No. 773,069. PATENTED OCT. 25, 1904.

C. E. FREEMAN.

APPARATUS FOR UTILIZING ELECTRICAL OSCILLATIONS FOR SIGNALING PURPOSES.

APPLICATION FILED JAN. 14, 1901.

NO MODEL.

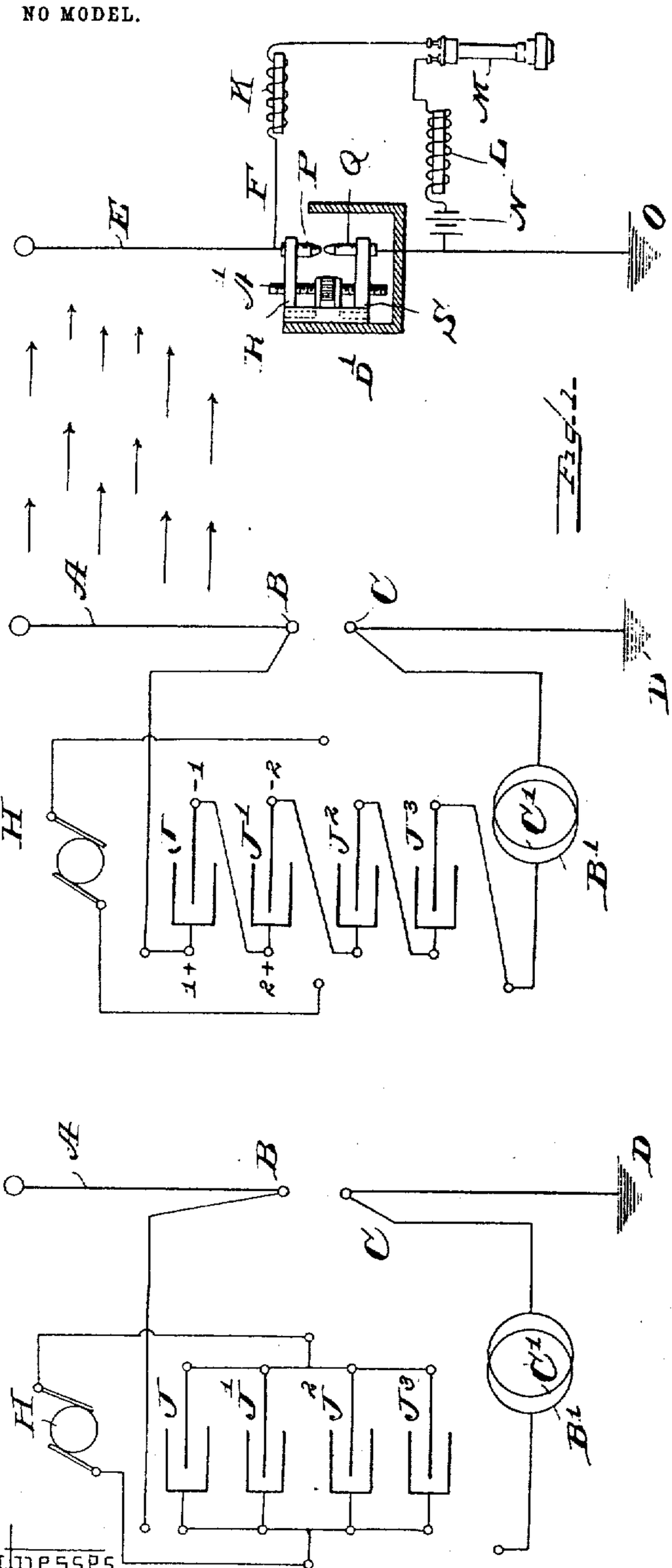

Fig. 1.

Fig. 2.

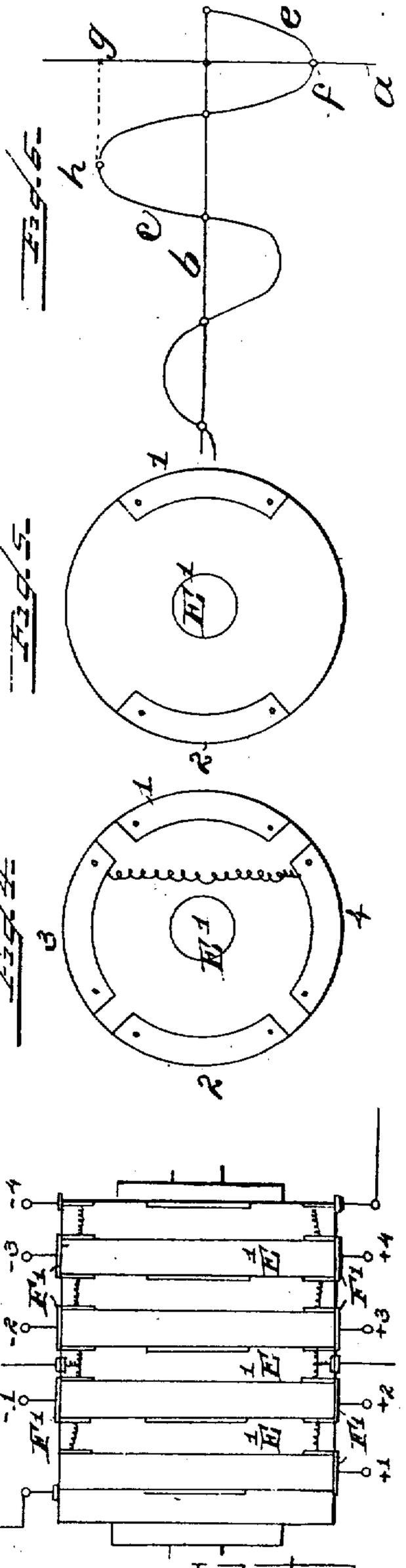

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 6.

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No. 773,069. Patented October 25, 1904.

UNITED STATES PATENT OFFICE.

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APPARATUS FOR UTILIZING ELECTRICAL OSCILLATIONS FOR SIGNALING PURPOSES.

SPECIFICATION forming part of Letters Patent No. 773,069, dated October 25, 1904.

Application filed January 14, 1901. Serial No. 43,096. (No model.)

To all whom it may concern:

Be it known that I, CLARENCE E. FREEMAN, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Apparatus for Utilizing Electrical Oscillations for Signaling Purposes, of which the following is a specification.

This invention relates to apparatus for utilizing electrical oscillations for signaling purposes.

The object of the invention is to provide a construction and arrangement of apparatus which is simple and efficient, whereby signaling, telephoning, or telegraphing may be effected between distant points or stations through the medium of electrical oscillations or other similar form of radiating energy.

A further object of the invention is to provide means whereby the energy is produced and radiated in the most efficient manner for signaling, telephoning, or telegraphing purposes.

A further object is to provide means whereby the transmitting conductor or radiator may be rapidly charged to a high and more uniform degree than has been accomplished heretofore.

Other objects of the invention will appear more fully hereinafter.

The invention consists, substantially, in the construction, arrangement, and operation, all as will be more fully hereinafter set forth, as shown in the accompanying drawings, and finally pointed out in the appended claims.

Referring to the accompanying drawings and to the various views and reference-signs appearing thereon, Figure 1 is a view, somewhat diagrammatical, illustrating an arrangement embodying the principles of my invention, the apparatus at the transmitting-station being diagrammatically illustrated in charging relation with respect to the radiating-conductor. Fig. 2 is a diagrammatic view illustrating the arrangement of apparatus at the transmitting-station in charging relation with respect to the condensers. Fig. 3 is a view in plan, somewhat diagrammatic, of an illustrative form of apparatus employed for effecting the circuit changes necessary for placing the transmitting apparatus in charging relation alternately with a generator or other source of current-supply and with the radiating-conductor. Figs. 4 and 5 are opposite face or side views of a portion of the apparatus shown in Fig. 3. Fig. 6 is a diagram employed in describing the operation of the apparatus.

In Patent No. 586,193, issued July 13, 1897, to Marconi, is shown, described, and claimed an apparatus for transmitting electrical signals. The present invention relates to an apparatus of this general nature and purpose, but involves certain radical changes and variations therefrom and in the operation thereof. For instance, in the Marconi patent referred to the transmitting-conductor is charged from the secondary of an induction-coil. The use of an induction-coil for this purpose I have found to be objectionable and insufficient to produce the best results for several reasons, one of which is that in apparatus of this class the best results are obtained when the transmitting-conductor is charged instantly to uniform potential after each discharge thereof, and this is not satisfactorily and continuously attainable in the use of an induction-coil, because upon completing the circuit of the primary of the induction-coil the current builds up gradually, the rate of change of which, combined with the permeability of the core, determines the difference of potential in the spark-producing apparatus, which in turn determines the potential to which the transmitting-conductor is raised, and consequently the amplitude of the electrical oscillations produced. In general the rate of change of current in the primary of the induction-coil on "make," due to the resistance and self-induction of such circuit, is insufficient to produce the necessary or requisite difference of potential which produces the spark by which the radiating-conductor is discharged, and hence so long as the primary circuit of the induction-coil remains closed no electrical oscillations suitable for signaling purposes are generated. Moreover, the amplitude of the electrical oscillations produced by the radiating-conductor on the "break" of the primary and which determines the electromotive force generated in the receiving apparatus is itself determined by the difference of

potential to which the radiating-conductor is raised. This difference of potential where an induction-coil is used is dependent upon the length of time the primary remains closed and the efficiency of electrical contact, which are variable features in every induction-coil, and consequently the introduction of such variable features seriously impairs the efficiency of the apparatus for the purposes intended. Another feature which also aids in determining the potential to which the transmitting-conductor is raised is the condition existing in or adjacent to the spark-producing apparatus—that is, the condition of the separated balls or terminals between which the spark passes on discharge of the transmitting-conductor. It has been found that after a short time of use the surfaces of the balls employed as terminals between which the spark is produced becomes roughened, and consequently a tendency is developed of producing a spark discharge between such terminals or balls and through the interposed dielectric at a much smaller difference of potential than that obtained initially or with brightened or polished surfaces. This condition at the spark-producing apparatus results in variations in the potential to which the transmitting-conductor is raised when charged, and hence results in variations in the amplitude of the wave produced.

Referring to the diagram in Fig. 6, line *a* designates the receiving-conductor, and *b* the line of direction of propagation of the energy-wave. Utilizing these lines as ordinate and abscissa lines, respectively, the wave-curve is indicated by reference-sign *c*, *e* designating the maximum ordinate of such curve and the distance between the points *f g* designating the maximum amplitude of the energy-wave, the distance between the point *g* and the point *h* corresponding to the time of a half period. Since the electromotive force generated in the receiving-conductor is dependent upon the rate at which it cuts or is cut by the lines of force or magnetic field produced by the electrical oscillations and a portion of which field is represented by the curve *c* of the diagram of Fig. 6, it will be observed that said electromotive force is dependent upon two things—one is the distance between the points *f* and *g*, or rather the amplitude of the energy-wave, another is the distance between points *g* and *h* or the time of a one-half period, since these factors determine the rate at which the receiving-conductor is being cut. The periodicity is, as is well known, a constant depending entirely upon the resistance, self-induction, and capacity of the transmitting-conductor. Therefore to obtain the best results in the receiving apparatus it is desirable that the amplitude of the energy-wave be as great as possible, for it will be seen by reference to Fig. 6 that the distance *f g* indicates the extent of cutting of the receiving-conductor by the energy-wave, the line *f h* representing the slope of the wave front relative to the direction of its propagation. It is of course understood that the ordinates of the curve *c* represent only the magnitude of the electromagnetic disturbance and not the direction of such disturbance. Moreover, it will be seen that the greater the amplitude of the wave—that is, the higher point *h* is above the line of propagation *b* and the lower point *f* is below said line of propagation—the steeper will be the line *h f* at a given periodicity, and hence the greater will be the electromotive force induced in the receiving-conductor. Consequently the greater the amplitude of the energy-wave the better the results attained in the receiving instrument, and the more uniform the initial amplitude of succeeding wave-trains the greater the degree of constancy attained in the receiving apparatus. The amplitude of the energy-wave, as is well known, is dependent for any given constants of the transmitting apparatus upon the potential to which the radiating-conductor is raised, and if said conductor is raised to uniform degree of potential after each discharge it will be apparent that the amplitude of succeeding energy-waves will be uniform. Again, in the use of apparatus of this nature when the potential of the transmitting or radiating conductor is raised comparatively slowly, as is the case when an induction-coil is used for charging purposes, no energy-waves are generated or produced during the charging operation, or if such waves are produced during the charging operation they are so weak as to be inappreciable in the effects thereof upon the distant receiving-station, whereas if the potential of the transmitting conductor or radiator is raised quickly and sharply in reciprocal relation to the decrease of the potential of such conductor or radiator when discharged during the sparking then energy-waves are produced during the charging of the radiating-conductor of similar character and of substantially equal amplitude with respect to those generated during the discharge thereof. In other words, if the aerial conductor is charged from a constant electrical head or pressure and is discharged to earth then the charging rate must be equal to the discharging rate, and the building up of the charge in the conductor must be in inverse ratio to the decrease of charge during discharge. It will also be seen that upon the amplitude of the energy-wave also depends to a large extent the distance apart the transmitting and receiving stations may be separated, and consequently the greater the amplitude of the energy-wave, as well as the "steepness," so to speak, of the wave front the longer the distance through which signaling may be effected.

It is the special purpose of my invention to produce in a system such as is above set forth an arrangement wherein the discharge of the

radiating-conductor is maintained through constant difference of potential, or, in other words, an arrangement in which each discharge or spark is produced or accompanied by the same difference of potential at the spark-terminals, and also wherein the use of an induction-coil is dispensed with, and the transmitting-conductor is uniformly charged and discharged. To accomplish these desirable objects, I employ a battery of condensers and arrange such condensers to be connected up in series with each other and the spark-producing terminals at the moment of charge of the radiating-conductor and of discharge between such terminals, and I arrange the battery of condensers to be connected up in parallel with each other and in circuit with a suitable generator or other source of electric energy by which the condensers may be charged. The circuit changes by which the condensers may be connected up alternately in series or in parallel relation with respect to each other and alternately connected to the spark-terminals and to the generator may be effected in any suitable manner.

Referring to the accompanying drawings, reference-sign A designates the transmitting or radiating conductor; B, one of the spark-terminals, connected to such conductor; C, the other spark-terminal, suitably connected to earth or other capacity D.

H indicates a generator or other source of current-supply; J J′ J^2 J^3, the condensers. As shown in Fig. 1, the condensers are in series with each other and with the terminals B C, the circuit of generator H being broken. In Fig. 2 the condensers are shown in parallel relation with respect to each other and included in the circuit of generator H, the circuit connection of the condensers with the terminals B C being broken.

From the foregoing arrangement it will be seen that by placing the condensers in series with each other and with the terminal points B C the potential to which the transmitting or radiating conductor is raised or charged is constant and also the difference of potential through which the spark occurs or which produces the spark between terminals B C is wholly independent of the condition in the space between the terminals B C and of the terminals themselves and is constant, being the sum of the difference of potentials of the various elements of the condenser-battery, and hence to produce each discharge the transmitting or radiating conductor is raised to the same degree of potential, thereby producing uniformity in amplitude of the energy-wave. Moreover, when the connection is made which places the condensers in series with each other and with the terminals B C the transmitting or radiating conductor is charged or the potential thereof raised to the maximum and uniform degree quickly and sharply, thus utilizing the charging of such conductor in the generation or production of the energy-waves as well as the discharge of such conductor in the generation or production of such waves.

E designates the receiving-conductor; F, the local circuit of the receiving-station, in which are included suitable choking-coils K L, a signaling, telegraphing, or telephoning instrument M, and a battery N. The receiving-conductor E is suitably connected to ground or other convenient capacity, as at O, such circuit also being included within a portion of the local-battery circuit, and a resistance device is interposed in this portion of the circuit and comprises suitable insulated electrodes P Q, which may be adjusted toward and from each other in any convenient manner—as, for instance, by mounting said electrodes in arms R S capable of being adjusted toward or from each other, as by means of a right and left screw-rod A′. Of course the particular construction and arrangement of this apparatus is immaterial and may be varied within wide limits without departure from the spirit and scope of the invention, and the specific details and arrangements thereof do not form any part of the present invention, except in the coöperative relation thereof with respect to the elements of the entire system as above explained. Interposed between the electrodes P and Q, I place a suitable fluid or liquid, which operates to complete the circuit between such electrodes. The interposition of the liquid or fluid between the electrodes P Q serves to form a normal closure device for the local-battery circuit; but the electrical potential generated in the receiving apparatus by the arriving energy-waves, as above explained, in passing to the earth or capacity connection at O operates to interpose a resistance between these electrodes sufficient to practically open the local-battery circuit, and the opening and closing of this local-battery circuit produces a signal. In the construction of resistance device employed in the Marconi patent above referred to, wherein the local-battery circuit is normally open and is closed by the electrical potential generated in the receiving-conductor, it has been found to necessitate the use of means for mechanically opening the local-battery circuit when the generation of electrical potential in the receiving-conductor ceases. This means is disclosed in said patent in the form of a tapper mechanically actuated and arranged to disturb the relative positions of the particles of filings employed. The use of mechanical means for restoring the parts to normal condition is objectionable, and in the system embodying the principles of my invention, as above explained, the breaking of the local-battery circuit by the passage of the electrical potential or energy generated in the receiving-conductor is automatically interrupted and the local-battery circuit again closed automatically when the

generation of electrical potential in the receiving-conductor ceases, and this reëstablishment of the local-battery circuit is effected instantly the generation ceases. Thus I avoid the use of a mechanical or mechanically-actuated tapper or other device for restoring the apparatus at the receiving-station to normal condition.

In a signaling system such as above set forth it is desirable to provide means whereby the receiving instrument or signal device in the operation thereof bears a definite relation to the rate of discharge of the transmitting or radiating conductor. In other words, the rate at which the sparks are produced between the terminals B and C should bear a definite relation to the responsive action and operation of the receiving instrument M, or, to state the idea in another way, it is desirable that the receiving instrument be attuned to a definite relation with respect to the rate of discharge of the transmitting or radiating conductor or rather to the rate of spark discharge. When this condition obtains, it will be evident that the receiving signal device will be influenced only when a certain and predetermined rate of spark discharge occurs. In this manner the receiving signal device will record or give response only to certain groups or trains of energy-waves and will not respond to other groups or trains of energy-waves. Therefore by suitably and properly controlling the rate of spark discharge at the transmitting-station, so as to tune such discharge to a certain pitch, so to speak, and arranging the receiving signal device to be acted upon or to be responsive to that same pitch a pseudo syntonism is produced which renders the receiving part of the apparatus selective as to the character and quality of energy-waves to which it is responsive. This result may be attained in different ways—as, for instance, through the proper actuation of a commutator or other circuit-changing device through which the number of makes and breaks per second of the series circuit of the condenser-battery may be controlled or determined.

It is desirable that the surgings or electrical oscillations in the sparking circuit—that is, the circuit formed by the series arrangement of the condensers, the induction-coils B′ C′, and the spark-gap—be at a very high rate in order to attain the best results. By reason of the large resistance and self-induction necessarily present and associated with the construction of induction-coils the surgings or oscillations in the sparking circuit thereof, which includes the secondary of the induction-coil and the spark-gap, are relatively low or at a comparatively low rate. This objection is overcome in the arrangement above set forth and in my invention, wherein the surgings or oscillations in the series or sparking circuit of the condensers are maintained at a high degree. Moreover, in the construction above set forth this surging can be varied and controlled by controlling or varying the self-induction of such circuit in any suitable manner—as, for instance, by introducing relatively adjustable coils in such circuit. In such arrangement simple coils of wire (indicated at B′ C′) are placed in series with each other in the spark-discharge circuit of the condensers and are arranged in planes angular with respect to each other, but adjustable as to such angularity. By relatively adjusting the angularity of the planes of these coils the "tuning," so to speak, of the spark discharge across the dielectric between the terminals B and C may be regulated and the surgings or oscillations in said spark-discharge circuit controlled. One object of this arrangement is to bring these surgings or electrical oscillations in the spark-circuit into rhythmic relation with respect to the surgings in the radiating-conductor circuit, thereby augmenting the effect of the energy-waves radiated from such conductor. Another object of this arrangement is to obtain surgings or electrical oscillations in the spark-discharge circuit of the condensers of such periodicity and amplitude as will give results comparable with or equal to those of the radiating-conductor.

In a system such as above described it is evident that by arranging a number of receiving signal devices M in the local-battery circuit at a receiving-station, each attuned to a different pitch—that is, each of which is constructed to be responsive to a particular number of wave-trains per second of time—the same receiving-station and apparatus may be utilized to receive simultaneously signals or messages from different transmitting or radiating stations, it being understood that each receiving signal device or instrument responds to energy-waves sent out or radiated from the particular transmitting or sending station at which the periodicity of the spark discharge corresponds to the tuning of that particular receiving signal instrument or device. I have above indicated that my system of utilization of electrical oscillations or energy-waves in signaling telegraphing differs from the Marconi system, as disclosed in the patent referred to, with reference to the receiving part of the system in that the signal or message receiving instrument is placed in a local-battery circuit which is normally closed and which is interrupted by the passage of the electrical potential generated in the receiving-conductor, whereas in the Marconi system the receiving signal instrument is arranged in a local-battery circuit which is normally open and which circuit is closed by the passage of the electrical potential generated or produced in the receiving-conductor. I have also indicated that in my system the local-battery circuit at the receiving-station is main-

tained normally closed by means of a fluid or liquid interposed between suitable electrodes arranged in said local-battery circuit. Many specifically different liquids or fluids may be employed for this purpose. I have found that glycerin is well adapted for this purpose, although many other liquids or fluids in liquid viscous or semiviscous form may be employed, and by suitably adjusting the electrodes with respect to each other a desirable range of regulation of the tension through the intervening liquid or fluid may be secured. A convenient arrangement for maintaining the liquid or fluid between the electrodes, but to which the invention is not limited or restricted, is shown, wherein the electrodes are arranged within a box or casing D', adapted to receive or to be filled with the liquid or fluid employed.

I have set forth in the foregoing description that to produce the spark across the dielectric between the terminals B C the condensers are placed in series with each other and with said terminals and that when the condensers are being charged such condensers are placed in parallel relation with respect to each other in circuit with a generator or other source of current-supply. I have also indicated that the circuit changes necessary to place the condensers in series or in parallel relation with respect to each other and to make and break the charging and discharging circuits of the condenser-battery may be effected in any suitable or convenient manner. In Fig. 3 I have shown a convenient arrangement of commutator through which such circuit changes may be effected; but I desire to be understood that my invention is not to be limited or restricted to the particular construction of circuit-changing device employed. In the particular form shown the commutator comprises a series of disks E', carrying suitable contact-plates 1 2 3 4, separated from each other by insulating-spaces and against which bear and coöperate suitable stationary brushes F', adapted during the rotation of the commutator to be brought into successive contact with the contact-plates 1, 2, 3, and 4 and the insulating-breaks between such contact-plates. By reference to Figs. 3, 4, and 5 it will be seen that the contact-plates 3 and 4 occur only on one face of each of the disks E' and are in electrical communication with each other, while the contact-plates 1 and 2 are placed on each side or face of each disk, so as to be simultaneously engaged by brushes arranged between adjacent disks. These brushes F' may be arranged in pairs and on diametrically opposite sides of the shaft upon which the disks E' are mounted, so as to give the proper leads in effecting the arrangement of the condensers into parallel or series relation, respectively, to be charged and discharged. However, since the arrangement of a commutator for effecting the desired result is a matter of workshop expediency which any skilled electrician may readily produce further description of the specific construction of this feature is unnecessary herein.

It is obvious that many variations and changes in the details of construction and arrangement would occur to persons skilled in the art and still fall within the spirit and scope of my invention. I do not desire, therefore, to be limited to the exact and specified arrangements shown and described; but,

Having now set forth the object and nature of my invention and a construction embodying the principles thereof, what I claim as new and useful and of my own invention, and desire to secure by Letters Patent, is—

1. In an apparatus for utilizing electrical oscillations for signaling purposes, a transmitting-station and a receiving-station, means for generating successive wave-trains with all the wave-trains having substantially the same maximum amplitude and receiving apparatus arranged at the receiving-station, as and for the purpose set forth.

2. In an apparatus of the class described, means for successively generating or producing electrical oscillations, said means including a sparking device, and means for producing the sparks at substantially uniform difference of potential, whereby the maximum amplitude of such electrical oscillations is substantially the same in the successive oscillations generated, as and for the purpose set forth.

3. In an apparatus for utilizing electrical oscillations for signaling or similar purposes, a radiating-conductor, spark-terminals therefor, and means for successively raising said spark-terminals to uniform difference of potential at the instant the spark is discharged, whereby the maximum amplitude of such electrical oscillations is substantially the same in the successive oscillations generated, as and for the purpose set forth.

4. In an apparatus of the class described, a transmitting apparatus including sparking apparatus, and means whereby successive sparking occurs at uniform difference of potential, whereby the maximum amplitude of electrical oscillations thus successively generated is substantially the same, as and for the purpose set forth.

5. In an apparatus of the class described, a transmitting mechanism including spark-terminals, and a condenser for charging said terminals and means for raising said condensers to uniform potential for each discharge, whereby the maximum amplitude of successive electrical oscillations generated is substantially the same, as and for the purpose set forth.

6. In an apparatus of the class described, a transmitting apparatus including a radiating-conductor, spark-terminals, a condenser-battery arranged to discharge through said spark-terminals, and means for charging said con-

densers to uniform potential for each discharge thereof, as and for the purpose set forth.

7. In an apparatus of the class described, a radiating-conductor, spark-terminals therefor, and a condenser-battery arranged to be coupled up in series with said terminals to effect the spark discharge, and means for charging said condensers to uniform potential for each discharge, as and for the purpose set forth.

8. In an apparatus of the class described, a radiating-conductor, spark-terminals therefor, and means whereby succeeding sparks are produced or accompanied by the same difference of potential at the spark-terminals, as and for the purpose set forth.

9. In an apparatus of the class described, a radiating-conductor, and means for raising the potential thereof in reciprocal relation to the decrease of the potential of such conductor when discharged, as and for the purpose set forth.

10. In an apparatus of the class described, means arranged to be charged with and discharged of electrical potential to generate or produce electrical oscillations, said means adapted to be charged or the potential thereof raised in reciprocal relation in respect of time to the discharge thereof, as and for the purpose set forth.

11. In an apparatus of the class described, a radiating-conductor, a spark-producing apparatus connected therewith, and means for raising the potential of said conductor in reciprocal relation to the decrease of such potential at the instant of spark discharge, as and for the purpose set forth.

12. In an apparatus of the class described, a radiating-conductor, spark-terminals therefor, a series of condensers, and means for coupling up said condensers in series with each other and with said spark-terminals to produce the spark discharge, as and for the purpose set forth.

13. In an apparatus of the class described, a transmitting device including spark-terminals, a condenser-battery, and a source of current-supply, in combination with means for alternately connecting said condenser-battery in circuit with said terminals and said source of current-supply, as and for the purpose set forth.

14. In an apparatus of the class described, a transmitting apparatus including spark-terminals, a condenser-battery and a source of current-supply for charging said battery, and means for alternately making and breaking the charging and discharging circuits of said battery, as and for the purpose set forth.

15. In the apparatus of the class described, a transmitting apparatus including spark-terminals, a series of condensers, a charging-circuit and a discharging-circuit for said condensers, said discharging-circuit including said spark-terminals, and means whereby said condensers are connected up in series in the discharge-circuit thereof and alternately therewith are connected up in parallel relation with respect to each other in said charging-circuit, as and for the purpose set forth.

16. In an apparatus of the class described, a series of condensers, a charging-circuit and a discharging-circuit therefor, means for alternately making and breaking said circuits, said means operating to connect said condensers in parallel with respect to each other in the charging-circuit and in series with respect to each other in the discharging-circuit, means for generating or producing electrical oscillations including spark-terminals, said terminals being connected in series in the series circuit of said condensers, as and for the purpose set forth.

17. In an apparatus of the class described, a condenser-battery, a charging-circuit and a discharging-circuit for said battery, movable contacts arranged to alternately make and break said circuits, a radiating-conductor, spark-terminals therefor, said terminals being included in the discharging-circuit of said condensers, as and for the purpose set forth.

18. In an apparatus of the class described, a condenser-battery, a charging-circuit and a discharging-circuit therefor, relatively movable and stationary contacts for alternately making and breaking said circuits, a radiating-conductor, spark-terminals therefor, said spark-terminals being arranged in the discharging-circuit of said condenser-battery circuit, as and for the purpose set forth.

19. In an apparatus of the class described, a condenser-battery, a charging-circuit and a discharging-circuit therefor, a commutator arranged to alternately change the relation of the elements of said battery from parallel to series and correspondingly making and breaking the charging and discharging circuits, a radiating-conductor, spark-terminals therefor, said spark-terminals being included in the series discharge-circuit of said battery, as and for the purpose set forth.

20. In an apparatus of the class described, a transmitting apparatus, including spark-terminals and a radiating-conductor, and means for varying the rate per second of the spark discharge between said terminals, as and for the purpose set forth.

21. In an apparatus of the class described, a radiating-conductor, means for raising the potential thereof in reciprocal relation to the decrease of the potential of such conductor when charged, spark-terminals for said conductor, and means for controlling the rate per second of the discharge of said conductor between said terminals, as and for the purpose set forth.

22. In an apparatus of the class described, a radiating-conductor, spark-terminals therefor, means for charging said conductor to uniform potential prior to each discharge thereof, and means for varying the rate per second

of such discharge, as and for the purpose set forth.

23. In an apparatus of the class described, a radiating-conductor, means for charging the same to uniform potential prior to each discharge thereof, and means for varying the self-induction of the charging-circuit to vary the rate of discharge of such conductor, as and for the purpose set forth.

24. In an apparatus of the class described, a radiating-conductor, spark-terminals therefor, a charging-circuit, means arranged in said circuit for charging said conductor to uniform potential prior to each discharge thereof between said terminals, self-induction devices arranged in series in said circuit, and means for varying the angle of inclination of said self-induction devices with respect to each other to vary the rate per second of said discharge, as and for the purpose set forth.

25. In an apparatus of the class described, a radiating-conductor, spark-terminals therefor, a charging-circuit connected to said conductor, means arranged in said circuit for charging said conductor to uniform potential prior to each discharge between said terminals, and coils arranged in series in said circuit, said coils being relatively adjustable to vary the angle therebetween, whereby the rate per second of discharge between said terminals is varied, as and for the purpose set forth.

26. In an apparatus of the class described, a radiating-conductor, spark-terminals therefor, a charging-circuit arranged to raise the electrical potential of said radiating-conductor, said electrical potential being reduced when a spark occurs across said terminals whereby electrical oscillations are produced or generated, and means for varying the electrical surgings or oscillations in the charging-circuit to comparable relation with respect to the electrical oscillations produced by the charge and discharge of said radiating-conductor, as and for the purpose set forth.

27. In an apparatus of the class described, a transmitting apparatus, comprising in combination a radiating-conductor, spark-terminals, a condenser-battery and a generator, means for alternately connecting said condenser-battery to said generator and to said spark-terminals, and relatively adjustable coils arranged in the spark-terminal circuit of said battery, as and for the purpose set forth.

28. In an apparatus of the class described, means for generating electrical oscillations of uniform maximum amplitude, in combination with a receiving apparatus comprising a receiving-conductor having a ground or capacity connection, a local circuit, a receiving instrument arranged in said local circuit, electrodes common to both said ground or capacity connection and said local circuit, and means for maintaining said local circuit normally closed through said terminals, as and for the purpose set forth.

29. In an apparatus of the class described, means for generating or producing electrical oscillations, said means including a sparking device, means for producing the sparks at substantially uniform difference of potential, a receiving-station including a receiving-conductor having a ground connection, a local circuit, and a signal device arranged in said local circuit, a pair of electrodes insulated from each other and common to both said ground connection and said local circuit, and means for maintaining a fluid or liquid connection between said electrodes whereby said local circuit is normally closed, as and for the purpose set forth.

30. In an apparatus of the class described, and in combination with means for generating or producing electrical oscillations of uniform maximum amplitude, a receiving apparatus comprising a receiving-conductor having a ground or capacity connection, a local circuit, a signal device arranged in said local circuit, a pair of electrodes insulated from each other and common to both said local circuit and said ground or capacity connection, means for normally maintaining said local circuit closed through said electrodes, and choking devices arranged in said local circuit, as and for the purpose set forth.

31. In an apparatus of the class described, and in combination with means for generating or producing electrical oscillations of substantially uniform maximum amplitude, a receiving apparatus comprising a receiving-conductor, a ground or capacity circuit therefor, a local circuit, a signal device arranged in said local circuit, and a resistance interposed in said local circuit and common to said ground or capacity connection, as and for the purpose set forth.

32. In an apparatus of the class described, and in combination with means for generating or producing electrical oscillations of uniform maximum amplitude, a receiving apparatus comprising a receiving-conductor, a ground or capacity connection therefor, a local circuit, a signal device included therein, a pair of electrodes insulated from each other and arranged in said local circuit and common to said ground connection, choke-coils arranged in said local circuit, and means for maintaining a fluid or liquid connection between said electrodes whereby said local circuit is normally closed, as and for the purpose set forth.

33. In an apparatus of the class described, the combination with a radiating-conductor, means for charging and discharging said conductor in reciprocal relation with respect to each other, a receiving apparatus including a receiving-conductor, a ground or capacity connection therefor, a local signal-circuit, and a resistance common to both said ground or capacity connection and said local circuit, as and for the purpose set forth.

34. The combination with a radiating-con-

ductor, means for electrically charging and discharging the same in reciprocal relation whereby electrical oscillations are generated or produced during the charging and the discharging operation, a receiving apparatus including a receiving-conductor, a ground or capacity connection therefor, a local signal-circuit, electrodes common to both said ground or capacity connection and said signal-circuit, and means for maintaining a fluid or liquid connection between said electrodes, as and for the purpose set forth.

35. In an apparatus of the class described, a transmitting device including a radiating-conductor and spark-terminals, means for charging and discharging said radiating-conductor at uniform recurring electrical potential, and a receiving device including a receiving-conductor, a ground or capacity circuit therefor, a signal-circuit and a resistance device common to both said ground connection and said signal-circuit and operating to normally close said signal-circuit, as and for the purpose set forth.

36. In an apparatus of the class described, a radiating-conductor, spark-terminals therefor, a condenser-battery arranged to discharge through said terminals, a receiving-conductor, a ground or capacity connection therefor, a signal-circuit, a pair of electrodes insulated from each other and common to said ground or capacity connection and said signal-circuit, and means for maintaining liquid or fluid connection between said electrodes, as and for the purpose set forth.

37. In an apparatus of the class described, a radiating-conductor, spark-terminals therefor, a charging-circuit for said terminals and conductor, means for establishing rhythmic relation between the electrical surgings or oscillations in said sparking circuit and the electrical oscillations produced by the charge and discharge of said conductor, a receiving apparatus including a receiving-conductor, a ground or capacity connection therefor, a local circuit, a signal device arranged therein, choke devices also arranged in said signal-circuit, and a resistance device common to both said ground or capacity connection and said local or signal circuit and operating to normally close said signal-circuit, as and for the purpose set forth.

In witness whereof I have hereunto set my hand, this 7th day of January, 1901, in the presence of the subscribing witnesses.

CLARENCE E. FREEMAN.

Witnesses:
S. E. DARBY,
C. H. SEEM.