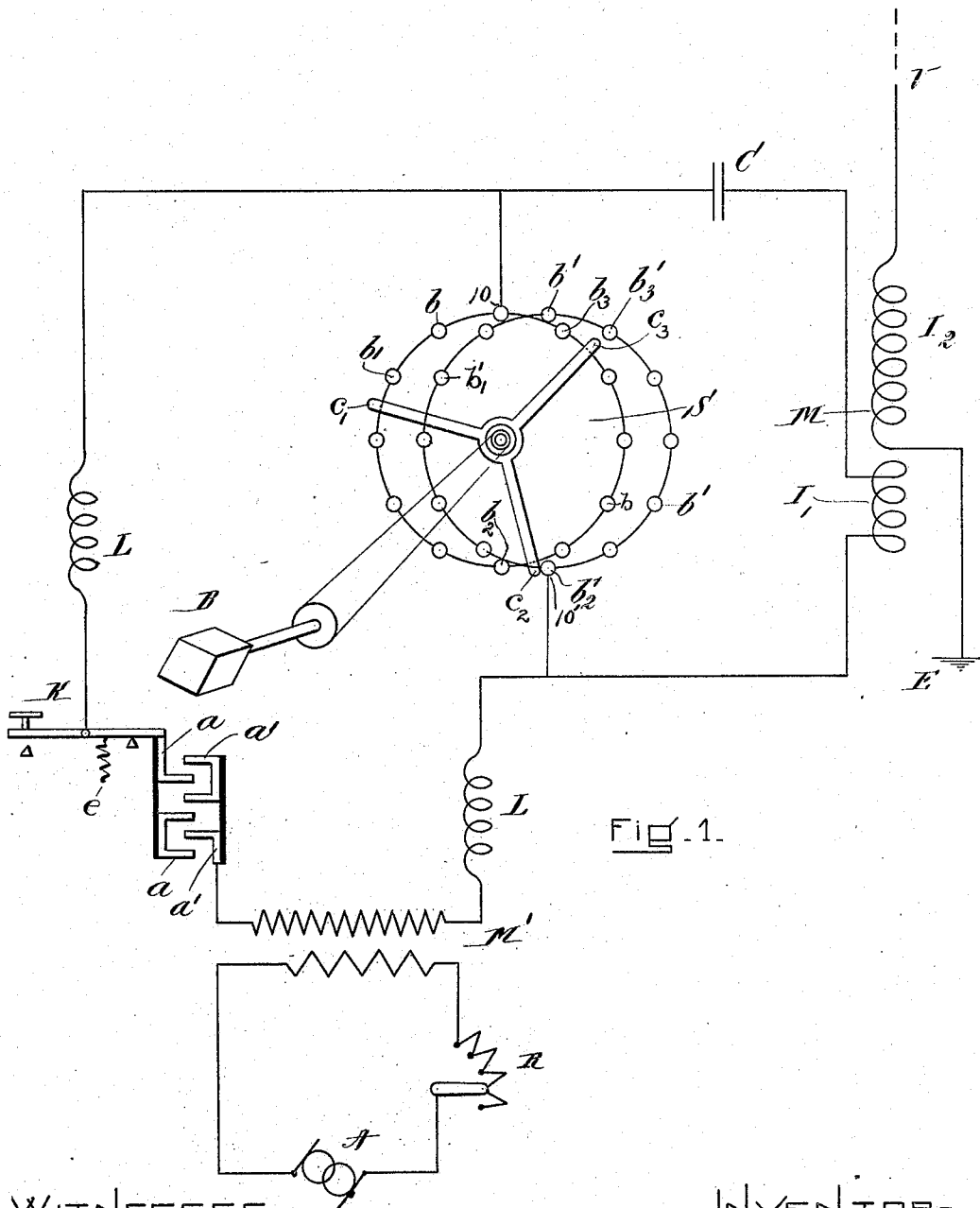


S. CABOT.
SPACE TELEGRAPHY.
APPLICATION FILED DEC. 31, 1906.

937,281.

Patented Oct. 19, 1909.

4 SHEETS—SHEET 1.



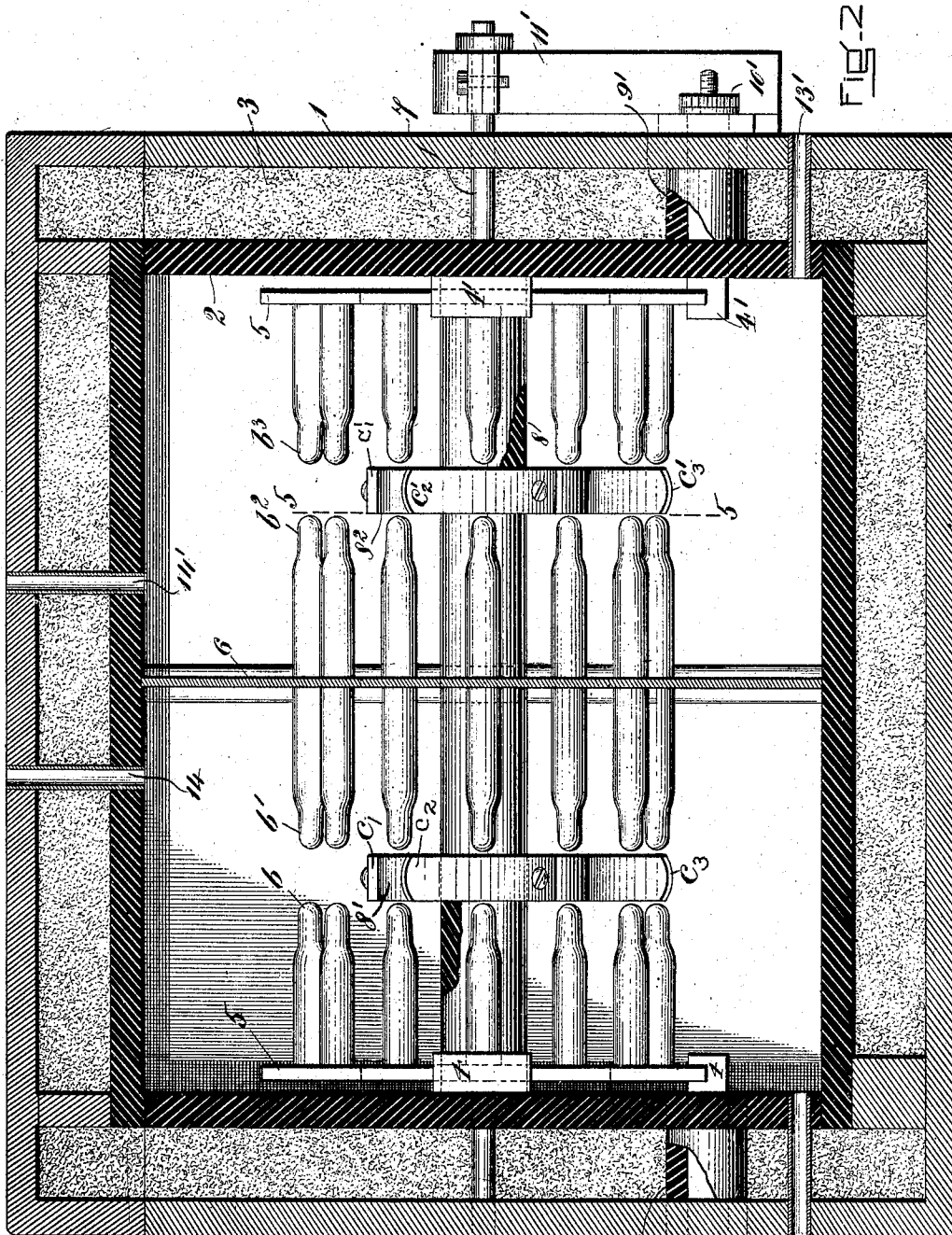
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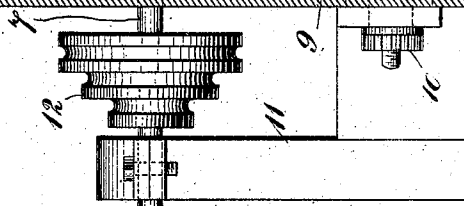
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4 SHEETS—SHEET 2.



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4 SHEETS—SHEET 3.

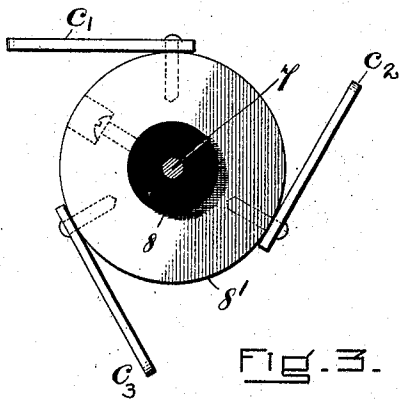


FIG. 3.

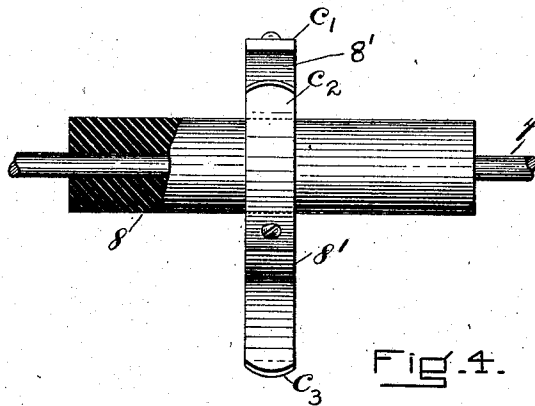


FIG. 4.

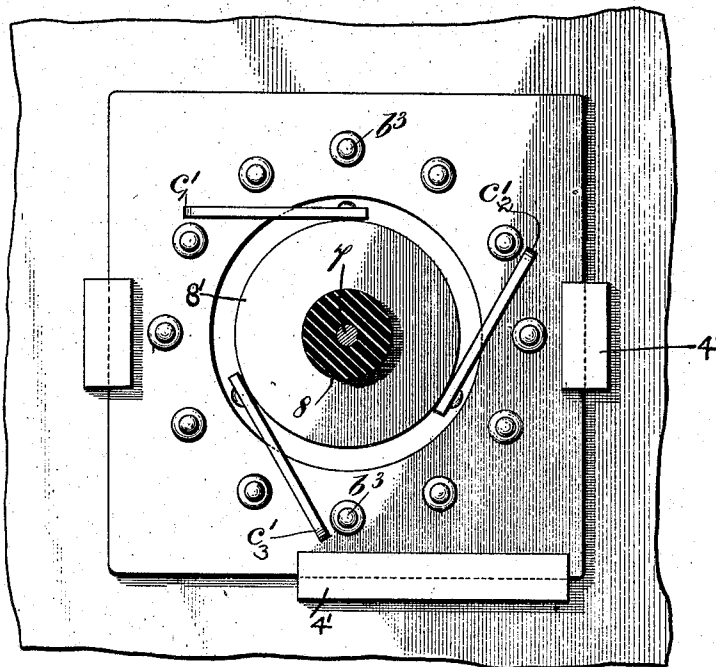


FIG. 5.

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4 SHEETS—SHEET 4.

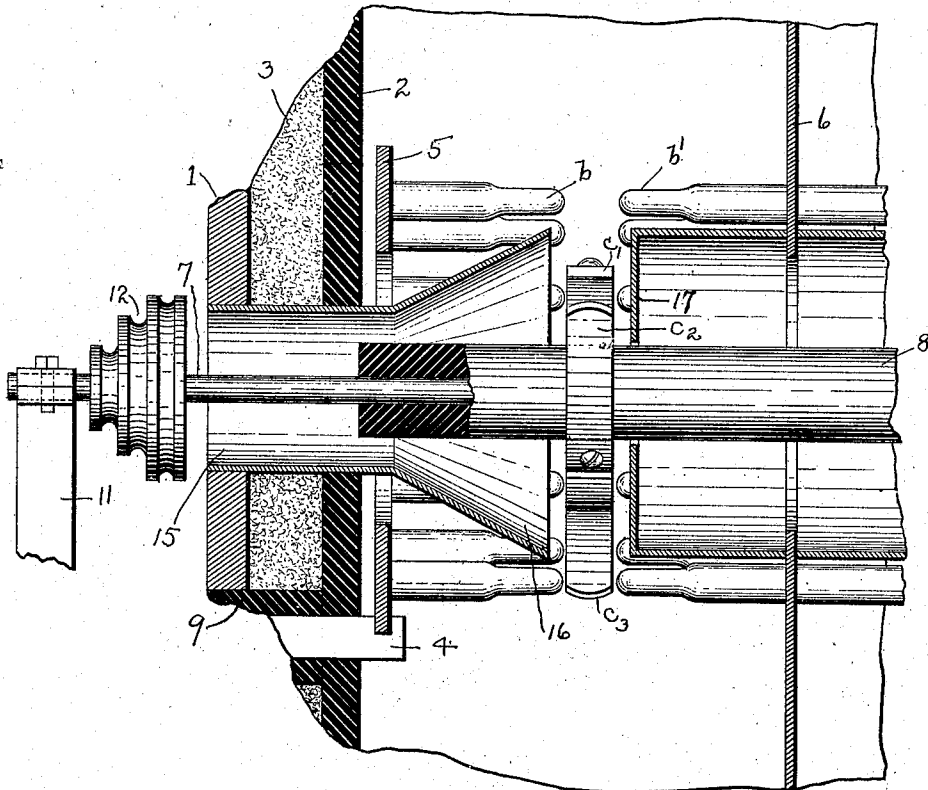


FIG. 6.

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SPACE TELEGRAPHY.

937,281.

Specification of Letters Patent.

Patented Oct. 19, 1909.

Application filed December 31, 1906. Serial No. 350,256.

To all whom it may concern:

Be it known that I, SEWALL CABOT, a citizen of the United States, and a resident of Brookline, in the county of Norfolk 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 space telegraphy and more especially to space telegraph transmitting systems in which a large amount of electrical energy is radiated in the form of electromagnetic waves.

In space telegraph systems in which a sonorous or oscillating circuit is associated with a radiating conductor, the amount of energy absorbed by said sonorous circuit in a given unit of time from the prime source of energy of a given potential is a direct function of the capacity of the condenser included in said sonorous circuit and of the frequency of the spark and is equal to CV^2n , where C represents the capacity of

said condenser, V the applied pressure and n the frequency of the current in the primary power circuit. In such systems, especially where the association or coupling of the oscillating circuit with the radiating conductor is effected by means of a magnetic field, a limitation to the maximum capacity that may be included in the oscillating circuit, for electrical oscillations of a given frequency and with a source of energy of given potential, is imposed by the fact that a certain minimum of inductance is required to maintain an effective coupling and also to maintain the persistency of said circuit. Before this minimum of inductance is reached, the frequency of the oscillating circuit may be increased by reducing the inductance of said circuit; but after said minimum of inductance has been reached the maximum frequency of said circuit with a given energy absorption remains fixed, thereby imposing a limitation upon the usefulness of the system which includes said circuit for selective communication with a number of receiving systems some of which may be attuned to respond to a higher frequency than the aforesaid maximum.

Certain engineering difficulties militate against increasing the energy which may be absorbed in an oscillating circuit by increasing the frequency of the current in the primary power circuit.

One of the objects of my invention, therefore, is to provide a space telegraph transmitting system in which the energy absorbed by the sonorous circuit from the primary power circuit in a given unit of time may be increased without unduly increasing the capacity of said sonorous circuit, the potential of the prime source of power or the frequency of the current in said primary power circuit—as, for example, one in which a sonorous circuit including a condenser of relatively small capacity, say, .015 microfarads, may be used to absorb a relatively large amount of energy at a given potential in a given unit of time from a primary power circuit which is energized by a commercial alternator of ordinary low frequency, say, 60 cycles per second.

It is now well understood that the sensitiveness of the human ear to sonorous vibrations produced by a magneto telephone receiver energized by vibratory currents is a function of the frequency of said currents and that the frequency of said sonorous vibrations for which the ear is most sensitive is about 640 per second, see Rayleigh, *Theory of Sound*, page 473. Also it is a fact that as the frequency of said sonorous vibrations is increased from that which marks the lower limit of audibility up to about 640 vibrations per second, the sensitiveness of the ear to said vibrations increases as a high power of such increase in frequency. For example, when the frequency is raised from 128 to 640, the sensitiveness is increased in the ratio 64 to 1. While it is possible by means of a specially designed alternating current generator giving a relatively high frequency to create at a transmitting station electrical oscillations having a spark frequency of the order of 640 per second so that the rate of vibration of the currents in the local receiving circuit including a telephone receiver shall be of the same order, it is desirable as aforesaid to employ in the primary power circuit a vibratory current not greatly exceeding 60 cycles per second in frequency.

Another object of my invention, therefore, is to provide a space telegraph transmitting system in which, by means of an alternating current of ordinary commercial low frequency, electrical oscillations having a spark frequency much higher than the frequency of said alternating current may be developed, to the ends not only that a circuit in-

cluding a condenser of relatively small capacity may be employed as aforesaid to absorb in a given unit of time a relatively large amount of energy from a prime source of power of given potential, but also that the telephone receiver at the receiving station may be energized by currents of those frequencies to which the human ear is most sensitive.

10 Further objects of my invention are to provide a discharger for the condenser of a sonorous circuit comprising a spark gap constructed and arranged to alter the energy absorbed by said sonorous circuit without altering the length of said gap, and also constructed and arranged so that an air blast may be created by one member thereof and directed across the gap to prevent, or at least to diminish, arcing at said gap.

20 My invention may best be understood by having reference to the drawings which accompany and form a part of this specification and which illustrate one of the many possible embodiments of the discharger which has given good results in practice, together with one arrangement of circuits showing one of the several ways in which said discharger may be connected with a space telegraph transmitting system.

30 In the drawings Figure 1 is a diagram showing a space telegraph transmitting system constructed in accordance with the present invention. Fig. 2 shows an elevation partly in section of one embodiment of my discharger from which the funnel 16, shown in Fig. 6, has been omitted for the sake of clearness. Fig. 3 is an end view partly in section of one of the rotating electrodes and Fig. 4 is a side view also partly in section thereof. Fig. 5 shows a section taken on a line 5—5 of Fig. 2 looking toward the right. Fig. 6 is a fragmentary view showing part of a central vertical section of the discharger illustrated in Fig. 2 and including the aforesaid funnel 16.

45 In Fig. 1, V is an elevated conductor, E is an earth connection, M M' are transformers, C is a condenser, S is a spark gap, L L are inductances, I₁ I₂ are the primary and secondary respectively of the transformer M, B is a motor or prime mover of any suitable type, K is a key, A is a source of vibratory current and R is a rheostat or other suitable means for regulating the output of the source A.

50 The spark gap S as shown comprises a plurality of series of stationary electrodes, one series being shown for purposes of illustration as having 12 electrodes *b*, and the other series as having a like number of electrodes *b'*. The respective members of the series of stationary electrodes are arranged so that each one in series *b* is directly opposite one in series *b'* and also so that all the electrodes of one series are equidistant from

the corresponding electrodes of the other series. For example, *b*₁ is directly opposite *b'*₁; *b*₂ is directly opposite *b'*₂ and *b*₃ is directly opposite *b'*₃ and the distances between each pair of electrodes are all exactly equal, so that the planes determined by the extremities of the two series of electrodes are parallel. A movable member of conducting material having three electrodes *c*₁, *c*₂ and *c*₃ is arranged to rotate between the two series of stationary electrodes, and the movable electrodes may be so positioned as to be equidistant from the planes determined by the two series of stationary electrodes. The movable electrodes are arranged symmetrically with respect to the stationary electrodes so that the movable electrodes, respectively, always are equidistant from a pair of stationary electrodes. For example, in the position shown in Fig. 1, the distances *b*₁ *c*₁ *b'*₁, *b*₂ *c*₂ *b'*₂, and *b*₃ *c*₃ *b'*₃ are equal. The gap S therefore is multiple-series spark gap and electrical discharges simultaneously take place always through three paths which are in multiple with respect to the sonorous circuit S I₁ C.

Any suitable means may be employed for rotating the movable electrodes and in the present instance I have shown the same connected by a belt to the prime mover B, which is preferably so designed as to rotate the movable electrodes at a relatively high speed. It will be understood of course that I do not limit myself to any particular number of series of stationary electrodes or to any particular number of electrodes in each of said series or to any particular number of movable electrodes or to any particular rotational speed of the latter; but I prefer to so relate the speed of rotation of the movable electrodes with the number of the stationary electrodes that the condenser C will be discharged about 640 times per second. By thus discharging said condenser about 640 times per second,—in other words, by creating in the sonorous circuit electrical oscillations having a spark frequency very much greater than the frequency of the currents delivered by the source A,—I greatly increase the energy absorbed per second by the sonorous circuit from the primary power circuit. Thus for example, if the frequency of the source A is 60 cycles per second, the spark frequency of the oscillations created in the sonorous circuit by discharging the condenser thereof through a spark gap of the usual type would be about 120 per second; but by charging and discharging the condenser 600 times per second in lieu of 120 times per second, in accordance with the present invention, I increase the energy absorbed per second by the sonorous circuit from the primary power circuit in the ratio of 5 to 1, and I also produce in the circuit of the telephone receiver at the

receiving station electrical currents of the frequency of those sonorous vibrations to which the human ear is most sensitive.

While any suitable key or sending device may be employed for controlling the current supplied to the sonorous circuit in accordance with the signal to be sent, I prefer to use the type of key shown at K in which the members a and a' form a series gap in the intermediate circuit between the primary power circuit and the sonorous circuit. When the key is held by the spring e in its normal or open position, the resistance of said series gap is too great to permit the complete charging of the condenser C and when said key is depressed the series gap is of sufficiently low resistance to permit the potential impressed upon its terminals to arc across the same and fully charge said condenser.

It will be readily apparent that a spark gap of the kind herein described will automatically alter the energy absorbable by the sonorous circuit in a given unit of time and therefore render any alteration of the length of the spark gap unnecessary, for the distances between each corresponding pair of stationary electrodes, such as $b, b', b_2, b_2', b_3, b_3',$ etc., are such that under no conditions of operation will a spark pass directly therebetween and it is only when one of the conducting members c_1, c_2, c_3 is moved up into proximity to a pair of stationary electrodes that the condenser C will discharge. The position of a movable electrode with respect to a pair of stationary electrodes at which sparking will take place depends upon the adjustment of the rheostat R or other current regulating device in the primary power circuit. The generator A, rheostat R and transformer M' are of course so adjusted with respect to the distances between the stationary electrodes of one series that there can be but one path for the discharge of the condenser C between a member of the series b , a movable electrode and a member of the series b' . For example, the spacing of the several electrodes b and b' is so proportioned that with the maximum potential developable at the terminals of the secondary of the transformer M', sparking will not take place when a movable electrode is equidistant from two stationary electrodes of the series b and, consequently, equidistant from two members of the series b' . If, therefore, we assume that the electrode c_1 is equidistant from b_1 and the electrode of the series b next below b_1 , and, consequently, is equidistant from the electrode b_1' and that electrode of the series b' which is next below b_1' , no spark will pass; but when c_1 moves past such midway position toward b_1, b_1' , a spark will pass from b_1 to b_1' by way of c_1 when the dielectric strength of the gap b_1, c_1, b_1' becomes sufficiently small to be ruptured by the differ-

ence of potential between the series b and the series b' . Clearly, therefore, by regulating the primary power circuit by the rheostat R or other suitable device, the potential to which the condenser C may become charged, said potential below the maximum possible depending upon the length of its discharge path, may be automatically adjusted by the spark gap or discharger itself. For example, if it be desired to charge the condenser C to 75000 volts, the rheostat R is adjusted until the difference of potential between the series b and b' is 75000 volts and then, when the gap between said two series via a movable electrode becomes equal to that which will break down at 75000 volts, the condenser discharges at three points simultaneously from b to b' via the three movable electrodes respectively; and, in like manner, if it be desired to charge said condenser C merely to 5000 volts, the rheostat R is adjusted until the difference of potential between the series b and b' is 5000 volts, in which case the condenser C will discharge as before at three points from b to b' via said three movable electrodes respectively, when the gap between b and b' at each of said points becomes sufficiently small to be broken down by 5000 volts.

The inductances L L are so related to the other inductances and to the capacity of the circuit M' L I, C L a, a' that the inductance reactance of said circuit for alternating currents of the frequency generated by the source A is practically equal and opposite in sign to the capacity reactance of said circuit, so that while the condenser C is charging practically the only opposition to the development of current in said circuit is the ohmic resistance thereof. When said condenser discharges across the gap S, the condenser is practically short-circuited with respect to the secondary of transformer M' by the spark so that during such discharge the inductance reactance of the coils L L is not neutralized by the capacity reactance of said condenser, and therefore said secondary is not short-circuited by said spark and the potential at its terminals is maintained. The oscillatory discharge of the condenser C takes place, even when the sonorous circuit is very persistent, in an interval of time very much smaller than that required for one of the movable electrodes to pass between two consecutive stationary electrodes of one series, so that no difficulty is encountered in creating as many prime discharges of said condenser, or as many trains of oscillations, as desired during the continuance of each half cycle of alternating potential in the primary power circuit.

It will be obvious that the discharger, the principle of which has been explained above in connection with the conventional showing in Fig. 1, may be embodied in a great

variety of working apparatus, and accordingly I desire to be understood that the particular working apparatus which is now to be explained in connection with Figs. 2 to 6 inclusive, is included herein merely for the purpose of more fully disclosing my invention and that it is not in the nature of a limitation.

In Fig. 2, 1 is a casing which may be of hard wood, inclosing an inner casing 2, which may be of rubber or other insulating material, and the space between said casings may be filled with mineral wool 3, or other suitable material for deadening the sound of the spark discharges. The shaft 7 is journaled in the standards 11 11', which may be provided with the pulley 12 adapted to receive a belt from any suitable type of prime mover, and carries one or more disks 8' 8² of conducting material which are secured to the insulating bushing 8. Each disk is provided as shown in the present case with three electrodes c_1 c_2 c_3 , c'_1 c'_2 c'_3 which preferably are secured tangentially to the disks. By means of the clips 4 4', the plates 5 5' are held in position at the ends of the inner casing 2, and each plate carries a series of stationary electrodes b , b^3 , respectively. The central partition 6 of conducting material carries two oppositely arranged series of stationary electrodes b' b^2 . The movable electrodes are arranged as shown in the spaces between the series of stationary electrodes b b' and b^2 b^3 , respectively. The plates 5 5' are connected to the binding posts 10 10' respectively, and the discharger is connected with the sonorous circuit by means of said binding posts as indicated by the numerals 10 10' in the diagram shown in Fig. 1. The clips 4 4' which terminate in the aforesaid binding posts may be surrounded by insulating bushings 9 9'. 13 13' and 14 14' are ventilating apertures. While various means may be employed for creating a blast of air and directing the same across the spark gap for preventing arcing, I prefer as shown in the fragmentary view illustrated in Fig. 6, to insert a tube 15 terminating in a funnel 16 through the casings and surrounding the shaft 7 so that the movable electrode itself will operate as a blower, drawing air into the inner casing and directing an air-blast of considerable force through the space between the terminals of the oppositely arranged series of stationary electrodes. In order to confine the air in said space the shield 17 may be arranged as shown within the series of stationary electrodes opposite that within which the funnel 16 is placed. It will be understood of course that a similar inlet tube, funnel and shield are provided for the second set of electrodes b^2 b^3 which are shown in Fig. 2, and that for the sake of clearness these details have not been illustrated in said Fig. 2.

I do not wish to be understood as limiting myself to the structural details or circuit arrangements which I have herein specifically described for the purpose of more fully disclosing my invention and illustrating the principle thereof, inasmuch as many modifications may be made in said details and arrangements without departing from the spirit of my invention.

I claim,

1. The combination with a sonorous circuit of a multiple spark gap having a rotating member.
2. The combination with a sonorous circuit of a multiple spark gap having stationary members, a movable member, and means creating relative movement between said stationary members and movable member.
3. A discharger for the condenser of a sonorous circuit having in combination a plurality of stationary electrodes connected in multiple, a movable electrode consisting of a plurality of conducting members symmetrically arranged with respect to said stationary electrodes, and means for creating relative movement between said electrodes.
4. The combination with a sonorous circuit of a multiple series spark gap having a rotating member.
5. The combination with a sonorous circuit of a multiple series spark gap having stationary members, a movable member, and means creating relative movement between said stationary members and movable member.
6. The combination with a sonorous circuit of a multiple series spark gap having a plurality of rotating members.
7. The combination with a sonorous circuit of a multiple series spark gap having stationary members, a plurality of movable members, and means creating relative movement between said stationary members and movable members.
8. The combination with a sonorous circuit of a multiple spark gap having a plurality of rotating members.
9. The combination with a sonorous circuit of a multiple spark gap having stationary members, a plurality of movable members, and means creating relative movement between said stationary members and movable members.
10. The combination with a sonorous circuit of a series spark gap having a plurality of sets of stationary members and a plurality of sets of rotating members.
11. The combination with a sonorous circuit of a series spark gap having a plurality of sets of stationary members, a plurality of movable members, and means creating relative movement between said stationary members and movable members.

12. The combination with a sonorous circuit of a multiple series spark gap having a plurality of sets of stationary electrodes, and a movable electrode arranged between
5 adjacent members of said sets of stationary electrodes.

13. The combination with a sonorous circuit of a multiple series spark gap having two sets of stationary electrodes and a movable electrode arranged therebetween.
13

14. The combination with a sonorous circuit of multiple series spark gap for discharging the condenser thereof, said gap

having stationary and movable members and being constructed and arranged to permit the increase of energy absorbed by said sonorous circuit without altering the separation of said stationary members. 15

In testimony whereof, I have hereunto subscribed my name this 29 day of Dec. 20 1906.

SEWALL CABOT.

Witnesses:

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