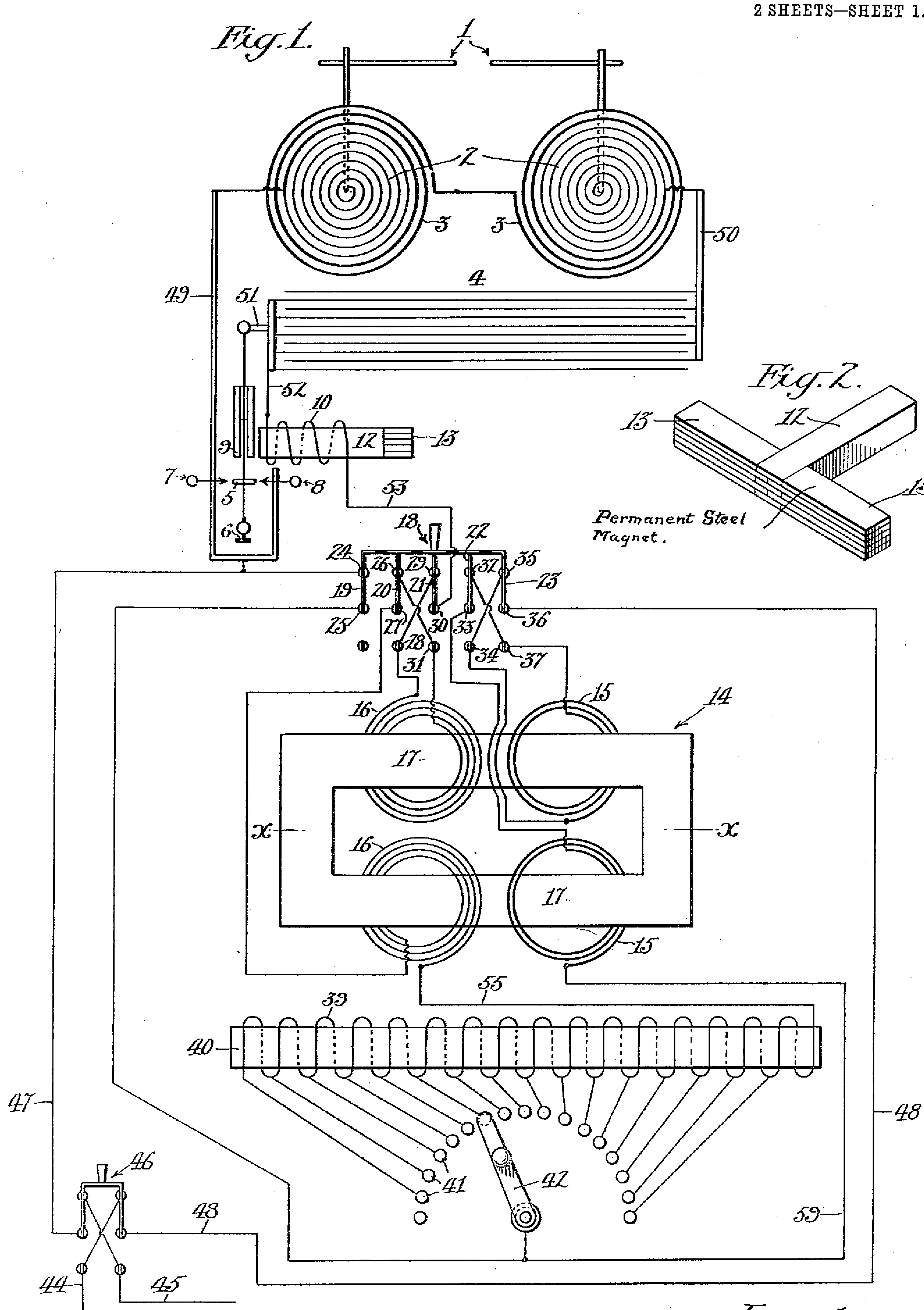
No. 880,046. PATENTED FEB. 25, 1908.

J. E. SEELEY.

HIGH FREQUENCY DISCHARGE APPARATUS.

APPLICATION FILED NOV. 26, 1906.

2 SHEETS—SHEET 1.



Witnesses:—
Frank L. A. Graham
Isabel Hall.

Inventor;
James E. Seeley.
By Townsend, Lyon Hackley & Knight
his Att'ys

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2 SHEETS—SHEET 2.

Fig. 3.

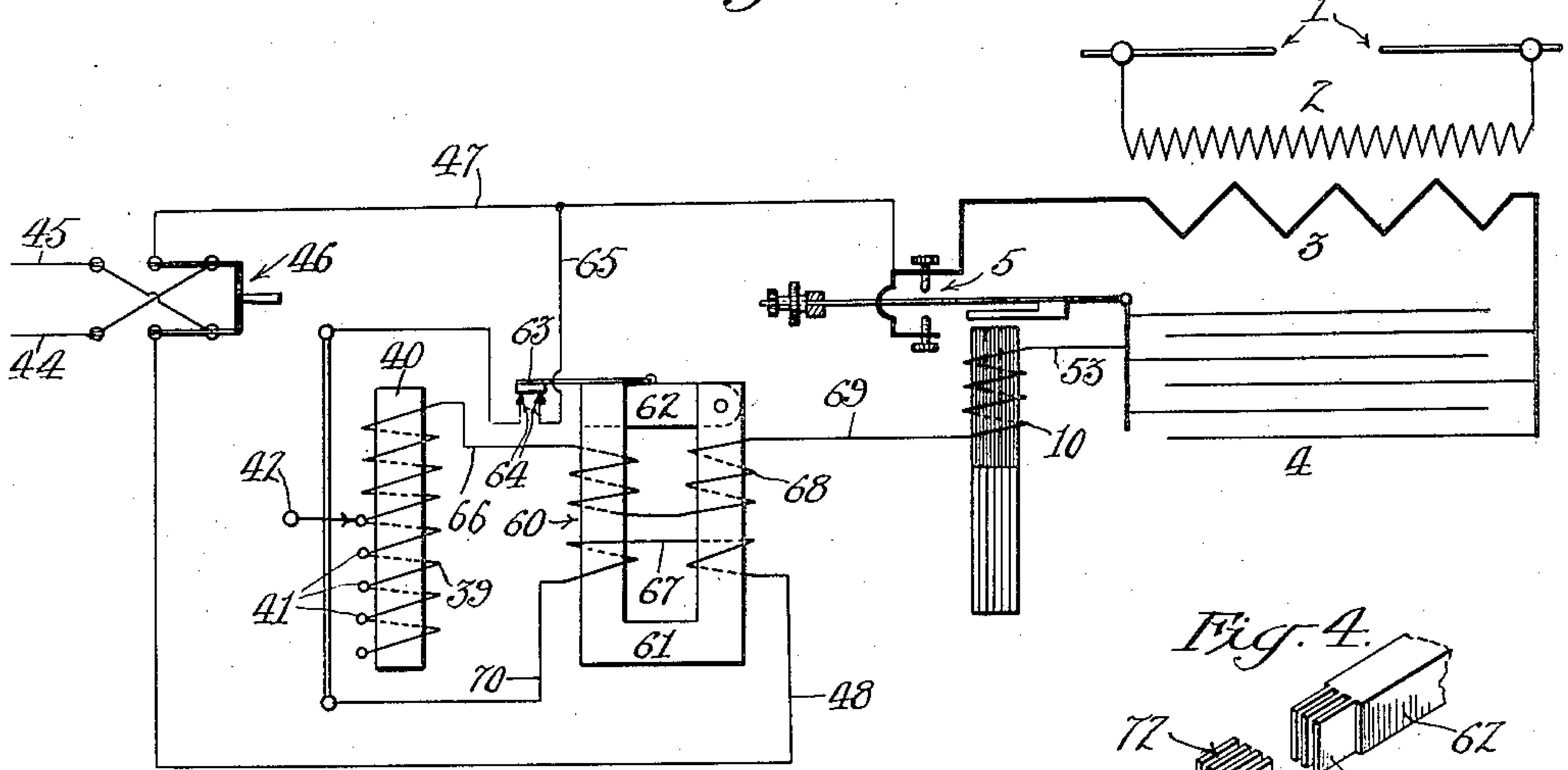


Fig. 4.

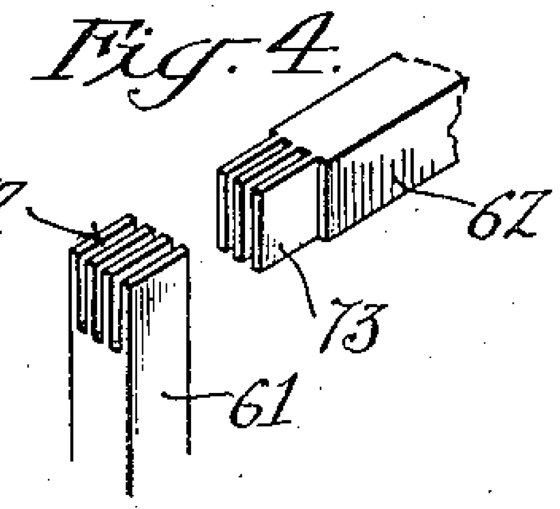
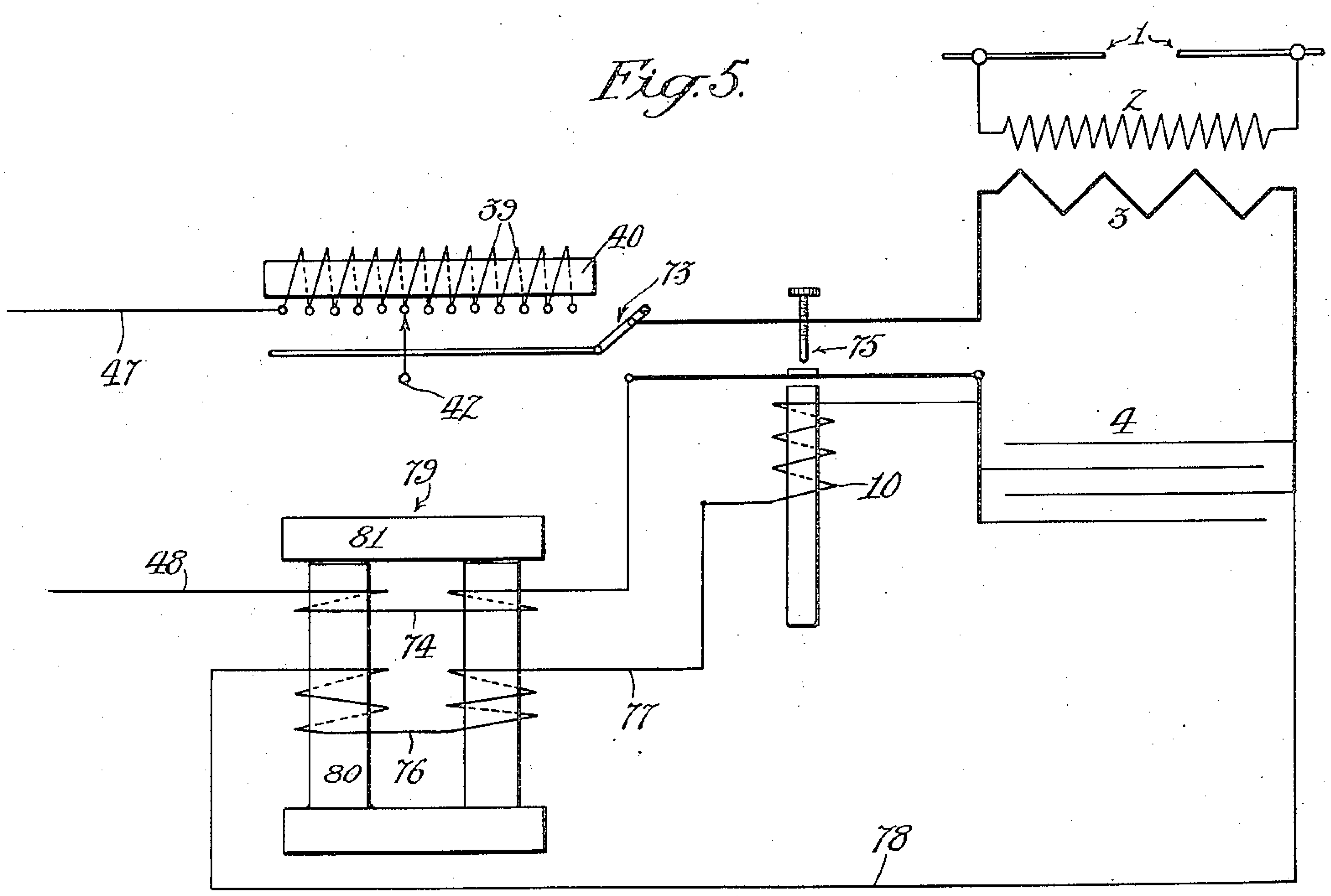


Fig. 5.



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James E. Seeley.
By Townsend, Lyon, Hackley & Knight
Attys

UNITED STATES PATENT OFFICE.

JAMES E. SEELEY, OF LOS ANGELES, CALIFORNIA, ASSIGNOR TO SYNCHRONOUS STATIC COMPANY, OF LOS ANGELES, CALIFORNIA, A CORPORATION OF CALIFORNIA.

HIGH-FREQUENCY DISCHARGE APPARATUS.

No. 880,046. Specification of Letters Patent. Patented Feb. 25, 1908.

Application filed November 26, 1906. Serial No. 345,242.

To all whom it may concern:

Be it known that I, JAMES E. SEELEY, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles, State of California, have invented a new and useful High-Frequency Discharge Apparatus, of which the following is a specification.

This invention relates to means for producing high frequency electric discharges by the use of either alternating or direct current.

One object of the invention is to provide, in such an apparatus, induction means for producing the discharge which will also operate as a transformer when on alternating current, to supply energy by induction from the supply line to the charging circuit.

Another object of the invention is to provide for energizing the interrupter of the discharge apparatus without direct connection of said apparatus to the line.

Another object of the invention is to provide inductive means which will operate efficiently both on alternating and direct circuit connections.

Another object is to provide sufficient induction in the charging circuit to give the requisite charge to the condenser, without at the same time producing such impedance as to prevent flow of sufficient current from the line to give the full output of the apparatus.

The accompanying drawings illustrate the invention:—

Figure 1 is a diagram of an electric discharge apparatus embodying the invention. Fig. 2 is a perspective of the polarizing means for the interrupter. Fig. 3 is a diagram of another form of the invention. Fig. 4 is a perspective of a part of the combined inductance and transformer means in Fig. 3. Fig. 5 is a diagram of another form of the invention.

Referring to Fig. 1, the apparatus comprises discharge terminals 1 connected to the secondary 2 of an induction coil whose primary 3 is connected to one side of a condenser 4, the other side of which is connected through the interrupter 5 to the other side of the primary 3 of the induction coil. The interrupter 5 may be of any usual or suitable construction, but is shown as a ribbon stretched by an adjusting screw 6 to vary its tension and rate of vibration, back and front contacts 7, 8 between said ribbon vibrates, and an armature 9 carried by said ribbon and acted upon by an electro-magnetic device 10 consisting of a coil on core 12. Said electro-magnetic device is energized to produce periodic operation of the interrupter, the periodicity being determined by the interrupter itself on direct current and being determined by the frequency of the alternating current when the latter is used. Such operation of the electro-magnetic device is effected by an energizing connection, which with direct current, is supplied with energy from the line, and with alternating current, is supplied with energy by induction from the line. To enable this electro-magnetic device to respond quickly to the energizing impulses, its core 12 is preferably laminated soft iron and in order to give a quick action to the interrupter the said core is preferably polarized, as by means of a permanent steel magnet contacting therewith at one end. Said steel magnet is shown as consisting of two members 13 placed end to end and inter-locking with the soft iron core 12, see Fig. 2.

14 represents an electro-magnetic device which serves as a transformer for producing by induction from the line current for energizing the interrupter and for charging the condenser, and also serves as a means for providing the proper amount of inductance in the charging circuit. Said electro-magnetic induction device 14 is provided with two windings 15, 16 wound on a core 17, the winding 15 comprising a pair of coils wound on two legs or sides of said core, and the winding 16 comprising a pair of coils wound respectively over or alongside of the coils 15. Core 17 is preferably a closed iron circuit core, the windings and switching connections of the coils being such that on alternating current both pairs of coils act conjointly to produce magnetic flux in the same direction in the core in a closed magnetic circuit, and on direct current the coils act oppositely on the core so as to produce polarization or an open magnetic circuit, the coils 15, 16 on the upper leg, for example, acting to produce polarity in one direction and the coils 15 and 16 on the lower leg acting to produce polarity in the opposite direction, so that the poles are developed on the line x—x. Such change in the connections of the coil for alternating and direct current is effected by means of a

switch comprising blades 19, 20, 21, 22, 23, preferably operated in unison, and terminals 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37.

39 designates a variable impedance consisting for example of a coil wound on a core 40 and connected at different points along its length to contacts 41 controlled by and coöperating with a switch arm 42 to include any desired part of the impedance in circuit.

The supply line indicated at 44, 45 is connected through a reversing switch 46 to wires 47, 48 leading to contacts 24, 36 of the switch 18, wire 47 also being connected to one side or wire 49 of the primary of the discharge circuit. The other side 50 of the discharge circuit is connected to one side of the condenser 4 from the other side of which a connection 51 is made to the interrupter and another connection 52 is made to the energizing winding 10 for the interrupter. From the interrupter a wire 53 leads to contact 30 of switch 18. The contacts 26, 27, 28, 29, and 31 are connected to coils 16 of the induction device in such manner as to connect the same in series in either direction between the wire 53 and a wire 55, connected to one end of the variable impedance. The contacts 32, 33, 34, 35, 37 of the switch 18 serve a similar purpose for the coils 15.

The operation is as follows:—Assuming that alternating current is being supplied by the line wires 44, 45, the switch 18 is placed in position shown in the drawings, and current entering from wire 44 passes through switch 46, wire 48, switch terminal 36, switch blade 23, terminals 35, 34, upper coil 15, terminals 37, 32, switch blade 22, terminal 33, lower coil 15, wire 59, switch terminal 25, switch blade 19, terminal 24 and wire 47 to the other side of switch 46 and of the line. There is another circuit from the wire 59 through the variable impedance and the secondary coil 16, etc., but as far as the current from the line is concerned this connection is short-circuited by switch blade 19 and need not be considered, There is thus impressed upon the induction device the full alternating electro-motive force of the line and the alternating magnetic flux thereby developed in said induction device generates in the secondary coils 16, an induced current passing as follows:—From upper coil 16 to terminals 28, 29, switch blade 21, terminal 30, wire 53, interrupter operating winding 10, connection 52, interrupter 5, back contact 7 or front contact 8, primary discharge circuit 49, wire 47, terminal 24, switch blade 19, terminal 25, wire 59, contact arm 42, variable impedance 39, lower coil 16, contact 27, switch blade 20, terminals 26, 31 to the other side of the coil 16. The windings of the coil 15, 16 are such that this discharge impulse is of considerably higher potential than the alternating supply. It is a matter of some difficulty in devices of this character to provide for sufficient intensity of discharge without at the same time producing such impedance in the induction device as to choke off the current from the line and seriously diminish the output of the apparatus. By making the induction producing coils separate from the energizing coils receiving the alternating supply, I am enabled to make such energizing coils of sufficiently low induction to allow heavy flow of current from the line and full energization of the core of the induction device or transformer and at the same time the self induction of the device which is used to charge the condenser is rendered sufficiently high for that purpose. A further object of this construction is that it enables the proper intensity of charging electro-motive force to be obtained, both with alternating current and with direct current. At each charging impulse coming from the coils 16 and the variable impedance there is an electro-motive force applied to the opposite sides of the condenser, this, however, being insufficient to produce a high frequency discharge. A further effect of this charging impulse is to operate the interrupter by energizing, such operation being in synchronism with the current in the supply circuit. At the moment of the break, for example, at the back contact, the kick from the coil 16 and the impedance and also from the coil 10 charges the condenser, and the condenser then discharges in a high frequency oscillatory discharge in the circuit 4, 51, 5, 7, 49, 3, 50, thereby generating in the secondary 2 of the induction coil a high tension discharge passing between the electrodes 1. A similar operation is produced when the interrupter breaks at the front contact 8, the polarized core 12 serving to cause positive operation of the interrupter in both directions. The number of impulses for the given number of operations of the interrupter is thereby doubled. It will be noted that in case of alternating current, by suitably proportioning the winding 10 and the condenser 4 thereof, to secure quick action, the interrupter may be operated by the current passing from the coils 16 into the condenser even when contacts 7 and 8 are open, the capacity of the condenser allowing sufficient current flow to start the vibrator into operation.

For operation on direct current, the front contact 8 should be moved out of operating position, leaving the interrupter in contact with the back contact. The switch 18 is turned down to close contact with terminals 28, 31, 34, 37, and switch 46 is placed in one or the other position, according to the direction of the supply current. The current will then pass as follows:—From wire 44 through switch 46 to wire 47, primary discharge circuit wire 49, interrupter contacts 7, interrupter 5, wire 52, coil 10, wire 53, terminal 30, switch blade 21, terminal 31, upper coil 16, terminal 28, switch blade 20, terminal 27, lower coil 16, wire 55, impedance 39, switch 42, wire 59, lower coil 15, terminal 33, switch blade 22, terminal 34, upper coil 15, terminal 37, switch blade 23, wire 48 and the other side of the switch 46 of the line. The two pairs of coils 16, 15 are thus placed in series, the current passing therethrough in a direction to produce polarization or open circuit magnetization of the core on the line $x—x$ in two oppositely directed magnetic circuits; upper coils 15, 16 polarize the upper half of the core in one direction and lower coils 15, 16 polarize the lower half in the opposite direction. The core thus acts as an open magnetic circuit giving a sharp, quick discharge on breaking the energizing circuit. The higher reluctance due to this open magnetic circuit is compensated for by the fact that the energizing coils 15, 16 are connected in series on each side, the action of coil 15 being supplemented by coil 16, which has a greater number of turns. This placing the two coils in series is also of advantage in that the mean effective electro-motive force in a direct current circuit of given nominal potential is higher than that of an alternating current circuit of the same nominal potential and therefore requires a greater number of turns. At each operation of the interrupter by the direct current flow as above, the condenser is charged and discharges in a high frequency oscillatory current substantially as above described.

The form of the invention shown in Fig. 3 is similar to that in Fig. 1 except that the electromagnetic induction device 60 is wound so that the coils 67, 68 thereof act in similar directions both on alternating and direct current, and the open magnetic circuit which is desirable for obtaining the proper discharge on direct current, is obtained by forming the core 61 of said device with a bridge 62 which may be moved to make an open magnetic circuit or to make a closed magnetic circuit. A switch 63 is operated by the movement of this bridge to close connection with contacts 64 in the circuit 65 from the supply line 47 to the variable impedance. This circuit may continue through wire 66 to the coils 68 of the electromagnetic induction device and by a connection 69 to coil 10 and thence to the condenser and interrupter and back to wire 47, as above described. The coils 67 of the electromagnetic device are connected by wires 70, 48 to the variable impedance and to the main switch 46. The connections are otherwise as above described. The bridge 62 of the electro-magnetic induction device and the core of said device are laminated and are preferably interlocked by grooves 72 and projections 73 as shown in Fig. 4 to decrease the reluctance of the closed magnetic circuit.

When alternating current is used to supply the apparatus the combined switch and bridge device 62 is lowered, closing the magnetic circuit of the induction device and also closing the circuit at 63 so that an energizing circuit for the said induction device is established from line 44, 45 through wire 47, the impedance means 39, coil 67 of the induction device and return wire 48 to the other side of the line.

For operation with direct current the combined magnetic bridge and switch 62 is raised, opening the connection at 63 and opening the magnetic circuit of the induction means 60, so as to enable the latter to discharge rapidly. Current will flow from the line 44 through wire 47, to the back contact of the interrupter, through the interrupter to the other side of the primary discharge circuit, through connection 53, windings 10, 68 and impedance means 39 to contact means 24, and by wire 72, and winding 67 to the other side of the line at 45. The current so passing will energize the interrupter operating magnet, and the induction device 13 and will change the condenser substantially as above described

In the form of the invention shown in Fig. 5, a switch 73 is provided for connecting line wire 44 and variable impedance 39, either to the interrupter 75 or to the energizing coil 74 of the induction device 79. The secondary coil 76 of the induction device is connected by wires 77, 78 with the interrupter operating magnet 10 and the condenser. The operation will be understood from the above. Core 80 of the induction device has a keeper 81. On direct circuit this keeper may be removed to give the quick discharge.

What I claim is:—

1. A high frequency discharge apparatus comprising a discharge circuit, a charging circuit, a supply circuit, an induction apparatus having a plurality of windings, means for connecting one of said windings in the supply circuit and the other of said windings in the charging circuit, and means for connecting both of said windings in the charging circuit.

2. A high frequency discharge apparatus comprising a discharge circuit, a charging circuit, a supply circuit, an induction apparatus having a plurality of windings, means for connecting one of said windings in the supply circuit and the other of said windings in the charging circuit, and means for closing or opening the magnetic circuit of the induction device to adapt it for operation with either alternating or direct current.

3. A high frequency discharge apparatus comprising a discharge circuit, a charging circuit, a supply circuit, an induction apparatus having a plurality of windings, means for connecting one of said windings in the supply circuit and the other of said windings in

the charging circuit, said induction device having a closed circuit core, and switch means for connecting the coils on said core to energize the core on closed magnetic circuit or in open magnetic circuits in opposite directions.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 16th day of November 1906.

JAMES E. SEELEY.

In presence of—
ARTHUR P. KNIGHT,
FRANK L. A. GRAHAM.