No. 892,764. PATENTED JULY 7, 1908.

C. C. RUPRECHT.

HIGH FREQUENCY APPARATUS.

APPLICATION FILED FEB. 4, 1907.

3 SHEETS—SHEET 1.

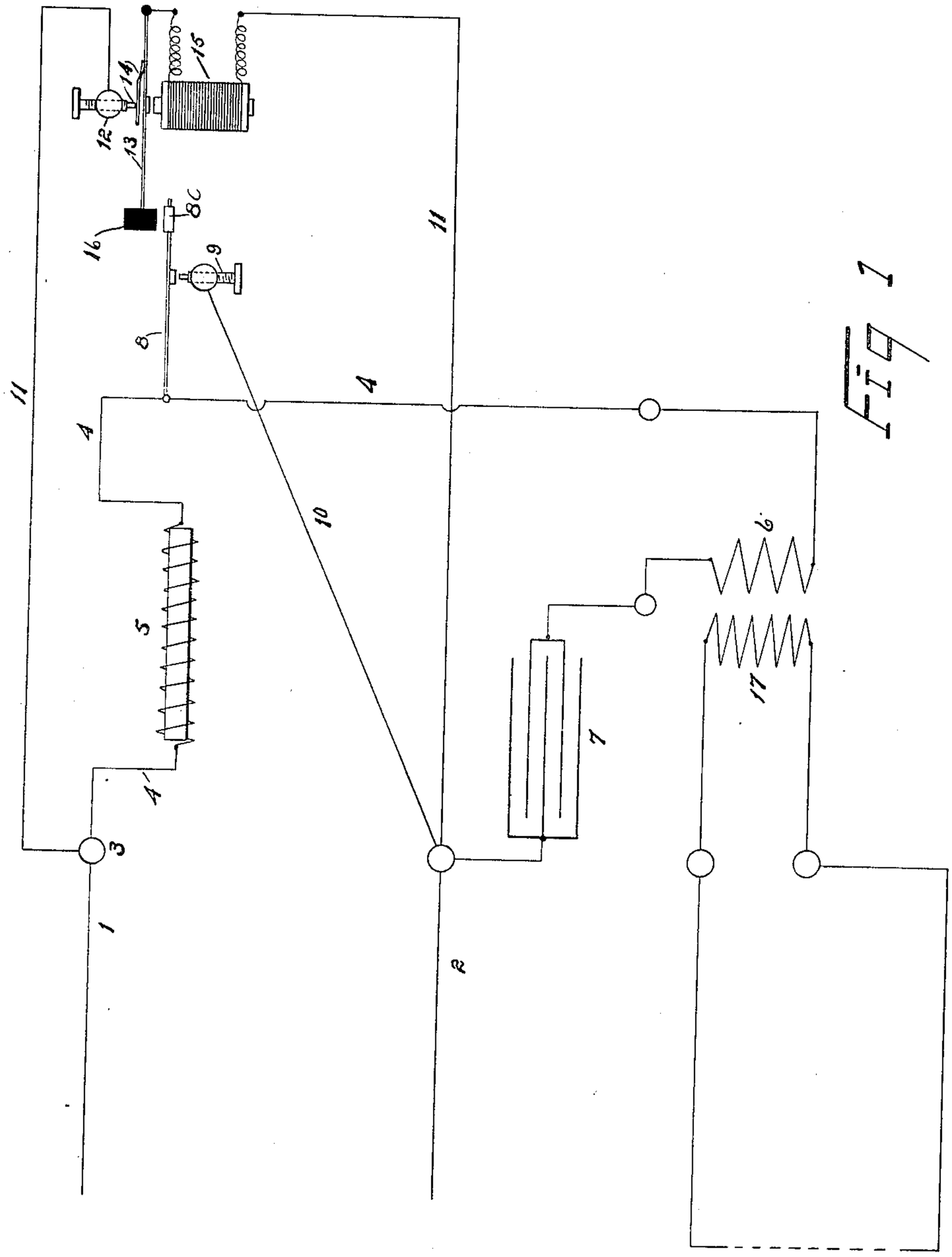

Fig 1

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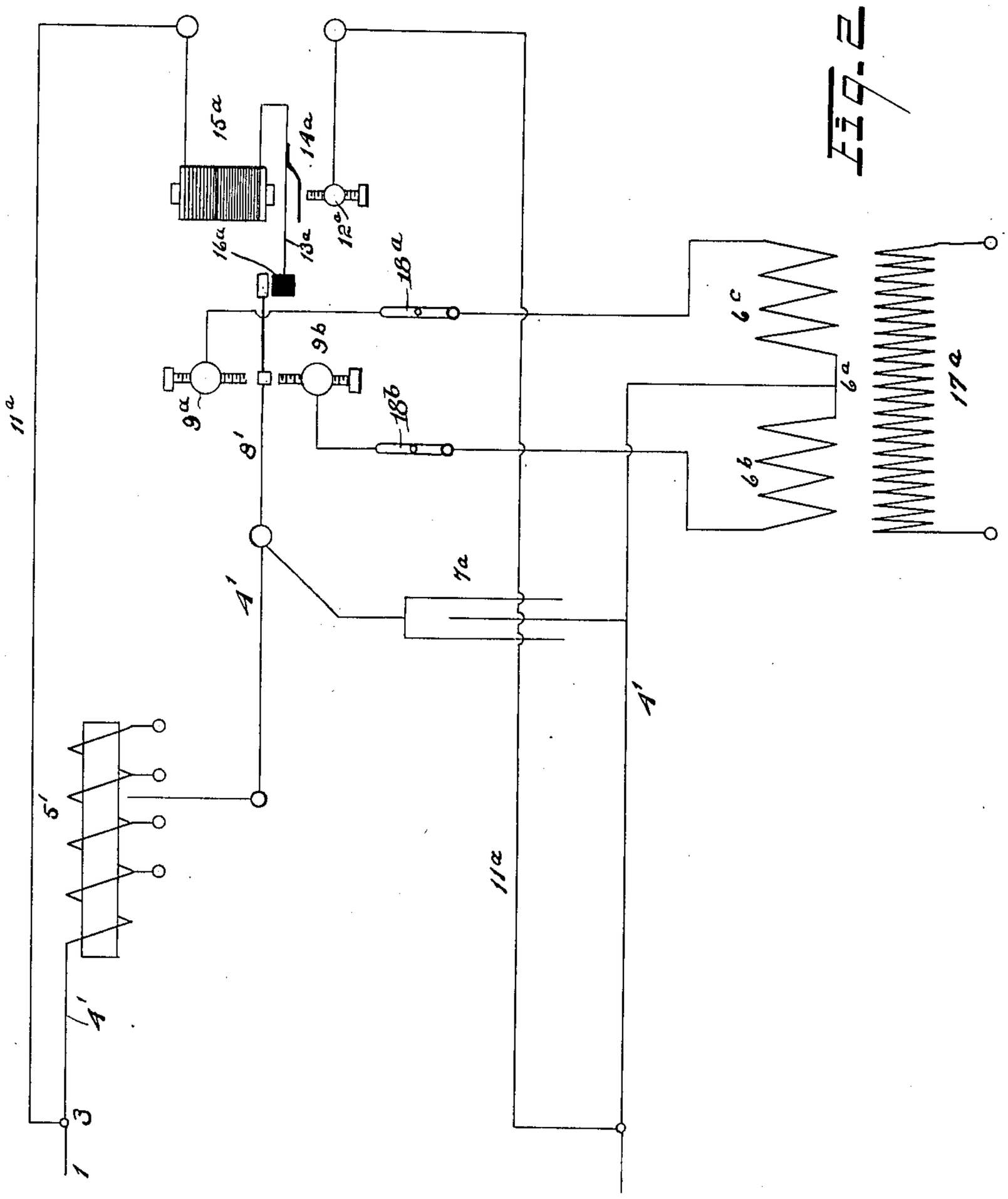
3 SHEETS—SHEET 2.

FIG. 2



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3 SHEETS—SHEET 3.

11a

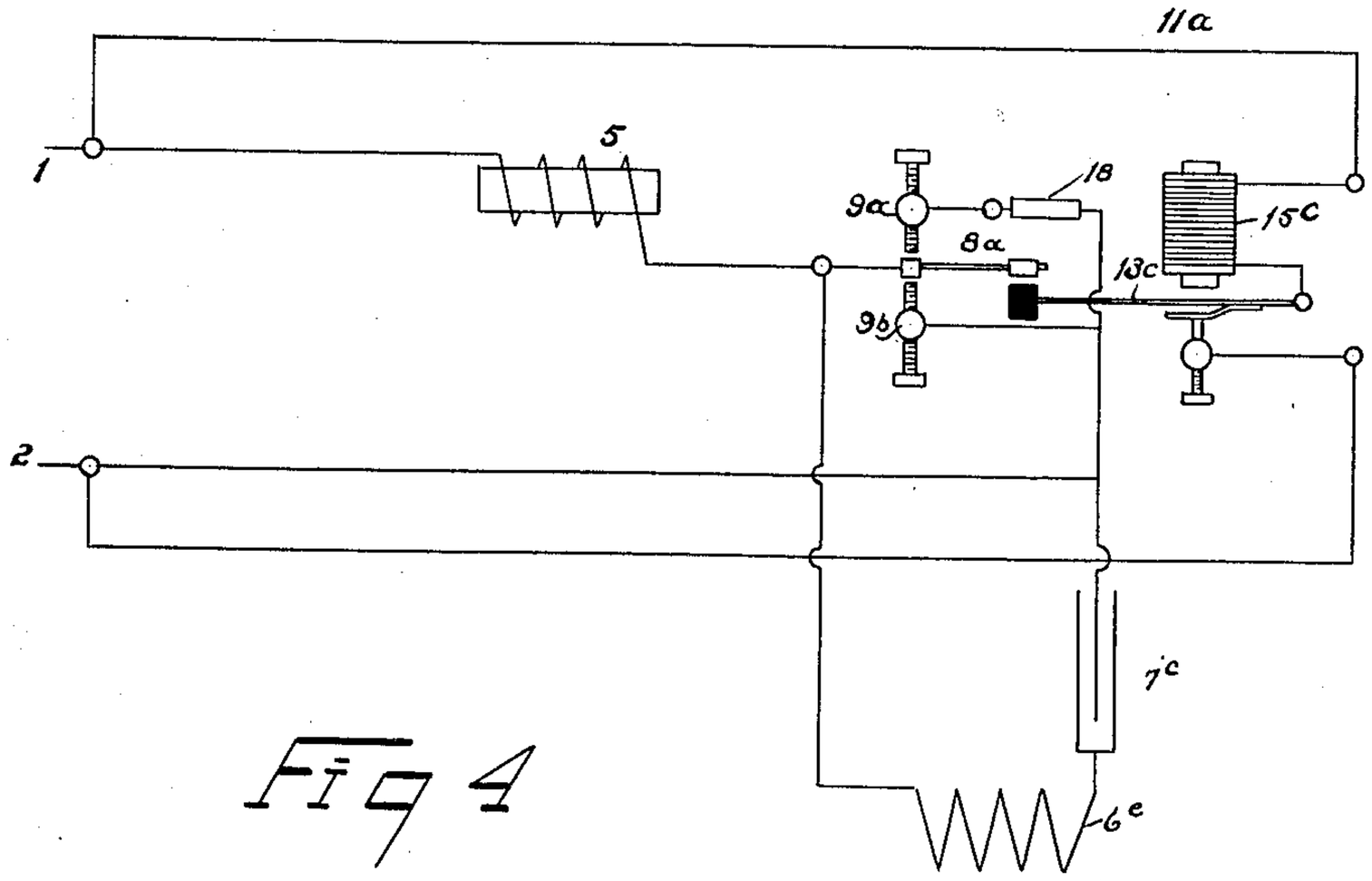


Fig 4

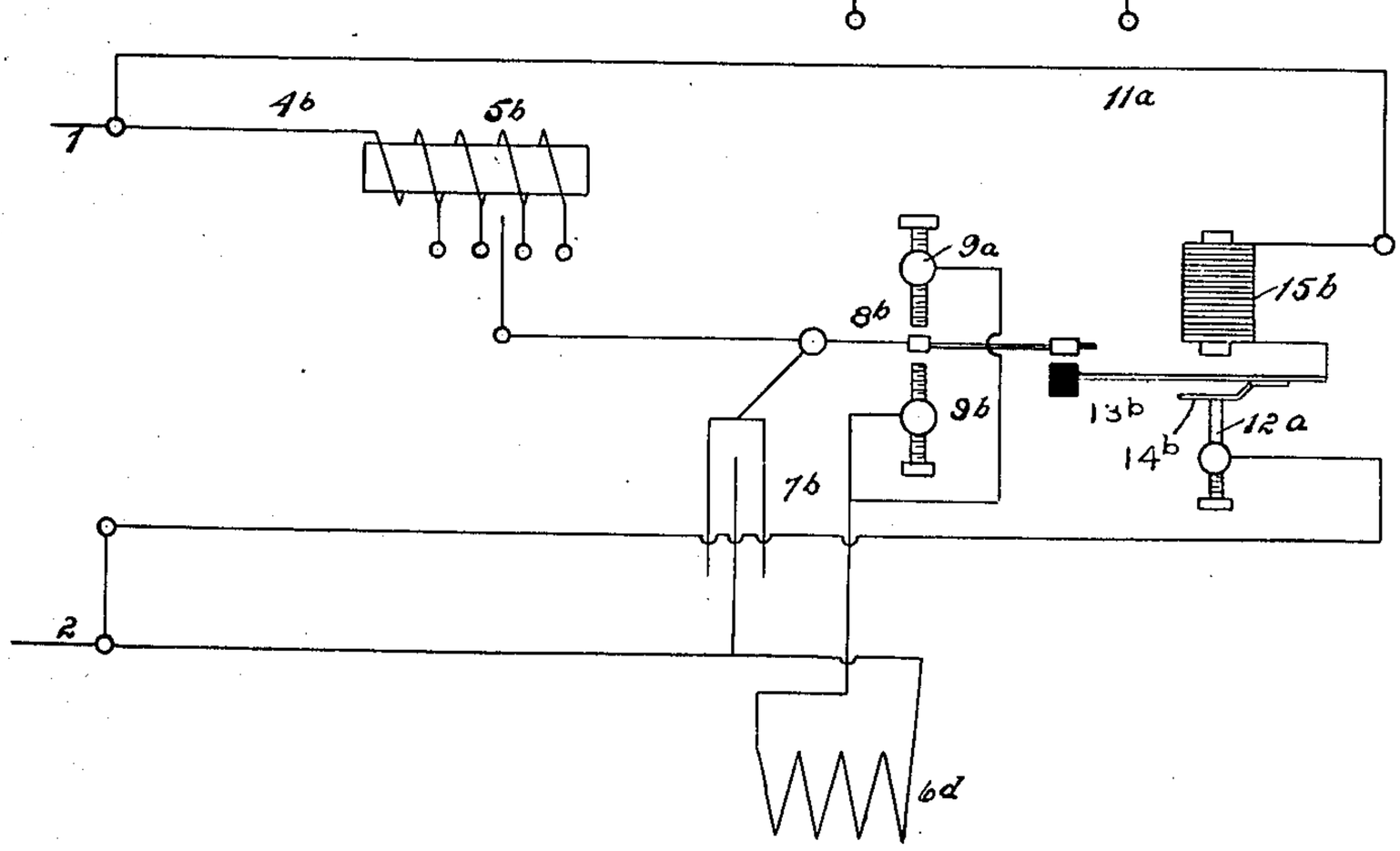
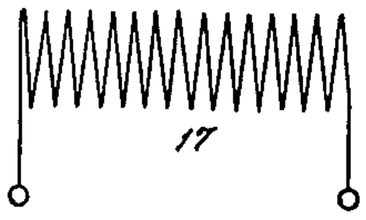


Fig 3



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UNITED STATES PATENT OFFICE.

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HIGH-FREQUENCY APPARATUS.

No. 892,764. Specification of Letters Patent. Patented July 7, 1908.

Application filed February 4, 1907. Serial No. 355,597.

To all whom it may concern:

Be it known that I, CHARLES C. RUPRECHT, residing at Cleveland, in the county of Cuyahoga and State of Ohio, have invented a certain new and useful Improvement in High-Frequency Apparatus, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings.

My invention relates to apparatus for producing high frequencies in any desired circuit. While this result is of importance in various arts, it is especially so in connection with the operation of electro-medical apparatus and for the production of certain therapeutic effects. Among such apparatus may be mentioned vibrators or applicators, and vacuum or X-ray tubes.

The object of the invention is the provision of simple and effective means for producing high frequencies in a circuit; furthermore, to produce in such circuit currents of high frequency having certain characteristics which adapt them especially for electro-medical purposes.

Generally speaking, the invention may be defined as consisting of the combinations of elements, for the purposes specified, embodied in the claims hereto annexed.

Referring to the drawings forming part hereof, Figure 1 represents a diagrammatic view of an apparatus constructed in accordance with my invention; Fig. 2 represents a similar view of a modified form of the invention disclosed in Fig. 1; Figs. 3 and 4 represent similar views of other modifications.

Referring more particularly to the apparatus disclosed in Fig. 1, 1 and 2 designate respectively the terminals of the main line. Terminal 1 is branched at 3, one branch 4 leading to the choke coil or inductive resistance 5 and thence, through the primary 6 of a high-frequency transformer to condenser 7 and from the other side of said condenser to terminal 2. Branch 4 is also divided or branched to include a circuit-breaker or interrupter comprising a weighted vibratory reed 8 and contact 9, said circuit breaker or interrupter being placed in shunt with the primary 6 and condenser 7 through conductor 10 extending between the fixed contact 9 and main terminal 2. Reed 8 is provided with a weight 80 and when at rest is out of contact with 9. The other branch 11 extends from line terminal 1 and includes and is for the purpose of operating an electro-magnetic device by which the circuit through the interrupter hereinbefore referred to is closed. This electro-magnetic device comprises a contact 12, vibratory reed or lever 13 having a spring 14 normally engaging said contact and an electro-magnet 15. Conductor 11 is connected with line terminal 2, whereby the electro-magnetic device is in shunt with branch 4 and the inductive resistance 5, primary 6 and condenser 7.

The reed or lever 13 will preferably be so weighted and operated that its cycle of oscillation will be of considerably longer duration than that of reed 8, and will be independent of the cycle of the circuit which includes the electro-magnet 15. Moreover, it is so located with respect to magnet 15, contact 12 and reed 8 as to engage the reed 8 only during a relatively small portion of its oscillation, thereby enabling 8 to make a number of contacts with 9 before it is again engaged by 13. By properly arranging the parts, 8 may be given a new impetus before it fails to contact with 9 on its swing toward the same, thus insuring an unbroken and effective operation of the interrupter during the time that the apparatus is in use. To prevent short circuiting, reeds 8 and 13 are insulated, as by a weight 16 of suitable insulating material on the latter.

With the parts arranged as above described, suppose that a current enters the apparatus through terminal 1. The current flows through 7, branch 11 and the electro-magnetic device therein. This causes magnet 15 to attract lever 13, the insulating material 16 on which engages the adjacent portion of reed 8 and forces said reed into contact with 9, thereby closing the circuit through 4, 8, 9 and 10. When the circuit is broken, the condenser 7 is charged and when closed the condenser is discharged. The weighting of 8 causes it to vibrate slowly and to break the circuit slowly between itself and contact 9, with the result that, with the high potential developed by the use of the inductive resistance 5, the arc between 8 and 9 will persist for a relatively long period after actual contact between the same has been broken. During the persistence of this arc, which is secured by the slow break between 8 and 9, the condenser will

continue to discharge back and forth across the gap between 8 and 9 a great number of times. The breaking down of the high resistance of the air gap between the contact 9 and contact on reed 8 by the slow vibration of the said reed, together with the manner of connecting the condenser and the primary 6 and the reactance due to resistance 5 produces an oscillatory discharge between the opposite sides of the condenser which is equalized through the primary 6, producing currents of correspondingly high frequency and potential in the circuit including the secondary 17.

The apparatus disclosed herein will operate to produce the desired current in the circuit which includes the secondary coil, whether the current supplied through terminal 1 be direct or alternating. With the latter circuit there may be employed any suitable apparatus with which it is desired to make use of the high frequencies developed within the same. As previously intimated, a circuit having such high potential and high frequencies is particularly useful in connection with vibrators or applicators, in vacuum tubes and other electro-medical apparatus.

It will be observed that the choke-coil or inductive resistance 5 is in the circuit which includes the primary 6 and condenser 7 as well as in the circuit 4, 8, 9 and 10 which is in shunt with said condenser and primary coil, while the discharging circuit for the condenser is of less resistance, as it does not include resistance 5.

In Fig. 2, the arrangement of parts is generally the same as that shown in Fig. 1. In this modification, the current supplied through 1 is divided as before, part being enabled to flow through the conductor 4′, variable inductive resistance or choke coil 5′ to reed 8′ and through either of the contacts 9^a, 9^b, to primary 6^a and thence to terminal 2. Condenser 7^a is shunted across between the portion of 4′ which connects 5′ and 8′ and that portion of 4′ which connects primary 6^a and terminal 2. Circuit through 11^a includes electro-magnet 15^a, reed 13^a, spring 14^a and contact 12^a, and, as before, extends therefrom to terminal 2. Reeds 8′ and 13^a are suitably insulated, as by means of a block of insulation 16^a carried by reed 13^a.

There are two main points of difference between the apparatus shown in this figure and that shown in the preceding figure. In the first place, the primary winding 6^a of the high frequency transformer is divided. When the circuit is closed through 8′ and 9^a, through energizing magnet 15^a and movement of 13^a, current flows through half of the primary winding from the right hand to the center thereof and thence to line terminal 2. When the circuit is closed through 8′ and 9^b, the current will flow through the other half of the primary winding; from the left hand to the center thereof and thence to line terminal 2.

With the parts arranged as described and with both contacts in operation, which result will be secured by closing the switches 18^a and 18^b in the circuits including contacts 9^a, 9^b, and the primary 6^a, there will be a reversal of the inductive effects in the primary windings 6^b, 6^c. Furthermore, the condenser in Fig. 2 is not in series with both branches of the primary of the high-frequency transformer at the same time and is shunted across the interrupter.

By suitably weighting the reed 8′, as in the case with the embodiment of my invention disclosed in Fig. 1, the arc formed between the contact portion of said reed and contacts 9^a and 9^b will persist, and permit the condenser 7^a to discharge across the gap during the persistence of the arc and to produce currents of high frequency and high potential in the circuit including the secondary 17^a. At the same time, the reversal of the inductive effects in the primary windings 6^b, 6^c greatly increases the efficiency of the transformer, the number of frequencies thereof, and the therapeutic effects produced in the circuit including the secondary winding.

For a period of the persistence of the arc, the condenser discharge is oscillatory in character, producing an oscillatory current in the primary coil or winding, with a corresponding oscillatory current in the secondary. This oscillatory discharge persists until the resistance produced by the elongation of the arc between the fixed and the movable contact is greater than $\sqrt{\frac{4L}{K}}$ (wherein K denotes the capacity of the condenser and L the inductance of the circuit). This elongation of the arc produces a damping effect on the condenser which, with the tendency of the gases of the arc to transmit in one direction only, produces a unidirectional discharge from the condenser, with corresponding unidirectional currents in the primary and secondary windings. This result is secured by the slow break between the fixed and movable contacts and by securing a proper balance between the capacity of the condenser and the inductance of the circuit. By the construction and arrangement of parts herein disclosed, and particularly the construction and arrangement illustrated in Figs. 2 and 3 of the drawings, I am enabled to produce in electro-medical apparatus a polarized discharge which produces certain therapeutic effects ordinarily incapable of production by alternating currents. The character of the currents produced in the circuit including the secondary winding is such as to enable electrolysis to be accomplished thereby, which, so far as I am aware, has not been accomplished heretofore by other alternating currents. Furthermore, it enables

me to operate vacuum tubes and X-ray apparatus without the deleterious effects of the reflex charge. The polarization of the discharge when coupled with the method of connecting the parts by which the charging current passes through the primary of a high frequency transformer enables me to obtain currents capable of high frequency which will produce static effects. So far as I am aware, these static effects have hitherto been secured only through the means of frictional machines and have not been obtained from an alternating current. The discharge from the condenser 7^a is utilized in both branches 6^b and 6^c of the primary, and the current used to charge the inductive resistance 5′ must pass through said branches. This creates a condition which is productive of increased results therein by preventing the persistence of an arc of non-oscillating character and by other effects due to magnetic reactions.

In Fig. 3, there is shown an apparatus, similar to that shown in Fig. 2, but with the employment of a single winding for the primary of the high frequency transformer. In this figure, the circuit from line terminal 1 branches, one circuit including conductor 4^b, variable inductive resistance or choke coil 5^b, reed 8^b, either of the contacts 9^a, 9^b, primary winding 6^d and main terminal 2. Condenser 7^b is connected in the same manner as in Fig. 2. The other circuit includes conductor 11^a, electro-magnet 15^a, reed or lever 13^b, spring contact 14^b, fixed contact 12^a and line terminal 2, as in the case of Fig. 2. With the exception that there is no central tap to the primary winding of the high frequency transformer, the arrangement of the parts of the apparatus shown in this figure is the same as that shown in Fig. 2.

In Fig. 4 there is shown a somewhat similar arrangement of parts. In this embodiment, the same form of resistance 5 is employed as in Fig. 1, but I make use of the two contacts 9^a, 9^b, as is the case with the embodiment shown in Fig. 3. In Fig. 4, the condenser 7^c is in series with the primary winding 6^e of the high frequency transformer. When in a state of rest, the reed 8^a is in contact with neither of the fixed contacts 9^a, 9^b, and it is only upon the movement of the reed 13^c, which is in the shunt circuit 11^a, that the circuit including reed 8^a is closed. The impulse given to the reed 8^a is such as to cause it to move first in engagement with one fixed contact and then in engagement with the other, resulting, when the switch 18 is closed, in doubling the number of contacts ordinarily made and the number of frequencies set up within the circuit including the secondary 17.

In all forms of my invention, I make use of a circuit independent of the interrupter circuit for the purpose of automatically operating the interrupter. If the vibratory reed 8 were omitted and the electro-magnetic make-and-break device were used in place thereof, the desired results could not be obtained in the circuit including the secondary. The current in said circuit would be irregular in action and highly destructive to the contact points. The employment of an independent circuit and an independent actuating device for the interrupter enables me to avoid destructive sparking between the contacts of the interrupter.

I claim:

1. In an apparatus for producing high frequency currents, the combination of a circuit having in series therewith the primary coil or winding of a transformer, a circuit including the secondary winding of said transformer, a condenser arranged to have its discharge equalized through said primary coil or winding, and an interrupter for discharging said condenser including a fixed and a movable contact, said interrupter being constructed to maintain a relatively long contact between the fixed and movable contacts compared with the period of vibration of the movable contact, substantially as specified.

2. In an apparatus for producing high frequency currents, the combination of a circuit having in series therewith the primary coil or winding of a transformer, a condenser arranged to have its discharge equalized through said primary coil or winding, and means for discharging said condenser, said means comprising a fixed contact and a vibratory reed, said vibratory reed being weighted to cause it to vibrate slowly and produce an arc with the fixed contact on breaking the circuit thereat, and for a relatively long period thereafter and a circuit including the secondary coil or winding of said transformer, substantially as specified.

3. In an apparatus for the purpose described, the combination of a condenser, a circuit including the primary coil of a transformer, a circuit including the secondary coil of said transformer, and a circuit breaker or interrupter for said condenser, said circuit breaker or interrupter comprising a fixed and a movable contact, the parts being arranged to retard the separation of the fixed and movable contacts after engagement, substantially as specified.

4. In an apparatus for the purpose described, the combination of a circuit, and means for producing a current of high frequency therein, said means including a condenser, a circuit breaker for discharging said condenser, and a separate circuit having therein a periodically operating actuating device for said circuit breaker, the periodicity of the actuating device being independent of the cycle of the circuit which includes the same, substantially as specified.

5. In an apparatus for the purpose described, the combination of a circuit and

means for producing therein a current of high frequency, said means including a condenser, and means for discharging said condenser, said last-mentioned means comprising a circuit breaker having a fixed contact and a vibratory contact, and a circuit, independent of said contacts, having means therein for initially operating said vibratory contact, substantially as specified.

6. In an apparatus for the purpose described, the combination of a circuit and means for producing therein a current of high frequency, said means including a condenser, and means for discharging said condenser, said last-mentioned means comprising a circuit breaker having a fixed contact and a vibratory contact, and a circuit, independent of said contacts, having means therein for periodically moving the vibratory contact into engagement with the fixed contact, substantially as specified.

7. In an apparatus for the purpose described, the combination of a circuit and means for producing therein a current of high frequency, said means including a condenser, and means for discharging said condenser, said last-mentioned means comprising a circuit breaker having a fixed contact and a vibratory contact, and a circuit, independent of said contacts, having means therein for initially operating said vibratory contact and for thereafter operating the same periodically to insure effective circuit-closing between the fixed and vibratory contacts, substantially as specified.

8. In an apparatus for the purpose described, the combination of a circuit, and means for producing a current of high frequency therein, said means comprising a condenser, a circuit including a fixed contact and a vibratory contact for discharging said condenser, and a circuit, independent of the former circuits, having therein an electromagnet, and an armature for said magnet arranged to engage said vibratory contact, substantially as specified.

9. In an apparatus for the purpose described, the combination of a circuit, and means for producing a current of high frequency therein, said means comprising a condenser, a circuit including a fixed contact and a vibratory contact for discharging said condenser, and a circuit, independent of the former circuits, having therein an electromagnet, and an armature for said magnet arranged to engage said vibratory contact and move the same into engagement with the fixed contact, substantially as specified.

10. In an apparatus for the purpose described, the combination of a circuit, and means for producing therein a current of high frequency, said means including a condenser, a circuit including a fixed contact and a vibratory contact for discharging said condenser, and a circuit independent of the former circuits and having therein an electro-magnet and a vibratory armature therefor arranged to engage the vibratory contact, the vibration-frequency of the armature being lower than that of said vibratory contact, substantially as specified.

11. In an apparatus for the purpose described, the combination of a circuit having in series therewith the primary coil or winding of a transformer, a second circuit including the secondary coil or winding of said transformer, a condenser arranged to have its discharge equalized through said primary coil or winding, means for discharging said condenser, said means including a circuit breaker or interrupter arranged to break the circuit slowly thereat to produce an arc between the fixed and movable contacts of said breaker or interrupter, and means for reversing the direction of flow of the currents in said primary coil or winding, substantially as specified.

12. In an apparatus for the purpose described, the combination of a circuit having in series therewith the primary coil or winding of a transformer, a second circuit including the secondary coil or winding of said transformer, a condenser arranged to have its discharge equalized through said primary coil or winding, means for discharging said condenser through said primary coil or winding, said means comprising a pair of fixed contacts, a vibratory contact interposed between the fixed contacts and arranged to engage both of said fixed contacts alternately, and connections between said contacts and said primary coil or winding, substantially as specified.

13. In an apparatus for the purpose described, the combination of a circuit having therein an inductive resistance, an interrupter and the primary winding of a high frequency transformer, a second circuit including the secondary coil or winding of the latter transformer, a condenser in series with said interrupter and in series with the primary coil or winding of said high frequency transformer, said interrupter comprising a vibratory contact and two fixed contacts, and said primary winding being branched, one branch connecting with one of the fixed contacts and the other branch connecting with the other fixed contact, and a central tap connected to one side of the condenser and the central portions of the two branches of the winding, substantially as specified.

14. In an apparatus for the purpose described, the combination of a circuit, and means for producing a current of high frequency therein, said means comprising a condenser, a circuit breaker for discharging said condenser, said circuit breaker including a vibratory contact and a pair of fixed contacts, a primary winding comprising two oppositely wound branches each connected

with a fixed contact and a common tap leading from said branches, substantially as specified.

15. In an apparatus for the purpose specified, the combination of a circuit having therein the secondary winding of a transformer, and means for producing in said circuit currents of high frequency, said means comprising a circuit having therein the primary of said transformer, said primary consisting of two windings extending in opposite directions from the central portion of said primary, a pair of fixed contacts connected with opposite ends of said primary, a vibratory contact operative between said fixed contacts, and a condenser in series with the central portion of said primary and alternately in series with each of said contacts, substantially as specified.

16. In an apparatus for the purpose specified, the combination of a circuit having therein the secondary winding of a transformer, and means for producing in said circuit currents of high frequency, said means comprising a circuit having therein the primary of said transformer and an inductive resistance, said primary consisting of two windings extending in opposite directions from the central portion of said primary, a pair of fixed contacts connected with opposite ends of said primary, a vibratory contact operative between said fixed contacts, and a condenser one side whereof is connected with the central portion of said primary and the other side whereof is connected in the second circuit between the inductive transformer and the contacts.

17. In an apparatus for the purpose specified, the combination of a circuit and means for producing a current of high frequency therein, said means comprising a primary and a secondary winding, a condenser arranged to discharge through said primary winding, and means for producing a unidirectional discharge from said condenser for a portion of the interval required for complete discharge, substantially as specified.

18. In a high-frequency apparatus, the combination of a circuit having in series an inductive resistance or choke coil, an interrupter, and the coil or winding of a high frequency apparatus, and a condenser arranged to equalize its discharge through said coil or winding, the interrupter comprising a fixed and a movable contact constructed and arranged to produce a prolonged contact and a retarded movement after contact, substantially as specified.

19. In a high-frequency apparatus, the combination of a circuit having in series an inductive resistance or choke coil, an interrupter, and the primary coil or winding of a high-frequency transformer, and a condenser arranged to equalize its discharge through said coil or winding, said interrupter being arranged to reverse the direction of the current in said coil or winding, substantially as specified.

20. In an apparatus for the purpose specified, the combination of a circuit and means for producing a current of high frequency therein, said means comprising a primary and a secondary winding, a condenser arranged to discharge through said primary winding, and a circuit breaker or interrupter for discharging said condenser, said circuit breaker or interrupter comprising a fixed contact and a flexible vibratory reed arranged to engage the fixed contact intermediate its fixed and free ends, the free end being weighted at a distance from the fixed contact, whereby said reed may flex between the fixed contact and the weighted portion thereof, substantially as specified.

21. In an apparatus for the purpose specified, the combination of a circuit, and means for producing a current of high frequency therein, said means comprising a primary coil or winding, a condenser arranged to discharge through said coil or winding, and a circuit breaker or interrupter for discharging said condenser, said circuit breaker or interrupter comprising a flexible vibratory reed having adjacent to its free end a weight, and a fixed contact intermediate the fixed end of said reed and the weight and arranged to engage said reed at a point distant from the weight to permit flexing of the reed between said contact and said weight, said fixed contact being adjustable toward and from said reed, and means for initially operating said reed, substantially as specified.

In testimony whereof, I hereunto affix my signature in the presence of two witnesses.

CHARLES C. RUPRECHT.

Witnesses:
J. B. HULL,
H. MILLER.