

Jan. 6, 1942.

P. B. MURPHY

2,269,034

BROADCAST SWITCHING SYSTEM

Filed Aug. 23, 1940

12 Sheets-Sheet 1

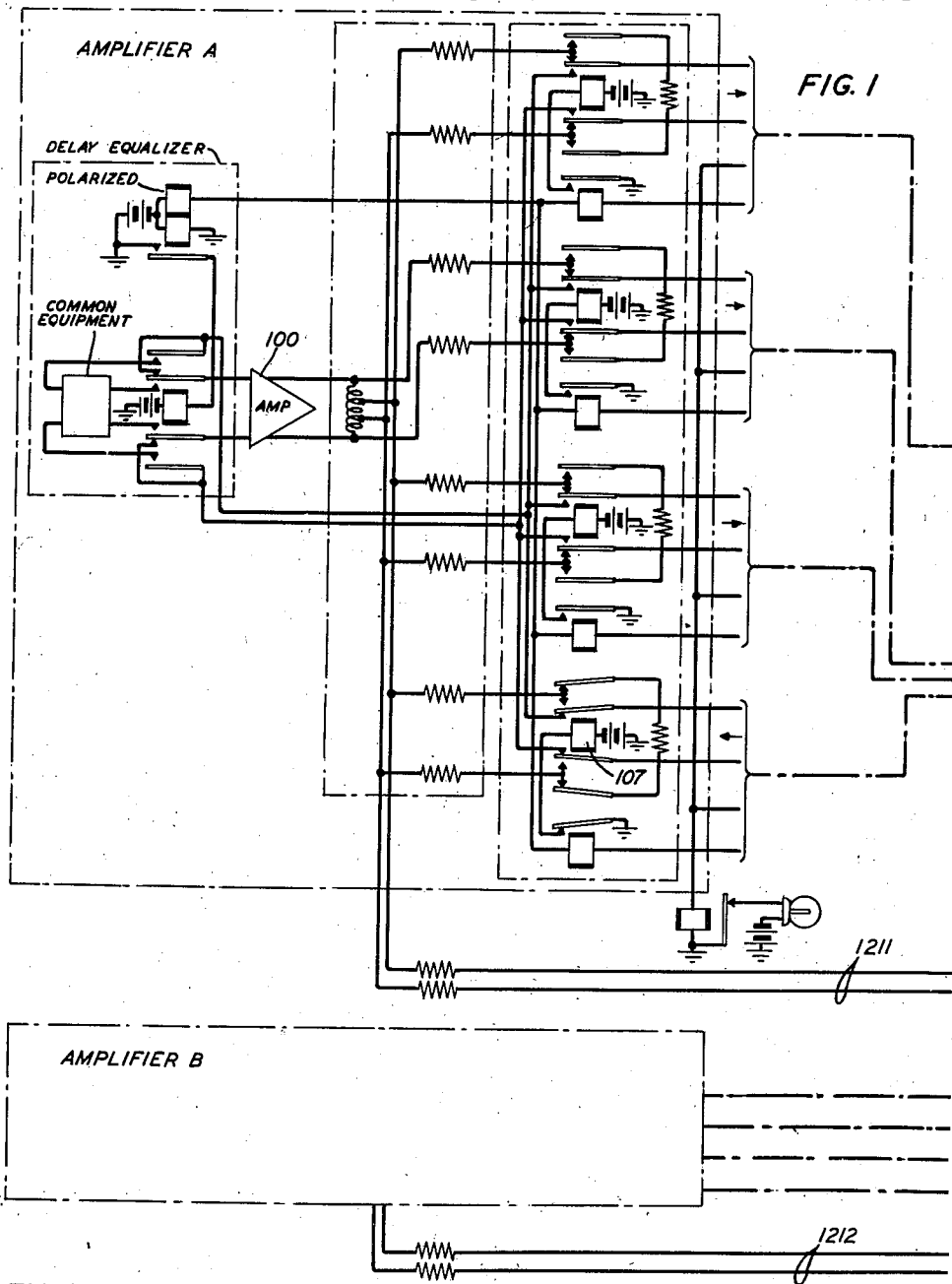


FIG. 13

		FIG. 4	FIG. 7	FIG. 10	FIG. 11	FIG. 12
FIG. 1	FIG. 2	FIG. 5	FIG. 8			
	FIG. 3	FIG. 6	FIG. 9			

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12 Sheets-Sheet 2

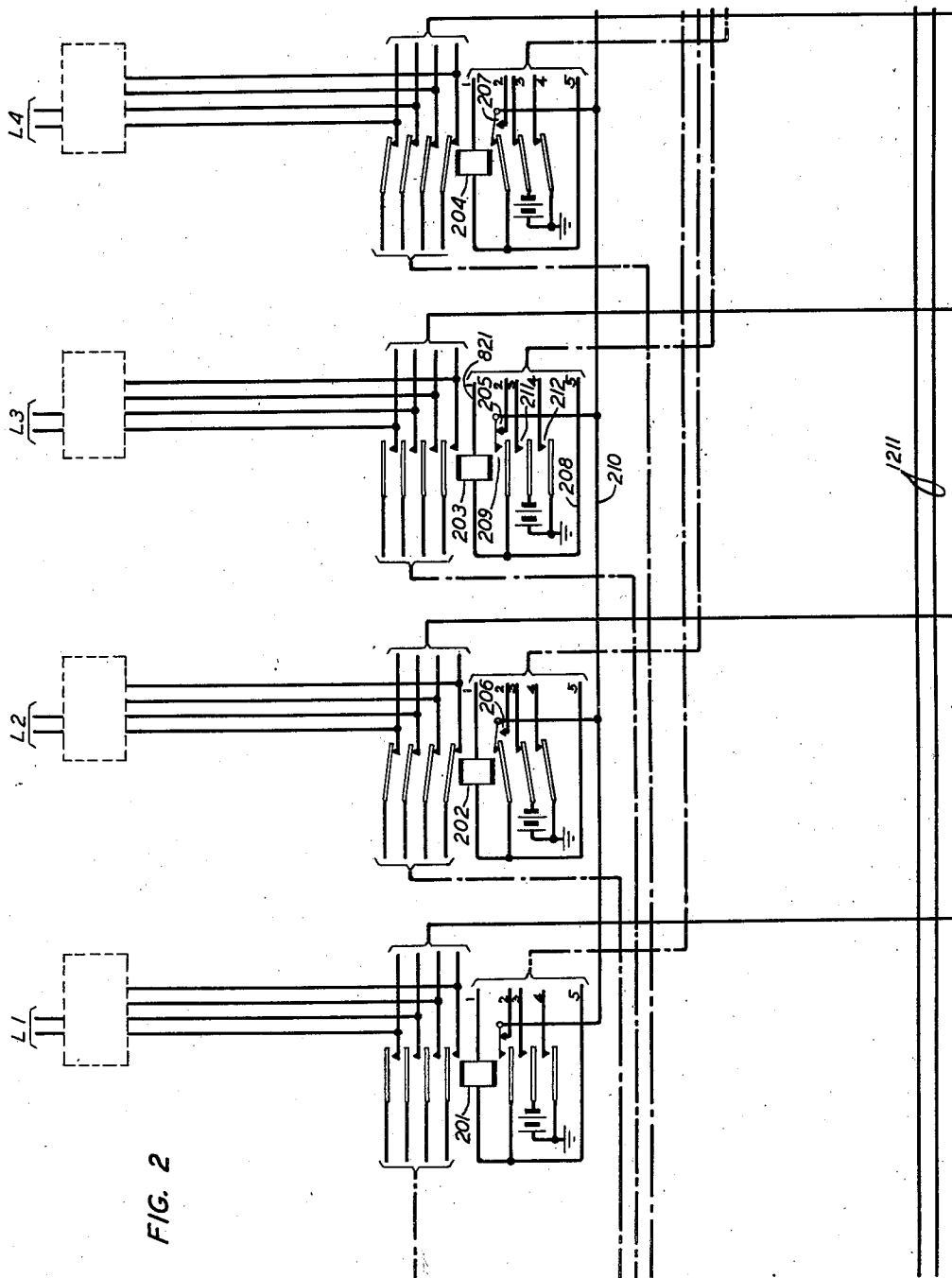


FIG. 2

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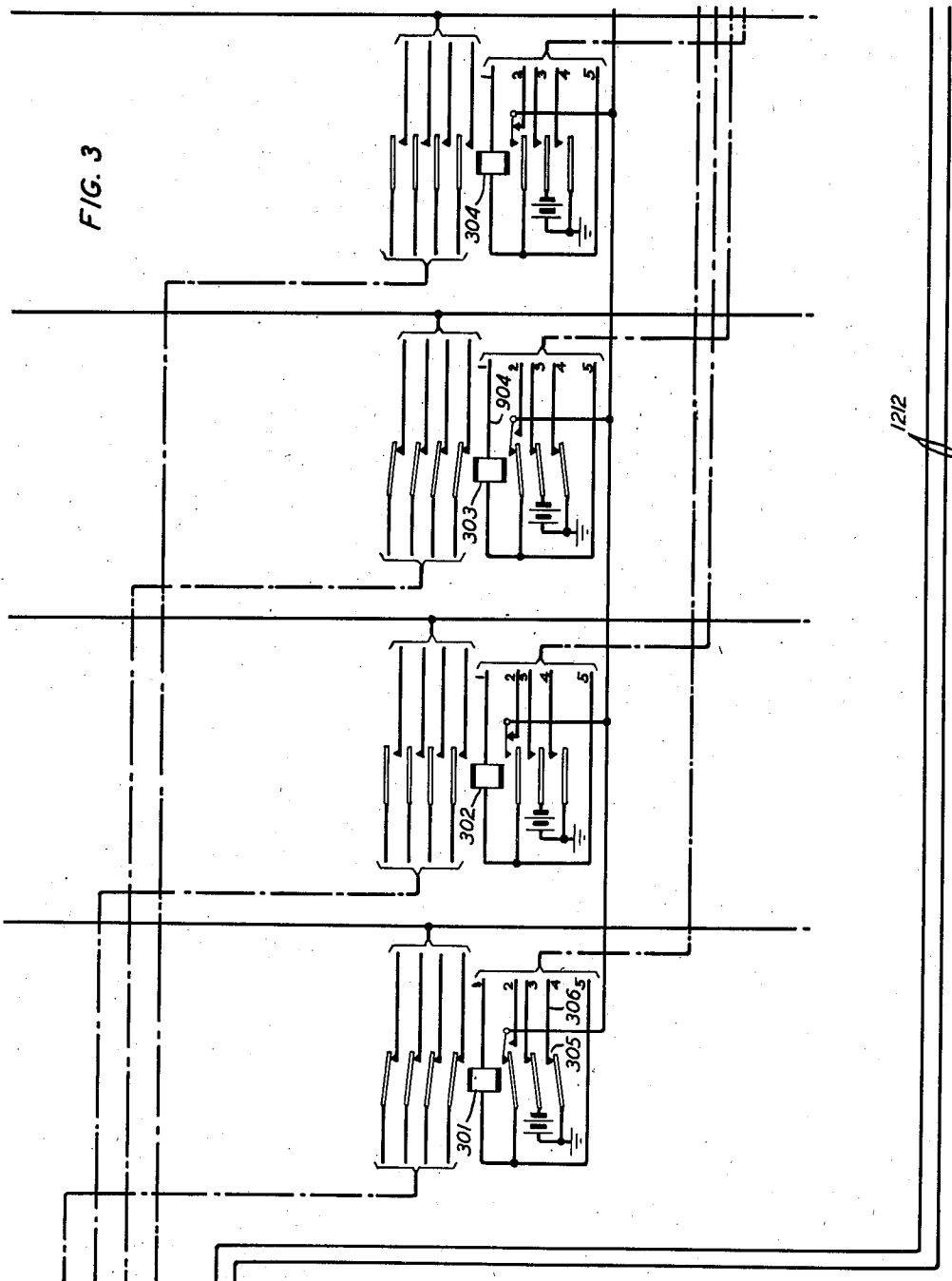
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BROADCAST SWITCHING SYSTEM

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12 Sheets-Sheet 3



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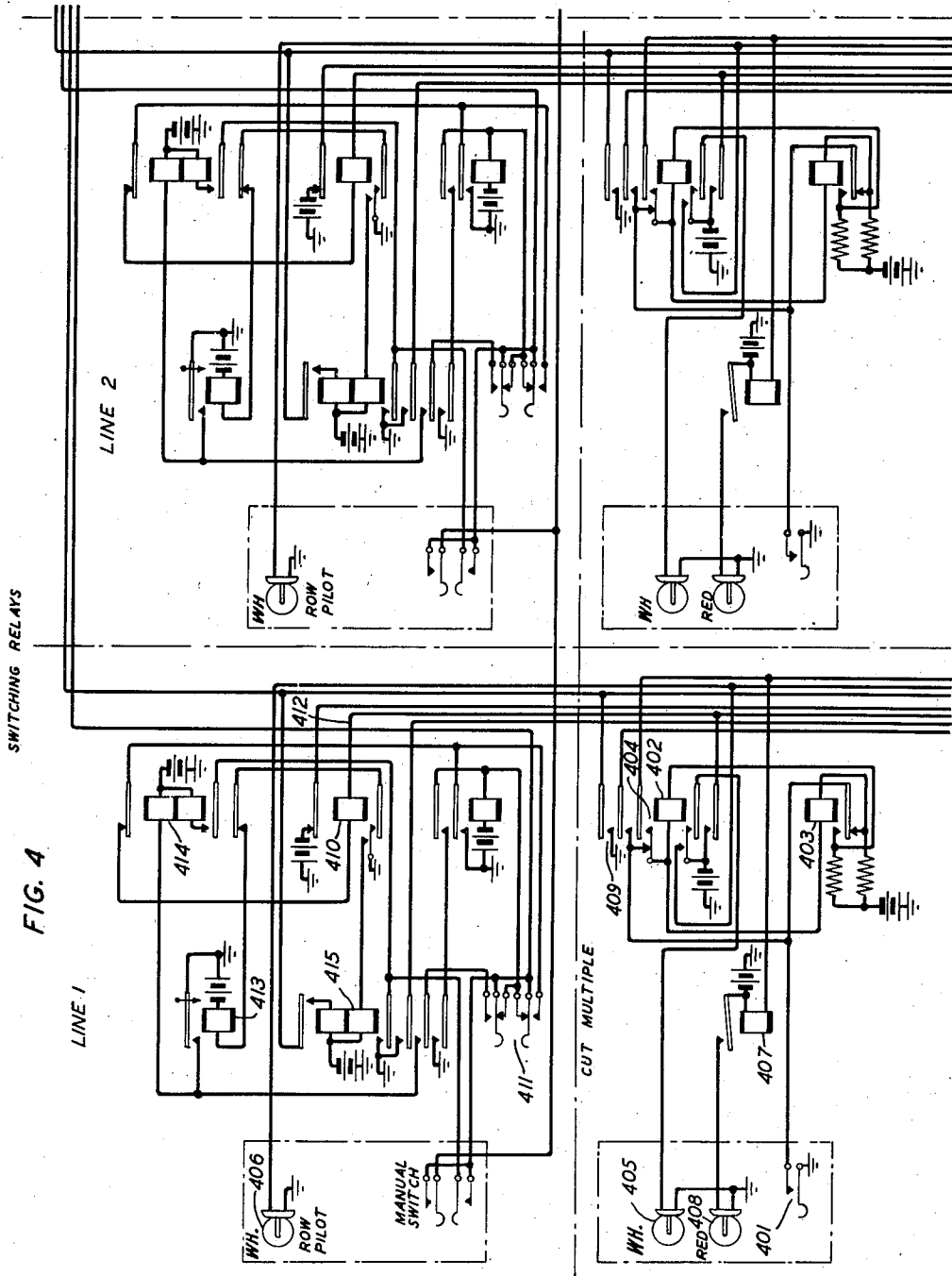
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12 Sheets-Sheet 4



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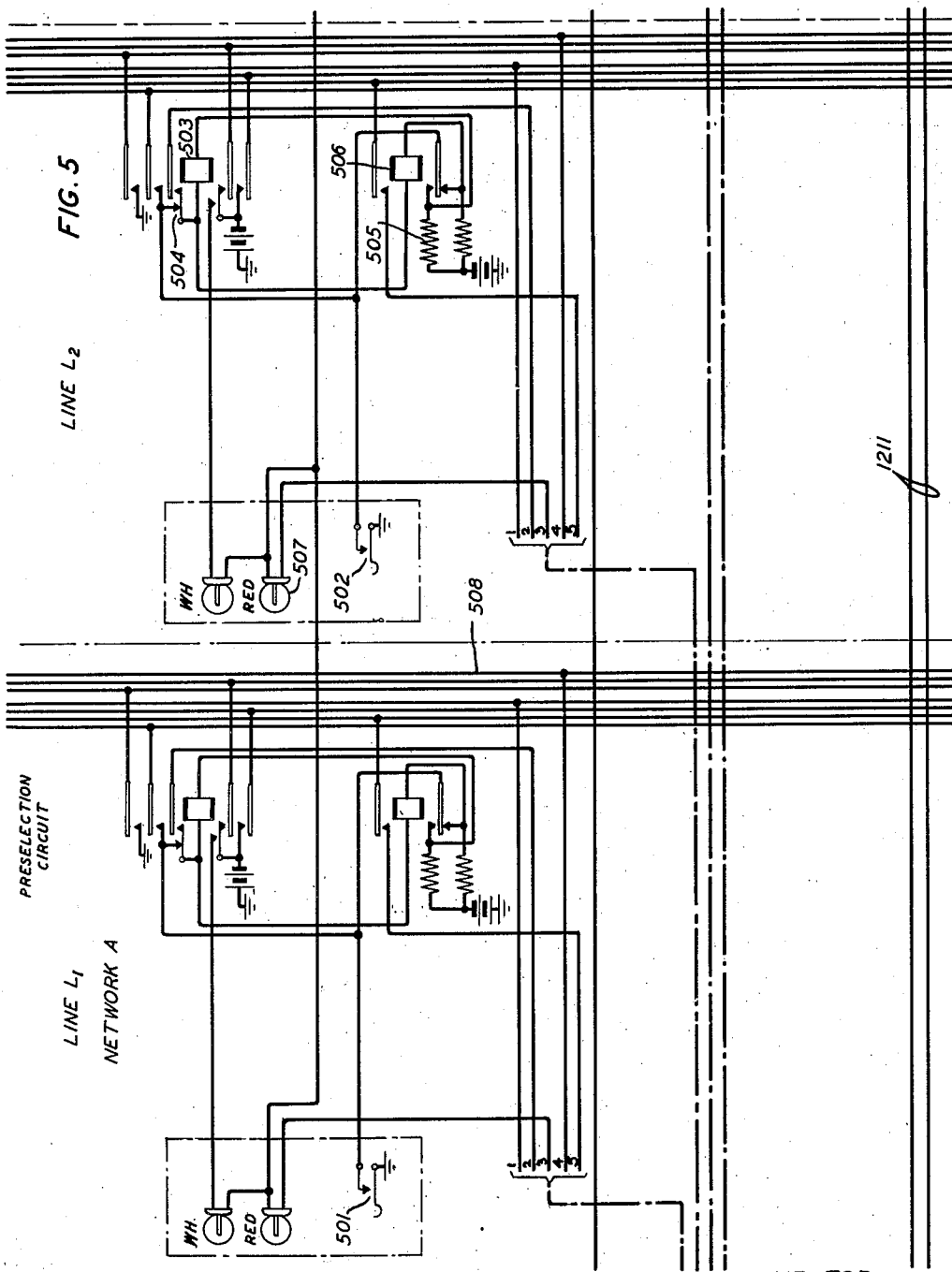
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12 Sheets-Sheet 5



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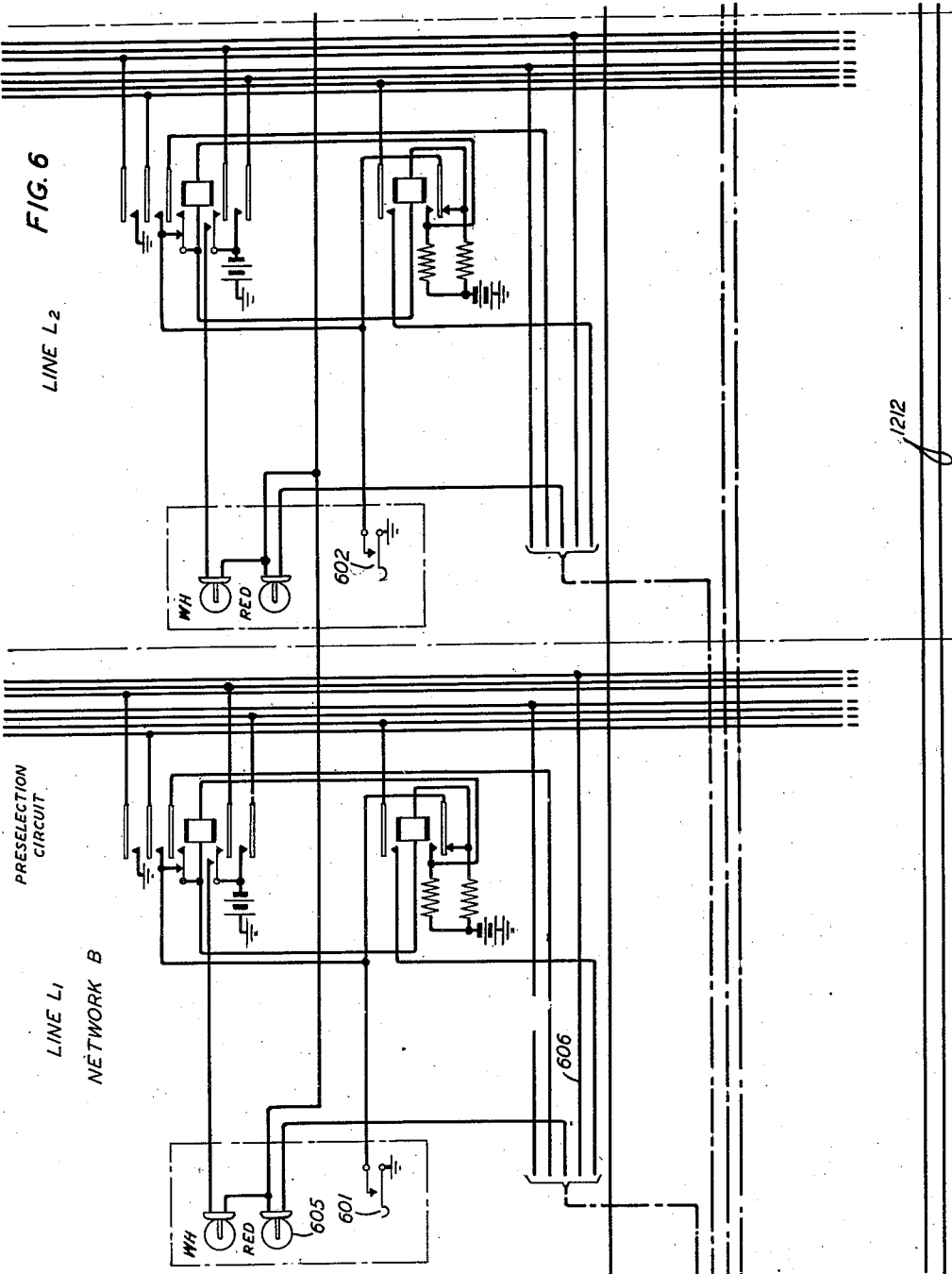
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12 Sheets-Sheet 6



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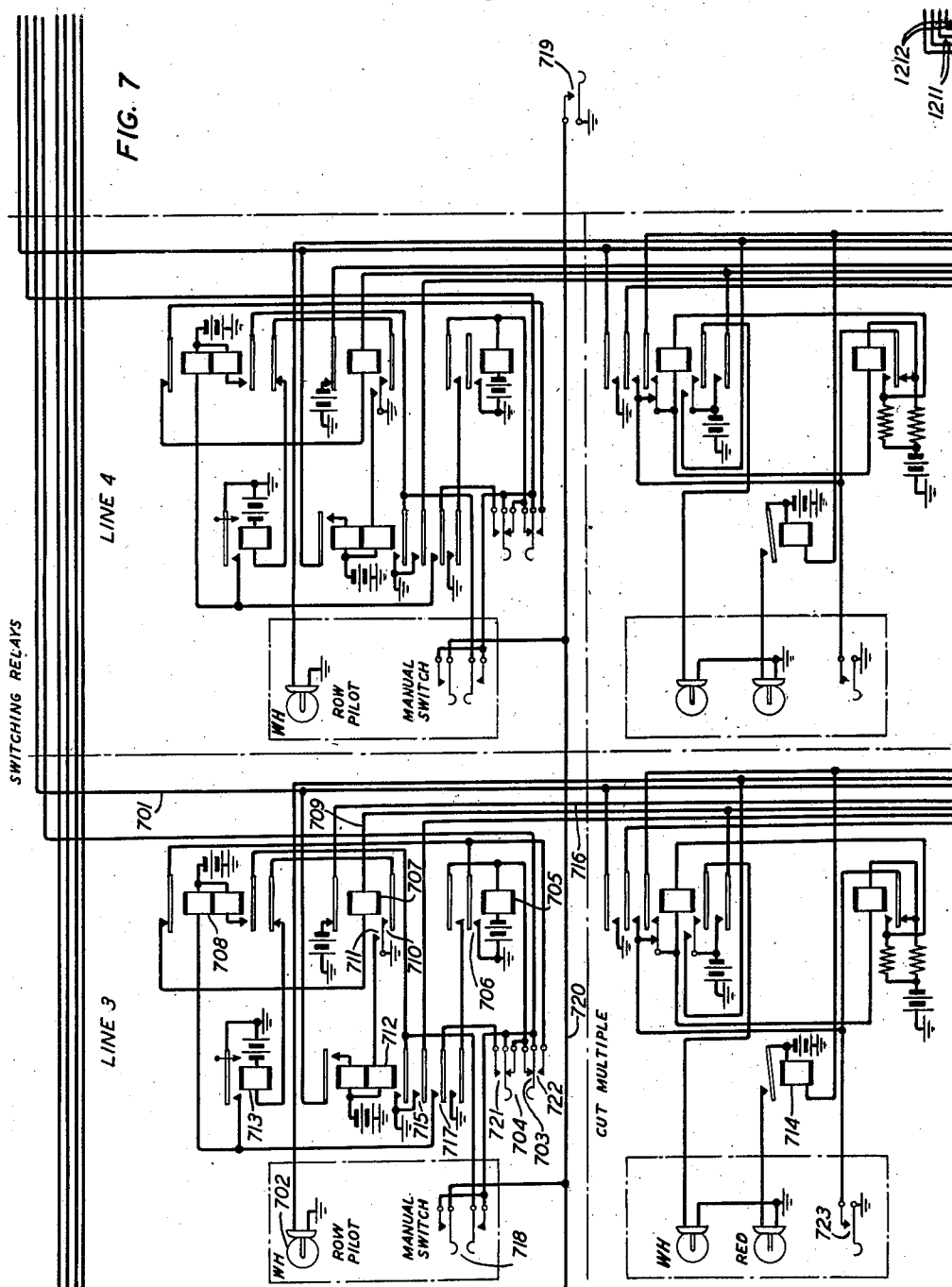
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2,269,034

BROADCAST SWITCHING SYSTEM

Filed Aug. 23, 1940

12 Sheets-Sheet 7



Jan. 6, 1942.

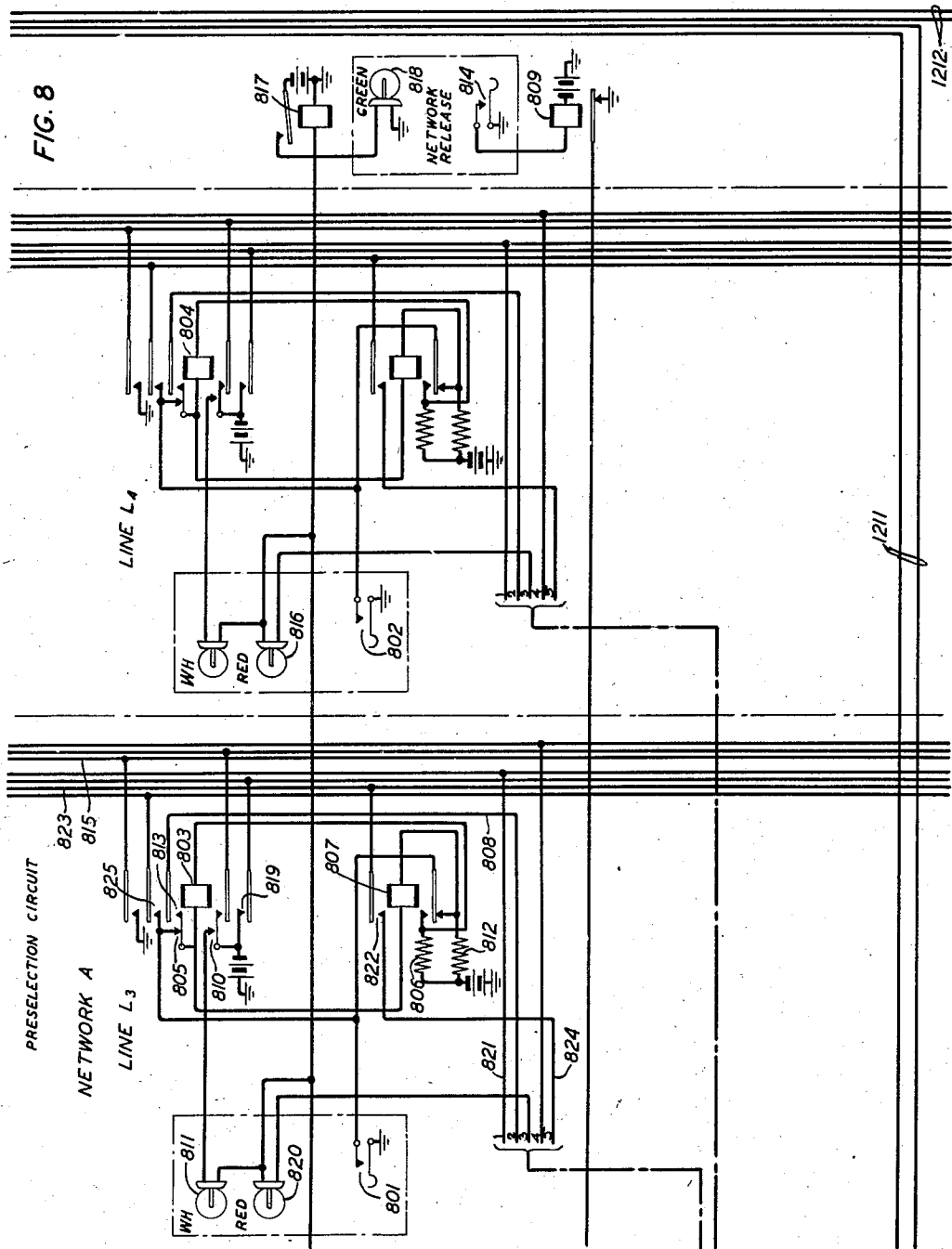
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BROADCAST SWITCHING SYSTEM

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12 Sheets-Sheet 8



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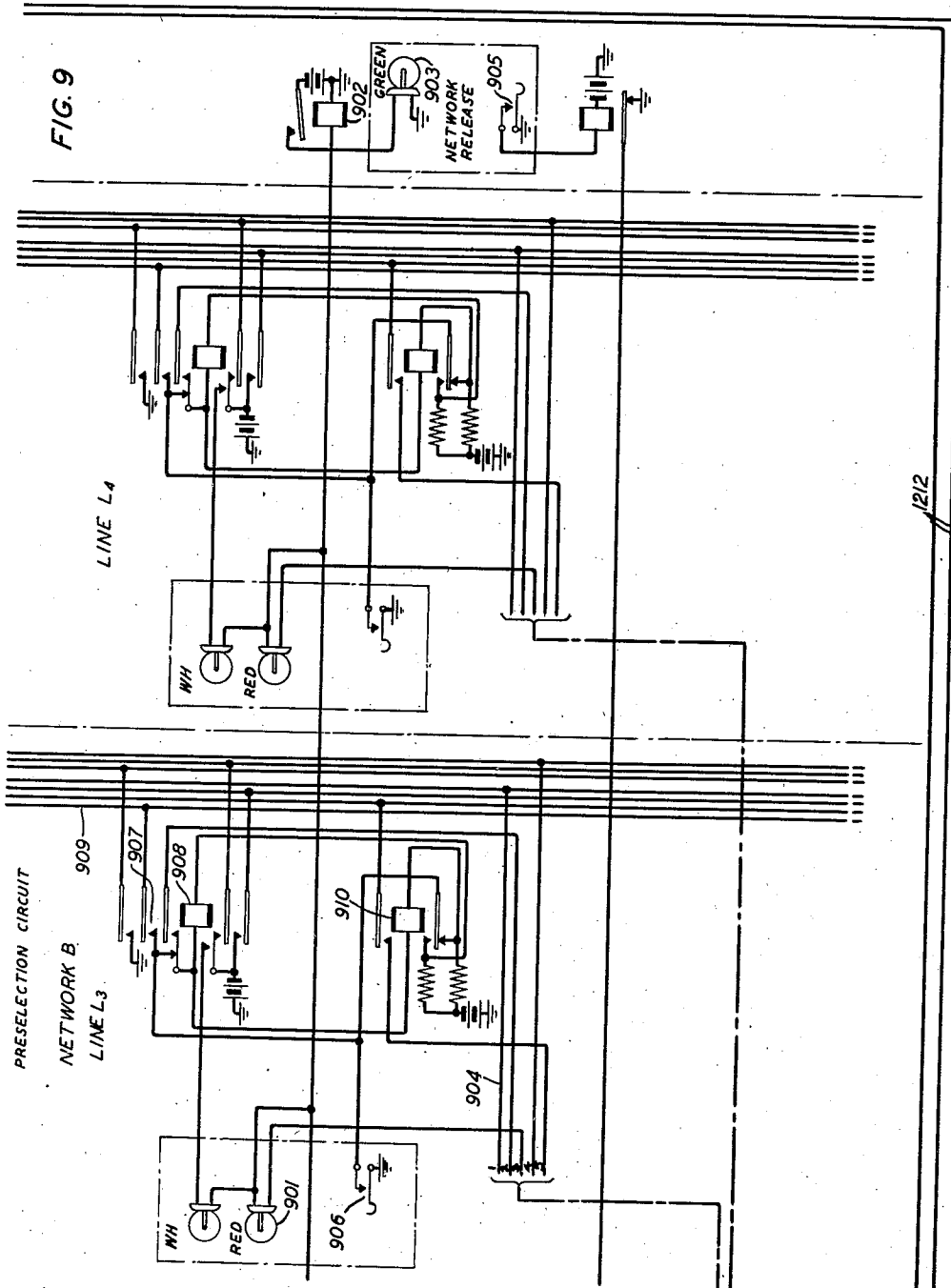
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BROADCAST SWITCHING SYSTEM

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12 Sheets-Sheet 9



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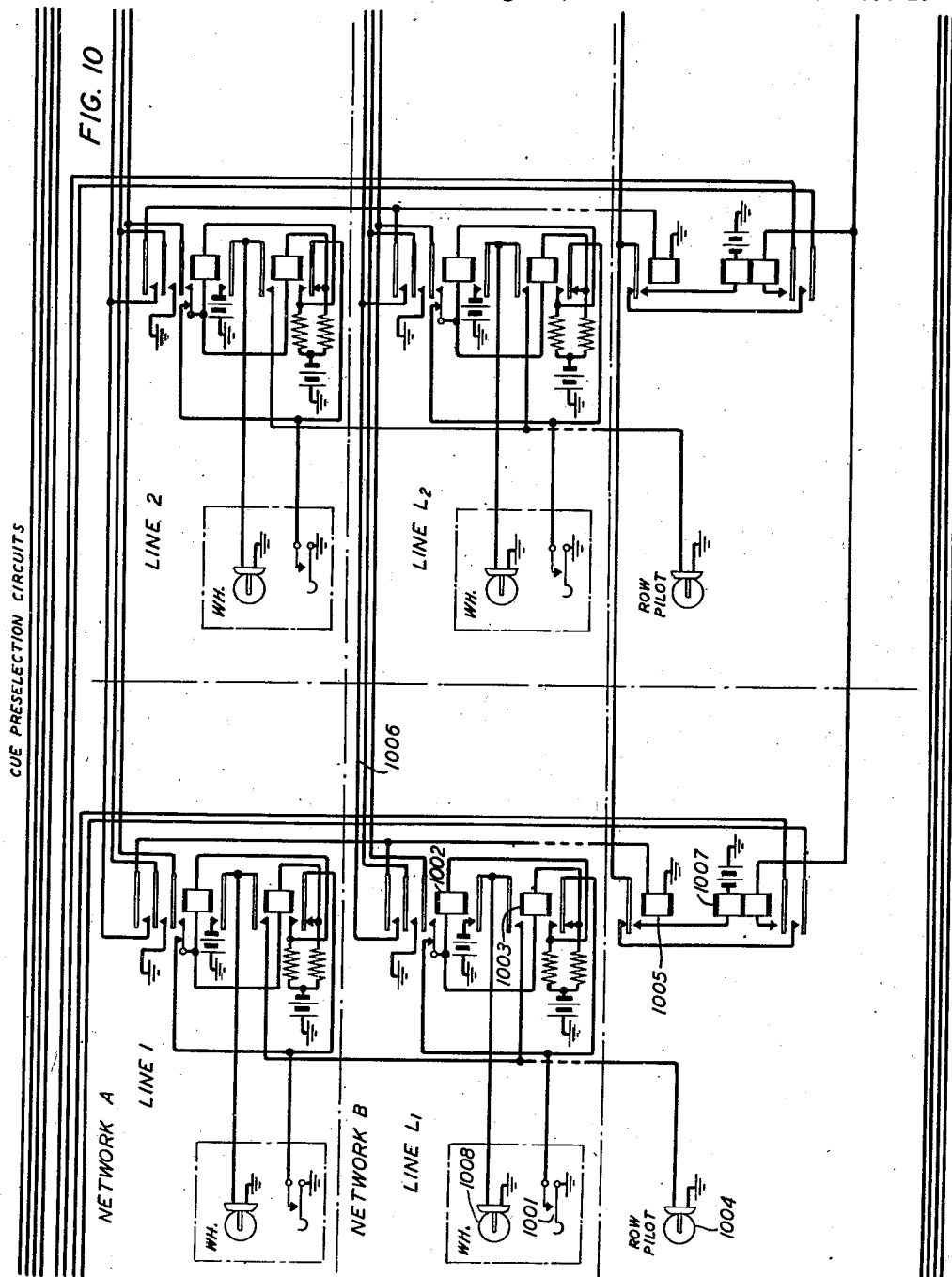
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BROADCAST SWITCHING SYSTEM

Filed Aug. 23, 1940

12 Sheets-Sheet 10



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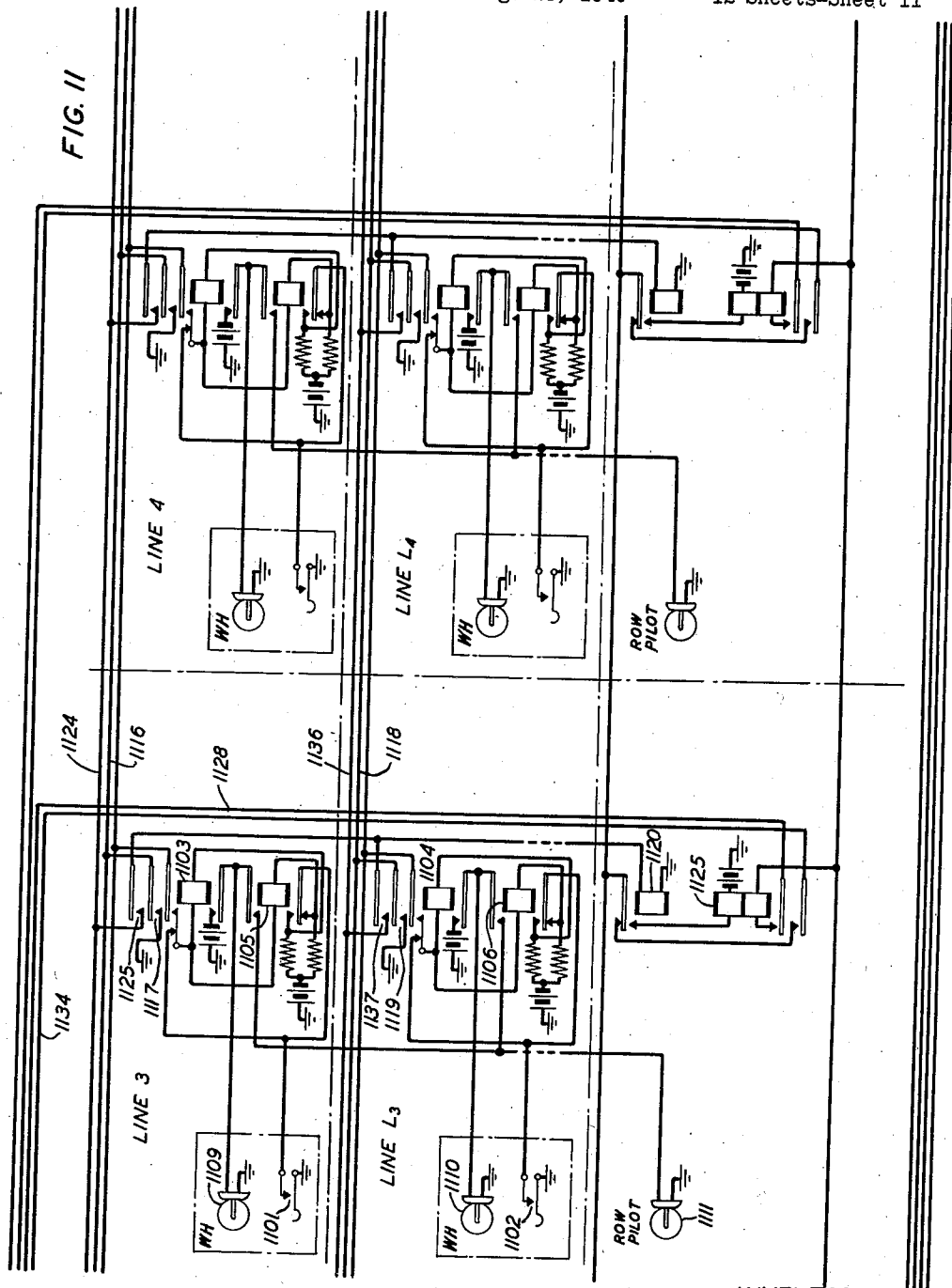
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BROADCAST SWITCHING SYSTEM

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12 Sheets-Sheet 11



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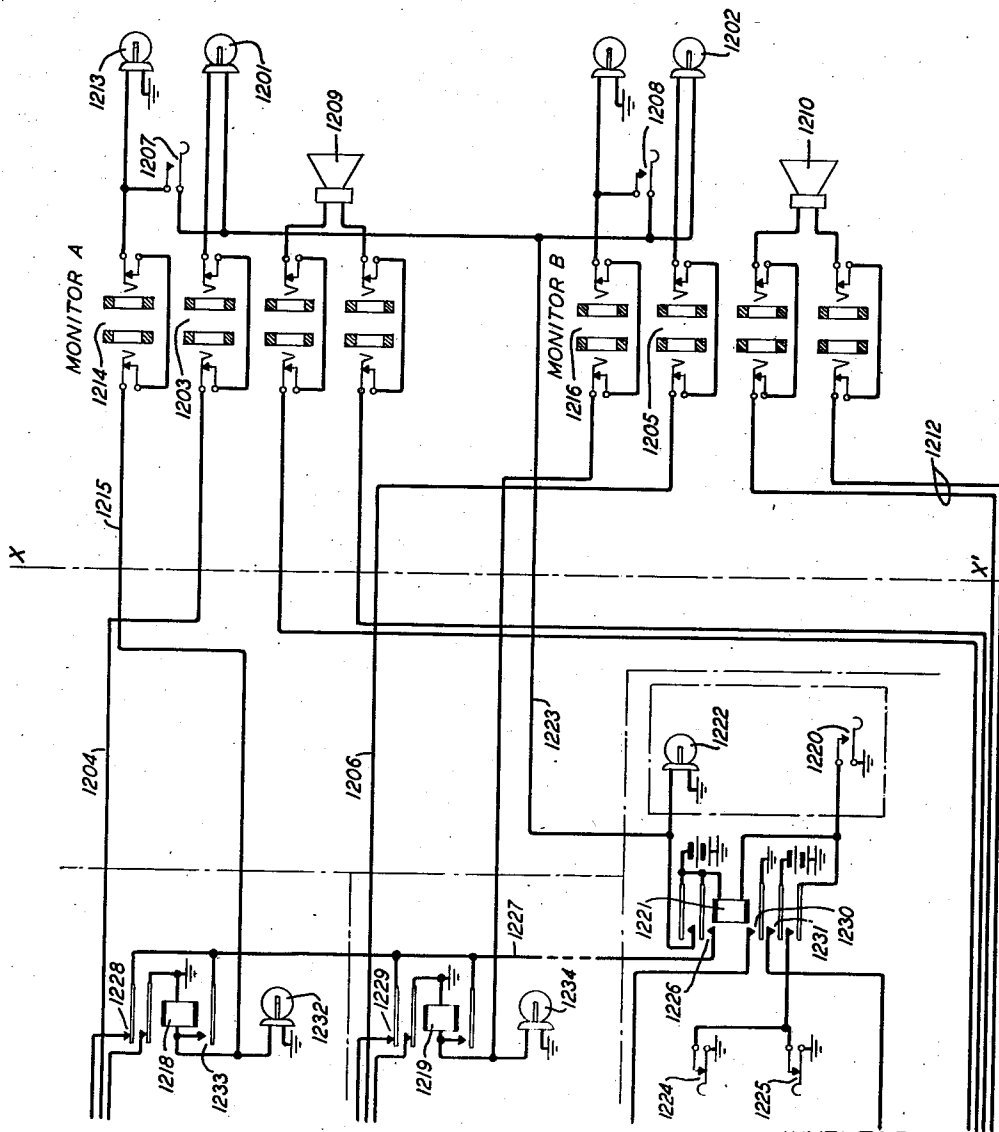
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BROADCAST SWITCHING SYSTEM

Filed Aug. 23, 1940

12 Sheets-Sheet 12

FIG. 12



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UNITED STATES PATENT OFFICE

2,269,034

BROADCAST SWITCHING SYSTEM

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Application August 23, 1940, Serial No. 353,851

7 Claims. (Cl. 179—1)

This invention relates to program broadcasting systems and more particularly to arrangements for switching transmission lines over which programs are transmitted. It is well known that a great many of the popular programs, simultaneously broadcast by radio stations throughout the country, originate in a single studio or at some other "pick-up" point, which pick-up point is connected to the transmitters of the various stations broadcasting the program by means of a group of interconnected wire lines. Such a group of interconnected lines, and the transmitters which they supply, is referred to as a network.

There are a number of such networks known, for example, the Red Network, the Blue Network, the Yankee Network, etc., into which programs originating at different points are transmitted. For example, at a certain hour one program may originate in a studio of the National Broadcasting Company at New York which is transmitted locally over Station WJZ and also supplied over wire lines to stations in a number of other cities throughout the country and requiring four lines outgoing from New York, i. e., one East, two South and one West. At this same hour another program may be picked up at a convention hall, transmitted locally by Station WEA, and distributed to another network of stations which may require three other outgoing lines from New York. The above-mentioned program networks require that the four lines first mentioned be connected together at some central point in New York, for example, in the terminal room of a telephone central office, and to the output of a voice amplifier and a fifth line, over which the program is incoming shall be connected to the input of the same amplifier. Similar connections must also be made to a second amplifier so that the three lines comprising the second network are connected to its output and a line supplying the program is connected to the input.

At the conclusion of the foregoing programs it may be desired to rearrange the above lines and add another line, which at present is connected to a third network in order to establish two different network combinations, one of which shall include three of the first four lines and one of the other three lines and the other network shall include the remaining line of the first group of four, the other two of the second group and the additional line. Since time is essential both from the standpoint of continuity of broadcast and from the standpoint of the sponsor of the pro-

gram, the above switching operations must be made as nearly instantaneous as possible.

Further it may be desired to establish additional networks, each of which requires a plurality of lines, some or all of which may, or may not, be connected to other networks at the time.

Originally switches of the above character were manually effected through the medium of jacks and plug-ended cords and later by manually operated keys as disclosed and claimed in U. S. Patent 1,871,310 to A. E. Bachelet et al., issued August 9, 1932 which patented arrangement greatly improved and shortened the time of making the switching transfers, yet as the volume of broadcasting has increased, and the number of lines required to transmit the programs has increased in proportion, it has been necessary to further improve such facilities whereby still greater speed and flexibility is attained.

An object of the invention as before indicated is to provide improved means for quickly and accurately rearranging the interconnection of program lines.

A feature of the invention resides in means for preselecting any one or more lines of a group for future transfer from networks to which they may be connected to other networks, a master switch corresponding to each network for initiating said transfers and further preselecting means for rendering said master switches effective to control said transfers either singly or jointly.

Another feature resides in means for preselecting any one or more lines for future disconnection from networks to which they may be connected, without transfer to another network, under control of the master keys aforesaid.

Another feature of the invention resides in means for erasing the preselection of a line responsive to a subsequent preselection of the same line for connection to another network.

A further feature resides in means for simultaneously disconnecting all lines that may be connected to a particular network.

Another feature resides in means for preselecting a delay, to be later introduced, between the disconnection of a line from a connected network and its connection to another network.

An understanding of the invention will be had from the following description of an arrangement, embodying the foregoing features, when read in connection with the accompanying drawings the figures of which, when arranged in accordance with Fig. 13, illustrate the arrangement and circuits of switching panels for controlling

the establishment of two program networks from a total of four lines, it being understood that in practice a greater number of lines are usually involved and also facilities may, and generally will, be provided for establishing a greater number of networks, a typical installation comprising about fifteen lines and facilities for establishing about five networks.

Referring to the drawings:

Fig. 1 shows two amplifiers, one of which is shown in detail and the other, which is a duplicate of the first, being merely indicated by a broken line rectangle. Each of these amplifier arrangements, which are shown and described in United States Patent 2,198,326 to A. E. Bachelet, are arranged, as described in the patent, to receive a program over one line connected to the input of the amplifier and to transmit the program properly amplified to a plurality of other lines connected to the output, the determination of which line shall be connected to the input and which lines to the output being controlled over the connected lines in the manner described in the patent. This method of control, however, forms no part of the present invention, it being sufficient to state that each amplifier shown forms a link for interconnecting a plurality of lines into a so-called network.

Figs. 2 and 3 show the switching relays for connecting the four lines L_1 , L_2 , L_3 and L_4 , shown at the top of Fig. 2, to either of the network amplifiers shown in Fig. 1. The small broken line rectangles, interposed between the various lines and their respective relays, shown at the top of Fig. 2, represent the necessary equipment for each line as shown for example in Figs. 4, 6, 7, 8, 11 and 13, of the beforementioned Bachelet Patent 2,198,326. Figs. 2 and 3 therefore will be understood to show the switching means whereby the lines are grouped into desired networks.

Figs. 4 to 9, inclusive, show the preselecting and switching control circuits whereby the switching relays, shown in Figs. 2 and 3, are preselected for future operation and later controlled in their operation.

Fig. 12, to the right of the vertical broken line X, X' , shows the circuits of the so-called monitors' positions, one for each network, whereby control is exercised, by monitoring attendants, over the switching control circuits of Figs. 4 to 9, to effect operation of the switching relays of Figs. 2 and 3. Figs. 10 and 11 show the so-called cue preselection circuits, one for each network, whose function is to control the effective operation of the monitors' circuits of Fig. 12.

Fig. 13 is a block diagram showing relative arrangement of the other figures.

For the purpose of describing the operation of the system disclosed by the drawings, it will be assumed that switching relays 202 and 204 and 301 and 303 have been previously operated thereby connecting lines L_2 and L_4 to amplifier A (Fig. 1) and lines L_1 and L_3 to amplifier B, it being understood that any group of lines connected to amplifier A will be hereinafter referred to as network A and any group connected to amplifier B as network B. Therefore, we will start our description by assuming that lines L_2 and L_4 are connected to network A and that lines L_1 and L_3 are connected to network B as indicated by lighted red lamp 507, 816, 605 and 901. Further, relays 817 and 902 are operated thereby opening the circuit of "idle multiple" pilot lamps 818 and 903, respectively to indicate that the respective networks are engaged.

From the drawing (Fig. 1) it will be noted that a control impulse has been received over line L_4 to cause operation of relay 107 thereby connecting line L_4 to the input of amplifier 100 as described in the Bachelet patent before mentioned. This, however, is unimportant, in connection with the present invention, as control of relays 201 and 202, 203, 204, 301, 302, 303 and 304 is the only feature herein considered.

It will now be assumed that at the conclusion of the broadcast period for which the present networks were established, it is desired to maintain lines L_2 and L_4 connected to network A, line L_1 to remain connected to network B, and to add line L_3 to network A by transferring it from network B. Therefore, the control attendant, at some time well in advance of the time for changing programs, will momentarily operate keys 502, 801 and 802 thereby operating relays 503, 803 and 804, the circuit for relay 803, for example being traced from ground, contacts of key 801, contacts 805 of relay 803, winding of relay 803 and resistance 806 to battery. Relay 807 does not operate at this time due to the fact that ground is connected to both ends of its winding. Relay 803 in operating locks to ground at network release relay 809 in a circuit which can be traced from battery, resistance 806, winding of relay 803, contact 813 thereof, conductor 808, contact 205 of relay 203 and the common conductor 210 to ground at relay 809. Immediately following operation of keys 502, 801 and 802, these keys are released whereupon relays 503 and 804 release as their locking paths are open at contacts 206 and 207 of their respective switching relays 202 and 204, as it will be remembered that these relays are already operated thereby connecting lines L_2 and L_4 to network A which is the same connection desired for the next program. It is therefore immaterial whether keys 502 and 802 are operated at all in the particular preselection which we have assumed. Due to the fact that line L_1 is to be left connected to network B, it will also be unnecessary to operate key 601.

Returning to Fig. 8, relay 803 is now operated and locked and key 801 released. When relay 803 operated, it closed its contacts 810 thereby lighting the white pilot lamp 811, in series with relay 817, as an indication that line L_3 has been preselected for future connection to network A. Relays 817 and 902 remain operated. Row pilot lamp 702 is also lighted in parallel with lamp 811. This lamp 702 serves as a check to indicate that the particular line (L_3) has been preselected in case the individual network lamps, such as 811 should fail. When key 801 was released it removed ground from the right-hand end of the winding of relay 807, the circuit of which includes the lower back contact of this relay. Relay 807 therefore immediately operated in a circuit from battery, resistance 812, winding of relay 807, contacts 813 of relay 803, conductor 808, and to ground at the contact of relay 809 over contacts 205 of relay 203. Relays 803 and 807 are therefore held operated under control of release relay 809 and switching relay 203 and the white pilot lamp 811 is lighted to indicate that the line L_3 has been preselected for future transfer. Should it be desired to wipe out the foregoing preselection on network A, it is only necessary to reoperate key 801 thereby short-circuiting relays 803 which releases. When key 801 is released relay 807 releases. Further, in case a preselection of a line for a particular network has been errone-

ously made it can be corrected by merely operating the preselection key corresponding to the proper network.

For example, if a preselection of line L₃ for network A was erroneously made and the preselection of this line for network B was intended, the operation of key 906 will connect ground over contacts 907 of relay 908, conductor 909 and contacts 825 of relay 803 to short-circuit relay 803 which therefore releases and in turn releases relay 807. When key 906 is released relay 910 will operate in the manner previously described thereby establishing the desired proper preselection. This arrangement prevents the preselection of one line to more than one network at the same time.

Assuming, however, that the foregoing preselection is to remain and that the transfer of line L₃ from network B to network A is not to be effected until the current programs on both networks are finished, the attendant will then make what is known as the "cue preselection", i. e., he will momentarily operate the "cue keys" in both network multiples corresponding to line L₃, i. e., keys 1101 and 1102, thereby operating the respective relays 1103 and 1104. Upon the release of keys 1101 and 1102, relays 1105 and 1106 respectively will operate in the same manner as described for relay 807 except that the holding grounds for relays 1103 and 1105 exist at the back contact of relay 1218 and for relays 1104 and 1106 at back contacts of relay 1219 instead of at the contacts of the preselection release relay 809. Relay 1103 in operating lights the cue preselection pilot lamp 1108 and relay 1104 lights the corresponding pilot lamp 1110 and when relays 1105 and 1106 operate, they close a multiple circuit to light the row pilot lamp 1111.

Shortly before the end of the present program period the master cue control key 1220 is operated, thereby operating relay 1221 which lights master cue pilot lamp 1222 and connects battery to conductor 1223 to light the "cue ready" lamps 1201 and 1202 at the monitor's position for each network (Fig. 12) and indicated as monitor A and monitor B, respectively. The circuit of lamp 1201 can be traced from battery, uppermost contact of relay 1221, conductor 1223, lamp 1201, contacts of patching jack 1203 and conductors 1204 and 1116 to ground at contact 1117 of relay 1103. The circuit of lamp 1202 is likewise traced from battery on conductor 1223, lamp 1202, patching jack 1205, conductors 1206 and 1118 to ground at contact 1119 of relay 1104. The lighting of lamps 1201 and 1202 indicates to the monitors that the necessary cue preselections have been made and they may initiate the desired preselected switching operations by operating the respective cue or master keys 1207 and 1208 when the predetermined "cue" is received over the loud-speakers 1209 and 1210, which speakers are connected to amplifiers A and B over conductor pairs 1211 and 1212, respectively.

Relay 1221 locks up over its lowermost contacts to ground over release keys 1224 and 1225 in parallel, two keys being provided in order to prevent accidental operation of one key from releasing the preselection circuits already established.

Operation of relay 1221 also causes operation of relay 1120 which circuit can be traced from battery, contacts 1226 of relay 1221, conductor 1227, contact 1228 of relay 1218, conductor 1124, contacts 1125 of relay 1103 and winding of relay 1120 to ground. A parallel operating path of relay 1120 is provided from battery, contacts 1226

of relay 1221, conductor 1227, contacts 1229 of relay 1219, conductor 1136, contacts 1137 of relay 1104, and winding of relay 1120 to ground. Relay 1120 in operating closes a circuit to operate relay 1125 which can be traced from ground, contact 1230 of relay 1221, front contact of relay 1120 and upper winding of relay 1125 to battery. Relay 1125 in operating locks in series with its lower winding and its inner lower contacts in a circuit from battery, contacts 1231 of relay 1221, lower winding and inner lower contact of relay 1125, conductors 1128, 701 and 815 to ground at the uppermost contacts of relay 803. The operation of relay 1125 closes its lowermost contact thus preparing a circuit for initiating operation of certain relays to effect the preselected switch, i. e., to operate relay 203 and release relay 303, which operation will next be described.

When the program monitors (Fig. 12), who constantly listen to the programs on the networks to which they are assigned by means of loud-speakers 1209 and 1210, receive the predetermined audible "cue" indicating the close of the program to which they are listening, they merely operate a single key, key 1207 in the case of the monitor on network A and 1208 at the monitor's position of network B.

Assuming that key 1207 is first operated, the "cue sent" pilot lamp 1213 lights from battery on conductor 1223. Operation of key 1207 also extends battery from conductor 1223 over contacts of patching jacks 1214 and conductor 1215 to light the red pilot lamp 1232 and operate relay 1218 in parallel. Relay 1218 locks over its contacts 1233 to battery under control of relay 1221. Relay 1218 also opens its inner upper contact thereby disconnecting the holding ground from relays 1103 and 1105 which thereupon release thereby extinguishing lamp 1109. Row pilot lamp 1111 and relay 1120, however, remain energized, lamp 1111 being held lighted over upper contacts of relay 1106 to battery over lower contacts of relay 1104, and relay 1120 being held over contacts 1137 of relay 1104, conductor 1136, contacts 1229 of relay 1219, conductor 1227 and contacts 1226 of relay 1221 of battery.

It will be noted at this point that relay 1120 is now held operated solely under control of relay 1219 which is not operated until monitor B actuates cue key 1208.

When monitor B receives the predetermined cue on network B, cue key 1208 will be immediately actuated thereby operating relay 1219 in the same manner as previously described for relay 1218, i. e., from battery on conductor 1223, contact of key 1208, patching jack 1216 and relay 1219, and the lamp 1234, in parallel, to ground. Relay 1219 locks up over its lowermost contacts to relay 1221 and at its upper contacts releases relays 1104 and 1106 and removes the holding battery for relay 1120 which now releases.

With the release of relay 1120 the previously prepared circuit to effect the preselected switching operation is now completed which circuit can be traced from ground, contacts 1230 of relay 1221, upper back contact of relay 1120, lowermost contact of relay 1125, conductor 1134, contact 703 of key 704 and winding of relay 705 to battery. Relay 705 in operating closes its contact 706 thereby operating relay 707 in a circuit to ground, contacts 706 of relay 705, upper contacts of relay 708, winding of relay 707, conductor 709 and contacts 819 of relay 803 to battery. Relay 707 in operating closes its contacts

710 and 711 thereby operating relay 712 over its lower winding and energizing slow relay 713 which starts to operate but, due to its construction delays closure of its contact for a short interval (for example three seconds). Relay 707 also opens its upper contact thereby disconnecting battery from conductors 716 and 904 to release relay 303 thereby disconnecting line L₃ from network B. Relay 712 locks up over its upper winding and upper contacts to ground at the uppermost contacts of relay 803 and establishes a holding path for relay 705 from ground, lowermost contact of relay 712, and uppermost contact of relay 705. Relay 712 also connects ground at its contact 715 to prepare a circuit to operate relay 203 when relay 707 releases.

Following the foregoing operation which resulted in the release of relay 303, a short interval of time elapses, after which relay 713 operates thereby closing an obvious circuit to operate relay 708 which latter relay locks up over its lower winding, lower contact and inner lower contact of relay 712. Relay 708 in operating opens its lowermost contacts to release relay 713 and opens its upper contact thereby releasing relay 707 thereby completing the previously prepared circuit to operate relay 203, the circuit of which can be traced from battery, upper contact of relay 707, conductor 821, winding of relay 203, conductors 208 and 824, contact 822 of relay 807, conductor 823 and contact 715 of relay 712 to ground. Relay 203 in operating connects line L₃ to amplifier A, locks up over its contact 209 to conductor 210 and ground at contacts of relay 809. Relay 203 in operating also opens its contact 205 thereby opening the previously traced holding circuit for relays 803 and 807 which relays release. Further, relay 203 closes contacts 211 and 212 thereby lighting the red lamp 820, in series with relay 817, and operating relay 714 in the "cut" multiple selecting circuit to be referred to later. Relay 817 is therefore maintained operated and green pilot lamp 818 extinguished thereby indicating that the network A is not idle.

Release of relay 803 extinguishes lamp 811 and 702, releases relay 712, and also releases relay 1125 in the cue preselection circuit. Relay 712 in releasing opens the circuit of relays 708 and 705.

As soon as the switching attendant notes that all white lamps in the cue preselection panel are extinguished, i. e., 1109, 1110 and 1111, he will simultaneously operate keys 1224 and 1225 thereby releasing relay 1221 which in turn releases relays 1218 and 1219 and extinguishes the master cue lamp 1222 thereby restoring the cue preselection circuit to normal.

The transfer of line L₃ from network B to network A has now been completed and red pilot lamps 507, 820 and 816 are lighted under control of their respective switching relays 202, 203 and 204 and lamp 605 is lighted under control of relay 301.

The foregoing description is based on the assumption that it was desired that a short delay be introduced between the time line L₃ is disconnected from network B and reconnected to network A, which delay is controlled by the two-position key 704 which, in the position shown on the drawing, causes such a delay to be introduced. In case, however, it is desired that a substantially instantaneous transfer be effected the attendant will actuate relay 704 to its other

position, prior to the time of transfer, whereby the following operations take place which differ slightly from those previously described.

When the monitors have operated keys 1207 and 1208 relay 1120 releases as before and ground is connected to conductor 1134 which immediately causes the operation of relay 707, the circuit for 707 extending from ground on conductor 1134, contacts 722 of key 704, upper contacts of relay 708, winding of relay 707, conductor 709 and contacts 819 of relay 803 to battery. Relay 707 opens its upper contact thereby disconnecting battery from relay 303 which immediately releases to disconnect line L₃ from network B. Relay 707 also closes its contact 711 thereby operating relay 712 which in closing its contact 717 extends ground, on conductor 1134, over contact 721 of key 704, to relay 708 which operates to open its upper contacts thereby releasing relay 707 which recloses its upper contact to reconnect battery to conductors 716 and 821. Due to the fact that relay 712 is now operated, a circuit is completed to operate relay 203 in a circuit as previously described which relay in operating connects line L₃ to network A and releases relays 803 and 807. The switching preselection and cue preselection circuits are restored to normal as before described, leaving only red pilot lamps 507, 820, 816 and 605 lighted.

Cut multiple

We will next assume that line L₁ is to remain idle during the next broadcast, i. e., when the present program ends it is to be disconnected from network B but not connected to another network. To effect this condition line L₁ will be preselected in what is known as the "cut multiple," the circuits of which are shown at the bottom of Figs. 4 and 7. To preselect line L₁ into the cut multiple the attendant when making the preselection for transferring line L₃ to network A will also operate and release the cut multiple preselection key 401 thereby operating relays 402 and 403 in the same manner as previously described for relays 803 and 807. Relays 402 and 403 lock up to ground in a circuit from ground, contact 305 of relay 301, conductors 306, 606 and 508, and contacts 404 of relay 402. Relay 402 in operating lights the white pilot lamp 405 and the white "row pilot" lamp 406. Ground on conductor 508 holds relay 407 operated thereby maintaining the red pilot lamp 408 extinguished which is lighted when the line L₁ is not connected to a network. The attendant will also, when making the cue preselections, actuate and release the one preselection key 1001 thereby causing relays 1002 and 1003 to operate and lock to ground at relay 1219, as described in connection with relays 1104 and 1106.

The joint operation of relays 1002 and 1003 lights "row pilot" lamp 1004 and the operation of relay 1002 connects relay 1005 to the normally open contacts 1226 of relay 1221, over conductor 1006 and the uppermost normal contact of relay 1219. Relay 1002 in operating also lights pilot lamp 1008.

When the attendant operates key 1220, to place the preselected switches under control of the monitors, relay 1005 operates due to closure of contact 1226 of relay 1221 thereby operating relay 1007, which locks up to ground at contact 409 of relay 402.

When the monitor actuates key 1208, relay 1219 operates thereby releasing relay 1005 and

completing the circuit to eventually cause operation of relay 410 in the same manner as previously described for relay 707.

Relay 410 in operating opens its upper contact thereby disconnecting the holding battery from relay 301, at present operated, which relay immediately releases and disconnects line L₁ from network B. The release of relay 301 opens its contact 305 thereby releasing relays 402 and 403 and also relay 407 which operates when relay 301 was first operated. Relay 402 in releasing extinguishes pilot lamp 405 and the release of relay 407 lights pilot lamp 408 to indicate that line L₁ is not connected to any network.

Manual transfer

If desired the attendant can, subsequent to the preselection of any line for connection to any multiple, cause the transfer to be effected at once, on a "fast" or "slow" basis, by manually operating a switch key individual to the line. For example, if for any reason it is desired to cause the immediate transfer of line L₃ from network B to network A before the end of the program, the attendant can operate key 704 to condition the circuit for a "fast" transfer and then operate keys 718 and 719 simultaneously. The function of key 719 is to ground the common conductor 720 only during the act of effecting a manual transfer, i. e., at the time key 718 for example is operated, thus preventing a false transfer due to the accidental operation of one of the manual switching keys. Simultaneous operation of keys 718 and 719 connects ground over contacts 722 of key 704, to operate relay 707 thereby releasing relay 303 and immediately operating relay 203 in the same manner as previously described when the transfer was effected by operation of keys 1207 and 1208 at the monitor's position. The extinguishing of lamp 901 and the lighting of lamp 820 is an indication to the attendant that the transfer has been effected.

In case it is desired to immediately disconnect line L₃ from network B without connecting it to network A the attendant before effecting the manual transfer above described will preselect line L₃ into the cut multiple of that line by momentarily operating key 723.

Disconnection of a network

In case it is desired, for any reason, to simultaneously disconnect all lines from a particular network to which they may be connected the attendant can operate the release key common to the particular network, i. e., key 814 for network A or key 905 for network B. Operation of key 814, for example, causes operation of relay 809 which disconnects ground from the common conductor 210 thereby releasing all switching relays (201, 202, 203 and 204) which may be operated and locked to this conductor. This operation also releases any preselection relays, such as 803 and 807, which may have been operated.

What is claimed is:

1. In a communication system, a plurality of lines, switching means for interconnecting said lines into independent groups in any desired com-

bination, means for preselecting and preparing circuit arrangements to control said switching means to rearrange the interconnection of said lines as desired, a master switch for each group for completing said prepared circuits, and other preselecting means for rendering said master switches effective, either singly or in any desired combination, to effect said rearrangement.

2. A system in accordance with claim 1 characterized by other preselecting means, individual to each line, for conditioning said circuit arrangements to disconnect the preselected line from a connected group, but prevent its reconnection to another group in response to operation of said master switches.

3. A system in accordance with claim 1, characterized by means responsive to a second preselection of any line for transfer prior to the completion of said transfer, to cancel the preselection previously made.

4. A system in accordance with claim 1, characterized by release means common to each group for simultaneously disconnecting all lines from the respective group.

5. A system in accordance with claim 1, characterized by means individual to each line for introducing a time delay between the disconnection of the respective line from one group and its reconnection to another group.

6. In a communication system, a plurality of lines, a plurality of amplifiers, a relay individual to each amplifier for each line, each relay being arranged, when operated to interconnect the respective amplifier and line, manually controlled preselecting means individual to each relay adapted, when operated, to prepare a circuit for causing the release of any operated relay associated with the respective line and the subsequent operation of the relay corresponding to the preselecting means, a master switch for each amplifier, and other manually controlled preselecting means for rendering said master switches effective in any desired combination, subsequent to the preparation of said relay circuits, to complete said circuits.

7. In a communication system, a plurality of lines, switching means for interconnecting said lines into independent groups in any desired combination, means for preselecting and preparing circuit arrangements to control said switching means to rearrange the interconnection of said lines as desired, a master switch for each group for causing the completion of said prepared circuits, other preselecting means for rendering said master switches effective, either singly or in any desired combination to effect said rearrangement, further preselecting means, individual to each line, for conditioning said circuit arrangement to disconnect the preselected line from a connected group and prevent its reconnection to another group in response to operation of said master switches, and means responsive to a second preselection of any line, prior to completion of a switching operation to cancel the preselection previously made.

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