course to be understood that the particular methods illustrated, of associating the indicating device 30 in the different embodiments of the invention herein disclosed are not to be taken as limitations but merely as illustrations of some ways in which this element of the system may be supplied.

35 In the embodiment of the invention illustrated in Fig. 1, 1 is the antenna, 2 and 2' are two inductance coils which are used as primaries of transformers and can also be used as loading coils for tuning purposes, 8 40 is the ground connection of the antenna, 4, 5 and 4', 5' are secondary oscillation circuits consisting of inductance coils 4, 4', and condensers 5, 5', the coils 4 and 4' being interlinked, electromagnetically, with the coils 45 2 and 2' respectively. 6, 6' are stopping condensers, and 7, 7' are the detectors. 8, 9 is a loop circuit consisting of inductance 8 and condenser 9, and their values are so adjusted as to bring the loop circuit into reso-50 nance for the frequency of the current of the signal which is desired to be received. 10, 11 and 10', 11' are transformers preferably having iron cores, and 12 is the indicating device, which may be telephones or a

55 suitable recording device.

The operation is as follows: Electromagnetic waves acting on the antenna generate a current in it which passes through the primary coils 2 and 2', and through the trans-60 former action of 2, 4 and 2', 4' generate currents in the secondary oscillation circuits which affect the detectors 7 and 7'. Now the secondary circuit which has the loop circuit 8, 9 in it, is practically opaque to cur-15 rents of a frequency to which the loop cir-

cuit is tuned, hence, if we adjust the inductance and capacity of the loop circuit to be in resonance for the frequency of the current of the signal desired to be received, the signal has no effect on that circuit, and con- 70 sequently only manifests itself in the indicating device through the action of the receiver from which the loop circuit is absent. In other words, we get the same effect as if we only had one receiver coupled to the 75 antenna circuit. Any other signal which may be sent out by nearby stations and of any frequency but different from that of the signals to be received, will act on both receiving equipments. If now the couplings 80 2, 4 and 2', 4', or 10, 11 and 10', 11', be so adjusted relatively to each other that the indicating device is acted upon equally by both receiving equipments, and the sec-ondaries 11 and 11 of detector transformers are so connected that the currents generated in them are of opposite sign, then the effect of electrical disturbances due to signals of frequencies different from that of the signal to be received becomes neutralized and does 90 not manifest itself in the indicating device.

In order to make this system effective for the elimination of static disturbances, it is necessary to detune slightly the antenna circuit 1, 2, 2', 3, so that the oscillations gen- 95 erated in it by impulsive disturbances, such as are produced by static, will make the antenna system oscillate with a frequency slightly different from the resonance frequency of the loop circuit 8, 9, and consequently, the currents induced in the secondary circuits will be equally effective in both 4, 5, and 4', 5', and their effects neutralized in the indicating device 12 because of the reverse magnetic coupling 10, 11, 10', 11'. 105

As illustrated in Fig. 2, the loop circuit 8, 9 may be introduced in the oscillation circuit

instead of in the detector circuit. According to Fig. 3, the two primaries to which the oscillatory circuits are coupled, 110 are joined in parallel. The currents generated in the antenna divide equally in the said two branches and thus generate currents of the same magnitude in both receiving equipments except for currents of the fre- 115 quency to which the loop circuit in one of the receiving equipments is tuned, and in that case only one of the receiving equipments is effective. The operation is exactly the same as in the case of Fig. 1 described 120 above. As a means for indicating the differential effect of the two receiving equipments, a differential telephone is shown in Fig. 8, but the arrangement shown in this figure is of course not limited to use with 125 this particular method of introducing the

indicating device. Fig. 4 is a modification of Fig. 3, which consists in introducing a loading call 14 in the antenna, and two condensers 15 1

and 15' in the two parallel branches. The purpose of these extra elements is to enable one to tune independently the antenna and the two branches. By this means, antenna 1 and loading coil 14 can be tuned for the frequency of the current of the signal to be received, and also branch 15', 2' is tuned independently to the same frequency; while branch 15, 2 is tuned to a slightly different frequency; so that the current of the signal to be received will pass mostly through branch 15', 2', and very little will be diverted through branch 15, 2. This is desirable, because the energy of the incoming signal is transmitted to the indicating device only through the receiving equipment coupled to branch 15', 2', and the signal current flowing in branch 15, 2, is entirely wasted; the loop circuit in the receiving equipment associated with branch 15, 2, does not permit any current of that frequency to pass.

Fig. 5 suggests the use of two independent antennæ 1, 1', having independent primary 25 coils 2, 2', to which are coupled the two receiving equipments. The operation is similar to that of Fig. 1. The independent antennæ may be so closely associated as to be mounted upon the same mast, if desired.

As shown in Fig. 6, the present invention may be realized by the use of a single receiving equipment, provided two detector circuits be associated with it, one of which detector circuits has associated with it, a solop circuit tuned to the frequency of the signal desired to be received.

I claim:-

1. The method of eliminating effects of foreign electrical disturbances from the indi45 cating device in the reception of radio signals, which consists in transforming the currents of said disturbances into two currents of substantially equal magnitude, delivering them to the indicating device as currents of opposite sign, through two circuits, one of which contains a loop circuit tuned to the

frequency of the current desired to be received, and delivering the current of said signal only through the other of said circuits.

2. The improvement in the art of radio signaling which consists in employing two receiving equipments with an indicating device common to both; rendering one receiving equipment opaque to currents of the particular frequency of the signal to be received by means of a loop circuit tuned to the frequency of the incoming signal, thereby leaving the other receiving equipment alone affected by the incoming signal, and 60 causing currents of all other frequencies or electrostatic disturbances to affect both receiving equipments and oppose their effects in the indicating device.

3. The improvement in the art of radio signaling which consists in employing two receiving equipments with an indicating device common to both and with a loop circuit, tuned to the frequency of the signal to be received, introduced in the detector circuit 70 of one of the receiving equipments, thereby rendering said receiving equipment opaque to currents of the patricular frequency of the signal to be received, and leaving the other receiving equipment alone affected by 75 the incoming signal, and causing currents of all other frequencies or electrostatic disturbances to affect both receiving equipments and oppose their effects in the indicating device.

4. A system of radio signaling comprising two receiving equipments separately related to a suitable antenna through means of oscillation transformers, a loop circuit embodied in one receiving equipment adapted to be tuned to current frequency of a signal to be received, and an indicating derice common to both receiving equipments.

The foregoing specification signed at Washington, District of Columbia, this 6th 90 day of September, 1916.

LOUIS COHEN.





M. C. A. LATOUR.
RADIOSIGNALING INSTALLATION.
APPLICATION FILED NOV. 15, 1917.

1,317,025.

Patented Sept. 23, 1919.

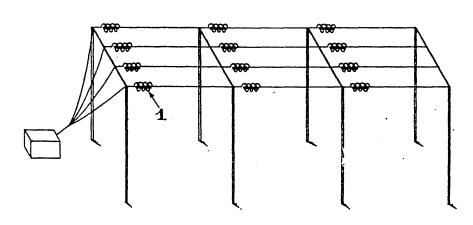


Fig. 1

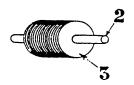


Fig. 2

Inventor:
Marine G. a. Latone
per f. W. Plucker
Attorney.









UNITED STATES PATENT OFFICE.

MARIUS C. A. LATOUR, OF PARIS, FRANCE.

RADIOSIGNALING INSTALLATION.

1,317,025.

Specification of Letters Patent. Patented Sept. 23, 1919.

Application filed November 15, 1917. Serial No. 202,232.

To all whom it may concern:

Be it known that I, Marius C. A. Latour, a citizen of the Republic of France, residing at 10 Rue Auber, Paris, in the Republic of France, have invented certain new and useful Improvements in Radiosignaling Installations, of which the following is a specification.

The invention relates to a device enabling the fundamental wave length of an antenna of radio telegraphic or radio-telephonic stations to be considerably augmented.

It consists in distributing several selfinduction coils along the antenna wires.

15 Although it is very usual in radiotelegraphy to place large inductances at the base of the antennæ, and although several inventors have suggested placing self-induction coils at the top of the antennæ, a plurality of self-induction coils have never yet been distributed along the same wire in order to increase the wave length of the said wire.

It is possible however to distribute self-induction coils in this way along the antenna wire, even under conditions compatible with the mechanical overloading that the said self-induction coils will impose on the antenna wire. With this end in view these coils may be arranged in the neighborhood of transverse bearers, but on the other hand they may be constructed in such a way as to be extremely light.

The drawings given by way of example show one of the constructional forms of the invention. Figure 1 shows a portion of an antenna in sheet form in the wires of which several self-induction coils 1 have been dis-

tributed.

These self-induction coils will preferably be constructed with magnetic circuits of 40 iron or any other magnetic material.

Fig. 2 gives an example of a method of constructing these self-induction coils. They may consist merely of sheet iron disks 3 threaded on to the antenna wire 2, but are 45 otherwise insulated from one another by means of a coating of varnish or other suitable insulating material.

In a general way that quality of sheet iron will be employed which gives the lowest 50 losses by hysteresis and by Foucault currents (plates of silicon iron, of iron cast in a vacuum, etc.)

What I claim and desire to secure by Letters Patent of the United States is:

1. In a radio signaling installation, an antenna, and means for increasing the wave length thereof, comprising a plurality of uncompensated inductances distributed along said antenna and including each a plurality 60 of metal disks connected to said antenna, but otherwise insulated from one another.

2. In a radio signaling installation, an antenna having a plurality of self-induction coils distributed along its wires, each induction tion coil comprising a plurality of sheetiron disks threaded upon the antenna wire, but otherwise insulated from one another; for the purpose specified.

In testimony whereof I affix my signature 70 in presence of two witnesses.

MARIUS C. A. LATOUR.

Witnesses:

EUGENE PRESSLY, CHAS. P. PRESSLY.

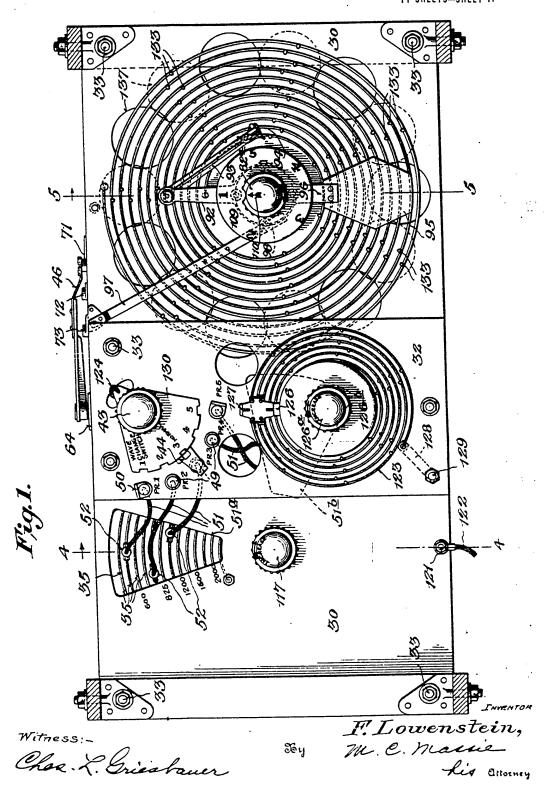
Sopies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."





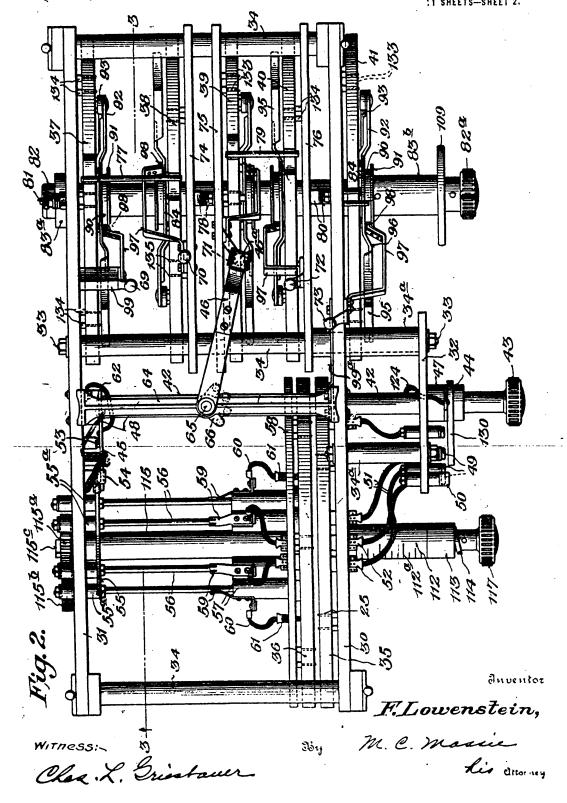
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1,339,772.



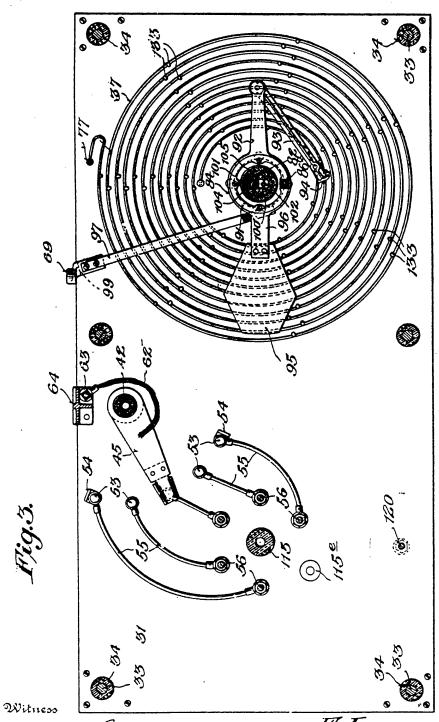


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1,339,772.

Patented May 11, 1920.



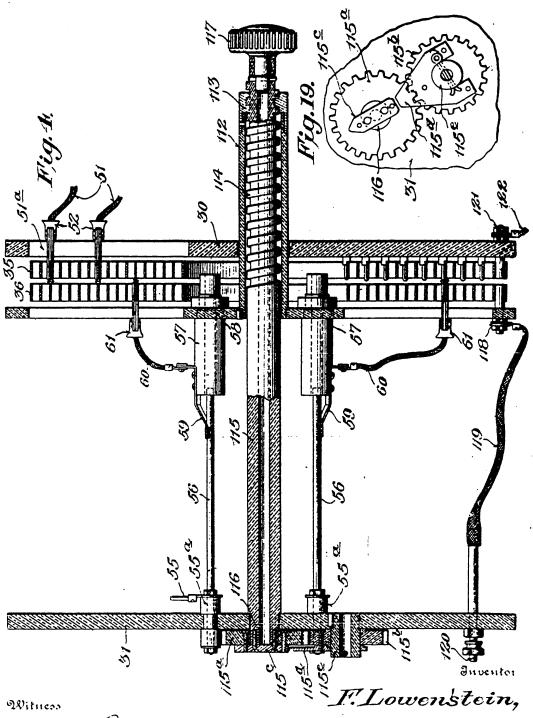
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Chas. X. Briestauer

F. Lowenstein,
W. E Massie
Lis Chorney

1,339,772.

Patented May 11, 1920.



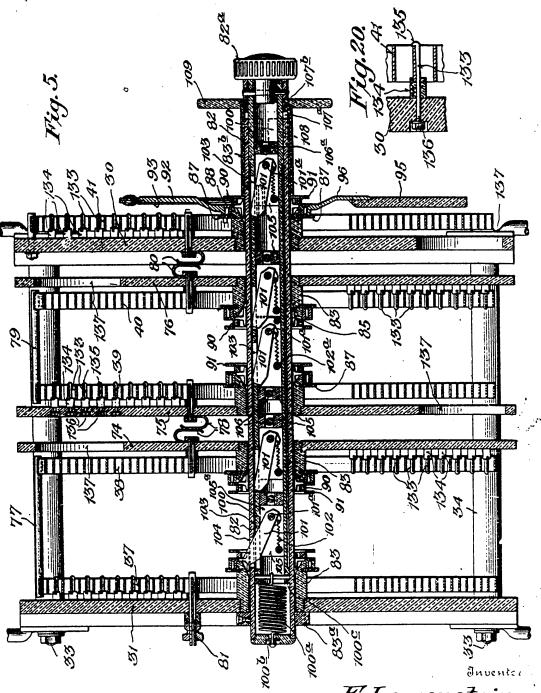
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1,339,772.

Patented May 11, 1920.



Big

Witness

Ches. L. Griesbauer

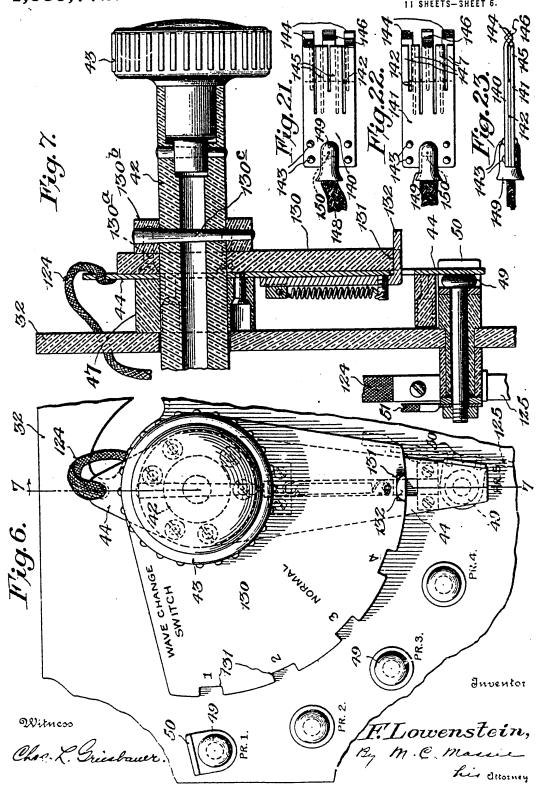
F.Lowenstein,

M. C. Massie

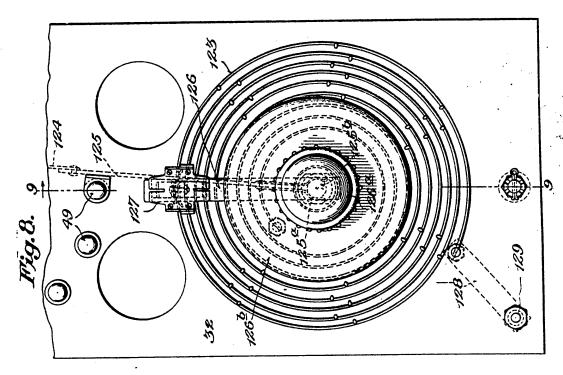
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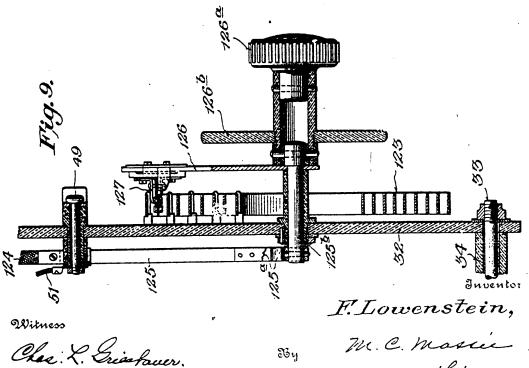


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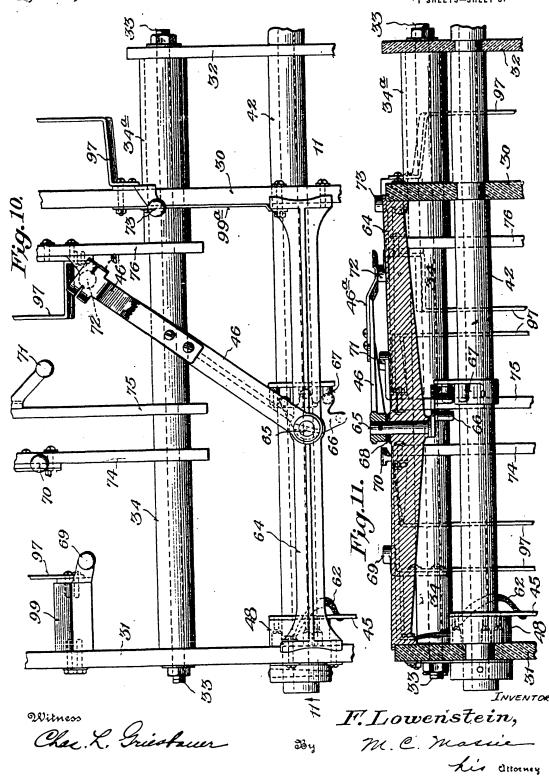
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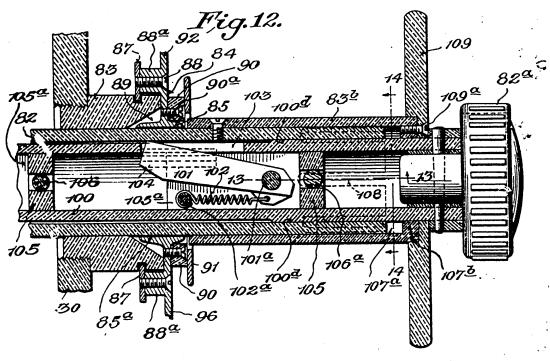
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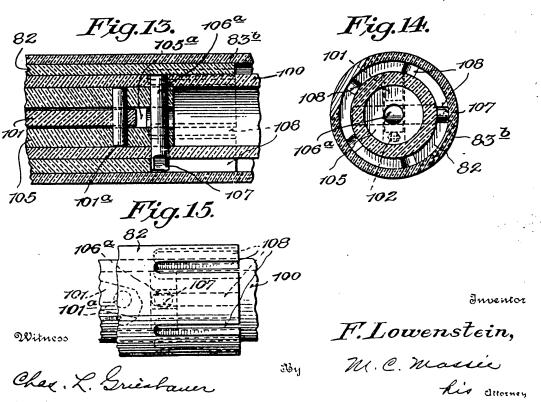


F. LOWENSTEIN. RADIOSIGNALING APPARATUS.

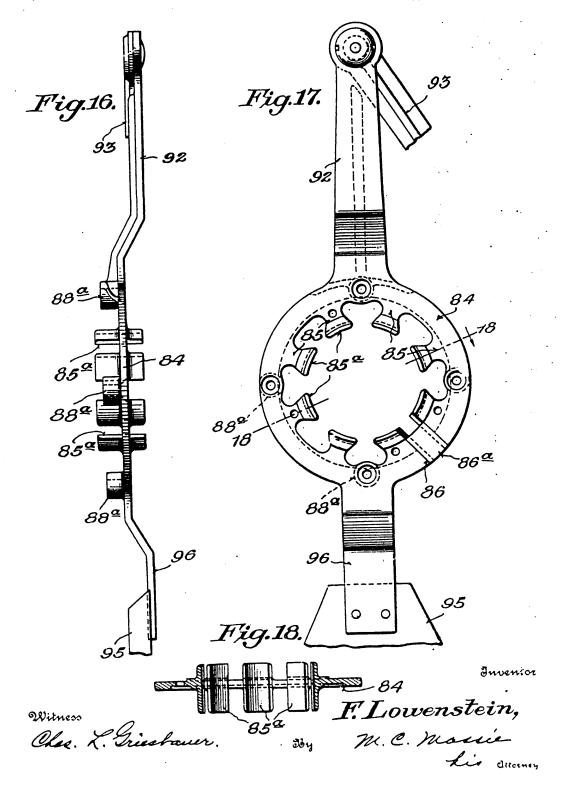
APPLICATION FILED JAN. 19, 1918.

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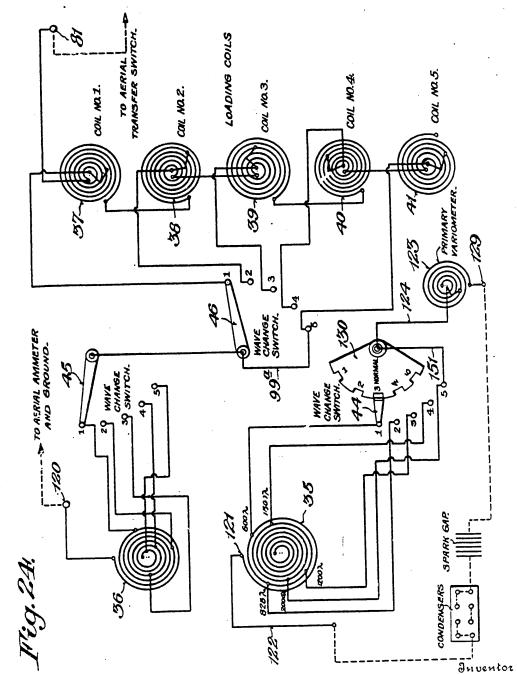


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Patented May 11, 1920.



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UNITED STATES PATENT OFFICE.

FRITZ LOWENSTEIN. OF BROOKLYN, NEW YORK.

RADIOSIGNALING APPARATUS.

1,339,772.

Specification of Letters Patent.

Patented May 11, 1920.

Application filed January 19, 1918. Serial No. 212.615.

To all whom it may concern:

Be it known that I, FRITZ LOWENSTEIN, a citizen of the United States, residing at Brooklyn, county of Kings, and State of 5 New York, have invented certain new and useful Improvements in Radiosignaling Apparatus: and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will en-10 able others skilled in the art to which it ap-

pertains to make and use the same.

This invention relates to radio signaling apparatus of a type in which provision is made for rapidly changing the operating 15 wave length, either in sending or receiving, by means of mechanism operable to actuate simultaneously a reactance-varying device in each of two cooperating oscillation circuits, such reactance-varying devices com-20 prising variable inductance or variable capacity, or both. Apparatus of this general character is described and broadly claimed in my prior applications Ser. No. 569.324, filed June 28, 1910, and Ser. No. 10,592, filed 25 February 25, 1915. The present disclosure relates to certain improved embodiments of the broad principles disclosed in said prior

applications, and also includes other novel features of general application in this art. For certain kinds of service, and especially in military operations, it is necessary to employ portable radio or wireless signaling apparatus which must be characterized by reasonably high power and efficiency. 35 lightness, compactness, resistance to shocks and rough usage generally, and also by simplicity and convenience of operation. Some of these requirements are to a certain extent mutually conflicting, with the result 40 that it is difficult to satisfactorily meet them all in one combined construction. For example, compactness, rigidity and massiveness of supporting structure, which are required for the portability, strength and 45 durability essential to apparatus capable of withstanding rough treatment, are difficult to attain while complying with the requirement to guard against jumping of the current between high tension parts of high power apparatus. It is a primary object of the invention to provide apparatus which shall successfully meet all the requirements in question and which shall at the same time

embody features of improvement desirable

in and of themselves, whether employed or 55 not in portable apparatus of the specific character to be more particularly hereinafter described.

By way of concrete illustration and in order that the invention may be fully un 60 derstood by those skilled in this art, an especially desirable form of transmitter apparatus embodying the principles of the invention and shown in the accompanying drawings will be described in detail. It is 65 to be understood, however, that the invention is not limited to a transmitter nor to the specific construction here chosen for purposes of explanation. In the drawings,

Figure 1 is a front elevation of the as- 70

sembled apparatus;

Fig. 2 is a plan view of the same;

Fig. 3 is an elevation, partly in section on

the line 3-3 of Fig. 2;

Figs. 4 and 5 are longitudinal sections on 75 the lines 4-4 and 5-5, respectively of

Fig. 6 is a front elevation of a part of the wave change mechanism, on an enlarged scale;

Fig. 7 is a section on the line 7-7 of

Fig. 6;

Fig. 8 is an enlarged detail of the variometer coil and switch. in elevation;

Fig. 9 is a section on the line 9-9 of 85

Fig. 8;

Fig. 10 is a plan view on an enlarged scale of a part of the apparatus shown in Fig. 2:

Fig. 11 is a view of the same in side elevation, partly in section on the line 11-11 of 90 Fig. 10;

Fig. 12 is a sectional detail, on an enlarged scale, of a part of the selector mechanism shown in Fig. 5;

Figs. 13 and 14 are sections on the lines 95

13—13 and 14—14 of Fig. 12;

Fig. 15 is a fragmentary view in elevation of part of the selector mechanism shown in Figs. 13 and 14;

Figs. 16 and 17 are a side elevation and 100 plan, respectively, of variable switch means

employed on the loading coils:

Fig. 18 is a section on the line 18-18 of

Fig. 17;

Fig. 19 is an enlarged detail, in elevation, 105 of stop means for the transformer coupling changer:

Fig. 20 is an enlarged detail showing a

method of mounting the flat conductor of which the coils are formed;

Figs. 21, 22 and 23 are enlarged detail views of a terminal clip useful in tapping 5 the transformer coils; and

Fig. 24 is a circuit diagram. The transmitter here illustrated as a typical embodiment of apparatus within the scope of my invention, may be generally 10 described as comprising an oscillation transformer having inductively related primary and secondary windings or coils, and loading coils in circuit with the secondary or coupling coil but substantially out of its 15 inductive influence. Means are provided whereby the effective inductance values of the transformer primary and secondary, and of the loading coils, or, speaking more generally, the self induction of the two 20 oscillatory circuits, may be varied rapidly and simultaneously in a predetermined manner to change the operating wave length without materially disturbing a previously established desired tune relationship be-25 tween said circuits. In the particular form of apparatus shown in the drawings, the transformer primary and secondary coils, and the loading coils, together with the necessary operating and controlling means 30 therefor, are here shown supported in compact arrangement as a mechanical unit by means of a substantial insulating framework. This framework comprises main front and rear plates or panels 30, and 31, 35 respectively, and a smaller supplemental front plate or panel 32, all rigidly held together in proper spaced relation by longitudinally extending tie rods 33, here shown as of metal, incased in heavy insulat-40 ing sleeves 34 which also act as spacing or distance members between the panels. The plates or panels are also of suitable insulating material. Most desirably, and as here shown, the several coils supported on this 45 framework are flat helical coils of copper ribbon, commonly known as pancake coils. The oscillation transformer is mounted to one side of the center line of the framework and consists of the two parallel coaxial pan-50 cake coils 35 and 36, the primary coil 35 being stationarily mounted on the rear face of the main front panel 30, while the adjustable secondary or coupling coil 36 is mounted in such a way as to be movable toward 55 and away from the primary by means hereinafter described, whereby the transformer coupling distance may be adjusted or varied as desired. In the drawings, the secondary is shown in the position for maximum close 60 coupling. On the other side of the center line of the framework are supported the loading coils 37, 38, 39, 40 and 41, these loading coils being electrically connected in series with each other, and also arranged 65 for connection in circuit with the trans-

former secondary and the antenna, in a manner to be hereinafter more fully described. The arrangement is such that the loading coils are within inductive range of each other, but are practically out of induc- 70 tive range of the transformer. Five loading coils are employed in the present exampie, since this particular transmitter is designed for quick change operation over five different wave lengths, and it is con- 75 venient to have the loading inductance divided into the same number of sections.

The mechanism for rapidly changing wave lengths takes the form, in this instance, of manual operating means compris- 80 ing a rotatable operating rod or shaft 42, of insulating material, provided with a hand knob 43, said rod serving to connect for movement in unison the primary switch arm 44, secondary switch arm 45, and load- 85 ing inductance switch arm 46. The primary and secondary switch arms are secured, respectively, to insulating distance collars 47 and 48, collar 48 being best secured to the shaft 42, and collar 47 being 90 loose on said shaft. The several switch arms or blades are respectively arranged for variable connection to the transformer primary and secondary, and the loading coils. Thus primary switch arm 44, con- 95 nected to the shaft 42 by means to be hereinafter described, sweeps over a series of contacts 49, representing different effective inductance values of the transformer primary and corresponding in number to the 100 number of wave lengths at which it is desired the transmitter shall be operable, five in this instance. Stops 50 are provided, one at each end of the series of contacts, which are mounted on the front pane, 32, 10; to suitably limit the movement of the switch arm. The contacts 49 are connected respectively by flexible conductors 51 leading through openings 514, 516, to spring clips 52, each of which can be adjustably set in 110 any desired position on the primary coil. Similarly, the secondary switch arm 45 sweeps over a second series of five contacts 53, mounted on the rear frame plate 31, this second series of contacts being also pro- 117 vided with terminal stops 54. The contacts 53 are connected to tapping points on the movable transformer secondary by special means. As here shown, such means comprise conductors 55 conne ting the respec- 120 tive contacts 53 with horizontal conducting rods 56, which are fixed to the rear panel and which extend forwardly and enter hollow insulating supporting sleeves or guides 57, carried by the movable insulating plate 58. Brushes 59 secured to the sleeves 57 bear upon the conducting rods 56, and are connacted by flexible leads 60 to clips 61. five in number, which are adjustable in position on the turns of the transformer 130 1,339,772

secondary coil. The connecting terminals of conductors 55 are best mounted on in-

sulating spacers 55°, as shown.

The secondary switch arm 45 may be elec-5 trically connected in the secondary circuit of the transmitter in series with the loading inductance switch arm 46, in any suitable manner. In this instance, this connection is effected through a flexible lead 62 going to 10 terminal 63 on the conducting bar 64, which latter extends between the panels 30 and 31, and thus also incidentally constitutes a bracing girder. As is shown most clearly in Figs. 10 and 11, the bar or girder 64 provides at a point intermediate its length a bearing for a vertical conducting spindle 65, to the upper end of which is pinned the switch arm 46. The lower end of the spindle carries a pin gear segment 66 with which 20 a similar gear segment 67, carried by the wave change rod 42, meshes. A spring washer 68 placed between the hub of the switch arm 46 and the bar 64, insures good electrical contact between the switch arm 25 and bar. The loading inductance switch arm 46 carries a brush 46a which sweeps over a series of five contacts 69, 70, 71, 72 and 73, mounted in an arc above the frame, as shown. These contacts are respectively con-30 nected to adjustable tapping points on the loading coils, in a manner to be hereinafter described.

Loading coils 37 and 41 are supported, as shown, directly on the rear panel 31 and front panel 30, respectively. The intermediate loading coils 38, 39 and 40 are mounted on intermediate insulating plates 74, 75 and 76, respectively. As before stated, the loading coils are connected in series. In order 40 to simplify the series connections, and at the same time not to interfere with the mutual inductive effect of the loading coils, the following arrangement is particularly convenient. The five coils viewed from one end 45 of the series, are wound, alternately clockwise and counter-clockwise, and the leads connecting pairs of adjacent coils therefor extend alternately between adjacent coil peripheries and adjacent coil centers. Thus, the connection between coils 37 and 38 is through conducting rod 77 which extends Letween the outer peripheries of these coils. Coils 38 and 39, on the other hand, are connected through cooperating spring contacts 55 78, each of which is secured to the central or innermost turn of its corresponding coil. In a similar manner, conducting rod 79 connects the outer peripheries of coils 39 and 40: while cooperating spring contacts 80 connect the centers of coils 40 and 41. At 81 is a binding post whereby the center of coil 37 may be connected directly or indirectly to an anterina. Any other convenient arrangement and connection of the loading 65 coils may of course be employed.

As before stated, provision is made for connecting each of the several loading coils with its respective contact in the series of contacts 69 to 73, over which the loading inductance switch arm 46 sweeps. This 70 provision is such that the loading coils are successively cut into or out of the secondary circuit by the switch arm 46, as the shaft 42 is turned to change the operating wave length. In this way, the proper amounts of 75 primary and coupling inductance, and the proper number of loading coils, for each of the five selected wave lengths, are placed in circuit by simultaneously shifting the three switch devices. It is also desirable that 80 provision be made for varying the proportion of any loading coil actively in circuit easily and rapidly in accordance with operating conditions at the different wave lengths for which the wave change mecha- 85 nism may be set. The following arrangement is particularly suitable for the above purposes. A hollow shaft or sleeve 82 of insulating material extends axially through the series of loading coils and through the 90 plates 30, 37, 74, 75 and 76, and is revolubly supported in suitable insulating bushings or hubs 83 which are screwed into the several plates. Stop collar 83° at the rear and sleeve 83b at the front hold sleeve 82 against 95 longitudinal movement. For each loading coil there is a conducting arm or switch device rotatably supported by the corresponding bushing 83. This contact arm comprises a central spider 84 having inwardly 100 extending spaced radial fingers 85, terminating in broad cylindrical surfaced ends 85" concentric with and closely adjacent sleeve 82 which fits loosely therewithin. The spider is radially slotted at 86 t pre- 105 vent eddy currents, the gap being closed by a piece of insulating material 80°. Without some such precaution, overheating may eccur in operation. The spider is rotatably supported on the hub 83 by means of 110 washers or disks 87, which are secured thereto by screws 88 in bosses 884, and which fit easily within a cooperating peripheral groove or track on the hub. the broad ends of fingers 85 of the spider pro- 116 jecting into the recess 89 formed in the end of the hub 83 adjacent said spider. A spacing ring 90 of insulating material is secured to the spider 84 by screws 901; and by means of similar screws (not shown) 120 the metal slip ring 91 is secured to ring 90, said slip ring being electrically connected. as by one or more of said screws, to spider 84. The slip ring is slotted, similarly to the spider 84, to prevent eddy currents; but 125 the slotting is in a different angular position from the slotting of the spider, for rensons which will presently appear. A conducting arm 92, integral with spider 84, extends radially to a point about midway be- 130

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tween the innermost and outermost turn of the loading coil, at which point another conducting arm 93 is hinged to it. The arm 93 carries at its free end a clip or slider 5 94 which is movable along the conducting ribbon of which the loading coil is formed. so that by rotation of the spider, this clip can be moved to any desired position on the pancake coil. In order to guard against 10 accidental movement of the clip along the conductor by reason of shocks or jars, a counterpoise 95, may be attached to arm 95 of the spider. The employment of a hinged or jointed contact-making arm of the char-15 acter described has special advantages in connection with large coils like the loading coils here shown, when the conditions of operation are such that the potential in the outer turns of such coils is very high due 20 to auto-transformation. This condition is most pronounced when operating at short wave lengths; and for the arrangement of coils here shown is most likely to occur in coils 37, 39 and 41, especially in coil 37. 25 By means of the hinged arm, the difference in potential between the coil conductor and arm 92 never exceeds that due to approximately one-half the total number of coil turns. It will be noted that the contact 30 arm for coil 37 is spaced farther from the coil than are the arms of the other coils. This is on account of the particularly high potentials in coil 57, and the spacing would have to be still greater were it not for the 35 hinged arm arrangement.

Each spider is connected to its corresponding switch contact 69, 70, 71, 72 or 73, by means of a conducting bar 97, which carries a brush 98 confined between slip ring 91 40 and the revoluble spider S4, the arrangement being such that the brush always makes good electrical contact with both. Since the slotting of the spider and the slip ring to prevent eddy currents is not at opposite or 45 adjacent points, the brush 98 is always electrically connected to the spider either by direct contact or through the slip ring. It will be noted that each of the bars 97 is disposed tangentially with respect to the 50 spider with which it makes contact. By this arrangement the force occasioned by friction between the brush 98 and the spider is exerted longitudinally of the bar instead of transversely: and this is an important con-55 sideration especially in the specific form of apparatus here chosen for illustration, where the bars 97 are positively held at their upper ends only. The bars 97 are bent outwardly as shown, extending in a radial di-50 rection but well spaced away from the loading coil, then going to a point of connection with the contact corresponding to the particular loading coil in question. Thus, coil 41 is connected to contact 73, and so on for vs the other loading coils. Because of the high

potentials normally existing in the end loading coil 37 in operation, it is desirable to mount its switch terminal 69 on a relatively long insulating spacer 99. It has been found undesirable to leave as dead ends those portions of the loading inductance not actively in the secondary or aerial circuit. Accordingly the last loading coil 41 has its contact stud 73 always connected to the loading switch 46 through lead 99^a going to girder 75 64. This shunts the unused portions of the loading inductance and avoids unduly high potentials.

Means are provided for selectively retain-

ing any one of the rotatable spiders 84 and 80 its hinged contact arm in order to adjust the position of the contact clip or slider on the corresponding loading coil. A convenient and satisfactory mechanism for this purpose is here shown. It comprises a se- 85 lector tube or hollow shaft 100 of insulating material, within the sleeve 82, and slidably movable longitudinally therein within limits. This inner tube or shaft 100 contains suitably mounted therewithin five piv-190 oted latches or dogs 101, one for each loading coil, each latch controlled by a spring 102 which tends to force the tail of the latch outwardly through a longitudinal slot 103, provided in the tube, the five slots 103 being 95 in alinement as shown. Normally these latches are held inoperative by their contact with the inner surface of the surrounding sleeve 82, but upon rotation of the inner tube 100 relatively to the outer sleeve 100 through different predetermined angles, each of the alined slots in the inner tube may be made to register with a slot 104 in the outer tube or casing 82, as will be more fully explained later, whereupon the par- 109 ticular latch in question is thrust outwardly by its controlling spring to engage between a pair of the inwardly projecting fingers 85 on the spider whose arm governs the clip or slider on the corresponding loading coil. In 110 this position, illustrated for example at the extreme left in Fig. 5, the latch mechanism for coil 37 is thus in operative position; and with the two tubes \$2 and 100 thus coupled together and also coupled to the spider 84, 115 turning of the operating knob S2ª will result in shifting the sliding contact around on the helical conductor of coil 37 into any desired position. Any practical method of mounting the latches 101 within the tube 120 100 may be adopted, but that here shown is simple and effective. Short lengths of heavy walled insulating tubing 105 of the proper diameter, are sawed through longitudinally for the greater part of their length 1 to provide chambers 105°. Within each of these chambers one of the latches 101 is pivoted on cross pin 1014, its controlling spring being anchored to a cross piece 102°. In assembling the selector mechanism, each 130

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of these mounting blocks or tube-sections. with its latch in place, is inserted into the tube 100, and after being pushed into proper position is secured in place by means of a pin passing through the unsawed end of the block and into the walls of tube 100. In the apparatus of Fig. 5 these securing pins are most desirably of insulating material. as indicated at 106, for all the blocks except 10 that at the extreme right, the securing pin 106° for the latter being of stronger material, such as steel, and also differing slightly from the others in form, for reasons which

will presently appear. In order to provide for easily selecting and operatively positioning the particular latch 101 corresponding to the loading coil whose slider it is desired to adjust, means are provided for rapidly and accurately 20 bringing into registry the particular pair of cooperating slots 103, 104, through which that latch is adapted to project. In the apparatus here shown, the front end of the outer selector tube is provided with five 25 longitudinally extending slots 108, angularly spaced to agree with the spacing of the slots 104, which may be equiangular, as here, for convenience. The pin 106° is elongated to provide a reduced projection at 30 107 (Fig. 14), adapted to enter any one of the five slots 108 selectively. By pulling the inner tube 100 outwardly until the selector pin projection 107 clears the end of selector sleeve \$2, where it can move freely 35 in the annular space 107° between the end of the sleeve 82 and the flange 1076 of the outer sleeve 836, then rotating the tube relatively to sleeve 82 to place the end of the selector pin opposite a selected slot 108, 40 and finally permitting the sleeve 100 to be drawn back by its controlling spring 100°, one of the five pairs of cooperating slots 103-104 is thereupon brought into registry. the proper latch member operates, and the 45 telescoping selector tubes are thus coupled together and to the contact spider of the particular loading coil whose slider it is desired to adjust. For convenience, an indicator dial 109 is secured as by screws 109a 50 to flange 107b, and carries the numerals 1. 2. 3, 4 and 5, which correspond to the several loading coils. A pointer 110 on the operating knob 82ª cooperates with the dial. Thus by pulling out the sleeve 100 and then 55 setting the pointer or arrow to point to the proper number on the indicating dial, the latch mechanism for coupling the operating knob to the corresponding loading coil automatically comes into operation, when the 60 sleeve 100 is allowed to be drawn back into

place by its controlling spring 100a.

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this connection it should be noted that said

controlling spring is swiveled at 100b to the

end of sleeve 82, thus permitting free rela-

rotational movement between

sleeve \$2, and the inner tube 100. Furthermore, to insure free relative movement between selector tube 100 and sleeve 82, these members actually contact only at bearing surfaces 100° and 100°.

Turning now to the transformer construction, any suitable means may be provided for shifting the movable secondary or coupling coil 36 toward and away from the primary coil to vary the coupling distance. 75 and in the particular construction shown. the movable supporting plate 58 carries fixed thereto a long axial sleeve 112, which terminates in an internally threaded member 113, preferably of metal, the threads of 80 this member being engaged by external threads 114 of an operating rod 115 of insulating material, this rod being rotatable within the sleeve 112 and in a bearing provided at 116 in the rear panel 31. Rotation 85 of the rod can be readily effected by means of knob 117. It will be seen that by rotating the knob in one direction the sleeve 112 will be forced toward the rear and will carry with it the movable plate 58 with coil 90 36 mounted thereon: while turning the knob in the opposite direction will move the secondary coil toward the primary coil. The coupling distance may be read off on a scale 112ª provided on the sleeve 112. Suit- 95 able stop means should be provided to prevent forward and rearward movement of the coupling coil or transformer secondary beyond predetermined extreme positions for maximum loose coupling and maximum 100 close coupling. This stop means is desirably of such character as to guard against jamming or forcing of the movable parts. As here shown, this is accomplished by means of a gear stop device mounted at the rear of the apparatus and consisting of intermeshed pinions 115a, and 115b, which carry, respectively, stop members 115° and 115°. Pinion 115°, secured to shaft 115, has 24 teeth: while pinion 115b which is loose on 110 stud 115°, has 22 teeth. The pinions and stop members are so related that the operating shaft 115 may be turned through ten complete revolutions from either limiting position of the secondary coil. The stop 115 members then come into locking engagement and prevent further movement.

Terminal 118 connected to the outer turn of the secondary coil of the transformer may be connected through flexible lead 119 120 and binding post 120 to ground through a suitable ammeter (not shown). The outer turn of the primary transformer coil may be connected to the condensers in the primary circuit through binding post 121 and lead 125 122. The variable connection to the transformer primary, represented by the primary switch arm 44, is connected to an adjustable point on the variable inductance or variometer coil 123 by flexible lend 124 and con- 130

ducting bar 125 (Figs. 6-9), which latter carries a double brush 125" bearing against a contact collar on rotatable conducting shaft 125b, to which shaft is secured switch arm 126 of the variometer. This switch arm is a simple radial arm carrying a contact clip 127 which engages the conducting ribbon of the variometer coil and which is also longitudinally slidable on the arm 126 as 10 the latter is rotated by means of hand knob 126a. The operating handle may be provided with a guard plate 126b. This simple type of contact shifter can be used in this location because the variometer coil is com-15 posed of comparatively few turns, and hence there are no dangerous potentials in the outer turns under operating conditions. The outer turn of the variometer coil may be connected to the other side of the closed 20 oscillating circuit, in this instance at the spark gap, through lead 128 and binding post 129. This variometer provides a small value of variable inductance which is required in tuning the primary circuit to in-25 termediate wave lengths occurring between the turns of the large primary coil.

Returning now to the mechanical connection of the primary arm 44 of the wave change switch to the wave change shaft or 30 rod 42, this may be effected in any convenient manner. Where the set is to be always used with a standard aerial of say 450 meters, the arm 44 may be permanently fixed on said shaft. But where the set may 35 have to operate with acrials of longer or shorter periods than the standard aerial. it is important to provide means whereby the relation of the primary switch arm of the wave changer to the secondary switch arm 40 45 and loading inductance switch arm 46 may be varied. Various expedients may be adopted for this purpose. In the arrangement here shown, the switch arm 44 is adjustable on the shaft 42 into different 45 angular positions in the following manner. A sector 130 of insulating material is fixedly mounted upon shaft 42. As here shown said sector is secured by means of screws 130° to a collar 130°, which in turn is secured by pin 130° to the shaft 42. The sector is provided at its outer margin with notches 131. which may be conveniently numbered 1, 2, 3. 4 and 5 as shown in Fig. 6. A manually operable spring catch 132, radially slidable 55 on the rear face of swit h blade 44, is adapted to engage the notches 131, so that the switch blade may be shifted to any one of the numbered positions and held in place by the engagement of catch 132 in the correso sponding notch. When the switch blade is in the No. 3, or "normal" position, the wave change switch is arranged to connect in the aerial circuit the proper coupling and load-

ing coil inductance for any one of the five

predetermined wave lengths when the aerial 65 employed is of the standard period. Should the aerial be of shorter period, an additional coil can be added to the aerial circuit by shifting the primary switch blade from "normal" position to No. 2 notch. With the 70 blade in No. 1 notch, two loading coils are added. This will permit tuning of the set for use with an aerial of approximately 300 meters. When the set is required to operate with aerials of more than 450 meters, 75 the primary switch blade is shifted from the "normal" to No. 4 notch, which decreases the inductance in circuit with the aerial coil. A shift from "normal" to No. 5 notch effects a decrease by two loading coils.

Referring again to the mounting of the loading coils, the arrangement described has important practical advantages as above pointed out. But this entails having two supporting plates 74 and 75, between coils \$5 38 and 39; and, similarly, two plates 76 and 30, between coils 40 and 41; the coils of each pair being thus mounted back to back. Each coil is mounted on its supporting plate by means of studs 133, which extend through 90 the supporting plate and through spacers 134, desirably of insulating material, notche ! as shown to receive the ribbon conductor. each stud being hooked at 135 to engage the conductor, and being threaded at the other 95 end for engagement by a securing nut 136. which is received in a countersink on the back of the supporting plate. The backs of the plates in the two pairs, 74-75 and 76-30, are necessarily rather close together 100 in this design of apparatus, and hence special precautions are taken to prevent current jumping across from the mounting studs of one coil to the studs or even to the turns of the adjacent coil. This is likely to 105 occur only, in the outer portions of coils whose peripheries are not directly connected, where the potential differences are often very high. Jumping across between the mounting studs is guarded against by stag- 110 gering the studs in some way. As here shown, the studs of each coil are arranged in six radial sets or series, and the sets are staggered in the successive plates so that the stud sets of adjacent coils do not come oppo- 115 site. But there is nevertheless the tendency. in the outer coil turns for current to jump from the study of one coil to the torus of the next adjacent coil; and since the dielectric constant of any solid insulating mater 120 rial is higher than that of air, this tendency would be furthered by the presence of the supporting plate interposed between such studs and coil turns Accordingly, apertures 137, circular in the present example, 1 are formed in circular series in each of the supporting plates 74, 75, 76 and 30 opposite the outer coil turns and between the radial

sets of studs. It is apparent therefore that in each pair of coils in question, the studs supporting the outer turns are separated from the outer turns of the next adjacent coil by an unobstructed air space. At the same time almost none of the strength and rigidity inherent in the use of solid supporting plates, so essential especially for apparatus intended for military purposes, is sacrificed.

A novel detail of considerable practical importance is the construction of the contact clips shown at 32 and 61 for adjustable connection of the primary and secondary 15 contact studs to the transformer coils 35 and 36. As shown in Figs. 4, 21, 22 and 23, each contact clip is a laminated structure comprising three resilient metal strips 140, 141. and 142, which are secured together by riv-20 ets 143. The strip 140 is longitudinally slotted to form four fingers, of which the two outside fingers 144 extend beyond the two intermediate fingers 145, and are bent at their projecting ends, as shown. The strip 25 141 is slotted in such a way as to provide five fingers, of which the central finger 146 extends beyond the others and is bent similarly to fingers 144 but oppositely thereto. The two pairs of fingers 147 on either side of 30 finger 146 are of substantially the same length as fingers 145, and like them are tapered or beveled at their free ends. The strip 142, lying between strips 140 and 141 is considerably shorter than the two outer 35 strips and is not slotted. Viewing the contact clip from one edge, it will be seen that the double bends in the fingers 144 and 146 are such that said fingers appear to converge or intersect and then diverge again. The 40 distance between the line of convergence and the free end of intermediate plate 142 is substantially equal to the width of the copper ribbon of which the pancake coils 35 and 36 are wound. The end of a lead 148 may be 45 connected to the clip by means of a bifurented socket 149 which slips over the opposite end of the clip between the rivets, at which point the clip may be not hed as shown at 150. After inserting the end of 50 the lead in the socket, both the socket and the lead may be firmly soldered to the clip

to form an integral construction.

The manner of employing this type of clip is sufficiently obvious. By presenting the ends of the fingers 144 and 146 to the edge of the ribbon conductor, so that the divergent ends straddle the conductor edge, and then pushing the clip firmly into place, the fingers 144 and 146 first are moved apart to guide the conductor edge accurately between the cooperating sets of contact fingers 145 and 147, and then spring toward each other again to engage the farther edge of the ribbon conductor. In the meantime the

first mentioned edge of the conductor has 65 come into abutment with the end of the intermediate strip 142. It is evident that this arrangement provides a clip which can be accurately and rapidly applied to the conductor, and which embraces the same firmly 70 enough to adequately guard against acci-

dental displacement.

The electrical relation between the various parts of the apparatus has been indicated in the foregoing detailed description, 75 and said relation is also clearly indicated diagrammatically in Fig. 24 where the parts previously referred to in this description bear the same reference characters, so far as necessary. For the sake of clearness the so-mechanical connection between the switch arms 44, 45 and 46 is not shown in this diagram. A short-circuiting connection 151 between primary stud No. 5 of the wave change mechanism and the pivoted end of 85 switch blade 44, shunts all unused turns of the primary transformer coil. This provision is made to eliminate high potentials and consequent broshing of the primary circuit. In connection with the wave change mecha- 50 nism as previously described, the diagrammatic showing of Fig. 24 indicates that operating the wave change shaft to increase or decrease the wave length, always increases or decreases all three of the variable inclue- 95 tance factors, namely, the primary inductan e, coupling inductance, and loading inductance. This is not necessarily so, however, in the case of the coupling inductance. In tuning the circuits for the different wave 100 lengths, it frequently happens that the adjustable taps on the secondary or coupling coil, have to be set in such manner that the coupling inductance both increases and decrows during a complete movement of the 105 wave changer in either direction over the entire range of wave lengths. Of course the primary and adeondary inductances, considered as entireties, always increase or decrease for increase or decrease in wave 110 length. I have also found that by a suitable adjustment of the various parts and connections, the several tapping points on the secondary or coupling coil can be concentrated within a comparatively short length of the 115 conductor composing said coil, in some intraces on a single turn of said conductor. It is possible even to use but a single tapping point on the coupling coil, thus eliminating the secondary switch arm 45; but with such 420 an arrangement the operator is required to edjust the coupling at the different wavelengths more than is needsary when severaltopping points are used in the coupling coil, 1911

The manner of operating the transmitter 125 apparatus herein described is sufficiently obvious to those skilled in the art from the foregoing description, but will nevertheless

be briefly summarized. Assuming the set to be employed with a standard aerial, the operator first adjusts the apparatus for operation at five definite wave lengths which in practice may be 600, 825, 1200, 1500 and 2,000 meters. The proper positions of the adjustable contact clips 52 on the primary coil 35, corresponding to the selected wave lengths, may be closely approximated by to reference to the scale appearing at the left of the sector opening in panel 30, as shown in Fig. 1. In order to effect the complete adjustment, it is necessary to tune the cooperating oscillation circuits for each of the 15 five operating wave lengths. For instance, with the switch blade 44 set at "normal" in notch No. 3 of sector 130, the wave changer is moved if necessary to place switch blade 44 on primary contact stud 1. In this posi-20 tion of the wave changer, switch blades 45 and 46 will also contact with the No. 1 studs of their respective series. The general method of tuning the circuits for any given wave length is well understood by those 25 skilled in the art and requires no detailed explanation here except as regards manipulation of the specific apparatus shown. In order to make the necessary adjustment of inductance in the aerial circuit for tuning 30 at the first wave length, 600 meters, the operator pulls out the selector rod, turns the handle until the arrow 110 points to the numeral 1, indicating the first loading coil, and then releases the handle, said handle being 35 thereupon coupled to the movable switch arm of loading coil No. 1 by operation of the selective latch mechanism hereinbefore described. The selector handle may then be rotated to increase or decrease the aerial inductance to the necessary extent. The coupling of the circuits may be adjusted by rotating the coupling handle 117 in either direction. The foregoing operations are re-peated for all five wave lengths, the wave 45 change device being of course operated to bring the switch blades 44, 45 and 46 into contact with the remaining studs of their respective series successively, and the aerial inductance being adjusted in each case by 50 selecting and shifting the rotary contact arm on the particular loading coil corresponding to the wave length for which adjustment is being made. When the transmitter has been tuned, and coupled in the 55 above manner at all five wave lengths, the operator may shift from one wave length to any other of the selected wave lengths by moving the wave change switch to the primary stud corresponding to the wave length co desired. This is not only an advantage in the general operation of the set, but may be used in secret transmission by coding the wave lengths according to a prearranged schedule.

Where it is necessary to adjust the trans-

mitter for operation with aerials of either longer or shorter periods than the standard aerial above assumed, the procedure for tuning and coupling is in general the same. However, if the aerial is of longer 70 period than the standard, and assuming it is desired to tune the circuit for a wave length of 1200 meters, that is, with the wave change switch blade 44 on primary stud No. 3, the operator shifts said switch blade to 75 No. 4 notch, but leaves the blade in contact with No. 3 stud. This decreases the aerial inductance by one loading coil, and the selector rod must be moved to adjust No. 2 loading coil. If resonance is not ob- '80 tained within the range of this coil, the switch blade is shifted to No. 5 notch while remaining on No. 3 stud. This decreases the aerial inductance by two loading coils, and the selector rod is then moved to ad- 85 just No. 1 coil. Similarly, if the aerial is of shorter period than standard, switch blade 44 is set in No. 2 notch, and then in No. 1 notch if necessary, resulting in the addition of one and two loading coils, re- 90 spectively, and the selector rod being moved to connect with No. 4 or No. 5 loading coil, as the case may be, to effect final adjustment of the aerial inductance.

From the foregoing, it will be seen that 95 the additional adjustments necessitated by operation with aerials which are not standard, amount mechanically to changing the normal relation between the simultaneously movable primary and secondary switch 100 blades or arms. This necessarily reduces to some extent the range of wave lengths over which the wave change mechanism can be operated, as compared to its operation with a standard antenna, but other wise the general principle of simultaneous variation of electrical values in the cooperating circuits simultaneously is not altered.

It is obvious that the set can be adjusted for operations of wave lengths intermediate 110 those arbitrarily selected above for purposes of illustration. The clips on the primary transformer coil can be shifted if necessary to give the exact number of primary turns required for each desired wave length, 115 and the circuits can then be tuned for each such selected wave length in the manner already described. This having been done, the wave change mechanism will then connect in the circuits the proper primary 120 turns, coupling inductance, and aerial inductance necessary for the indicated primary wave lengths.

By careful adjustment of the transmitter for the different wave lengths selected, 13 only very slight adjustment of the coupling, if any, is necessary in shifting from one wave length to another.

Certain features shown and disclosed, but not claimed, in the present application are 130

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disclosed and claimed in a copending divisional application, Serial No. 341,990, filed December 2, 1919.

What I claim is:

1. Radio transmitter apparatus comprising in combination, substantially parallel main front and rear plates or panels arranged a suitable distance apart and connected together to form a unitary support-10 ing structure, a pancake inductance coil stationarily mounted on the front panel and constituting a transformer primary, a plate intermediate said main plates and parallel therewith and mounted for movement for-15 wardly and rearwardly, a second pancake inductance coil constituting the transformer secondary mounted on said intermediate plate in inductive relation to the primary coil and substantially coaxial therewith, 20 means for moving said intermediate plate to vary the transformer coupling distance. a plurality of substantially parallel pancake coils electrically connected in series and constituting loading inductance, said coils be-25 ing mounted upon said supporting structure in parallel spaced arrangement on an axis substantially parallel to that of the transformer coils, a set of contacts electrically connected to adjustable taps on said pri-30 mary transformer coil, a second set of contacts electrically connected to adjustable taps on said secondary transformer coil, a third set of contacts each electrically connected to an adjustable tap on one of said 35 loading coils, a separate movable switch member for each set of contacts, the secondary coil switch member and the loading coil switch member being electrically connected in series, and means mechanically con-40 necting the three switch members and operable to move them simultaneously whereby the inductance values of the primary, secondary and loading coils in circuit may be varied in a predetermined manner.

2. Radio transmitter apparatus comprising, in combination, a rigid supporting structure, a flat coil stationarily mounted thereon and constituting the primary of a transformer, a second flat coil constituting 50 the transformer secondary mounted on said structure substantially coaxially with the primary coil and movable toward and away from the same, a plurality of flat loading coils electrically connected in series sup-55 ported by said structure on a common axis substantially parallel to the transformer axis but to one side thereof, a set of contacts electrically connected to adjustable taps on said primary coil, a second set of contacts electrically connected to adjustable taps on said secondary coil, both sets of contacts being arranged in planes substantially parallel to the transformer coils, a third set of contacts arranged in a plane 65 transverse to said transformer and lording

coils, each of said third set being electrically connected to a variable point on one of said loading coils, a switch cooperating with each said set of contacts, the switches for the second and third sets being connected in 70 series, and means connecting all said switches mechanically and operable to move them in unison.

3. Radio transmitter apparatus comprising, in combination, an oscillation trans- 75 former, a plurality of loading coils in circuit with the transformer secondary, three sets of contacts of which two sets are connected, respectively, to adjustable tapping points on the transformer primary and sec- so ondary and are in parallel arrangement, while the third set is connected to adjustable tapping points on the loading coils. and has its constituent contacts lying in a plane transverse to the first two sets, sepa- 85 rate switches cooperating respectively, with the three sets of contacts, and means mechanically connecting said switches and operable to move them all in unison.

4. Radio transmitter apparatus compris- 90 ing, in combination with a supporting structure, a transformer having flat primary and secondary coils coaxially mounted on said structure, the secondary coil being movable with respect to the primary coil to vary the 95 coupling distance, a set of contacts mounted near one end of said structure, adjacent the transformer primary and connected to tapping points on said primary, a second set of contacts mounted near the opposite end 100 of said structure and connected to tapping points on the transformer secondary. switches respectively cooperating with said sets of contacts, an operating shaft mechanically connecting said switches and rotatable 40: to move them both, a plurality of flat loading coils in circuit with the transformer secondary and mounted on said structure at one side of the transformer, a third set of contacts, each |contact mounted adjacent a 110 loading coil and electrically connected thereto, said third set of contacts extending intermediate the ends of said structure, a switch cooperating therewith, and means connecting said switch with said operating 11:

5. Radio transmitter apparatus comprising, in combination, a variable transformer consisting of relatively movable primary and secondary coils, loading inductance 121 coils in circuit with the transformer secondary and located in substantially noninductive relation to said transformer, a 17 substantially unitary structure supporting the foregoing parts, control means for vary- 125 ing the coupling distance between the transformer primary and secondary, switches movable, to vary the inductance of the transformer primary and secondary, respectively. a third switch movable to vary the number too

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of loading coils in circuit, operating means common to all three said switches for moving them in unison to effect predetermined changes in wave lengths, an adjustable tap-5 ping contact on each loading coil for determining the effective inductance value thereof, and selecting mechanism operable to adjust such tapping contact on any of the loading coils at will, said control means, 10 operating means, and selecting mechanism all being manually operable from one end

of said supporting structure.

6. Radio transmitter apparatus comprising, in combination, a substantially unitary 15 supporting structure, transformer primary and secondary coils mounted thereon, a coupling changer operable to alter the coupling distance between said coils, a variometer in circuit with said primary coil, loading in-20 ductance in circuit with said secondary coil. interconnected switches operable to simultaneously vary the effective inductance values of the transformer and loading inductance in a predetermined manner, means 25 for fine adjustment of said loading inductance, and separate manual controls, all grouped in closely adjacent positions on said structure, for operating said coupling changer, said variometer, said intercon-30 nected switches, and said means for fine adjustment, substantially as and for the purposes set forth.

7. Radio signaling apparatus comprising, in combination, cooperating oscillatory cir-35 cuits each including reactance - varying means, a member associated with each said means and movable to actuate the same, and controlling means connecting said members and operable to move them simultaneously 40 and thereby to change the wave length in both circuits according to a predetermined reactance relation between said circuits, the connection of said controlling means to said members being adjustable to alter said pre-45 determined reactance relation and to permit simultaneous operation of said members by said controlling means according to the al-

tered relation.

8. Radio signaling apparatus comprising. 50 in combination, cooperating oscillatory circuits, one of which is arranged for connection to an antenna, wave change means common to said circuits and operable to vary the electrical values thereof simultaneously ac-55 cording to a predetermined relation between said values in the circuits, said relation being based on operation of the apparatus with a given antenna as a standard, said wave change means being adjustable to establish 60 another relation between said values, based on operation of the apparatus with an antenna differing substantially from the standard, and being operable to vary the electrical values in the circuits simultaneously acas conding to the changed relation.

 Radio signaling apparatus comprising, in combination, cooperating oscillatory circuits each including a variable inductance, sets of contacts connected to tapping points on the respective inductances, a switch de- 70 vice for each said set movable to engage the contacts thereof and thereby to vary the proportion of the corresponding inductance in circuit, and means mechanically connect-a ing said switch devices and operable to move 75 them simultaneously to engage functionally related contacts, one in each set, in a series of successive pairs, the arrangement being adjustable to permit another series of pairs of functionally related contacts, differing 80 from the first mentioned pairs, to be engaged by said switch devices when the latter are simultaneously moved by such mechanical connecting means.

10. Radio transmitter apparatus compris- 85 ing, in combination, an oscillation transformer, loading inductance in circuit with said transformer, a set of contacts connected to tapping points on said transformer, another, set of contacts connected to tapping on points on said loading inductance, switch members respectively cooperating with said sets of contacts and connected for simultaneous movement to engage functionally related contacts, one in each set, in successive 25 pairs, and means whereby the relation of said switch members may be altered in such manner that said switch members are connected for simultaneous movement to engage functionally related contacts, one in 100 each set, in pairs differing from the first mentioned pairs.

11. Radio signaling apparatus comprising, in combination, cooperating oscillatory circuits each including an inductance, a 105 switch device in each circuit movable to include in that circuit different proportions of the corresponding inductance, controlling A. means connecting said switch devices and operable to move them to increase or di- 110 minish simultaneously the effective induc-

nce of each circuit in definite steps, said switch devices being adjustable with respect to each other to permit altering the relation between the proportions of the respective 115 inductances included in circuit at different

steps. 12. Radio signaling apparatus comprising in combination, primary and secondary windings of an oscillation transformer, 120 loading inductance in series with said secondary winding, switch devices operable respectively to vary the effective inductance values of said primary and secondary windings and said loading inductance, and operating means connecting said switch devices for simultaneous movement to change the operating wave length in a predetermined manner, the connection of said switch devices to said operating means being adjustance

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able to establish different desired relations between the inductances of the primary and secondary circuits, said operating means being still operable to move said switch devices simultaneously after such adjustment.

13. Radio signaling apparatus comprising in combination, primary and secondary windings of an oscillation transformer, a set of contacts connected to adjustable tap-10 ping points on the transformer primary, and corresponding in number to the different operating wave lengths desired, a second set of contacts, equal in number to the first set, connected to adjustable tapping points 15 on the transformer secondary, an equal number of flat loading coils in relatively close parallel arrangement and electrically connected in series, a third set of contacts, one for each loading coil, each respectively con-20 nected to a movable contact arm on its corresponding loading coil, three separate switch devices cooperating, respectively, with the three sets of contacts, the switches for the second and third sets being electri-25 cally connected in series, an operating rod arranged to move all three switches simultaneously to engage successive groups of contacts, one in each set, and means whereby the relative positions of said switch de-30 vices may be varied to alter the number of loading coils in the secondary circuit for given positions of the primary switch device.

14. Radio signaling apparatus comprising, in combination, coöperating oscillatory circuits each including variable inductance, a switch device for each said inductance movable to vary the effective proportion thereof in circuit, an operating number mechanically connecting said switch devices for simultaneous movement in a series of steps to include different proportions of both inductances in the respective circuits, the proportion of primary and secondary inductance in circuit at each step having a

predetermined functional relation, and one of said switch devices being adjustable with respect to said operating member in such manner as to permit changing said predemined relation.

15. Radio signaling apparatus comprising, in combination, operatively associated primary and secondary inductances and circuit connections therefor, switch members respectively movable to alter by definite 55 steps the effective proportions of said inductances in circuit, an operating rod to which one of said switch members has a relatively fixed connection, and means adjustable to connect the other switch member to said shaft in different positions relatively to the first switch member, whereby said switch members may be moved simultaneously in different relations.

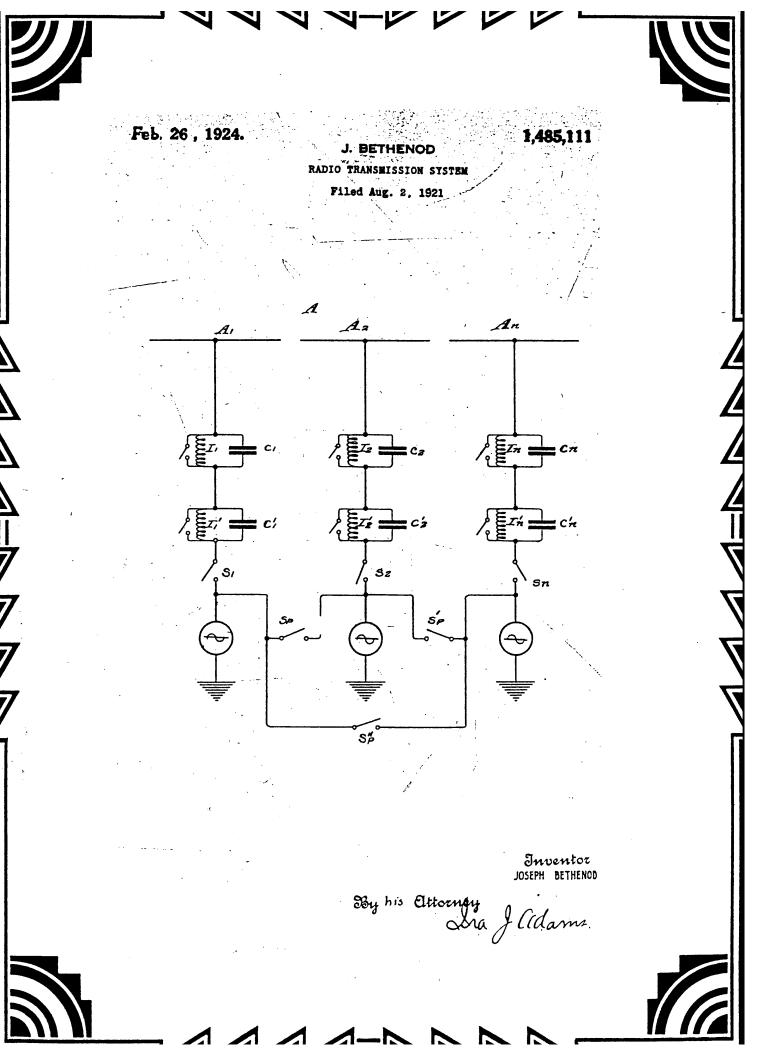
16. Radio signaling apparatus compris- 65 ing, in combination, a primary transformer coil, a secondary coupling coil movable with respect to the primary coil to vary the coupling distance, a stationary terminal whereby said coupling coil may be connected in a circuit, and a wiping brush connection between said coupling coil and said terminal.

17. Radio signaling apparatus comprising in combination, a primary transformer 75 coil, a secondary coupling coil movable with respect to the primary coil to vary the coupling distance, a set of stationary contact studs connected by leads to tapping points on said primary coil, a second set of so stationary contact studs, stationary conducting rods connected thereto, and brushes mounted to move with said coupling coil and bearing, respectively, on said rods, sai brushes being connected by leads to tapping 85 points on said coupling coil.

In testimony whereof I hereunto affix my signature.

FRITZ LOWENSTEIN.





UNITED STATES PATENT

JOSEPH BETHENOD, OF PARIS, FRANCE.

RADIO TRANSMISSION SYSTEM.

Application filed August 2, 1921. Serial No. 489,306.

To all whom it may concern:

Be it known that I. Joseph Bethenod, a citizen of the Republic of France, and a resident of Paris, France, have invented cer-5 tain new and useful Improvements in Radio Transmission Systems, of which the following is a specification, accompanied by draw-

The object of the present invention is to 10 make improvements in radiotelegraphic stations comprising a plurality of high frequency generators. The purpose of the invention is to effect by very simple operations and at the will of the oprator, either the 15 simultaneous operation of these generators at the same frequency so as to apply to the antenna the total power of the generating station, or independently to operate these generators at different frequencies so as to 20 obtain a so-called multiplex transmission.

My invention is illustrated in the single

figure of the accompanying drawing.

The principle of the invention consists in the division of the usually net shaped 25 antenna A, extended in one direction, into several sections A_1 , A_2 , A_n , each of which is supplied with current by a high frequency generator G₁, G₂, G_n, and to provide a device for limiting the currents caused by the elec-30 tromagnetic or electrostatic induction be-

tween any two sections.

In this manner, n independent stations will be provided enabling multiplex transmission to the n degree, each station having 85 a wave length slightly different from that of the others. By means of switching means comprising antenna switches S_1 , S_2 , S_n , and alternator paralleling switches S_p , S_p' , S_p'' , S_p'' the operator may at will inter-connect all or a part of the stations, whereby if n=3, triplex, or duplex (one transmission having double the power of the other), or simplex transmission is practicable with the total power of the station.

The limiting of the induced currents is preferably accomplished by means of an arrangement comprising a self-inductance such as I₁, I'₁, I₂, I'₂, I_n, I'_n and a capacity C₁, C'₁, C₂, C'₂, C_n, C'_n (connected in paral-50 lel) which are included in each of the circuits formed by an antenna section, the generator being connected to ground. If the sending is of the *n* degree, each circuit (n-1) must be protected by the arrangement (all connected in series). Each of

be tuned to one of the frequencies corresponding to one of the n-1 other transmissions, so as to provide an almost infinite impedance to said frequencies.

Obviously, the arrangements (trap circuits) of one and the same section may be combined with each other for reducing the total number of the constituting elements.

One of the characteristics of the invention 65 resides in the division into n sections of the antenna, in combination with the use of the infinite impedance or so-called frequency

The use of such traps with an undivided 70 antenna would not furnish a practical solution of the problem of multiplex transmission because, in order efficaciously to protect each generator against the currents generated by the others, very expensive self- 75 inductances and capacities must be provided to avoid serious losses, i. e. a reduction of the output. This is proved by theory and practice. It may be easily proved that, in case of multiplex operation, the partial use 80 of the antenna has no disadvantage for a given power for each generator.

Having described my invention what I

claim is:

1. In a radio transmission system, an 85 aerial divided into two separate sections adapted to radiate different wave lengths, generators therefor, and a connection of substantially infinite impedance in each of said sections to the wave length of the other sec- 90 tion for limiting induction effects therebetween.

2. In a radio transmission system, an aerial divided into two separate sections adapted to radiate different wave lengths, 95 generators therefor, a connection of substantially infinite impedance, in each of said sections to the wave length of the other section for limiting induction effects therebetween, and means for connecting both of 100 said generators to the same section.

3. In a radio transmission system, an aerial divided into n separate sections adapted to radiate different wave lengths, n separate generators, and connections in 105 each of said sections, having infinite impedance to frequencies corresponding to the wave lengths radiated by the other sections.

4. In a radio transmission system, an aerial divided into a plurality of separate 110 sections, a plurality of generators, means these arrangements or trap circuits should for connecting some of said generators to

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a desired one of said sections, and the remainder of said generators to the other sections, said generators connected to different sections being adjusted to generate different frequencies, and said generators connected to the same section being adjusted to generate the same frequencies, and circuits of infinite impedance in each of the radiating sections for limiting self induction from the other sections.

5. In a radio transmission system, an aerial divided into n separate sections, n separate generators each of different wave length, connected to said sections, and n—1 infinite impedance circuits in each section for limiting self induction from the n—1 other sections of different wave length.

6. In a radio transmission system, an aerial divided into two separate sections

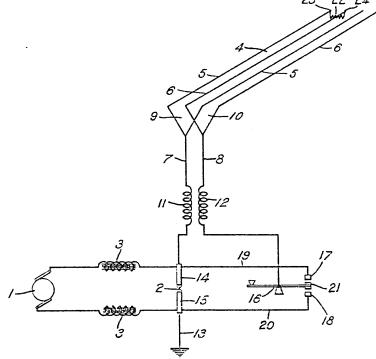
a desired one of said sections, and the remainder of said generators to the other sections, said generators connected to different sections being adjusted to generate different frequencies, and said generators connected to the frequency of the other section. 20 adapted to radiate different wave lengths, 20 a pair of generators therefor, and a trap circuit in each section comprising inductance and capacity connected in parallel and tuned to the frequency of the other section.

7. In a radio transmission system, an 25 antenna divided into a plurality of sections, a plurality of generators and means whereby any desired number of said generators may be utilized to feed any section of said antenna.

8. In a radio transmission system, an antenna divided into a plurality of sections, a plurality of generators and switching means for connecting any desired number of said generators in parallel to any antenna 35 section.

JOSEPH BETHENOD.

1,504,604 Aug. 12, 1924. L. W. CHUBB SYSTEM OF CONTROL Filed May 24, 1921



WITNESSES:

INVENTOR
Lewis Warrington Chubb.

BY

Loesley L.

UNITED STATES PATENT OFFICE.

LEWIS WARRINGTON CHUBB, OF EDGEWOOD PARK, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENNSYLVANIA.

SYSTEM OF CONTROL.

Application filed May 24, 1921. Serial No. 472,055.

To all whom it may concern:

Be it known that I, Lewis Warrington CHUBB, a citizen of the United States, and a resident of Edgewood Park, in the county 5 of Allegheny and State of Pennsylvania. have invented a new and useful Improvement in Systems of Control, of which the following is a specification.

My invention relates to wireless teleg-10 raphy and more especially to systems of control that are employed in connection with

wireless transmission systems.

One object of my invention is to provide a system of control which will maintain a 15 substantially constant load on the source of energy during the signaling and non-signal-· ing periods.

A further object of my invention is to provide a radio transmission system in 20 which the frequency of the alternating component of current in the source of energy may be maintained constant in value during the signaling and non-signaling periods to

obtain stable operation.

A still further object of my invention is to provide a transmitting system wherein the antenna circuit may be employed as an absorbing circuit, as well as a radiating circuit, thereby permitting the elimination of 30 the expensive separate absorbing apparatus which has heretofore been employed.

In the operation of arc converters, it is highly desirable to maintain the amplitude and frequency of the alternating component 35 of current through the arc substantially constant in order to permit the arc to operate

at maximum efficiency.

One system of control for accomplishing the desired result is the absorption-circuit 40 system of control. The system of control just mentioned involves the use of an absorption circuit which may be selectively caused to absorb the energy in the antenna circuit, thereby decreasing the radiation 45 therefrom. In the absorption-circuit system of control, as applied particularly to arc generators, the signals are formed by causing the arc to oscillate either in the main antenna circuit or in an absorbing circuit, 50 depending upon the energy loss in the one or the other circuit being the greater.

period of the radiating system remains constant during the signaling and non-signaling 55 operations.

Another advantage of the absorption-circuit system is that a constant load may be maintained upon the source of energy, which, in the case of arc-converters, causes 60 an increase in the stability and operating efficiency of the arc.

The particular disadvantage of the absorption-circuit system of control, as heretofore known, resides in the fact that expen- 65 sive apparatus must be employed in the absorbing circuit to render it effective.

According to my invention, I provide a control system embodying the absorptioncircuit principle of operation, which per- 70 mits a load of substantially constant amplitude and frequency to be maintained upon the source of energy during the signaling and non-signaling periods and which also permits the elimination of the expensive 75 auxiliary equipment heretofore associated with absorption circuits.

The desired result is accomplished by employing a plurality of radiating antennæ and providing means whereby the antenna 80 may be operated in parallel during the signaling period, and in series, as a condenser, in an absorbing circuit, during the

non-signaling period.

A novel feature of my invention, which I 85 wish to point out, particularly, is the disposition of the absorbing resistor. The resistor is so disposed, with respect to the antennæ, that it becomes effective as an energy-absorbing element only during the non-signal- 90 ing period.

My invention may best be understood by reference to the accompanying drawings, in

The single figure is a diagrammatic view 95 of circuits and apparatus embodying my invention, as applied to wireless transmission

In the drawing, I have shown a source of energy 1, energizing an arc 2 through a pair 100 of choke coils 3. The antennæ system comprises an elevated conductor system 4, alternate wires 5 and 6 of which are connected to down-leads 7 and 8, respectively, to form One advantage of the last-mentioned sys- two independent radiating antennæ 9 and 105 tem of control resides in the fact that the 10. The down-lead 7 is connected to a

ground conductor 13 through the coupling coil 11 and the arc 2. The down-lead 8 may be connected to either electrode 14 or electrode 15 of the arc 2 by means of a key 16.

The key 16 comprises upper and lower stationary contact members 17 and 18 which are connected, respectively, to the arc electrodes 14 and 15 by means of conductors 19 and 20, and coacting movable contact member 21 which is electrically connected to the down-lead 8 and may be actuated, successively, into engagement with the stationary contact members 17 and 18.

A resistor 22 connects the two antennæ
systems, the connecting points 23 and 24 being equi-potential points when the antennæ
and 10 are operating in parallel relation.
The resistance of resistor 22 is of such value that it is capable of placing a load upon the
source of energy during the non-signaling period comparable to the load thereon during the signaling period.

Upon actuating the movable contact member 21 of the key 16 into engagement with the stationary contact member 17, the down lead 3 is connected to the arc electrode 14 to admit of the operation of the antennæ 9 and 10 in parallel.

Upon actuating the movable contact member 21 of the key 16 into engagement with
the stationary contact member 18, the down
lead 8 is connected to the arc electrode 15
of opposite polarity, to include the arc 2 in
an absorbing circuit which comprises the arc
the mutually inductive coils 11 and 12,
the down leads 7 and 8, the elevated antennæ
and 10, the key 16 and the conductor 20.

In operation, upon actuating the co-acting movable contact member 21 into engagement 40 with the stationary contact member 17, the antennæ 9 and 10 are connected in parallel relation, thereby causing a maximum amount of radiation therefrom. With the antennæ 9 and 10 so connected, the frequency of the alternating component of current supplied to the antennæ 9 and 10 is determined by the product L1-C1, where L1 is the inductance of the coils 11 and 12, with the currents flowing through the coils 50 in the same direction, and C1 is the sum of the individual capacities of the antennæ 9 and 10 to ground. With the antennæ operating in parallel, substantially no current is carried by the resistor 22 which connects equipotential points 23 and 24 of the antennæ 9 and 10.

Upon actuating the co-acting movable contact member 21 into engagement with the stationary contact member 18, the antennæ 9 and 10 are connected in series and caused to function as a condenser in an absorbing circuit, as hereinbefore described. The period of the alternating component of energy through the arc 2 is now determined by the product of L²—C², where L² is the in-

ductance of the coils 11 and 12 when the currents therethrough are in phase opposition, and C² is the capacitance between the two antennæ 9 and 10.

By reason of the fact that C¹ is smaller 10 than C² and that L¹ is larger than L², the products L¹—C¹ and L²—C², which determine the frequency of the alternating component of current, may be maintained constant by adjusting either the one or the other 15 of the variables. For example, the variables L¹ and L² may be adjusted to the desired value by varying the mutual inductance between the coils 11 and 12. The mutual inductance of the coils 11 and 12 may be varied 80 by adjusting the distance between them.

With the key in the position just described, the resistor 22 becomes effective as an energy-absorbing element to maintain a load upon the arc substantially equal to the 85 load thereon during the signaling period.

In the drawing, I have shown a system in which alternate wires 5 and 6 of a single large antenna have been connected to form two separate antennæ 9 and 10. It is evident, however, that the arrangement of the antennæ may be modified by further separating them and supporting them individually. Assuming the antennæ 9 and 10 so separated that C¹ equals C², the mutual inductance between the coils 11 and 12 must be substantially zero in order to maintain the frequency of the alternating component of current constant during the signaling and nonsignaling periods.

Assuming another position in which the antennæ are still further separated, so that. C² is greater than C¹, the connections of one of the coils 11 or 12 must be reversed in order to maintain the product of L¹—C¹ and 105 L²—C² equal.

From the foregoing description, it will be seen that my invention provides a system of control of unusual simplicity and ease of operation which admits of the elimination of expensive apparatus heretofore necessary in wireless transmission systems employing the absorption-circuit method of control.

While I have shown only one embodiment of my invention in the appended drawing. I do not wish to be restricted thereto, but I desire that only such limitations shall be imposed upon my invention as are set forth in the appended claims.

I claim as my invention:

1. In a wireless transmission system, a plurality of radiating antennæ and means whereby said antennæ may be included in an absorbing circuit.

2. In a wireless transmission system, a plurality of antennæ and means whereby said antennæ may be caused to function as a condenser in an absorbing circuit.

ergy through the arc 2 is now determined 3. In a wirel ss transmission system, a by the product of L²—C², where L² is the indouble antenna, a source of energy therefor

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and means whereby said double antenna may function as capacitance in an absorbing circuit.

. In a wireless transmission system, a double antenna, an energy-absorbing element associated therewith, a source of energy for said double antenna and means for providing an absorbing circuit shunted around said source of energy and includ-10 ing said double antenna as a condenser.

5. In a wireless transmission system, an absorbing circuit comprising a source of energy, a plurality of adjacently-disposed radiating antenna, an energy-absorbing ele-13 ment associated therewith and means whereby said absorbing circuit may be selectively rendered effective or non-effective to control the radiation of energy from said antenna.

6. In a wireless transmission system, an absorbing circuit comprising a source of mergy, a plurality of adjacently-disposed eries-connected radiating antennæ, a resistor for connecting said antennæ; the con-25 necting points of said resistor having substantially equal potentials when said antennæ are operating in parallel, and means. whereby said absorbing circuit may be selectively rendered effective or non-effective to control the radiation of energy from said plurality of antennæ.

7. In a wireless transmission system, an absorbing circuit comprising a source of energy, a plurality of adjacently-disposed 35 series-connected radiating antennæ, an energy-absorbing element electrically connecting said radiating antennæ and means whereby said absorbing circuit may be selectively interrupted and said radiating an-40 tennæ connected in parallel relation.

8. In a wireless transmission system, an absorbing circuit comprising a source of energy, a plurality of adjacently disposed series-connected radiating antennæ, an energy-absorbing element, a power-connection between each antenna and said source of energy, each power-connection including a coil, said coils being disposed in mutually inductive relation, and means whereby said 50 absorbing circuit may be selectively interrupted and said rediating antennæ connected in parallel relation.

9. In a wireless transmission system, an absorbing circuit comprising a source of 55 energy, a plurality of adjacently-disposed radiating antennæ, an energy-absorbing element, a power connection between each antenna and said source of energy, a coil individual to each power-connection, said coils being mutually inductive, and means included in one of said power-connections whereby said absorbing circuit may be selectively rendered effective or non-effective to scontrol the radiation of energy from said radiating antenna.

10. In a wireless transmission system, an antenna, a down lead therefor, said down lead containing inductance, a source of energy, a ground connection therefor, a second antenna disposed in electrostatic rela- 70 tion to said first antenna, an energy-absorbing element electrically connecting said antennæ, a down lead for said second antenna, said second-named down lead including an inductance coil, and means whereby said 75 second-named down lead may be successively connected to opposite terminals of said source of energy.

11. In a wireless transmission system, an antenna, a down lead therefor, said down to lead comprising an inductance coil, a source of energy, a ground connection therefor, a second antenna disposed in electrostatic relation to said first antenna, a down lead for said second named antenna, said last-men- 85 tioned down lead including an inductance coil disposed in mutual inductive relation to said first-named coil, means whereby said last-named down lead may be successively connected to opposite terminals of said 90 source of energy whereby said antennæ may be successively connected in parallel and in series relation, and an energy-absorbing element connecting said antennæ, the points of connection of said element being substan- 95 tially equipotential when said antennæ are operating in parallel.

12. In a wireless transmission system, a plurality of antennæ, a source of energy therefor, and means for electrically connect- 100 ing said antennæ to said source of energy, said means including a switching device for connecting one of said antennæ to either the one or the other of the terminals of said source whereby said antennæ may be selec- 105 tively caused to operate in series as a condenser in an absorbing circuit or to operate in parallel as radiating circuits, said means including mutually inductive coils so disposed that the period of said absorbing cir- 110 cuit is equal to the period of said radiating circuits.

13. In a wireless transmission system, a plurality of antennæ, a source of energy therefor, a resistor connecting said plurality 115 of. antennæ at equipotential points, and means for electrically connecting said antennæ to said source of energy, one of said means including a switching device whereby said antennæ may be selectively caused to 120 operate in series as a condenser in an absorbing circuit or to operate in parallel as radiating circuits, both of said means including mutually inductive coils so disposed that the period of said absorbing circuit is 125 equal to the period of said radiating system with said antennæ operating in parallel.

14. In a wireless transmission system, a radiating system comprising a plurality of antennæ and an energy-absorbing element 130

connecting said plurality of antenne at

equipotential points.

1b. A high-frequency transmission system comprising a plurality of antennæ circuits, a spurce of high-frequency oscillations and mashs for operating said antennæ

circuits in parallel for radiating energy and in series for absorbing energy substantially without radiation.

10. 16. A high-frequency transmission system comprising a plurality of antenna circuits, tuning devices therefor, a source of high-frequency oscillations and means for operating said antenna circuits in parallel for erating said antenna circuits in parallel for 15 radiating energy and in series for absorbing energy substantially without radiation, said circuits being so arranged that the frequency thereof is substantially the same for both radiating and absorbing,

17. A high-frequency transmission system comprising a plurality of antennæ circuits, a source of high-frequency oscillations therefor, means for operating said antennæ circuits in parallel for radiating energy and 25 in series for absorbing energy substantially without radiation, and means whereby the load drawn by said circuits from said source is substantially constant whether energy is radiated or absorbed.

18. A high frequency transmission system comprising a plurality of antennæ circuits, a source of high-frequency oscillations therefor, connections between said source

and said antennes circuits and means for changing said connections to operate said antennæ circuits in parallel for radiating energy and in series for absorbing energy substantially without radiation.

19. A high frequency transmission system comprising a plurality of antennæ cir- 40 cuits, tuning devices therefor, a source of high-frequency oscillations, connections between said source and said antennæ circuits, means for changing said connections to operate said untenna circuits in parallel for 45 radiating energy and in series for absorbing energy substantially without radiation, said circuits being so arranged that the frequency is substantially the same for both radiating and absorbing.

20. A high-frequency transmission system comprising a plurality of antennæ circuits, a source of high-frequency oscillations therefor, connections between said source and said antennæ circuits, means for connecting said source to operate said antennæ circuits in parallel for radiating energy and in series for absorbing energy, substantially without radiation, and means whereby the load drawn by said circuits from said source 60 is substantially constant, whether energy is radiated or absorbed.

In testimony whereof, I have hereunto subscribed my name this 18th day of May, 1921.

LEWIS WARRINGTON CHUBB.

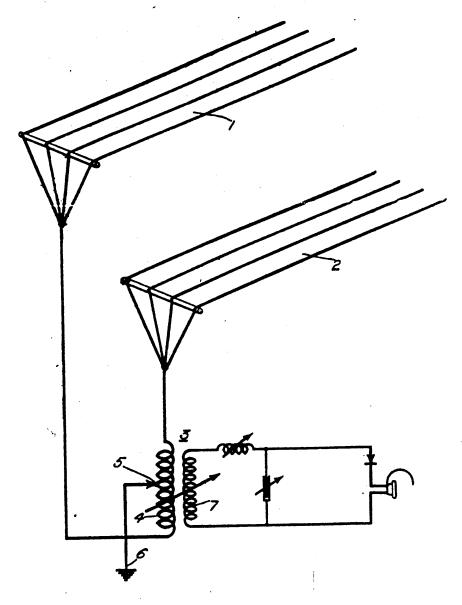
Oct. 28, 1924.

1,513,223

F. CONRAD

RECEIVING CIRCUIT FOR THE ELIMINATION OF STATIC DISTURBANCES

Filed, Oct. 17, 1918



WITNESSES: J. A. Helsel A. C. Clavis. INVENTOR

Frank Conrad

BY

Clean Storney

UNITED STATES PATENT OFFICE.

FRANK CONRAD, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY. A CORPORATION OF PENNSYLVANIA.

RECEIVING CIRCUIT FOR THE ELIMINATION OF STATIC DISTURBANCES.

Application filed October 17, 1918. Serial No. 258,530.

To all whom it may concern:

Be it known that I. Frank Conrad. a citizen of the United States, and a resident of Pittsburgh, in the county of Allegheny and 5 State of Pennsylvania, have invented a new and useful Improvement in Receiving Circuits for the Elimination of Static Disturbances, of which the following is a specification.

My invention relates to receiving circuits for use in connection with wireless apparatus, and it has for its object to provide simple and effective means whereby interference, particularly that known as "static." 15 may be largely eliminated, at the same time permitting the ready receipt of transmitted impulses.

The single figure of the accompanying drawing is a diagram of a wireless receiving circuit embodying a preferred form of my invention.

In the wireless transmission of intelligence. it is well known that the receipt of transmitted impulses is frequently seriously disturbed by static charges produced upon the antenna by the passage of wind thereover, these static charges flowing to ground through the receiving apparatus. Similarly, the passage of electrostatically charged clouds over the antenna attracts or repels charges from the ground, these also passing through the receiving apparatus and confusing the operator.

I find that the static charges and static induction in antenna of different heights is substantially the same, whereas the intensity of the impulse set up in an antenna by incoming signals varies with the height, being much stronger for an antenna of considerable height than for one of moderate height. I make use of this phenomenon in eliminating the disturbing effects of static electricity by employing two antenne for the receipt of messages, these antenne being so associated with receiving apparatus that the substantially coupl charges imparted thereto by static influences cancel each other within the receiving apparatus, thus being rendered imperceptible to the operator. The unequal amounts of energy imparted to the antenna by incoming impulses fail to cancel each other and thus a residual effect is imparted in the receiving apparatus which may be amplified if desirable in order to render it more clearly perceptible to the operator, the secondary winding 7, setting up current 110

Referring to the drawing for a more detailed understanding of my invention. I show a relatively high wireless antenna at 1 and a relatively low antenna at 2. These antenne are shown of the flat-top type but 60 it is to be understood that any antennæ of the open-circuit kind may be used. Some antenna, usually in the form of a coil, act wholly, or at least largely, by the change in flux through them which is caused by an 65 arriving ether wave. Other antennæ act wholly or mainly in virtue of the electrostatic changes which accompany such a wave. I have used the term open-circuit antenna herein to designate any form of an 70 tenna belonging in the latter class. A receiving transformer is shown at 3 and the antenna 1 is connected to one end of a primary widing 4 thereof, whereas the antenna 2 is connected to the other end thereof. An 75 adjustable tap 5 is provided at an intermediate point in the primary winding 4 and is grounded at 6. The secondary winding 7 of the transformer 3 is connected to a receiving circuit of usual form.

Assuming equal sizes for the two antennathe amounts of energy received therein are substantially equal with undesired static disturbances but are quite unequal with trans mitted impulses, the high antenna develop- 85 ing much more energy in the latter case. The point of attachment 5 is, under these conditions, placed at substantially the mid point of the winding 4. so that, with a given static impulse, the upwardly flowing current 90 in the lower half of the winding 4 magnetically neutralizes the downwardly flowing current in the upper half of this winding. the current of both antennæ flowing to ground though the tap 5 and the lead 6. As 95 a result, with a static impulse, no flux is developed in the transformer 3, and consequently, no electromotive force is produced in the winding 7 and no effect is produced in the local receiving circuit.

Turning now to the effect upon the receipt of a transmitted impulse, the current flowing from the antenna 1 is much larger than that flowing from the antenna 2 and, therefore, the magnetomotive force developed in the 105 lower half of the winding 4 is greater than that developed in the upper half thereof. As a consequence, flux is developed in the core of the transformer 3 which traverses

flow in the local receiving circuit. The arriving signal produces a greater effect on the antenna 1, not only because a higher antenna possesses a better receiving capacity, but also because, being further from roofs, trees and the like, it is more exposed to the action of the arriving wave.

It is obvious that the resultant impulse at the receiving instrument is considerably weaker than would be the case were this apparatus connected to a single antenna, but any well-known type of amplifier may be employed to increase the magnitude of the signals so that they shall be readily andible.

While I have shown my invention in its preferred form, it will be obvious to those skilled in the art that it is susceptible of still other minor changes and modifications without departing from the spirit thereof and I desire, therefore, that only such limitations shall be placed thereupon as are imposed by the prior art or are specifically set forth in the appended claims.

I claim as my invention:

In a wireless receiving circuit, the combination with two antennæ of different heights, of a common local receiving circuit differentially connected to said two antennæ and susceptible of adjustment so that the energy received on one antenna from a static impulse cancels the energy received upon the other antenna, and so that similar cancellation is not effected with incoming transmitted impulses.

2. In a wireless receiving circuit, the combination with two antennæ of different heights, of a common receiving transformer

having its primary winding connected between said antennæ, a local receiving circuit dynamically interlinked therewith, and a 40 connection from an intermediate point in said transformer primary winding to ground. said point being so selected that the inductive effects of the current flow from the two antennæ mutually cancel upon the receipt of a static impulse and fail to do so upon the receipt of a transmitted impulse.

3. In a wireless receiving circuit, the combination with two antenna of different heights, of a common receiving transformer thaving its primary winding connected between said antenna, a local receiving circuit dynamically interlinked therewith, and an adjustable connection from an intermediate point in said transformer primary winding 55 to ground.

4. In radio signaling apparatus, an antenna system having associated portions arranged at different elevations but at substantially the same distance from the source of signals to be received, and means for detecting signals including means for balancing out the effects of static disturbances.

5. In a signal receiving system, two adjacent flat-top antennæ of different height.

6. In a signal receiving system, two adjacent flat-top antennæ of different height and signal translating means controlled by the difference of energy between said antennæ.

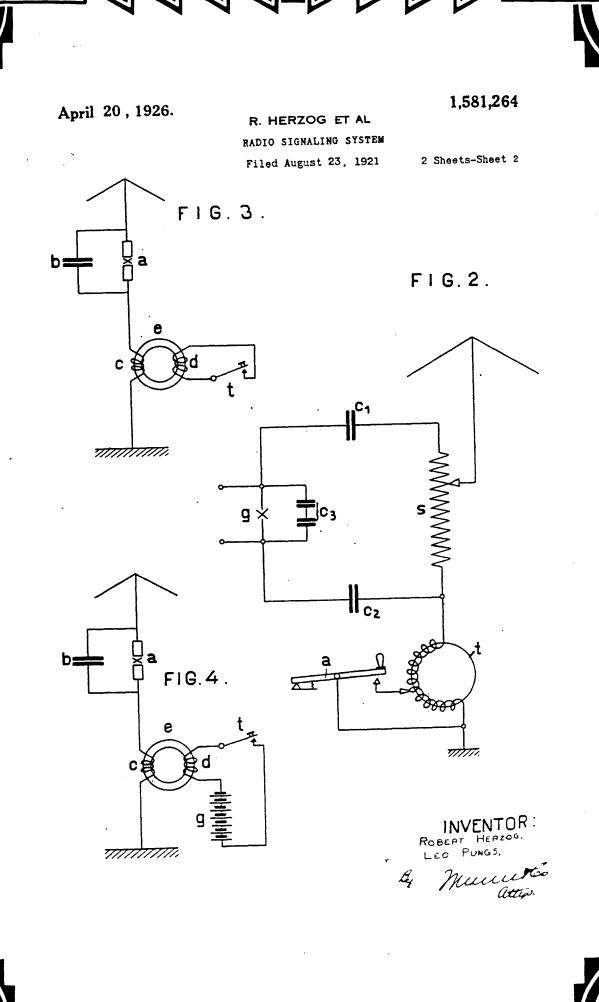
In testimony whereof, I have hereunto 70 subscribed my name this 25th day of Sept., 1918

FRANK CONRAD.

1,581,264 April 20, 1926. R. HERZOG ET AL RADIO SIGNALING SYSTEM 2 Sheets-Sheet 1 Filed August 23, 1921 FIG. 1. **=** C3 C2

INVENTOR: ROBERT HERZOG LEO PUNGS

Mucusto attys.



1,581,264

patented Apr. 20, 1926.

UNITED STATES PATENT OFFICE.

ROBERT HERZOG. OF BERLIN, AND LEO PUNGS. OF BERLIN-CHARLOTTENBURG, GER-MANY, ASSIGNORS TO C. LORENZ AKTIENGESELLSCHAFT, OF LORENSWEG-BERLIN-TEMPELHOF, GERMANY.

RADIO SIGNALING SYSTEM.

Application filed August 23, 1921. Serial No. 494,516.

In all whom it may concern:

Be it known that we, ROBERT HERZOG, residing at Berlin, Germany, and Leo Pusos, residing at Berlin-Charlottenburg, , Germany, both citizens of Germany, have invented certain new and useful Improvements in Radio Signaling Systems (for which I have filed applications in Germany on the following dates, July 15, 1919, August 5, 1919, September 16, 1919, and April 1. 1920), of which the following is a specineation.

This invention relates to a key connection for the purposes of the wireless transmis-; sion of messages which permits to control disturbance of the high frequency generator. The invention is consequently specially adapted for such generators in which the a chief object is the production of absolutely constant oscillations which can be easily influenced by the control.

In the novel connection a transformer is laid parallel to the generator, a condenser 5 for taking up the non-radiated energy being inserted at the same time in this parallel branch. An independent transformer is connected in the earth circuit, but the two transformers are not continuously energized. n The secondary windings are inserted in the parallel branch to the generator or in the earth connection whilst the primary windings are connected with the sender sender short-circuits either the primary winding of the transformer inserted in the parallel branch of the generator or the priis produced according to the example illuso trated on the drawings.

Figure 1 is a diagrammatic sketch of a transmitting circuit arranged in accordance with the invention and employing two regu-

lating transformers.

Figures 2, 3 and 4 are similar diagrams showing different hook-ups requiring the use

of only one regulating transformer.

block condensers c_1 , c_2 . A key condenser c_3 at any transmitting point, are of small diis inserted in the parallel branch and seriesconnected with the primary winding of the transformer t_1 . The primary winding of tage that an accelerated control of the high

the transformer t_2 is inserted in the earth connection. The transformers t_1 and t_2 are 55 preferably with closed magnetic circuit and they possess each two windings, the primary winding comprising many turns of a thin wire and the secondary winding comprising few turns of a thick wire. The secondary 60 windings are connected with the key in such a manner that no high frequency oscillations are radiated in the position shown as the oscillations produced by the generator gtravel over c_1 , c_3 , winding w_1 , c_2 . The key 65 u short-circuits the secondary winding of the transformer t_1 so that the choking effect of the primary winding is neutralized and large energies free from sparks and without the condenser o_3 takes up the output from the generator g. The oscillations circuit 70 c_1, c_3, w_1, c_2 is earth connected. When transmitting signs the key is short-circuited by the secondary winding w_2 of the transformer t_2 , the choking effect of the primary coil is neutralized and the oscillations of the 75 generator are radiated whilst the loading condenser c_3 is choked by the primary coil w_1 of the transformer t_1 in which the shortcircuit of the primary coil is suspended by-

As the example of execution shows the invention consisting in the use of two, not continuous-current magnetized preferably closed magnetic circuited transformers. whose secondary windings are connected 85 The with the key in such a manner that, when the key is open as shown in the drawing, the choking effect of the transformer arranged in the parallel branch to the generator is mary winding of the transformer inserted suspended whilst when the key is depressed 90 in the earth connection so that a connection the secondary winding of the second transformer is short-circuited so that the choking effect of its primary coil is suspended.

The invention can be utilized evidently also in economical transformer connection or 95 with utilization of corresponding strong choking coils without iron. The use of closed magnetic circuited transformers has however the advantage that, owing to the narrow coupling resulting herefrom, com- 100 On Fig. 1 g is the generator, which can paratively small coils can be used so that consist for instance of a Poulsen arc, with the key apparatus, which can be arranged mension and of little weight.

The invention presents the further advan- 105

frequency current can be carried through keying of Poulsen-generators either the anwith full security of service so that the key arrangement is adapted specially for rapid service for the control of great energies.

The novel key arrangement can be carried out, differing from the form of construction shown on the drawing, in using only one transformer t_1 . In this case there is however no complete interruption of the 10 high frequency current effected so that high frequency current flows in the antenna indicated on the drawing, even at the position or rest.

The invention relates further to a key 15 connection in which the choking effect of a transformer is utilized also, only one transformer being however employed, which, according to the position of the key, closes or opens the radiating circuit, the transformer being for instance inserted in the earth connection, or it cuts out this earth connection being cut out when the key is open. The connection must be arranged so that, when the key is open, the generator is in closed circuit and the supply of energy, is not interrupted.

Hitherto the sending of signs has been effected by conducting the high frequency oscillations over a capacity when the key is

This method as well as similar methods present the inconvenience that the source of current and the generator are equally loaded. At transmitting with great telegraphing speed the second transformer according to the invention can be avoided by inserting only one transformer in the radiating circuit (antenna). The key is arranged this time in the transformer so that the choking effect of the same is utilized.

Consequently the source of current and the generator are fully loaded during the sending of signs while only very little current is consumed in the intervals. This is rendered possible by the arrangement according to which the generator is situated in a closed circuit when the key is open and the earth connection is cut out.

Fig. 2 shows a form of execution of the connection in which the generator g, which can be for instance an arc generator or a machine, is inserted in a circuit consisting of a capacity c_1 and c_2 and self inductance s_2 in whose earth connection the transformer t with the key a is inserted. The generator can be short-circuited by one capacity or by several series-connected capacities c. Instead of the transformer t two choking coils could be used, of which one has an iron core and is alternately short-circuited and cut-in by the key. The arrangement could further be such that the transformer or the choking coils are not directly earth-connected but inserted in the antenna branch.

tenna was desyntonized or the arc was reversed from the antenna to a key circuit which usually consists of a greater capacity and of a resistance and alters as little as possible the ratio of loading. The first method suffers from the defect, that the desyntonizing wave is set out with almost full energy. The second method is complicated by the indispensable interruption of the : antenna circuit and the cutting-in of the key circuit, this being connected with great difficulties specially at the rapid telegraphy.

The invention has further for its object to avoid these inconveniences, in laying constantly a capacity or a self-induction or a combination of the two parallel to the arc, this capacity being dimensioned so that on the one hand an increase of the efficiency of the arrangment is produced (energy connection) and on the other hand the arc can work exclusively without disturbance upon this parallel circuit without simultaneous cutting out of the antenna. Exhaustive experiments have shown that it is possible to 9, make the arrangement such that the arc is not disturbed and not extinguished during the operation of the key. The key is operated in a simple manner by interrupting the antenna circuit in the intervals between the 93 types and the earth connection whilst during the rotating period the parallel circuit to the arc is not interrupted. A reversing of the arc from one circuit to the other does not take place so that consequently the inconveniences resulting from this are avoided.

Experiments have further shown that it is not necessary with an arrangement described to maintain constant the loading of the are generator in order to avoid disturbances or extinction of the arc. It is possible to select the condition so that during the intervals the connection works with small loading so that an economy of energy and in the size of the machine is realized.

The method can be utilized with special advantage in connection with coils with iron cores whose saturation is varied by superposition of a continuous current magnetization or by short-circuiting of windings-The operation of the key is effected by alteration of the saturation so that all reversal. and the alteration itself are suppressed.

Figs. 3 and 4 show examples of execution 15

of the method.

In Fig. 3 a is the arc which works upon the antenna circuit, b is the auxiliary circuit which is parallel to the are and which contains for instance the capacity. e is a contract with iron core whose winding c is cut into the earth connection of the antenna while the winding d can be short-circuited by akey t. At short-circuiting the field in the coil is suspended so that the antenna takes p According to the known methods for the up the full current. At suppression of the

1,581,264

short-circuiting the antenna current is sup- and back contacts connected with the oppopresed by the iron core.

According to Fig. 4 an iron coil is used for the operation of the key but the iteration of the saturation is caused by a entinuous current flowing in the winding d and closed by the key t. The circuit b which parallel to the arc prevents also in this same as in the arrangement shown on Fig. 3, that the arc is extinguished at the ration of the key.

I claim:

1. A high frequency signal transmission ...tem comprising in combination a generator of high frequency oscillations, a radiatme circuit connected with said generator, an exillatory circuit connecting with said generator in parallel relationship to said rajusting circuit, a pair of independent transformers each having primary and secondary windings, with the primary winding of one transformer interposed in said oscillatory ircuit and the primary winding of the other transformer interposed in said radiating ciruit, said secondary windings being connectal to have a common terminal and having connections to a keying circuit whereby said orimary windings may be alternately made iffective as high frequency chokes in accordance with the production of signals.

2. A high frequency signal transmission system comprising in combination a generator of high frequency oscillations, a radiating circuit connected with said generator. an oscillatory circuit connecting with said generator in parallel relationship to said

radiating circuit, a pair of transformers each having primary and secondary windings with the primary winding of one transformer interposed in said oscillatory circuit and the primary winding of said other transformer interposed in said radiating circuit, said secondary windings being connected to have a common terminal, a keying system comprising a circuit closing device having front and rear contacts, a connection between the common terminals of said secondary windings and said keying system and connections between opposite ends of said secondary wind-

ings with said contacts whereby said keying system may be operated in accordance with signals to alternately shunt said secondary

windings.

3. A high frequency signaling system comprising in combination a source of high frequency oscillations, a radiating system, a circuit interconnecting said source of high frequency oscillations with said radiating system, a pair of transformers each having primary and secondary windings with said primary windings connected independently in circuit with said radiating system and in said first mentioned circuit, a common connection between the ends of said secondary windings, a double-acting key having front

site ends of said secondary windings, and a key lever connected with said common connection for alternately short circuiting the respective secondary windings for the pro- 70

duction of signals.

4. A high frequency signaling system comprising in combination a source of high frequency oscillations, a radiating circuit connected therewith, an oscillatory circuit 75 connected in parallel with said source of high frequency oscillations, a pair of transformers each having primary and secondary windings, with the primary windings of each transformer independently connected 90 in said radiating circuit and said oscillatory circuit respectively, said secondary windings being connected to have a common terminal, a double-acting key having front and back contacts, a key lever for alternately making 85 connections with said front and back contacts, a connection between said key lever and the common terminals of said secondary windings and connections between said front and back contacts with the opposite ends of 90 said secondary windings, whereby said secondary windings may be alternately shunted by said key lever and said contacts for neutralizing the choking effects of said primary windings and enabling said source of 95 high frequency oscillations to be alternately effective upon said radiating circuit or said

oscillatory circuit. 5. A high frequency signaling system comprising in combination a source of high 100

frequency oscillations, a radiating circuit connected therewith, an oscillatory circuit connected in parallel with said source of high frequency oscillations, a pair of transformers each having primary and secondary 105 windings with the primary windings of each transformer independently connected in said radiating circuit and said oscillatory circuit respectively, said secondary windings being connected to have a common terminal, a double-acting key having front and back contacts, a key lever for alternately making connections with said front and back contacts, a connection between said key lever and the common terminals of said secondary 115 windings, and connections between said front and back contacts with the opposite ends of said secondary windings, said primary windings each having a plurality of turns of relatively fine wire and normally 120 serving as a choke to the passage of high frequency oscillations, and said secondary windings comprising a relatively small num-

ber of turns of heavy wire, whereby upon shunting of ends of said secondary wind- 125 ings the choking effects of said primary windings may be alternately suspended for making effective said high frequency oscillations upon said radiating circuit.

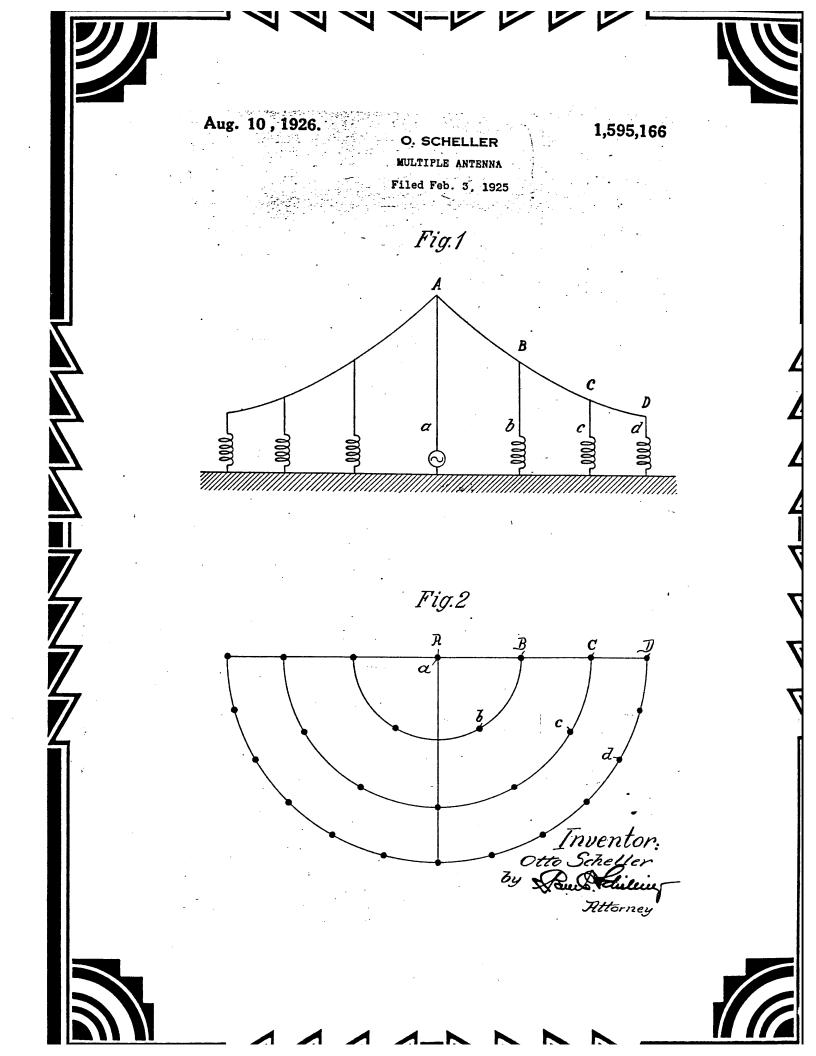
6. In a high frequency signal transmission 130

system the combination with a source of high ing as a high frequency choke coil when frequency oscillations of a radiating circuit, cooperating secondary windings are open, a parallel branch circuit connected with the choking effects thereof being suspended said radiating circuit and with said source of high frequency oscillations, a pair of transformers each having primary and secondary windings may be opened or shunted in accordance with signals for alternately rendering said source being disposed in the radiating circuit and of oscillations effective upon said parallel the other transformer being disposed in the 10 parallel branch circuit, means for shunting either one of said secondary windings when specification. the other of said secondary windings is . open, said primary windings each function-

when the cooperating secondary winding is open, whereby said secondary windings may branch circuit or said radiating circuit.

In testimony whereof we have signed this

ROBERT HERZOG. LEO PUNGS.



OTTO SCHELLER, OF BERLIN-GROSS-LICHTERFELDE, GERMANY, ASSIGNOR TO C. LORENZ AKTIENGESELLSCHAFT, OF BERLIN-TEMPELHOF, GERMANY.

THE PLANE MULTIPLE ANTENNA.

Application filed February 3, 1925, Serial No. 6,593, and in Germany September 11, 1923.

systems of radio communication and has for its object to increase their radiating power.

All the transmitters of radiotelegraphy 5 hitherto constructed have a very low efficiency owing to the fact that only a small portion of the energy converted to oscillations in the aerial is utilized for the purpose of radiation. A portion does not leave the · 10 aerial system and is gradually damped by its ohmic resistance. Of an energy really radiated only a small portion is radiated to a sufficient distance required for the working of the transmitter.

The manner of viewing things hitherto as to the action at a distance of a straight wire does not lead to an idea, which allows the arrangement to be effectively accomplished. The ideas which Maxwell has developed in the last century about the propagation of electrical oscillations, have not yet been taken up by technics, which would be necessary to utilize them fully for the present task of improving radiation.

In space telegraphy the action at a distance must be imagined to be caused in the following way:

As the displacement currents generate in the dielectric magnetic fields in the same 30 way as currents do in conductors, and as further in a freely oscillating circuit consisting of capacity and self-inductance, the displacement currents in the capacity must be referring to time) in phase coincidence 35 with the currents in the conductor, the magnetic field of an oscillation circuit can only be such a one as can be produced by closed current lines. This law must be valid for all the current circuits, for closed ones as well as for open ones. The displacement currents must be in phase coincidence with the line-currents, since at the times when the whole energy is in the condenser, both currents, displacement currents and line-currents, must be zero. The form of the condenser cannot have any influence upon it.

The prior conception of the action at a distance of a conductor, e. g. a straight wire, can no more be maintained; the considerations about the action at a distance started from the magnetic field of a straight limited conductor, which for itself cannot exist the lines of courrent occur only as closed rection which is well known. paths, there are in reality only fields such .. By the dense arrangement of the different 110

My invention relates to aerials for use in as are generated by such closed current circuits.

An action at a distance is only imaginable, if lines of current of reversed direction have such a great distance that the fields of 60 the single line of current interfere with each other so that they do not neutralize each other, but sum each other, if possible. In the normal aerial systems hitherto used the action at a distance is done by at least some 65 lines of the displacement current running at a large distance from the conductor, thereby an action of interference being made between the field of these lines of current and the current in the conductor.

I may essentially improve radiation—according to my proposal dating from the year 1911—by giving the conductor a diameter as large as possible, by which more lines of force are forced outwards, so that 75 more lines of current take part in the interference action. Thus by increasing the diameter I can increase radiation nearly at my will, I do not yet obtain, however, the maximum of radiation which is possible at 80 the actual diameter of the aerial system.

In order to obtain this maximum radiation it is necessary that as few displacement currents as possible run in the neighbourhood of the conductor. I obtain that—just as in \$5 the former proposal—by subdividing the conductor into many single lines and by making all the single conductors oscillate in phase, but by distributing the single lines in such a way that as far as possible no lines 90 of force can circulate from the upper end of the lines between the single conductors but that, if possible, all the displacement current lines are forced outwards. For this purpose the lines individually tuned, ac- 95 cording to the density of electric fields generated by them, are distributed over the whole area covered by the aerial. For the first approximation it will be sufficient to distribute the conductors upon a ring which 100 is most favo rably fed with energy from the centre. Since all the fields oscillate in phase, they generate fields of the same sense. Thereby the back running lines of current of the displaced currents find their way 105 between the conductors barred, and these are forced outwards. By the form of the area and cannot be realized therefore. Since all I can prefer the radiation in a certain di-



Patented Aug.

earth area below the whole radiator system is covered with the earthing devices somewhat equally, so that great densities of combination of a central earthed conductor, 5 earth-currents are avoided and in the same a high frequency source for energizing said time the development of displacement currents in contrary direction within the aerial arranged around and all united with said system is effectively counteracted against. By way of example of my invention the

10 accompanying drawings show an aerial which mainly is carried by one single high mast, and which is to radiate in all direc-

tions uniformly.

Fig. 1 shows the elevation,

Fig. 2 half the plan. wards the vertical lines a, b, c, d are arranged closer together. When A is the highest point of the line a, the tuning of b, c, d can be effected in such a manner that reflection of the energy oscillating in these lines take place in A. Correspondingly, when B marks the junction point of c at the highest point of b, C the junction 25 point of d at the highest point of c, on the other hand the tuning of c may also be effected in such a way that reflection takes place at point B, that of d so that reflection takes place at C. The exact position of the 30 reflection points is not essential for the utilization of my invention provided they do not lie on the single lines a, b, c and d, for in these lines all the currents are to oscillate at the same time in the same direction. 35 a having the smallest capacity, here the wattless currents will be smallest, practically a carries only the whole watt current. Therefore the whole transmitting set may be made smaller. As the distance of the 49 upper part of d to the earth is less than say of b, there is a risk that considerably more lines of force run to earth between c and d. Therefore the intervals between c and d and between the single lines of d (Fig. 2) are chosen smaller than in the middle of the system. In case the uniformity of radiation at an aerial system according to Fig. 2 should not be sufficient, the number of the lines going radially from the middle of the arrangement and directed downwards such as AD (D being the highest point of d) can be increased as may be required.

1. A multiple antenna structure comprising in combination a plurality of earthed conductors, a source of high frequency current for exciting said conductors in like time phase, means for neutralizing substan-tially all electric lines within the antenna structure and forcing them outside said structure by suitably dimensioning the earthed conductors and distributing them

What I claim is:

in proportion to the strength of the electric ferent distances and each of said plurality

radiators I obtain in the same time that the ation of said source and reducing losses therein.

2. In a multiple antenna structure the conductor, a plurality of earthed conductors central conductor, said plurality of earthed conductors having heights decreasing with the distance from said central conductor and with their respective distances one from another proportioned according to the density of the electric lines of force generated

therein by them.

3. In a multiple antenna structure, the 80 As the height of the aerial decreases out- combination of a central earthed conductor, a high frequency source for exciting said conductor, a plurality of concentric rows of earthed conductors united all at their upper ends with said central conductor, each 85 row of said last mentioned conductors decreasing in height in an outward direction and each concentric row having said plurality of conductors decreasing in spaced relationship in proportion to the height there-

> 4. A multiple antenna structure comprising in combination a central vertically disposed grounded conductor, a source of high frequency oscillations connected with said 95 conductor, a plurality of tuned conductors positioned in radial lines with respect to said central conductor, said last mentioned conductors being spaced from each other at varying distances and each having varying heights with the upper extremities thereof connected with the upper extremity of said central conductor for increasing the radiation of said source and reducing the losses in said antenna structure.

5. A multiple antenna structure comprising in combination a central vertically disposed conductor, a high frequency source for exciting said conductor, a plurality of vertically disposed conductors positioned in radial lines with respect to said central conductor, said plurality of conductors being spaced one from another at varying distances and each varying in height and having the extremities thereof connected with 115 the extremity of said central conductor for increasing the radiation of said source and reducing the losses in said antenna struc-

6. A multiple antenna structure comprising in combination a vertical centrally disposed conductor, a source of high frequency current for exciting said conductor, a plurality of vertically extending conductors positioned in radial lines on either side of said 125 central vertical conductor, said plurality of conductors being spaced one from another and from said central conductor over dif-65 fields generated thereby for increasing radi- of conductors having different heights with

respect to said central conductor, with the upper extremities thereof connected with the upper extremity of said central conductor, a source of high frequency oscillations for exciting said conductor, a source and reducing losses in said antenna structure.

7. A multiple antenna structure comprising in combination a central vertically disposed conductor, a plurality of vertically disposed conductors arranged in radial lines with respect to said central conductor and in concentric circles around said central conductor with the distances between the concentric circles in which said plurality of vertically disposed conductors are arranged varying one from another and with the heights of said plurality of conductors varying one from another and connected at their upper extremities with the upper extremities with the upper extremity of said central conductor for increasing the radiation from said antenna structure and reducing electrical losses therein.

In testing ductor, sa arranged tances between the extend out said plural as said plural to conductor for their upper extremities with the upper extremities with the upper extremities with the upper therein.

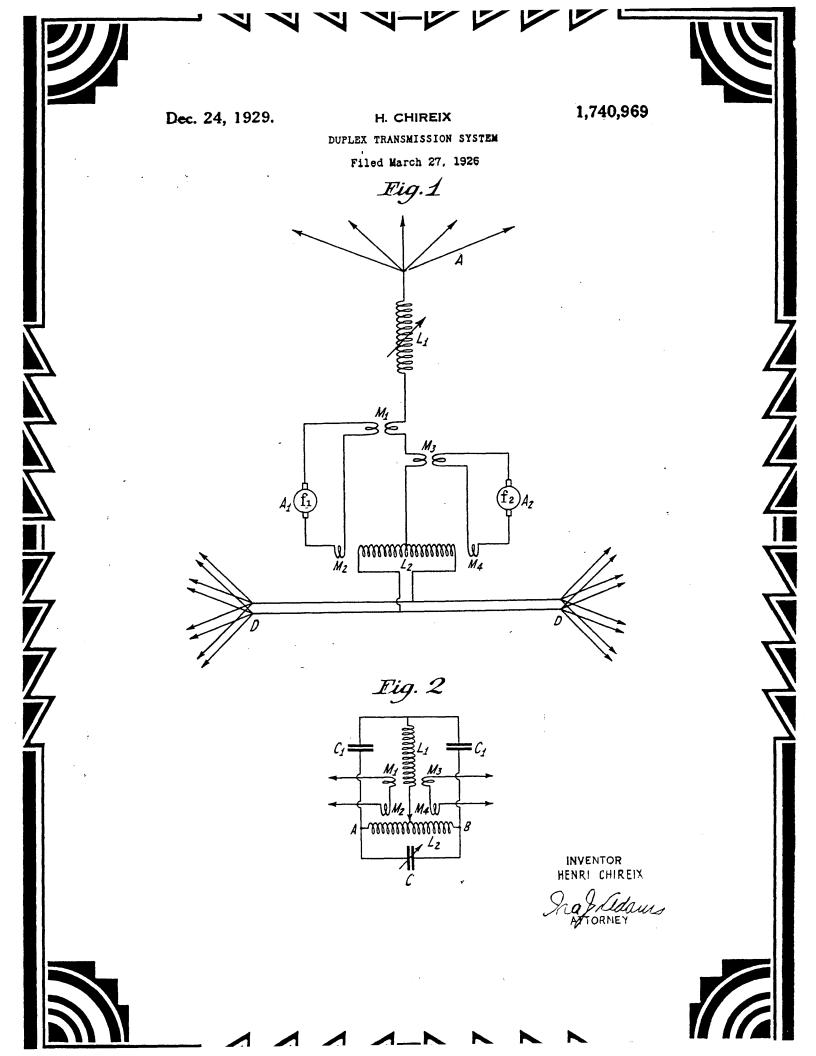
8. A multiple antenna structure compris-

posed conductor, a source of high frequency oscillations for exciting said conductor, .s plurality of vertically disposed conductors arranged in radially extending lines on opposite sides of said centrally disposed conductor, said plurality of conductors being arranged in concentric circles with the distances between said concentric circles growing smaller as said plurality of conductors extend outwardly and with the heights of 35 said plurality of conductors growing smaller as said plurality of conductors extend outwardly, with connections extending from the extremity of said centrally disposed conductor in a downward direction to the 40 extremities of each of said plurality of conductors for increasing the radiation of said antenna structure and reducing the losses therein.

In testimony whereof I have affixed my 45 signature.

OTTO SCHELLER.





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UNITED STATES PATENT OFFICE

HENRI CHIREIX, OF PARIS, FRANCE

DUPLEX TRANSMISSION SYSTEM

Application filed March 27, 1926, Serial No. 97.877, and in France August 12, 1925.

transmissions are sent out simultaneously by one and the same antenna.

Lt has already been suggested for this purpose to divide the antenna used for transmission into two parts, and to compensate at the base the exchange or transfer currents between said two parts by the aid of inducmetive coupling of convenient kind between them. This scheme however, among other drawbacks, involves the inconvenience that. on account of the fact that but one half of the antenna is used for each transmission, 15the aerial resistance is reduced.

The present invention has as its object to remedy the inconveniences in arrangements previously disclosed, by the simultaneous use for each of two transmissions of the entire 201 transmitting antenna. For this object two counterpoises are used provided in the neighborhood of each other and utilized to diminish in known manner the resistance of the aerialground circuit, and to play the part of ca-25 pacity in an auxiliary resonant circuit, with the end in view of imparting to the aerial two resonance periods. The invention furthermore provides a simple arrangement adapted to prevent the flow of current from one of 30 the alternators into the other.

The basic idea of the present invention will be better understood by reference to the accompanying drawing in which

Fig. 1 is a circuit diagram of the arrangements, while

Fig. 2 shows an equivalent diagram in which the capacities between the counterpoises and between the aerial and each of the counterpoises are indicated in the form

of condensers. Referring now to Fig. 1 an antenna is shown at A, having in its circuit a tuning inductance L₁ connected to an intermediate **Point of a second inductance L2, whose ter**ininals are connected to different portions of so that the required electrostatic capacity exists between them as explained below. The left will be found to an all limits of the two frequencies before 100 lternators are shown at A_1 and A_2 designed L_1 only for one of the two frequencies before 100

The present invention relates to radio com- to generate respectively the two frequencies munication apparatus by means of which two f_1 and f_2 to be transmitted. The alternator A_1 is connected to the antenna circuit by two inductive couplings M_1 and M_2 , the former being in the antenna lead-in wire while the 55 latter comprises the inductance L₂ as one of its elements. The alternator A2 is connected to the antenna by similar inductive couplings

M₂ and M₄.

The equivalent circuit diagram shown in 60 Fig. 2 makes it clear that the system comprises, as a matter of fact, three circuits in electrostatic coupling relationship.

In this diagram the capacity between the two portions of the counterpoise is repre- 65 sented by C, and that between the aerial and each portion of the counterpoise by C1.

The operation of this arrangement is as

If self-inductance coil L₁ is connected 70 exactly at the middle of coil L2, on exciting self-inductance coil L₁ by means of an oscillation generator, there is obtained a single resonance period which is independent of the value which C may be given, indeed, the latter 75 may be varied within wide limits without altering the current flowing through the selfinductance coil L₁. This goes to show that points A and B, by virtue of symmetry, are at the same potential. But if the self-induc- 80 tance coil L_1 is not connected exactly in the middle of coil L2, a very precise and definite value for condenser C will be found for which the current in coil L₁ undergoes a decrease. This value of C corresponds to the condition 85 where circuit L_2C is tuned to the transmitter. If, then, while not changing condenser C which is set to this value, the point of connection between coils L, and L2 is varied, two frequencies will be obtained located upon 90 either side of the original frequency, in the presence of which a certain current flows in the coil Li. Moreover the farther the tap or connection at coil L₂ departs from the middle. the more these frequencies differ from the 95 a double counterpoise D. The two portions mean frequency. Hence, the system has now of the latter are placed close enough together two resonance frequencies. If, then, two equal couplings are provided at M. M2. curexists between them as explained below. Two rent will be found to flow in inductance coil

obtained, say, the lower one. If, next, one first and means for coupling it thereto to perof the couplings is reversed, no current is found to flow any more in self-inductance coil L₁ for the lower frequency, but only for the higher frequency. This evidently goes to show that, for one sense of coupling of the coil M_2 , for instance, the reaction of the sender upon the system is zero. A current of this same frequency flowing through the 10 system will furthermore not induce any electro-motive-force in the assembly of the two coils M_1 and M_2 .

into practice, one of the two generators, A_1 , 15 for example, is connected with the antennaground circuit by means of an electromagnetic coupling M_1 , and with the auxiliary circuit through the agency of a second electromagnetic coupler M_2 . The generator A_2 , on couplings M₃ and M₄ with the antennaground and the auxiliary circuit, respectively.

With proper connection of the four cou-25 pling means before-mentioned, it is thus possible to obtain and insure perfect independence of each of two transmissions, the frequencies of which correspond, respectively, to each of the two natural frequencies of oscil-30 lation of the radiating system. Contradistinct to what happens in an antenna divided into two parts, no interchange currents will be produced in the down-leads of the antennas; and these, as is well known, caused a considerable reduction in the effective height in the system previously disclosed.

The provision of the counterpoises is of the lowest possible cost, the potentials set up between the two parts of the counterpoise are 40 not high, and this in turn means lower expense for insulation, while preserving the efficiency of operations at the same order of magnitude as in simplex working.

The fact that for each transmission the 45 total capacitance of the wave radiating system is available contributes in large measure to an increase of the effectiveness of the sys-

Having described my invention I claim:

1. A duplex transmission system comprising a single transmission conductor, means connected thereto for simultaneously imparting two resonant frequencies to the system and means for supplying energy to said system at each of said frequencies.

2. A duplex transmission system comprising a transmission conductor, means connected thereto to impart two resonant frequencies 60 to the system, an energizing means for said system and means for coupling it thereto to permit energization at one of said frequencies and prevent energization at the other of said frequencies, a second energizing means for 65 said system acting simultaneously with the

mit energization at the second of said frequencies and prevent energization at the first of said frequencies.

3. An antenna system comprising an antenna, an inductance having said antenna connected thereto intermediate its ends and a separate counterpoise connected to each end of said inductance, the capacity of these counterpoises forming with said inductance a 75 resonant circuit.

4. An antenna system comprising an an-In carrying the basic idea of the invention tenna, two unequal inductance sections each having one end connected to said antenna, a counterpoise connected to the other end of 80 each of said inductance sections, said counterpoises forming with both of said inductance sections a resonant circuit.

5. A duplex transmission system compris-20 the other hand, is united by electromagnetic ing an antenna, an inductance having sepa- 85 rate counterpoises connected to each end and forming therewith a resonant circuit, a lead connecting the antenna to an intermediate point of said inductance and two separate energizing means of different frequencies for 90: energizing said system.

6. A duplex transmission system comprising an antenna, an inductance having a separate counterpoise connected to each end and forming therewith a resonant circuit, a lead connecting said antenna to an intermediate point of said inductance, two sources of high frequency current, inductive means for coupling each of said sources to said inductance, and means for coupling said sources to said 100 lead.

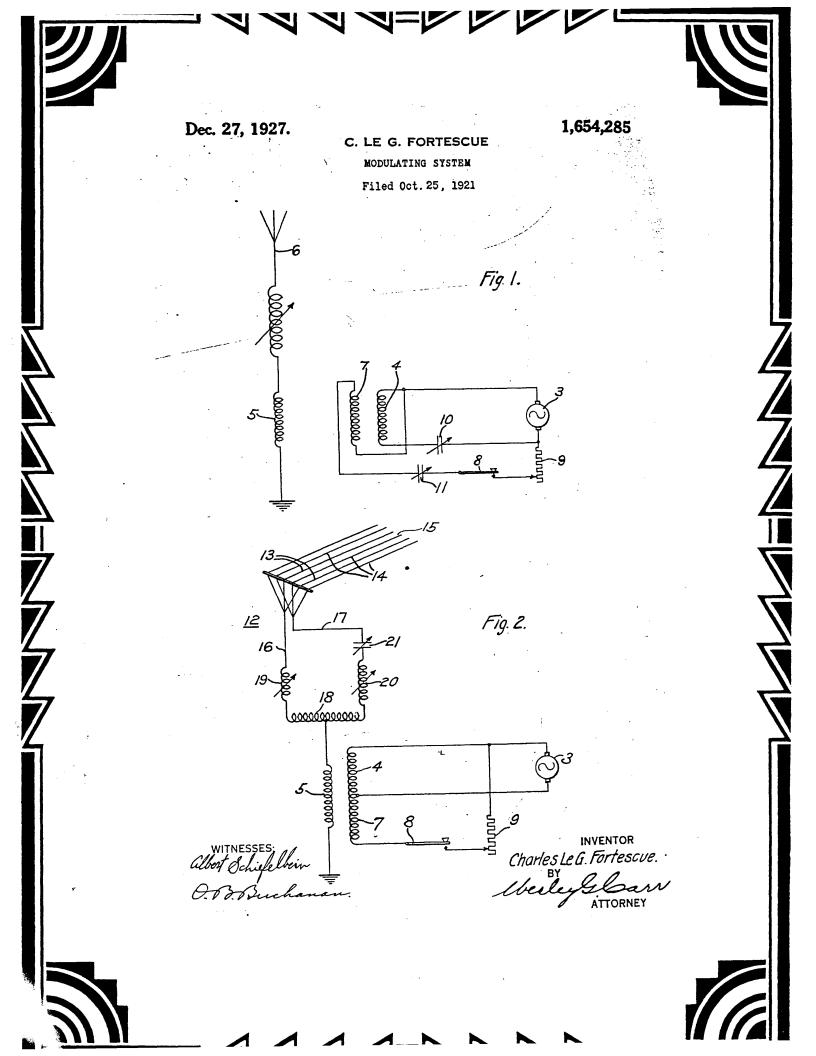
7. A duplex transmission system comprising a single antenna, an inductance associated therewith through a variable connection, a counterpoise connected to each end of said inductance, the arrangement being such that said inductance and the capacity between counterpoises forms an auxiliary circuit possessing two resonant periods, and a pair of oscillation generators each coupled to both the antenna and said inductance for simultaneously energizing said antenna at both said resonant periods.

HENRI CHIREIX.

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UNITED STATES PATENT OFFICE.

CHARLES LE G. FORTESCUE, OF PITTSBURGH, PENNSYLVANIA, ASSIGNOR TO WEST-INGHOUSE ELECTRIC & MANUFACTURING COMPANY, A CORPORATION OF PENN-

MODULATING SYSTEM.

Application filed October 25, 1921. Serial No. 510,337.

controlling the power output of a trans- Fig. 1. mitting antenna system.

the transfer of energy therebetween.

10 between the contact points of the sending

A still further object is to provide means for quickly absorbing the residual energy stored in the radiating circuit by causing 15 the residual oscillations to set up a branchto-branch current in a multiple-branch an-

My invention consists in the methods and apparatus described in the following detailed description and illustrated in the accompanying drawing, wherein:

Figure 1 is a digrammatic view of an embodiment of my invention employing a common form of antenna. and

employing a multiple-branch antenna in accordance with my invention.

In the system shown in Fig. 1, I provide a high-frequency source 3, which is connected to the primary coil 4 of a coupling transformer having a loosely coupled secondary coil 5, which is included in an antenna circuit 6. Connected in shunt relation to the primary coil 4 is a closely coupled, 55 oppositely wound tertiary coil 7 including in circuit therewith a controlling key 8 and a resistor 9.

By virtue of the arrangement just described, power is supplied to the antenna key is closed, current flows through the primary and tertiary coils in opposite directions, thereby suistantially neutralizing the coupling of these coils to the secondary coil 45 5, and the energy of the source 3 is absorbed by the resistor 9 which may be of such value as to maintain a sibstantially constant load upon the source. When the key is again opened, there is no tendency to arc, as the secondary circuit begins at once to deprive the tertiary circuit of its energy.

Under certain circumstances, it may be found advantageous to include a capacitive

My invention relates to wireless teleg- in order to neutralize the leakage inductance 55 raphy and more particularly to means for of the system, as indicated at 10 and 11 in

In Fig. 2, I have shown a similar system, One of the objects of my invention is to in which the usual antenna circuit 6 has neutralize the coupling between the supply been replaced by a multiple-branch antenna 60 circuit and the antenna circuit to prevent circuit 12 including two adjacent antenna 13 and 14. The antennæ 13 and 14 are A further object is to avoid all arcing shown as comprising alternate wires of a single antenna construction 15, said alternate wires being connected, in two groups, to an- 65 tenna leads 16 and 17, respectively. Connected to the ends of the antenna leads is a balancing coil 18 having its mid-point connected to ground through the secondary coupling coil 5.

The antenna leads 16 and 17 may include tuning coils 19 and 20, respectively, whereby the antennæ may be tuned to the frequency of the source 3. Means are provided, also, as by making the tuning coil 20 larger than 75 the tuning coil 19 and inserting a compensating condenser 21, whereby the time constant of one of the antennæ is made larger Fig. 2 is a similar view of a modification than that of the other for a purpose which will appear hereinafter.

In operation, the switch 8 is manipulated as in the system shown in Fig. 1. During transmission of signal impulses, the current divides equally between the two halves of the balancing coil 18, and energy is trans- s5 mitted from the two antennæ operating in unison. When the energy of the source is diverted from the secondary coupling coil 5, the residual stored energy in the antenna circuits causes the oscillations to continue so for a few cycles, dependent upon the time constant of the system.

In order to increase the rate at which 40 circuit 6 when the key 8 is open. When the the oscillations will decrease after the interruption of the source of supply to the 95 antennæ, the system is so designed that one antenna has a larger time constant than the other, whereby circulating currents are established in the circuit including the capacitance between the two antenne, the 100 tuning coil 19, the balancing coil 18, the tuning coil 20 and the condenser 21. The circuit just mentioned is designed to have a natural period corresponding to the frequency of the source 3, whereby local oscilla- 105 tions will be set up therein which will quickly absorb the stored energy without reactance in the primary or tertiary circuit causing any sparking at the switch 8.

my invention in detail, and while I have pointed out certain of the most obvious principles and purposes thereof, I do not 5 intend that the language employed in the following claims shall be limited to the preclaims shall be construed to cover all coinbinations which are fairly included in the 10 language thereof, when read in view of the prior art regardless of the details and functions mentioned in the description or illustrated in the drawing.

I claim as my invention:—

1. In combination with a transformer having an auxiliary demagnetizing winding, an antenna system, said transformer constituting a loose coupling for supplying energy to said antenna, a load for said 20 auxiliary winding, and means for transferring energy from said antenna system to said load by demagnetizing said driver transformer.

2. A coupling system comprising a pri-25 mary induction coil, a secondary induction coil, a tertiary induction coil, the primary and tertiary coils being relatively-tightly coupled and the secondary coil being relatively-loosely coupled to the primary coil. 30 the tertiary coil being wound to oppose the effect of the primary coil on the secondary coil, means for controlling the flow of current through the tertiary coil, and a con-densive reactor in circuit with the tertiary coil to resonate with the leakage inductance of the system.

3. A coupling system comprising a primary inductance coil, a secondary induction coil, a tertiary induction coil, the primary and tertiary coils being relatively tightly coupled and the secondary coil being relatively-loosely coupled to said primary coil, the tertiary coil being wound to oppose the effect of the primary coil on the secondary coil, means for controlling the flow of current through the tertiary coil, and a resistance device and a capacitance device in circuit with the tertiary coil, said capacitance device being of such size as to resonate with the leakage inductance of the system.

4. A sending system comprising a multiple-branch radiating circuit including an antenna, means for supplying current to the multiple-branch circuit, and means for 55 modulating said current, said radiating circuit including means for causing residual antenna-charges to set up a brach-to-branch current.

of high-frequency oscillations, a multiplebranch antenna coupled thereto, an inductance device in each branch, and means for controlling the current supplied to the multiple antenna from the high-frequency being also tuned to the signaling frequency source, said antenna including means

While I have described certain forms of whereby a branch-to-branch current is set up when the energy supplied to said antenna by the high-frequency source is reduced.

6. A sending system comprising a continuous-wave source of high-frequency cise features described, but I intend that the oscillations, a multiple-branch antenna coupled thereto, means for controlling the current supplied to the multiple-branch antenna, and means for causing residual charges 75 to set up current-flow in a branch-to-branch circuit.

7. A sending system comprising a continuous-wave source of high frequency oscil, lations, a primary induction coil energized so therefrom, a secondary induction coil relatively-loosely coupled to said primary coil. a tertiary induction coil relatively-tightly coupled to the primary coil, the tertiary coil being so wound as to oppose the effect of the & primary coil on the secondary coil, and a multiple-branch antenna energized from said secondary coil and including a resonant branch-to-branch circuit.

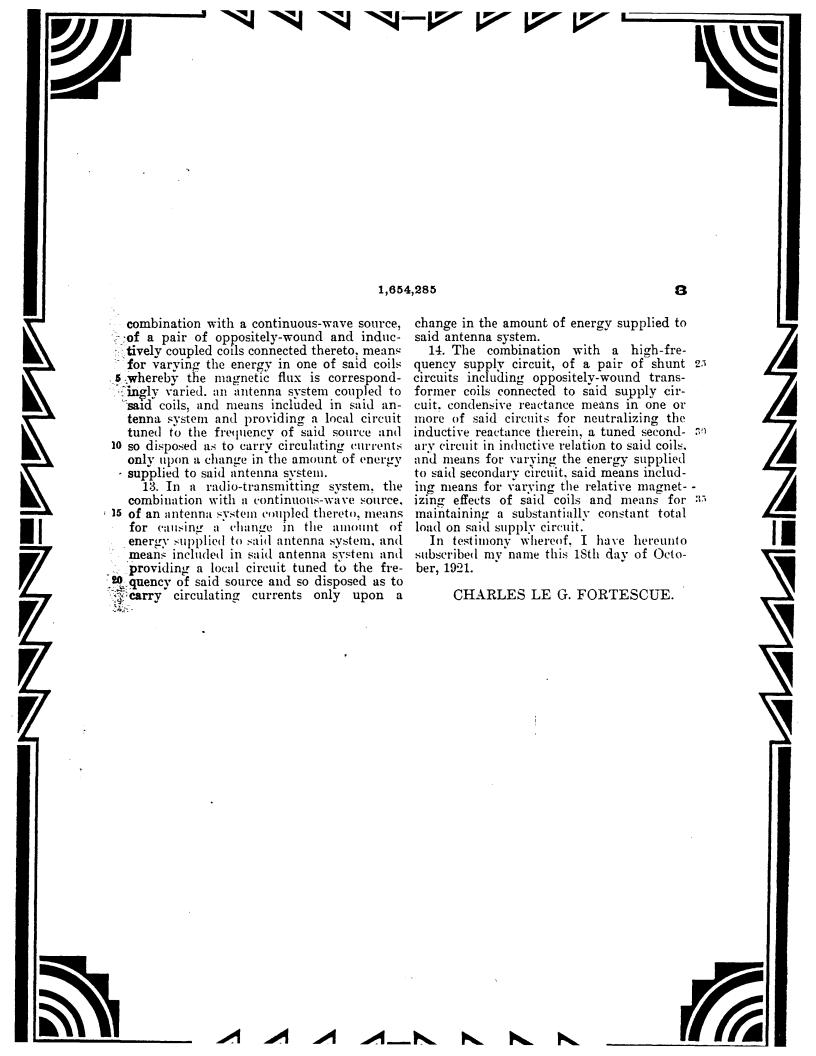
8. The combination with a pair of antenna-to-ground circuits having different time constants, of means for energizing said circuits from a common source, and means for providing a tuned antenna-to-antenna circuit for increasing the damping of the cir- 85 cuits with respect to said common energizing means.

9. A wireless transmitting system including two antennæ, antenna-leads connected thereto, an impedance device joining said 100 leads, a ground connection from an intermediate point of said impedance device, means associated with said ground connection for energizing said antenne for radiation in unison, means for tuning the antenna-to-ground and antenna-to-antenna circuits, and means for causing one antennato-ground circuit to have a different time constant than the other.

10. The combination with a pair of an, tennæ and a source of high-frequency energy, of means for causing said energy to divide substantially equally between said antennæ during transmission of signal impulses, means for diverting the energy of a said source from said antennæ, and means for causing a time lag of the residual oscillations in one antennæ with respect to those in the other, and means for providing an antenna-to-antenna circuit effective to circulate local currents resulting from said time lag. 2. Viletara bive merchan of 20

11. A wireless signaling system includ-5. A sending system comprising a source ing an antenna-to-ground circuit and a loop circuit associated therewith, said loop cir-b cuit including two branches tuned to the signaling frequency and having different time constants, said loop circuit, as a whole,

12. In a radio-transmitting system, the



Jan. 8, 1929.

1,697,948

H. CHIREIX

GROUND CONNECTION FOR RADIO ELECTRIC ANTENNAE

Filed Oct. 7, 1922

2 Sheets-Sheet 1



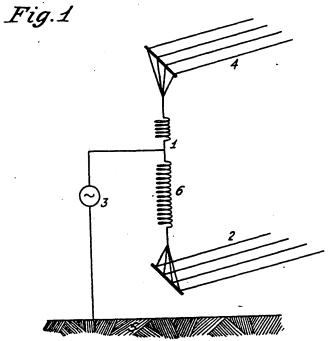
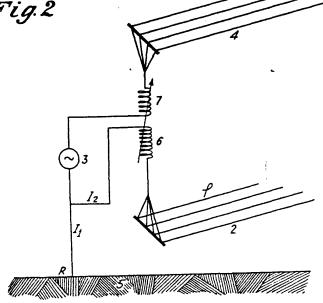


Fig.2



By his Attorney 14 . Wans

Jan. 8, 1929. 1,697,948 H. CHIREIX GROUND CONNECTION FOR RADIO ELECTRIC ANTENNAE Filed Oct. 7, 1922 2 Sheets-Sheet 2 Fig. 3 10 MIDAMINI Fig.4

Inventor
HENRI CHIREIX
Boy his Attorney na J. Uduus

1,697,948

UNITED STATES PAIENT OFFICE.

HENRI CHIREIX, OF PARIS, FRANCE.

GROUND CONNECTION FOR RADIO ELECTRIC ANTENNÆ.

Application filed October 7, 1922, Serial No. 592.944, and in France October 14, 1921.

It is known that, for the purpose of im- minimum. Due to the fact that the current such association, and by means of this invention the maximum results are obtained from this association without affecting the economy of the installation.

My invention is illustrated in the accompanying drawing in which

Fig. 1 shows an arrangement old in the art. Fig. 2 shows the application of my invention to an antenna such as shown in Fig. 1.

work according to my invention and

Fig. 4 shows my invention applied to an

antenna of the radial type.

The circuits are usually arranged in the 20 following manner (Fig. 1); the point 1 lo- the ground and the counterpoise 2 so as to obcated in the conductor between the source 3 and the antenna 4 is connected with the counter-poise 2. The source is grounded at 5. This arrangement necessitates the inser-25 tion of a reactance 6 between the counterpoise and the antenna, which reactance is greater than the one connecting the antenna with ground.

necting point 1 of the counter-poise is located in the junction between the source 3 and the ground 5, the source being connected with the antenna 4 through an inductance 7. 'In necessity for which was pointed out in the themselves. above, and notwithstanding this, the maximum effect is obtained from the elements used. i. e. the ground connection losses are re-40 duced to a minimum.

As a matter of fact, if the effective ohmic resistance of the counter-poise is designated by p, and the ground connection by R, the results obtained from my experimental research 45 show that the currents I, and I, flowing in the two branches, and which are in phase because by its nature the counter-poise is tuned. will be to each other as inversely as the resistances which they traverse;

As known, this condition is necessary and suf- between antenna 4 and counterpoise 2 in Fig. ficient to insure that the sum of the ohmic 2 is annulled as explained above. Another 65 losses in the two resistances shall be at a compensating element such as 9 (formed e.g. 110

proving the ground connections of an an-flowing in antenna 4 and counterpoise 2 are tenna, a counter-poise may be associated with not necessarily equal, owing to the fact that this ground connection. The present inven- it is desirable to have some current flowing 5 tion makes provision for a novel method of in the ground connection in order to minimize 60 the total resistance losses in the ground connection and counterpoise, a certain voltage will exist in the system between the counterpoise and ground. This voltage is due to the fact that more lines of force are emanating 65 from the antenna 4 and cutting the counterpoise 2 than are emanating from the counterpoise 2 and cutting the antenna 4. It is desirable to control this voltage. This is accom-Fig. 3 shows an arrangement for multiplex plished by inductively coupling the induc- 70 tances 6 and 7 whereby the reactance 6 has a suitable electromotive force induced in it by the currents flowing in reactance 7 to enable the currents to be distributed between tain minimum ohmic losses.

The present invention is particularly applicable to antennæ which are divided for multiplex working. Each antenna section is provided with a counter-poise, which may be 80 tuned by any suitable and well known means to the wave length individual to the sending antenna section. On or between the various On the other hand, in accordance with the counter-poises compensating arrangements 30 present invention, as shown in Fig. 2, the con- are provided (resonance plugs, mutual in- 55 ductance, self inductance) for annulling or reducing the induction effect of one counterpoise on the other. These devices may be combined with those used for compensating the 35 this manner I economize on inductance, the reactions of the antenna sections between 90

> Assuming that multiplex work is used, the installation will be arranged in the manner illustrated in Fig. 3. This figure exemplifies without limiting the application of the in- 95 vention to multiplex working. The junction point of the counter-poises 2 and 2' is always located between the sources 3 and 3' and the ground 5. Compensating elements such as 7 and 7' are provided (formed e. g. by in- 100 ductances having a mutual induction co-efficient, which together with the self-induction of the antenna may be tuned, or by any other equivalent system) whereby the reaction of each section of antenna 4 4' on its 105 respective counter-poises. 2 2' is annulled in a manner similar to that in which the reaction

by two inductances having an adjustable netic reactive relation therewith inserted beequivalent arrangement) makes it possible to annul the reaction of counter-poises 2 2' on each other. The adjustable inductance 10 combination with an antenna having a plu- 60 aerials 4 and 4' forms a series circuit of high source for feeding each section and each 65

compensating elements may be combined serted between each counterpoise and the 70 without departing from the spirit of the inconnection between source and ground.

vention.

ing. The above described arrangements may be applied to multiplex working, in which more than two messages are sent, by providing for each group of antennæ and counter-35 poises arranged for a determined frequency, compensating elements which annul respectively the actions of other groups operating at different frequencies. Obviously, each installation may be simplified by combining 40 certain ones of these elements.

Having now described my invention, I de-

clare that what I claim is:

1. An antenna system for multiplex transmission, comprising a plurality of sections. 45 a counterpoise for each section, and magnetic coupling between counterpoises for neutralizing capacity coupling therebetween.

2: In a multiplex transmission system, the combination with an antenna having a pluloading coil inserted between each section tions upon each other. and its associated source, and a coil in mag-

mutual induction coefficient, or by any other tween each counterpoise and the connection

between source and ground.

3. In a multiplex transmission system, the constitutes the compensating element of the rality of sections a variable self-inductance reaction between the antenna section 4 and connected between sections for neutralizing 4' by reason of the fact that the inductance the reaction therebetween, a counterpoise as-10 together with the capacity between the sociated with each section, a high frequency impedance and consequently functions as a source being connected to a common ground, trap circuit to prevent a reactance of one an- an antenna loading coil inserted between each tenna 4 on the other antenna 4' and vice versa. section and its associated source, and a coil Obviously, in certain cases some of these in magnetic reactive relation therewith in-

4. In a multiplex transmission system, the It may also be possible to eliminate some combination with an antenna having a pluof these elements. For instance, if the two rality of sections, a variable self-inductance 20 antenna sections are of the radial type, the connected between sections for neutralizing 75 wires of counter-poises 2 and 2' are prefer- the reaction therebetween, a counterpoise asably staggered as shown in the plan view sociated with each section, a high frequency (Fig. 4), and it will not be necessary to pro- source for feeding each section and each vide a special compensating element for an-source being connected to a common ground, 25 nulling the reaction of one counter-poise on an antenna loading coil inserted between 80 the other, the effect of this reaction being to each section and its associated source, and a cause the circulation in the detuned counter- coil in magnetic reactive relation therewith poise of a current, which is in phase with the inserted between each counterpoise and the one flowing in the tuned counter-poise. The connection between source and ground, and whole counter-poise is used for each send- magnetic coupling between counterpoises for 85 neutralizing the capacity coupling therebetween.

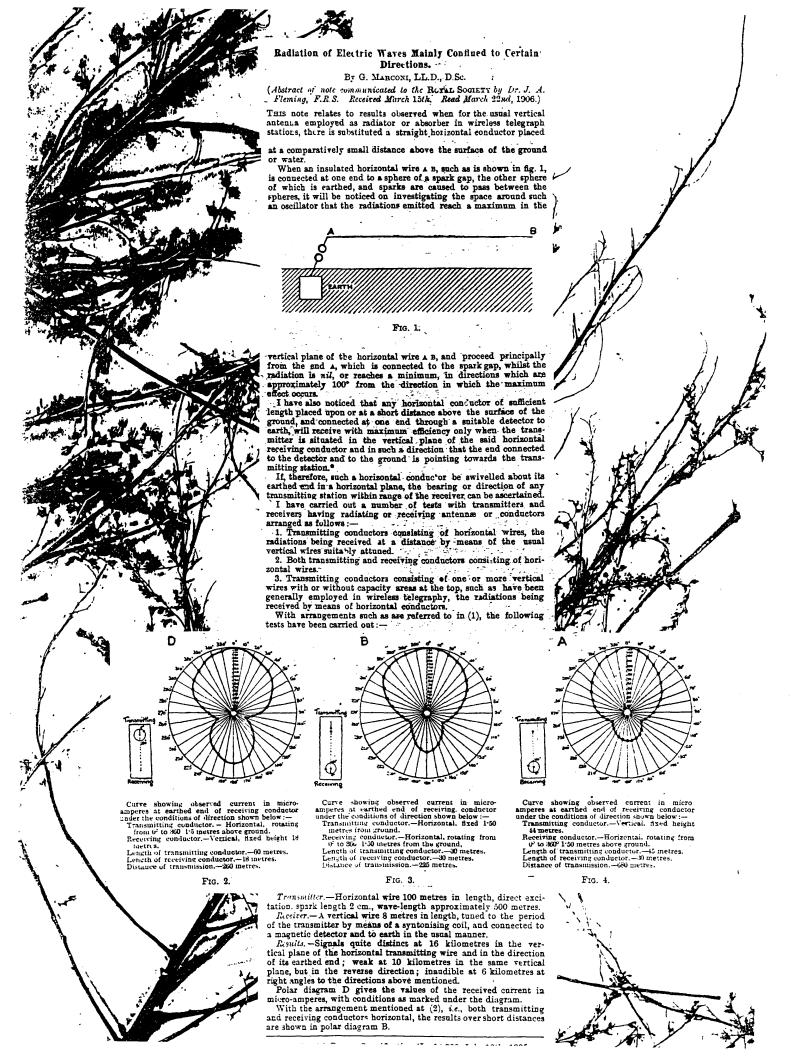
> 5. An antenna system comprising a plurality of sections and a counterpoise for each section, means for neutralizing the capacity 90 coupling between antenna sections, and means for neutralizing the capacity coupling between counterpoises.

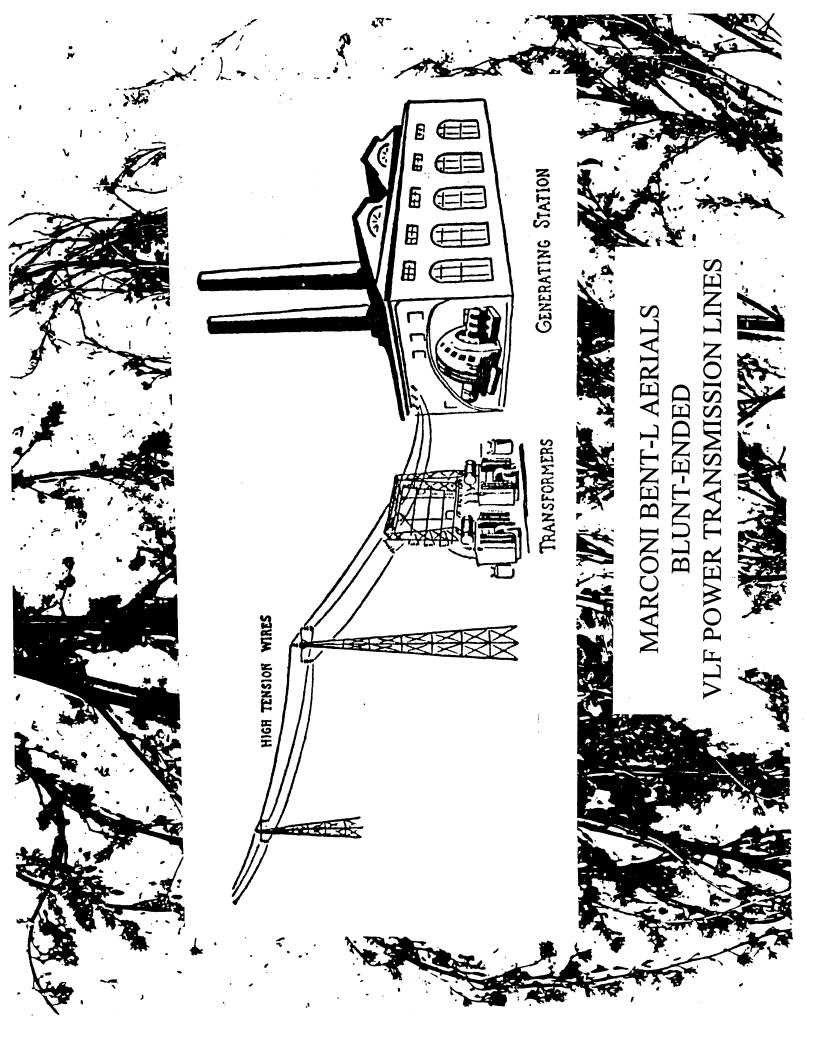
> 6. An antenna system comprising a plurality of sections and a counterpoise for each 95 section, a variable inductance connected between antenna sections for neutralizing reaction therebetween, and magnetic coupling between counterpoises for neutralizing capac-

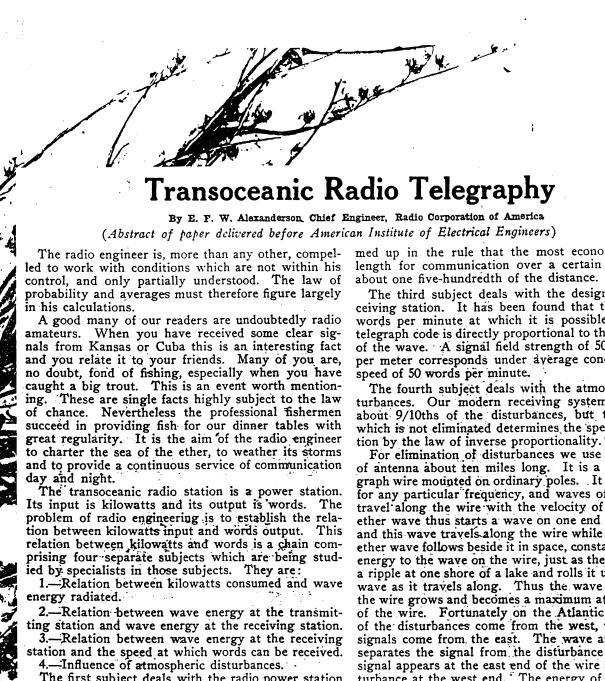
ity coupling therebetween.

7. In radio signalling apparatus, the combination of an antenna having a plurality of sections, a counterpoise for each section, means for neutralizing the reaction between 50 rality of sections, a counterpoise associated each antenna section and its counterpoise. 105 with each section, a high frequency source for means for neutralizing the reaction of the feeding each section and each source being counterpoises upon each other, and means for connected to a common ground, an antenna neutralizing the reaction of the antenna sec-

H. CHIREIX.







The first subject deals with the radio power station and the antenna. The Radio Central antenna is designed from the ground up. It has six ground connections distributed over a distance of one mile and 150 miles of wire buried in the ground. Through these devices the ground resistance has been reduced to 1/10 ohm. The best antenna of types previously used have ground resistances of about 2 ohms. The losses in the ground have thus been reduced at the rate of 20 to 1.

The second subject is wave propagation. We have now a great deal of practical data which can be summed up in the rule that the most economical wave length for communication over a certain distance is

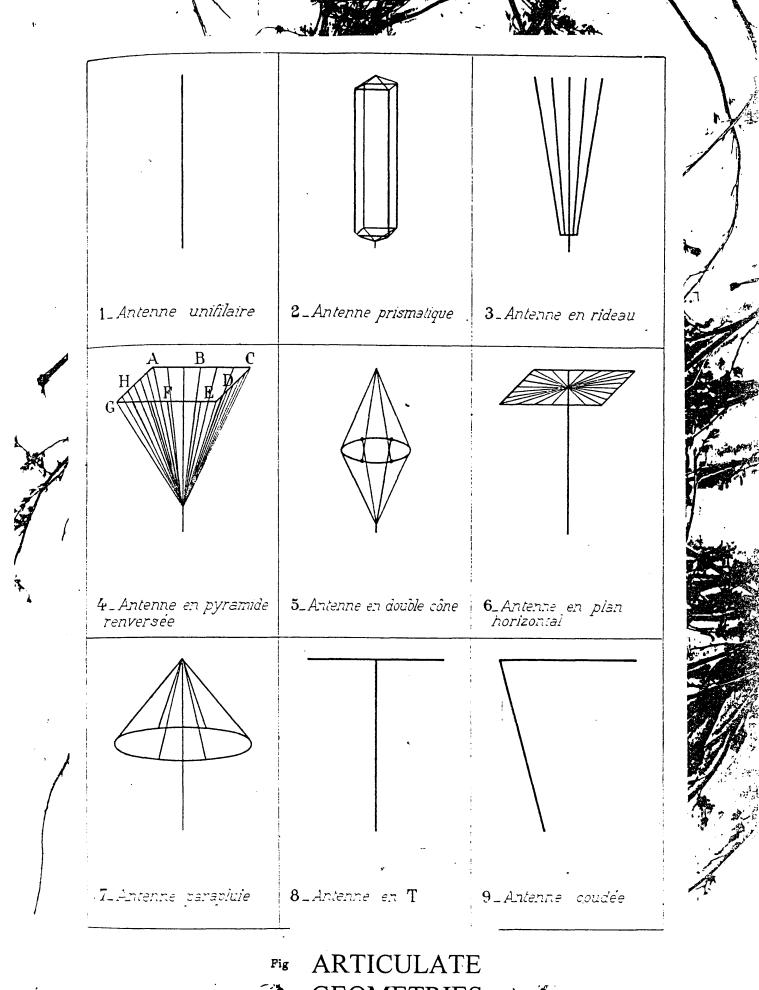
The third subject deals with the design of the receiving station. It has been found that the speed in words per minute at which it is possible to receive telegraph code is directly proportional to the amplitude of the wave. A signal field strength of 50 microvolts per meter corresponds under average conditions to a

The fourth subject deals with the atmospheric disturbances. Our modern receiving system eliminates about 9/10ths of the disturbances, but the residual which is not eliminated determines the speed of recep-

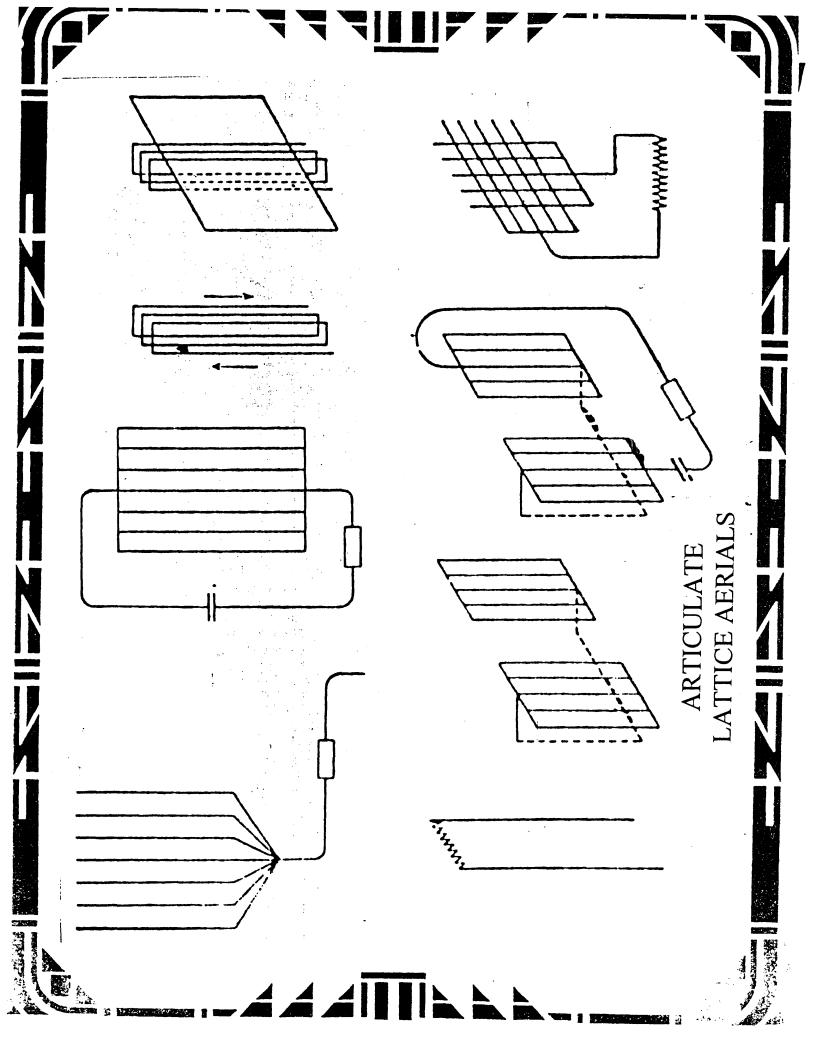
For elimination of disturbances we use a new type of antenna about ten miles long. It is a simple telegraph wire mounted on ordinary poles. It is not tuned for any particular frequency, and waves of all lengths travel along the wire with the velocity of light. The ether wave thus starts a wave on one end of the wire. and this wave travels along the wire while the original ether wave follows beside it in space, constantly adding energy to the wave on the wire, just as the wind starts a ripple at one shore of a lake and rolls it up to a large wave as it travels along. Thus the wave intensity in the wire grows and becomes a maximum at the far end of the wire. Fortunately on the Atlantic coast most of the disturbances come from the west, whereas the signals come from the east. The wave antenna thus separates the signal from the disturbance so that the signal appears at the east end of the wire and the disturbance at the west end. The energy of the disturbance is destroyed by absorption in a resistance at the west end of the wire, whereas a practically pure signal can be collected at the east end.

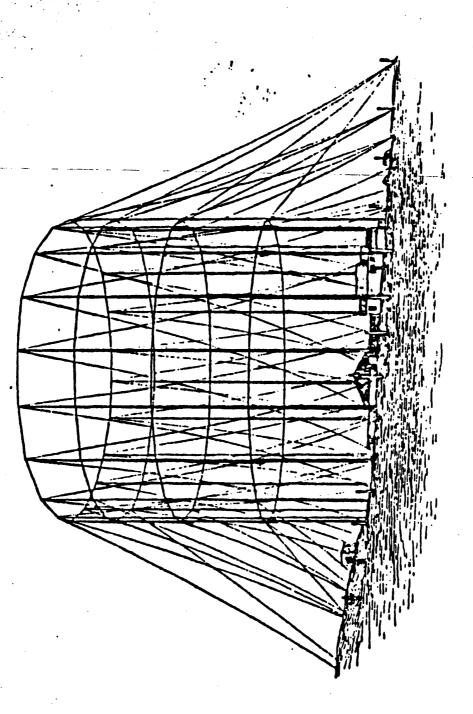
With the data that is thus available the planning of a new radio system is no longer a matter of guesswork. Before designing the South American system we sent an expedition of engineers to chart the atmospheric disturbances. Their findings led to a modification of the original plan because it was discovered that at the location first selected the principal disturbances came from the same direction as the signal, and there-



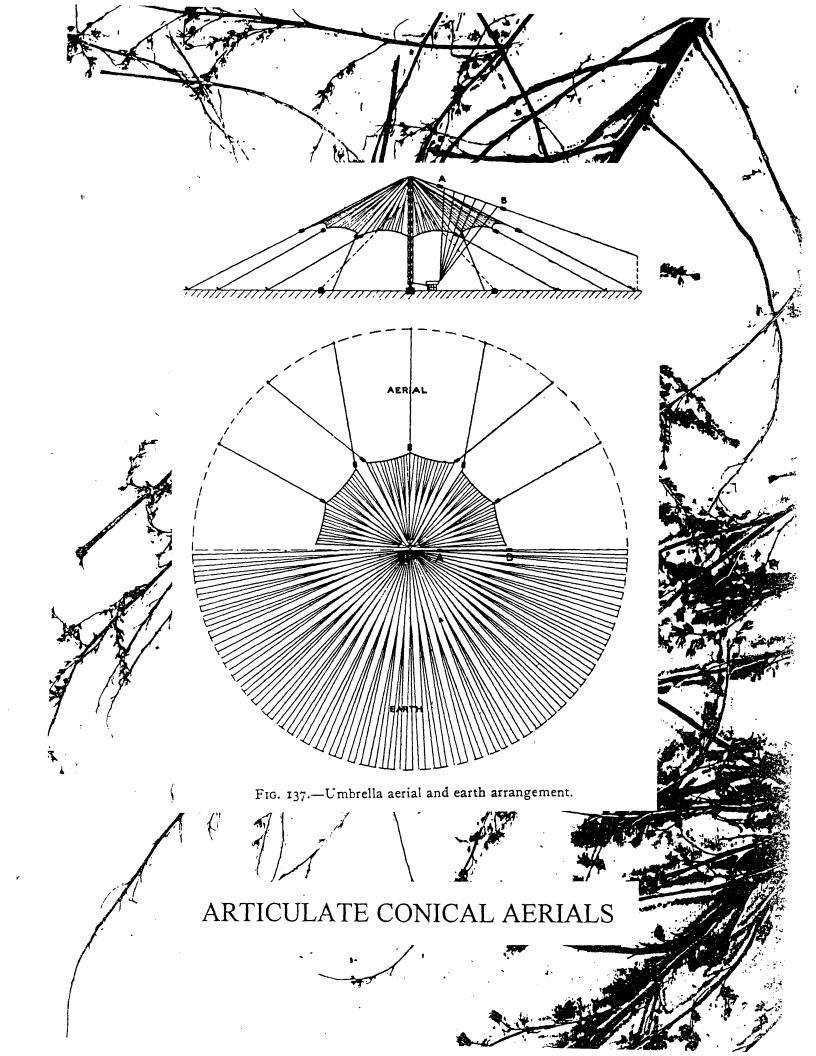


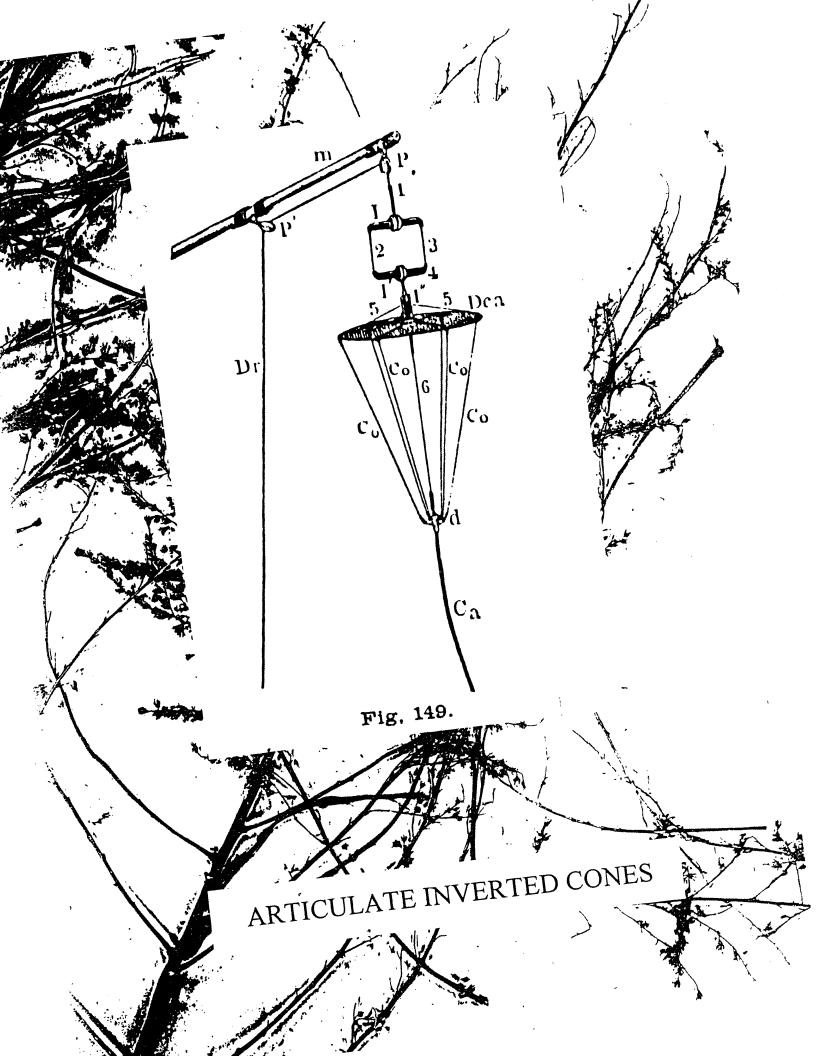
GEOMETRIES

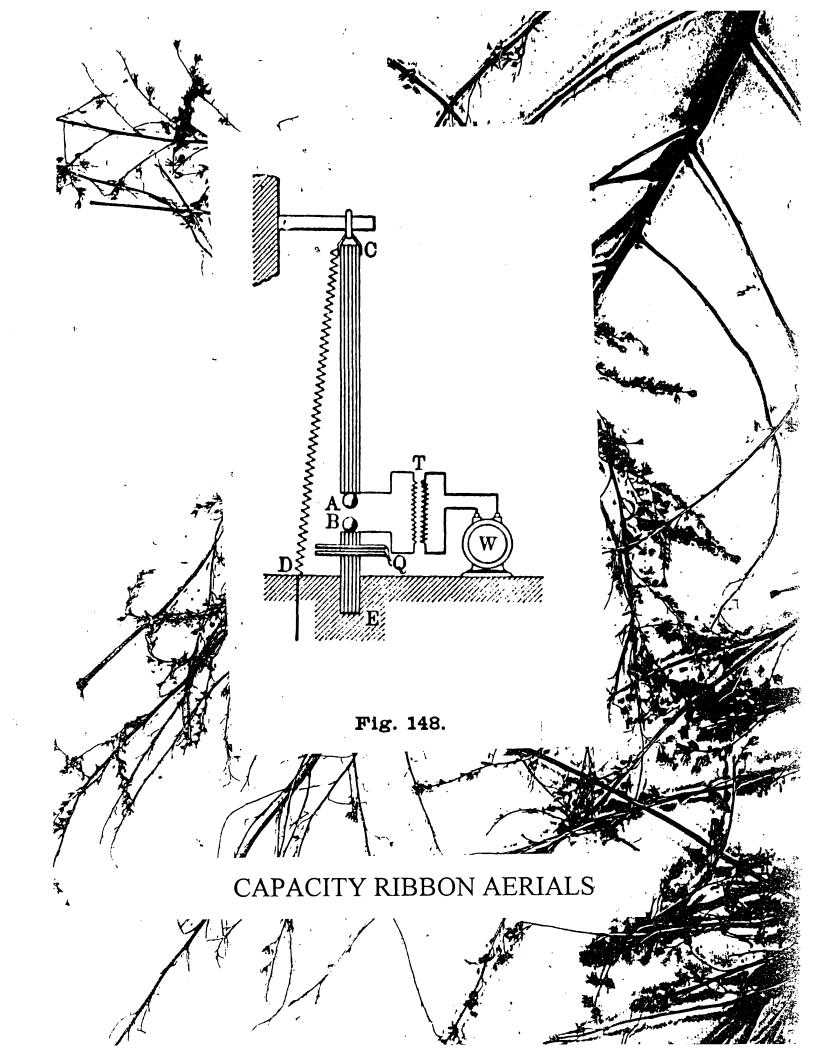


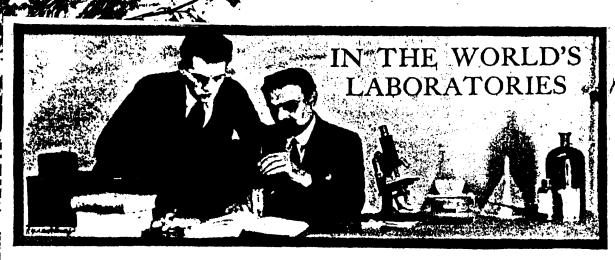


A wireless station, the beginning of the end for the brass pounders









CONDUCTED BY DR. E. E. FREE

Earth Screens for Radio Reception

THE use of an earth screen, composed of wires stretched along the ground under the antenna, is already usual in transmitting stations and it has been proved that a considerable lowering of the antenna resistance can be accomplished in this way. The theory is a little complicated but what happens essentially is that the wires of the screen serve as an attachment for the lower ends of the lines of electric force the upper ends of which arise from the antenna.

Another way of looking at it is to consider the antenna-to-earth's-surface system as a condenser. The antenna is one plate; the earth's surface is another plate. A metallic-wire screen placed underneath the antenna acts as a substitute for the earth's surface. The screen becomes the lower plate of the condenser. Naturally a set of highly-conductive wires has a lower resistance than the earth. Also it is more perfectly attached, electrically, to the transmitting apparatus. The net effect, then, is as if you substituted a good, metallic condenser, with its two plates exactly opposite to each other, for an imperfect condenser one plate of which was made of poorly conducting material.

In the case of transmitting systems all this has been well-known for two or three years. Recently, however, two scientists at the British National Physical Laboratory, at Teddington, England, have completed a series of experiments on the application of this same earth-screen idea to receiving antennas, including antennas used in ordinary broadcast reception.*

There is no theoretical reason why this should give any especial improvement of reception. The problems of transmitting antennas are very different from those encountered when the antenna is to be used for reception only. Nevertheless, actual tests proved that an earth screen really does give a considerable advan-

*"Some Experiments with Aerial and Earth Systems for Reception," by R. L. Smith Rose and F. M. Colebrook. Experimental Wireless (London), vol. 2, pages 207-217 (January, 1925).

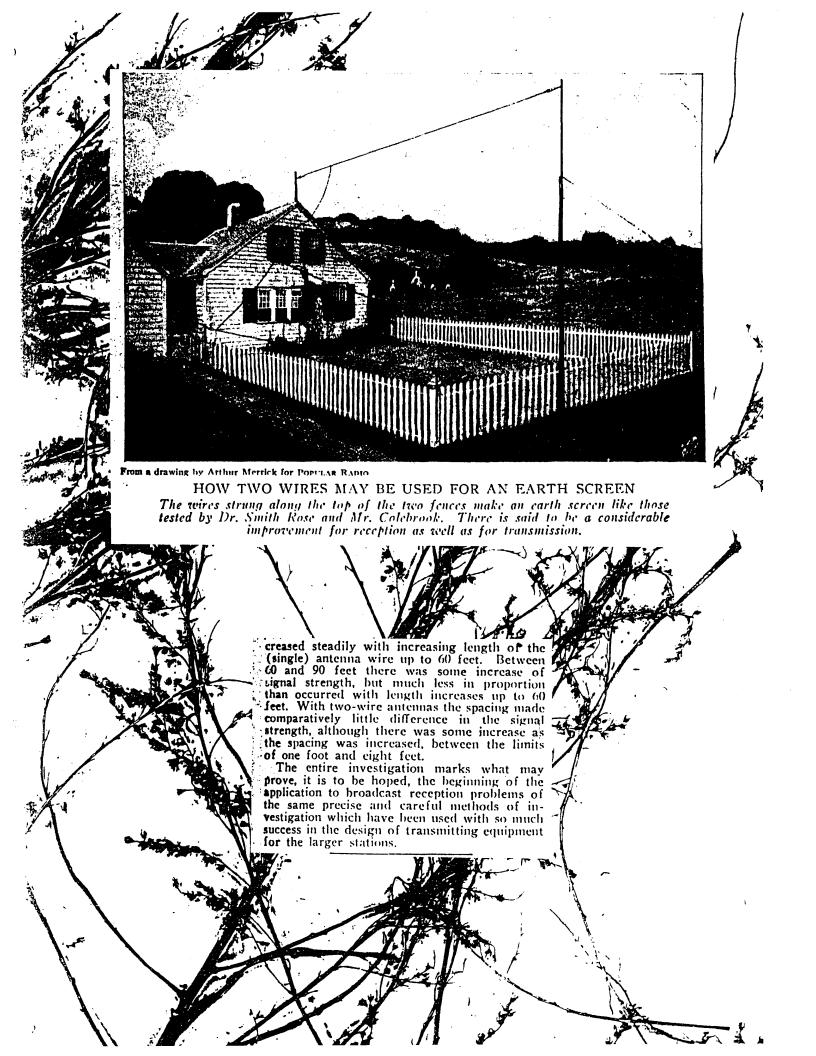
tage in reception as well as in transmission. With three of four wires arranged a few feet above the ground, underneath the antenna and parallel to it, the received current was found to be approximately twice as great and the antenna resistance approximately one-half that found when a water-system ground of usual type was used.

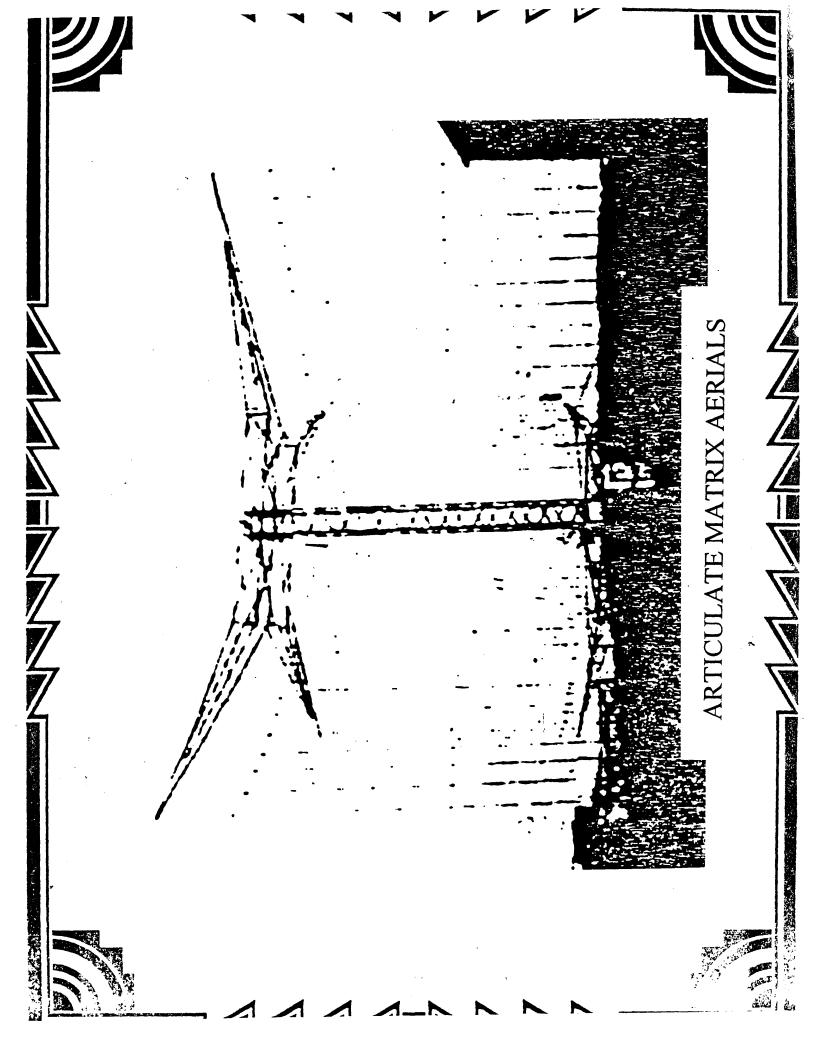
In order to make use of as many as three or four such wires in an earth screen it is necessary to fence off the land under the antenna, a procedure which is seldom possible to the ordinary radio fan either in England or in America. But what can be done, in many instances, is to provide two wires stretched parallel to the antenna and more or less underneath it. For example, if the antenna wire runs the length of a long narrow lot or garden like the usual city "backyard," it is possible to stretch the two wires along the tops of the two side fences of the yard.

This procedure was tested by Dr. Smith Rose and Mr. Colebrook and was found to be almost as satisfactory as the three or four parallel wires with which the main experiments were made. In one test the two-wire screen system gave an antenna resistance of 13,5 ohms as against 10 ohms for the four-wire screen. In contrast with these low values, the antenna resistance when a water-system ground was employed was in the neighborhood of 25 ohms.

It is apparent, of course, that the advantage of low antenna resistance is of much greater practical importance with crystal sets or other sets having no great amplification and no source of local energy than it is in the multitube, high amplification sets now common in the United States. Nevertheless there are many circumstances under which the two-wire, garden fence screen device of Dr. Smith Rose and Mr. Colebrook is well worth trying.

In the same paper these gentlemen report, also, some experiments on the effect of the height, length and wire spacing of the antenna on the strength of the received signal and on the antenna resistance. The signal strength increased with the antenna height up to 25 feet above the earth screen, which was the greatest height tested. The signal strength also in-







NON- DIRECTIONAL

Why?

SUPER-AERIAL EFFICIENCY—ANYWHERE

INCREASED SELECTIVITY

MORE VOLUME

CLEARER RECEPTION

REDUCES FADING

OVERCOMES BLIND SPOTS

BRINGS IN MORE STATIONS

Why?



Patented in Canada and other countries

(Without Mast)

The Acid Test

The Patent PERFEX AERIA

HAS SINCE 1923 PASSED THE ACID TEST IN THE USE BY THOUSANDS OF LISTENERS IN MANY PARTS, AND BY THEIR TESTIFIED EXPER IENCE HAS PROVED THAT IRRESPECTIVE OF SET OR PREVIOUS AERIAL USED, RECEPTION WAS CONSIDER-ABLY IMPROVED IN EVERY

THE PERFEX PRINCIPLES

- 1. The wire being carried on rectangular spreaders, broadcasting can be received equally well from all direc-
- The spreaders act as conductors for the energy col-lected, enabling it to flow to the downlead over the shortest path and thus reduce resistance, avoiding loss from this cause.
- The aerial wire being in a vertical plane, advantage is taken of the proved fact that a vertical wire collects a greater amount of wireless energy than a horizontal one, and also avoids capacity losses.
- 4. The special "PERFEX" Aerial Wire is the most efficient yet invented, taking the form of an open woven tube with the whole surface of each strand exposed to the oncoming ether waves.
- 5. The position in which the aerial is erected and method of installation are as important as the design. The greater the effective height and the clearer it is of surrounding objects, the greater the efficiency.

To the set owner or buyer-

NATURALLY, YOU DESIRE THE BEST! INSIST ON A DEMONSTRA-TION OF THE PERFEX AERIAL.

To the dealer and jobber-

BY SELLING THE BEST, YOU GUAR-ANTEE SATISFACTION. GIVE YOUR CUSTOMER THE AERIAL THAT BRINGS THE BEST OUT OF HIS SET. **SELL HIM PERFEX!**

Manufactured in Canada by

57 COLBORNE STREET

PHONE ADELAIDE 1885.

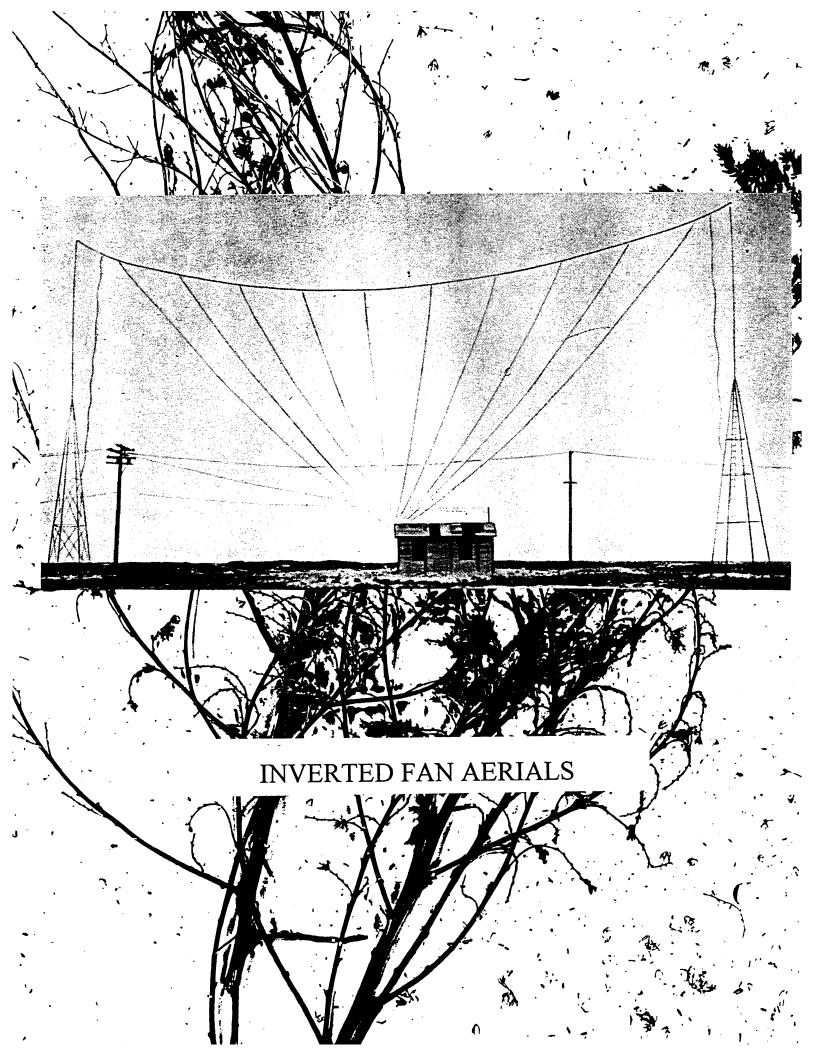
OMPANY, LTD.

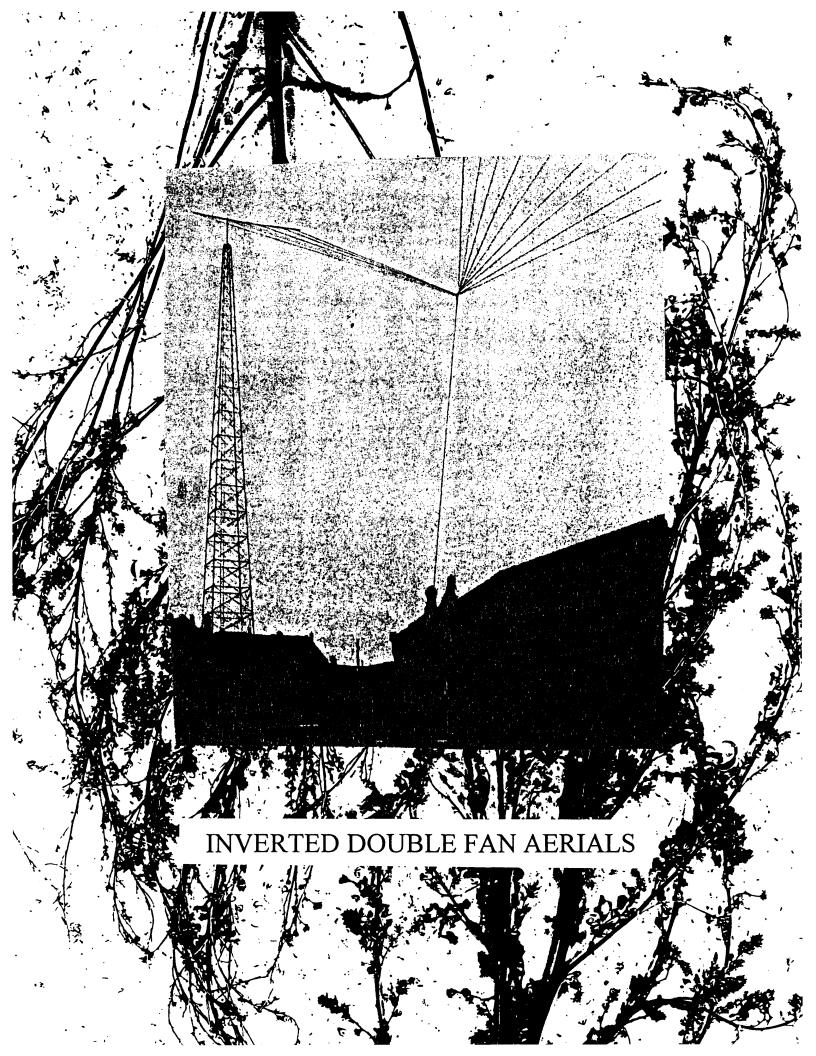
TORONTO 2

CABLES "FEDRAD," TORONTO.











TALKING TAPE doesn't have to be carefully strung outdoors or on the roof—you don't have to buy lightning arresters, or insulators. Just put Talking Tape indoors—anywhere you find it convenient, and you'll be surprised—and delighted—at the results. It's the answer to indoor reception!

Use Talking Tape instead of a loop—the results you can obtain by following a few simple directions, supplied with each roll of Talking Tape will prove a revelation in Radio entertainment.

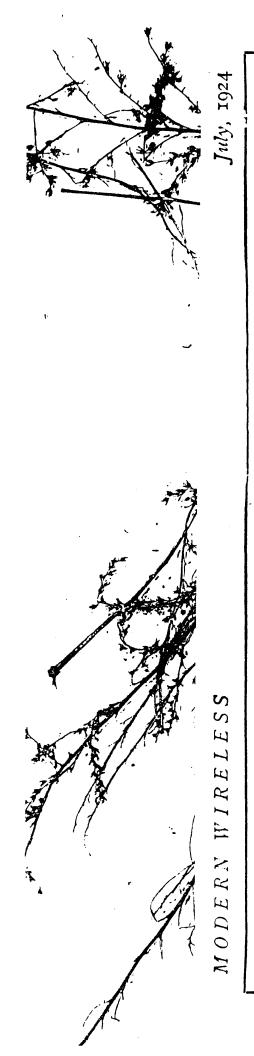
Ask your dealer about Talking Tape—he knows the story. Better still, buy a dollar's worth and try it yourself—that's the inexpensive way to better Radio.

Manufactured by
HOPE WEBBING COMPANY

For Forty Years
The World's Largest Manufacturers of Electric Tapes
PROVIDENCE, R. I.



The Perfect Radio Aerial



MEAN EARTH SET. GOOD MAXIMUM EFFICIENCY FROM YOUR AND GOOD AERIAL "REMEMBER"

MAGNIFLEX

The Range, Strength and Clearness are increased up to 40% by installing a MAGNIPLEX AERIAL as tested by experts. This applies to both Valve and Crystal Sets, either in or out of doors. MAGNIPLEX is made of Special Woven Wire Gauze of high tensile strength and conductivity.



Patent Applied for.

Our claim is backed by a guarantee that we refund your cash if results are not better than your present Aerial, and more than justify the Any user of MAGNIPLEX will give you a testimonial extra cost of the MAGNIPLEN.

If your dealer does not stock them, send direct to us.

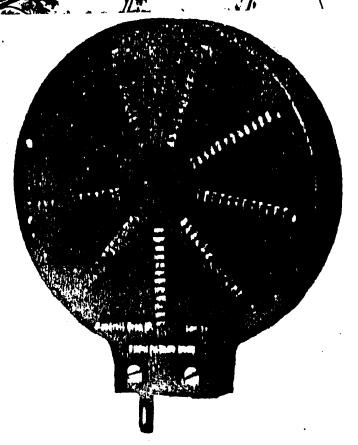
HELIXO Prices:—? in. wide 3d. per ft.: 4 in. wide 2d. per ft. Supplied in lengths of 50, 75 and 100 feet, including httings, viz:—End Terminal for Down Lead and Insulators ready for erecting. For lengths under 50 ft. fittings charged 15. 3d. extra. Postage and packing 15. extra.



FOLDED COILS







IS your set

suffering from summer lassitude? Does it receive 🕏 only with difficulty stations which were quite strong during the winter months? If you were to consult a specialist he would probably diagnose a severe attack of high frequency losses and advise you that the only remedy is to fit "Efficiency" Inductances.

The result is immediate and gives to your set that "Efficiency feeling." Below are some of the reasons why "Efficiency" Inductances always effect a cure:-

Low Self Capacity. Low Effective Resistance. Uniform Size for all Wave-lengths. Great Mechanical Strength. Larger Tuning Range.

Maximum Inductance.

Uniform Distribution of Current.

A Backing of 30 years' Coil Winding Experience.

A Postcard will bring copy of our leastet on industances.

GAMBRELL Bros., Ltd. 76, Victoria St., S.W.1.

West End Agent: J. V. MULHOLLAND, 4. Blenheim Street, Bond Street, W.1.

Works: Southfields, S.W.18. Victoria 9938.

Phone:

inductance.

LISSENIUM

TYPES OF MAGNETIC

With many types of coils the magnetic

field is mostly concentrated in the centre

of the coil, and the field does not extend

to any appreciable degree. The character-

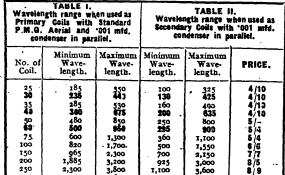
istics of the magnetic field in such coils

is closely analogous to the ordinary solenoid

CONCENTRATION-

MODERN LISSENAGON TUNING CHART.

Note the Intermediate coils, 30, 40 and 60.



IF YOU EVER WANT COILS WHICH INTEN-SIFY TUNING - USE LISSENAGON -

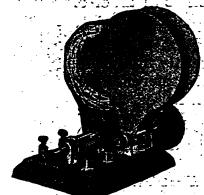
LISSEMACO

PROV PAT

WIRELESS

1,550 2,150 3,000 3,600

In the case of LISSENAGON (pronounced LISSEN-AGON) coils, however, the magnetic field, in addition to being very strong in the centre of the coil, is also distributed on each side of the coil. This accounts for the remarkably strong magnetic linkage obtained with LISSENAGON coils in reaction circuits, and ALSO FOR THE PECULIAR EFFICIENCY OF THE COLLS WITH EDDY CURRENT TUNING.



when capacity is low and inductance is high. If, where, say, a No. 35 coil is ordinarily used with added capacity to tune it to a given wavelength, a No. 60 coil can be used. AND WITHOUT ADDED CAPACITY, other things being equal, it follows that signals would be stronger.

In the new LISSEN CRYSTAL SET a form of tuning has been introduced which permits of a No. 60 LISSENAGON (pronounced LISSEN-AGON) coil being used, and dispenses with the need of added capacity to tune it. A big signal voltage is built up. But apart from its high inductance efficiency, too, there are other considerations which place this receiver far above all other crystal sets, NO MATTER WHAT THE PRICE.

THERE IS AN UNDISTURBED ELECTRICAL CIRCUIT, for instance. The only moving part is the metal plate, and although this is entirely unconnected with the electrical circuit, its influence on the inductance is effectively applied through the medium of the magnetic field created.

In conjunction with the principle of EDDY CURRENT TUNING employed in this new LISSEN CRYSTAL SET, LISSENAGON COILS ARE PECULIARLY EFFICIENT. No other coils give the same results.

By fitting the appropriate LISSENAGON (pronounced LISSEN-AGON) coil. the LISSEN CRYSTAL SET can be used for any station within range. Two coils would be needed for London and Chelmsford, for instance—to change over from one station to the other, take one LISSENAGON coil out, and plag the other one in.

On long aerials it would be possible to use a coil one size less in each cas e e.g., No. 40 instead of 50; 50 instead of 60; 60 instead of 75; 200 instead of 250.

NOTE.—One LISSENAGON coil must be ordered with each set—the receiver will not be sold without a LISSENAGON coil because the use of these coils ensures very high efficiency.

No paper-no cardboard—no loose contacts—no loose wires—connections stamped-out strips—the whole receiver is an instrument throughout—robust—and THE MOST EFFICIENT CRYSTAL SET MADE—WITH THE MOST EFFICIENT INDUCTANCE.

LIMITED, LISSEN

20-24, WOODGER ROAD, GOLDHAWK ROAD, SHEPHERD'S BUSH, LONDON, W.12.

TELEPHONES: Rivereide 3380, 3381, 3382, 1072.

TELEGRAMS: "Lissenium, London.

THE PROPERTY OF THE PARTY OF TH



includes Price οŝ receiver crystal), patent pending

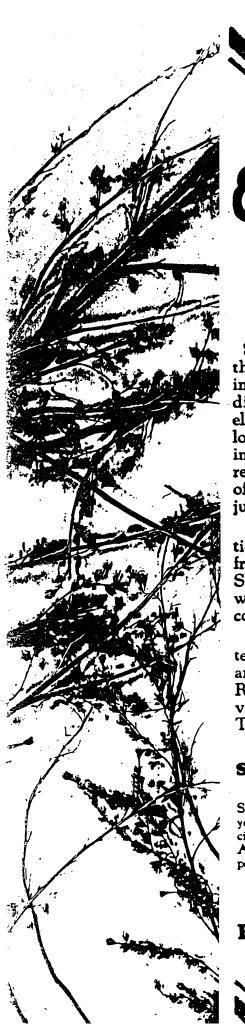
LISSENAGON coil 50 covers 300 to 350 metres on this receiver) ...

60 LISSENAGON coil covers 350 to 400 metres on this receiver) ..

75 LISSENAGON coil covers 400 to 500 metres on this receiver) ..

No. 250 LISSENAGON coil for Chelmsford

5/4



6.J. Juner

Simplifies the building of a Radio set by eliminating loss producing taps and

reducing tuning operation to setting of one condenser reading and adjusting tuner to maximum volume.

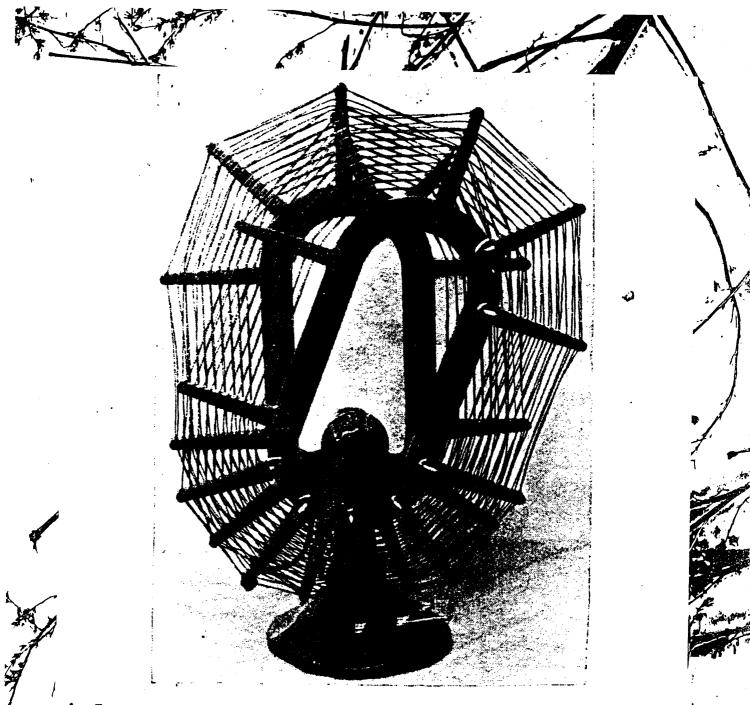
High efficiency is obtained by practically eliminating solid dielectrics from the coil field. Vernier control. Single hole panel mounting. Wide wave band covered without changing coil units.

This is one of Mr. Flewelling's master designs. It will enable you to build an efficient set at a minimum cost. Requires little room but produces big volume reception. Price includes Tuner complete with dial.

SOCKETS

E. T. Flewelling Sockets will make your set more efficient. Price \$1.00. At your dealer's or postpaid. At Your Dealers or Postpaid

BUELL MANUFACTURING COMPANY
2979 Cottage Grove Avenue
CHICAGO



A Loop Antenna That You Can Tune

Name of instrument: "Tun-A-Loop."

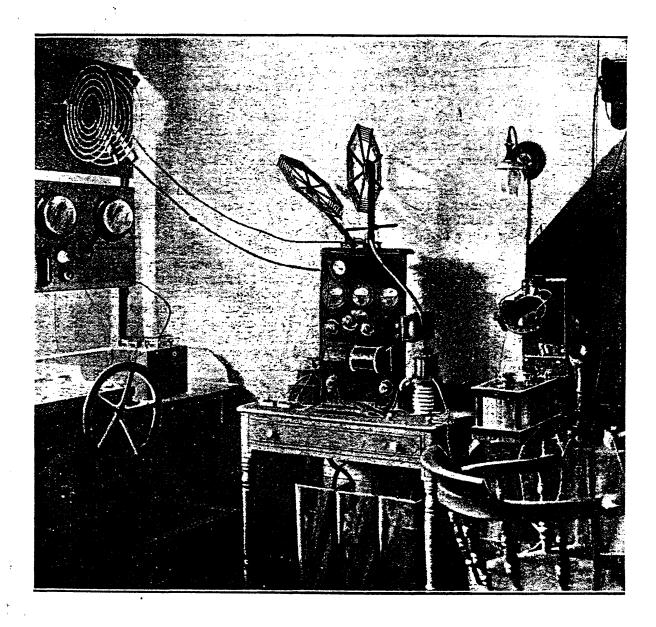
Description: This loop antenna consists of two separate loop windings, so arranged that the position of one can be varied in its relation with the other, in this way varying the inductance of the entire unit. The two windings, in other words, act like a variometer. The frames upon which the wire is wound are of bakelite. The windings are of the spider-web type and are of silk-covered phosphorbronze wire. The positions of the sections are varied by means of a knob on one of them. Three terminals are

provided so that the loop may be used in circuits which require a center-tapped loop. There is a calibrated scale on the loop base for use in noting the settings of the loop.

Usage: As a coil antenna for use with any radio receiver that is capable of operation with a loop antenna.

Outstanding features: The inductance of the loop may be varied to match the loop tuning condenser used. Also, it may be varied until its inductance is such that the settings of the loop tuning condenser will approximately correspond, for a given wavelength, with those of the other tuned circuits in the receiver. Good efficiency. Carefully made.

Maker: English-Whitman Products, Inc.



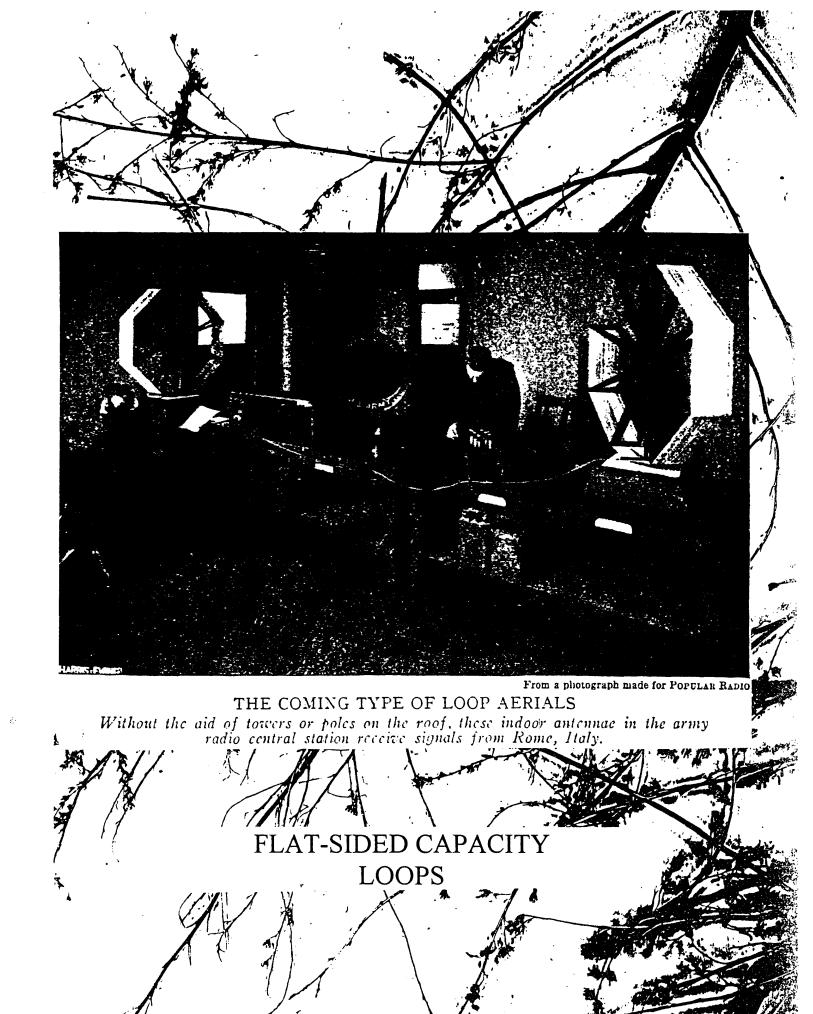




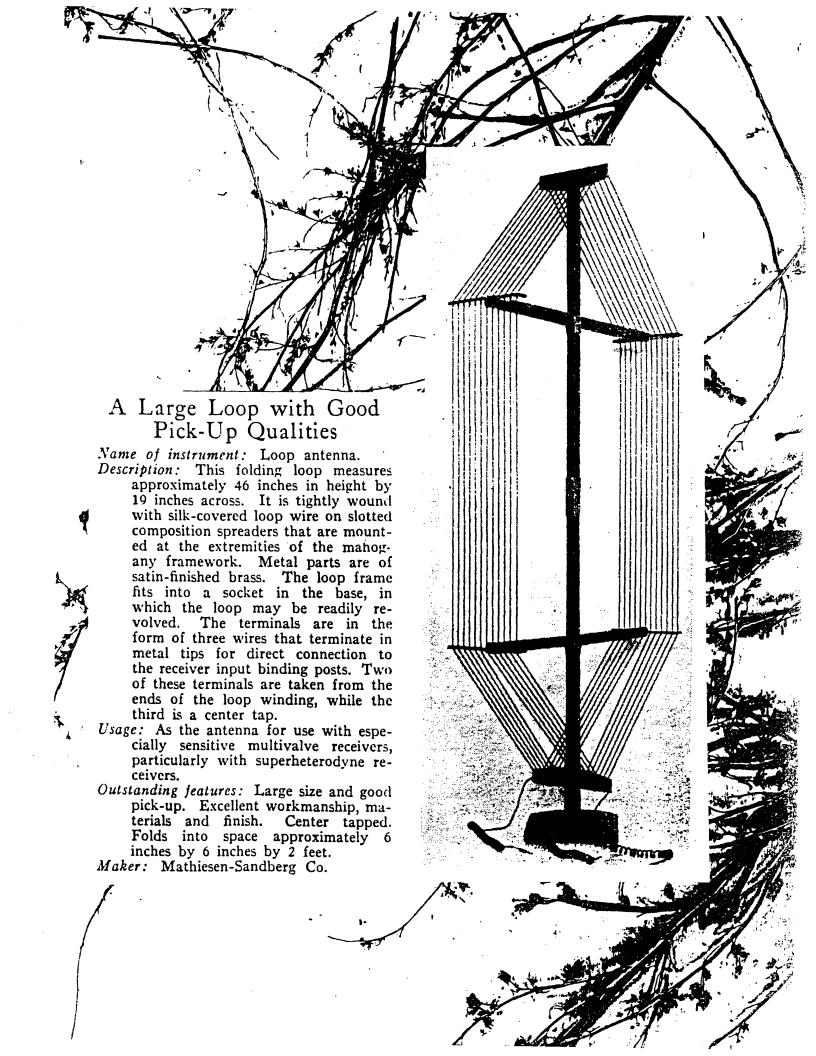


A REMARKABLE PORTABLE EIGHT-TUBE SUPER

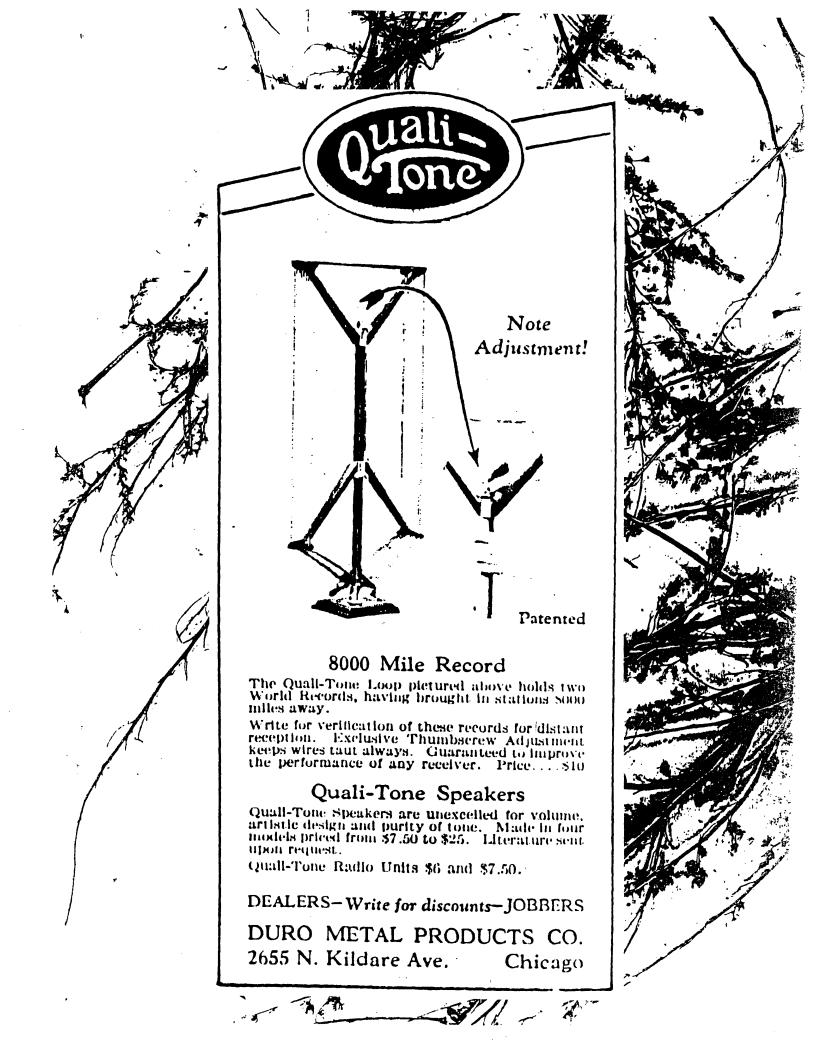
A Boston fan, A. S. Moffat, has built this eight-tube superheterodyne set, together with its batteries, loudspeaker and loop, into a space no larger than that of a small suitcase. Its best pickup, so far, is CFCN, Calgary which is over 2,800 miles from Boston.

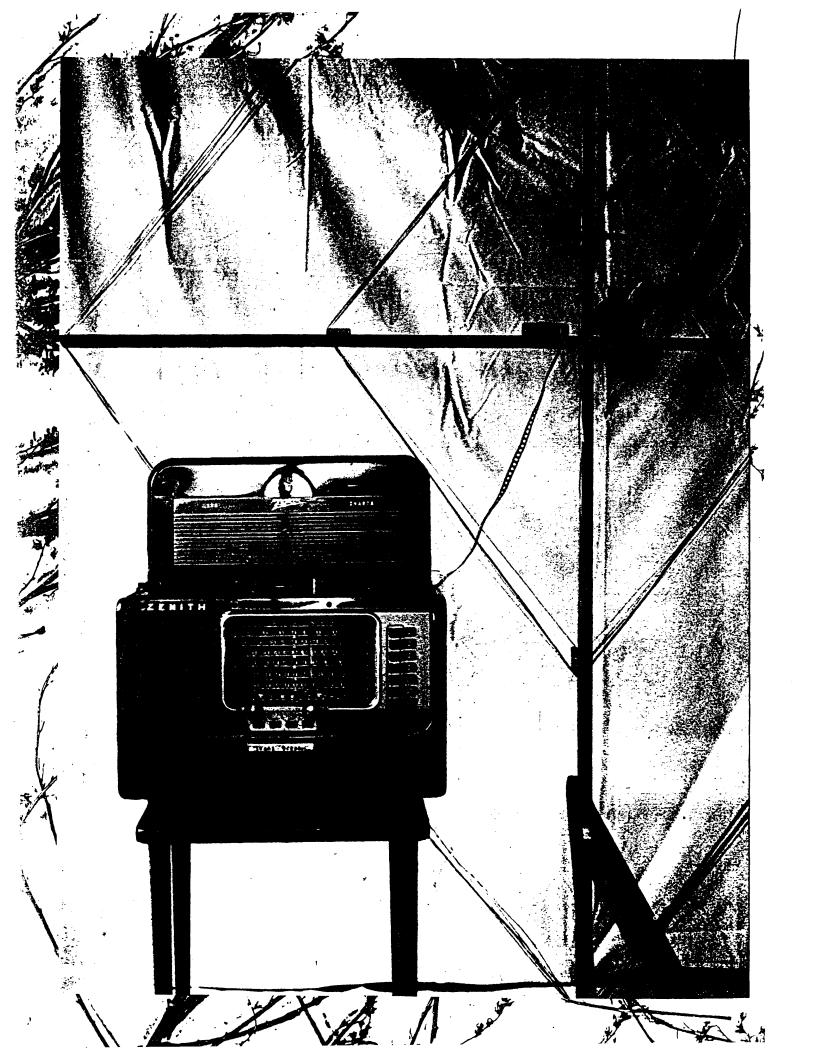


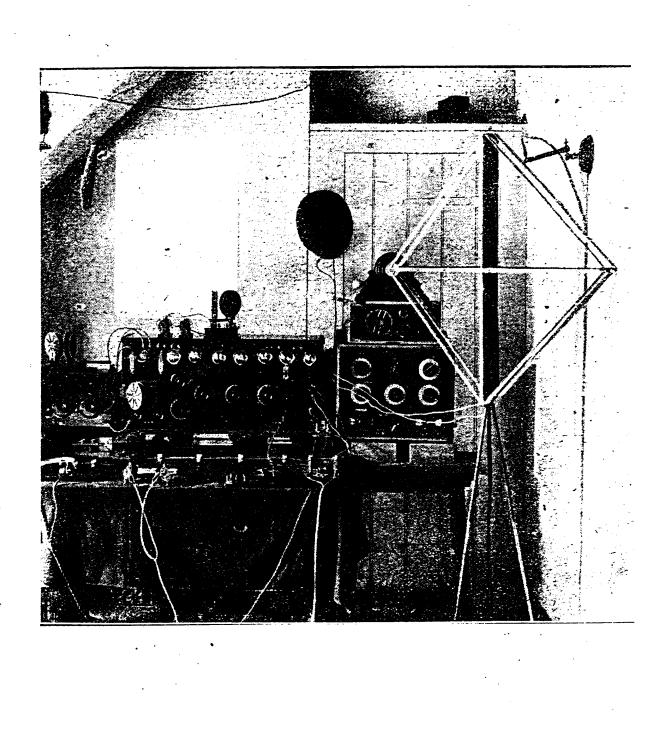


















SECTION 5

VRIL
AND
WORLD
COMMUNICATIONS

VIRELESS WORLD & RADIO REVIEW January 21st, 1925

THE

RADIO REVIEW

PRICE 4.D NET.

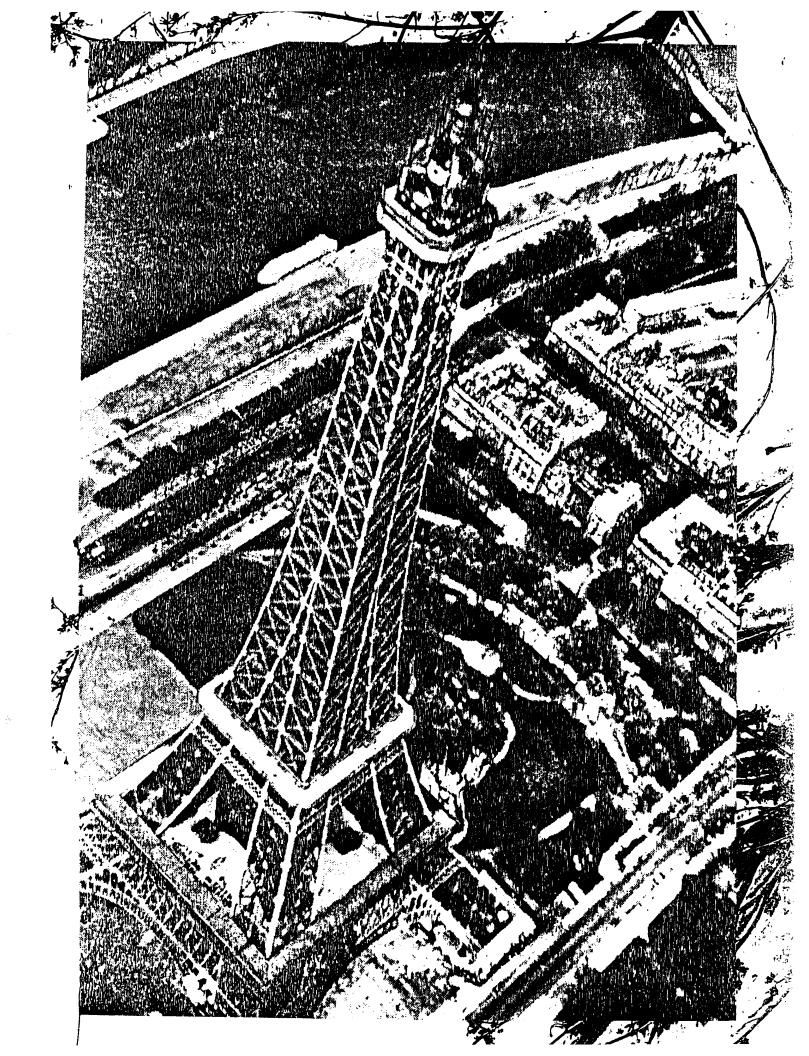
A PRACTICAL SYSTEM OF

TELEVISION

SHORT WAVE **RECEIVERS**

No. 284 [No. 17 Vol. XV]

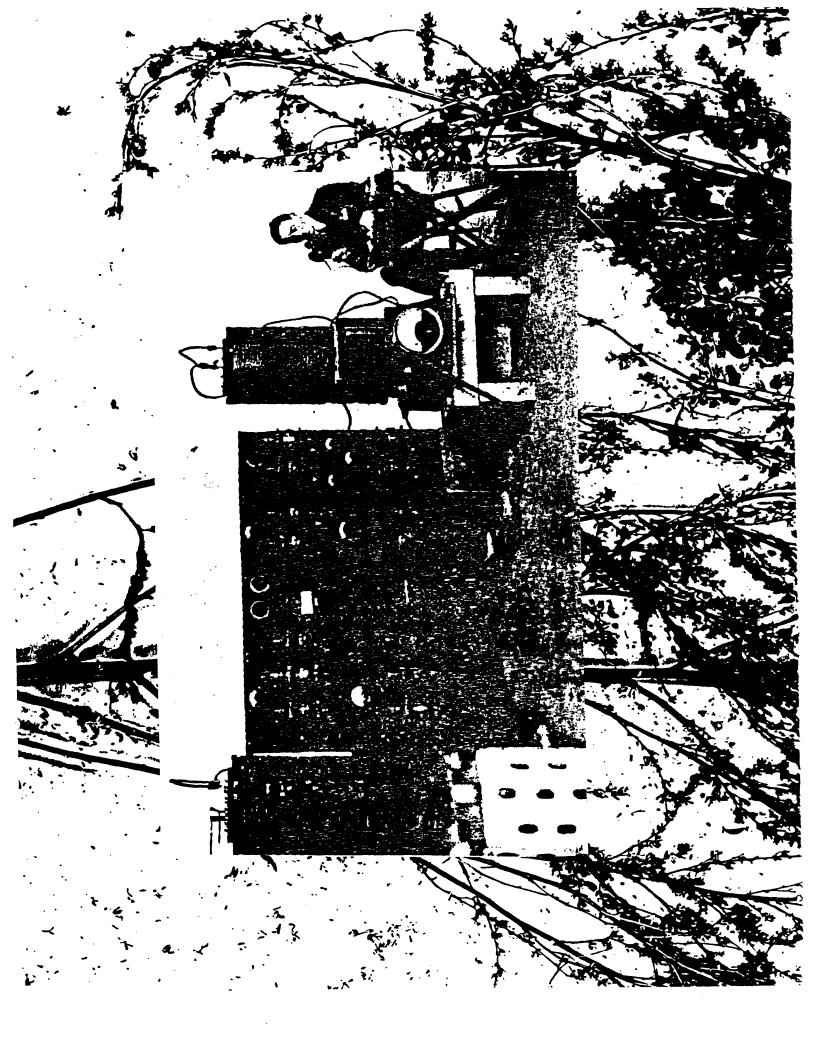
AN EASILY BUILT TWO-VALVE SET

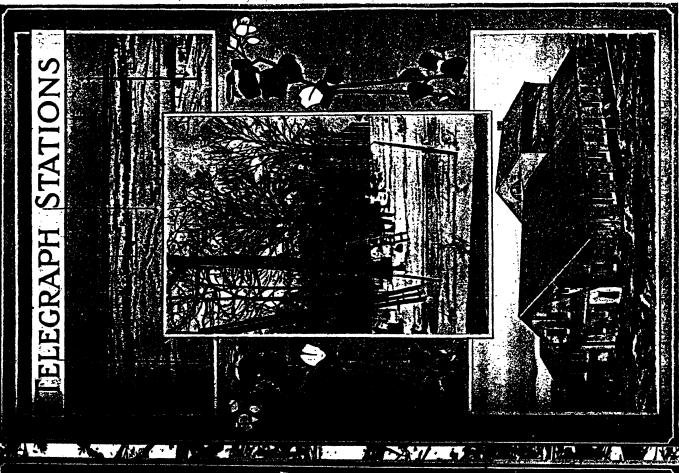




WHERE SHORT WAVES ARE GENERATED AT THE EIFFEL TOWER The Commandant of the great French radio station at the Eiffel Tower, in Paris is demonstrating to Mr. Delano, Paris correspondent of Popular Radio, a part of the apparatus used to generate the 45-meter waves and other waves of less than 100 meters which have been used in recent tests from this station.

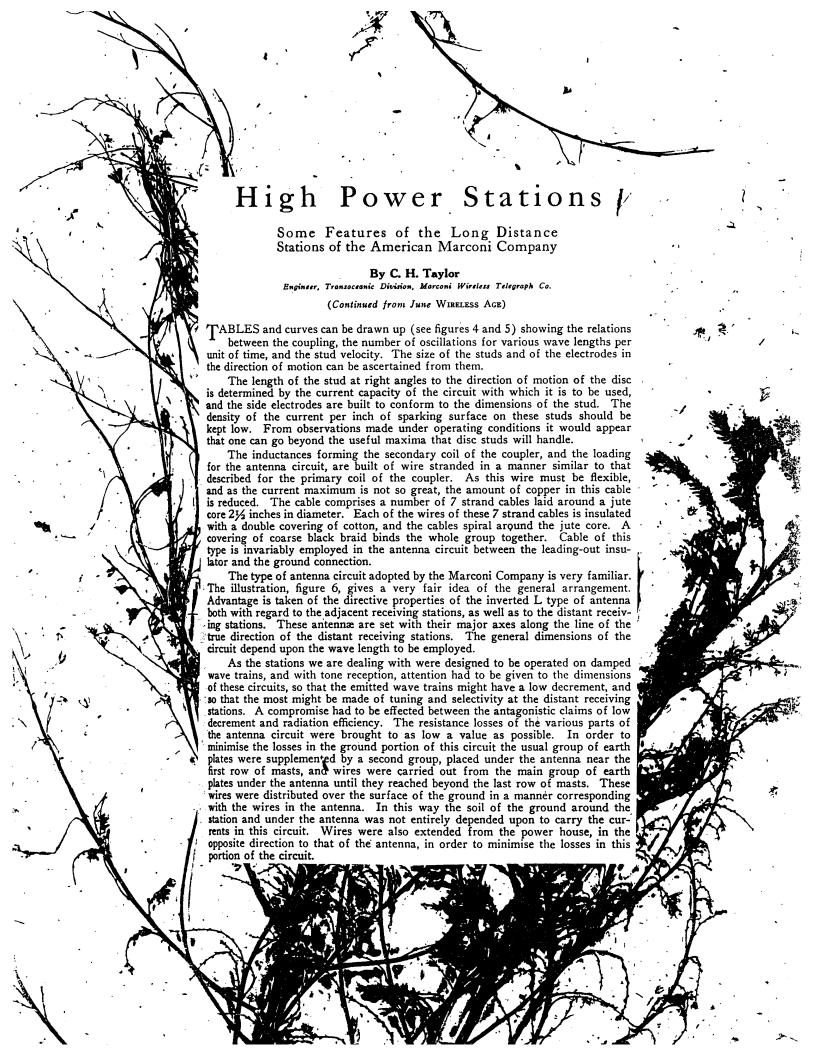


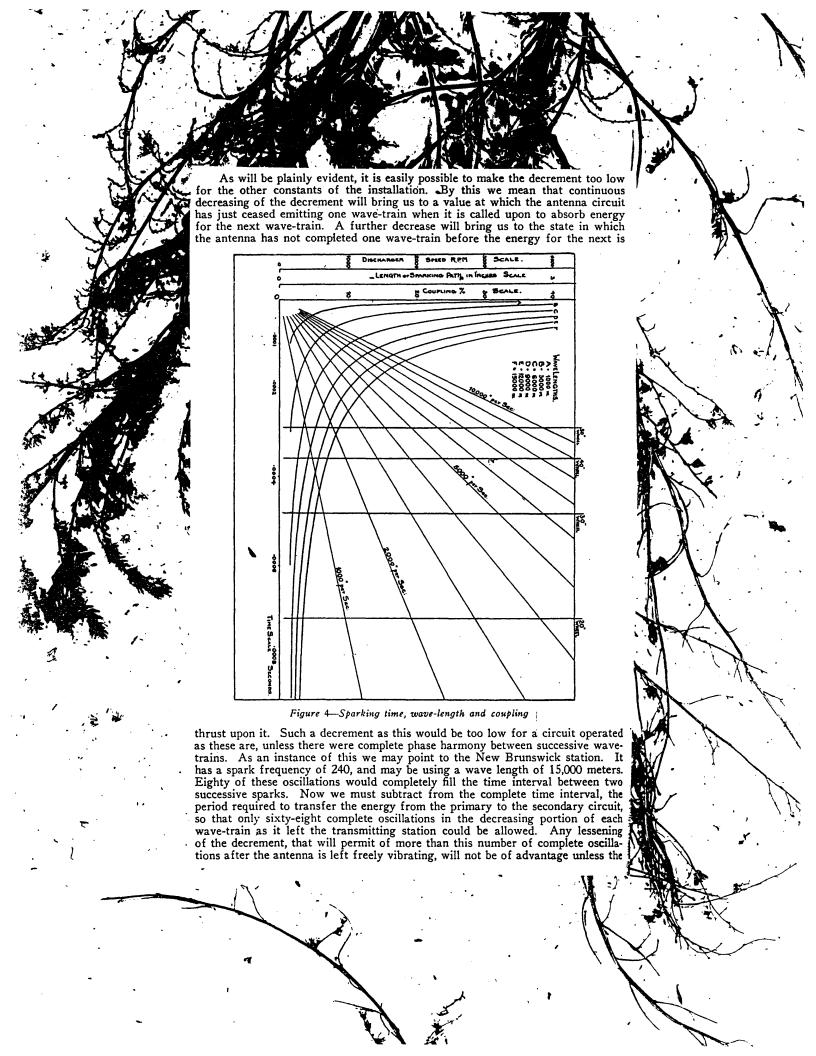


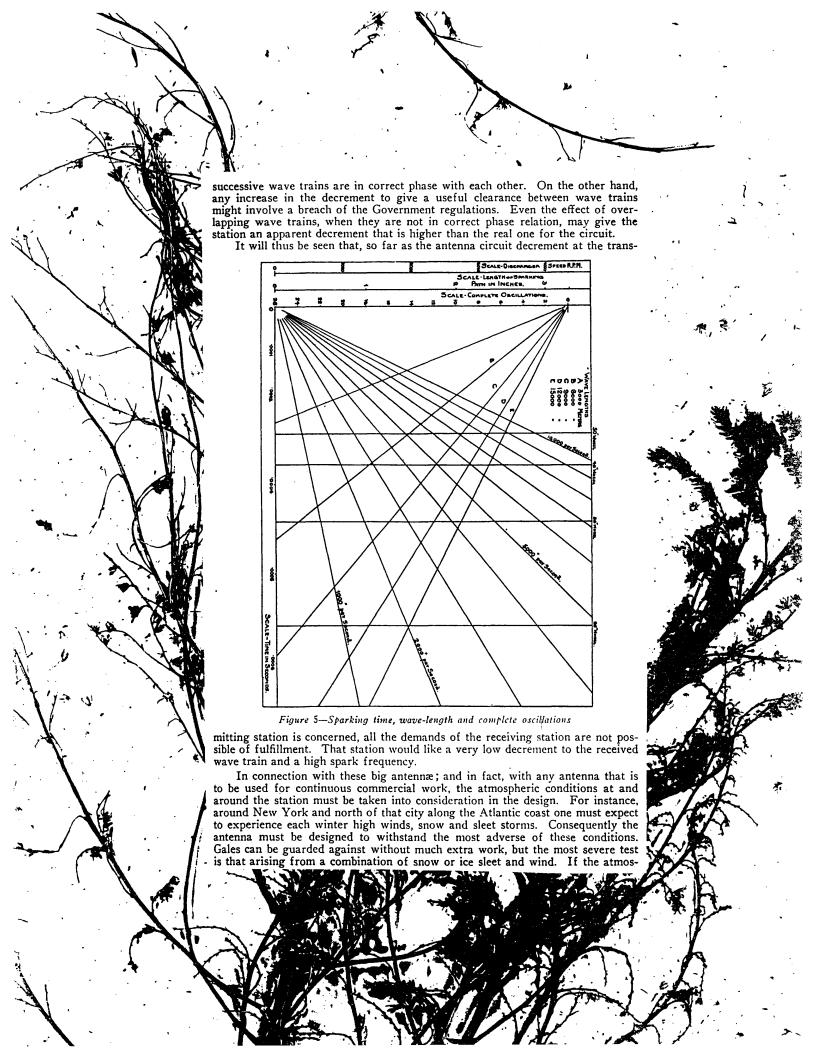


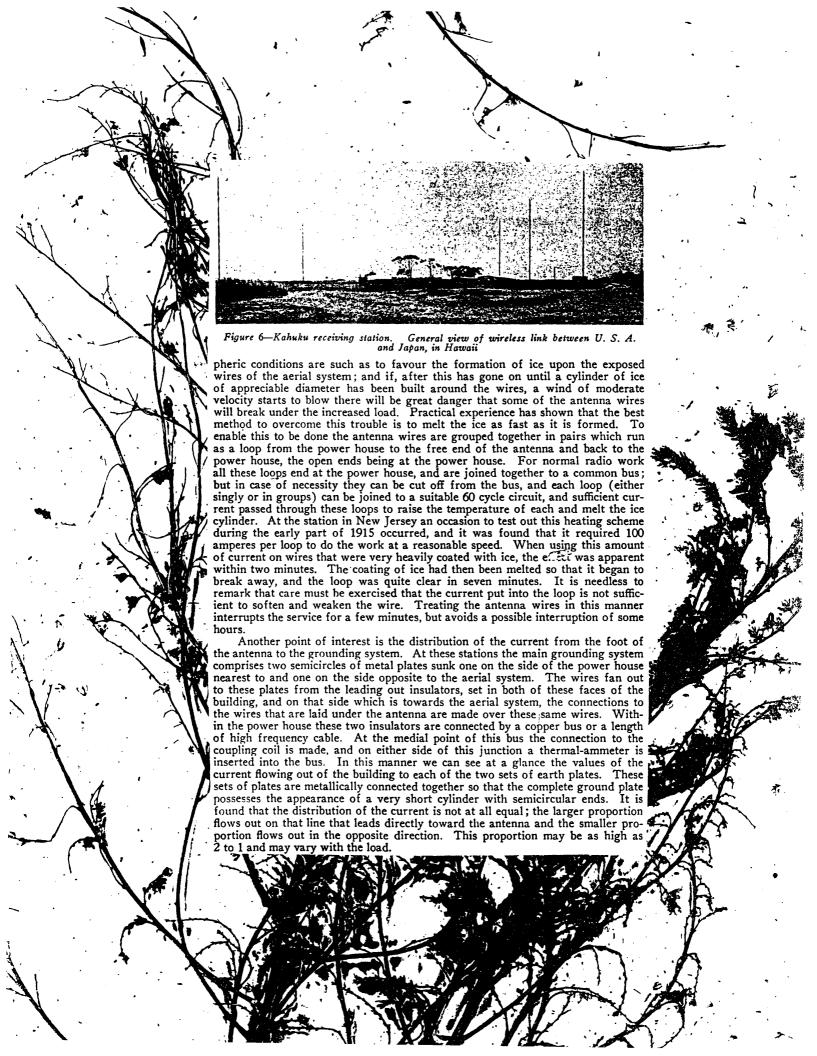
TRANS (OCEA

1.—Transmitting Station, Stavanger, Norway. 2.—Belmar, N.J. (U.S.A.) The only means of transportation. 3.—Top of 400 ft. mast at Carnaryon. 4.—Base of the same mast. 5.—Belmar, N.J., operators' quarters.

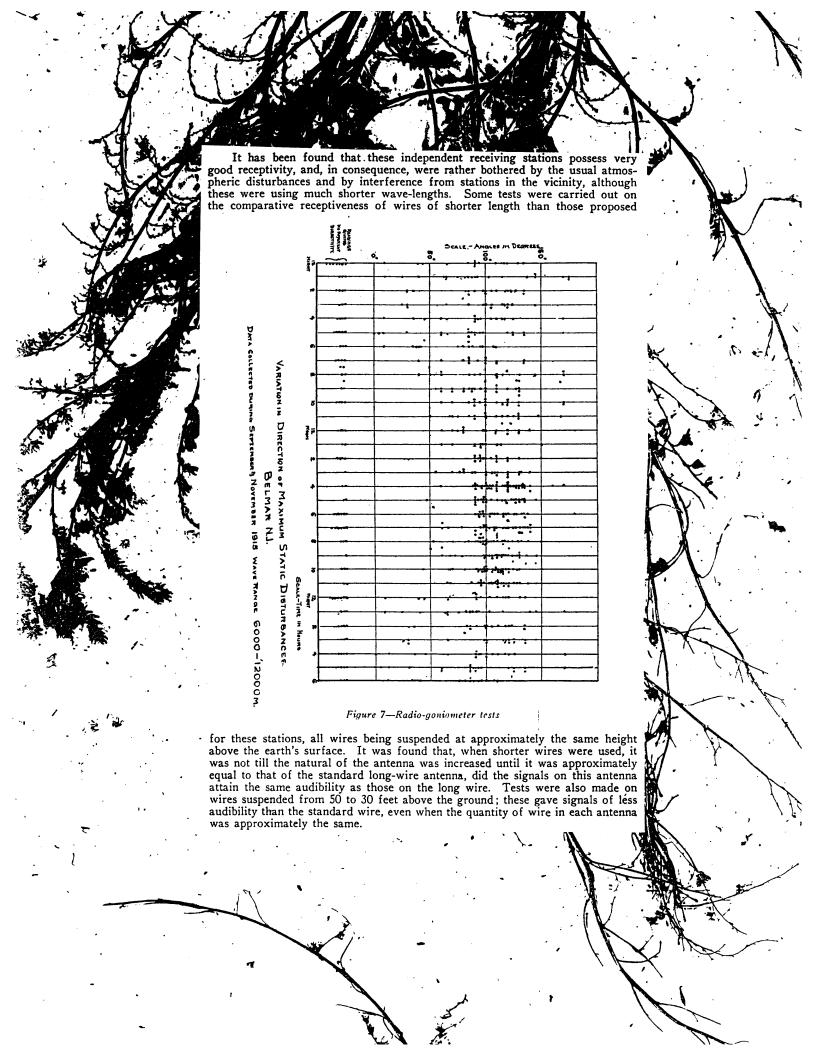












RADIO DEPARTMENT

Wireless Telegraphy By E. B. PILLSBURY

Seneral Superinte Cent, Marconi Wireless Telegraph Company of America, New York

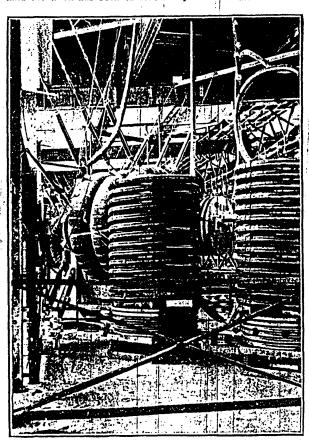
HE history of wireless telegraphy repeats once more the old story that is so often connected with great inventions. The world being possest of a new scientific principle, many minds in many parts of the world are simultaneously bent upon its practical application, with the result that the fundamental principle finds embodiment in various methods of accomplishing a similar purpose. The startling nature of the discovery of electric waves was bound to give rise to unprecedented activity in the field of experimental investigation, and such experiments as were particularly successful were bound to prompt investigators to seek patent protection on their modifications, and this in turn gave rise to several systems of radio-telegraphy.

A voluminous list of names could be given of those who have contributed to the advancement of radio-telegraphy in regard to both theory and practise. Among the best-known American investigators are Fessenden, Shoemaker, de Forest, Clark, Stone and Massie. Each of these men has devised a system which bears his name. In England the work has been carried on by men

such unqualified distiliction as Lodge, Alexander, Muirhead, Heming, Thomson and Rutherford. Slaby, Arco and Braun are the names best known in Germany. |The French are represented by Ducretet, Branly, Rochefort and Tissot, besides other men of lesser fame. Italy has contributed largely to the subject, principally thru Marconi, Bellini, Tossi and Righi. Denmark is represented by Poulsen. Spain, Austria Belgium and Argentina have all produced systems which have been more or less used in their respective countries. The Japanese have also devised a system that successfully stood the test of service in the Russo-Japanese



Interesting View of a Bank of High-speed, Automatic Sending Keys and Bus-bar Connections in a Typical High-power Narconi Radio Station.



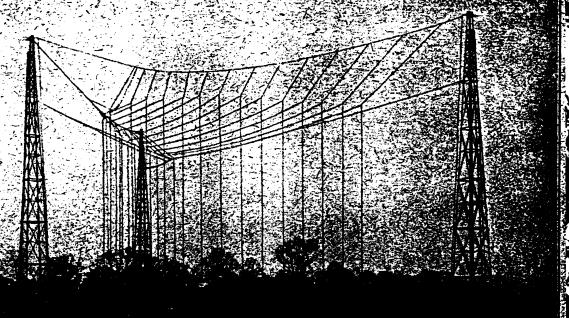
Gigantic Oscillation Transformers and Tuning Inductances In

The development of the art in the various countries has been car-ried on largels by representative investigators, and in many instances the governments have adopted a system exploited by their subjects. The United States government, however, has experimented with most of the prominent systems offered, and, as a result, the army and navy equipments are comprised of quite a variety of apparatus of different inven-

Wireless telegraphy was the subject of earnest experimentation as

early as 1838, but, as far as the public mind is concerned, the science began when Marconi sent his first message across the Atlantic from Cornwall to Newfoundland in 1902. This wonderful accomplishment had so much of the spectacular element in it that wireless telegraphy and Marconi became famous at once and, measured by results, he has eclipsed all other inventors.

Marconi first interested himself in the problem of wireless telegraphy in 1895. In the following year he took out the first pattent ever granted in England for a practical system of wireless telegraphy by the use of electric waves. In 1897 he successfully communicated across Bristol Channel, a distance of nine miles. At the invitation of the Italian government, Mr. Marconi subsequent went to Spezia, where his system was put to practical test on board two Italian I relevants.



The Wireless Beam in Practice

An Account of Results Obtained in Experimental Work on Stations Already

BY R. H. WHITE, M.I.E.E.

XPERIMENTAL stations employing the Beam principle have been erected by the Marconi Co. at m Hendon, Birmingham, Inchkeith, the South Foreland, and at Poldhu. The pioneer work carried out at to Hendon, Birmingham, and Inchkeith was described by Mr. G. S. Franklin in a paper before the Institution of Electrical Engineers in May, 1922.

In 1919, experiments with valve transmitters were carried out at Carnarvon. Experiments were first made with waves of a hundred metres or so, and gradually, step by step, the length was reduced, until waves were produced which could be employed in conjunction with reflectors of moderate dimensions.

Wavelength of 15 Metres Chosen.

Finally, a wave of 15 metres was selected, and efforts were then made to increase the power which might be transmitted and to improve the receiver.

The distance over which speech could be transmitted was very small at first; it was, in fact, some time before the stations could be separated more than a few miles apart. The struggle went on steadily, and at last substantial improvements, principally in the receiver, made it possible to jump from some three miles to a distance of twenty miles.

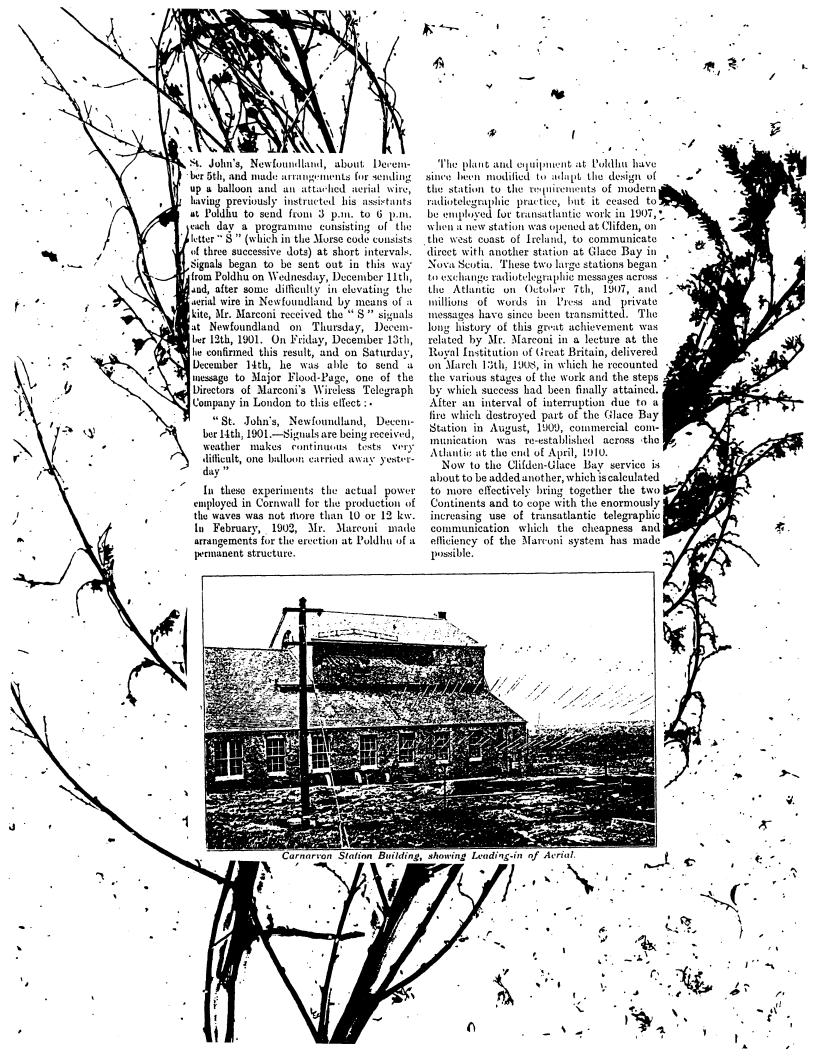
Next a receiver was fitted up at Holyhead, twenty miles from the Carnarvon station, and the strength of speech received there was so encouraging that permission to install a receiver on one of the Dublin Steam Packet Co.'s boats was sought and obtained. The ship steamed away from Holyhead to Kingstown, Ireland, and speech was heard right up to and after entering that port.

An interesting point was that there was no reduction or cutting off of these short waves (15 metres) even when the ship was well down over the horizon from Carnarvon. This distance was seventy nautical miles over sea. It was now decided to experiment entirely over land.

A site for a station was selected at Hendon, and a reflector erected pointing towards Birmingham. This reflector is illustrated in the photograph at the head of this article.

A receiver was installed in a motor car, a fishing rod was carried to serve as a mast, and the car started towards Birmingham, making halts by the roadside and testing with Hendon. The speech was excellent up to Edge Hill, but after that it began to fall off somewhat. In general, it would be fair to say that very good speech was obtained up to sixty miles, and fair speech when on high land even as Birmingham was approached.





LONG WAVES FOR TRANSATLANTIC TELEPHONY.

An Interview with M. Marius Latour.

ONSIDERING the recent trend of opinion in favour of the shorter wavelengths for long-distance wireless communication, the views held on this subject by the famous French wireless scientist, M. Marius Latour, are of more than passing interest.

M. Latour, who is at present in New York, is the inventor of a high-frequency alternator, and many other radio devices in general use both in Europe and America. In the course of an interview with a representative of The Wircless World M. Latour discussed the possibilities of a regular telephone service across the Atlantic.

phones will be an ordinary medium of communication in a few years' time. But, instead of the uncertain, low-powered short wave with which most experimenters are now working, I cannot help feeling that the high-powered long-wave station will ultimately be adopted. I admit that occasionally the short wave has proved of immense value, and that for high speed work it is superior to the long wave. Consider, however, the sensitiveness of the short wave to atmospheric conditions, and particularly its susceptibility to fading.

High Broadcasting Wavelengths.

In their long-distance work, do the big American commercial stations experience the same difficulties as the broadcasting stations? Hardly, for they always use high wavelengths, generally in the 10,000 metre band.

Turning to the European broadcasting stations, look at Eiffel Tower, Daventry, Königswusterhausen, Moscow, Radio-Paris, and Radio-Vienna. These are the most popular and well-known in Europe, and their wavelengths are all comparatively high, ranging from 1,000 to 4,000 metres.

M Latour referred to the recent test transmissions between European and American broadcasting stations.

What did these tests prove? According to the Press, pothing. But to me they proved something quite definite, lamely, the value of the long-wave high power station. Practically no one in America heard Daventry, which raismits on 1,600 metres, because American broadcast receivers are tuned to the lower band. For the same reason Radio-Paris and Eiffel Tower were mute. The rests were a failure, the stations on the lower wavelengths rearrely being heard at all.

A Forecast.

observations, that the radio telephone service between London and New York, when it does come, will use a longer wave than has been expected."

M. Latour's forecast on this point is specially noteworthy in the light of the results obtained during the past few weeks in the transatlantic telephony experiments between Rugby and New York.



M. Marius Latour, the celebrated French wireless inventor, who, in the interview reported on this page, expressed the opinion that long waves, rather than short, should be used for transatiantic wireless telephony.

"Recent experience would seem to indicate," said M. Latour, "that a suitable wavelength would lie between 4,000 and 5,000 metres, transmission being of the "carrier-less" type now being investigated by the Bell Telephone Laboratories. It would be necessary, of course, to use high power.

Eliminating Interference.

"One serious drawback might arise from the use of the higher wavelengths, this being interference between stations. The lower wave bands undoubtedly possess the advantage that frequency variations are very great even on a slight variation of wavelength, whereas, with higher wavelengths the frequencies vary but slightly. This would necessitate a limitation in the number of telephone stations working simultaneously.

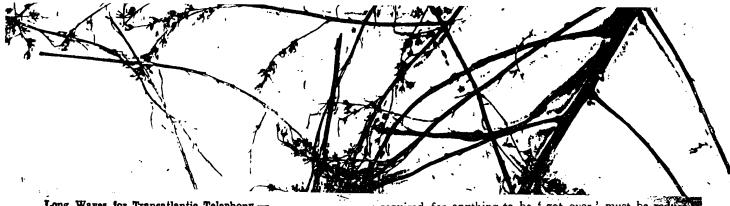
"On the other hand, it must be remembered that directional effects are not impossible on the higher wavebands, and a judicious use of this property would diminish the risk of clashing."

M. Latour propounded an interesting theory regarding the relationships likely to exist in the future between cables and wireless for transatlantic work.

"It seems quite possible," he remarked, "that some

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Long Waves for Transatlantic Telephony.

-day wireless between Europe and America will consist entirely of telephony, while telegraphic work will remain with the cables. While the cables are more suitable for code work, wireless has shown its superiority in the transmission of the human voice. If such a scheme materialised, the higher wavelengths would be free for telephony, another important step in the elimination of interference between stations.'

"Do you consider that it will be possible to secure privacy in wireless telephony conversations?" M. Latour was asked.

"I do not yet know," he replied. "Others are working in this direction and deserve every encouragement, but I should like to see practical proof of some of the claims now being made."

Television.

On the inevitable question of television M. Latour expressed his unhesitating belief in the feasibility of transmitting scenes by wireless.

"The problem is to increase the speed of photo reprohe added. "The four or five minutes now duction,"

required for anything to be 'got over' must be reduce to a twentieth of a second, or less. If I may say so believe I was one of the first to suggest the use of its photo-electric effect of light applied to a metallic electrode to replace the old selenium cell, in which there was far too much inertia.

"Furthermore. I suggested modulating a high-frequence current to obtain an amplified current exactly proportionate to the actual varying output of the cell. Nor we have the potassium cell, and we may hope that some other photo-electric element, having still les inertia, will be discovered. No further basic invention required to make television a success—all that is need is an appropriate photo-electric element.'

At the conclusion of the interview M. Latour state his intention of returning to Europe very shortly resume his wireless researches, which have been held abeyance, owing to his enforced visit to America for in purpose of upholding patent rights.

"Meanwhile," said M. Latour, "remember wh have said regarding long waves for transatlantic te phony. They have been unfairly treated, but they have a great potential value."



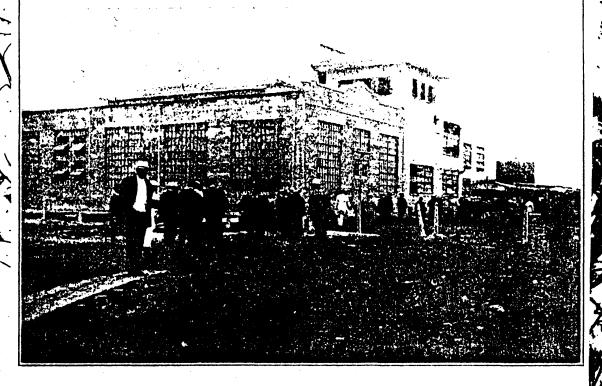






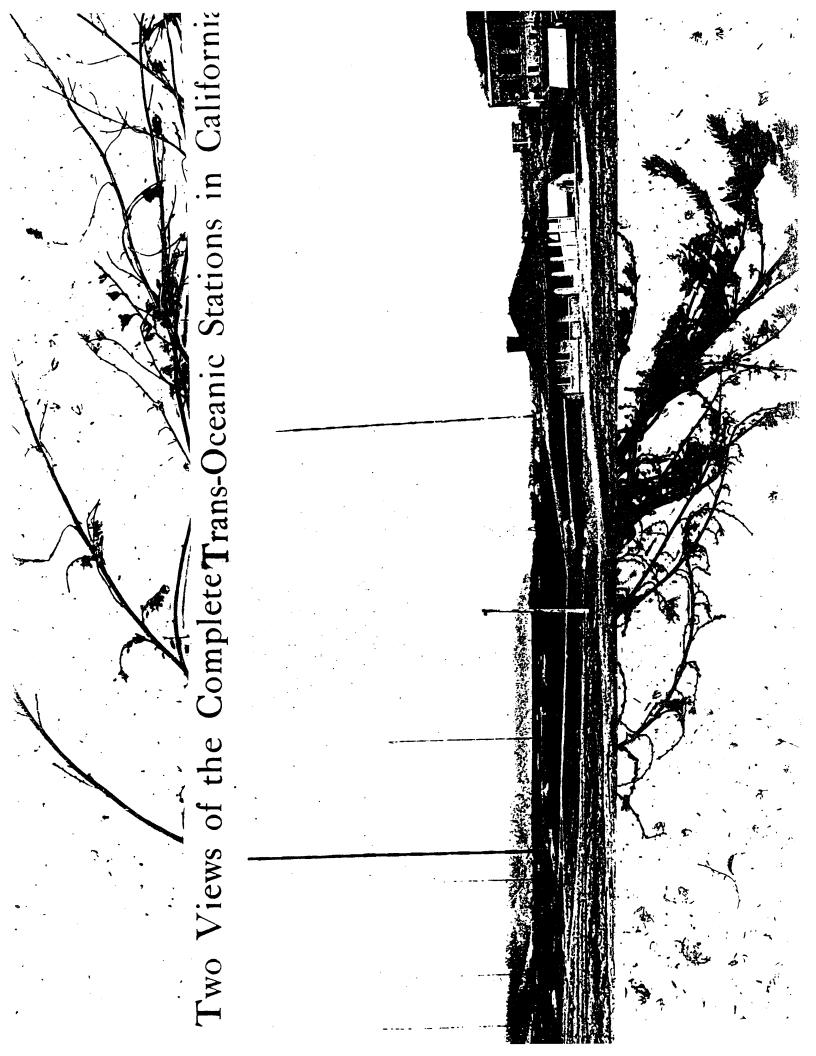




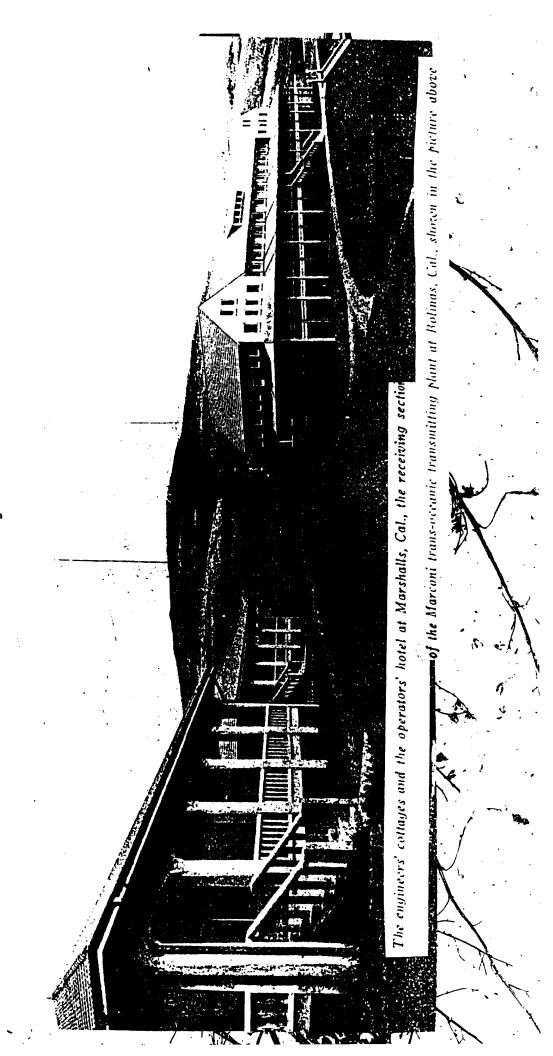


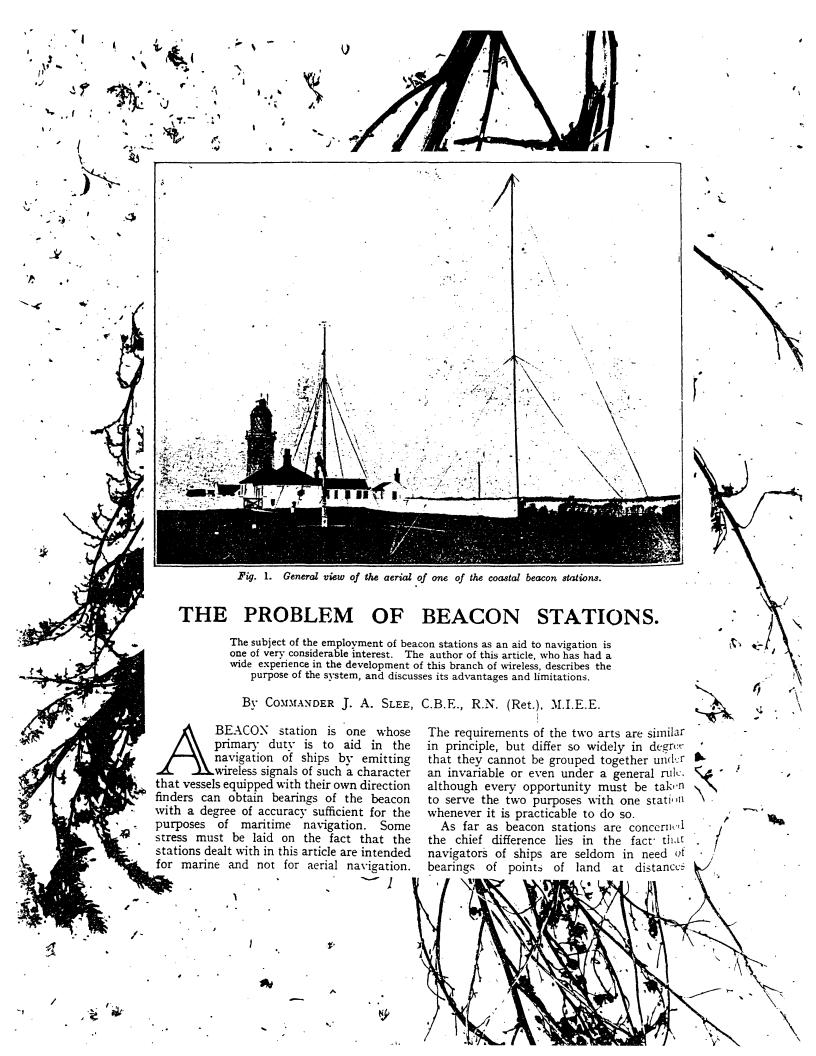
The photograph above and the one belove veere taken on September 21 last, during the ceremonies attending the opening of the Haveaii-California Marconi transoceanic veireless service. Several hundred representative business men, the governor and the mayor attended the lunckeon in fav-off Honolulu, President Wilson and the country's highest state officials sending messages





VIEW OF MARCONI STATION BOLINAS, CALIFORNIA







pearings necessary interrupted continuous wave th

the degree of reliability of bearings necessary for marine navigation, the interruptions must be such that the emission is reduced to zero between the wave-trains.

Experiments show that the proportion between metre-amps and range for interrupted continuous wave transmitters working to modern direction finders is the same as for spark transmitters. It is worthy of note that this figure must be obtained under conditions of accurate direction finding. If the amplifier in use is allowed to reach, or even to approach very closely, to a state of

interrupted continuous wave than for spark, transmission in the proportion of at least two to one.

The site of a beacon station for marine purposes must be chosen with care. It must be placed so that over all the area it is intended to serve no high land shall obtrude between the beacon and the ship making use of it. This requirement can as a rule be met if beacon stations are established at lightships or at lighthouses. If this condition is not fulfilled bearings observed in the arcs covered by what may be called the shadow

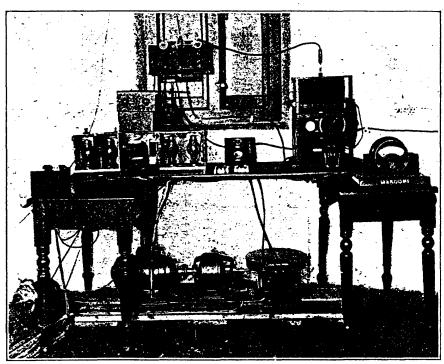


Fig. 2. Spark and C.W. transmitters.

self-oscillation, the bearings observed will be quite unreliable, and this limitation must be strictly adhered to. Interrupted continuous wave is well known to be a highly efficient form of transmission if the receiving amplifier can be worked at or close to the state of self-oscillation, but under direction finding conditions, when this state must be avoided at all costs, no remarkable efficiency of transmission can be expected. With an absolutely non-oscillating and non-integrating receiver, such as a plain crystal, the proportion of metre-amps to miles is higher for

of the obstruction will be erratic. This trouble is one of the chief causes of the inadequacy for the purposes of navigation of the existing wireless stations used for communication with ships. A glance at the "arcs of good bearings" shown in Fig. 3 will make this point clear.

Turning to the form of signal to be transmitted by the beacon, the first requirement is that it shall be possible for ships within range of it to obtain a bearing about once in five minutes, and a duration of transmission of about one minute is sufficient to enable

skilled observer to obtain a series of four

skilled observer to obtain a series of four or five bearings. At a few outlying stations ranges greater than 50 miles may be desirable, and such more powerful beacons might be limited to one period of transmission in 5 or perhaps 10 minutes.

The nature of the signals transmitted must be such that bearings are easy to observe and also such that it is easy to identify the beacon station.

beacon station. protracted Only trial can show what form of signal is preferred by the majority of observers, but the most promising form seems to be the steady repetition at a fair telegraphic speed of a group of three or four letters forming identification the signal of the beacon. The alternative method is to transmit a few repetitions of the identification signal at the beginning, middle, and end of the period of transmission, linked together by prolonged dashes, or by a regular series of dots and dashes.

In order to get an ideal fix, bearings of three beacons should be obtainable in rapid sequence, though in practice two such bearings are of very great value, and the necessity for covering the more important parts

of the narrow seas with the emissions from two or more beacons introduces a fresh complication. The actual operation of all current types of direction finders takes the form of determining the position of some sort of frame when it is receiving zero signals from the beacon under observation. The position of zero reception by a frame occurs when it lies in a plane at right angles to the plane of direction of the source of origin of

the signal, and the position of maximum reception by a frame occurs when it lies in the same plane as the source of origin, the former position being sharply defined and the latter being very broad. Hence, if the instrument is in a position to determine the bearing of any one beacon it will at the same time be receiving maximum signals from any other beacon that may happen to lie at or anywhere nearly at right angles to the

bearing of the station under observation.

If the times of transmission of two neighbouring beacons coincide, the observation of bearings becomes difficult to an unpractised ear, although a skilled telegraphist is capable of taking accurate bearings under such circumstances.

Since it is impossible to synchronise all beacons without most elaborate and costly apparatus, the next best thing is to run neighbouring beacons definitely out of step with one another, making the "one minute" unit of transmission only nominal, but maintaining the intervals of silence at four times of the length of the period transmission.

If the actual timing of one beacon is 65 secs. transmission and 4 mins. 20 secs.

silence, and that of the next beacon 55 secs. transmission and 3 mins. 40 secs. silence, complete clashing of the two is impossible, and they will only interfere seriously with one another three times in each hour.

The characteristic musical note of the signal is governed by the frequency of the motor-alternator supplying the transmitter with power, and if standard alternators are used for all beacons the variation in timing §

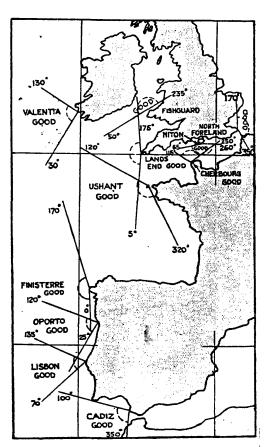
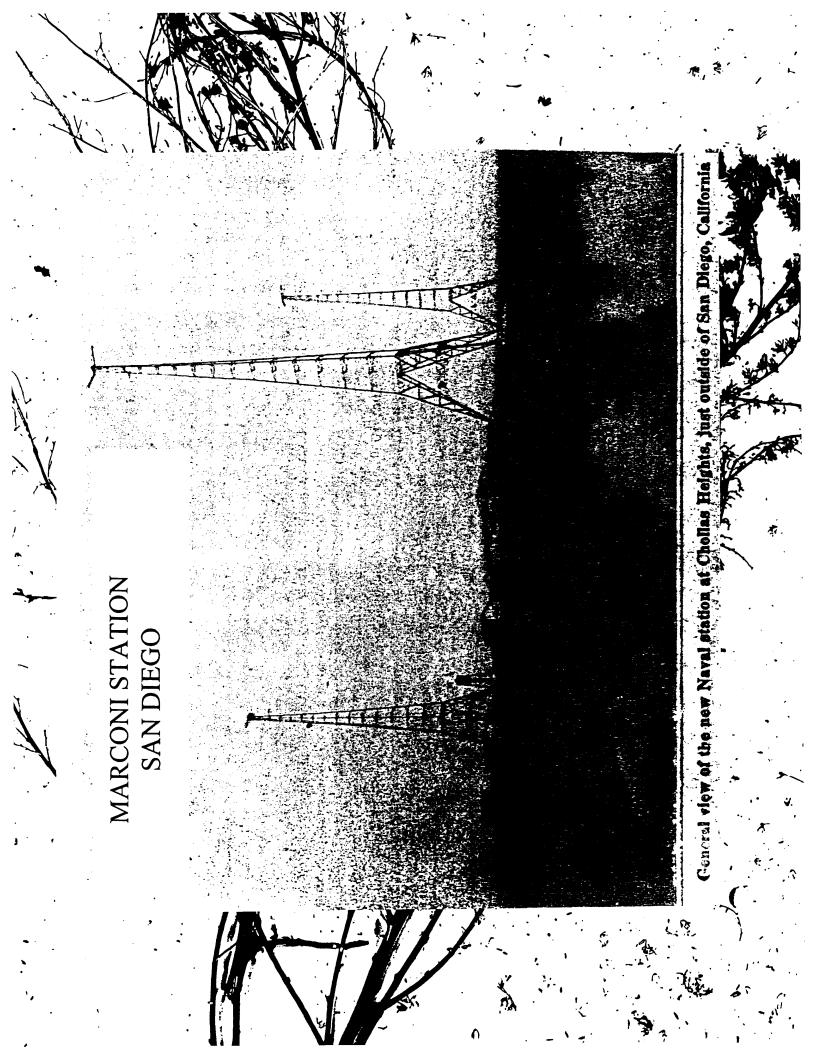


Fig. 3. Arcs of good bearings.





just described can be achieved by running as to be economically impossible. The the machines at different speeds. This will necessity for beacon stations is not always impart quite distinct notes to the various due to fog alone. A prolonged spell of signals, and will greatly facilitate the task cloudy weather may have deprived shipping of picking out the signals of one beacon from those of another. If beacons are of astronomical observations for some days before approaching the land, and in such cases one or more direction finder bearings worked on this system, there is nothing to be gained by attempting accurate timing. are of the greatest use in making a It would, of course, be of advantage if landfall. neighbouring beacons could make use of The apparatus required to produce an emission of 35 metre-amps is quite simple. distinctly different waves, but it is clear from the above that the service can be The power that must be supplied to the carried out with one wave, and the congestion aerial is not likely to exceed 100 watts even Fig. 4. The Austin automatic power plant. under most adverse conditions, and the of modern wireless traffic makes it much direct current power required for all purposes easier to allot one wave for this purpose should not exceed 400 watts when the than to find two. As the typical beacon station can be beacon is transmitting, and about half this amount during the periods of silence. expected to have a working range of 50 miles, The photographs show the prime mover. and as it is impossible for a man in charge transmitters and aerial, employed during of a beacon to know what the weather is like experiments just concluded at the lighthouse 50 miles to seaward, the only practicable at Nash Point, in the Bristol Channel, which plan is to keep the beacons always working. has been made available by Trinity House A satisfactory system of communication for the long series of experiments which have ships requiring the use of whereby been necessary to clear up the various points beacons could ask for them to be explained in this article. started implies the use of so large a staff



For grounding there has been put down approximately 25 miles of piping and copper cable within the 72 acres comprising the radio reservation

At the station have been erected a group of six buildings in mission style to be used as quarters for the officers and enlisted men on duty and the housing of the sending and receiving instruments and the generators

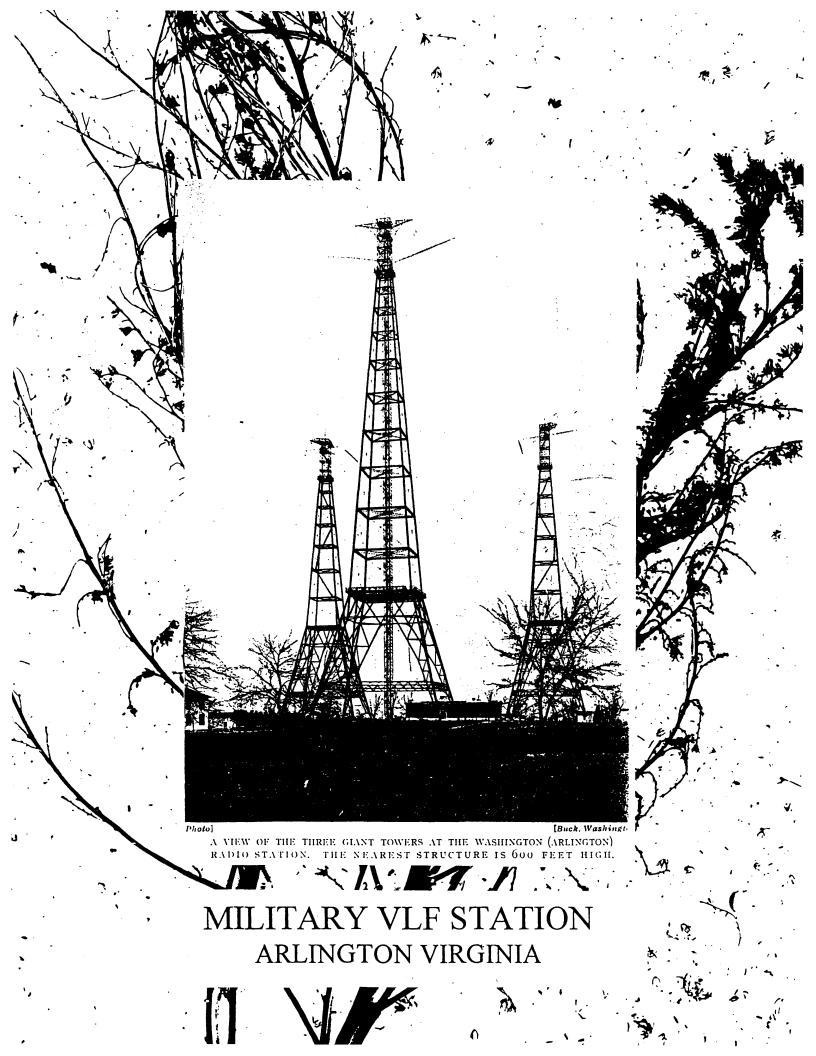
The radio apparatus installed is known as the Poulsen system of radio transmission, invented 11 years ago by Valdemar Poulsen, the patent rights for which in the United States are held by the Federal Telegraph Company. The Poulsen system employs a direct current arc of from 600 to 1,000 volts; burning

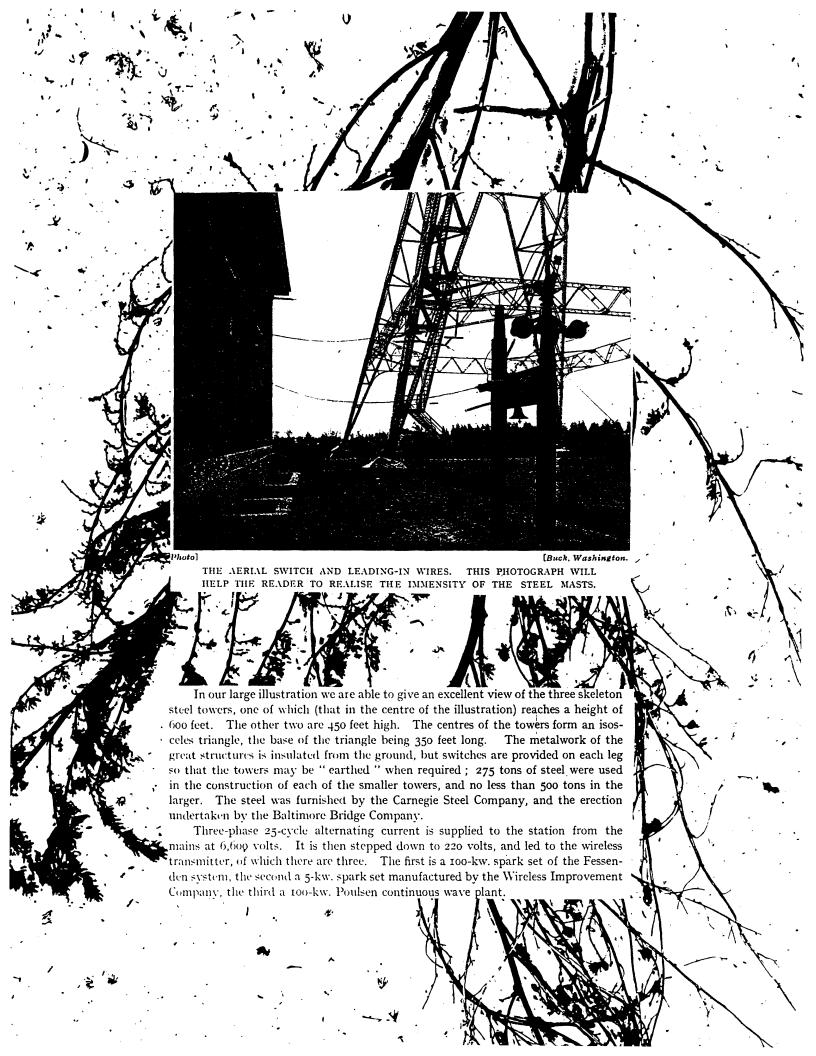
in a closed chamber of hydrogen, the terminals being placed at right angles in a powerful magnetic field. A 200-kilowatt, 1000-volt direct current generator, driven by a 300-horse-power, 2200-volt 60-cycle induction motor. furnishes the electric current for the set.

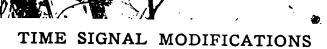
The San Diego station represents an expenditure by the Government of \$300,-000, and about two years have been occupied in the erection and equipping of the plant. The station has the necessary powerful apparatus for sending messages over a distance of 12,000 miles, and can receive from a like distance. The messages between the station and Arlington on the opening day were sent by Lieut.-Commander Hooper, who used a silver-plated telegraph key prepared for the occasion and later presented to him as a souvenir. Lieut. John Ashley will be the commanding officer of the San Diego atation, and will have a capable corps of radio electricians under him in carrying out the station's work

MARCONI GROUND SYSTEM SAN DIEGO









THE Superintendent of the U.S. Naval Radio Service, under date of June 10, 1914, announces certain changes of wave lengths used in sending time signals. These signals will hereafter be sent by the Naval radio stations as follows:

Station. Arlington, Va	meters. 2,500
Key West, Fla. New Orleans, La.	
North Head, Wash	2,000
Eureka, Cal. Point Arguello, Cal. San Diego, Cal Mare Island, Cal.	750 2,000

If for any reason the Arlington station is out of commission, the time signals will be sent daily at noon, Sundays and holidays excepted, by the Naval radio

stations at Newport, New York, Norfolk, and Charleston.

The time is sent from the Naval Observatory, Washington, for the Atlantic coast and from the observatory at Mare Island Navy Yard for the Pacific coast.

When sent.

Daily at 11.55 a. m. to noon and 9.55 to 10 p. m., Standard Time, 75th meridian

Same as Arlington.

Daily, 11.55 a. m. to noon, Standard Time, 75th meridian.

Daily, except Sundays and holidays, at 11.55 a. m. to noon, Standard Time, 120th meridian.

Same as North Head.

Do.

Do.

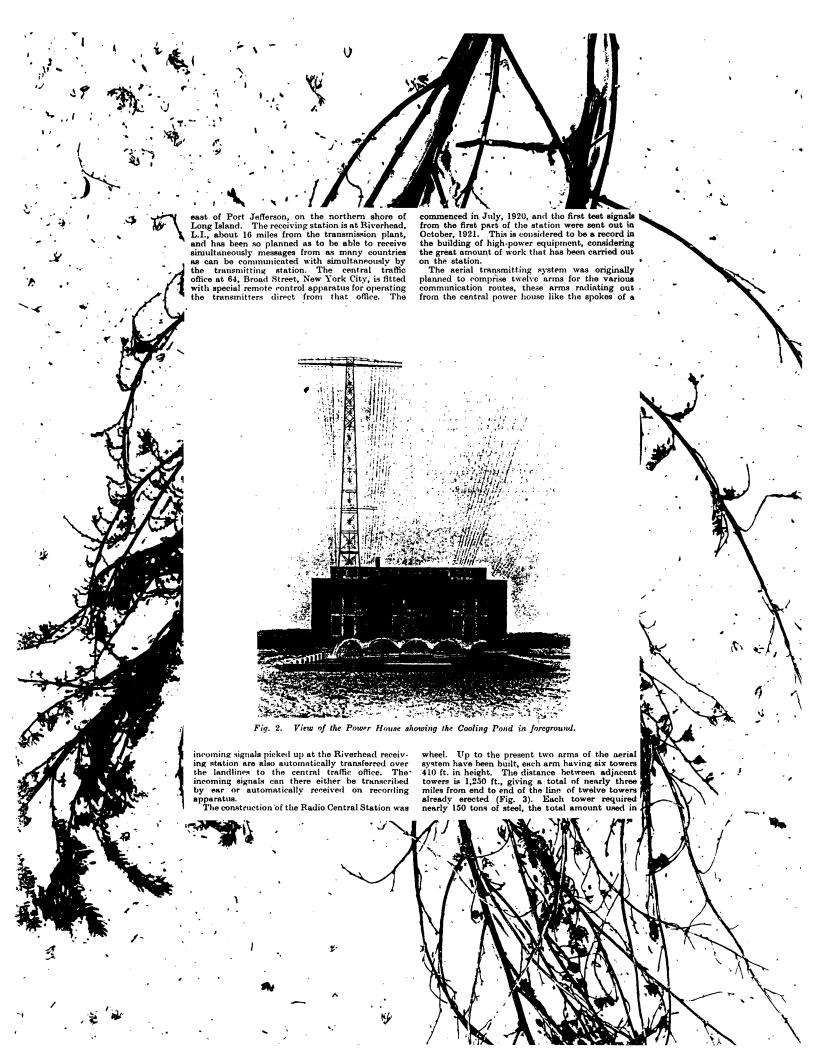
Every day at 11.55 a. m. to noon and 9.55 to 10 p. m., Standard Time, 120th meridian.

This modifies the information relating to this service published on the Pilot Chart of the North Atlantic Ocean for August, 1913.



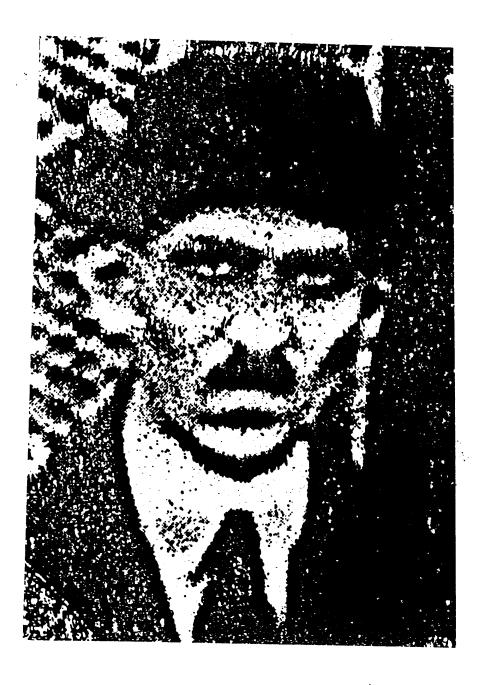




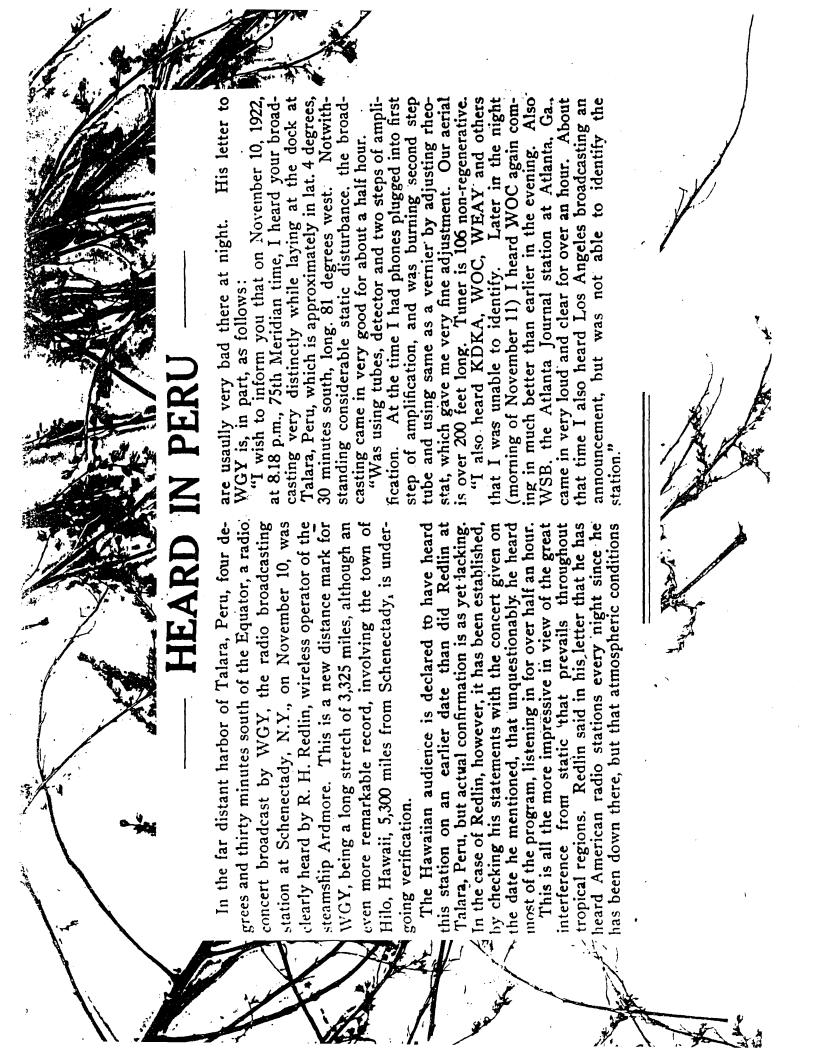








NIKOLA TESLA
NEW BRUNSWICK, NEW JERSEY
MARCONI WIRELESS STATION





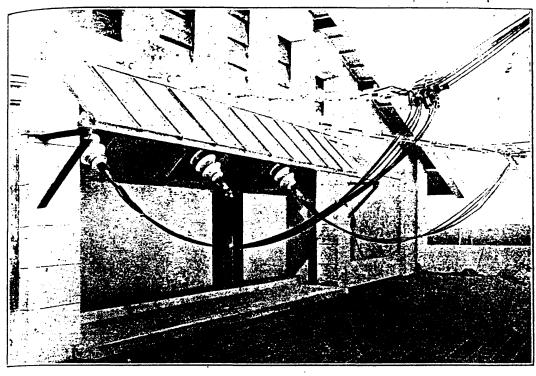


Fig. 2. Aerial lead-in to the transmitter building, showing the method of support.

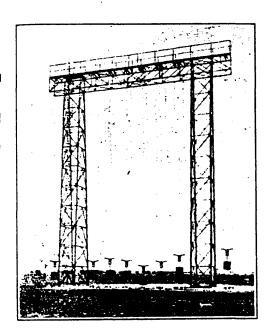


Fig. 3. Counter-weights to maintain the requisite tension on the aerial wires.

Six of the masts are built by the Telefunken Company, and the remaining four by the French company, C.T.S.F. The aerial is supported in some 200 places, and 1,000 insulators are used for this purpose. The masts which support the aerial wires are in pairs, with supports of steel cables run between them. These supports carry the aerial wires, which are on insulated rollers, and at either end of the aerial the wires are weighted as shown in the photograph, Fig. 3. these weights being 40 kg. each, and serving to maintain the requisite tension and to compensate for any variation in the length of the aerial wires due to differences of temperature. It is perhaps difficult when one is in the habit of thinking of aerial wires of, say, 100 ft. in length, to realise the enormous strain which can result from expansion or contraction of the wires constituting the aerial system of one of the high power stations.

By employment of the compensating weight, these differences in length due to variations in temperature are self-adjusting

without exercising any additional strain either on the aerial wires themselves or on the supporting masts.

The earthing arrangement consists of a buried network, and in addition, overground wires supported at a height of 10 metres from the ground. Fig. 1 shows the appearance of the main building, which is of an architecture similar to that adopted by most of the designers of modern high power stations. The central power station at Buenos Aires provides the electrical power for operating the station. On arrival at the station the supply is transformed down from 12,500 volts to 3,200 volts, and supplies two motors, which drive the dynamo and other machinery utilised in the equipment of the station.

Two high frequency machines are installed, one being employed for transmission whilst the other is in reserve. The high frequency generator gives an output of 1,000 amperes, 750 volts at a frequency of 6,000. Fig. 2 shows the method employed for leading in the aerial wires to the transmitting room. Fig. 4 gives an indication of the method of

supporting the aerial lead-in as it is brought to the station in order that all strain should be removed from the actual leads as they

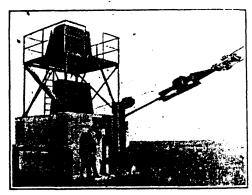


Fig. 4. Anchorage for the aerial lead-in.

enter the building. Fig. 5 is a view taken inside the transmitting building. Fig. 6 shows the interior view of the receiving station at Villa Elisa.

The station which is now conducting

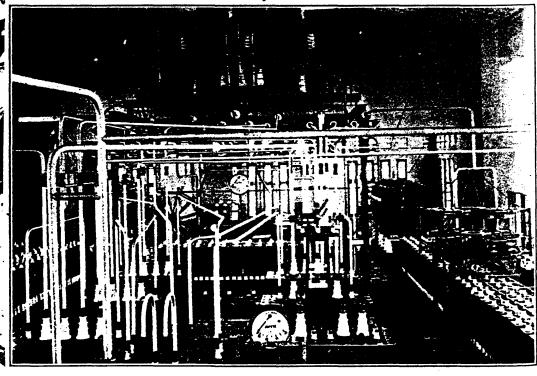
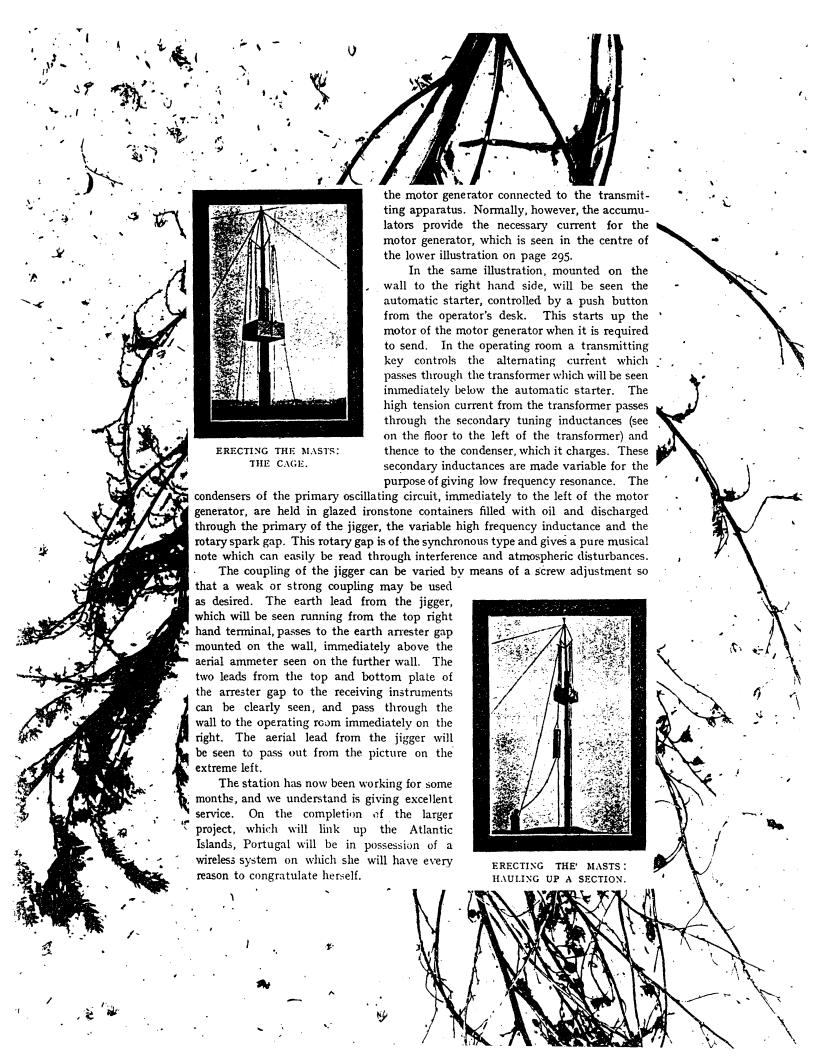
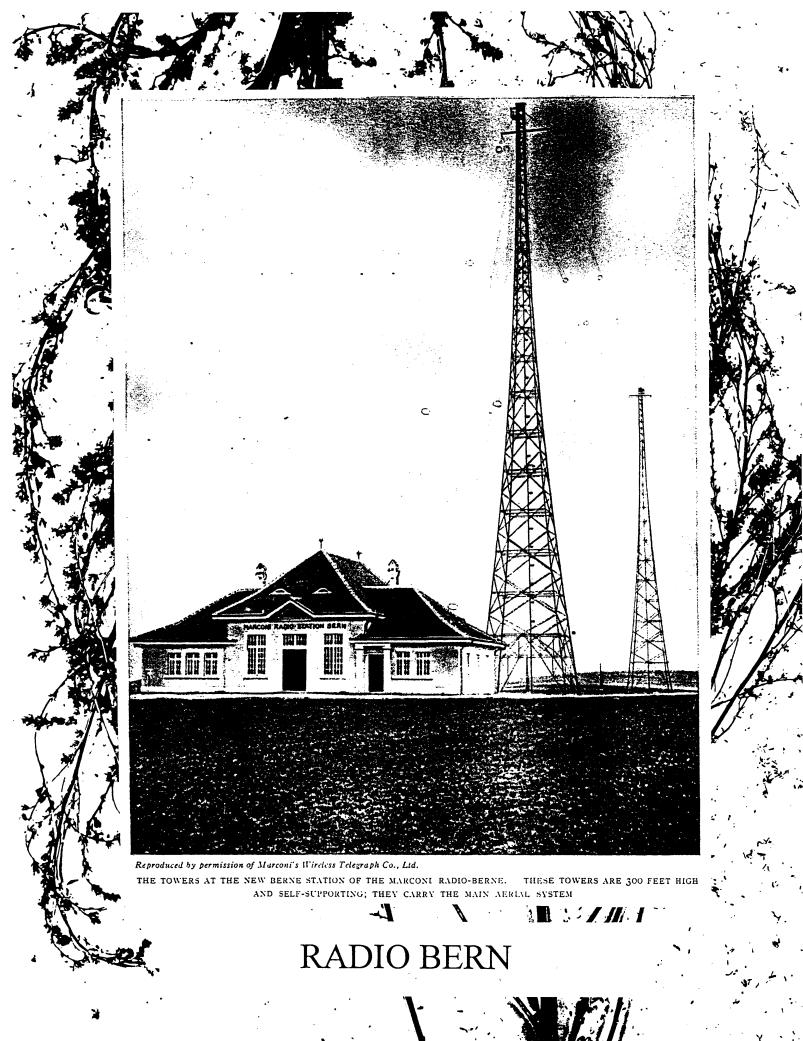


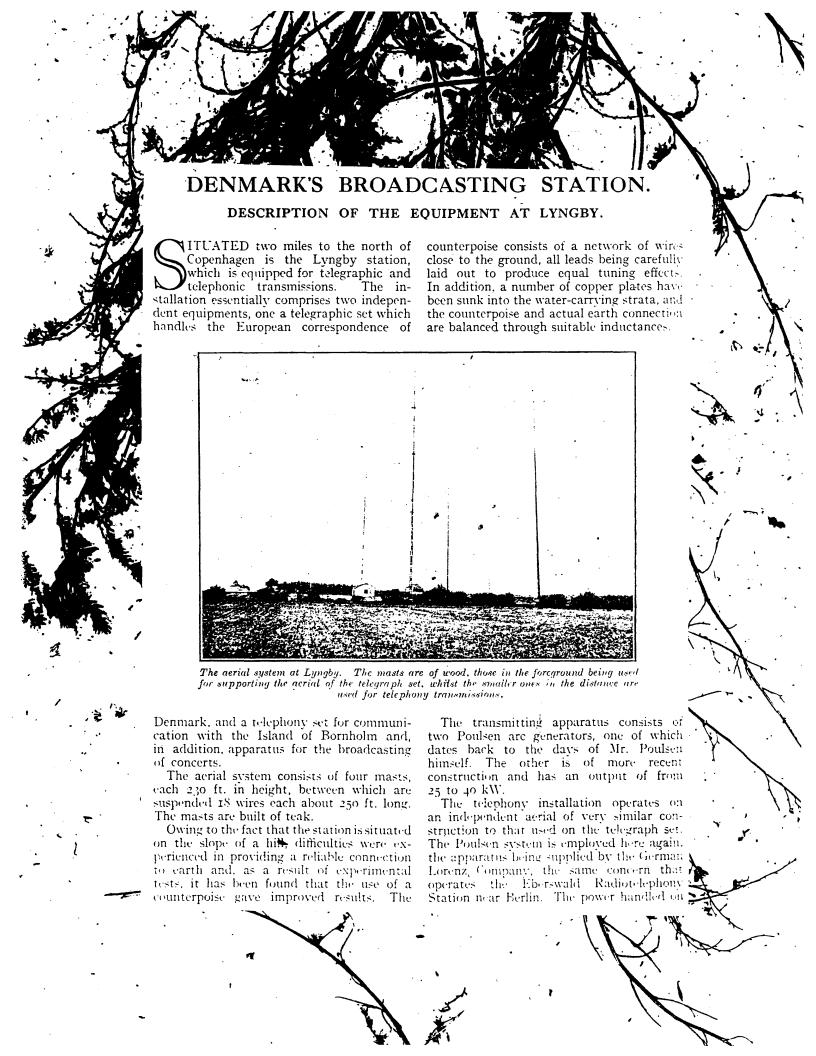
Fig. 5. Interior of the station building.









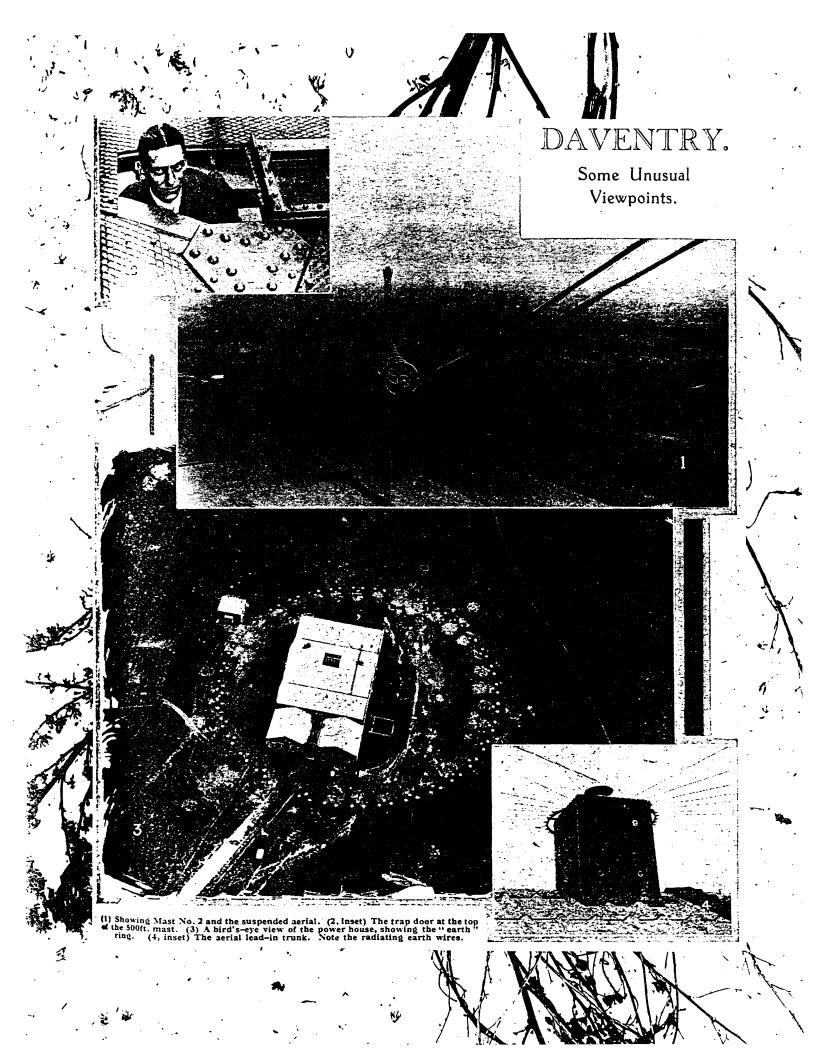


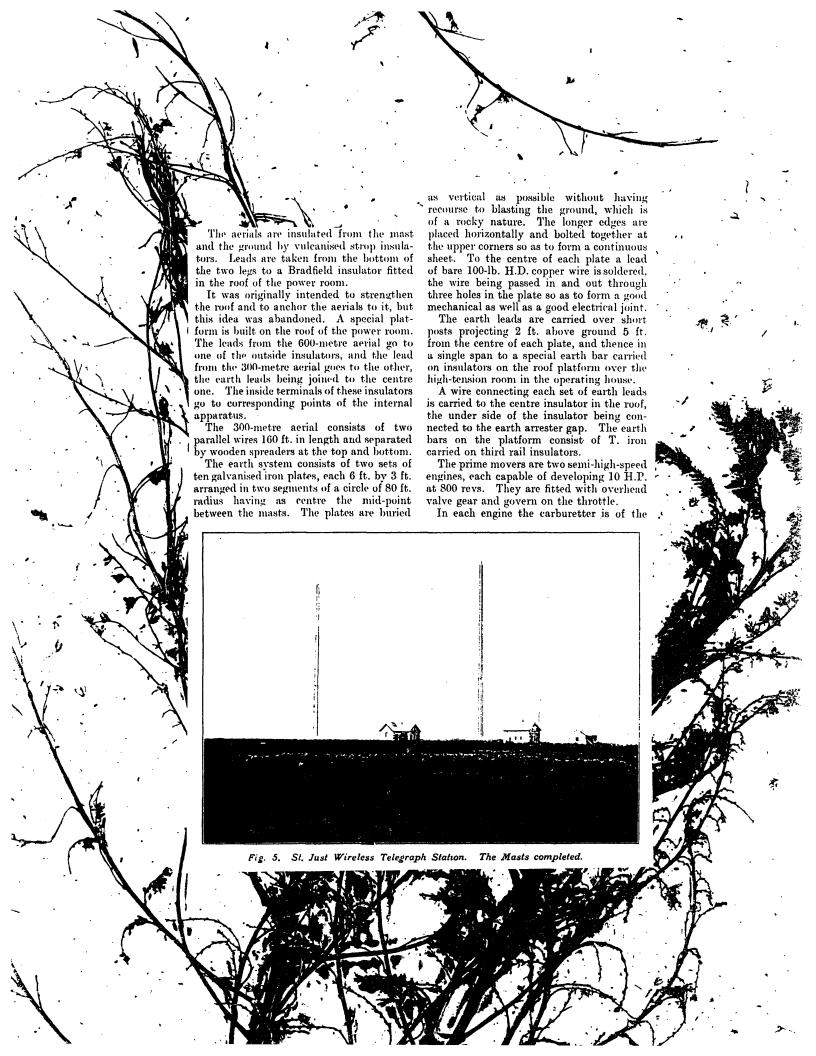
















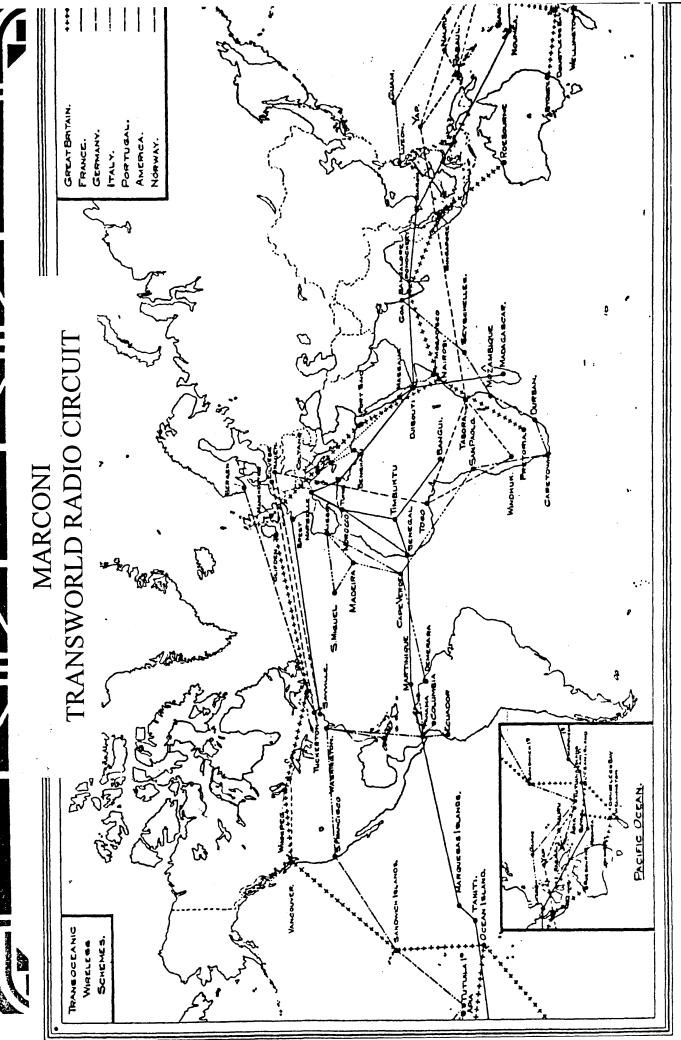
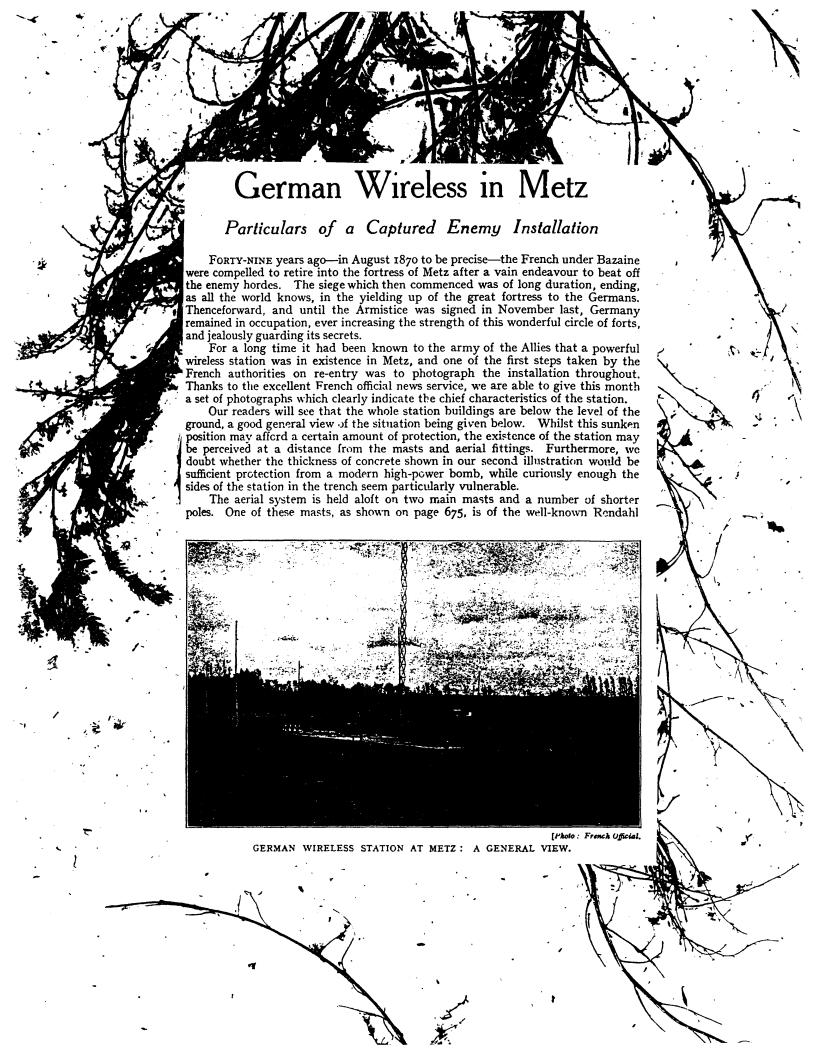


Fig. 154.—Trans-Oceanic wireless schemes.







The Field of 2LO

Signal Strength Distribution Over the Home Counties.

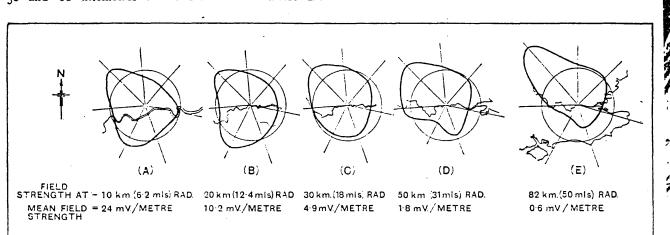
By W. H. F. GRIFFITHS, A.M.I.E.E., Mem.I.R.E.

N a recent article in this journal, by R. H. Barsield, an excellent contour map of 2LO was given. All kinds of maps are fascinating, especially to those possessing a bent for geography, and contour maps are, perhaps, the most fascinating of all. Who among the scientifically minded has not experienced a thrill upon being shown, for instance, the contour model or map of an ocean bottom?

The field strength contour of a popular broadcasting station should appeal equally to one's imagination inasmuch as it portrays that which can be measured, though it cannot be apprehended directly by any of the senses—a charting of the unseen.

If the field strength over the whole area served by a broadcasting station is to be shown on a single map there is no other manner in which to do so but by means of contours. Unfortunately, this method does not always give the true situation at a glance, due to the fact that the law connecting field strength with distance is non-linear. If, however, a single diagram be drawn to show the field strength at every point at a constant distance from the station, conditions at this distance are much more quickly apprehensible. In this way, using the data given in Mr. Barfield's article and in the paper read by him before the Institution of Electrical Engineers, diagrams have been drawn showing the field strength at 10, 20, 30, 50 and 82 kilometres radius from 2LO. These are

given in Fig. 1, A to E respectively. The radial dimension in any direction is proportional to the field strength obtained in that direction, the diagrams being plotted to varying scales so that, whatever the distance from the station, the representation of mean field strength is constant. The thin circles represent this mean strength and help in quickly forming an idea of the reception conditions prevailing in any particular direction at a given



distance from the station.

Fig. 1.—Γield strength contours of 2LO for various distances up to 50 miles.

The Field of 2LO .-

The great difference, at this distance from London, between reception conditions in northwesterly and south-westerly directions not being emphasised by the corresponding contours. Whereas with a glance at Fig. 1, E, it can at once be confirmed that Hampshire and West Sussex are "dead spots" to reception from 2LO.

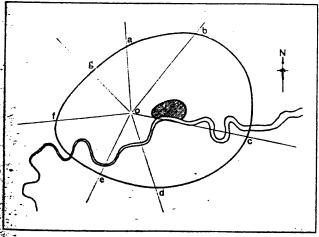


Fig. 2.—The densest part of London is here shown as an eggshaped area to the east of 2LO.

Although the diagrams are not plotted to a distance scale, the River Thames, and in some cases a portion of the coast line, may be included, if desired, to a scale bearing some relation to the radius for which the diagram is plotted in order to simplify comprehension still further. The scale of the map drawing can, for example, be fixed conveniently by making the mean field strength circle correspond with the distance circle at which the field strength is being shown

Each diagram can be made complete, quantitatively, by stating the value of mean field strength.

In any particular direction, moreover, the rate of attenuation above or below the normal value, due to local variations of the earth's surface, can be at once judged by noting the movement of the field strength curve relative to the circumference of the mean circle at that point in successive diagrams.

The Attenuation Due to a City.

In his article and paper Mr. Barfield deals very completely with the effect of well-wooded country upon attenuation, but there appears to be required some explanation for the want of uniformity of the initial attenuation at close range before reaching the really well-wooded parts.

The only explanation (except for slight directional effects of the transmitting aerial) can be that of a reduction of apparent surface conductivity due to absorption by the more or less conducting structures in the more densely constructed parts of the Metropolis. As a crude approximation, the densest part of London can be represented as an egg-shaped area with the City of London as its centre, as shown in Fig. 2. In this figure the position of 2LO is indicated as the centre from which the radial lines of transmission are drawn corresponding with the directions taken by Mr. Barfield. If the lengths oa. ob, oc, etc., of these lines be measured and their reciprocals be plotted in the same directions, a diagram (Fig. 3) somewhat like that of Fig. 1, B, is obtained. That is to say, it corresponds with the field strength actually obtained at a radius of 12.4 miles—the point where all City absorption has ceased, but before any very great vegetation absorption takes place. It is not claimed that this is sufficient proof of the initial uneven attenuation by the City, but it must, it is thought, have some bearing upon the matter.

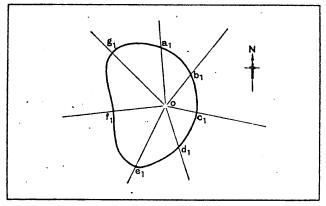
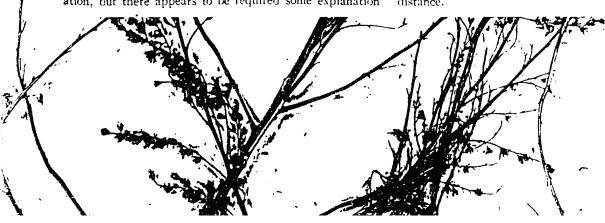


Fig. 3.—If oa, ob, oc, etc., n Fig. 2 be measured and their reciprocals plotted in the same directions, a diagram like Fig. 1, B, is obtained.

In conclusion, it should perhaps be mentioned that tests in a direction E.S.E. of London at a radius of about 10 miles, in October of last year, gave a field strength of 12 millivolts per metre. The tests were made by measuring the resonance volts across an inductance in series with an aerial of known constants, and the result apparently agrees well with the value given by Mr. Barfield for this distance.



April, 1923

MODERN WIRELESS

TIMES OF REGULAR TRANSMISSIONS

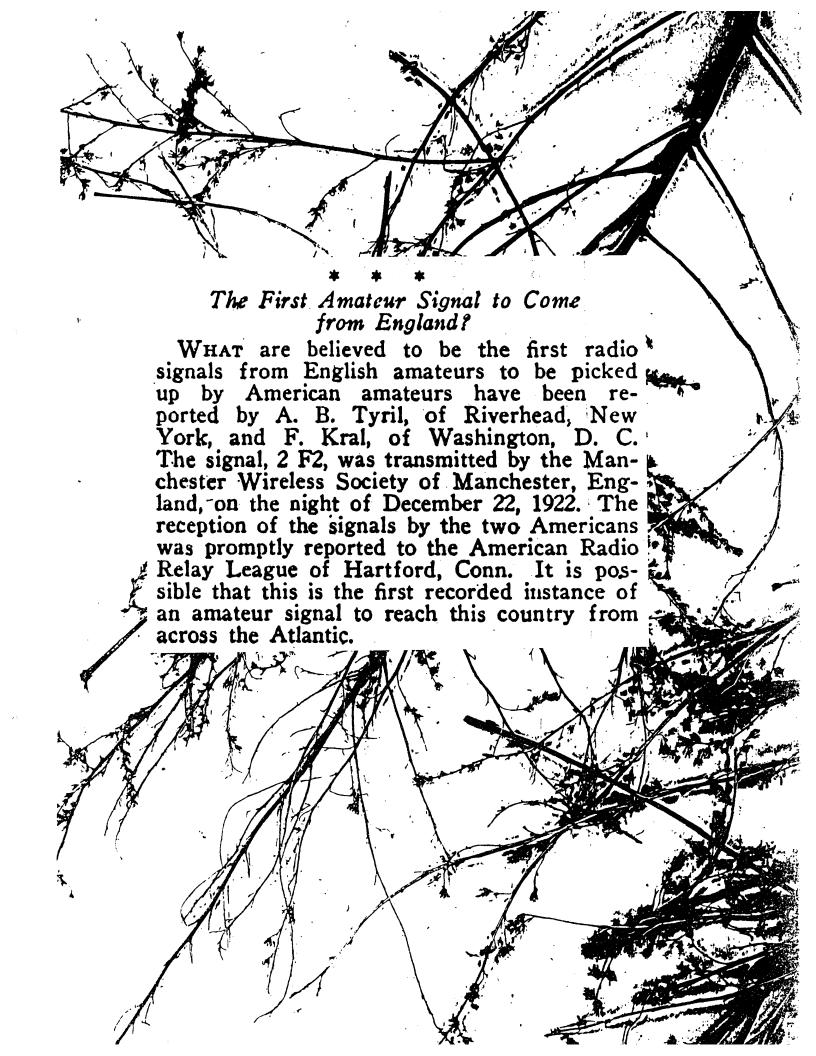
This list, though short, includes only those stations actually heard in England.

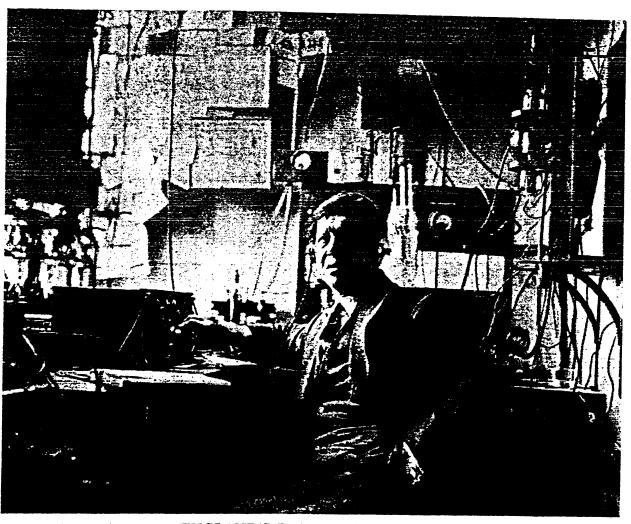
TIME CALL-	NAME OF STATION.	WAVELENGTH.	TIME	CALL-	NAME OF	STATION.	WAVELENGTH
(G.M.T.) SIGN.			(G.M.T.)	SIGN.			
Mid-		and the second s	1425	OPO	Brussels		1,680 C.W.
night GBL	Leafield Paris	, 8,750 C.W.	1428	$\mathbf{Z}\mathbf{M}$	Le Bourget		1,680 C.W.
0005-} FL	Paris		1430	YN	Lyons		15,000 C.W.
0205		7,000	1435	GFA	Air Ministry		1,680 C.W.
oroo POZ	Nauen	12,000 C.W.	1435	FL	Paris		6,500 C.W.
oroo ICI	Guglielmo Marconi (Coltano) Leafield	∴ 5,250 C.W.	1500	FL	Paris/		7,300 C.W.
0120 GBL	Leafield Northolt Air Ministry Nantes	8,750 C.W.	1500-)	FL	Paris		7,000 C.W.
0200 GKB	Northolt	6,850 C.W.	1600		_		
0200 GFA	Air Ministry	4,100 C.W.	1505	STB	Soesterburg		1,680 C.W.
0230 UA	Nantes	9,000 C.W.	1525	OPO	Brussels		1,680 C.W.
0300 HB	Dudapest		1528	ZM	Le Bourget		1,680 C.W.
ogr5 FUA	Bizerta	5,150 C.W.	1535	GFA	Air Ministry		1,680 C.W.
0330 FL	Paris Nontes	6.500 C.W.	1625	OPO ZM	Brussels		1,680 C.W.
0400 UA 0430 FL	Nantes Paris	9,000 C.W. 7,400 C.W.	1628	GFA	Le Bourget		1,680 C.W. 1,680 C.W.
	Guglielmo Marconi (Coltano)	5,250 C.W.	1635		Air Ministry		•
0550 ICI 0600 GFA	Air Ministry	4,100 C.W.	1715-}	FL	Paris		7,000 C.W.
0600 IDO	Rome	11,000 C.W.	1800	POZ	Nauen		6,500 C.W.
0635 LP	Berlin (Königswusterhausen)		1800	FL	Paris		6,800 C.W.
0650 LP	Berlin (Königswusterhausen)	5,250 C.W.	1830	POZ	Nauen		9,000 C.W.
0700 POZ	Nauen		1830	STB	Soesterburg		1,680 C.W.
0700 FL	Paris	3,200 C.W.	1900	OUI ·	Hanover		9,500 C.W.
0715 FL	Paris		. 1900	GFA	Air Ministry	. •	4,100 C.W.
0730 ŪĀ	Nantes	9,000 C.W.	1900-		·		
0735 GFA	Air Ministry	1,681 C.W.	1930	FL	Paris		7,000 C.W.
9740 SAJ	Karlsborg	4,300 C.W.	1945	CNM			5,000 C.W.
0750 BUC	Bucharest	7,500 C.W.	1955	LY	Bordeaux		23,500 C.W.
o8oo EAA	Aranjuez	6,700 C.W.	2000	GBL	Leafield		8,750 C.W.
o8oo GFA	Air Ministry	4,100 C.W.	2000	SAJ	Karlsborg		2,500 Spark
0835 GFA	Air Ministry	1,680 C.W.	2000	EGC	Madrid		1,600 Spark.
0840 LP	Berlin (Königswusterhausen)	5.250 C.W.	2015	LY	Bordeaux		23,500 C.W.
0845 CNM		5,000 C.W.	2015-1				
0850 GFA	Air Ministry	4.100 C.W.	2200	FL	Paris		7,000 C.W.
0850 LP	Berlin (Königswusterhausen)	5.250 C.W.	2030	EGC	Madrid		2,000 Spark.
0855 STB	Soesterburg	1,680 C.W.	2045	IDO	Rome		11,000 C.W.
0904 YN		. TS 000 C.W.	2130	LY	Bordeaux		23,500 C.W.
0915 GFA	Air Ministry	4,100 C.W.	2200	FL	Paris		2,600 Spark.
0923-1					Nantes		9.500 C.W.
0923- 0930 FL	Paris	2,600 Spark.	2230.	UA	Nantes Paris		9,500 C.W. 2,600 Spark.
0930		2,600 Spark.	2230. 2235	UA FL	Paris		2,600 Spark.
0930 FL	Paris		2230 2235 2236-}	UA FL FL			
0930 FL 0925 FL 0928 ZM		2,600 Spark. 2,600 Spark.	2230 2235 2236- 2249	UA FL	Paris		2,600 Spark.
0930 FL 0925 FL 0928 ZM 0930 IDO	Paris Le Bourget	2,600 Spark. 2,600 Spark. 1,680 C.W.	2230 2235 2236-}	UA FL FL	Paris Paris		2,600 Spark. 2,600 Spark.
0930 FL 0925 FL 0928 ZM 0930 IDO 0935 GFA	Paris Le Bourget Rome Air Ministry	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 1,680 C.W.	2230 2235 2236-} 2249	UA FL FL FL	Paris Paris Paris		2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark.
0930 FL 0925 FL 0928 ZM 0930 IDO	Paris Le Bourget Rome	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 1,680 C.W. 2,600 Spark.	2230 2235 2236- 2249 2244 2300	UA FL FL IDO	Paris Paris Paris Rome		2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W.
0930 FL 0925 FL 0928 ZM 0930 IDO 0935 GFA 0958-	Paris Le Bourget Rome Air Ministry	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark.	2230 2235 2236-} 2249 2244 2300 2315 2330	UA FL FL IDO PCH POZ	Paris Paris Paris Rome Scheveningen Nauen		2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark.
0930 FL 0925 FL 0928 ZM 0930 IDO 0935 GFA 0958- 1015 FL	Paris Le Bourget Rome Air Ministry Paris	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 1,680 C.W. 2,600 Spark. 2,600 Spark. 3,200 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330	UA FL FL IDO PCH POZ ing almo	Paris Paris Paris Rome Scheveningen Nauen st continuously:		2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W.
0930 FL 0925 FL 0928 ZM 0930 IDO 0935 GFA 0958- FL 1015 FL	Paris Le Bourget Rome Air Ministry Paris Paris	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark.	2230 2235 2236-} 2249 2244 2300 2315 2330	UA FL FL IDO PCH POZ ing almo	Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris		2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W.
0930 FL 0925 FL 0928 ZM 0930 IDO 0935 GFA 0958- 1015 FL 1000 FL	Paris Le Bourget Rome Air Ministry Paris Paris Paris	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,600 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 3,200 C.W. 1,680 C.W. 2,600 Spark.	2230 2235 2236-} 2249 2244 2300 2315 2330	UA FL FL IDO PCH POZ ing almo FL GB	Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay		2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 8,000 C.W. 7,850 C.W.
0930 FL 0925 FL 0928 ZM 0930 IDO 0935 GFA 0958- 1015 FL 1000 FL 1003 FL 1025 FL 1035 FL	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 3,200 C.W. 1,680 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330	UA FL FL IDO PCH POZ ing almo FL GB GBL	Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield		2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 8,000 C.W. 7,850 C.W.
0930 FL 0928 ZM 0930 IDO 0935 FL 1015 FL 1000 FL 1028 ZM 1035 FL 1035 FL 1036 FL	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 3,200 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330	UA FL FL IDO PCH POZ ing almo FL GB GBL GKU	Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes		2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 8,750 C.W. 2,100 C.W.
0930 FL 0925 FL 0926 ZM 0930 IDO 0935 GFA 0958 FL 1000 FL 1028 ZM 1035 GFA 1036 FL	Paris Le Bourget Rome Air Ministry Paris Paris Le Bourget Paris Air Ministry	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,600 C.W. 2,600 Spark. 2,600 Spark. 3,200 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330	UA FL FL IDO PCH POZ ing almo FL GB GBL GKU GLA	Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar		2,600 Spark. 2,600 Spark. 1,000 C.W. 1,800 Spark. 12,600 C.W. 1,800 C.W. 7,850 C.W. 2,100 C.W. 2,100 C.W.
0930 FL 0925 FL 0928 ZM 0930 IDO 0935 GFA 0958 FL 1015 FL 1000 FL 1028 ZM 1035 FL 1035 GFA 1036 FL 1044 FL	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Paris	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 3,200 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 2,600 Spark.	2230 2235 2236-} 2249 2244 2300 2315 2330	FL FL IDO PCH POZ ing almo FL GB GBL GGLA GLB	Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar		2,600 Spark. 2,600 Spark. 1,000 C.W. 1,800 Spark. 12,600 C.W. 8,000 C.W. 7,850 C.W. 2,100 C.W. 2,900 C.W.
0930 FL 0928 ZM 0930 IDO 0935 FL 1015 FL 1000 FL 1028 ZM 1035 FL 1035 FL 1036 FL 1049 FL 1049 FL 1050 ZM	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Le Bourget	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 3,200 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark.	2230 2235 2236-} 2249 2244 2300 2315 2330	UA FL FL FL IDO PCH POZ ing almo FL GBL GKU GLA GLB GLB GLO	Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar		2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 2,100 C.W. 2,100 C.W. 2,900 C.W. 3,800 C.W.
0930 FL 0928 ZM 0930 IDO 0935 GFA 0958 FL 1000 FL 1028 ZM 1035 FL 1035 FL 1036 FL 1044 FL 1054 FL 1055 ZM 1115 PCH	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Le Bourget	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 3,200 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark.	2230 2235 2236-} 2249 2244 2300 2315 2330	UA FL FL FL IDO PCH POZ ing almo FL GBL GCH GCH GCH GCH GCH GCH GCH GCH GCH GCH	Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven		2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 8,750 C.W. 2,100 C.W. 2,900 C.W. 4,350 C.W.
0930 FL 0925 FL 0926 GFA 0930 IDO 0935 GFA 1015 FL 1000 FL 1003 FL 1028 ZM 1035 FL 1035 GFA 1036 FL 1044 FL 1050 ZM 1115 PCH 11128 ZM	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Le Bourget Paris Le Bourget Paris Le Bourget	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 3,200 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 1,680 C.W. 1,680 C.W. 1,680 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330	UA FL FL FL IDO PCH POZ ing almo FL GBL GCH GLA GLB GLO GLW LCM	Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger		2,600 Spark. 2,600 Spark. 1,000 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 8,750 C.W. 2,100 C.W. 2,900 C.W. 3,800 C.W. 4,350 C.W.
0930 FL 0928 ZM 0930 IDO 0935 FL 1015 FL 1000 FL 1028 ZM 1035 FL 1035 GFA 1036 FL 1049 FL 1050 ZM 1115 PCH 1128 ZM 1130 FL	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Le Bourget Paris De Bourget Paris Le Bourget Paris Le Bourget	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 3,200 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 1,680 C.W. 1,680 C.W. 1,600 Spark. 1,680 C.W. 1,600 Spark. 1,680 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330	FL FL IDO PCH POZ ing almo FL GBL GKU GLA GLB GLO GSW LCM LDO	Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome		2,600 Spark. 2,600 Spark. 1,000 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 2,100 C.W. 2,100 C.W. 2,900 C.W. 3,800 C.W. 5,000 C.W.
0930 FL 0928 ZM 0930 IDO 0935 GFA 0958 FL 1000 FL 1003 FL 1028 ZM 1035 FL 1049 FL 1050 ZM 1115 PCH 1128 ZM 1135 GFA	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Le Bourget Paris Le Bourget Paris Le Bourget	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 3,200 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 1,680 C.W. 1,680 C.W. 1,680 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330	UA FL FL FL IDO PCH POZ ing almo FL GBL GLA GLB GLO GSW LCM MUU	Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon		2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 2,100 C.W. 2,100 C.W. 2,900 C.W. 4,350 C.W. 12,000 C.W. 11,000 C.W.
0930 FL 0925 FL 0926 ZM 0930 IDO 0935 GFA 0958 FL 1000 FL 1028 ZM 1035 FL 1035 GFA 1036 FL 1044 FL 1050 ZM 1135 FCH 1128 ZM 1130 FL 1135 GFA 1130 FL	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Le Bourget Paris Air Bourget Le Bourget Paris	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 3,200 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 1,800 Spark. 1,680 C.W. 1,800 Spark. 1,680 C.W. 1,600 Spark. 1,680 C.W. 1,600 Spark. 1,680 C.W. 1,600 Spark. 1,680 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330	UA FL FL IDO PCH POZ ing almo FL GBL GBL GLB GLO GLB GLW IDO UCM IDO UNION	Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover		2,600 Spark. 2,600 Spark. 1,000 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 8,000 C.W. 2,100 C.W. 2,100 C.W. 3,800 C.W. 4,350 C.W. 11,000 C.W. 11,000 C.W. 14,000 C.W.
0930 FL 0928 ZM 0930 IDO 0935 FL 1000 FL 1003 FL 1028 ZM 1035 FL 1035 GFA 1036-	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Le Bourget Paris De Bourget Paris Le Bourget Paris Le Bourget	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 3,200 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 1,680 C.W. 1,680 C.W. 1,600 Spark. 1,680 C.W. 1,600 Spark. 1,680 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330	FL FL IDO PCH POZ ING SIMO FL GBL GKU GLB GLO MUUI POZ	Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stouehaven Stavanger Rome Carnarvon Hanover Nauen		2,600 Spark. 2,600 Spark. 1,000 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 2,100 C.W. 2,100 C.W. 2,100 C.W. 1,800 C.W. 1,500 C.W. 1,000 C.W. 12,000 C.W. 14,500 C.W. 14,500 C.W. 14,500 C.W.
0930 FL 0925 FL 0926 ZM 0930 IDO 0935 FL 1000 FL 1028 ZM 1035 FL 1035 FL 1036 FL 1044 FL 1050 ZM 1115 PCH 1128 ZM 1130 FL 1130 FL	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Le Bourget Paris Air Bourget Le Bourget Paris	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 3,200 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 1,800 Spark. 1,680 C.W. 1,800 Spark. 1,680 C.W. 1,600 Spark. 1,680 C.W. 1,600 Spark. 1,680 C.W. 1,600 Spark. 1,680 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330	FL FL IDO PCH POZ ing almo FL GBL GLA GLB GLO GSW LCM MUU OUI PCH CUTT	Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover Nauen Saint Assises		2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 2,100 C.W. 2,100 C.W. 2,900 C.W. 4,350 C.W. 12,000 C.W. 11,000 C.W. 14,000 C.W. 14,500 C.W. 12,600 C.W.
0930 FL 0928 ZM 0930 IDO 0935 GFA 0958 FL 1000 FL 1028 ZM 1035 FL 1035 FL 1044 FL 1050 FL 1128 ZM 1130 FL 1130 FL 1130 FL 1130 FL	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Le Bourget Paris Le Bourget Paris Le Bourget Scheveningen Le Bourget Paris Air Ministry Paris Air Ministry Paris	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 3,200 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 1,680 C.W. 1,680 C.W. 1,680 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 C.W. 7,000 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330	UA FL FL IDO PCH POZ Ing almo FL GBL GGBL GLB GLW IDO UCT WGG	Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover Nauen Saint Assises Tuckerton		2,600 Spark. 2,600 Spark. 1,600 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 8,750 C.W. 2,100 C.W. 2,100 C.W. 1,350 C.W. 1,500 C.W. 12,000 C.W. 12,000 C.W. 14,500 C.W. 14,500 C.W. 15,000 C.W. 15,000 C.W.
0930 FL 0928 ZM 0930 IDO 0935 FL 1000 FL 1003 FL 1035 FL 1035 GFA 1036-	Paris Le Bourget Rome Air Ministry Paris Paris Le Bourget Paris Le Bourget Paris Le Bourget Paris Le Bourget Paris Paris Le Bourget Paris Le Bourget Scheveningen Le Bourget Paris Air Ministry Paris Le Bourget Paris Le Bourget Paris Le Bourget Paris Le Bourget	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 1,680 C.W. 1,680 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W. 1,600 Spark. 1,680 C.W. 1,600 C.W. 1,600 C.W. 1,600 C.W. 1,600 C.W. 1,600 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330	FL FL IDO PCH POZ ING AIMO FL GBL GKU GLB GLO MUUI POZ UFGG WII	Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover Nauen Saint Assises Tuckerton New Brunswick		2,600 Spark. 2,600 Spark. 1,000 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 2,100 C.W. 2,100 C.W. 2,100 C.W. 1,500 C.W. 1,000 C.W. 12,000 C.W. 12,000 C.W. 12,000 C.W. 14,500 C.W. 14,500 C.W. 14,500 C.W. 14,500 C.W. 14,500 C.W. 15,000 C.W. 16,100 C.W. 15,000 C.W. 16,100 C.W. 15,000 C.W.
0930 FL 0928 ZM 0930 IDO 0935 FL 1003 FL 1028 ZM 1035 FL 1130 FCH 11205 FL 1130 ZM 1130 FL 1130 ZM 1155 POZ	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Le Bourget Paris Air Ministry Paris Le Bourget Scheveningen Le Bourget Paris Air Ministry Paris Le Bourget Scheveningen Le Bourget Paris Le Bourget Paris Le Bourget Paris	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 1,680 C.W. 2,600 Spark. 2,600 Spark. 3,200 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 2,600 Spark. 1,680 C.W. 1,800 Spark. 1,680 C.W. 1,800 Spark. 1,680 C.W. 1,600 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330	FL FL IDO PCH POZ ing almo FL GBL GKU GLA GLO GSW LCM MUU OUI WGG WII WOK WII WOK WII WOK WII WOK WII WOK WOK WOK FL CONTROL WOK WOK WOK FL CONTROL WOK WII WOK FL CONTROL WOK WOK FL CONTROL WOK FL CONT	Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover Nauen Saint Assises Tuckerton New Brunswick Long Island		2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 2,100 C.W. 2,100 C.W. 2,900 C.W. 13,600 C.W. 14,000 C.W. 15,000 C.W. 16,460 C.W.
0930 FL 0928 ZM 0930 IDO 0935 GFA 0958- FL 1000 FL 1028 ZM 1035 FL 1035 FL 1044 FL 1050 PCH 1128 ZM 1130 FL 1130 GFA	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Paris Le Bourget Scheveningen Le Bourget Paris Air Ministry Paris Le Bourget Scheveningen Le Bourget Paris Air Ministry Paris Le Bourget Paris Air Ministry Paris Le Bourget Leafield	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 1,680 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 1,680 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330	UA FL FL FL FIDO PCH POZ Ing almo FL GBL GGLW GLB GGLW HIDO WUI POZ WII WUGG WII WOKL	Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover Nauen Saint Assises Tuckerton New Brunswick Long Island		2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 2,100 C.W. 2,100 C.W. 2,900 C.W. 13,500 C.W. 12,000 C.W. 12,000 C.W. 14,500 C.W. 14,500 C.W. 14,500 C.W. 14,500 C.W. 14,600 C.W. 15,000 C.W. 16,100 C.W. 16,400 C.W. 16,400 C.W. 19,200 C.W.
0930 FL 0928 ZM 0930 IDO 0935 FL 1000 FL 1003 FL 1028 ZM 1035 GFA 1036- FL 1035 GFA 1036- FL 1035 FL 1035 FL 1035 FL 1130 GFA 1130 FL 1130 GFA 1130 FL 1130 GFA 11	Paris Le Bourget Rome Air Ministry Paris Paris Le Bourget Scheveningen Le Bourget Paris Air Ministry Paris Le Bourget Paris Le Bourget Paris Le Bourget Le Bourget Paris Le Bourget Paris Le Bourget Paris Le Bourget Nauen Leafield Guglielmo Marconi (Coltano)	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 2,000 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330	UA FL FL FL FL IDO PCH POZ Ing almo FL GBL GKU GLB GLO MUUI POZ WII WOK WOL WSO	Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover Nauen Saint Assises Tuckerton New Brunswick Long Island Marion		2,600 Spark. 2,600 Spark. 1,000 C.W. 1,800 Spark. 12,600 C.W. 1,800 C.W. 2,100 C.W. 2,100 C.W. 2,100 C.W. 2,100 C.W. 1,000 C.W. 12,000 C.W. 12,000 C.W. 14,500 C.W. 14,500 C.W. 14,500 C.W. 14,500 C.W. 15,000 C.W. 16,100 C.W. 16,100 C.W. 16,100 C.W. 11,000 C.W.
0930 FL 0928 ZM 0930 IDO 0935 FL 1003 FL 1028 ZM 1035 FL 1035 FL 1036 FL 1036 FL 1135 FCH 1128 ZM 1130 FL 1130 GFA 1130 FL 11205 ZM 1155 POZ 1200 GBL 1200 ICI 1228 ZM	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Le Bourget Paris Le Bourget Scheveningen Le Bourget Paris Air Ministry Paris Le Bourget Coheveningen Le Bourget Paris Le Bourget Paris Air Ministry Paris Le Bourget Paris Le Bourget Paris Le Bourget Paris Le Bourget Nauen Leafield Guglielmo Marconi (Coltano) Le Bourget	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 1,800 Spark. 1,680 C.W. 1,800 Spark. 1,680 C.W. 1,680 C.W. 2,000 Spark. 1,680 C.W. 2,000 Spark. 1,680 C.W. 2,000 Spark. 1,680 C.W. 2,000 C.W. 1,680 C.W. 1,680 C.W. 1,680 C.W. 1,680 C.W. 1,680 C.W. 1,680 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330	FL FL IDO PCH POZ ING AIMO FL GBL GKU GLA GGLA GGLO MUU OUZ UFT WGI WOK WOL WYN	Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover Nauen Saint Assises Tuckerton New Brunswick Long Island Long Island Marion Lyons		2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 2,100 C.W. 2,100 C.W. 2,900 C.W. 14,000 C.W. 14,000 C.W. 14,000 C.W. 14,000 C.W. 14,000 C.W. 15,000 C.W. 16,160 C.W. 15,000 C.W.
0930 FL 0928 ZM 0930 IDO 0935 GFA 0958 FL 1000 FL 1028 ZM 1035 FL 1036 FL 1036 FL 1036 FL 1135 GFA 1130 FL	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Paris Le Bourget Scheveningen Le Bourget Paris Le Bourget Paris Le Bourget Constant Ministry Paris Le Bourget Nauen Leafield Guglielmo Marconi (Coltano) Le Bourget Nantes	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 1,680 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 1,680 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330	UA FL FL FL FL IDO PCH POZ Ing almo FL GBL GKU GLB GLO MUUI POZ WII WOK WOL WSO	Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover Nauen Saint Assises Tuckerton New Brunswick Long Island Marion		2,600 Spark. 2,600 Spark. 1,000 C.W. 1,800 Spark. 12,600 C.W. 1,800 C.W. 2,100 C.W. 2,100 C.W. 2,100 C.W. 2,100 C.W. 1,000 C.W. 12,000 C.W. 12,000 C.W. 14,500 C.W. 14,500 C.W. 14,500 C.W. 14,500 C.W. 15,000 C.W. 16,100 C.W. 16,100 C.W. 16,100 C.W. 11,000 C.W.
0930 FL 0928 ZM 0930 IDO 0935 FA 0958- FL 1000 FL 1028 ZM 1035 FL 1035 GFA 1036- FL 1035 GFA 1130- FL 1130 FL 1130- GFA 1130- GBL 11200 ICI 11228 ZM 11230 GBL 11200 ICI 11228 ZM 11230 GFA	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Le Bourget Scheveningen Le Bourget Paris Air Ministry Paris Le Bourget Caris Le Bourget Caris Le Bourget Paris Le Bourget Paris Air Ministry Paris Le Bourget Nauen Leafield Guglielmo Marconi (Coltano) Le Bourget Nantes Air Ministry	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 2,600 C.W. 1,680 C.W. 3,100 Spark. 8,500 C.W. 1,680 C.W. 3,100 Spark. 8,500 C.W. 1,680 C.W. 3,400 Spark. 1,680 C.W. 3,400 Spark. 1,680 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330 Operati	FL F	Paris Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover Nauen Saint Assises Tuckerton New Brunswick Long Island Long Island Marion Lyons Bordeaux	ING CONTINU	2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 2,600 C.W. 2,100 C.W. 2,100 C.W. 2,100 C.W. 2,100 C.W. 1,000 C.W. 12,000 C.W. 12,000 C.W. 14,500 C.W. 14,500 C.W. 14,500 C.W. 15,000 C.W. 16,100 C.W. 16,100 C.W. 15,000 C.W.
0930 FL 0928 ZM 0930 IDO 0935 FL 1000 FL 1003 FL 1028 ZM 1035 GFA 1035 GFA 1035 GFA 1130 FL 11	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Paris Le Bourget Scheveningen Le Bourget Paris Le Bourget Paris Le Bourget Constant Ministry Paris Le Bourget Nauen Leafield Guglielmo Marconi (Coltano) Le Bourget Nantes	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 2,600 C.W. 1,680 C.W. 3,100 Spark. 8,500 C.W. 1,680 C.W. 3,100 Spark. 8,500 C.W. 1,680 C.W. 3,100 Spark. 8,500 C.W. 1,680 C.W. 3,400 Spark. 1,680 C.W. 2,600 C.W. 1,680 C.W. 3,500 C.W.	2230 2235 2236-} 2249 2244 2300 Operati	UA FL FL FL IDO PCH POZ ing almo FL GBL GKU GLB GLO MUUI POZ UFT WGK WOK WOK WYN LY H COAST	Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover Nauen Saint Assises Tuckerton New Brunswick Long Island Long Island Marion Lyons	ing Continu	2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 2,600 C.W. 2,100 C.W. 2,100 C.W. 2,100 C.W. 2,100 C.W. 1,000 C.W. 12,000 C.W. 12,000 C.W. 14,500 C.W. 14,500 C.W. 14,500 C.W. 15,000 C.W. 16,100 C.W. 16,100 C.W. 15,000 C.W.
0930 FL 0928 ZM 0930 IDO 0935 GFA 0958 FL 1000 FL 1028 ZM 1035 FL 1036 FL 1036 FL 1135 GFA 1130 FL 1130 GFA 1130 FL 11	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Le Bourget Scheveningen Le Bourget Paris Air Ministry Paris Le Bourget Caris Le Bourget Caris Le Bourget Paris Le Bourget Paris Air Ministry Paris Le Bourget Nauen Leafield Guglielmo Marconi (Coltano) Le Bourget Nantes Air Ministry	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 2,600 C.W. 1,680 C.W. 3,100 Spark. 8,500 C.W. 1,680 C.W. 3,100 Spark. 8,500 C.W. 1,680 C.W. 3,400 Spark. 1,680 C.W. 3,400 Spark. 1,680 C.W.	2230 2235 2246—} 2244 2300 2315 2330 Operation	UA FL FL FL IDO PCH POZ Ing almo FL GKU GGBL GGBL GGBL GGBL GUB	Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover Nauen Saint Assises Tuckerton New Brunswick Long Island Marion Lyons Bordeaux STATIONS WORK		2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 2,100 C.W. 2,100 C.W. 2,000 C.W. 13,600 C.W. 14,000 C.W. 14,000 C.W. 14,000 C.W. 14,000 C.W. 14,000 C.W. 15,000 C.W. 16,100 C.W. 15,000 C.W. 10,400 C.W. 10,400 C.W. 10,400 C.W. 11,500 C.W.
0930 FL 0928 ZM 0930 IDO 0935 FL 1000 FL 1003 FL 1028 ZM 1035 GFA 1036-	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Le Bourget Paris Le Bourget Scheveningen Le Bourget Paris Air Ministry Paris Le Bourget Paris Le Bourget Control of the Marconi Le Bourget Nauen Leafield Guglielmo Marconi (Coltano) Le Bourget Nantes Air Ministry Bordeaux Paris	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 7,000 C.W. 1,680 C.W. 3,100 Spark. 8,500 C.W. 1,680 C.W. 3,100 Spark. 8,500 C.W. 1,680 C.W. 3,100 Spark. 8,500 C.W. 1,680 C.W. 3,400 Spark. 1,680 C.W. 3,400 Spark. 1,680 C.W. 23,500 C.W. 7,000 C.W.	2230 2235 2236-} 2244 2300 2315 2330 Operati	UA FL	Paris Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover Nauen Saint Assises Tuckerton New Brunswick Long Island Long Island Long Island Long Island Marion Lyons Bordeaux STATIONS WORK LORY, GCB Lochboi	sdale, GCC C	2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 2,600 C.W. 2,100 C.W. 2,100 C.W. 2,100 C.W. 2,100 C.W. 12,000 C.W. 12,000 C.W. 12,000 C.W. 12,000 C.W. 14,500 C.W. 14,500 C.W. 14,500 C.W. 15,000 C.W. 16,100 C.W. 16,100 C.W. 15,000 C.W.
0930 FL 0928 ZM 0930 IDO 0935 FL 1000 FL 1003 FL 1028 ZM 1035 FL 1030 FL 1130 ICI 1228 ZM 1230 ICI 1228 ICI 1230 ICI 1240 ICI 1250 ICI 125	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Le Bourget Paris Le Bourget Scheveningen Le Bourget Paris Air Ministry Paris Le Bourget Paris Le Bourget Paris Le Bourget Paris Air Ministry Paris Paris Le Bourget Paris Le Bourget Paris Air Ministry Paris Le Bourget Nauen Leafield Guglielmo Marconi (Coltano) Le Bourget Nantes Air Ministry Bordeaux Paris Nimes	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 1,680 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 1,680 C.W. 1,680 C.W. 2,600 Spark. 1,680 C.W. 2,600 C.W. 1,680 C.W. 3,100 Spark. 8,500 C.W. 1,680 C.W. 2,300 C.W. 1,680 C.W. 2,3500 C.W. 1,680 C.W.	2230 2235 2236-} 2249 2244 2300 2315 2330 Operation	UA FL FL FL IDO PCH POZ Ing almo FL GBL GGRU GGLB GGLO MUUI POZ UFT WORK WOO YN LY H COAST TOBERT GGRR TOBERT	Paris Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover Nauen Saint Assises Tuckerton New Brunswick Long Island Long Island Marion Lyons Bordeaux STATIONS WORK LOTY, GCB Lochboi Wick, GLD Land	sdale, GCC C s_End, GLV	2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 2,100 C.W. 2,100 C.W. 2,100 C.W. 1,500 C.W. 12,000 C.W. 12,000 C.W. 12,000 C.W. 14,000 C.W. 14,000 C.W. 15,000 C.W. 23,500 C.W.
0930 FL 0928 ZM 0930 IDO 0935 FL 1000 FL 1003 FL 1028 ZM 1035 FL 1036 FL 1036 FL 1036 FL 1135 GFA 1130 FL 11	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Air Ministry Paris Le Bourget Scheveningen Le Bourget Scheveningen Le Bourget Paris Air Ministry Paris Le Bourget Scheveningen Le Bourget Paris Air Ministry Paris Le Bourget Nair Paris Le Bourget Nauen Leafield Guglielmo Marconi (Coltano) Le Bourget Nantes Air Ministry Bordeaux Paris Nimes Le Bourget	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 1,680 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 1,680 C.W. 3,100 Spark. 8,500 C.W. 1,680 C.W.	2230 2235 2246 2244 2300 2315 2330 Operation	UA FL FL FL IDO PCH POZ ing almo FL GBL GGKU GGLA GGLA GGLO MUU OUZ UFT WGGL WOOL WOOL WYN LY COAST S: Tobern FGKR Foreland	Paris Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover Nauen Saint Assises Tuckerton New Brunswick Long Island Long Island Marion Lyons Bordeaux STATIONS WORK TORY, GCB Lochboi Wick, GLD Land' I, GNI Niton, GPQ	sdale, GCC C s_End, GLV	2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 2,100 C.W. 2,100 C.W. 2,100 C.W. 1,500 C.W. 12,000 C.W. 12,000 C.W. 12,000 C.W. 14,000 C.W. 14,000 C.W. 15,000 C.W. 23,500 C.W.
0930 FL 0928 ZM 0930 IDO 0935 GFA 0958 FL 1000 FL 1028 ZM 1035 FL 1036 FL 1050 FL 1130 FL 11	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Le Bourget Paris Le Bourget Scheveningen Le Bourget Paris Air Ministry Paris Le Bourget Paris Air Ministry Paris Le Bourget Paris Air Ministry Paris Paris Le Bourget Nauen Leafield Guglielmo Marconi (Coltano) Le Bourget Nantes Air Ministry Bordeaux Paris Nimes Le Bourget Air Ministry	2,600 Spark. 2,600 Spark. 1,680 C.W. 1,680 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 1,680 C.W. 1,680 C.W. 1,680 C.W. 7,000 C.W. 7,000 C.W. 1,680 C.W.	2230 2235 2236-} 2244 2300 2315 2330 Operation	UA FL FL FL IDO PCH POZ Ing almo FL GBBL GGBL GGBL GGBL GGBL GGBL GGBL G	Paris Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover Nauen Saint Assises Tuckerton New Brunswick Long Island Marion Lyons Bordeaux STATIONS WORK LORY, GCB Lochboi Wick, GLD Land' I, GNI Niton, GPQ Tookhaven.	sdale, GCC C s End, GLV Parkeston Q	2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 2,600 C.W. 2,100 C.W. 2,100 C.W. 2,100 C.W. 12,000 C.W. 12,000 C.W. 12,000 C.W. 12,000 C.W. 14,500 C.W. 14,500 C.W. 14,500 C.W. 15,000 C.W.
0930 FL 0928 ZM 0930 IDO 0935 FL 1000 FL 1003 FL 1035 FL 1035 GFA 1036 FL 1035 GFA 1130 FL 113	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Le Bourget Paris Le Bourget Scheveningen Le Bourget Paris Air Ministry Paris Le Bourget Paris Air Ministry Paris Le Bourget Paris Air Ministry Paris Paris Le Bourget Nauen Leafield Gugtielmo Marconi (Coltano) Le Bourget Nantes Air Ministry Bordeaux Paris Nimes Le Bourget Air Ministry Bordeaux Paris Nimes Le Bourget Air Ministry	2,600 Spark. 2,600 Spark. 1,680 C.W. 11,000 C.W. 1,680 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 2,600 C.W. 1,680 C.W.	2230 2235 2236-} 2244 2300 2315 2330 Operation BRITISI METRE: GCA Caister North guard, CONTIN	UA FL FL FL IDO PCH POZ ing almo FL GKU GLB GLB GLO MUUI POZ UFT WOL WSO YN LY H COAST S TOBERT GKR Foreland GKR Foreland GCHA FORELAND FO	Paris Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover Nauen Saint Assises Tuckerton New Brunswick Long Island Long Island Marion Lyons Bordeaux STATIONS WORK TORY, GCB Lochboi Wick, GLD Land' I, GNI Niton, GPQ	sdale, GCC C s End, GLV Parkeston Q	2,600 Spark. 2,600 Spark. 2,600 Spark. 11,000 C.W. 1,800 Spark. 12,600 C.W. 2,600 C.W. 2,100 C.W. 2,100 C.W. 2,100 C.W. 12,000 C.W. 12,000 C.W. 12,000 C.W. 12,000 C.W. 14,500 C.W. 14,500 C.W. 14,500 C.W. 15,000 C.W.
0930 FL 0928 ZM 0930 IDO 0935 GFA 0958 FL 1000 FL 1028 ZM 1035 FL 1036 FL 1050 FL 1130 FL 11	Paris Le Bourget Rome Air Ministry Paris Paris Paris Le Bourget Paris Le Bourget Paris Le Bourget Scheveningen Le Bourget Paris Air Ministry Paris Le Bourget Paris Air Ministry Paris Le Bourget Paris Air Ministry Paris Paris Le Bourget Nauen Leafield Guglielmo Marconi (Coltano) Le Bourget Nantes Air Ministry Bordeaux Paris Nimes Le Bourget Air Ministry	2,600 Spark. 2,600 Spark. 1,680 C.W. 1,680 C.W. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 2,600 Spark. 1,680 C.W. 2,600 Spark. 1,680 C.W. 1,680 C.W. 1,680 C.W. 1,680 C.W. 7,000 C.W. 7,000 C.W. 1,680 C.W.	2230 2235 2246 } 2244 2300 2315 2330 Operation	UA FL FL IDO PCH POZ Ing almo FL GBL GBL GGBL GCB	Paris Paris Paris Paris Paris Rome Scheveningen Nauen st continuously: Paris Glace Bay Leafield Devizes Ongar Ongar Ongar Stonehaven Stavanger Rome Carnarvon Hanover Nauen Saint Assises Tuckerton New Brunswick Long Island Marion Lyons Bordeaux STATIONS WORK LORY, GCB Lochboi Wick, GLD Land' I, GNI Niton, GPQ Tookhaven.	sdale, GCC C s End, GLV Parkeston Qu DNTINUOUSLY	2,600 Spark. 2,600 Spark. 2,600 Spark. 1,000 C.W. 1,800 Spark. 12,600 C.W. 7,850 C.W. 2,100 C.W. 2,100 C.W. 2,900 C.W. 1,3600 C.W. 12,000 C.W. 11,000 C.W. 11,000 C.W. 12,600 C.W. 13,600 C.W. 15,000 C.W.

METRES:
FFB Boulogne, OST Ostend, PCH Scheveningen.









ENGLAND'S BEST-KNOWN "HAM"

Thousands of American amateurs are familiar with the signals of Mr. Gerald Marcuse (2 NM). Here is the radio shack from which they come at Caterham, Surrey, England. Mr. Marcuse's receiving apparatus is shown at the left of the picture, while just to the right of his head may be seen the huge quartz tube used in many recent transmissions.

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phones themselves. The swivel argangement is of the latest approved style, so that the phones will fit the car sough to eachide all

the car smally to exclude all external more. We use a Statement prine silk covered out with two tips.

The magnets are wound with No. 13 B.A. S. ENAM. I.I. COPPER WHRI. The magnets are a great deal made of the best imported Swed ish tungsten sted.

We lay particular stress on the magnets of this recommendation of the magnets of this recommendation.

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Smallest and most compact long distance wireless receiving outfit manufactured. No. 11000 "Electro" Vario. Selective Coupler no phones or detector: \$6.50



No. 11000 Shipping weight 5 lbs

Guaranteed "Electro" Storage Batteries

As Made by Us for 12 Years

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This buttery, which was first designed by us as an action to take buttery, where it meets with the great that the original that the contained and selection to a proof. There is not an action to get out of origin and with a function of the selection of with a function of the buttery will last

I consequential term with it there is practically a good for age better. It is a second term of the consequence of the conseque

No. 2325 "Theorie" Storage Battery, 4 xolts, 40 ampset bours, size 7x7x3 10 \$4.20 \$5.00 \$5

40 ampère hours, size 8 ,3538 in

No. 2327 "Theorro" Storage Battery, 4 volts, 60 amps to hours, size 7 (3) vs us \$5.50

No. 288 "Flectro" Storage Battery, 6 volts, 60 ampere hours size 6 (888.00

\$8.00
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The most wonderful of all crystals. More sensitive than Galena, more sensitive than ANY other crystal or mineral.

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DAK CASE

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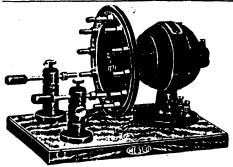
New 1916 Edition Wireless Manual A9

READY MAY 1st, Send 10c. for It YOU WILL GET YOUR 10 CENTS BACK ON AN ORDER FOR \$1.00

New diagrams. New matter. Everything brought up-to-the-minute. Most complete Manual as well as list of up-to-date, reliable wireless goods. We manufacture a lot ourselves and handle the very best that others make.

Our Pocket Electrical Catalogue W28, 248 pages, mailed on request. This catalogue contains practically everything in general use in the electrical line and is in fact a small pocket encyclopedia of electrical goods information.

EVERY ONE SHOULD HAVE A COPY OF BOTH



Mesco Rotary Spark Gap

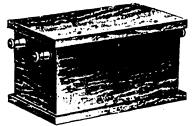
Limits a bach musical note. Can be heard at growter distances had the note from the stationary. Type: Cannot be mistaken for statle or other atmospheric distintances. Produces pure serve of lost damping decrement. Increases transmitting efficiency 20 to 30 per cent.

The rotating member has twelve sparking points mounted on a hard rubber disk and is carried on the motor shaft. Can be session our spark colls or transformers up to 1 K.W. Has two stationary electrodes with special adjusting devices.

Our Globe Motor is used. Will operate on 110 A. C. or D. C. fronts. speed of 4,500 K.P.M. Also made with our Globe Rattery Motor, which can be operated on a six-voit circuit.

Price List. Na.

Mesco Intensifying Transformer



Use lafor intensifying signals received from any crystal detector by connecting an audion detector on the other side of the transcence winding. Used between two audion detectors, signals will be intensined 10 to 25 times. As matic as three of these transformers can be connected between audion detectors in case adv. forming an intensitier, in using it possible to read signals not heard with any single known detector. Diagram of connections with full directions with cach instrument.

Mesco High Efficiency Spark Gap



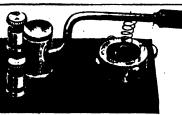
Adapted for stations up to by K. W. caport.

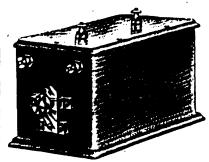
1. Bose by dipalished hard redder. Star dards are of find rather compensation, pl. 16. Inches to the compensation of the horizont and rather reads to the large transmission of the large transmission properties.

Mesco Universal Detector Stand

Has a heavy brass cup, with four binding screws; will hold crystals up to \$\frac{1}{2}\$ in diameter A holiow standard encloses a brass ball. Through an opening a brass arm with hard rubber handle is severed fast to the ball, making a ball and seeket joint, allowing it to be adjusted at any angle or used in any position. Hard rubber base \$2^{\frac{1}{2}} \text{d}_{\text{h}}^{\frac{1}{2}} \text{s}_{\text{l}}^{\frac{1}{2}}\$ in All metal parts included by the description last North and the parts and vibrations of every description.

pars and vibrations of every seem option.
List No.
245 Mesos Universal Detector Stand . 3





Mesco Wireles's Spark Colls

Have low current consumption. Bost to operate on dry batteries. Contact points of heavy plati-num iridium. Has primary condensor in case Made for wireless work. Permits of close tuning Spark at interrupter reduced to a minimum; spark is heavy, made in t_4 -inch to 4-inch sizes. Our Manual gives all the technical points.

Spark Coll, I Inch; can be operated on

Mesco Wireless Receivers



copper where obtainable used in construction of the permanent magnets. Users have had head sets for five years and over without any deriv-oration in sensitiveness. This cannot be said of any light-weight receives. This cannot be said of any light-weight receives. This cannot be said of ally light-weight receives. The price said cord and two receivers, 1989 of other each.



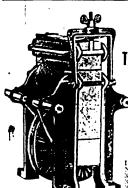
Comprises a regular telegraph key, without our out breaker a special high pitch buzzer, one cell Rest Scal dry battery, and four feet of green silk covered flexible cord. The main object of the set is to enable the beginner to master the wireless code, and the buzzer reproduces the sound of the signals of the most modern wireless.

Wireless Key



Steel lever is nickel plated, and brass frame is finely grained and lacquered.

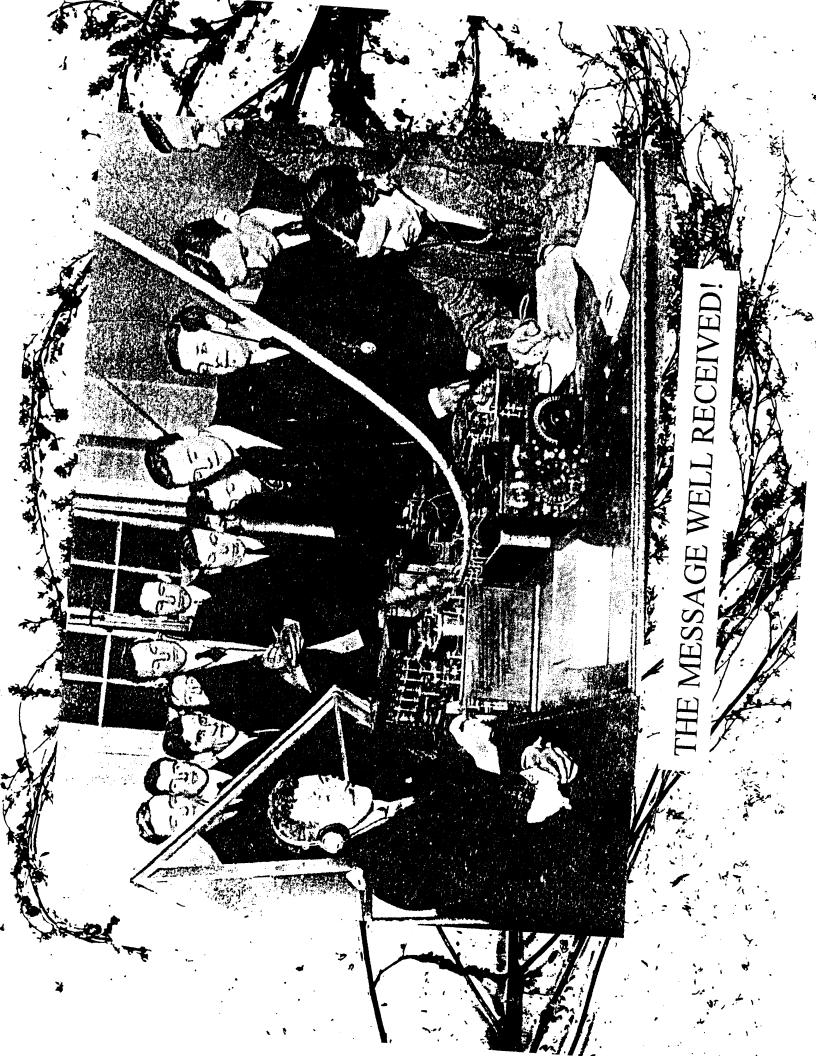
List, No. 452 Nickle plated lever, brans frame......



Mesco Flexible WIRELESS

Will make wheeless apparatus 200 | ter ceep more efficient. When short chretited or when charging condensers does not consume any more power than the magnetic should be set for Can be connected direct to alternating circuit. Ca. Second.

Manhattan Electrical Supply Co., 17 Park Place



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