

Sept. 11, 1928.

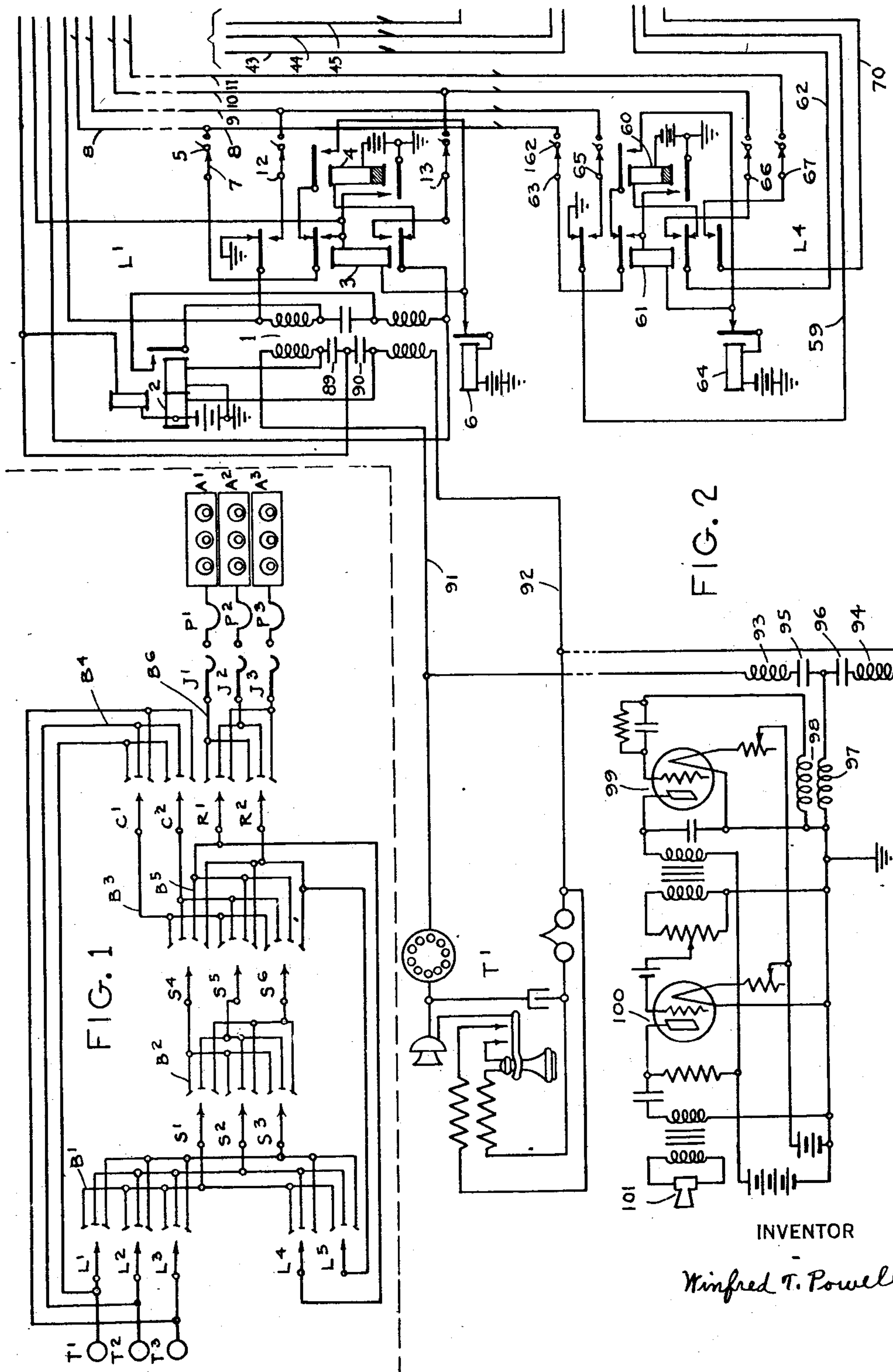
1,684,361

W. T. POWELL

RADIO RECEIVING SYSTEM

Filed Nov. 14, 1925

3 Sheets-Sheet 1



INVENTOR

Winfred T. Powell

Sept. 11, 1928.

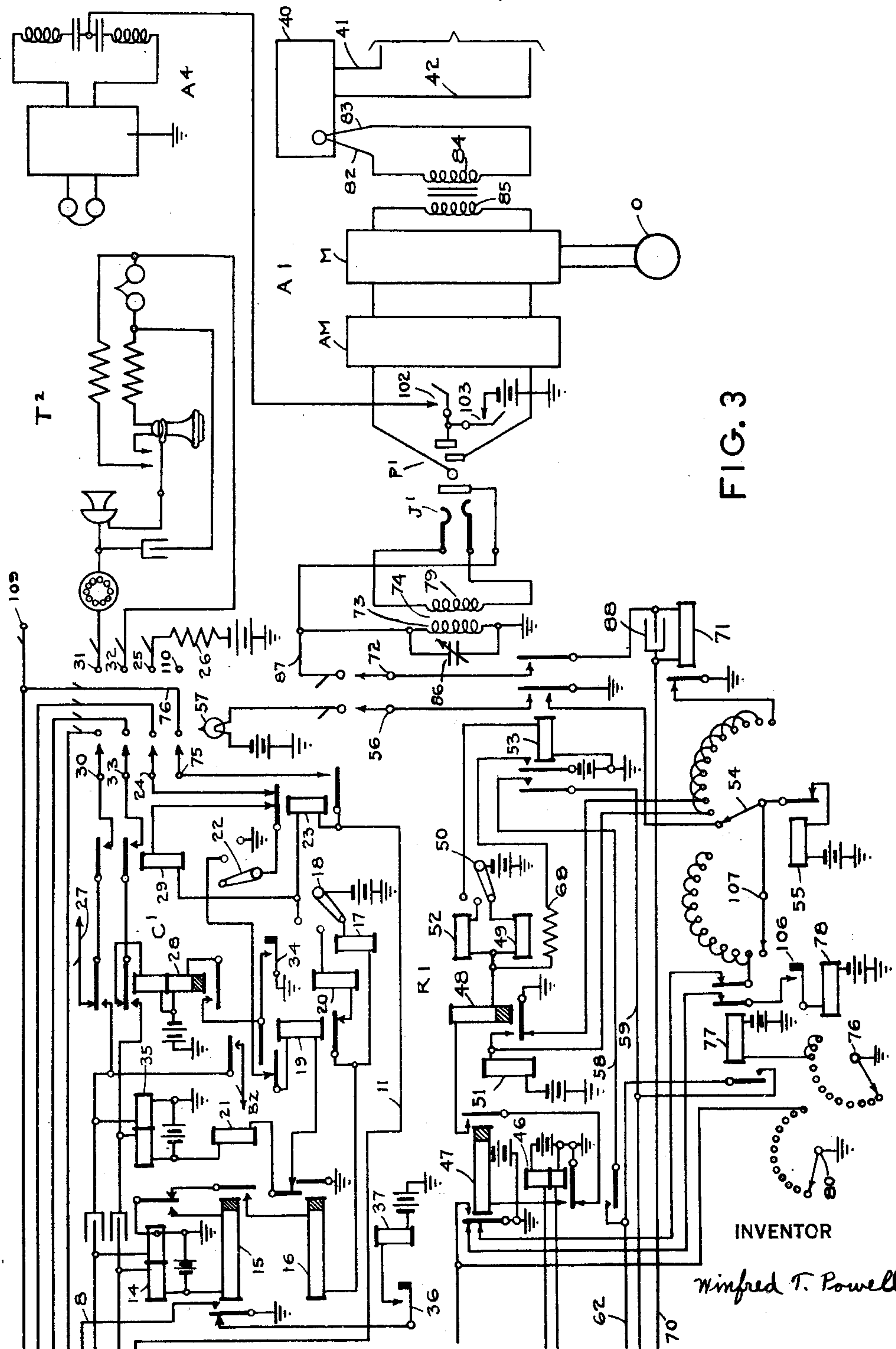
W. T. POWELL

1,684,361

RADIO RECEIVING SYSTEM

Filed Nov. 14, 1925

3 Sheets-Sheet 2



Sept. 11, 1928.

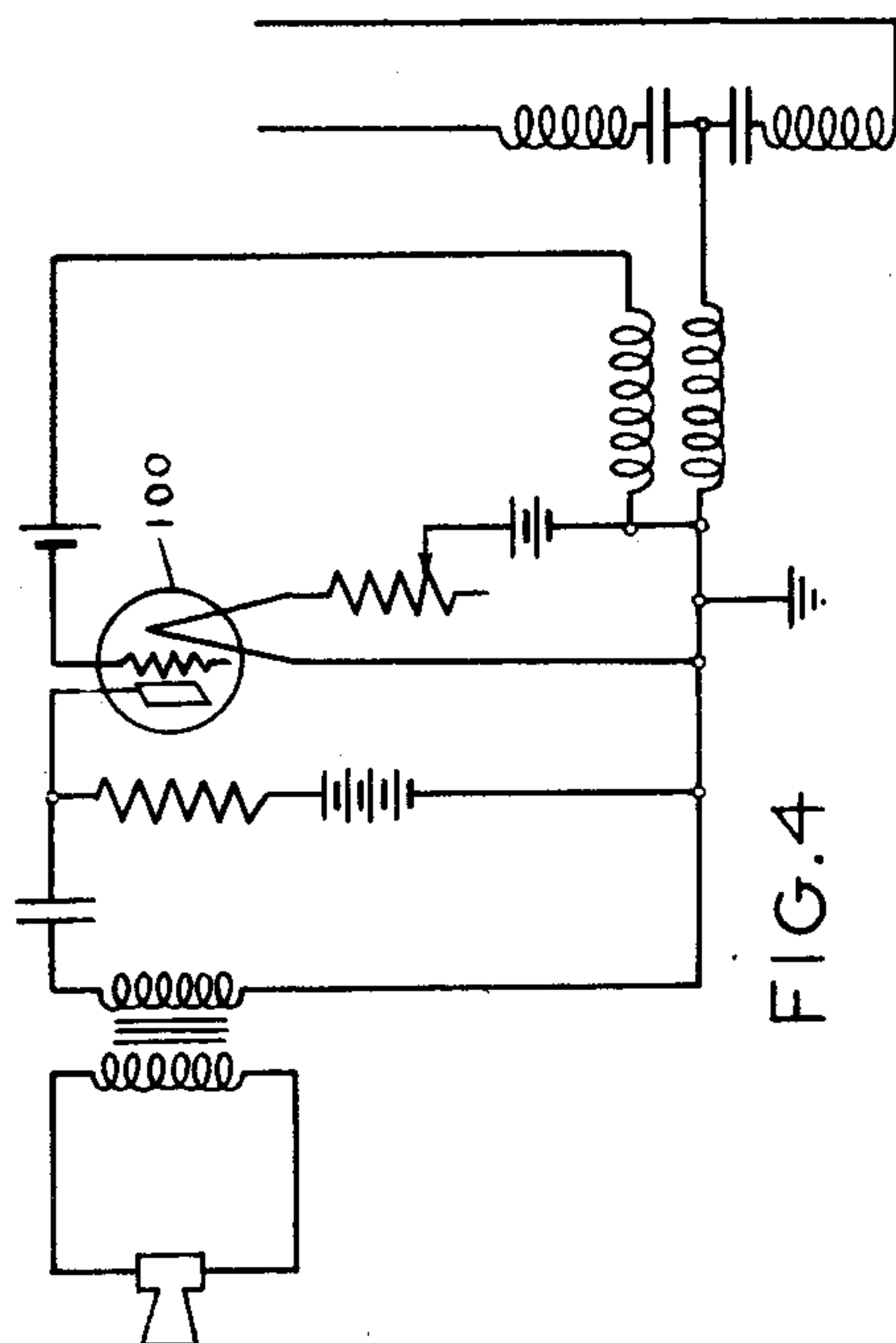
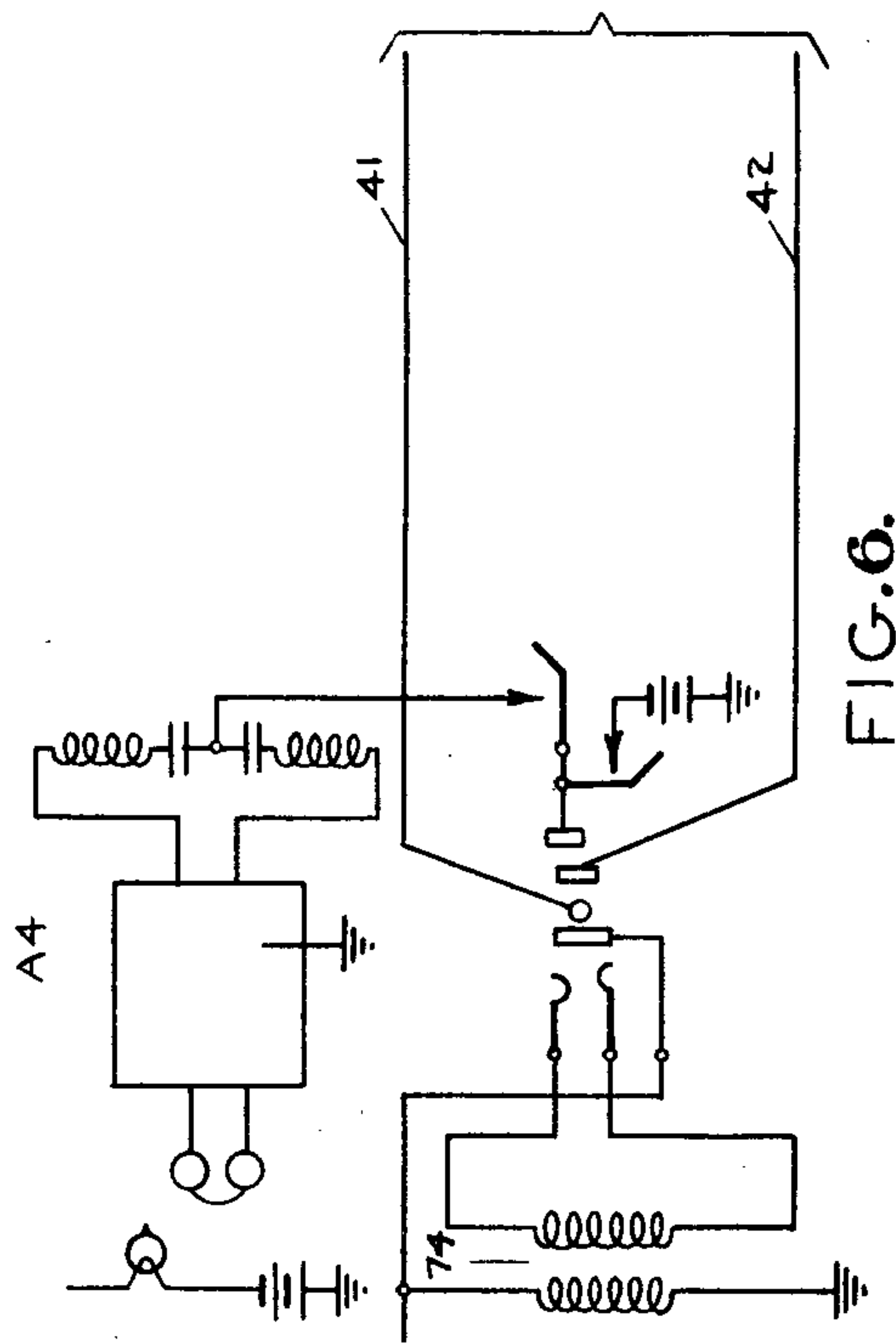
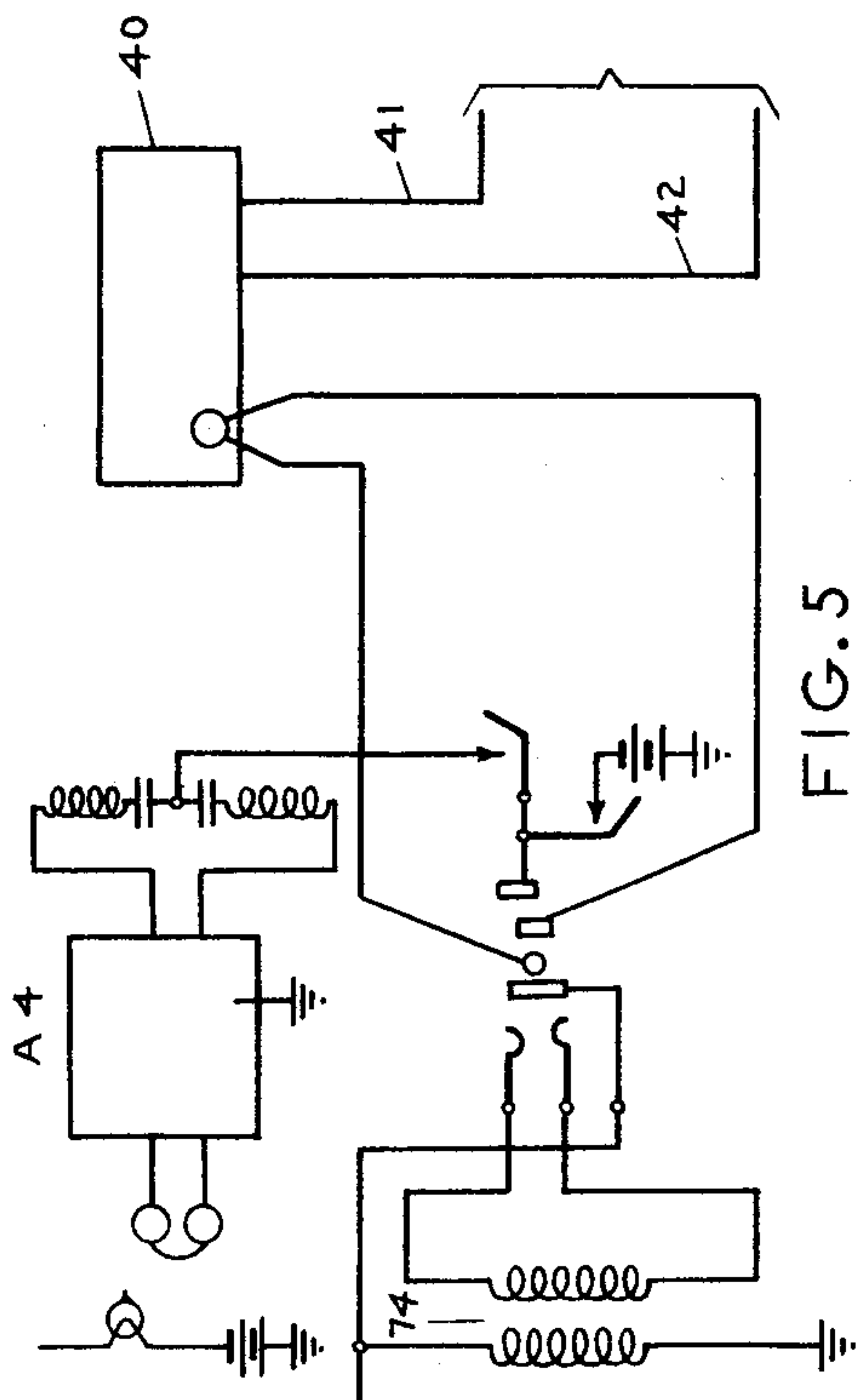
W. T. POWELL

1,684,361

RADIO RECEIVING SYSTEM

Filed Nov. 14, 1925

3 Sheets-Sheet 3



INVENTOR

Winfred T. Powell

UNITED STATES PATENT OFFICE.

WINFRED T. POWELL, OF ROCHESTER, NEW YORK, ASSIGNOR TO THE STROMBERG-CARLSON TELEPHONE MANUFACTURING COMPANY, OF ROCHESTER, NEW YORK, A CORPORATION OF NEW YORK.

RADIO RECEIVING SYSTEM.

Application filed November 14, 1925. Serial No. 69,132.

This invention relates to radio receiving systems and more particularly to such radio receiving systems as are used for broadcast reception.

5 More specifically this invention relates to the use of telephone lines in either manual or automatic telephone systems for receiving radio broadcast programs.

10 One of the features of this invention resides in providing means by which the circuits of a radio receiver are simplified.

Another feature is the provision of means by which the tuning adjustments of a radio receiver are eliminated.

15 Another feature of this invention is the provision of means by which the tuning of a radio receiving circuit is accomplished at a distant point such as a telephone exchange.

20 A further feature of this invention is the provision of means by which radio programs are received over the usual telephone lines.

25 Still another feature of this invention is the provision of means by which a regular telephone line may be used for usual telephone service at the same time that it is being used to receive a radio program.

30 An additional feature of this invention is the provision of means whereby different radio stations may be selected by connecting to different numbers in a telephone system.

35 A further feature of this invention is the provision of means such that when a radio program is being received over a telephone line, the disconnection from the radio receiving circuit may be controlled either by the subscriber or by the central office operator.

40 Other features of this invention will be apparent from the following description when read in connection with the accompanying drawings.

The novel features which are considered characteristic of this invention are particularly set forth in the appended claims.

45 It is well understood that in order for radio broadcasting to be most effective, the upper power level must be maintained as high as possible over large areas. By the use of so-called super-power broadcasting stations, there is an excessively high power level in the neighborhood of the broadcast-
50 ing station and this level falls off rapidly with increase in distance from the station.

Systems are well known in which pro-

grams of music, news, information and the like are distributed over wire lines, received 55 at local broadcasting stations and then broadcast by wireless from these local stations. In these systems there is not an excessive amount of power at any point, the power level being more uniform. The radio 60 signals in a system of this type, after being translated into wireless signals are subject to interference, such as static, signals from other stations, etc.

65 In the system of this invention, it is proposed to first receive radio programs at a central station such as a telephone exchange, after which these programs are distributed to telephone subscribers by way of the usual line circuits. These programs may be re- 70 ceived at the central telephone exchange, either over wire lines from the distant broadcasting studio or by means of carrier waves through the ether.

75 In this system there is no need for using an excessive amount of power for sending out the radio signals, since they are sent over wire circuits in which the signals are directed to their required destination with small loss. Neither will the signals in this 80 system be subject to such interference as previously was the case, because they are translated into relatively low frequency waves before being connected to the tele- 85 phone lines and these low frequency waves are not so sensitive to static and other influences, as are the extremely high frequency waves.

85 Although shown applied to an automatic telephone system, it will be readily under- 90 stood that the system of this invention may equally well be operated in a manual telephone system. It is thought that the inven- 95 tion will best be understood by first describing the operation of the circuits in connection with a regular automatic telephone connection, after which a connection to the central office radio receiving circuit will be described.

100 The drawings with Fig. 3 arranged to the right of Figs. 1 and 2 show one form of the invention.

Fig. 1 shows, in schematic form, the lay- out of the system of this invention.

105 Fig. 2 shows the telephone substation circuit together with the radio receiving cir-

cuit located at the subscriber's station, also the rotary line switch circuits.

In Fig. 3 is shown a connector circuit which is used for regular telephone connections, also a special third selector circuit with its associated control switch used for connecting to the central office radio receiving circuit. In this figure certain radio circuits are indicated, such as an amplifier, an oscillator and a receiver, the function of which will be pointed out in the detailed description, which follows.

Fig. 4 illustrates a circuit which may be substituted for the radio receiver circuit shown in the lower left hand portion of Fig. 2 and Fig. 5 shows a circuit of the central office radio receiver, which may be substituted for the central office radio receiver shown at the right, central portion of Fig. 3. Both of these substitutions constitute an alternative form of the invention in which a so-called short wave receiver is used at the central office, the operation of which will be described.

Fig. 6 shows a circuit of the central office radio receiver, which may be substituted for the central office radio receiver shown at the right, central portion of Fig. 3. Both of these substitutions constitute a further modification of the invention by which radio programs are received over wire lines from a distant broadcast station and these programs selected by telephone subscribers as will be described.

Referring to Fig. 1 of the drawings, T^1 , T^2 and T^3 represent three telephone substations connected over the usual line circuits to associated primary line switches L^1 , L^2 and L^3 .

S^1 , S^2 and S^3 represent three first selectors and S^4 , S^5 and S^6 represent three second selectors, all of which are commonly used in automatic telephone systems. C^1 and C^2 represent the usual connector type switches as used in automatic telephone systems, while R^1 and R^2 refer to special third selectors.

J^1 , J^2 and J^3 indicate three manual telephone jacks appearing before one or more special attendants or operators, while P^1 , P^2 and P^3 refer to plug and cord circuits associated with radio receivers A^1 , A^2 and A^3 . Below the line switches L^1 , L^2 and L^3 are shown two special line switches L^4 and L^5 , whose bank contacts are multiplied with those of the regular line switches L^1 , L^2 and L^3 .

With further reference to Fig. 1, the operation of this system in general is as follows:—Certain numbers in the automatic telephone exchange are assigned for use in receiving radio programs and when these numbers are dialled, subscribers may listen to the particular program being received.

It will be assumed that the subscriber

represented at T^1 desires to obtain a telephone connection with the subscriber represented by T^2 . When the first mentioned subscriber removes the receiver from its switchhook, line switch L^1 functions to select an idle trunk such as B^1 leading to first selector S^1 . The first digit of the wanted number will now be dialled, this being effective to cause first selector S^1 to advance to the level corresponding to this first digit, after which it will select an idle trunk in this level such as B^2 associated with a second selector S^4 . The second digit is now dialled and this is effective to cause the second selector S^4 to advance to the level corresponding to the second digit, after which it will automatically select an idle trunk such as B^3 associated with a connector switch C^1 .

Assuming this to be a four digit system, the third and fourth digits dialled will be effective to cause connector C^1 to make connection with the number in its bank associated with a connection such as B^4 leading back to the line circuit of substation T^2 . It will be understood that in the case of systems having more than four digits, it is only necessary to introduce other selector groups between the selectors indicated by S^4 , S^5 and S^6 and the connectors indicated by C^1 and C^2 .

It will now be assumed that the subscriber associated with telephone substation T^1 desires to receive a radio program from KDKA, and that programs being received from this station are selected by subscribers dialling number 2811. The calling subscriber at T^1 removes the telephone receiver from its switchhook which is effective to cause line switch L^1 to select an idle trunk such as B^1 associated with second selector S^1 . The first digit (2) of the special number is now dialled, which is effective to advance the first selector S^1 to the second level, after which this selector will connect to a trunk such as B^2 leading to an idle second selector S^4 . The second digit (8) is now dialled, which is effective to advance the second selector to the eighth level, after which this second selector will connect to a trunk such as B^3 leading to special third selector R^1 . The third and fourth digits (11) are now dialled, causing selector R^1 to connect to a trunk such as B^6 leading to jack J^1 . The selection of this special number is effective to light a lamp associated with this number before the special radio operator. This lamp is an indication to this operator that she is required to connect a radio receiving set such as A^1 , which is receiving a program from KDKA to the calling line. She does this by inserting plug P^1 into jack J^1 .

It should be noted at this time that a special second selector level is used to connect to special third selectors R^1 and R^2 for con-

necting to radio receiving circuits. Other second selectors levels lead to connector switches and are used for regular telephone service.

6 The calling subscriber now dials his own number, which operation is effective to extend the central office radio receiver circuit A^1 to the calling line. As soon as the last digit of the special number is dialled, a circuit condition is set up which causes a line switch such as L^4 , associated with the special third selector used, to automatically select an idle first selector such as S^2 . The selection of his own number, by the calling subscriber, is effective to cause first selector S^2 , a second selector such as S^5 and a connector such as C^1 to connect with the calling line. When this latter connection is made, the usual busy test circuit of the connector is disabled in order that the connection may be made to the calling line. The telephone receiver is now placed on the switchhook and the radio program is received, over a simplex circuit including the calling line, until this special connection is released. This release may be brought about by the operator, if the subscriber neglects to release the connection, after the broadcast station terminates the program. 30 The subscriber may release the connection by dialling a special release number which is effective to restore the operated switches to normal. Another number associated with a different broadcast station, for example 2812 associated with WGY, may now be dialled, the operation of which is similar to that above described.

Detailed operation.

40 Assuming that the subscriber, whose substation is represented by T^1 desires to establish a connection with the subscriber, whose substation is represented by T^2 , the removal of the receiver from the switchhook at substation T^1 will close a circuit over the calling line and calling substation in series through the left hand windings of repeating coil 1 and both windings of impulse relay 2 to battery and ground. This circuit is effective to operate relay 2, which in turn closes a circuit by way of its make contact and the right hand windings of repeating coil 1 to ground at the upper back contact of cut-off relay 3 and to grounded battery through the winding of line relay 4. This circuit closure causes the individual line switch L^1 associated with the calling line to test for and seize an idle outgoing trunk leading to a first selector.

60 Assuming that the trunk is busy upon which the wipers of switch L^1 are connected, there will be a ground on terminal 5 associated with this trunk, which ground is effective to cause the operation of stepping magnet 6 over a circuit which may be traced

from battery, winding and back contact of stepping magnet 6, upper make contact of line relay 4, inner, upper back contact of cut-off relay 3 and wiper 7 to ground on contact 5. At this time there will be a ground connected by way of the lower make contact of relay 4 to one side of cut-off relay 3 and the previously mentioned ground from test terminal 5 will be applied to the other side of cut-off relay 3, thus short-circuiting and preventing the operation of relay 3 when test brush 7 encounters busy trunks. 70

Assuming that the first idle trunk tested is that one to which trunk conductors 8, 9, 10 and 11 are associated, there will be no ground on conductor 8 in this instance. A circuit is now effective to operate relay 3, traceable from grounded battery, winding and back contact of magnet 6, winding of relay 3 and lower make contact of relay 4 to ground. Relay 3 operates and extends the closed circuit, consisting of the right hand windings of repeating coil 1, by way of wipers 12 and 13 and trunk conductors 9 and 10 to the line relay of the chosen first selector. 80

The operation of the calling subscriber's dial for recording the first and second digits of the wanted number is effective to advance the first and second selectors to the proper trunks for connecting to an idle connector switch, such as C^1 of Fig. 3. The dotted portions of conductors 8, 9, 10 and 11, which lead to connector switch C^1 , indicate that first and second selectors are interposed between the line switch and connector, if this system is a four digit system. It is well understood that in case of systems of the larger type, there will be other selectors such as third selectors and fourth selectors in addition to firsts and seconds. 95

In order to simplify the drawings and the description of this invention, it is not believed necessary to show complete circuits of these first and second selectors, since they may be like those shown at E of the patent to W. T. Powell, No. 1,350,882, patented August 24, 1920. In this patent it is shown how line conductors such as 9 and 10, a release trunk conductor such as 8 and an extra conductor such as 11 may be carried through the first, second and other selectors to the final or connector switch circuit. In the above mentioned patent these conductors are connected through the selector switch E by means of wipers 21, 22, 23 and 24. 105

The closed circuit through the right hand windings of repeating coil 1 by way of conductors 9 and 10 is now effective to operate impulse relay 14 of the connector switch and this relay at its front contact closes a circuit for operating the slow releasing relay 15. Relay 15 at its left hand front contact closes a circuit from ground, conductor 8, wiper 7, inner, upper make contact of re- 125

130

lay 3, winding of relay 3, back contact and winding of magnet 6 to grounded battery. This circuit functions to maintain relay 3 in its operated position and also to make this particular connector switch test busy to other calling lines.

The calling subscriber now operates the dial in accordance with the tens digit of the wanted number, which causes relay 2 to retract and attract its armature in synchronism with the dial impulses. Relay 2 acts as a repeating relay by opening and closing the circuit of the right hand windings of repeating coil 1, which in turn causes relay 14 to retract and attract its armature a number of times corresponding to the tens digit of the wanted line. At each retraction of the armature of relay 14, a circuit is closed from ground, back contact of this relay, make contact of relay 15, winding of change-over relay 16, winding of primary magnet 17 and side switch wiper 18 in its first position to grounded battery. This circuit is effective to cause the advance of the connector switch to the group of lines represented by the tens digit. This circuit is also effective to cause the operation of change-over relay 16, which in turn closes a circuit from ground, make contact of relay 16 and winding of escape magnet 21 to grounded battery. At the termination of the series of impulses corresponding to the tens digit, relay 14 maintains its armature attracted for a relatively long interval which allows relay 16 to release, this latter relay opens the circuit of escape magnet 21 allowing this magnet to release and advance the side switch wipers from their first to their second position.

The calling subscriber now operates the dial in accordance with the units digit of the wanted number, this operation being effective to again cause the retraction and attraction of relay 14 a number of times corresponding to the units digit. At each retraction of the armature of relay 14, a circuit is closed from ground, back contact of relay 14, make contact of relay 15, winding of relay 16, back contact of busy relay 19, winding of secondary stepping magnet 20 and the second position of side switch wiper 18 to grounded battery.

This circuit is effective to advance the connector switch in its secondary movement to select and test the terminals associated with the wanted line. At the time the armature of relay 14 is retracted, the circuit of relay 15 is open, but since this relay is slow to release it will maintain its armature attracted until relay 14 energizes and again closes the circuit of relay 15.

During the operation of relay 14, the circuit from ground at its back contact, which is effective to advance the secondary magnet 20, is also effective to cause the operation of relay 16. This relay being slow to

release maintains its armature attracted during the sending of the units series of impulses and at its make contact closes a circuit for operating and holding escape magnet 21 until the end of this series of impulses, when relay 16 releases and opens the circuit of magnet 21 for releasing this magnet and advancing the side switch wipers from their second to their third position. The above is assuming that the wanted line is idle.

A circuit is now closed from ground, side switch wiper 22 in its third position, back contact of relay 23, connector wiper 24, terminal 25 associated with the called line and winding 26 representing the called line cut-off relay, to grounded battery. This circuit is effective to make the called line busy and also to operate the cut-off relay 26 of the called line switch. Another circuit is closed from ground, side switch wiper 22 in its third position, back contact of relay 23, winding of relay 29 and side switch wiper 18 in its third position to grounded battery. This circuit is effective to operate the cut-through relay 29 for connecting to the line circuit of the called line. The circuit for ringing the bell of the called substation may now be traced from the common generator (not shown), wire 27, upper back contact of trip relay 28, upper make contact of relay 29, connector wiper 30, terminal 31, upper side of the called line, called substation bell, lower side of the called line, terminal 32, connector wiper 33, inner make contact of relay 29, inner, upper back contact and upper winding of relay 28 to grounded battery. Relay 28 is so designed that it will not operate when alternating ringing current for ringing the called bell is flowing through its upper winding, as above described, but when the called subscriber removes the receiver from the switchhook, a direct current circuit is closed over the above traced circuit for energizing relay 28. This relay closes its lower make contact before opening either of its back contacts, which establishes a locking circuit for itself from grounded battery, lower winding and lower make contact of relay 28, to ground at off-normal contact 34. Talking battery is applied to the called line through windings of impedance coil 35 and upper make contacts of relay 28, while talking battery to the calling line is applied through windings of relay 2.

At the close of conversation, the release of the connection is controlled by the calling subscriber, who, upon replacing the receiver on its switchhook, opens the calling line and causes relay 2 to retract its armature. This opens the circuit through the right hand windings of repeating coil 1 and the windings of relay 14 of the connector switch, which is effective to release this latter relay and in turn open the circuit of, and release the relay 15. Relay 15 at its left hand make

contact removes the ground from conductor 8, thereby releasing relay 3 of the calling line switch, thus restoring the circuit of this line switch to its normal condition. The release
 5 of relay 15 closes a circuit from ground, left hand back contact, off-normal contact 36 and winding of release magnet 37 to grounded battery. This circuit is effective to operate the release magnet which in turn restores the
 10 connector switch to its normal position.

Assuming the called line to be busy at the end of the units series of impulses, a circuit to ground will be found on terminal 25 associated with this line. At the close of the
 15 units series of impulses, relay 16 retracts its armature and closes a circuit from grounded battery, winding of escape magnet 21, continuity spring and back contact of relay 16, winding of busy relay 19, continuity
 20 spring and back contact of relay 19, side switch wiper 22 in its second position, back contact of relay 23, wiper 24 and terminal 25 to ground. It will be understood that this ground, which makes the called line busy,
 25 may either be applied to terminal 25 by means of a side switch wiper 22 in its third position of some other connector switch, similar to C¹ or it may be applied to terminal 25 from the ground on a trunk similar to 8 to
 30 which the called line switch is connected, if this line is busy due to an originating call.

The above traced circuit to ground through relay 19 is effective to operate this relay and to hold escape magnet 21 operated,
 35 thus maintaining the side switch wipers in their second position. The operation of relay 19 connects a source of busy tone current, BZ, to the calling line as an indication of the busy condition of the called line. Re-
 40 lay 19 and magnet 21 are now locked operated to ground at off-normal contact 34 until the release of the connection.

It will be noted that line switches, similar to L¹ associated with calling lines are equipped
 45 with three wipers such as 7, 12 and 13 and that the trunks to which these line switches connect are three-wire trunks. Conductor 11 is not multiply connected to the bank contacts of line switches, such as L¹, L² and L³, but it is
 50 only wired to the bank contacts of special line switches, such as L⁴ and L⁵. The line and release trunks 9, 10 and 8 are multiply connected to these special line switches, as well as to regular line switches.

55 It will now be explained how a calling subscriber may connect a calling telephone circuit, such as T¹, with a radio receiver circuit, such as A¹.

Assume that the calling subscriber whose
 60 substation is represented by T¹ desires to receive a program from KDKA and that #2811 is assigned for receiving programs from this particular radio broadcast station. The calling subscriber upon removing the
 65 receiver from its switchhook causes line

switch L¹ to connect with a first selector as previously described in connection with a regular automatic telephone connection. The first and second digits (28) are now
 70 dialled, causing first and second selectors to be operated in the manner previously described, except in this case the second selector will advance to a group of trunks leading to special third selectors, such as R¹. It
 75 will be understood that the trunk lines 43, 44 and 45 are connected to a number of multiply connected bank contacts associated with the group of second selectors.

Assuming that the second selector selects a trunk represented by trunk conductors 43, 80 44 and 45, the closed circuit at the make contact of relay 2 by way of line switch wipers 12 and 13 will be extended by way of conductors 43 and 44 and the windings of relay 46 to ground and grounded battery. 85 Relay 46 is operated over the above described circuit and closes at its inner make contact a circuit for operating slow releasing relay 47. At the left hand make contact of re-
 90 lay 47, ground is connected to conductor 45, to which line switch brush 7 is connected, and this ground is effective to make this special third selector busy and also to hold the cut-off relay 3 of line switch L¹.

The calling subscriber now operates the
 95 dial in accordance with the tens digit, which in this case is assumed to be #1. This will cause relay 46 to retract and attract its armature once. With the armature of relay 46 retracted, a circuit is closed from ground, 100 back contact of relay 46, right hand make contact of relay 47, winding of change-over relay 48, winding of primary stepping magnet 49 and first position of side switch wiper 50 to grounded battery. The primary step- 105 ping magnet 49 is operated one point over this circuit and the change-over relay 48 is operated, thereby closing a circuit for energizing escape magnet 51. At the close of the tens series of impulses, relay 46 main- 110 tains its armature energized sufficiently long enough for relay 48 to retract its armature, thus releasing the escape magnet and allowing the side switch wiper to go into its sec- 115 ond position.

The subscriber now dials the units digit, which is again effective to operate relay 46 as above described, except that in this in- 120 stance the secondary stepping magnet 52 is operated, since side switch wiper 50 is in its second position. At the completion of this digit, relay 48 and magnet 51 deenergize, thus advancing the side switch wiper into its third position. There is no busy test fea- 125 ture associated with the circuit of the special third selectors since it is desired that a plurality of calling subscribers may be connected to each central office radio receiver circuit simultaneously. A circuit is now
 130 closed for operating relay 53, traceable from

grounded battery, side switch wiper 50 in its third position and winding of relay 53 to ground. Relay 53, at its inner right hand make contact closes a circuit from ground, first position of control switch wiper 54, back contact and winding of control switch magnet 55 to grounded battery. Connection is also extended from this same ground by way of third selector wiper 56, to light lamp 57 associated with #2811. This lamp is an indication for the special radio operator to tune a radio receiver, such as 40, to station KDKA and then to connect this receiver by way of plug P¹ and jack J¹ to the calling line, which will presently be connected to this jack.

A circuit is now closed at the outer left hand make contact of relay 53 by way of conductors 58 and 59 and lower make contact of relay 46 for operating line relay 60 of line switch L⁴, this line switch being associated with special third selector R¹. This circuit may be traced from grounded battery, winding of relay 60, inner, lower back contact of relay 61, conductor 62, lower make contact of relay 46, conductor 58, outer left hand contact of relay 53, conductor 59, outer, upper back contact of relay 61 to ground. Relay 60 is operated in this circuit and functions to cause line switch L⁴ to connect with an idle first selector. This line switch will be advanced over busy first selector trunks by means of connections to ground, which will be found on contacts similar to 162. This ground is extended over wiper 63, inner back contact of relay 61, upper make contact of relay 60, back contact and winding of stepping magnet 64 to grounded battery.

Let it be assumed that the first idle trunk tested, is one having conductors similar to 8, 9, 10 and 11. Since there is no ground on conductor 8, motor magnet 64 will not be advanced beyond this set of conductors and a circuit will be closed for operating relay 61, traceable from grounded battery, winding and back contact of magnet 64, winding of relay 61 and lower make contact of relay 60 to ground. Relay 61 is operated and extends the previously described closed circuit across conductors 59 and 62, by way of wipers 65 and 66 to conductors 9 and 10 of the selected first selector.

The subscriber is instructed to dial his own number and the first two digits of this number are effective to cause the first and second selectors to be advanced to a trunk, which leads to a connector similar to C¹, as has been previously described in connection with a regular automatic telephone connection. It will be understood that the impulses generated by the calling subscriber's dial are effective to operate relay 2 which, by means of its make contact, interrupts the circuit including the right hand windings of repeat-

ing coil 1 and the windings of relay 46 in series. These impulses are effective to vibrate the armature of relay 46 and by means of the lower make contact of this relay a circuit is closed and opened including conductors 59 and 62, for operating the first and second selectors as above described. It will be noted that line switch L⁴ is provided with an additional wiper 67 and that this wiper connects with a fourth wire 11 of the trunk circuit leading to a connector similar to C¹. The calling subscriber will now operate the dial in accordance with the tens and units digits of his own number, this being effective to open and close the circuit across conductors 59 and 62, as above described for advancing the connector switch C¹ in its primary and secondary movements, the detailed operation of which has been described in connection with a regular automatic telephone connection.

With the connector side switch wiper 18 in its third position a circuit is closed from grounded battery, side switch wiper 18 in its third position, winding of relay 23, conductor 11, line switch wiper 67, lower, outer make contact of relay 61, conductor 70, winding of relay 71, outer right hand make contact of relay 53, third selector wiper 72 and the terminal with which it is connected, winding 73 of transformer 74 to ground. This circuit is effective to operate relay 23 and extend this connection from ground on conductor 11 by way of the lower make contact of relay 23, wiper 75, conductor 76 to the mid-point of the left hand windings of repeating coil 1. This circuit is for the purpose of connecting the received radio signals to the calling line as will presently be described, and also for the purpose of causing the connector C¹ to discriminate between a regular automatic telephone connection and a connection back to the calling subscriber's line used for receiving a radio program. In a connection of the former class it has been shown that trunk 11 is not used, thus relay 23 is not operated, but in the latter case trunk 11 is used for the purpose of operating relay 23.

The operation of relay 23 opens at its upper back contact, the circuit of connector test wiper 24 and relay 29, thus preventing the operation of relay 29 when a connection is made from a calling line by way of this connector, back to the same line. The opening of the circuit of wiper 24 disables the busy testing feature, in order that this line may be used either for an originating or a terminating regular automatic connection at the same time that it is being used for receiving a radio program.

During the time that relay 46 is being operated to record the first digit of the calling subscriber's number, a circuit is closed from ground, inner back contact of relay 46, right

hand make contact of relay 47, winding of relay 48, resistance coil 68 and inner left hand make contact of relay 53 to grounded battery. This circuit is effective to operate
 5 relay 48, which in turn closes a circuit from ground, make contact of relay 48, control switch wiper 54, in its second position, back contact and winding of magnet 55, to grounded battery. The control switch is
 10 thereby advanced to its third position. At the close of the first series of impulses corresponding to the first digit of the calling line, relay 48 retracts its armature and closes a circuit from ground, back contact of relay
 15 48, control switch wiper 54 in its third position, back contact and winding of magnet 55, to grounded battery, which circuit is effective to advance the control switch to its fourth position.

20 During the time that relay 46 is being operated to record the second digit of the calling line, relay 48, is operated and closes a circuit from ground, make contact of relay 48, control switch wiper 54 in its fourth position, back contact and winding of magnet 55,
 25 to grounded battery, this circuit being effective to advance the control switch to position 5. At the close of the series of impulses corresponding to the second digit of the calling line, relay 48 retracts its armature and
 30 closes a circuit from ground, back contact of relay 48, control switch wiper 54 in its fifth position, back contact and winding of magnet 55 to grounded battery, this circuit being effective to advance the control switch into
 35 its sixth position.

During the time that relay 46 is being operated to record the third series of impulses, relay 48 is energized and closes a
 40 circuit from ground, make contact of relay 48, control switch wiper 54 in its sixth position, back contact and winding of magnet 55 to grounded battery, this circuit being effective to advance the control switch into
 45 position 7. At the close of this series of impulses, relay 48 retracts its armature and closes a circuit from ground, back contact of this relay, control switch wiper in its seventh position, back contact and winding
 50 of magnet 55 to grounded battery, this circuit being effective to advance the control switch into its eighth position.

During the time that relay 46 is being operated to record the fourth series of im-
 55 pulses, relay 48 is energized and closes a circuit from ground, make contact of relay 48, control switch wiper 54 in its eighth position, back contact and winding of magnet 55 to grounded battery, this circuit being
 60 effective to advance the control switch into its ninth position. At the close of this series of impulses, relay 48 retracts its armature and closes a circuit from ground, back contact of this relay, control switch
 65 wiper 54 in its ninth position, back contact

and winding of magnet 55 to grounded battery, this circuit being effective to advance the control switch into position 10.

A circuit is now closed from ground, control switch wiper 76 in its tenth position 70 and winding of relay 77 to grounded battery. Relay 77 is operated and at its left hand make contact places a short-circuit across conductors 62 and 59 for the purpose of holding the established connection to the
 75 calling line when the calling subscriber hangs up the receiver. Relay 77 opens, at its right hand back contacts, the releasing circuit for third selector release magnet 78 and control switch stepping magnet 55, in
 80 order that these two switches will not be released when relay 47 deenergizes, after the calling subscriber hangs up the receiver.

The calling subscriber now being con- 85 nected with his own line replaces his receiver upon its switchhook, thus opening the circuit of relay 2, which deenergizes and at its make contact, opens the circuit of relay 46, which retracts its armature and in turn
 90 opens the circuit of relay 47, which also deenergizes. During the interval between the release of relay 46 and the release of relay 47, a circuit is closed from ground, back contact of relay 46, right hand make con- 95 tact of relay 47, winding of relay 48, resistance 68 and inner left hand make contact of relay 53 to grounded battery. This circuit is effective to energize relay 48, which in turn closes a circuit from ground, make
 100 contact of relay 48, control switch wiper 54 in its tenth position, back contact and winding of magnet 55 to grounded battery, this circuit being effective to advance the control switch into its eleventh position. Shortly 105 after this, relay 47 deenergizes and opens the above traced circuit of relay 48, this latter relay deenergizes and closes a circuit from ground, back contact of relay 48, control switch wiper 54, in its eleventh position, 110 back contact and winding of magnet 55 to grounded battery, this circuit being effective to advance the control switch into its twelfth and last position.

When the calling subscriber replaces the 115 receiver upon its switchhook and releases relays 46 and 47, as above described, relay 47, at its left hand make contact, removes ground from conductor 45, which is effective to release the first selector, second se- 120 lector and line switch used in establishing connection with special third selector R¹. When the control switch advances to its twelfth position, as above described, wiper 80 connects ground to conductor 45, so that 125 this special third selector cannot be selected by another calling party until it has been released from the present connection.

Rectangle 40, shown in the right central 130 portion of Fig. 3, represents a radio receiver

of any approved type having proper facilities for selecting different broadcast stations. This radio receiver is designed to receive stations within the present broadcast range, for example, those operating on wave lengths of approximately 200 to 600 meters. Wires 41 and 42 may either connect to a loop antenna or to elevated antenna and ground connections. A radio receiver circuit such as is shown in Fig. 1 of the patent to J. Scott Taggart No. 1,524,581, may be the circuit represented by rectangle 40. The two wires leading to receiver T of this patent, instead of connecting to said receiver, may connect to wires 82 and 83 shown leading out of rectangle 40 of Fig. 3. There are a plurality of radio receivers, such as A¹, A² and A³ as indicated in Fig. 1, located at an attendant's position and it is the duty of this attendant to tune such receivers to those stations which calling subscribers desire to hear.

The circuits represented by rectangle 40 provide means whereby modulated radio frequency waves are received in an antenna circuit connected to wires 41 and 42 of the radio receiver. These modulated carrier waves are amplified and detected by the circuits of the radio receiver 40, after which the detected or audio frequency signals are impressed on the winding 84 of an audio transformer. It will be understood that wires 82 and 83 may be permanently connected to the output of the detector or to the output of an audio amplifier stage of radio receiver 40, or these two wires may terminate in a plug, thus furnishing means by which the transformer winding 84 may be selectably connected, either with the output of the detector or an audio stage of the radio receiver.

The audio frequency signals are induced in the secondary winding 85 of the audio transformer, after which they are applied to a modulator circuit represented by the rectangle M. An oscillator O is also connected to the modulator and these two devices in combination serve the purpose of translating into an intermediate frequency, the audio frequency signals produced by the broadcast station to which receiver 40 is tuned. It is proposed to operate oscillator O at a comparatively high frequency, that is, one that is above the audible range, but one that is not sufficiently high to be within the range of the carrier frequencies used by broadcast stations. A suitable frequency for oscillator O may be fifty kilo-cycles. The effect of modulator M and oscillator O on the audio frequency signals is to apply a modulated fifty kilo-cycles or intermediate frequency wave to amplifier AM. This amplifier consists of circuits for amplifying most efficiently a modulated fifty kilo-cycle wave and will increase the amplitude of this

wave and apply it to the tip and ring conductors of plug P¹.

In order to simplify the drawings and the description of this invention, those circuits which are not closely related to the features of the invention are shown in diagrammatic form only. Oscillator O, modulator M and amplifier AM, may be well known circuits of these devices, such as are indicated by O, M and A in Fig. 1 of the patent to J. Mills No. 1,457,447.

The modulated intermediate waves applied to the tip and ring conductors of plug P¹ are now extended over the circuit including the tip and ring contacts of jack J¹ and through winding 79 of transformer 74. The secondary winding 73 of this transformer is tuned to the intermediate carrier frequency, which appears in the output of amplifier AM, this tuning being accomplished by means of variable condenser 86. Since this carrier frequency is not variable, but at all times consists of approximately a constant frequency irrespective of the wave length of the station being received, condenser 86, when once set at the proper point for tuning the secondary circuit 73 of the transformer to this frequency, need not be changed, except to slightly increase or decrease its capacity to compensate for varying line conditions to which this circuit is connected.

The signal, which is induced into winding 73 of transformer 74, may now be traced from ground, winding 73, conductor 87, selector wiper 72, outer right hand make contact of relay 53, condenser 88, conductor 70, lower outer make contact of relay 61, wiper 67, conductor 11, lower make contact of relay 23, wiper 75, conductor 76, mid-point of the left hand windings of repeating coil 1, at which point it divides and goes through condensers 89 and 90, both of the left hand windings of repeating coil 1 and both sides of the calling line conductors 91 and 92 in multiple, through windings 93 and 94 and condensers 95 and 96 associated with an impedance coil and winding 97 of transformer 98 to ground. The impedance coil windings 93 and 94 and condensers 95 and 96 are so proportioned that they will most efficiently transmit current waves of the intermediate frequency. Transformer 98 is also designed to efficiently repeat this intermediate frequency signal, after which it is detected by detector 99 and amplified by audio frequency amplifier 100 in a manner which is well known in the art.

The audio frequency signal in the output of amplifier 100 is now impressed on the circuit including the loud speaker or receiver 101. The dotted lines connecting the radio receiver of Fig. 2 to telephone line conductors 91 and 92 indicate that this radio receiver may be permanently connected to

these line conductors or it may be connected by means of a key or by means of a plug and a jack.

From the above description it will be seen that a modulated high frequency radio signal is received by a receiver, such as 40, in the central office, after which the audio frequency component of this incoming signal is translated into a modulated intermediate frequency signal, amplified and then impressed on the telephone subscriber's line by means of a simplex circuit. It will be noted that the expensive and complicated receiving apparatus is located at the central telephone office, where it may be more efficiently maintained and adjusted and that a very simple and inexpensive type of radio receiver is located at the subscriber's substation.

Since the radio program is being received over a simplex circuit including the calling line wires in multiple and a connection to ground and since the calling line switch, such as L^1 has been released, it will be evident that the calling subscriber, whose substation is represented by T^1 , may remove the receiver and establish an automatic telephone connection at this time, in the same manner as has been already described. It will also be evident that, while a radio program is being received over this line, the line may be selected by a connector, such as C^1 and a terminating automatic telephone connection established.

The attendant operator in the telephone exchange may monitor the connection when plug P^1 is in connection with jack J^1 , by operating the listening key 102, which operation connects a simplified radio receiver, indicated at A^4 , in multiple with the existing connection. Receiver A^4 is not shown in detail, since it consists of a duplicate of the circuit of the substation radio receiver as shown in the lower left hand corner of Fig. 2. The operator may make minor tuning adjustments by varying the setting of condenser 86.

If the calling subscriber fails to release the connection after the program has been discontinued, the attendant may operate key 103, which is effective to connect main battery by way of the sleeve contacts of the plug and jack to conductor 87, which functions to short-circuit and release relay 71, since this relay now has main battery on both of its terminals. The main battery on the left hand terminal of relay 71 is applied from the third position of connector side switch wiper 18. The operation of key 103, likewise releases relay 23.

The release of relay 71 closes a circuit from ground, back contact of this relay, control switch wiper 54, in its twelfth position, back contact and winding of control

switch stepping magnet 55 to grounded battery, this circuit being effective to restore the control switch to its first and normal position. Control switch wiper 80 disconnects the ground from trunk 45, thus releasing the line switch, first selector and second selector, which was connected to special third selector R^1 . Control switch brush 76 opens the circuit of relay 77, which deenergizes and removes the short-circuit from conductors 62 and 59, thus releasing the connection which was established back to the terminals of the calling line, this connection including line switch L^4 , first selector, second selector and connector.

Relay 77 at its inner back contact closes a circuit from ground, back contact of relay 47, off-normal contact 106 and winding of special third selector release magnet 78 to grounded battery, this circuit being effective to release third selector R^1 . At its outer right hand back contact, relay 77 closes a circuit from ground, back contact of relay 47, control switch wiper 107 in any of its off-normal positions, back contact and winding of magnet 55 to grounded battery. This circuit and the one previously described including magnet 78 are for the purpose of restoring the third selector and its associated control switch in case the calling subscriber prematurely disconnects.

The operator now withdraws the plug P^1 from jack J^1 after which she may tune radio receiver 40 to some other station and connect it by means of plug P^1 to some other jack, similar to jack J^1 , which has its associated lamp similar to 57 lighted as an indication that it is desired to receive a program from said other station.

It will now be assumed that the calling subscriber desires to disconnect from station KDKA and listen to some other station. In this case he will remove the receiver of substation T^1 from its switch-hook, which will function to cause line switch L^1 to select an idle first selector as previously described. He will now dial a special release number consisting of four digits, and this act will be effective to cause the first selector, second selector and connector switches to be advanced to this special number in a manner previously described. In this particular instance, however, bank contacts similar to 31, 32 and 110 associated with this special release number are not wired. Bank contact 109, which is similar to contact 25 and is the one to which connector wiper 24 makes connection, is connected to conductor 76 as shown in the upper central portion of Fig. 3. When the special release number has been dialled, ground from the third position of connector side switch wiper 22, is applied to terminal 109 by way of connector brush 24 and this ground is ef-

fective to short-circuit and release relay 71 of the control switch, this ground being applied to the left hand terminal of relay 71, over conductors 76, 11 and 70. The ground on the right hand terminal of relay 71 is that applied through winding 73, of transformer 74. Relay 71 will retract its armature and release the connection in a manner previously described. The subscriber may now release this connection to the special number, after which he may dial a number corresponding to some other broadcast station.

Although the principle of this invention has been shown applied to a system in which the modulated high frequency waves are translated into intermediate frequency signals by means of certain modulator and oscillator circuits, it should be understood that this invention in its broad conception is not limited to the particular type of radio receiving circuits, modulator circuits, oscillating circuits and amplifier circuits, described in connection with this invention, since these particular circuits and the values assumed in the description, may be varied or modified in such a way that they would still be within the scope of the invention. For example, the circuit indicated by rectangle 40 may consist of a so-called short-wave receiver connected as shown in Fig. 5. In this case the transformer, modulator, selector and amplifier may be dispensed with and the audio frequency signal in the output or receiver 40 applied directly to the primary winding of transformer 74, after which it is connected to the calling telephone line over a simplex circuit in the manner previously described and received by the radio receiver circuit shown in Fig. 4. It is to be understood that the circuit of Fig. 4 is connected to conductors 91 and 92 in place of the receiver circuit shown in Fig. 2. In this case the detector of Fig. 2 is eliminated, since it is only necessary to receive the audio frequency signal and amplify it by amplifier 100 as shown in Fig. 4.

Fig. 6 may likewise be substituted for A⁴, radio receiver 40, modulator M, oscillator O and amplifier AM of Fig. 3. When the circuit of Fig. 6 is substituted as above mentioned, programs of music, news, information, etc., may be received in the form of audio frequency signals from a distant station, over wire lines connected to conductors 41 and 42 of Fig. 6, in which case they would be connected directly to transformer 74 by means of the plug and jack circuits, shown in Fig. 6. In this instance the radio receiving circuit located at the substation would be as shown in Fig. 6. It would be connected to line wires 91 and 92 in the same manner as previously described in con-

nection with the radio receiver circuit shown in the lower left hand corner of Fig. 2, which in this instance would be eliminated.

It will be obvious that the general principle herein disclosed may be embodied in many other organizations differing widely from those illustrated without departing from the spirit of the invention as defined in the following claims.

What is claimed is:

1. In an automatic telephone system, a calling line, a called station, a discriminating trunk associated with said called station, means controlled over said calling line in series for thereafter extending said discriminating trunk to said calling line, and means including said discriminating trunk for disabling the usual busy test feature of said called line whereby a connection is extended to said calling line over a simplex circuit including said calling line in multiple.

2. In an automatic telephone system, a calling line, a busy test circuit associated with said line, a called line, a radio receiving station, a discriminating trunk associated with said station, means controlled over the two sides of said calling line in series for establishing a radio signalling connection from said station to said calling line by way of said discriminating trunk, means controlled by said discriminating trunk for disabling said busy test circuit, and means for establishing a contemporaneous connection from said calling line to said called line.

3. The method of providing telephone service between subscribers' stations and furnishing radio programs to certain of said stations which consists in successively establishing links in a telephone connection from a calling subscriber to a called subscriber under the selective control of a calling subscriber, and in furnishing a radio program to said calling subscriber by first directly setting up a control agency from the calling subscriber to the source of radio signals, and employing said control agency to directly establish a channel under the control of the calling subscriber from the source of radio signals to said calling subscriber.

4. In a combined telephone and program service system, a plurality of subscribers' stations, a program transmitting station, means including a plurality of automatic switches and link circuits directly controlled from a calling subscriber's station to establish a telephone connection from said station to any other subscriber's station, means including certain of said first automatic switches and link circuits for establishing a connection directly controlled from the calling subscriber's station to said program transmitting station, and means

controlled over said last-mentioned connection for establishing a program transmitting channel from said program transmitting station to said calling subscriber's station.

5 5. In a combined telephone and program service system, a plurality of subscribers' stations, a program transmitting station, means including a plurality of automatic switches and link circuits directively controlled from a calling subscriber's station to establish a telephone connection from said station to any other subscriber's station, means including certain of said first automatic switches and link circuits for establishing a connection directively controlled from the calling subscriber's station to said program transmitting station, and means controlled over said last-mentioned connection for establishing a program transmitting channel from said program transmitting station to said calling subscriber's station, said channel including therein a simplex circuit.

10 20

In witness whereof, I hereunto subscribe my name this 13th day of November A. D. 1925.

WINFRED T. POWELL.