

Dec. 25, 1928.

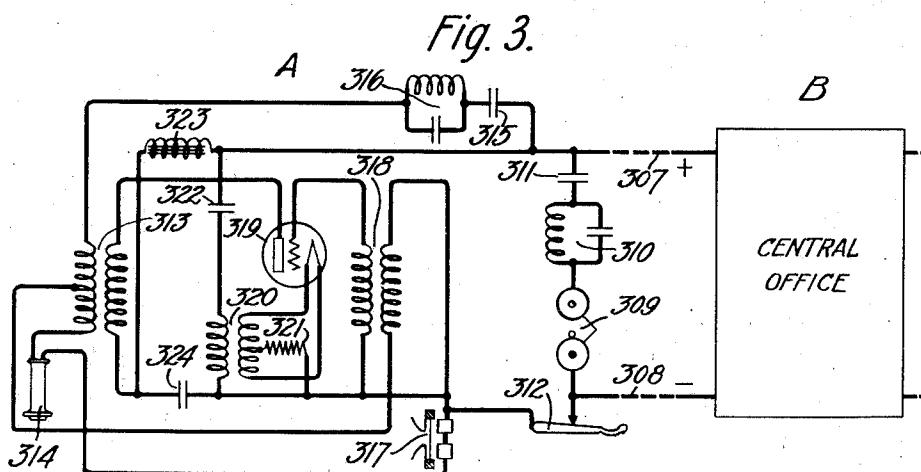
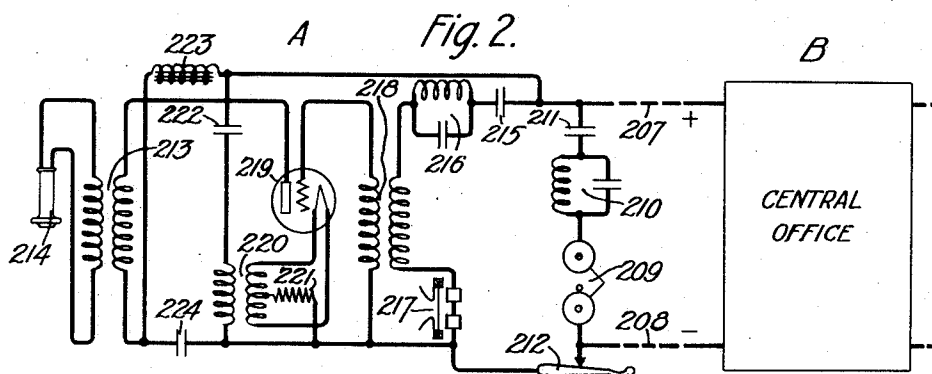
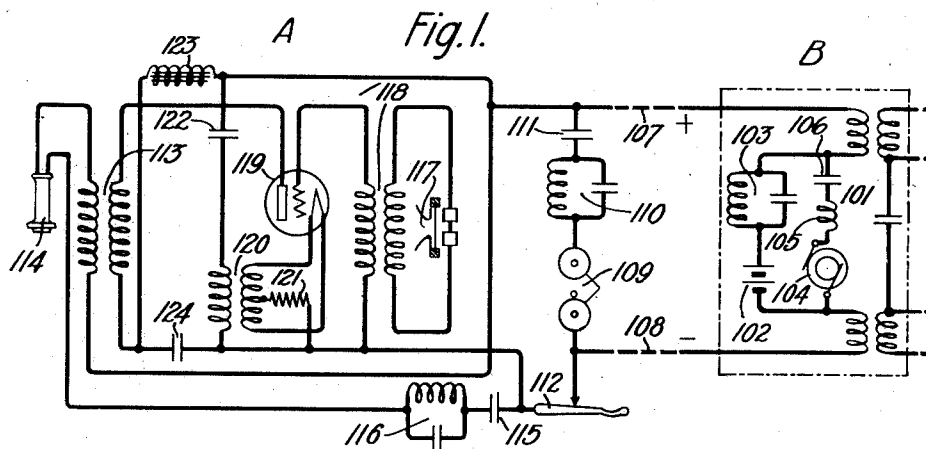
1,696,274

K. S. JOHNSON

SUBSTATION CIRCUITS

Filed Nov. 30, 1926

2 Sheets-Sheet 1



Inventor:
Kenneth S. Johnson.
by E. V. Griggs
Attorney.

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Fig. 4.

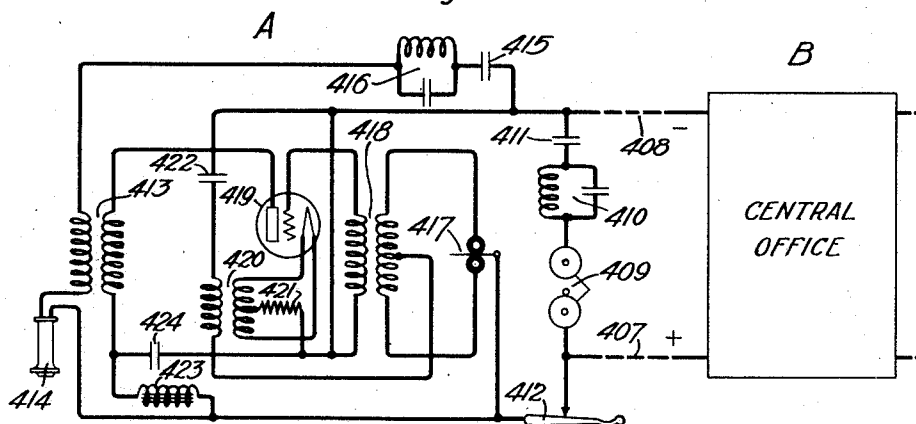
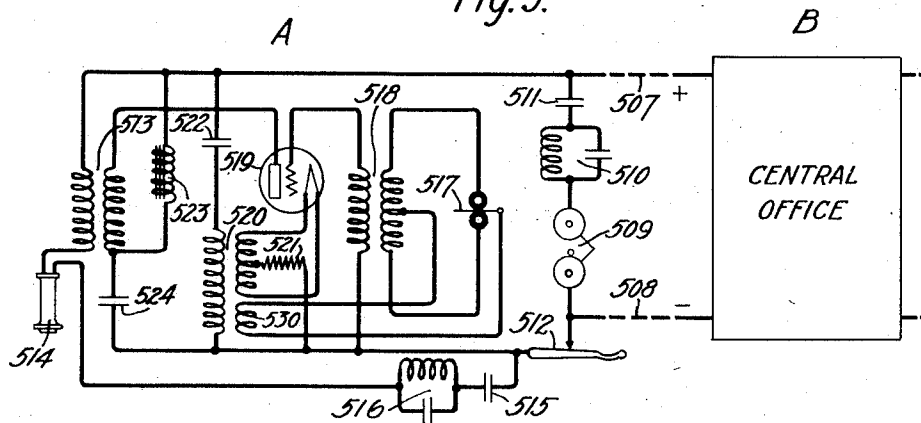


Fig. 5.



Inventor:
Kenneth S. Johnson.
by *W. Griggs*
Attorney.

UNITED STATES PATENT OFFICE.

KENNETH S. JOHNSON, OF JERSEY CITY, NEW JERSEY, ASSIGNOR TO BELL TELEPHONE LABORATORIES, INCORPORATED, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

SUBSTATION CIRCUITS.

Application filed November 30, 1926. Serial No. 151,627.

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

In accordance with the present invention the filament or cathode of such an amplifier is supplied with current from a low frequency alternating current source located at the central office and condensers and selective circuits are provided for restricting the direct current and low frequency alternating current to the proper circuits at the substation. According to one aspect of the invention a magnetic transmitter is employed which requires no direct current and according to another aspect of the invention a push-pull transmitter is employed supplied with alternating current, so that in either aspect of the invention practically the full potential of the central office battery is supplied to the plate or anode of the amplifier.

The use of an amplifier at a subscriber's substation is desirable in the case of subscribers who experience difficulty in hearing or being heard over the telephone. They also have a field where long subscribers' loops are necessary or where it is desirable to employ high quality low efficiency transmitters. The use of such amplifiers has been suggested previously but it has been necessary to supply them with current either from a local battery or from the central office battery. In the latter case the current, consumed by the cathode, and the carbon button transmitter if used, has so reduced the potential supplied to the anode of the amplifier as to materially affect the output of the amplifier. Where the cathode or filament is supplied with current from an alternating current source as proposed in accordance with the present invention, practically the full potential of the central office battery is available for the anode or plate of the amplifier.

The invention will be more clearly understood by reference to the following description in connection with the attached drawings in which

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

Fig. 2 shows an arrangement for amplifying received speech currents;

Fig. 3 shows an arrangement for ampli-

fying both transmitted and received speech currents;

Fig. 4 shows an arrangement for amplifying transmitted speech currents employing a push-pull transmitter; and

Fig. 5 shows a modification of the arrangement of Fig. 4.

The substation equipment is indicated at A and the central office equipment at B. The dotted conductors indicate the 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, are supplied not only with a direct current battery such as 102, but also with an alternating current generator such as 104. In order to prevent mutual interference the anti-resonant network 103 is connected in series with battery 102. This network is anti-resonant to the frequency of the alternating current from source 104. Condenser 106 excludes 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.

At the substation the ringer 109 is bridged across the line at all times. The bridge also includes the usual condenser 111 for excluding direct current and in addition the anti-resonant network 110, which is similar to network 103 for excluding the low frequency alternating current from the ringer 109. The switchhook contact is, of course, normally open but when the receiver is removed from the switchhook it is closed to render the amplifier effective as well as the transmitter and the receiver at the substation.

Since Fig. 1 shows an arrangement adapted for the amplification of transmitted speech only, receiver 114 is connected directly to the talking conductors 107 and 108, that is, in a circuit extending from the central office, over conductor 107 through the secondary winding of transformer 113, receiver 114, network 116 which is of the same general design as networks 103 and 110, condenser 115, switchhook contact 112, conductor 108 back to the

central office. Direct current and low frequency alternating current are eliminated from the receiver by condenser 115 and anti-resonant network 116 respectively. The transmitter 117 is of the magnetic type and is included in a local circuit with the primary winding of input transformer 118. Alternating current is supplied to the filament or cathode of amplifier 119 in a circuit which may be traced from one side of the alternating current generator 104, conductor 107, through condenser 122 which excludes direct current, primary winding of transformer 120, contact of switchhook 112 to conductor 108 and back to the alternating current source. The alternating current in this circuit induces an alternating current in the secondary winding of transformer 120 which heats the filament of the amplifier. The direct current potential is supplied to the plate of amplifier 119 over a circuit extending from direct current source 102, through anti-resonant network 103, upper left winding of the repeating coil 101 to conductor 107, retard coil 123, primary winding of transformer 113, plate of amplifier 119, filament of amplifier 119, through the upper and lower halves of the secondary winding of transformer 120 in parallel, resistance 121, contact of switchhook 112, conductor 108 back to battery 102. The retard coil 123 excludes alternating current of all frequencies from this circuit.

When the subscriber at substation A talks into transmitter 117, speech currents flow in the transmitter and in the primary of transformer 118. These in turn set up currents in the input circuit of the amplifier which may be traced from the secondary of transformer 118, grid and filament of amplifier 119, through the halves of the secondary winding of transformer 120 in parallel, resistance 121 to the other side of the winding of transformer 118. The variations in potential of the grid or control electrode react on the output circuit of the amplifier which may be traced from the plate of the amplifier, through the primary of transformer 113, condenser 124, resistance 121, upper and lower halves of the secondary of transformer 120 to the filament of the amplifier 119 and back to the plate. The variations in this circuit are transmitted to the secondary of transformer 113 and thence over the circuit traced for receiver 114 to the talking conductors 107 and 108 at the central office where they are repeated through repeating coil 101 to the subscriber at the other end of the talking connection. It will be noted that no biasing battery has been supplied for the grid or control electrode of the amplifier.

In the case of Fig. 2 received speech currents alone are amplified. Therefore transmitter 217 is connected in a circuit similar to the circuit for receiver 114 which may be traced from conductor 207, condenser 215,

anti-resonant network 216, primary winding of transformer 218, transmitter 217, contact of switchhook 212 to conductor 208. Received speech currents also flow in this circuit from which direct current and low frequency alternating current are excluded by condenser 215 and anti-resonant network 216, respectively. The circuits for supplying low frequency alternating current to the filament of amplifier 219, and direct current potential to the plate of amplifier 219 are the same as in Fig. 1, the corresponding portions of these circuits being given the same numbers as in Fig. 1 but in the second hundred. The numbering of the remaining figures is similar. In this case receiver 214 is connected in a local circuit in series with the secondary winding of output transformer 213 similar to the connection of transmitter 117 of Fig. 1. Incoming speech currents are therefore supplied to the input circuit of amplifier 219 and the amplified speech currents are transmitted to receiver 214.

Fig. 3 provides for the amplification of both transmitted and received speech currents. The circuits for supplying direct current and alternating current to the plate and filament of amplifier 319 respectively are the same as Figs. 1 and 2. Likewise, the circuits including the grid or control electrode and the plate of the amplifier are the same. Incoming speech currents are supplied to the input circuit of the amplifier by means of a circuit extending from conductor 307, condenser 315, anti-resonant network 316, upper half of the secondary winding of transformer 313, primary winding of transformer 318, contact of switchhook 312 to conductor 308. A part of this current also flows through the lower half of the secondary winding of transformer 313, through receiver 314 and transmitter 317. Speech currents generated by transmitter 317 flow in a circuit which may be traced from the transmitter, through the primary winding of input transformer 318 to the mid-point of the secondary winding of transformer 313, whence a part flows through the upper half of the winding to conductor 307, and part flows through receiver 314, back to the transmitter. Amplified speech currents flowing in the primary winding of output transformer 313 flow through the entire secondary winding of transformer 313, through the receiver and the transmitter to the talking conductors 307 and 308.

Fig. 4 shows an arrangement for amplifying transmitted speech currents with the use of a push-pull carbon button transmitter activated by means of alternating current. It differs from the disclosure of Fig. 1 only in that the alternating current flows from conductor 408, through condenser 422, and primary winding of transformer 420, through the upper and lower halves of the primary winding of input transformer 418 in parallel

1el to the two sides of the push-pull trans-
mitter 417 in parallel and thence back
over the contact of switch-hook 412 to
conductor 407. It will be noted that the posi-
5 tive side of the central office battery is con-
nected to conductor 407 which alters the ap-
pearance of the circuit somewhat. Since the
alternating current flows in opposite direc-
tions through the halves of the primary wind-
10 ing of input transformer 418, the amplifier
419 is not affected by the alternating current.

Fig. 5 differs from Fig. 4 in that the alter-
nating current for transmitter 517 is supplied
thereto by means of an additional secondary
15 winding 530 on transformer 520 thus permit-
ting the voltage applied to transmitter 517 to
be adapted to the needs of the transmitter
irrespective of the central office voltage.

What is claimed is:

20 1. In a telephone exchange system, a cen-
tral office, substation apparatus associated
therewith including means to receive and
produce speech currents, a space discharge
amplifier at said substation in cooperative re-
25 lation to said speech current receiving and
producing means, a source of direct current
and a source of alternating current at said
central office, a common means to transmit
current from said alternating current source
30 to said amplifier and to apply a poten-
tial from said direct current source to said
amplifier and means to transmit said speech
currents from said producing means to said
amplifier.

35 2. In a telephone exchange system, a cen-
tral office, substation apparatus associated
therewith including a receiver and a trans-
mitter, a space discharge amplifier at said
substation operatively associated with said
10 receiver and transmitter, said space dis-
charge amplifier including an anode, a cath-
ode and an impedance control element, a
source of direct current and a source of alter-
nating current at said central office, a com-
15 mon means to transmit current from said al-
ternating current source to said cathode and
to apply a potential from said direct current
source to said anode, means to transmit cur-
rent from said transmitter to the input cir-
20 cuit of said amplifier, and means to exclude
said alternating current and said direct cur-
rent from said input circuit.

3. In a telephone exchange system, a cen-
tral office, substation apparatus associated
53 therewith including a space discharge ampli-
fier, a receiver and a transmitter in coopera-
tive relation thereto for two-way operation,
said space discharge amplifier including an
anode, a cathode and an impedance control
60 element, said receiver being located in the
output circuit of said amplifier, a source of
direct current and a source of alternating
current at said central office, a common means
to transmit current from said alternating
65 current source to said cathode and to apply

a potential from said direct current source to
said anode and means to apply incoming
speech currents to the control element of said
amplifier.

4. In a telephone exchange system, a cen- 70
tral office, substation apparatus associated
by means of talking conductors with said
central office and including a receiver and a
high quality, low efficiency transmitter for
receiving and producing speech currents, a 75
space discharge amplifier at said substation
including an anode, a cathode and an imped-
ance control electrode, said transmitter be-
ing connected in the input circuit of said
amplifier, a source of direct current and 80
a source of alternating current at said
central office, means to transmit current from
said alternating current source to said cath-
ode over said talking conductors, means to
transmit a potential from said direct cur- 85
rent source to said anode over said talking
conductors and means to transmit amplified
speech currents to said talking conductors.

5. In a telephone exchange system, a cen- 90
tral office, substation apparatus associated
therewith including a space discharge am-
plifier, a receiver and transmitter for two-
way operation in cooperative relation to said
amplifier, said amplifier having an input cir-
cuit and an output circuit including a cath- 95
ode, a source of direct current and a source of
alternating current at said central office, a
common means for activating said cathode
by means of said alternating current and
for applying a potential from said direct 100
current source to said output circuit, and
means for excluding said alternating cur-
rent from said input and output circuits.

6. In a telephone exchange system, a cen- 105
tral office, substation apparatus associated
by means of talking conductors with said
central office and including a receiver and a
push-pull transmitter for producing and re-
ceiving speech currents, a space discharge
amplifier at said substation including an 110
anode, a cathode and an impedance control
electrode, a source of direct current and a
source of alternating current at said cen-
tral office, means to transmit current from
said alternating current source to said cath- 115
ode and said transmitter over said talking
conductors, means to transmit a potential
from said direct current source to said anode
over said talking conductors, means to apply
speech currents to the input circuit of said 120
amplifier, and means to transmit amplified
speech currents to said talking conductors.

7. In a telephone exchange system, a cen- 125
tral office, substation apparatus associated
by means of talking conductors with said cen-
tral office and including a receiver and a
push-pull transmitter for receiving and pro-
ducing speech currents, a space discharge
amplifier at said substation including an
anode, a cathode and an impedance control 130

- electrode, a source of direct current and a source of alternating current at said central office, means comprising said talking conductors to transmit alternating current to said cathode from said alternating current source through a transformer, an auxiliary winding on said transformer for supplying alternating current to said transmitter, means also comprising said talking conductors to transmit a potential from said direct current source to said anode, means to apply speech currents to the input circuit of said amplifier, and means to transmit amplified speech currents to said talking conductors.
8. In a telephone exchange system a central office, a subscriber's line, substation apparatus associated with said line including means to receive and produce speech currents, a source of direct current and a source of alternating current at said central office, an alternating current consuming device at said substation, said line serving to transmit current from said alternating current source to said alternating current consuming device, common means at said substation for simultaneously conditioning said transmitter and receiver and said consuming device for operation by the alternating current transmitted over said line, said line also providing a path between said substation and said central office for transmitting the direct current from said direct current source to said substation and for transmitting speech currents in two directions.
9. In a telephone system, a central office, substation apparatus including receiving and transmitting means for two-way operation, a space discharge amplifier associated in operative relation with said transmitting and receiving means, a line connecting said central office and said substation, means for connecting said amplifier to said line for amplifying the signals transmitted between said central office and said substation, a source of alternating current at said central office, and means for conducting said alternating current to said substation for energizing said amplifier, said means comprising said line.
10. In a telephone system, a central office, substation apparatus associated therewith comprising receiving and transmitting means, a space discharge amplifier at said substation comprising a cathode operatively associated with said receiving and transmitting means, a source of alternating current at said central office, and common means for conducting alternating current from said source to said amplifier for energizing said cathode and for conducting amplified speech currents between said central office and said substation.
11. In a telephone exchange system, a central office, a subscriber's line, substation apparatus associated with said line including means to receive and produce speech currents, a source of direct current and a source of alternating current at said central office, an alternating current consuming device at said substation operatively associated with said line, said line serving to transmit current from said alternating current source to said alternating current consuming device, and a switch at said subscriber's station for permitting the energization of said alternating current consuming device only when said transmitter and receiver are conditioned for operation, said line also providing a path between said substation and said central office for transmitting the direct current of said direct current source to said substation and for transmitting speech currents in two directions.
12. In a telephone exchange system, a central office, a subscriber's line, substation apparatus associated with said line including means to receive and produce speech currents, a source of direct current and a source of alternating current at said central office, an alternating current consuming device at said substation operatively associated with said line, said line serving to transmit current from said source to said alternating current consuming device, said line also providing a path between said substation and said central office for transmitting direct current from said current source to said substation and for transmitting speech currents in two directions, and a switch operable at said subscriber's station for simultaneously permitting said alternating current consuming device to be energized, and placing said transmitter and said receiver in operative relation with said line.
- In witness whereof, I hereunto subscribe my name this 29th day of November A. D., 1926.

KENNETH S. JOHNSON.