

March 20, 1928.

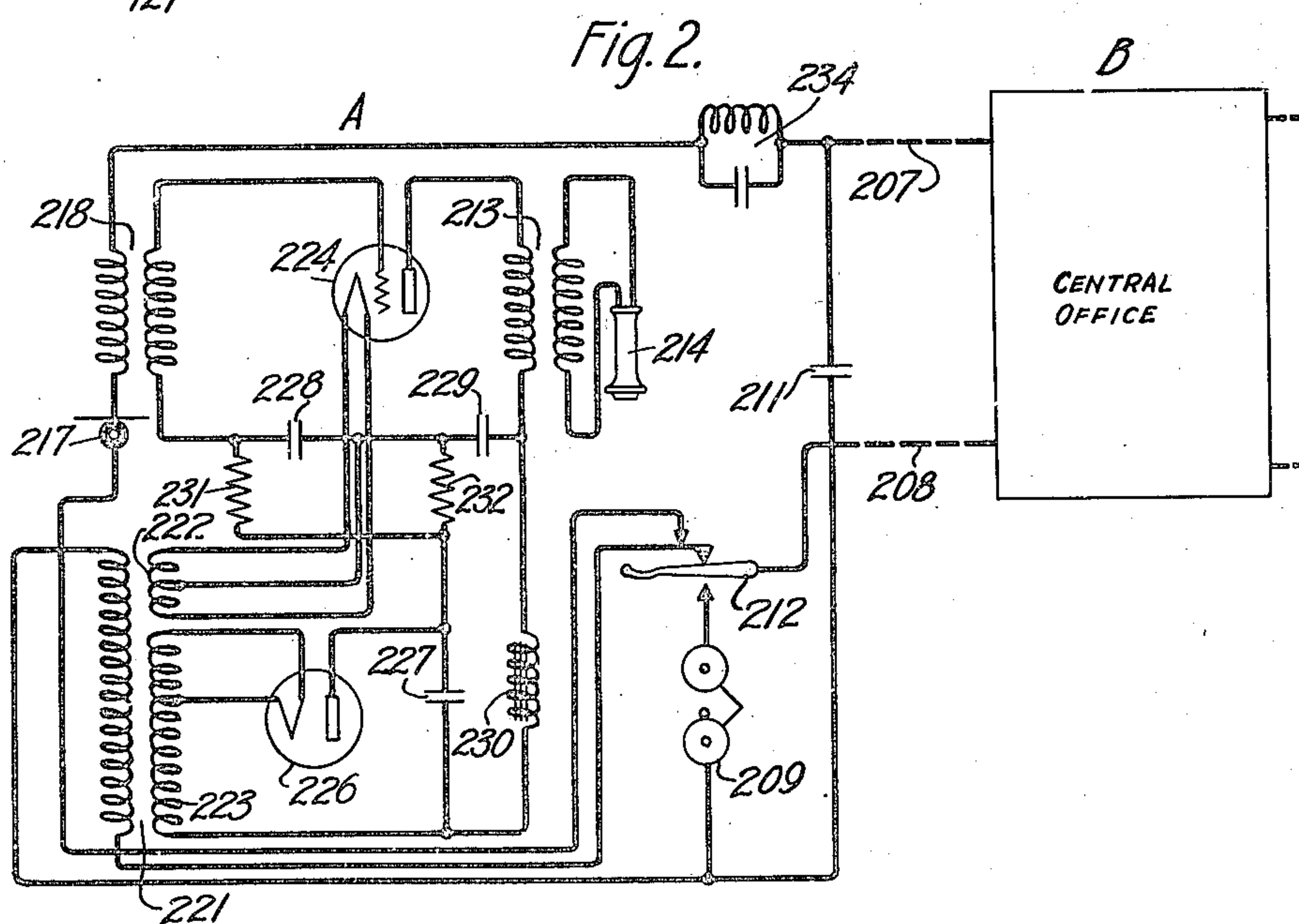
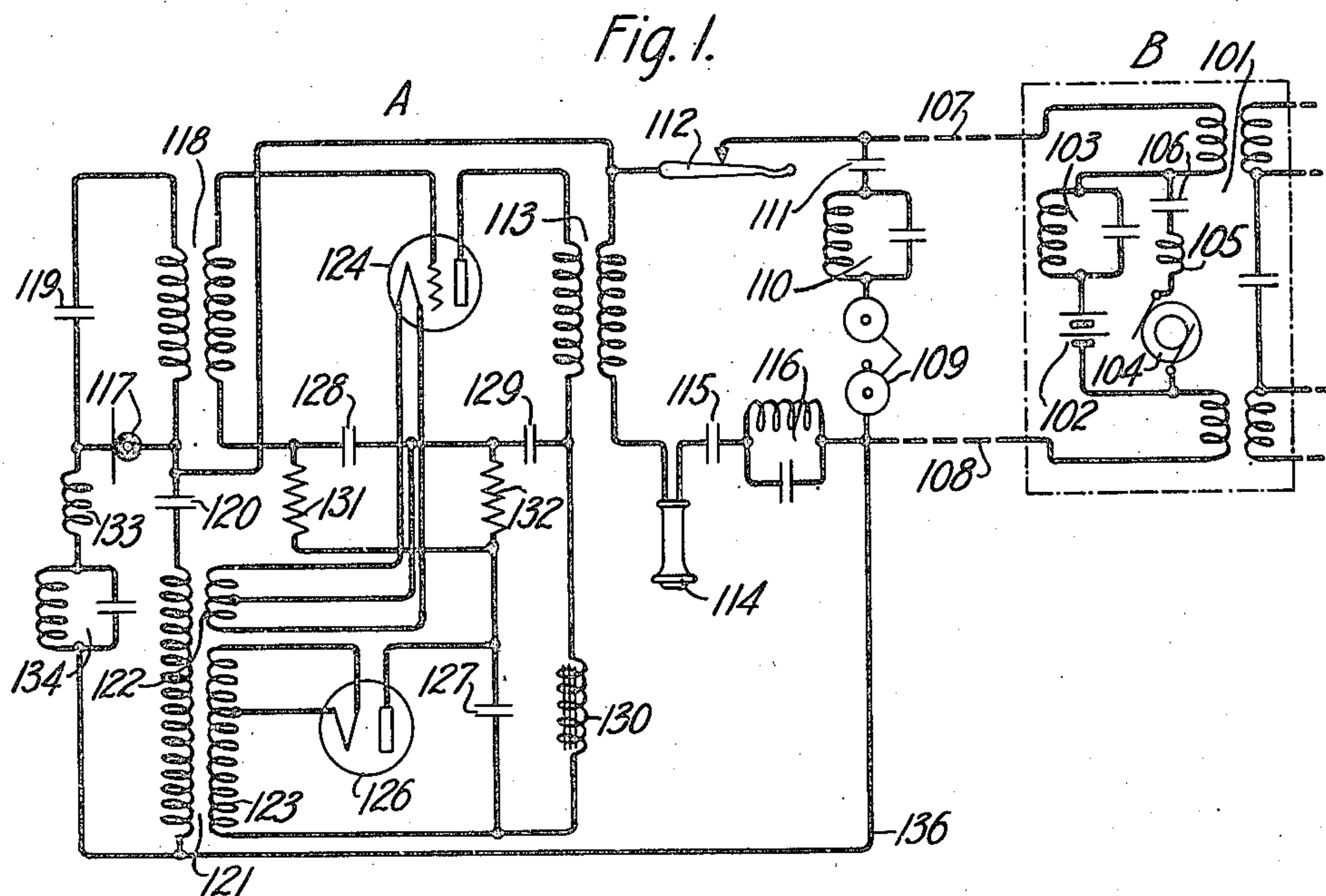
1,662,966

J. W. FOLEY

SUBSTATION CIRCUIT

Filed Nov. 30, 1926

2 Sheets-Sheet 1



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Fig. 3.

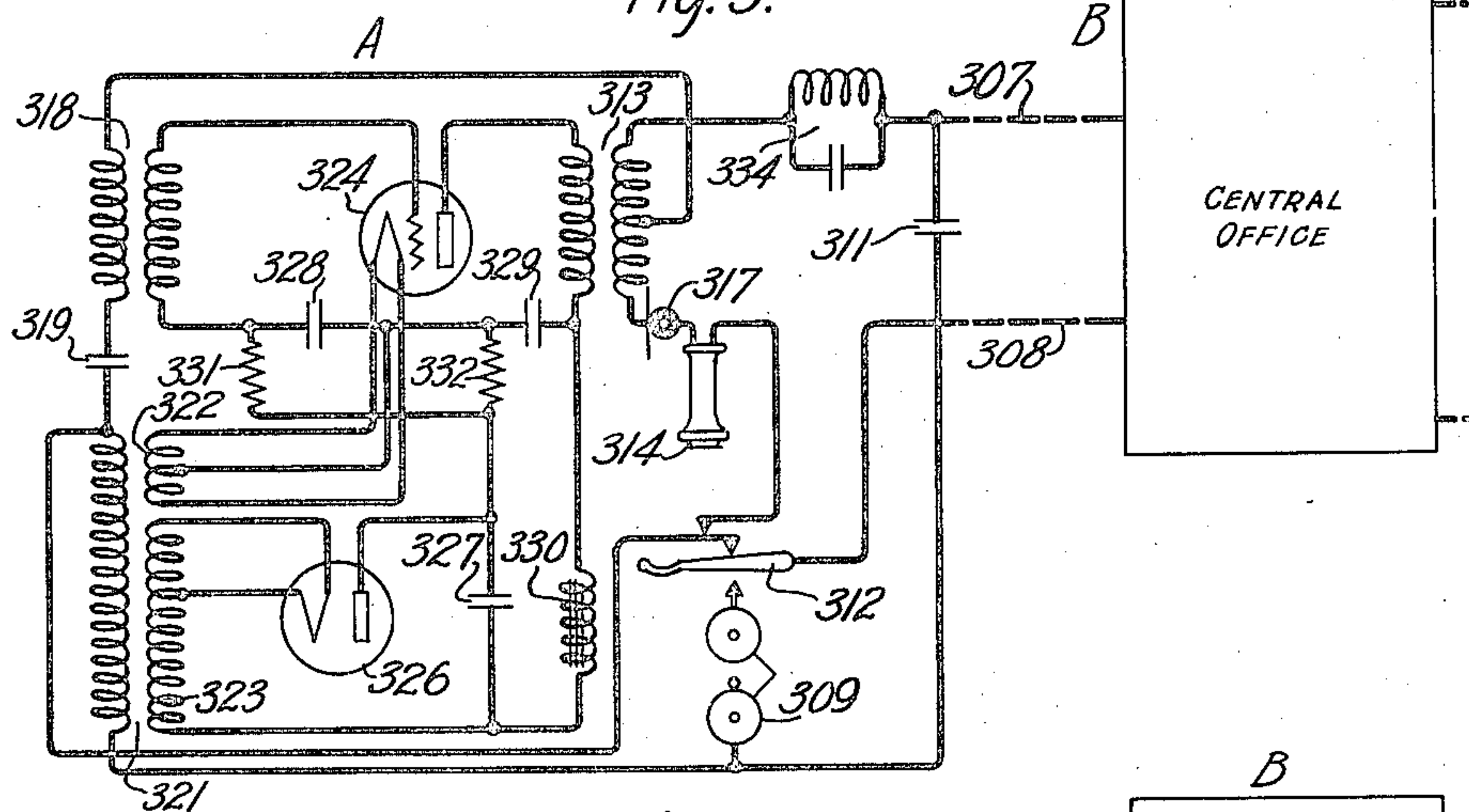


Fig. 4.

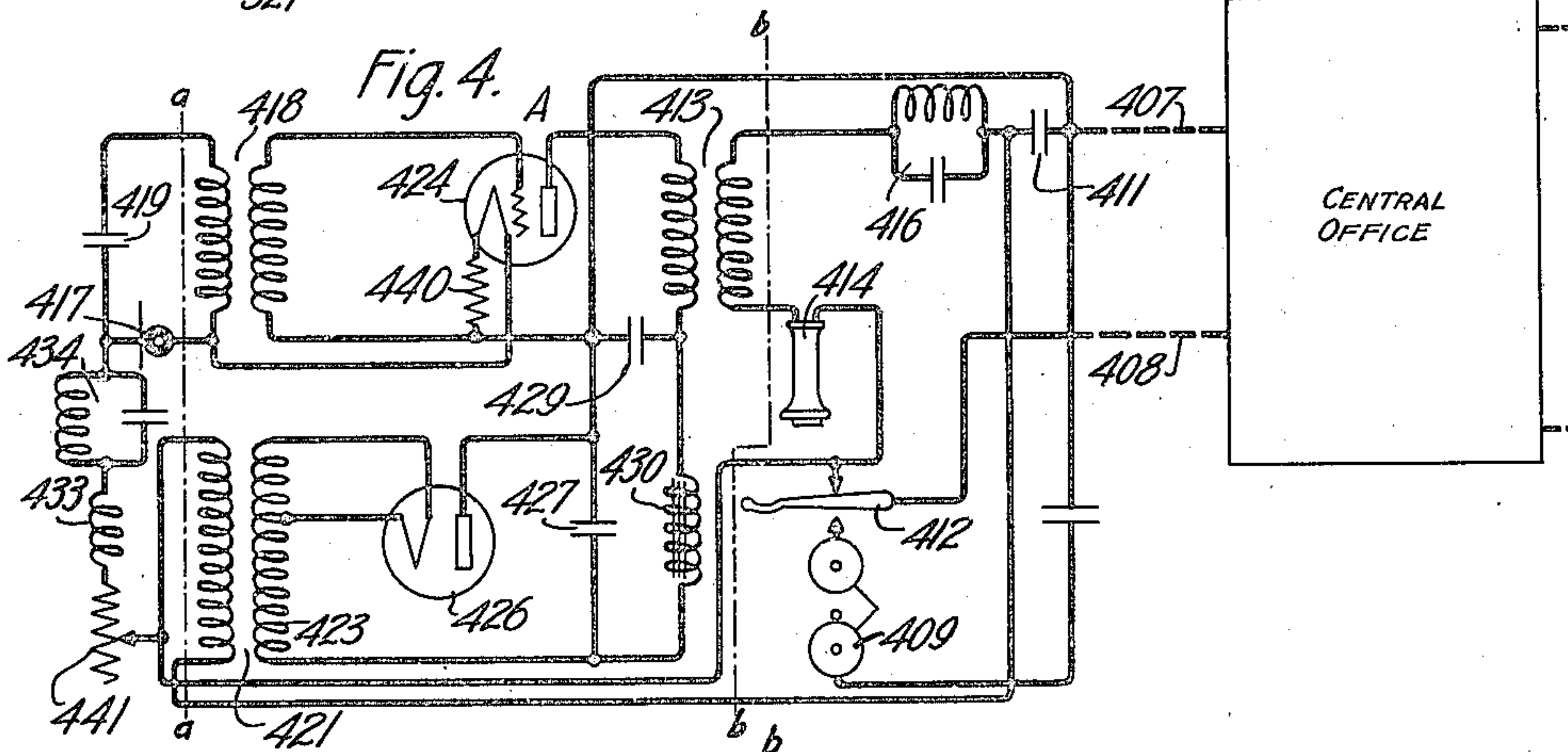
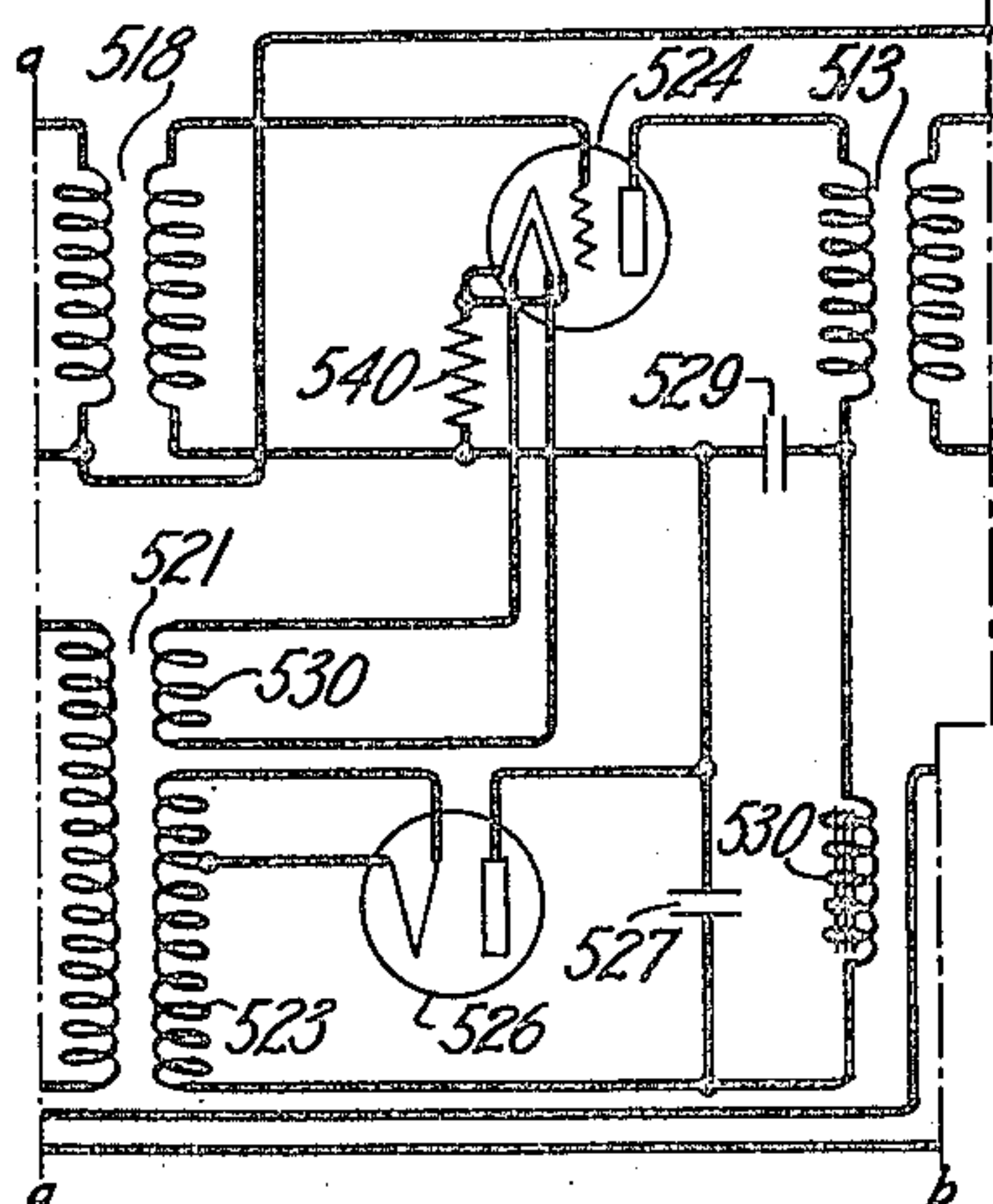


Fig. 5.



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UNITED STATES PATENT OFFICE.

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SUBSTATION CIRCUIT.

Application filed November 30, 1926. Serial No. 151,660.

This invention relates to subscriber's substation apparatus in telephone exchange systems and more particularly to subscriber's substations employing amplifiers for increasing the volume of both received and transmitted speech currents.

In accordance with the present invention a rectifier located at the subscriber's substation is employed for supplying potential to the output element of the amplifier, while employing alternating current for the activation of the filament of the amplifier.

This arrangement has the advantage that the potential of the output element may be regulated to any desired value and maintained constant. By the use of a rectifier it is possible to obtain any desirable operating voltages from alternating current of any voltage usually available. It also permits the use of the carbon button transmitter, in circuit with the central office battery without having the amplifier plate potential reduced by the voltage drop due to the current consumed in the transmitter and in the subscriber's line. By the use of such a scheme in connection with a magnetic transmitter, it would be possible to do away with direct current entirely, except possibly for signaling purposes.

The invention will be more clearly understood from a consideration of the following description in connection with the attached drawings in which:

Fig. 1 shows an arrangement for amplifying transmitted voice currents;

Fig. 2 shows an arrangement for amplifying the received voice currents;

Fig. 3 shows an arrangement amplifying both transmitted and received voice currents;

Fig. 4 shows an arrangement for amplifying transmitted speech currents where the transmitter and amplifier filament are activated by direct current from the central office; and

Fig. 5 shows a modification of Fig. 4 employing a tube wherein the filament is heated indirectly.

The substation equipment is indicated at A and the central office equipment at B. The dotted conductors indicate connecting apparatus as well as the talking conductors extending from the substation to the central office. Only one substation has been shown since it is obvious that substation A may be

associated with either a standard subscriber's set or with another like A. In order to carry out the present invention, the connecting circuits whether manual or mechanical at the central office will be supplied not only with direct current battery, such as 102, but also with an alternating current generator, such as 104. In order to prevent mutual interference the filter 103 is connected in series with battery 102. This filter is anti-resonant to the frequency of the alternating current from source 104. Condenser 106 eliminates direct current from the generator 104 and in combination with inductance 105 prevents the transmission to the subscriber's line of harmonics which might falsely operate the subscriber's bell, or otherwise interfere with speech transmission.

In Figs. 1, 2 and 3 the same amplifier unit is employed and this will first be described, with reference to Fig. 1. Currents for amplification are supplied to the input circuit of amplifier tube 124 by means of input transformer 118 and when amplified are transmitted to the output circuit by means of output transformer 113. The cathode or filament is heated by means of alternating current which is supplied to the filament through winding 122 of the power transformer 121. Alternating current for rectification is also supplied to the rectifier tube 126 by means of winding 123 on transformer 121. A portion of this current is supplied to the filament of the tube to heat it. The nature of the tube and circuit is such that only half of the alternating current wave will pass through so that a pulsating potential is established across condenser 127. This potential is applied to the plate of amplifier 124 through retard coil 130 and the primary winding of output transformer 113. Condensers 127 and 129 connected to each side of coil 130 cooperate therewith to smooth out the ripples in this pulsating current. This plate current circuit may be traced from condenser 127 through resistance 132 to the mid-point of winding 122 and to the filament, completing the space current circuit. The current flowing through resistance 132 produces a difference of potential which is applied to the grid of the amplifier to give it the proper negative bias. Condenser 128 and resistance 131 which is approximately 50,000

ohms, also serve to prevent fluctuations in the potential as applied to the grid and to prevent hum.

In Fig. 1 the ringer 109 is bridged across the talking conductors at all times. It is therefore connected in series with the condenser 111 which excludes direct current from the ringer in the usual manner and with filter 110 which excludes the low frequency alternating current from generator 104. In this figure the currents generated by the transmitter at the substation are to be amplified before application to the talking conductors 107 and 108. Direct current from the central office battery 102 flows over conductor 107, switchhook 112, transmitter 117, inductance 133, filter 134, conductor 136, back to talking conductor 108. Filter 134 prevents the flow of the alternating current in this circuit. When the subscriber talks into transmitter 117, speech currents of higher frequency are generated and flow in a local circuit including transmitter 117, primary winding of input transformer 118 and condenser 119. Inductance 133 prevents the flow of these speech currents in the direct current circuit previously traced. These speech currents are applied to the grid of amplifier 124 by input transformer 118 and when amplified are applied by means of transformer 113 to the talking conductors, the circuit carrying the amplified current being traceable from conductor 107, switchhook 112, secondary winding of transformer 113, receiver 114, condenser 115, filter 116 to conductor 108. The currents are repeated by means of repeating coil 101 to the other subscriber's line in the usual manner. It will be noted that the currents from transmitter 117 are also amplified to the receiver at substation A which would probably be of special design to respond to the amplified currents as well as to those not amplified, which are received directly over the talking conductors from the other substation. Condenser 115 excludes direct current from the receiver circuit and filter 116 excludes the low frequency alternating current from the receiver circuit.

In Fig. 2 the ringer is bridged across the talking conductors 207 and 208 only while the receiver is on the switchhook and therefore is connected with a condenser 211 only. In this arrangement speech currents received over the talking conductors 207 and 208 are to be amplified. The circuit for these currents extends from conductor 207, through filter 234, primary winding of input transformer 218, transmitter 217, switchhook 212, to conductor 208. The receiver 214 is connected in a local circuit with the secondary winding of the output transformer 213, thus responding to the amplified received speech as well as that generated by transmitter 217, although this transmitted current is not am-

plified in passing to conductors 207 and 208.

In Fig. 3 both received and transmitted currents are to be amplified. Incoming speech flows from conductor 307 through filter 334, through the upper half of the secondary winding of output transformer 313 and thence in parallel through the primary winding of input transformer 318, condenser 319, switchhook 312 to conductor 308 and also through the lower half of the secondary winding of transformer 313, through transmitter 317 and receiver 314, back to conductor 308. Currents generated by transmitter 317 flow in part through the lower half of the secondary winding of transformer 313, primary winding of transformer 318, condenser 319, switchhook 312, receiver 314 back to transmitter 317. A portion also flows in the direct current circuit over conductors 307 and 308 and the entire secondary winding of transformer 313. In the case of both received and transmitted currents, the circuit through the primary winding of input transformer 318 is the more effective and both currents are amplified by tube 324 and are returned to the talking conductors 307 and 308, through output transformer 313.

Fig. 4 is a modification of Fig. 1 in which the filament of the amplifier is supplied with direct current in series with the transmitter 417. This circuit may be traced from conductor 407, through resistance 440, filament of tube 424, transmitter 417, filter 434, inductance 433, adjustable rheostat 441, switchhook 412 to conductor 408. The rheostat 441 permits the adjustment of the transmitter and filament currents to any desired strength. Filter 434 and inductance 433 perform the same functions as filter 134 and inductance 131 in Fig. 1.

Fig. 5 when inserted in Fig. 4 along the dotted lines *aa* and *bb* constitutes a modification of Fig. 1 in which the filament of the amplifier 524 is heated by means of an auxiliary heating element which receives its heating current from a winding 530 on transformer 521.

Similar parts of the different figures have been given the same numbers in corresponding hundreds to facilitate reference to Fig. 1 which is described in the most detail.

What is claimed is:

1. In a telephone exchange system, a central office, substation apparatus associated with said central office, an amplifier at said substation including an anode, a cathode and an impedance control element, a source of alternating current at said central office, a line connecting said substation with said central office to transmit current from said alternating current source to said substation, means for transmitting speech currents in two directions over said line, means for applying said speech currents to said impedance control element, means at said substa-

tion to rectify said alternating current, means to supply said rectified current to said anode, means to supply said alternating current to said cathode, and means to exclude said alternating current from said control element.

2. In a telephone exchange system, a central office, substation apparatus associated therewith, including a receiver and a transmitter for two-way operation, a space discharge amplifier including an anode, cathode and an impedance control element, said receiver being located in the output circuit of said amplifier, a source of alternating current at said central office, means comprising a line to transmit current from the alternating current source to said substation, said means also conducting speech currents, means at said substation to rectify said alternating current, means to supply said rectified current to said anode, means to supply said alternating current to said cathode, means to apply said incoming speech currents to the control element of said amplifier, and means to apply the speech current variations of said transmitter to said line.

3. In a telephone exchange system, a central office, substation apparatus associated therewith, including a receiver and a transmitter for two-way operation, a space discharge amplifier including an anode, cathode, and an impedance control element, said transmitter being connected in the input circuit of said amplifier, said receiver connected in the output circuit of said amplifier, a source of alternating current at said central office, means to transmit current from the alternating current source to said substation and to conduct speech currents, means at said substation to rectify said alternating current, means to supply said rectified current to said anode, means to supply said alternating current to said cathode, and means to transmit amplified speech currents to said speech current conducting means.

4. In a telephone exchange system, a central office and a substation associated therewith, means for receiving and generating speech currents at said substation, an amplifier at said substation including an anode, a cathode and an impedance control element, a source of alternating current at said central office, means both for transmitting current from said alternating current source to said substation and for conducting the speech currents received and generated at said substation, means at said substation to rectify said alternating current, means to supply said rectified current to said anode, means to supply said alternating current to said cathode, means to transmit said speech currents to said control element, and means to exclude said alternating current from said control element.

5. In a telephone exchange system, a central office, substation apparatus associated with said central office, a transmitter at said substation, an amplifier at said substation including an anode, a cathode and an impedance control element, a source of direct current and a source of alternating current, means both for transmitting said alternating current from said alternating current source to said substation and for conducting speech currents, means to apply said speech currents to said impedance control element, means at said substation to rectify said alternating current, means to supply said rectified current to said anode, means to transmit said direct current to said cathode and said transmitter in series, and means to exclude said alternating current from said transmitter and said control element.

6. In a telephone exchange system, a central office, substation apparatus associated therewith, including a receiver and a transmitter for two-way operation, a space discharge amplifier including an anode, cathode, and an impedance control element, said receiver being located in the output circuit of said amplifier, a source of alternating current at said central office, a line both for transmitting current from the alternating current source to said substation and for conducting speech current, means at said substation to rectify said alternating current, means to supply said rectified current to said anode, auxiliary means for heating said cathode from said alternating current source and means to apply incoming speech currents to the control element of said amplifier, and means to apply the speech currents from said transmitter to said line.

7. In a telephone exchange system, a central office, a substation apparatus associated therewith, a line connecting said substation and said central office, a transmitter and a receiver at said substation for transmitting and receiving speech currents over said line, a space discharge amplifier having input and output circuits, a source of direct current and a source of alternating current at said central office, means to transmit direct current over said line from said direct current source to energize said transmitter, means including said line to transmit alternating current from said alternating current source to said substation, means at said substation for rectifying said alternating current, means to apply said rectified current to the output circuit of said amplifier, and means to impress the speech currents transmitted over said line on the input circuit of said amplifier.

In witness whereof, I hereunto subscribe my name this 29th day of November A. D., 1926.

JOHN W. FOLEY.