Oct. 16, 1928.

1,687,883

H. W. O'NEILL

TRANSMISSION SYSTEM

Filed Oct. 19, 1926

4 Sheets-Sheet 1

Fig. 1.

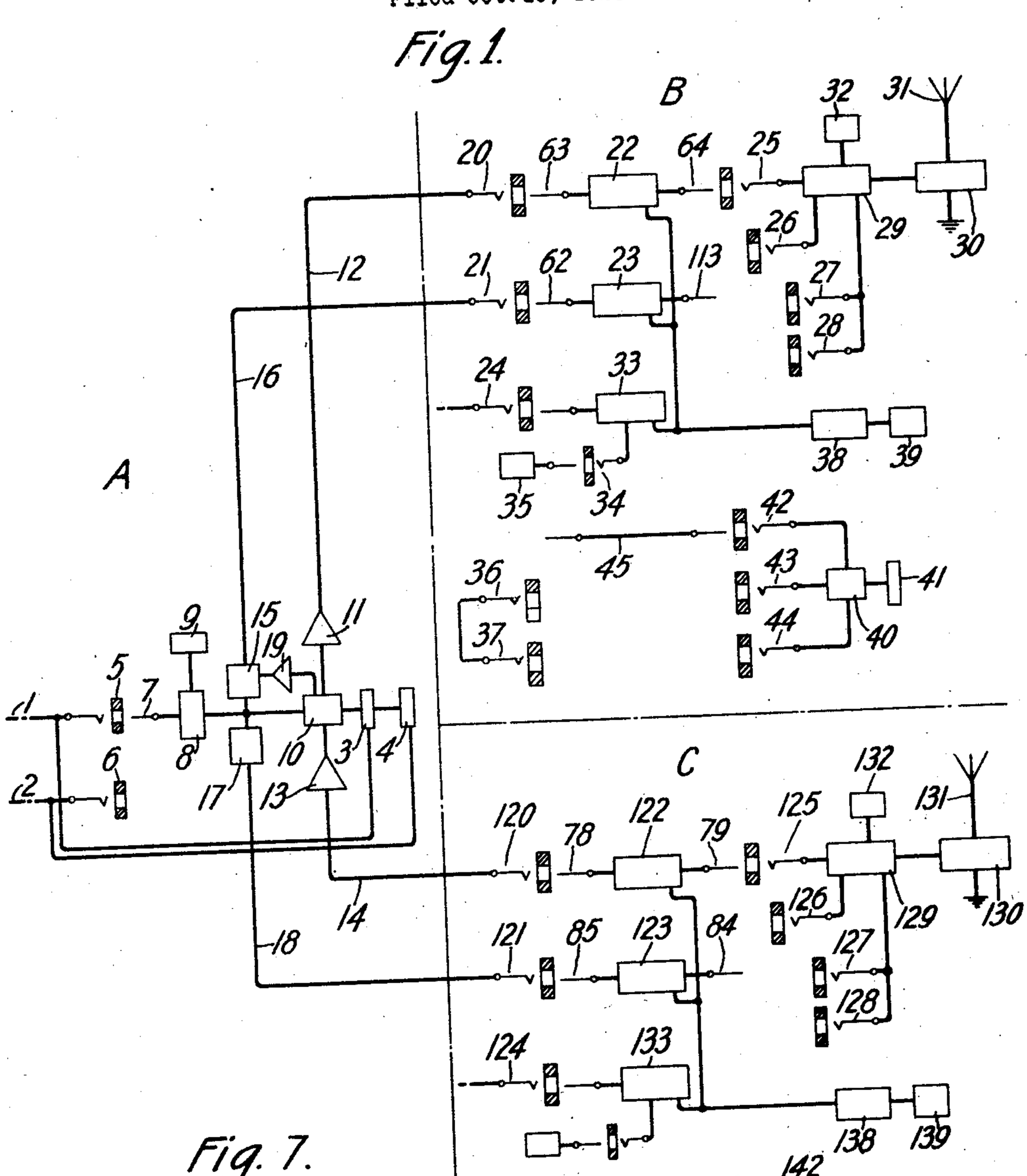

Fig. 7.

Fig.2.	Fig.3.	Fig.4.

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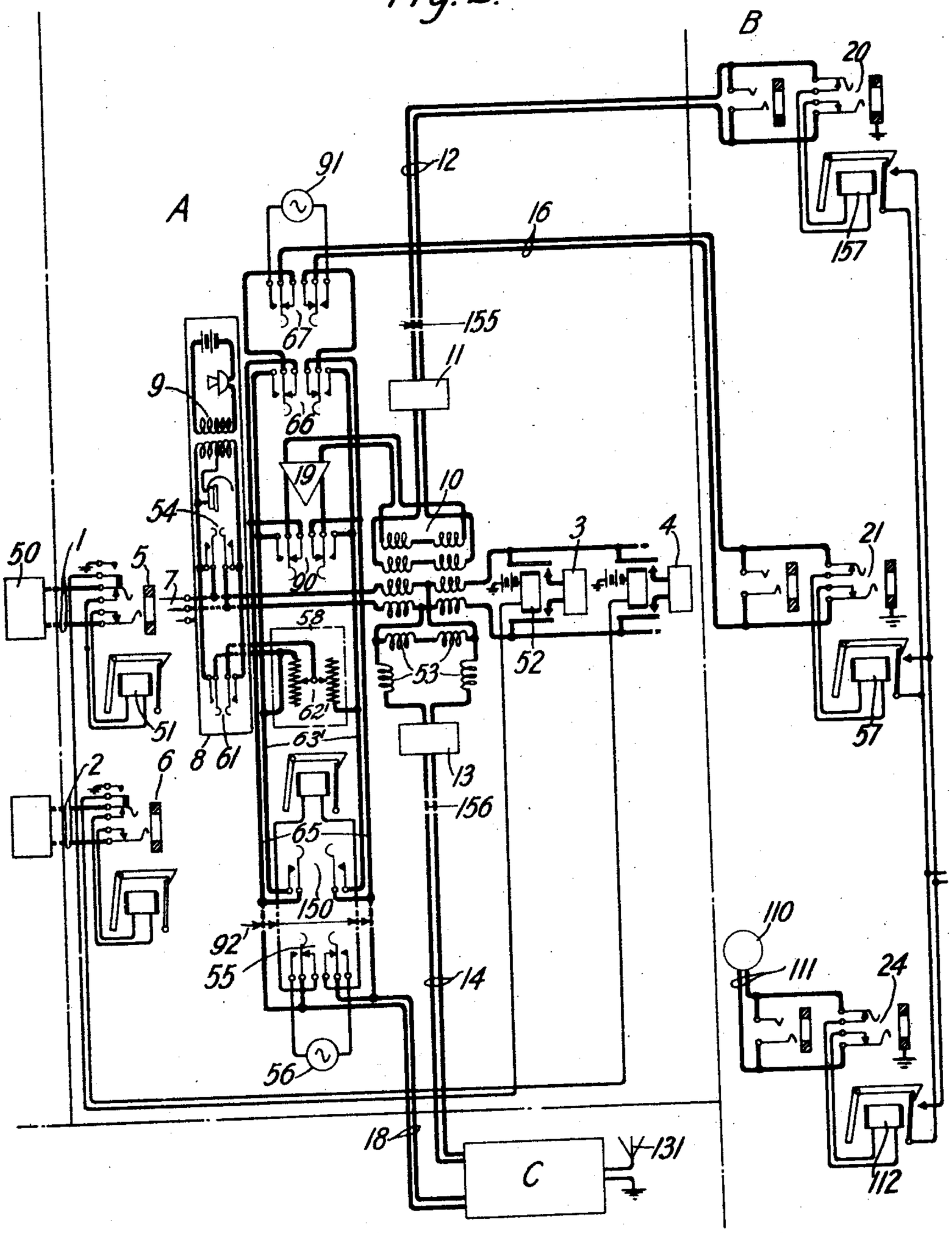
4 Sheets-Sheet 2

Fig. 2.



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TRANSMISSION SYSTEM

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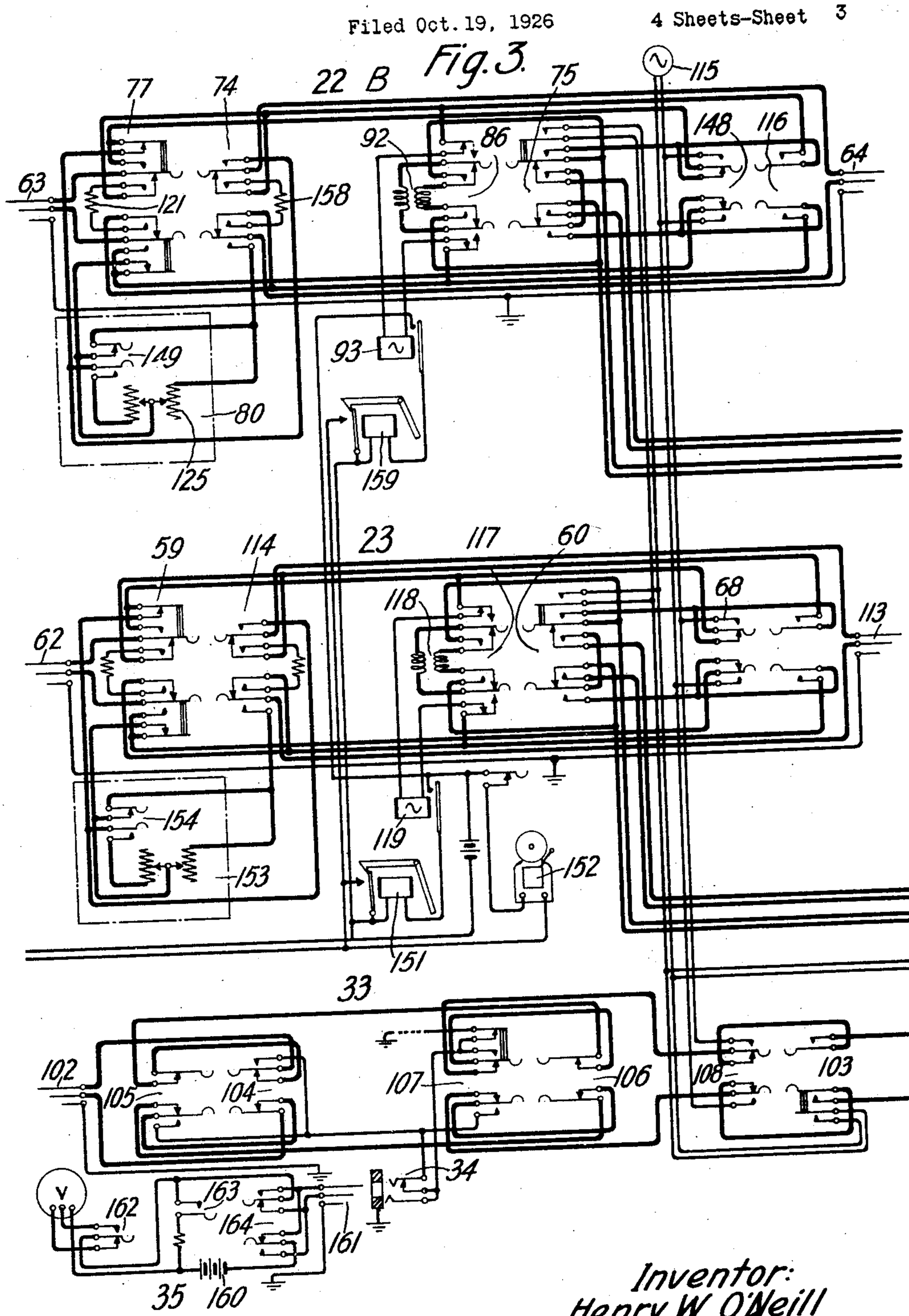
4 Sheets-Sheet 3

Fig. 3.



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TRANSMISSION SYSTEM

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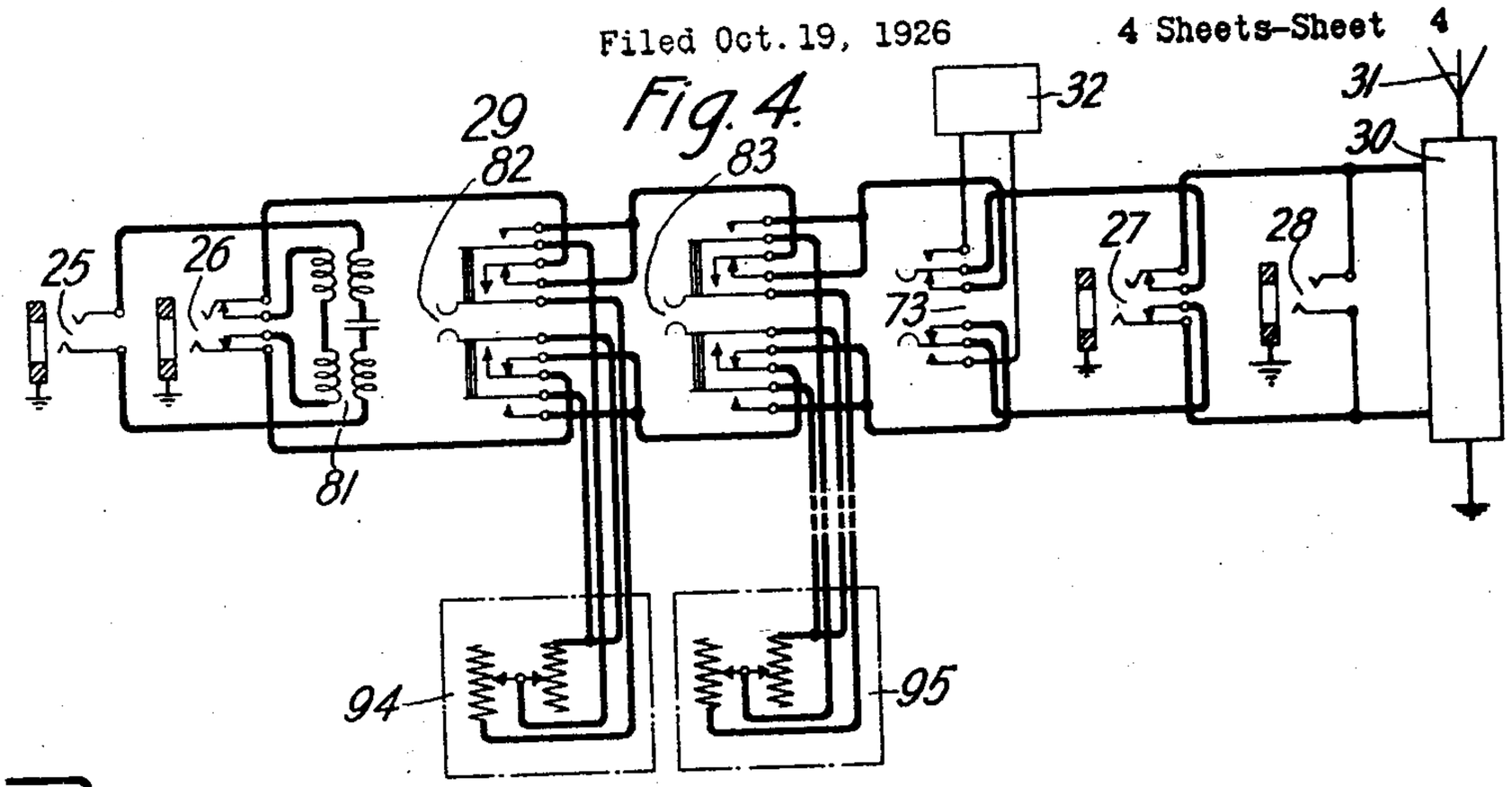
4 Sheets-Sheet 4

Fig. 4.



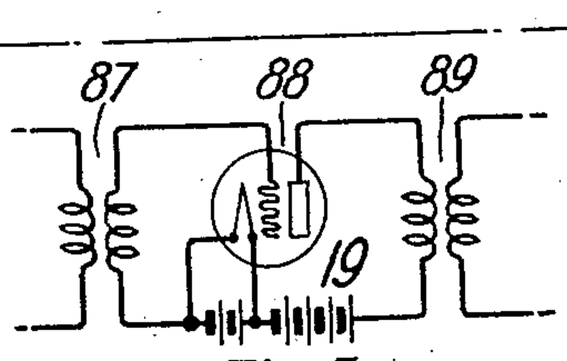


Fig. 5.

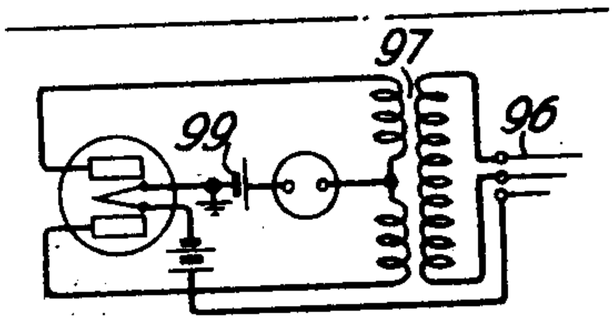
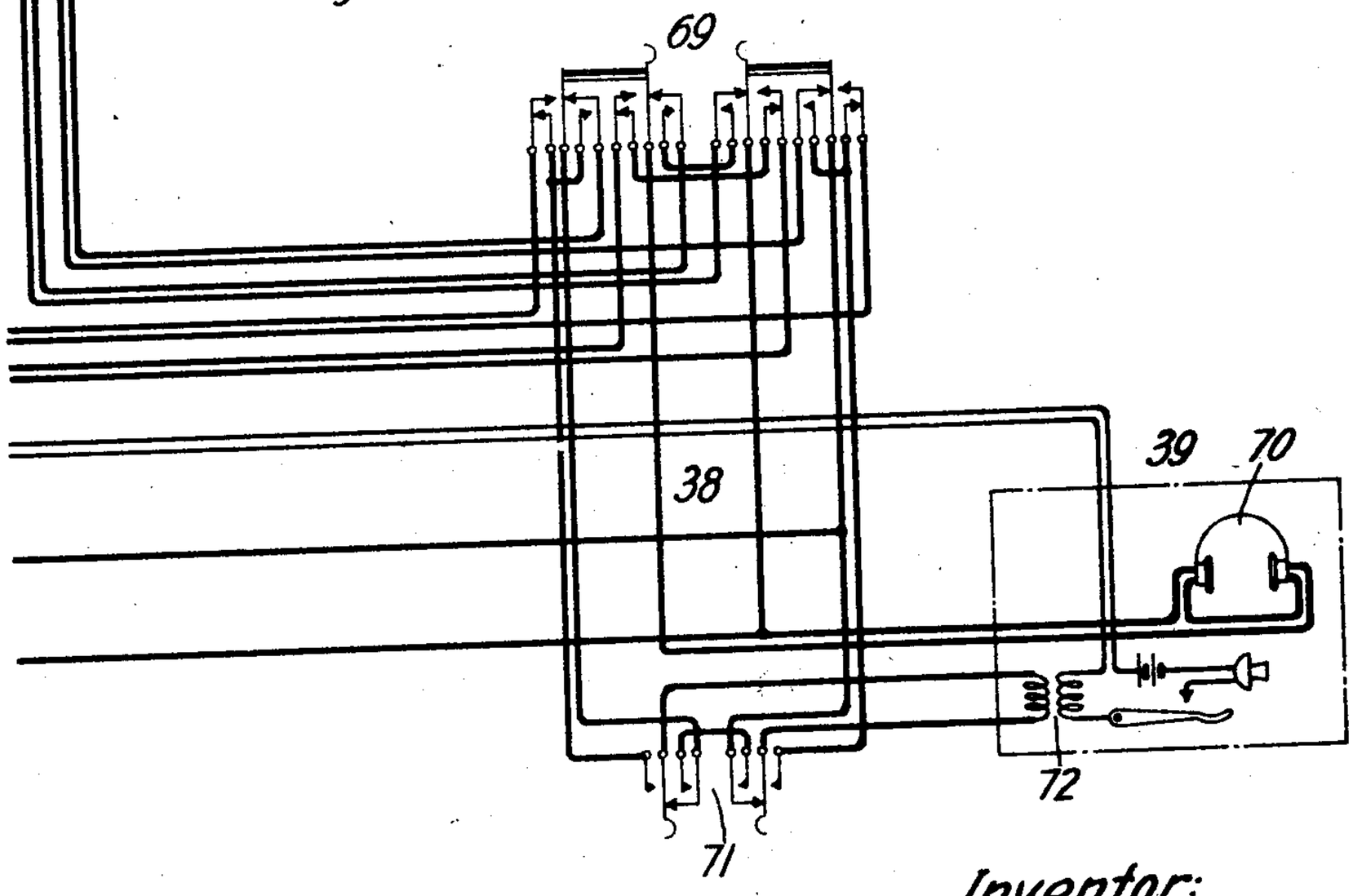


Fig. 6.



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Patented Oct. 16, 1928. 1,687,883

UNITED STATES PATENT OFFICE.

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TRANSMISSION SYSTEM.

Application filed October 19, 1926. Serial No. 142,587.

This invention relates to transmission systems, and more particularly to means and systems for joining land lines to radio channels.

The principal object of this invention is to provide an improved system for handling sound transmission over a chain of transmission channels.

In carrying out the present invention, facilities have been provided for affording so-called duplex service as regards the oppositely directioned transmissions of a telephone conversation. For this duplex arrangement, switching equipments at a first point, preferably a telephone switching center at which toll and long distance land line telephone circuits may be connectively accessible, are provided with transmission circuits and circuits ancillary thereto which may be branched to a second switching point at which radio transmitting equipment may be present and also to a third switching point which may serve radio receiving equipments. Separation of the two latter points is desirable in situations particularly to be met by the present system where the radio sections may be characterized by considerable length or great distances, as in transatlantic telephone working.

Certain features of this invention concern the provision of facilities at the first switching point which may be indicated as a toll center, for branching a connection from so-called two-wire line circuits into a four-wire circuit formed of the transmission circuits already mentioned as extending respectively to the radio transmitting and the radio receiving points.

A further feature concerns the ancillary circuit. This may be referred to as an "order-wire" line which in addition to serving as a means of signaling and communication between the three points or stations, may also function as a "monitoring" circuit over which an attendant or operator may "listen in" on a conversation over the transmission circuit.

An additional feature resides in the provision of means whereby voice currents from a connection may reach the order-wire circuit, while voice or signaling currents originating on the order-wire line may not reach nor affect the transmission circuits of a connection.

A further feature resides in the provision of a duplicate switching equipment at the radio transmitting and the radio receiving stations whereby a plurality of connections between the different points may be set up over which an attendant at either point may supervise and control or may entirely originate a call and converse on a full duplex basis either over the radio portion or over the land line portion of the system.

Another feature relates to link circuits, with associated facilities, so arranged that the same links may be employed either for two-wire or for four-wire working in connection with the work of handling calls and in completing connections.

Another feature provides means whereby connections may be transferred for the purpose of quickly isolating portions of the switching equipments in which irregularities may have developed, in substituting therefor duplicate equipments so that in meeting emergencies of this nature service may be resumed or may continue without appreciable interruption or delay.

A still further feature relates to the provision of testing equipment associated with the switching systems in such a manner that equipment or circuit irregularities either on the wire side, the radio side, or failures in the link circuit equipments may be searched out and localized with certainty and dispatch.

This invention is illustrated in the accompanying drawings in which—

Fig. 1 is in the form of a diagrammatic plan which shows the general relation of the three switching points and the circuits by which they are joined one point with the others;

Fig. 2 shows at A, the circuit arrangement of the equipment at the first point or toll switching center with circuits extending to the radio transmitting point "B" and also circuits extending to the radio receiving point "C";

Fig. 3 shows link and test circuit equipments at the radio transmitting point;

Fig. 4 shows circuits which serve the radio transmitter proper and also certain portions of the switching equipment including the circuits of an attendant or operator's telephone set;

Fig. 5 shows a circuit unit having an uni-

directional conductive characteristic for use in supervising the conversation of a connection;

Fig. 6 shows a meter system for measuring the volume of transmission currents, while;

Fig. 7 shows the relation in which the sheets Figs. 2, 3 and 4 should be placed for convenience in tracing the circuits and the relation of the connections which may be made.

In describing this system attention will first be directed to Fig. 1 of the drawing. At a telephone switching center, A, two two-wire circuits 1 and 2 having balancing networks 3 and 4, terminate respectively in jacks 5 and 6, from which connections may be extended by means of a link circuit 7. The latter circuit is provided with keys at point 8, an operator's telephone set at 9, while at 10, a coil system also in association with the networks 3 and 4, is provided for converting the two-wire circuit of the link into a four-wire circuit. Of this four-wire circuit one pair of conductors extend through a repeater 11 and leads 12 to a jack 20 at the switching point B, while the other pair is routed by way of a repeater 13 and leads 14 to a jack 120 at switching point C.

A circuit ancillary to the transmission circuits just traced, comprises a first section provided with keys at 15 and leads 16, which extend to a jack 21 at B, and a second section comprising keys at 17 and leads 18 which terminate in a jack 121 at the point B.

At 19, a unidirectional coupling unit preferably in the form of a thermionic tube device, is present for permitting currents from the coil system of the transmission circuits to reach the ancillary circuit.

At the station B, link circuits 22 and 23 serve for establishing connections between jacks 20, 21, 24 and jacks 25, 26, 27 and 28. The latter jacks serve equipment 29 of a radio transmitting system 30 which is provided with an antenna 31. At 32, there is provided equipment which may be employed for signaling or communicating by telegraph over the radio transmitter, when desired.

A test cord 33 is provided with a jack 34 for the connection of meter equipment 35, and may be employed for testing the circuits and apparatus connected with the various jacks at this point. Jacks 36 and 37 may serve as patching units in joining the test cord with either of the link or cord circuits 22 and 23, for testing such circuits.

Switching keys at 38 serve for converting the cord circuits 22 and 23 for either two-wire or for four-wire working, and also serve for isolating the common equipment which includes an operator's telephone set at 39, from either one of the cord equipments 22 or 23 on which irregularities may have developed, as already mentioned.

At 40 a coil system with a net work 41 provides that when a two-wire line as a line which may be assumed as terminating in the jack 24, may be joined by means of a so-called "patching" cord 45 with a jack 43, the two-wire circuit will be converted into a four-wire circuit which may be connected from jacks 42 and 44 over the radio equipments as presently will be described.

At the station C, the reference characters 120 to 144, inclusive, indicate equipments and devices corresponding respectively with those indicated at the station B by the reference characters 20 to 44 inclusive. At the point C, however, the equipments 132, 130 and 131 are for radio reception rather than radio transmitting.

Under a wire-radio connection, link or cord 7 may be connected to jack 5, cord 22 connected to join jacks 20 and 25, while cord 122 may connect the jacks 120 and 125. At a distant point, equipments in duplicate of that shown in the drawing may be considered as present in similarly joining a land line to the distant equipment of the present radio channels in completing a connection. Therefore, incoming transmission from the line 1 may traverse the circuit portions 5, 7, 8, 10, 11, 12, 20, 22, 25, 29 and 30 to be radiated from the transmitting antenna 31, while transmission originating through the transmitting portion of the distant radio station may be received through the antenna 131 and by way of circuit portions 130, 129, 125, 122, 120, 14, 13, 10, 8, 7 and 5 become effective with this line circuit 1.

The networks 3 and 4 have electrical characteristics to correspond with the characteristics of the line circuits 1 and 2 respectively. Under a connection, electro-responsive switching devices determine the network which will be connected, depending on which one of the lines 1 or 2 may have been taken for use.

In a more detailed description of the present system, a connection corresponding with the one briefly outlined above will now be traced and discussed. For this, reference will also be had to Figs. 2, 3 and 4 of the drawings wherein the transmission conductors proper have, in the main, been shown in shaded lines to distinguish from other conductors shown by non-shaded lines.

Under a call from a distant point or station 50 on the line 1 (Fig. 2) a signal 51 will be displayed. In response to this, the plug of cord 7 may be inserted in the jack 5 to disconnect the signal 51, close the main conductors of the line to the coil 10 and at the upper contacts of the jack 5, complete an obvious circuit from grounded battery to energize a relay 52 for connecting the balancing network 3 with the coil 10. This coil is a balancing unit of the type commonly referred to in the art as a "hybrid" coil. A separate coil unit comprising windings 53 serves

as an autotransformer for presenting a desired impedance towards the line section 14. Operation of a key 54 connects the operator's telephone set 9 so that a request may be received from over the line 1. Assuming that this is for a connection which must be completed by way of the radio channels, the answering operator may momentarily "throw" a key 55 in applying signaling current from a source 56 jointly to sections 16 and 18 of the order wire line. At the station B, a signal 57 will be operated, and at the station C a similar signal (not shown) will also be displayed. In answering this call at B, a plug 62 of the cord circuit 23 may be inserted in jack 21. This disconnects the signal 57, and with keys 59 and 60 operated on this cord and keys 61 and 150 operated at A the telephone set 9 will be connected to the telephone set 39 at B. At the point C equipment identical with that at B may have been employed in answering this call at that point, in placing a similar telephone set 139 in circuit to A. In tracing this talking circuit from the set 9, the metallic circuit is over contacts of keys 61, a network 62′, bus conductors 63′, the alternate sets of contacts of a key 100 to bus conductors 65. Thence, the circuit branches, one path to the line 18 and the other path by way of the normal sets of contacts of keys 66 and 67 and line 16 to the jack 21. Tracing the conductor singly from the upper member of the plug 62, at the point B, the path is over the upper alternate contacts of key 59 (now operated), upper normal contacts of a key 68, next upper alternate contacts of the key 60 (now operated), the third left-hand alternate contacts of a key 69 (now operated) receivers 70 of the telephone set 39, the third right-hand alternate contacts of key 69, next lower alternate contacts of key 60, right hand alternate contacts of key 69, right-hand normal contacts of a key 71, the secondary winding of an induction coil 72, left-hand normal contacts of the key 71, left-hand alternate contacts of key 69, the third upper and the lower alternate contacts of key 60, lower normal contacts of key 68, thence over the lower alternate contacts of key 59 to the lower main conductor of the plug 62. The circuit just traced is typical of the circuits not shown, but present at the point C, therefore, a request from the operator at A for the desired connection may be simultaneously received by the operators at the points B and C. In this position of the circuits, the transmission between the three operators will be on the two-wire basis. The operators at B and C now proceed to place the equipments in condition for sending and receiving, respectively.

For calling over the radio channel, a key 73 may be operated in connecting a calling or signal control device assumed as present at 32, over an obvious circuit to act outwardly over the transmitting antenna. In preparation for the desired connection 31, the cord circuit 22 may be connected to join the jacks 20 and 25, while the corresponding cord 122 may be similarly placed to join the jacks 120 and 125 at the receiving point.

Under a traffic procedure where the attendant at B may perform the operation of passing the call over the radio channel, the circuits of the operator's set at that point may now be positioned for four-wire working. For this, the transmitter side 72 of the telephone set 39 will be connected to the cord circuit 22 while the receivers 70 will be connected to the cord circuit 23. In this position of the circuits, keys 74 and 75 of the cord 22 will stand operated, keys 59 and 60 operated on the cord circuit 23 while keys 69 and 71 of the common equipment will also stand operated. In tracing the circuit for the operator's receivers 70, either signal or speech energy arriving over the receiving antenna 131 and the connection just described at C, may traverse the transmission circuit section 14, and, through the hybrid coil 10 become effective by way of the repeater 19 with the main conductors of the order-wire circuit including section 16 to the jack 21 in which the plug 62 is now present. Tracing singly from the upper conductor of this plug, the path includes the upper alternate contacts of the key 59, normal contacts of key 68, next upper alternate contacts of key 60, third left-hand alternate contacts of the key 69, receivers 70, third right-hand alternate contacts of the key 69, next lower alternate contacts of key 60, right-hand alternate contacts of key 69, right and left-hand inner sets of contacts of the key 71, left-hand alternate contacts of key 69, third upper and lower sets of alternate contacts of key 60, lower normal contacts of key 68, thence over the lower set of alternate contacts of the key 59 to the lower member of the plug 62. Thus, the receivers 70 now stand connected to the circuits of the receiving antenna 131 at station C.

The signal transmitter 32 may be arranged so that it may be "set" to automatically send out code or call signals for reaching any desired distant radio point or station, the call signals being repeated automatically. Since the receiving and the sending channels of the radio equipments are independent or on the duplex basis, the key 73 may remain in its operated position so that the call signal may be repeated until the called station answers by way of the receiving channel antenna 131. In case the answer may be by telegraph or code the operator at B will receive it in the receivers 70, and may then set the transmitter at 32 for telegraph sending and communicate with the answering radio station on that basis. In case the response is by voice, the operator may restore the key 32 and converse with the called station. For this, the re-

ceiver 70 will continue as already traced, while the circuit for the transmitter of the telephone set 39 may be traced from the upper member of the plug 64, now present in the jack 25, over the upper alternate contacts of key 74, upper normal contacts of keys 77 and 148, next upper contacts of key 75, right and left-hand inner alternate contacts of key 69, next lower alternate contacts of key 75, second right-hand alternate contacts of key 69, right-hand alternate contacts of key 71, secondary winding of induction coil 72, left-hand alternate contacts of key 71, second left-hand alternate contacts of key 69, third upper and the lower alternate contacts of key 75, lower normal contacts of keys 148 and 77, normal contacts of a key 149, thence over the lower alternate contacts of key 74 to the lower member of the plug 64.

From the connection at the jack 25 the present transmitting circuit is through the right-hand windings of a repeating coil 81, the opposite windings of this coil being connected over a loop through the opposite sets of normal contacts of keys 82, 83, 73 and jack 27 to the radio transmitter equipment 30.

For convenience of description, the transmission circuit over line 12, the cord circuit 22, and the radio sending system will be referred to as the "east" channel while the opposite side of the duplex circuit which consists of the radio receiving system as connected over cord 122 to the transmission section 14 will be indicated as the "west" channel.

The operated position of the key 74 disconnects the end of the cord circuit 22 towards the plug 63 and connects a balancing unit or resistance 158 in closing a loop now formed by the connection which may stand prepared by presence of the plug 63 in the jack 20 of the line section 12.

From the foregoing it will be clear that the transmitter side of the telephone set 39 may now be effective over that portion of the east channel which includes the right-hand end of the cord circuit as connected to the antenna 31, while the receivers 70 of this telephone set will be connected to the west channel as extended over the section 16 of the "order" line. In this way, the operator at the station B may converse with and request a connection from the distant operator who may have answered the present assumed call. On completion of the connection at the distant point, the operator at B may make any necessary verification by talking directly with the station connected, and assuming that the connection to the station 50 has been retained at A, restoration of the key 74 on the cord 22 will cut the transmitting circuit through so that the conversation of the connection may proceed.

It may be pointed out that over the cord circuit 22 the circuit of the "through" connection may be traced from the upper member of plug 63, second upper normal contacts of key 77, and the upper normal contacts of key 74 to the upper member of plug 64. The other path is from the lower member of plug 63, the next lower normal contacts of key 77, and lower normal contacts of key 74 to the lower member of plug 64.

During the period the call or connection may have been in process of completion, the operator at C may have had access to the west channel by means of a so-called monitoring key on the cord circuit 122, similar to a monitoring key 86 of the cord circuit 22, while the operator at A will have had access to the west channel either by means of a monitoring key (not shown) which may be present on the cord circuit 7, or by means of the key 61 the monitoring at this point may have been carried out by way of the order-wire circuit.

During the period of a connection, the operator at either or all of the stations A, B and C may monitor in a variety of ways. A first combination will be described whereby the three operators may, while monitoring by way of the order-wire line, speak to each other without affecting the circuits or without interfering with the progress of the conversation of the main connection under observation.

Under one method of monitoring by way of the order-wire line, the plug 62 may continue in the jack 21, the keys 59 and 60 remaining operated, while the keys 69 and 71 may stand in their normal positions at the station B. This places the telephone set 39 in the position in which the circuits were traced, for answering the call from station A over the order line. At the station C, the corresponding cord circuit 123 may be connected with the jack 121 and like keys positioned as at the station B. The key 61 at station A may be operated in connecting the telephone set 9 with the order circuit. Therefore, voice currents originating on the toll line 1 or voice currents originating at the distant station of the connection and manifested over the west channel may become effective through the receivers of the telephone sets 9, 39 and 139 at the respective points A, B and C.

The coupling unit 19 whereby these voice currents from the connection may become effective with the order-wire circuit may be formed of the arrangement shown in Fig. 5. Conductors from the hybrid coil 10 may connect to an input transformer 87 of a three element vacuum tube amplifier 88, an output transformer 89 of which may connect by way of the normal contacts of a key 90 with bus-conductors 65 of the order-wire circuit. As well understood in the art, this vacuum tube arrangement is conductive in the direction from the input towards the output side, but substantially opaque in the opposite direction as from the output to the input side. There-

fore, during monitoring under the circuit position just described, the operators at the stations A, B and C may speak one with the others, and in fact may converse over the order-wire without affecting the conversation of the connection which is under supervision. This is possible due to the unidirectional character of the coupling unit 19 which is substantially opaque to currents which otherwise would tend to flow from the order-wire circuit into the circuits of the connection, as already mentioned.

The transfer type key 66 serves for switching the order-wire section 16 from the section 18 to bus-conductors 63'. This leaves the monitoring connection with the latter section so that an operator at C may monitor, while the operators at A and B may be conversing over the first section 16. The ringing key 67, of "cut-off" type, permits the operator at A to apply current from the source 91 in signaling individually to the station B, while at a point 92 it will be understood that keys similar to the keys 66 and 67 may be present for individually signaling and talking from the station A to the station C. Under the last mentioned condition the operator at B may monitor over the section 16 while a conversation may be in progress between the operators at the points A and C over the circuit section 18.

In describing an alternate monitoring arrangement, the operator at A may hear both the east and the west transmissions by way of the unit 19 but independently of the order-wire circuits. This is accomplished by operation of the key 90 to switch the unit 19 from the bus-conductors 65 to the conductors 63' accessible as already traced, to the telephone set 9. During such monitoring at A the order-wire circuit will be free for use between the stations A and C. At B the operator may monitor on the east channel by restoring keys 69 and 71 and operating the key 86 of the cord circuit 22. For this, a bridge path extends from the upper main conductor over the upper alternate contacts of key 86, left-hand winding of a repeating coil 92 and the lower alternate contacts of the key 86 to the opposite or lower main conductor of this cord circuit 22. The receivers of the telephone set now stand connected respectively over the left and right-hand inner normal contacts of the key 69 and the upper and lower inner alternate contacts of the key 86 thence completing circuit through the right-hand winding of the coil 92. Respective upper and lower normal contacts of the key 86 disconnect a signaling relay 93 during the monitoring operation. The impedance of the left-hand winding of the monitoring transformer 92 is high, so that the transmission loss under its connection will be small or inappreciable.

At the station C monitoring on the west channel may be carried out in a manner similar to that just described for monitoring on the east channel at the station B.

In describing a further monitoring combination whereby each of the stations A, B and C may hear the transmission in each direction or as commonly expressed in the art, may hear both "sides" of a conversation, let it now be assumed that the key 90 may be in its operated position at A in appropriating the regular monitoring circuit for use at that point only, as already described, while the monitoring key 86 of the cord circuit 22 may be operated in connecting the receiver 70 through the coil 92 as above described. Now, by inserting the plug 102 of the test cord circuit 33 into the jack 21 of the order-wire line, and operating key 103 of this cord and key 71 the monitoring energy may divide between the receivers 70 and the order-wire line. At the point C a monitoring key corresponding with the key 86 may stand operated on the cord 122 while the test cord 133 may be connected with jack 121 of the order wire circuit and keys corresponding with keys 103 and 71 may stand operated. In this manner, voice currents from the east and west channels of a connection similar to the one already described, may become effective over the order-wire line with the receivers of the telephone sets 39 and 139 at the points B and C, respectively.

For the last mentioned monitoring arrangement the circuit may be traced from the upper member of plug 102, now in jack 21, over the upper normal sets of contacts of keys 104, 105, 106, next upper normal contacts of key 107, upper normal contacts of key 108, upper contacts of key 103 (now operated) the two sets of inner right and left-hand alternate contacts of key 71 (now operated), next left-hand normal contacts of key 69, upper normal contacts of key 75, the next upper alternate contacts of key 86, winding of monitoring coil 92, next lower alternate contacts of the key 86, inner right-hand normal contacts of key 69, next lower alternate contacts of key 103, thence over the lower normal contacts of keys 108, 106, 107, 105 and 104 to the lower main member of the plug 102. Thus, the circuit to the order-wire line forms a second bridge on the right-hand winding of the monitoring coil 92, the receivers 70 forming the first bridge as already traced. Over the circuit last traced, energy from the east channel will become effective in the order-wire circuit while the duplicate equipment at station C may similarly supply energy from the west channel. The character of the coil 92 and the corresponding monitoring coil at point C, while limiting the amount of energy taken from the transmission channels, also provide inefficient coupling in the inverse direction as towards the channels, respectively. Therefore, there is little or no tendency for transfer of energy between the main trans-

mission channels, by way of this monitoring circuit. The operated position of the key 71 disconnects the circuits of the transmitter side of the telephone set 39 while monitoring as first described.

In situations where during so-called "busy hour" periods a large number of connections may be handled between the toll center A and a similar distant toll center, the cords 22 and 122 at points B and C may remain connected to the respective jacks as described for the assumed connection in retaining the two radio channels in operative condition with the land lines terminating equipments. Therefore, the operator at A may work directly with the corresponding distant operator relative to disposing of completed conversations and in carrying out changes in switching at the land line centers in completing new connections. During such periods, the patching cords 45 or 145 may be employed, when desired, for respectively joining jacks 20, 25 and 120, 125 in substitution of the regular service cords 22 and 122, at the respective points B and C. Monitoring may still be carried out by way of the order-wire line or at the station B one end of the cord 22 may be connected by way of the jack 28 and key 86 operated in monitoring on the east channel. The cord 23 may also be used for this monitoring, at this point B. At the point C either the cord 122 or 123 may be joined to jack 128 in similarly monitoring at the latter point. By employing patching cords as just described, the number of devices and contacts in the circuits of a connection is reduced which is an obviously desirable condition.

Ordinarily, when repeaters are required as indicated at 11 and 13 (Fig. 2) they may be of the so-called "one-way" type. For example, the repeater 11 may transmit in the direction from A to B, while conversely, the repeater 13 may transmit in the direction from C to A only. Therefore, when monitoring at station B by way of the key 86, as described, the transmission on one channel only, the east, will be heard, while under corresponding monitoring at the station C the transmission of the opposite or west channel only will be heard. For such reasons, the advantages realized by providing that monitoring may be carried out by way of the order-wire circuit over which the two-way transmissions may be heard will at once be apparent.

The matter of regulating the amount or volume of transmission energy which may reach the radio transmitter 30 is of importance. This is in order to prevent distortion of speech or to prevent excess of energy beyond certain predetermined limits which would either damage the equipment or result in circuit "breaker" response on the associated power leads. In either case, interruption and delay would result. To meet this situation, keys 82 and 83 respectively serve for including or excluding attenuation networks 94 and 95 with the transmission leads. Either one or the other or both of these networks may be in circuit depending on the service routine at the station. This may vary or differ during a day or other period at a given station. The unit 94 may be in immediate association with the present switching devices, while the unit 95 may be at a point remote thereto as at the radio transmitter proper.

When the key 82 is operated, the key 83 will ordinarily be in its normal position and vice versa. Assuming the key 82 to be operated, the transmission path may be traced from the upper member of the jack 26 second upper alternate contacts of key 82, left-hand resistance of 94 and associated adjustable contact, thence over the upper alternate contacts of the key 82 to the upper main conductor towards the transmitter 30. From the lower member of the jack 26 the other path of the circuit is by way of the next lower alternate contacts of key 82, over a conductor loop to the upper right-hand terminal of 94, thence over the lower alternate contacts of the key 82 to the lower main conductor towards 30. When the key 83 is operated, paths in duplicate of those just traced place the unit 95 in circuit to the radio transmitter. By inspection, it will be seen that the units 94 and 95 are of the type commonly referred to in the art as constant impedance "gain" controls.

In connection with the use of the gain control devices 94 or 95 the meter system shown in Fig. 6 may be employed. This may correspond with the system of U. S. Patent No. 1,562,844, November 11, 1925, "transmission circuits." Insertion of a plug 96 into the jack 28 establishes the right-hand winding of a transformer 97 in bridge on the main conductors to the radio transmitter 30, while ground potential to the lower conductor of this plug completes an obvious circuit for energizing the filament of a vacuum tube rectifier 98. Each half-wave of alternating currents by way of the transformer 97, will be rectified and result in a unidirectional energy effect through an indicating device or meter M. A battery cell 99 serves to balance and stabilize the circuits of the rectifier system so that in the absence of incoming alternating currents the needle of the meter may rest at zero, and not be affected by the vacuum tube phenomenon commonly referred to as Edison effect. This meter system is proportioned to present a very high impedance across the transmission circuit, and, therefore, may remain connected during preparation for and the progress of a conversation, thus serving as a guide relative to adjustment of the volume control devices 94 or 95. Other jacks similar to the jack 28 or the additional jack in bridge on the lines 12, 16 and 111 may be present at different desired points on the system and may serve for connecting the vol-

ume meter and also for talking or testing purposes.

The purpose of a gain control unit 80 of the cord circuit 22 is principally to allow transmission adjustments at the transmitter 30 and the controls 94 or 95 during periods the operator at B may be speaking over the east radio channel in preparing for a connection. Operation of the key 149 effects obvious switching to insert the network 80 in the circuit already traced from the transmitter of the telephone set 39 to the main conductors of this cord circuit, the keys 74, 75, 69 and 71 having been set to their operated positions. When the operator at B may desire to adjust the controls for efficient transmission from the toll center A, the gain control 80 may be set to introduce a loss between the operator's set 39 and the radio set 30 which will be equal to the transmission loss over the circuits between A and the switching point B. Therefore, following adjustments of the radio transmitter and the distant radio receiving devices for this condition of speech from the set 39, substantially no change in speech volume may be experienced when the operator at B, after completing work from that point, may switch the connection through, as already described, for use by the operator at A. In a similar manner the operator at B, may, in speaking over the radio channel, first adjust the control 80 so that a loss will be introduced equivalent to moving the transmitter of the telephone set 39 back to the distant station point 50, thus providing that at the proper time in the handling of a connection, no transmission change may result when speech from the point 50 is substituted for speech from the telephone set 39 at point B.

At the station A the network 62′ is principally to provide for uniformity of distribution of transmission energy both for talking over and for monitoring by way of the order-wire circuit. Under a "conference" talk on the order-wire circuit in which the operators at points A, B and C may be taking part, the network 62 may be adjusted so that in terms of transmission, the telephone set 9 may be at the same distance from the junction point of the line sections 16 and 18 as the transmission distances from the stations B and C, respectively, to this junction.

This is also particularly desirable under three-way monitoring where the voice currents by way of the hybrid coil 10 are applied at the junction point of the two sections of the order wire.

It will be understood that a key similar to the key 149 of the network 80 may be provided for inserting or removing the network 62′ relative to the path from the bus-conductors 63′ to the telephone set 9, and further, that for monitoring at station A, the circuits at that point may be arranged in a manner similar to that at the stations B and C, whereby the telephone receiver of the set 9 may be separated from the circuits of the associated transmitter, and alone applied to the circuits for monitoring purposes.

In describing the handling of a "wire-radio" connection at the point "B" independently of the switching center "A", let it now be assumed that a call from a point 110 on a line 111, effects display of a signal 112. In answering this call either one of the cords 22, 23 or 33 may be used. Assuming that the cord 33 is used, plug 102 may be inserted in the jack 24 thereby disconnecting the signal 112, and extending the line 111 so that operation of key 103 will place the telephone set 39 in circuit to receive the request from point 110. Plug 113 may now be inserted into jack 21 of the order circuit, a splitting key 114 operated, then the ringing key 68 momentarily operated in applying current from a source 115 to operate a signal (not shown) on the order circuit at station C where the call may be answered and request received from the operator at B that the west channel be connected to the order circuit. The latter may be effected by joining jacks 120 and 125 by means of the cord circuit 122.

At the station B, a patching cord similar to 45 may be substituted for cord 33 at the jack 24 and its opposite end connected to the jack 43. The plug 62 of the cord 23 may be inserted into jack 44 while plugs 63 and 64 of cord circuit 22 may be respectively inserted into jacks 42 and 25. This places the two-wire line circuit 111 in circuit to the hybrid coil 40, whence a branching four-wire circuit is derived in which the east radio channel will be connected by cord 22 to jack 42 while the west channel will be connected by way of the order circuit, cord 23 and the jack 44. A call signal may now be sent from the point B over the radio transmitting system 30 in the same manner as that already described, while reply may be received over the west channel. Splitting keys 74 and 114, talking keys 75 and 60 of the cords 22 and 23, and keys 69 and 71 may now stand operated, the transmitter circuit 72 of the telephone set 39 will then be connected over the east channel, while the receivers 70 will be connected over the west channel for talking over the radio equipments. When the radio "side" of the desired connection is in readiness, the splitting keys 74 and 114 may be restored in completing the connection through to the line 111, so that the conversation may proceed. Restoration of the splitting keys 74 and 114 also disconnects the telephone set 39. The keys 75 and 60 may continue operated without effect until keys 116 and 86 may be operated, thereby permitting the telephone set 39 to be applied in bridge on the 4-wire side of the connection. The keys 69 and 71 remain operated so that the transmitter cir-

cuits of the telephone set will be connected to the east channel while the receiver of the set will be connected to the west channel. Speech originating at the set 39 may then reach the main conductors of the cord 22 thence the currents divide one portion traversing the radio transmitting equipment to the distant end of the connection while the other portion may traverse the hybrid coil 40 and the line 111 to the land line station 110. In turn, speech currents originating at the latter station as well as speech currents originating at the distant point may arrive over the west radio channel and become effective in the receivers of the operator's telephone set 39.

In tracing the transmitter circuit, the path is from the upper main conductor of the cord 22, upper contacts of the key 116, next upper alternate contacts of key 75, inner left and right-hand alternate contacts of key 69, next lower alternate contacts of key 75, second right-hand alternate contacts of key 69, right-hand alternate contacts of key 71, secondary winding of the induction coil 72, left-hand alternate contacts of key 71, second left-hand alternate contacts of key 69, third upper and the lower alternate contacts of key 75, thence over the lower contacts of key 116 to the lower main conductor of the cord circuit 22. The circuit for the receivers 70 is from the upper main conductor of the cord 23 over the upper contacts of key 68 next upper alternate contacts of key 60, third left-hand alternate contacts of key 69, receivers 70, third right-hand alternate contacts of key 69, next lower alternate contacts of key 60, right-hand alternate contacts of key 69, right and left-hand inner alternate contacts of key 71, left-hand alternate contacts of key 69, third upper and the lower alternate contact of key 60, thence over the lower contacts of key 68 to the lower main conductor of the cord circuit 23.

The operator at station B may monitor on this connection over either the cord 22 or 23. Assuming now that the keys 75, 116 and 60, 68 are restored and a monitoring key 117 on cord circuit 23 is operated, the upper and lower alternate contacts of this key establish the primary winding of a high impedance monitoring coil 118 in bridge on the two main conductors of the cord circuit. Assuming that the keys 69 and 71 are still in their operated positions, a loop may be traced from the upper end of the secondary winding of the coil 118 over the next upper alternate contact of key 117, third left-hand alternate contacts of key 69, receivers 70, third right-hand alternate contacts of key 69, and the next lower alternate contacts of key 117 to the lower end of the secondary winding on this monitoring coil 118.

In monitoring over the circuit just traced, voice currents originating at the station 110 as well as currents originating at the distant point served by the radio channels, may become effective with the receivers of the telephone set 39. This is due to the fact that currents from the line 111 may branch through the hybrid coil 40 into the receiving as well as into the sending side of the four-wire or duplex circuit, while the cord circuit 23 forms a link in the channel over which voice currents are conveyed from the distant station into the line 111. Under a high degree of balance relative to the network 41 and the line 111, currents from the west channel will be excluded from the opposite channel in which the cord circuit 22 forms a link. Therefore, in case monitoring may be by way of key 86 of the cord circuit 22, the key 69 being restored, only the voice currents originating in the line 111 may be heard in the receivers 70.

In case one way repeaters may be introduced at points intermediate the hybrid coil 40 and respective jacks 42 and 44, in the same relation in which the repeaters 11 and 13 are connected in the four-wire circuits from the hybrid coil 10, then only one side of a conversation may be heard in the receivers 70 when monitoring by way of the cord circuit 23. The reason for this is rendered clear by the description already given in connection with monitoring operations under the first assumed connection.

When desired, in handling connections similar to the one last described, the cord circuit 23 and the patching cord 45 may be interchanged, so that the latter cord may join the jacks 21 and 44 while the cord 23 will join jacks 24 and 43. This places the cord circuit 23 as a link to join the line 111 to the hybrid coil 40. Therefore, the operator's set 39 and other associated controls may be applied on a two-wire section of the present connection. For this, the key 69 may be operated while the key 71 may stand in its normal position so that talking or monitoring may be carried out from the telephone set as will be readily understood from the descriptions already given for the first assumed connection. In monitoring, both sides of the conversation will be effective in the receivers 70.

In case a call signal may originate at point 110 during the period of the last assumed connection, a relay 119, of high impedance and normally connected by way of upper and lower normal contact of key 117 in bridge on the main conductors of the cord circuit will respond. This closes an obvious circuit from battery through a signal 151, which responds and closes an obvious circuit from the same battery through an audible signal 152.

When it may be desired to signal the station 110 from the cord circuit, and assuming that the plug 62 is present in the jack 24, splitting key 59 may be operated followed by momentary operation of key 68. Energy from the source 115 may traverse the upper

alternate contacts of keys 68 and 59 thence over the upper members of plug 62 and jack 24, a loop formed by the line 111, thence over the lower main members of this jack and plug and the lower alternate contacts of the keys 59 and 68 to the source 115. In case the plug 113 had been present in the jack 24 the splitting key 114 rather than the key 59 would have been operated. Following this the same signaling key 68 would have been operated and energy from source 115 would then traverse the upper alternate contacts of key 68 upper normal contacts of key 59, upper alternate contacts of key 114, thence over the upper member of the plug 113 to return over the lower main member of this plug, lower alternate contacts of key 114, normal contacts of a key 154 of a gain control unit 153, the lower normal contacts of the key 59, and the lower alternate contacts of the key 68 to this source 115.

In situations where provision is made for signaling over the radio channels, as shown in Patent No. 1,624,672, granted to H. W. O'Neill, April 27, 1927, calling may be effected by keys 68 or 148 of the cord circuits 23 and 22 in a manner similar to that just described for signaling over the line 111. The signaling current to be applied, of course, is over that portion of a cord circuit which may be joined to one of the jacks 25—28 of the radio transmitting channel.

At the station C a line similar to the line 111 may be assumed as terminating in the jack 134, and the operator at C may establish a connection from such line to the radio channels. For this, cord 123 may join jacks 124 and 143, patching cord 145 may join jack 142 with jack 121 of the order circuit, while cord 122 may join jacks 144 and 125. Over the order wire circuit a request may be made for the operator at B to connect jack 21 of the order wire circuit with jack 25 of the radio channel.

From the description already given of the handling of the assumed connection from the line 111 at B, it will be obvious how the duplicate switching apparatus at C may be handled in providing a wire-radio connection for the line circuit of the jack 124.

In situations where it may be desired, signaling keys similar to the key 67 may be inserted at points 155 and 156 on the line sections 12 and 14 respectively, for control of a call signal 157 at the jack 20 and a similar signal (not shown) which may be present at the jack 120. By such means, the operator at A may signal or call the operator at B or at C independently of the order wire circuit, while during periods either the cord circuit 22 or 23 may be connected to the jack 20, operation of a key at point 155 may effect response of relay 93 and in turn operation of audible signal 152. In like manner, a key at point 156 may control either a line signal or a cord signal at the station C. From the drawing, it will be clear that the contacts of the line signals 57, 112 and 157 may close an obvious circuit to energize the audible signal 152.

It may be pointed out that at radio transmitting stations, the high frequency currents set up extraneous fields which may be manifested over areas occupied by radio transmitting equipments and also equipments and circuits in which associated land lines may terminate. Notwithstanding, the use of protecting measures as shielding and balanced connections to earth, such currents may, at times, reach the circuits and equipments not intended for currents at radio frequencies. In paths where direct currents may normally be present, high frequency currents may act or discharge through the insulation of conductors, coils and the like, following which, the direct current may then flow and establish a permanent fault. In addition to interruption of service, such faults introduce a certain amount of personal injury hazard as following a so-called "cutting through" of the high frequency currents, direct currents or currents of lower frequency but perhaps of high potentials, as commonly required with radio transmitting systems, may energize circuit parts with which operators or attendants come into contact. In order to afford a certain amount of protection to the operators and equipments, the present circuits have been planned particularly to afford substantially zero resistance ground connections for the more exposed circuit parts, as the shell members of the various jacks, and the corresponding members of the various plugs. To the end that protection may be provided for the main conductor strands of the various cord circuits, cords have been provided of a type in which a third flexible conductor strand is present. By grounding this strand as shown for the cords of circuits 22, 23, 33, 161 and the ground of low inductance for the cord 96, the transmission or non-grounded strands are, to a certain extent, protected due to the proximity of the associated grounded strand. This provides that in the event that high frequency currents or discharge effects may reach the voice transmission circuits in sufficient volume to constitute a hazard, they will generally pass to ground over the sleeve strand of a cord and ordinarily may not cause a trouble condition to continue to exist at the point of dissipation.

In order that determinations may be quickly made as to unbalance of the transmission circuits, discovering the nature of irregularities, and for locating the point at which an irregularity may be present, the cord circuit 33 has been arranged as a combined service and "testing" cord. A jack 34 provides for connection of either a suitable type of Wheatstone bridge, an impedance bridge,

which may be of the type shown in U. S. Patent No. 1,404,311, January 24, 1922, or a combined voltammeter system 131 shown in the drawing. Insertion of a plug 161 into the jack 34 connects the meter system 35 which comprises a meter V, a scale changing key 162, a meter shunt control key 163, a test battery 160 and a circuit reversing key 164.

In making tests, the plug 102 may be inserted into any of the jacks of the various equipments shown. The circuits have been arranged so that either so-called out-going tests or incoming tests may be carried out. It is believed that by tracing the test circuits only to the main members of the plug 102 that a clear understanding of the system may be had. Outgoing tests is the term commonly applied to tests made from a point at which the current indicating devices may be present, while incoming tests refer to switching effects carried out for the convenience of an attendant who may be making outgoing tests at a distant point on the same circuits.

For incoming tests, operation of key 104 connects ground by way of the upper normal contacts of key 107, normal contacts of jack 34 (now vacant) and the upper alternate contacts of the key 104 to the upper member of the plug. The circuit from the lower main member of this plug now stands open at the lower normal contacts of the key 104. Operation of key 105 establishes an inverse effect by grounding the lower main member while opening the circuit to the upper member of this plug 102. Operation of key 107 joins the upper to the lower main member of the plug 102. This may be traced from the upper member over the upper normal contacts of keys 104, 105 and 106, the upper alternate contacts of key 107, contacts of jack 34, lower alternate contacts of key 107, thence over the lower normal contacts of keys 104 and 105 to the lower main member of the plug 102. Operation of key 106 insures opening of the circuits from the plug 102 irrespective of whether the telephone set 39 may be connected due to an operated position of the talking key 103, as already described. Current from the source 115 may be applied to the main members of the plug 102 by operation of key 108.

For outward tests, plug 161 may be inserted into the jack 34. This operates the normally closed contacts of this jack and prepares a circuit from ground over the upper normal contacts of key 107, the lower main members of jack 34 and plug 161, upper normal contacts of key 164, normal contacts of key 162, the meter V, battery 160, the lower normal contacts of key 164, the upper members of the plug and jack, thence to stand open at the lower alternate contacts of keys 107 and 105 and the upper alternate contacts of key 104. Therefore, operation of the key 104 will place the series formed by the battery 160 and meter V in series from ground to the upper member of the plug 102, while the circuit to the other main member of this plug will stand open. Operation of key 105 connects the battery and meter in a like manner to the lower main member of the plug 102, while the circuit to the upper member will be opened. Operation of the key 107 disconnects the ground and places the series formed by the meter V and battery 160 in a loop to the main members of the plug 102. Operation of the key 164 reverses the polarity relation of the meter V relative to the battery 160. Tests to determine the continuity or insulation of conductors are usually made with the keys 162 and 163 positioned as shown. Approximate determinations as to the resistance of a circuit may more readily be made by operating the shunt control key 163, while current readings may be made by operating key 162 to connect the active winding only of the meter V.

In connecting a Wheatstone bridge or the impedance bridge of Patent No. 1,404,311 above mentioned, the "X" terminals or terminals of the unknown, may be provided with a plug which may be inserted into the jack 34, and measurements made under any of the various circuit combinations which may be set up by means of the keys of the test cord, as already described.

Following the detailed descriptions given, it will now be clear that one function of the key 69 is to place the telephone set 39 for use either with the cord circuit 22 or the cord circuit 23 on a 2-wire control basis. This being carried out in a manner to entirely disconnect the leads to the cord circuit vacated, so that in the event of irregularity in the operation of one of the cord circuits, the other cord circuit may be substituted.

The key 71 serves for either joining or separating the circuits of the receivers from the circuits of the transmitter of the telephone set 39. Under a separated condition of the receiver and transmitter circuits, the system will be on a 4-wire basis relative to control by way of the two 2-wire cord circuits 22 and 23. In this position of the circuits, the key 69 serves as a "transposing" key whereby the receiver and the transmitter circuits may be interchanged, respectively, relative to connection with the two cords. For example, when the key 69 is normal (key 71 operated) the receivers of the set 39 will be connected to the cord 22 while the transmitter will be connected to the cord 23, and inversely, when the key 69 is operated, the receivers will be connected to the cord 23 while the transmitter will be connected to the cord 22.

During periods the key 71 may be in its operated position, the circuits of the receivers 70 will also stand prepared to the key 103 for use with the combined service and test cord

33. Therefore when the key 69 is in its normal position the cord 33 may serve as the receiving side, while the cord circuit 23 may serve as the transmitting side of a 4-wire circuit. When the key 69 may be operated, the cord circuit 33 may continue as the receiving side, while the cord circuit 22 may then serve as the transmitting side of a 4-wire circuit. Therefore, the cord circuit 33 while being adapted to serve as a test cord may also serve either as a 2-wire service cord or as one portion or "side" of a 4-wire circuit.

In establishing connections with the radio transmitting system at B, the jack 25 is employed in situations where it may be desired to guard against the possibility of direct currents reaching the radio system, or, inversely, in insuring that direct currents from the radio equipment may not enter the terminating circuits of lines which may be connected. The transformer 81 serves as an insulating or blocking means against such direct currents. This transformer or repeating coil may also be of an unequal ratio type in providing that proper impedance relations may be had in coupling certain circuits to the radio equipment.

Connections may be made by way of the jack 26 in situations where it may not be necessary to observe the points mentioned next above. Insertion of a plug into this jack 26 disconnects the transformer 81 and also the jack 25. Connection may also be made at the jack 27 where insertion of a plug will disconnect all of the equipment to the left of this jack and afford a connection directly to the main conductors leading into the radio transmitter 30.

What is claimed is:

1. In a radio-wire telephone system, a transmission circuit formed of a first land line and a radio section, means for applying communication energy in either direction over said transmission circuit, a second circuit, means for applying communication energy in either direction over said second circuit, and means for conducting communication energy from said transmission circuit to said second circuit while excluding communication energy of said second circuit from said transmission circuit.

2. In a radio-wire telephone system, a transmission circuit formed of a land line section and a radio section, means for communicating over said circuit, a monitoring line and a plurality of telephone sets therefor, a derived path to join said transmission circuit to said monitoring line, and means to render said derived path conductive only in the direction from said transmission circuit to said monitoring line.

3. In a radio-wire telephone system, land lines, radio channels, a plurality of switching points for establishing a connection by way of said land lines and said radio channels, an independent circuit for communication between said switching points, coupling means to establish a derived path from said connection to said independent circuit, and means to render said derived path ineffective to conduct from said independent circuit into the circuit of said connection.

4. In a radio-wire telephone system, a first, a second, and a third switching point, a plurality of 2-wire lines served by said first point, means for creating a 4-wire circuit from a certain one of said 2-wire lines, and branching the 4-wire circuit to said second and third points, a radio transmitting channel and a radio receiving channel served by said second and third points, respectively, an independent two wire circuit joining said second and third points, 2-wire link circuits at said first point for establishing a connection between said certain circuit and other of the 2-wire circuits at that point, 4-wire link circuits at the second and third points for completing the connection from the branching paths of said 4-wire circuit to the radio transmitting and receiving channels, respectively, and also effecting connection with said independent circuit so that duplex operation may be carried out from the second and third points over either the land lines portion or the radio portion of the connection.

5. In a radio-wire telephone system, a plurality of land lines, a plurality of radio channels, testing means including a test cord circuit for localizing faults on said lines and said channels, a service cord circuit for use with said lines and channels, a telephone set connected on a two-wire basis to each of said cords, means to render said cords effective on a four-wire basis with said lines, and with said channels, and switching means for changing the connection of said telephone set from the two-wire to a four-wire basis on said cord circuit.

6. In a radio-wire telephone system, a plurality of land lines, a plurality of radio channels, a plurality of switching points, circuit control means at said points cooperatively to serve one point with the others in establishing a connection from said land lines to effect duplex transmission by way of said radio channels, first monitoring means individual to each of the points for respectively supervising the transmission of said connection, and second monitoring means common to all of said points for also supervising said transmission.

7. In a radio wire telephone system, a plurality of land lines, a plurality of radio channels, a plurality of switching points, a plurality of cord circuits at each of said points for use in cooperation one point with another in providing a connection from the land lines to effect transmission by way of said radio channels, signal receiving means

for said cord circuits, monitoring means for association with said cord circuits, and switching means to disable said signaling means while enabling said monitoring means.

8. In a radio-wire telephone system, land lines, radio channels, a first and a second cord circuit for connecting said lines to said channels, a telephone set having normally separated transmitter and receiver circuits, a key on each cord circuit for joining said transmitter and receiver circuits in connecting said telephone set respectively to said cord circuits, a key for again separating said transmitter and receiver circuits, and a key to transpose the relation of said transmitter and receiver circuits so that either circuit may be applied by way of the first mentioned keys to either the first or the second cord circuit, respectively.

9. In a radio-wire telephone system, land lines and radio channels, a telephone set including a transmitting circuit and a receiving circuit, a first and a second cord circuit for connecting said telephone set to said lines and channels, a key on each cord circuit for joining said transmitting and said receiving circuits in connecting said telephone set to said cord circuits respectively, a first master key to selectively limit the connection of said telephone set to one or the other of said cord circuits and a second master key to separate said transmitter and receiver circuits in rendering said first master key effective to switch the transmitter circuit to one cord circuit and the receiver circuit to the other cord circuit and vice versa.

10. In a radio-wire telephone system, line circuits and radio channels, a first and a second service cord circuit and a test cord circuit for use with said lines and channels, a telephone set including a transmitting and a receiving circuit, a key on each service cord circuit to respectively connect the telephone set to the cord circuits and normally to effect separation of the transmitter and receiver circuits at these cords, a master key interconnected with the keys of the service cords to render the telephone selectively effective with but one of these cords at one time, a key for connecting the telephone set to the test cord and interconnections between said telephone set, master key and the keys of the service cords to effect normal joinder of said transmitting and receiving circuit at the key of said test cord circuit.

11. In a radio-wire telephone system, a telephone set including a transmitter and a receiver circuit, a first key for joining or separating said transmitter and receiver circuits, a plurality of cord circuits, land lines and radio channels connectively accessible to said cord circuits, switching means for each cord circuit to join said transmitter and receiver circuits in respectively connecting said telephone set to said cord circuits, and a master key intermediate said first key and the keys of said cord circuits for transferring said telephone set from one to another of said cord circuits.

12. In a radio-wire telephone system, land lines and radio channels, a plurality of cord circuits for connecting said lines and channels, a telephone set, a key on each cord circuit for respectively connecting the telephone set to the cord, an adjustable network for introducing predetermined amounts of transmission loss for each cord circuit, and a splitting key for each cord circuit for electrically dividing the cord into two sections while inserting the associated network between said telephone set and one section of the cord circuit.

13. In a radio-wire telephone system, a telephone set including a transmitter and a receiver, separate circuits for said transmitter and receiver, land lines and radio channels, service cord circuits for use with said lines and channels, testing means including a cord circuit for use with said lines and channels, a talking key for each of said service cords at which the circuits of the transmitter and receiver will normally stand separated, a talking key for said testing cord circuit at which the transmitter and receiver circuits will stand normally joined, and a monitoring key on each of said service cords to connect said receiver circuit only to the associated cord circuit.

14. In a sound transmisison system, a transmission circuit comprising a chain of transmission channels, means for applying sound transmission energy in either direction over said transmission circuit, a second circuit, means for applying sound transmission energy in either direction over said second circuit and means for conducting sound transmission energy from said transmisison circuit to said second circuit while excluding sound transmission energy of said second circuit from said transmission circuit.

15. In a communication system, communication channels, a plurality of switching points for establishing a connection between said channels, an independent circuit for communication between said switching points, coupling means to establish a derived path from said connection to said independent circuit and means to render said derived path ineffective to conduct from said independent circuit into the circuit of said connection.

In witness whereof, I hereunto subscribe my name this 18th day of October A. D., 1926.

HENRY W. O'NEILL.