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E. R. TAYLOR ET AL

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MULTIPLEX BROADCASTING SYSTEM

Filed April 28, 1927

2 Sheets-Sheet 1

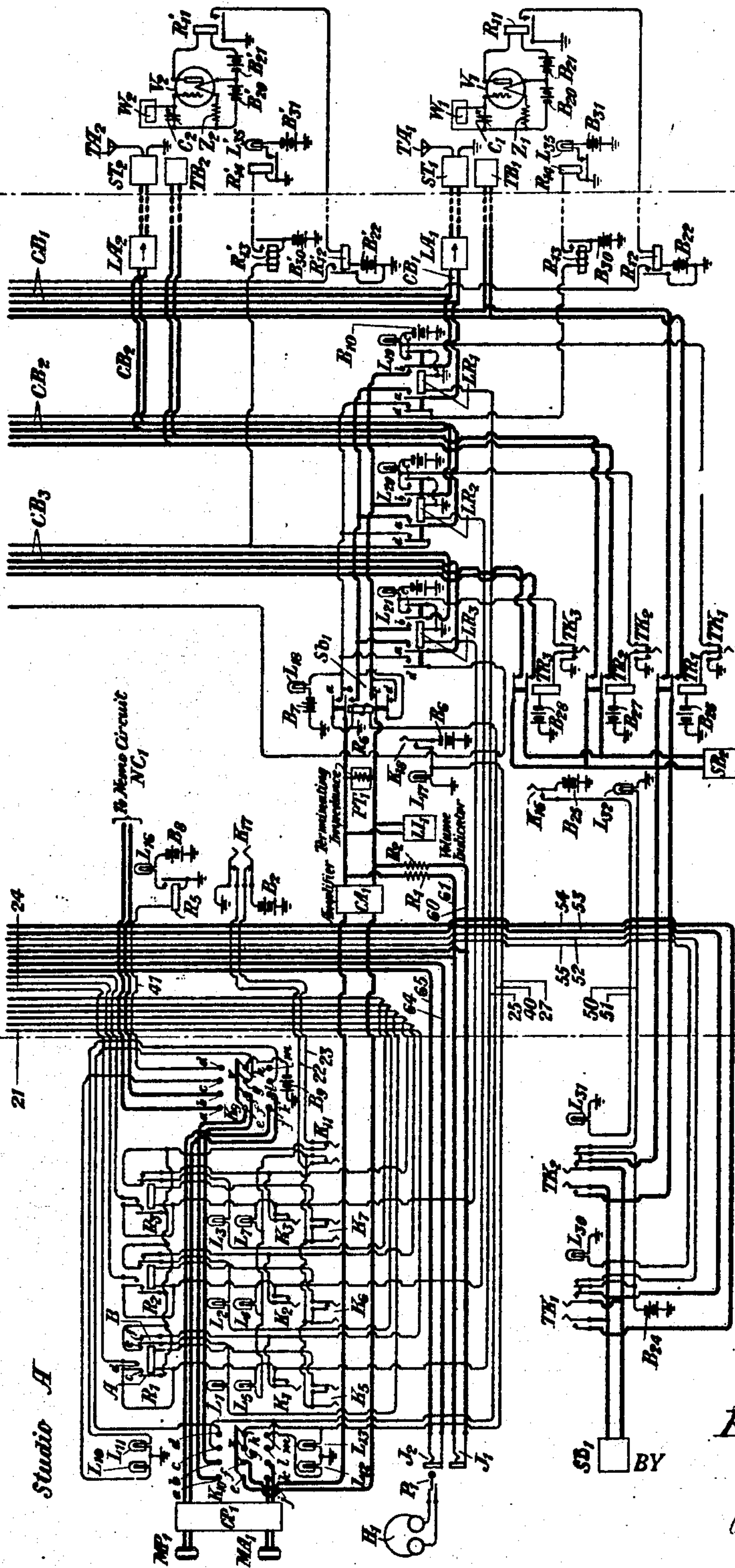


Fig. 1

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2 Sheets-Sheet 2

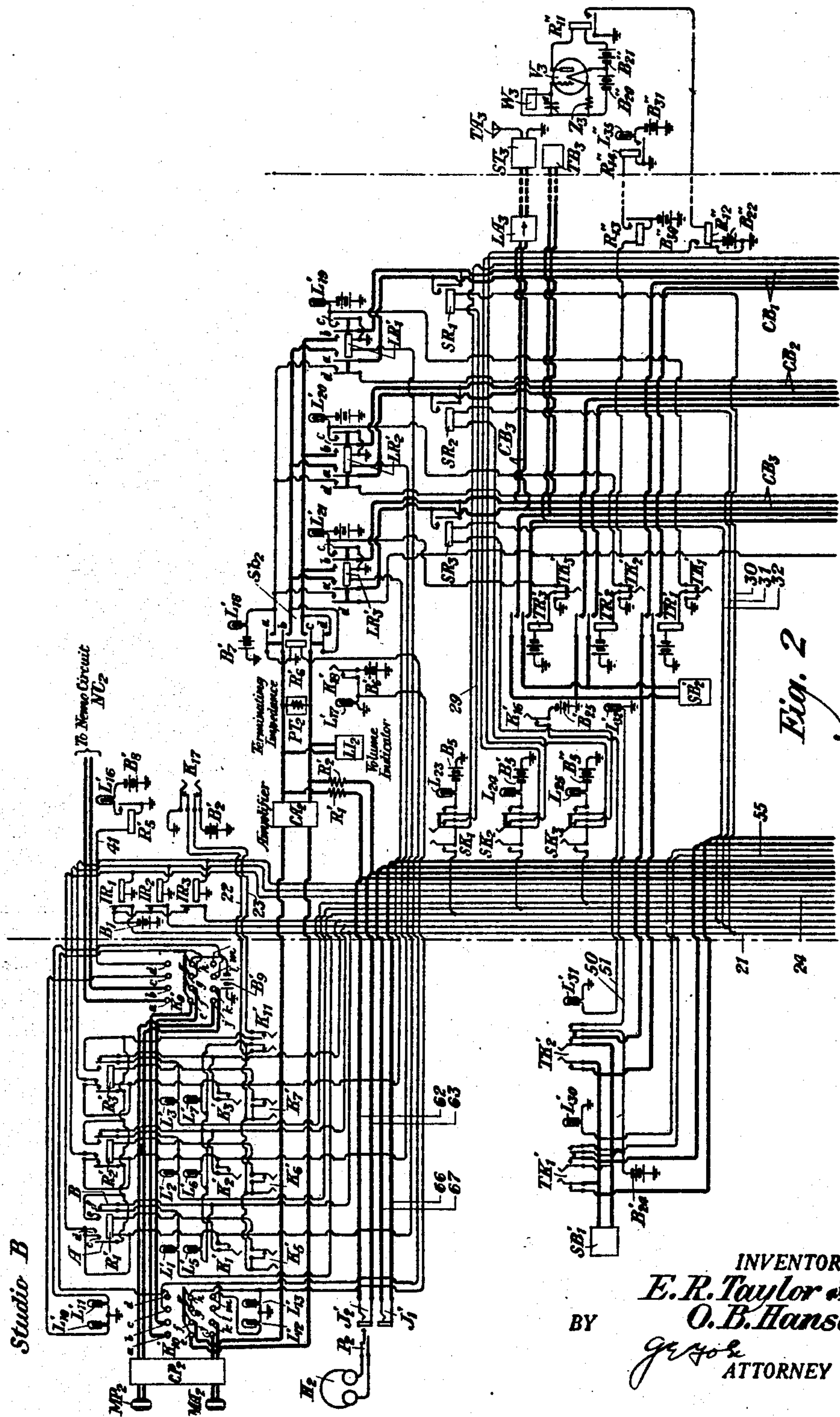


Fig. 2

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MULTIPLEX BROADCASTING SYSTEM

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This invention relates to multiplex broadcasting systems, and particularly to arrangements in such systems for interconnecting a plurality of sources of news, music or the like
5 with a plurality of transmitting stations, so that the programs originating at said sources may be simultaneously broadcast by said transmitting stations.

There will be shown herein a system for
10 operating a plurality of broadcasting studios in connection with a number of transmitting stations. A particular form of interconnecting system is described herein, merely for the sake of illustration, and is so arranged that
15 any one of the studios may be connected to any one of the transmitting stations, two studios not being connected to any one transmitting station at the same time. This is accomplished in a manner such that the audiences of the various transmitting stations do
20 not hear any of the switching noises and do not observe any appreciable delays between selections, or that any other program is being transmitted by any other transmitting
25 station except the one the audiences are scheduled to receive.

It is one of the objects of this invention to provide in a multiplex broadcasting system interconnecting a plurality of transmitting
30 stations through a control room, a telephone intercommunication circuit, so that the announcers in the various studios may be connected telephonically to the operator or operators in the control room. Accordingly,
35 there will be shown herein a system whereby any announcer may speak to the control room operator associated with his studio, and vice versa.

It is another object of this invention to provide in a multiplex broadcasting system interconnecting a plurality of studios and a plurality of transmitting stations through a control room, a telephone interconnecting circuit, so that an operator at any one of the
45 transmitting stations may be connected telephonically with the operator or operators at the control room and with the announcer or announcers at the various studios.

It is another object of this invention to provide a monitoring circuit or circuits in a radio

broadcasting system, so that anyone in a studio where program matter originates may monitor the program matter as it is being transmitted through the control room, or as it is being transmitted by the transmitting
55 station. In the particular circuit to be described hereinafter, a person in any one of the studios may monitor the program matter transmitted from any one of the studios.

It is another object of this invention to provide in a multiplex broadcasting system interconnecting a plurality of studios with a plurality of transmitting stations through a control room, means to indicate to the announcers in the various studios that the apparatus and
60 equipment at the control room are ready for the transmission of program matter through some or all of the various transmitting stations.

And it is a further object of this invention
70 to provide signals at the various transmitting stations to indicate to the operators at said transmitting stations that program matter should be coming into their stations from the
75 various studios.

While the nature of the invention will be pointed out with particularity in the appended claims, the invention itself, both as to its further objects and features, will be better understood from the detailed description
80 hereinafter following when read in connection with the accompanying drawing, in which Figs. 1 and 2, when placed side by side, show one application of the principles of this invention to a multiplex broadcasting
85 system.

Referring to the drawing, there is shown a multiplex broadcasting system interconnecting two studios A and B, and three transmitting stations comprising radio transmitters ST₁, ST₂, and ST₃, and corresponding
90 radio antennæ TA₁, TA₂ and TA₃. These studios and transmitting stations are so interrelated that the programs originating at these studios may be simultaneously broadcast
95 by the transmitting stations, the system being so interlocked that both studios may not be connected to any one transmitting station at the same time. Each studio has three control relays, one control relay correspond- 100

ing to each transmitting station. At studio A, these control relays are designated by the reference characters R_1 , R_2 and R_3 , and at studio B, these relays are designated by the reference characters R_1' , R_2' and R_3' . Some of the apparatus for connecting one of the studios with a particular transmitting station is located at that studio, and the rest of the apparatus is located at the control room. Each studio has a program microphone or microphones and an announcer's microphone or microphones. Moreover, a "nemo" circuit is connected to each studio so that the program from some distant pick-up point may be brought into the studio in order to be transmitted through an appropriate transmitting station. Yet, it will be understood that while only one "nemo" circuit is shown connected to any one studio, any number of these "nemo" circuits may be connected to the studio, within the scope of this invention, apparatus being provided to switch the apparatus at the studio from one "nemo" circuit to another "nemo" circuit associated therewith. The program microphones MP_1 and MP_2 , the announcer's microphones MA_1 and MA_2 and the "nemo" circuits NC_1 and NC_2 correspond, respectively, to studios A and B. Switches K_9 and K_{10} , and K_9' and K_{10}' are also located at the respective studios, so that any one or more of the transmitting stations may be transferred by these switches to one or the other of the studio microphones or to the microphones at some distant pick-up points connected to the corresponding "nemo" circuits. Studios A and B terminate in studio bus-bars Sb_1 and Sb_2 , respectively. The transmitting stations are connected through line amplifiers LA_1 , LA_2 and LA_3 to corresponding channel bus-bars CB_1 , CB_2 and CB_3 , respectively.

For the sake of convenience, the course of transmission from one of the studios, studio A, to one of the transmitting stations, such as the station associated with the channel bus-bar CB_1 , will now be considered in somewhat greater detail. At studio A, there is a microphone control panel CP_1 , which adjoins the program microphone MP_1 and the announcer's microphone MA_1 . Suitable means (not shown) is associated with the microphone control panel CP_1 for feeding current from a battery (not shown) to either or both of these microphones, and still other means (not shown) is provided for observing the magnitude of the current flowing from the battery through the particular microphone connected to the control panel CP_1 . It will be understood that these microphones may be of any well-known, type, as, for example, of the type known as the carbon transmitting microphone, or of the type known as the condenser microphone, with the amplifier usually associated therewith.

It is to be remembered that the equipment

at studio B is shown herein similar to the equipment at studio A, and that the description of the equipment at studio A applies equally well to the description of the equipment at studio B.

The circuits connected to the microphone control panel CP_1 have become known as the program and announcer's circuits. These circuits are connected, respectively, to the lower contacts j and k of the switches K_9 and K_{10} . A "nemo" circuit NC_1 is connected to the contacts a and b of the switch K_9 . Switches K_9 and K_{10} are so arranged as to connect the program microphone MP_1 , the announcer's microphone MA_1 or the "nemo" circuit NC_1 with the input of the amplifier CA_1 at the control room.

Three lamps L_{10} , L_{11} and L_{12} at studio A are also controlled by the switches K_9 and K_{10} and indicate to the announcer whether switches K_9 and K_{10} have been operated to connect the program microphone MP_1 , the announcer's microphone MA_1 or the "nemo" circuit NC_1 with the amplifier CA_1 . These connections will be described in somewhat greater detail hereinafter.

The main transmission path may be followed from the contacts e and f of the switch K_{10} through the amplifier CA_1 at the control room, which is terminated in a suitable impedance PT_1 , through the inner contacts b and c of the main relay R_6 to the studio bus-bar Sb_1 . The main relay R_6 functions to open the circuit between studio A and the corresponding bus-bar Sb_1 at times when it is considered undesirable to transmit the program matter originating in studio A. A volume indicator LI_1 is bridged across the main transmission path between the amplifier CA_1 and the terminating impedance PT_1 , both at the control room, to indicate the transmission volume or level after amplification. The magnitude of the terminating impedance PT_1 , mentioned hereinabove, is low as compared to the magnitude of the impedance in the inputs of the line amplifiers LA_1 , LA_2 and LA_3 , so that when one of the amplifiers, such as LA_1 , is connected to the studio bus-bar Sb_1 , the other amplifiers LA_2 and LA_3 , either or both of them, may be also connected thereto or disconnected therefrom without appreciably affecting the amount of energy transmitted by the amplifier LA_1 . This is so because most of the energy transmitted by the amplifier CA_1 is expended in the terminating impedance PT_1 , which is of a small magnitude, and because very little of the energy is expended in the input of each line amplifier. In order to minimize the possibility of cross-talk between studio bus-bars or channel bus-bars when the studio bus-bar Sb_1 is disconnected from the amplifier CA_1 , a contact is closed by armature d of the main relay R_6 , thereby short-circuiting the studio bus-

bar Sb_1 , so that when the main relay R_6 is not energized, the line relays LR_1 , LR_2 and LR_3 similarly become short-circuited, so that program matter can not be transmitted to these line relays. Accordingly, any volt-
 5 ages which may be induced in these circuits are prevented from being impressed upon the input of the line amplifiers LA_1 , LA_2 and LA_3 , and are further prevented from being
 10 amplified, all of which would cause objectionable cross-talk or interference. The operation of the line relays LR_1 , LR_2 and LR_3 will be described in somewhat greater detail hereinafter.

15 The system is so laid out that either of the studios may be connected with one or more transmitting stations simultaneously, and, moreover, so that any transmitting station may be connected to any studio. The inter-
 20 locking arrangement shown herein prevents any one transmitting station from being connected to both studios at the same time. This is essential to prevent confusion between programs. The omission of an inter-
 25 locking arrangement would permit the tying together of two or more studio bus-bars in the corresponding studios to the same transmitting station. The line relays LR_1 , LR_2 and LR_3 , and LR_1' , LR_2' and LR_3' associated
 30 with the studios A and B, respectively, are so arranged as to prevent any one transmitting station from being connected to both studios at the same time. Failure of operation, or improper operation of these line re-
 35 lays LR_1 and LR_1' would permit the transmitting station associated with the channel bus-bar CB_1 to become connected to studios A and B simultaneously. Improper operation of the other line relays will produce
 40 similar undesirable effects.

The studios and the control room are provided with signaling devices to keep the announcers at the studios and the operator or
 45 operators at the control room continuously advised of the manner in which the studios are connected with the various transmitting stations. Means are provided to permit the announcer at either studio to connect his
 50 studio to one or more of the transmitting stations. After his studio has been connected to these transmitting stations, the system is arranged so that the other studio can not be connected to the same transmitting stations at
 55 the same time. Thus, the announcer at any studio has at his disposal apparatus for picking up and for releasing the various transmitting stations, and he has also various signaling devices which keep him continuously advised as to whether or not the
 60 various transmitting stations are already connected to his studio or to the other studio. A description of the apparatus mentioned hereinabove will be described in somewhat greater detail hereinafter.

65 In studio A, keys K_1 , although shown as

permanent keys, may be K_5 , which are momentary contact keys and control the operation of relay R_1 . By closing key K_1 , relay R_1 becomes energized by the flow of current through the winding of that relay from a bat-
 70 tery B_1 , the circuit including the armature of the relay IR_1 , conductor 21, key K_1 , the winding of relay R_1 , key K_5 , key K_{11} , conductor 22, key K_{17} and ground. As the winding of the relay R_1 becomes energized, its arma-
 75 ture A closes a contact c , enabling the winding of the relay R_1 to receive current from a battery B_2 at the same time that current is flowing through the winding of that relay from a battery B_1 . The circuit from battery
 80 B_2 includes key K_{17} , conductor 23, key K_{11} , the armature A and the contact c of the relay R_1 , the winding of the relay R_1 , key K_5 , key K_{11} , conductor 22, key K_{17} and ground. After contact c of the relay R_1 has been
 85 closed by armature A of that relay, relay R_1 remains energized even after key K_1 is released. Shortly after contact c of the relay R_1 is closed by armature A, another contact d is closed by armature A. Current then
 90 flows from the battery B_2 through the winding of the relay IR_1 , this circuit including the battery B_2 , the key K_{17} , conductor 23, the key K_{11} , armature A of the relay R_1 , contacts c and d of the relay R_1 , conductor 24, the wind-
 95 ing of the relay IR_1 and ground. Thus, as the armature A of the relay R_1 closes its contact d , the relay IR_1 becomes energized to enable its armature to open the contact associated therewith, thereby disconnecting
 100 battery B_1 from the winding of the relay R_1 . Yet, the winding of the relay R_1 remains energized by the flow of current from the battery B_2 through the circuit including the key K_{17} , conductor 23, key K_{11} , armature A
 105 and contact c of the relay R_1 , the winding of the relay R_1 , key K_5 , key K_{11} , conductor 22, key K_{17} and ground. However, current may flow through the key K_1' at studio B only when the relay IR_1 is deenergized. After re-
 110 lay R_1 has operated to close contact d , and after relay IR_1 has become energized, the relay R_1' at studio B can not become operated by key K_1' at that studio until the relay IR_1 has first become deenergized.

The winding of the line relay LR_1 is in parallel relationship with the winding of the relay R_1 , conductor 25 connecting these wind-
 120 ings. Consequently, the energization or deenergization of the relay R_1 causes a corresponding action of the line relay LR_1 . The armatures a and b of the line relay LR_1 are connected through the channel bus-bar CB_1 to the line amplifier LA_1 , the radio trans-
 125 mitter ST_1 and the transmitting antenna TA_1 . Therefore, when the line relay LR_1 and the relay R_1 become energized, the main transmission circuit between the studio A and the transmitting station associated with the bus-bar CB_1 becomes closed. Also, the
 130

lamp L_5 at the studio indicates to the announcer that the relay R_1 has operated. Similarly, the lamp L_{19} at the control room indicates to the operator thereat that the line relay LR_1 has operated. The circuit of the lamp L_{19} includes a battery B_{10} , the lamp L_{19} , the armature c of the line relay LR_1 and ground. The relay R_1 at studio A may be deenergized by operating key K_5 , key K_{11} or key K_{17} , these keys all being included in a series path which includes the winding of the relay R_1 . Keys K_{11} and K_{17} are also in series with the windings of relays R_2 and R_3 at studio A, and hence are the studio and control room master release keys, respectively.

When the apparatus in the control room is ready for the transmission of program matter to a given radio transmitting station, such as the one associated with the radio transmitter ST_1 , the operator at the control room operates a key SK_1 , in order to signal the announcers in the studios that the apparatus is ready for the transmission of program matter. A feature of this invention lies in the provision of a link tying this signal with apparatus at the radio transmitting station in such a manner that the signal can not be given unless the carrier wave, characteristic of that transmitting station is "on the air". When the carrier frequency characteristic of the radio transmitter ST_1 is being radiated by the radio antenna TA_1 , some of the energy radiated by the antenna TA_1 is picked up by a coil W_1 coupled to the antenna. The coil W_1 is connected to a detector, shown herein as a vacuum tube detector, the coil W_1 bridging a condenser C_1 and being connected between the grid and filament of the vacuum tube V_1 . A battery B_{20} is connected to the filament of the vacuum tube V_1 through a resistance Z_1 , this filament being heated to an electron-emitting temperature by the current flowing from battery B_{20} . The output circuit of the vacuum tube V_1 includes a battery B_{21} , the filament and plate of the vacuum tube V_1 and the winding of a relay R_{11} . When radio frequency energy, characteristic of the radio transmitter ST_1 , is picked up by the winding W_1 , the winding of the relay R_{11} will become energized due to the flow of current therethrough from battery B_{21} , which is above a definite minimum value. Consequently, the armature of relay R_{11} will become attracted to close the circuit of another relay R_{12} at the control room, current flowing from a battery B_{22} through the winding of the relay R_{12} , the armature and contact of the relay R_{11} and ground. When the winding of the relay R_{12} becomes energized, its armature is attracted to close a contact associated therewith, thereby grounding the armature. Similarly, relays R_{11}' and R_{11}'' are associated with vacuum tubes V_2 and V_3 , in the input circuits of which are coupling coil W_2 and condenser C_2 and coupling coil W_3 and con-

denser C_3 , the windings W_2 and W_3 rendering relays R_{11}' and R_{11}'' operative when currents characteristic of radio transmitters ST_2 and ST_3 are being radiated by the transmitting antennae TA_2 and TA_3 , respectively. Similarly, there are relays R_{12}' and R_{12}'' at the control room, which become energized by the flow of current therethrough from batteries B_{22}' and B_{22}'' when the armatures of the relays R_{11}' and R_{11}'' are attracted, respectively, thereby grounding the armatures connected to these relays.

In order that the announcer at studio A may know which transmitting stations are prepared to receive and broadcast the program originating at his station, lamps L_1 , L_2 and L_3 are provided at that studio, each lamp being associated with one of the transmitting stations, these lamps corresponding to relays R_1 , R_2 and R_3 , respectively. Lamps L_1 , L_2 and L_3 at studio A, and lamps L_1' , L_2' and L_3' at studio B are controlled by the signal keys SK_1 , SK_2 and SK_3 , respectively, which are located at the control room, and which are under the supervision and control of the operator at the control room. The system is so arranged that when one of the relays, such as R_1 , becomes operated, the lamp L_1' at studio B corresponding to the relay R_1' at that studio will become extinguished. Thus, the lamp L_1 advises the announcer in studio A that the carrier wave of the transmitting station associated with the channel bus-bar CB_1 is "on the air" and that the transmission path to that transmitting station is ready for broadcasting service from studio A. By operating one of the signal keys, such as SK_1 , a lamp L_{23} becomes illuminated, current flowing from the battery B_5 through the lamp L_{23} , the key SK_1 , the armature of the relay R_{12} and ground. The lamp L_1 at the studio also becomes illuminated, regardless of the state of energization of the relay R_1 , as will be shown more clearly hereinafter. When the winding of the relay R_1 is deenergized, current flows from the battery B_1 through the armature of the relay IR_1 , the conductor 21, contact f and armature B of the relay R_1 , lamp L_1 , key SK_1 , the armature of the relay R_{12} and ground. When the winding of the relay R_1 becomes energized, current then flows from the battery B_2 through the key K_{17} , conductor 23, key K_{11} , contact e and armature B of the relay R_1 , lamp L_1 , key SK_1 , the armature of the relay R_{12} and ground. Similarly, the lamp L_1' in studio B becomes illuminated by closure of the key SK_1 , regardless of the state of energization of relay R_1' , current flowing through lamp L_1' from battery B_1 when the relay R_1' is deenergized, and current flowing from the battery B_2 through the lamp L_1' when the relay R_1' becomes energized. Yet, when the winding of the relay R_1 in studio A becomes energized, the corresponding lamp L_1' in studio B becomes ex-

tinguished, while the lamp L_1 in studio A remains illuminated. Thus, there is an indication to the announcer in studio B that the transmitting station connected to the channel bus-bar CB_1 is not available for the transmission of program matter originating at his studio. Obviously, when relay R_1 at studio A again becomes deenergized, both lamps L_1 and L_1' at studios A and B, respectively, again become illuminated, thus again providing an indication for the operators at both studios that the transmitting station connected to the channel bus-bar CB_1 is again available for the transmission of program matter.

Keys K_{11} and K_{17} , and K_{11}' and K_{17}' are the master release keys, keys K_{11} and K_{11}' being under the supervision and control of the announcers at studios A and B, respectively, and keys K_{17} and K_{17}' being under the supervision and control of the operator or operators at the control room. The keys at studios A and B permit the announcers at these studios to release any one or more of the program transmitting stations from their respective studios. The keys K_{17} and K_{17}' at the control room break the circuits of batteries B_2 and B_2' and ground, respectively, thereby releasing relays R_1 , R_2 and R_3 at studio A, and relays R_1' , R_2' and R_3' at studio B, respectively. The keys K_{11} and K_{11}' at studios A and B similarly release relays R_1 , R_2 and R_3 at studio A, and relays R_1' , R_2' and R_3' at studio B, respectively. Thus, the system enables either the announcer in the studio or the operator in the control room to simultaneously release all of the transmitting stations connected to his (the announcer's) studio.

In studio A, the output of the announcer's microphone MA_1 passes through the microphone control equipment CP_1 to the lower contacts j and k of the switch K_{10} . The output of the program microphone MP_1 similarly passes through the microphone control equipment CP_1 to the lower contacts j and k of the switch K_9 . The "nemo" circuit NC_1 is connected to the upper contacts a and b of the switch K_9 . The upper contacts a and b of the switch K_{10} are connected to the blades e and f of the switch K_9 . The blades e and f of the switch K_{10} are connected to the input of the amplifier CA_1 at the control room. When the switch K_{10} is thrown downwardly to engage contacts j and k , the announcer's microphone MA_1 is then connected to the amplifier CA_1 . By throwing the switch K_{10} upwardly to engage contacts a and b , and by throwing switch K_9 downwardly to engage contacts j and k , the program microphone MP_1 will then be connected to the amplifier CA_1 . By throwing both switches K_9 and K_{10} to their upward positions, the "nemo" circuit NC_1 will then be connected to the amplifier CA_1 . By leaving

switch K_9 in its upward position, and by operating switch K_{10} , the announcer at studio A may connect either the announcer's microphone MA_1 or the "nemo" circuit NC_1 to the amplifier CA_1 .

A lamp L_{13} is located at studio A and provides an indication to the announcer at studio A that the equipment of the control room corresponding to studio A is in readiness for operation. Clearly, the lamp L_{13} may, if desired, be a colored lamp to distinguish this lamp from some or all of the other lamps. By closing a key K_{18} at the control room, the control room operator then sends current from a battery B_6 through the lamp L_{13} at studio A, this circuit including the battery B_6 , key K_{18} , conductor 27, lamp L_{13} and ground. Another lamp L_{17} , which is located at the control room, is also operated by key K_{18} . The circuit of lamp L_{17} includes the battery B_6 , the key K_{18} , the lamp L_{17} and ground. It is to be noted that the winding of the main relay R_6 at the control room can not become energized unless the key K_{18} in the control room has first been closed. This will prevent the transmission of program matter to one or more of the radio transmitting stations before the proper connections have been made at the control room.

The main relays R_6 and R_6' at the control room open the main transmission paths between studios A and B and the studio bus-bars Sb_1 and Sb_2 , respectively, whenever it is considered undesirable to transmit the sounds originating in the studios. Again confining the description of the apparatus at the control room to that which corresponds to studio A, it is apparent that one terminal of the winding of the main relay R_6 is grounded, and that the other terminal of the winding of the main relay R_6 is connected through conductor 40 to the contacts c and l of the switch K_{10} . The blade g of the switch K_{10} is connected to the battery B_6 at the control room through conductor 27 and key K_{18} , when key K_{18} is closed. Thus, when key K_{18} is closed, the operation of the switch K_{10} at the studio to close either contact c or contact l will permit current to flow from the battery B_6 at the control room through conductors 27 and 40, and through the winding of the relay R_6 . When the winding of the relay R_6 becomes energized, one of its armatures a closes a contact which permits current to flow from the battery B_7 to the lamp L_{18} , this circuit being closed through the armature a of the relay R_6 and ground. Lamp L_{18} indicates to the operator at the control room whether or not relay R_6 has operated. The contacts b and c of the relay R_6 control the transmission through the main transmission path between the amplifier CA_1 at the control room and the studio bus-bar Sb_1 . When the winding of the relay R_6 is not energized, the armature d of this relay

short-circuits the studio bus-bar Sb_1 , thereby short-circuiting all of the line amplifiers connected thereto.

When the key K_{18} at the control room is operated, causing lamp L_{13} at the studio to become illuminated to provide an indication to the announcer at studio A that everything in the control room is in readiness for transmission of program matter originating in that studio, and when the switches K_9 and K_{10} at the studio are operated to connect either the program microphone MP_1 or the announcer's microphone MA_1 or the "nemo" circuit NC_1 to the amplifier CA_1 at the control room, either lamp L_{11} , L_{12} or L_{10} will be illuminated at the studio to indicate to the announcer which of these sources has been connected to the amplifier CA_2 at the control room. The circuit for lamp L_{11} includes the battery B_6 , the key K_{18} , conductor 27, blade h and contact d of the switch K_{10} , blade g and contact l of the switch K_9 , lamp L_{11} and ground. The circuit for lamp L_{12} includes the battery B_6 , key K_{18} , conductor 27, blade h and contact m of the switch K_{10} , lamp L_{12} and ground. The circuit for lamp L_{10} includes the battery B_6 , key K_{18} , conductor 27, blade h and contact d of the switch K_{10} , blade g and contact c of the switch K_9 , lamp L_{10} and ground. A lamp L_{16} is controlled by a relay R_5 , both of which are at the control room, the lamp providing a visible indication to the operator at the control room that the announcer at studio A has set up his equipment so as to transmit program matter coming over the "nemo" circuit NC_1 . The winding of the relay R_5 is connected to a battery B_8 at studio A through a conductor 41, the contact d and the blade h of the switch K_9 . Inasmuch as the switch K_9 must be thrown to its upward position to connect the "nemo" circuit NC_1 to studio A, the relay R_5 at the control room will thereupon become energized, attracting its armature and illuminating lamp L_{16} by the flow of current therethrough from a battery B_8 . Similarly, a relay R_5' controls a single lamp L_{16}' to provide a visible indication to the operator at the control room that the announcer at studio B has set up his equipment so as to transmit the program matter coming over the "nemo" circuit NC_2 . The line relays LR_1 , LR_2 and LR_3 , corresponding to studio A, and the line relays LR_1' , LR_2' and LR_3' , corresponding to studio B, are so arranged that the line amplifiers LA_1 , LA_2 and LA_3 may be switched from one studio bus-bar, such as Sb_1 , to the other studio bus-bar Sb_2 . This has already been explained hereinabove. Yet, in each of the line relays, such as LR_1 , one terminal of the winding of the relay is connected to an armature c of that relay, both being grounded. The operation of the line relay LR_1 illuminates a lamp L_{19} by the flow of current therethrough from a battery B_{10} , thereby providing an indication that the line

relay LR_1 has operated. The armatures a and b of the line relay LR_1 control the main transmission path between the studio bus-bar Sb_1 and the line amplifier LA_1 . The other terminal of the winding of the line relay LR_1 is connected to the winding of the relay R_1 in studio A. These windings are in parallel relationship and consequently are simultaneously energized or deenergized.

One of the features of this invention is the provision of a telephone communication system between the announcers in the various studios and the operator or operators in the control room, so that telephone service may be very promptly obtained. In this invention, a telephone system interconnects each studio with the control room, permitting the announcer in the studio to speak to the control room operator associated with his studio. Keys TK_1 and TK_2 , TK_1' and TK_2' are located in studios A and B, respectively. When the announcer in studio A closes the telephone key TK_2 , and lamp L_{32} at the control room lights up, current flowing from a battery B_{24} through the key TK_2 , conductor 50, lamp L_{32} and ground. Thus, the announcer at studio A attracts the attention of the operator at the control room, advising him that he desires to communicate with him telephonically. It will be understood, however, that lamp L_{32} , or other visual means, would not be necessary at the control room to attract the control room operator's attention if the operator at the control room continually wore a telephone headset. Similarly the operator at studio B may attract the attention of the operator at the control room by operating a telephone key TK_2' at his studio, lamp L_{32}' then becoming illuminated. Keys K_{16} and K_{16}' are located at the control room, one associated with each studio, these keys being employed to advise the announcers in the studios that the operator or operators in the control room desire to speak to the announcers in the studios by telephone. By closing key K_{16} at the control room, a lamp L_{31} at studio A is illuminated, current flowing from a battery B_{25} at the control room through the key K_{16} , conductor 51, lamp L_{31} and ground. Similarly, lamp L_{31}' at studio B indicates to the announcer at that studio that the control room operator desires to have a telephone conversation with him. Yet, it will also be understood that these visual means would not ordinarily be necessary if the announcers at the studios were equipped with telephone headsets.

The telephone key TK_1 and the lamp L_{30} , and the telephone key TK_1' and the lamp L_{30}' are located, respectively, in studios A and B, key TK_1 being operated by the announcer in studio A to illuminate lamp L_{30}' in studio B whenever the announcer in studio A desires to connect his telephone circuit to the telephone circuit in studio B, telephone

key TK_1' in studio B being operated to illuminate lamp L_{30} at studio A whenever the announcer in studio B desires to connect his telephone circuit to the telephone circuit at studio A. When the announcer in studio A closes the telephone key TK_1 , current flows from battery B_{24} at studio A through the telephone key TK_1 , conductor 52, lamp L_{30}' , at studio B, and ground. A telephone substation circuit SB_1 , including a telephone transmitter and a telephone receiver of any well known type, is connected to a similar telephone substation circuit SB_1' at studio B, telephonic currents flowing from the substation circuit SB_1 , at studio A, through key TK_1 , conductors 53 and 54, telephone key TK_1' at studio B, and the telephone substation circuit SB_1' . Similarly, when the announcer at studio B operates the telephone key TK_1' at his studio, current flows from a battery B_{24}' , at studio B, through the key TK_1' , conductor 55, lamp L_{30} , at studio A, and ground. Telephonic currents flow between the telephone substation circuit SB_1' , at studio B, and the telephone substation circuits SB_1 at studio A as soon as the announcer at studio A operates telephone key TK_1 .

It is another feature of this invention to provide a telephone circuit between the announcer in one of the studios, the operator at the control room and the operator at one of the radio transmitting stations, the radio station operator being therefore connected telephonically with the control room operator and with the announcer in the studio furnishing the program. Accordingly, relays TR_1 , TR_2 and TR_3 , and relays TR_1' , TR_2' and TR_3' are located in the control room, relays TR_1 and TR_1' corresponding to the radio transmitting station connected to the channel bus-bar CB_1 , relays TR_2 and TR_2' corresponding to the radio transmitting station connected to the channel bus-bar CB_2 , and relays TR_3 and TR_3' corresponding to the radio transmitting station connected to the channel bus-bar CB_3 . These relays are normally controlled by the line relays at the studio. In connection with studio A and the apparatus at the control room associated therewith, it may be said that the line relay LR_1 controls the operation of the relay TR_1 through the armature c of the line relay LR_1 . Thus, when the line relay LR_1 becomes operated, armature c is attracted, energizing the winding of the relay TR_1 , current flowing from a battery B_{26} , through the winding of the relay TR_1 , telephone key TK_1 , armature c of the line relay LR_1 and ground. Similarly, the operation of the armature c of the line relays LR_2 and LR_3 control the operation of the telephone relays TR_2 and TR_3 , current flowing from batteries B_{27} and B_{28} through the windings of these relays and through the telephone keys TK_2 and TK_3 , respectively. Accordingly, when one of the line relays, such

as LR_1 , is operated to connect studio A to the radio transmitting station connected to the channel bus-bar CB_1 , the corresponding telephone relay TR_1 at the control room is operated to connect the telephone substation circuit TB_1 , located at the same radio transmitting station, to the telephone substation circuit SB_2 at the control room, and, if the telephone key TK_2 at studio A is closed, to the telephone substation circuit SB_1 at studio A. Similarly, the operation of the line relays LR_2 and LR_3 bring about the operations of the corresponding telephone relays TR_2 and TR_3 , respectively, to connect the telephone substation circuits TB_2 and TB_3 at the radio transmitting stations connected to the channel bus-bars CB_2 and CB_3 , respectively, to the same telephone substation circuit SB_2 at the control room, and, if the telephone key TK_2 at studio A is closed, to the telephone substation circuit SB_1 at that studio. Telephone substation circuits TB_1 , TB_2 and TB_3 , located at the transmitting stations connected to the channel bus-bars CB_1 , CB_2 and CB_3 , respectively, may be connected to a telephone substation circuit SB_2' at the control room through the operations of the telephone relays TR_1' , TR_2' and TR_3' , respectively, and, if the telephone key TK_2' at studio B is closed, to the telephone substation circuit SB_1' at that studio.

The telephone relays have been shown hereinabove to be controlled by the line relays. These telephone relays may be controlled by the telephone keys at the control room. The telephone keys TK_1 , TK_2 and TK_3 may be used to control telephone relays TR_1 , TR_2 and TR_3 , and the telephone keys TK_1' , TK_2' and TK_3' may be used to control the telephone relays TR_1' , TR_2' and TR_3' respectively. In connection with studio A, it may be said that the operator at the control room may connect his substation circuit SB_2 to the substation circuit TB_1 at the radio transmitting station corresponding to the channel bus-bar CB_1 by closing key TK_1 . When key TK_1 is closed, a telephone relay TR_1 is energized by the flow of current from battery B_{26} through the winding of that relay, through key TK_1 and ground. The armatures of the relay TR_1 are attracted, thereby connecting the telephone substation circuit SB_2 , at the control room, to the telephone substation circuit TB_1 at the radio transmitting station. Similarly, the operation of the keys TK_2 and TK_3 may be used to connect the telephone substation circuit SB_2 , at the control room, to the telephone substation circuits TB_2 and TB_3 at the radio transmitting stations associated with the channel bus-bars CB_2 and CB_3 , respectively. It will be obvious that while only one telephone substation circuit has been shown herein at the control room, operatively associated with the telephone keys TK_1 , TK_2 and TK_3 , separate tele-

phone substation circuits may be connected to the various telephone substation circuits at the radio transmitting stations TB_1 , TB_2 and TB_3 , respectively.

5 Relays SR_1 , SR_2 and SR_3 are provided at the control room, and are energized when the corresponding line amplifiers LA_1 , LA_2 and LA_3 are ready for use, but are not connected to a studio bus-bar. The inputs of these line
10 amplifiers will become short-circuited by the armatures of the relays SR_1 , SR_2 and SR_3 when the line relays are operated. In other words, when the line relays LR_1 , LR_2 and LR_3 , corresponding to studio A, and the line
15 relays LR_1' , LR_2' and LR_3' , corresponding to studio B are not energized, relays SR_1 , SR_2 and SR_3 , at the control room, will be operated. The relays SR_1 , SR_2 and SR_3 are interlocked with the relays IR_1 , IR_2 and IR_3 , the signal
20 keys SK_1 , SK_2 and SK_3 , and the relays R_{12} , R_{12}' and R_{12}'' , respectively. The interlocking of these keys and relays permits the operation of relays SR_1 , SR_2 and SR_3 only when the signals keys SK_1 , SK_2 and SK_3 are closed,
25 when the relays IR_1 , IR_2 and IR_3 are unoperated, and when the relays R_{12} , R_{12}' and R_{12}'' are operated, respectively. For the sake of simplicity, the operation of only one of these relays, SR_1 , will be considered. One
30 terminal of the winding of the relay SR_1 is connected to ground through conductor 29, the middle contact of the key SK_1 and the armature of the relay R_{12} . The other terminal of the winding of the relay SR_1 is
35 connected to battery B_1 at the control room, through conductor 30, conductor 21 and the armature of the relay IR_1 . Therefore, upon closure of the signal key SK_1 , current will flow from battery B_1 through the winding of
40 the relay SR_1 , thereby operating said relay. The armature of the relay SR_1 is then attracted, providing a short-circuit for the input of the line amplifier LA_1 . Relay SR_1 is always operated to put a short circuit on the
45 input of the amplifier LA_1 when the signal key SK_1 is closed, when the relay IR_1 is unoperated and when the relay R_{12} is operated. When the winding of the relay IR_1 becomes energized, as, for example, when the relay
50 R_1 , in studio A, becomes energized, the circuit connecting battery B_1 , at the control room, and the winding of the relay SR_1 , is opened, deenergizing the winding of relay SR_1 , removing the short-circuit from the in-
55 put of the amplifier LA_1 and placing this channel in an operative condition. Similarly, relays SR_2 and SR_3 are energized by current from battery B_1 at the control room through the armatures of relays IR_2 and IR_3 ,
60 conductors 31 and 32, the middle contacts of signal keys SK_2 and SK_3 , the armatures of relays R_{12}' and R_{12}'' , respectively, and ground.

One of the features of this invention is the
65 provision of a monitoring system for moni-

toring the output of each studio while the program matter is being passed through the studio and through the amplifier at the control room. This permits the announcer in
70 the studio, or the artist speaking into the microphone to determine whether the program matter is being transmitted from the studio to the control room. Accordingly, the outputs of the amplifiers CA_1 and CA_2 are
75 multiplied to studios A and B through resistances R_1 and R_2 and conductors 60 and 61, and through resistances R_1' and R_2' and conductors 62 and 63, respectively. Conductors 60 and 61 terminate in a jack J_1 at
80 studio A, so that the operator at the studio, or the artist speaking into the microphone may monitor his own circuit if he connects a plug P_1 to jack J_1 , plug P_1 being connected to a headset H_1 . Conductors 62 and 63 are con-
85 nected to a jack J_2' so that the announcer, or artist at studio B may, upon connecting plug P_2 into jack J_2' , monitor the output of studio B after the program matter is transmitted through the amplifier CA_2 at the control
90 room, plug P_2 at studio B being connected to a headset H_2 . The operator in studio A may also connect plug P_1 at his studio with jack J_2 , jack J_2 being connected through con-
95 ductors 64 and 65, conductors 63 and 62, and through resistances R_1' and R_2' to the output of the amplifier CA_2 at the control room, this amplifier amplifying program matter trans-
100 mitted from studio B. Similarly, the operator at studio B may connect plug P_2 to jack J_1' , which is connected to the output of the amplifier CA_1 , at the control room, through
105 conductors 66 and 67, conductors 60 and 61 and resistances R_1 and R_2 to the amplifier CA_1 at the control room, amplifying the program matter transmitted from studio A. In
110 accordance with this invention, the operator at any one of the studios may monitor the program matter transmitted from his, or from any other studio, to the control room, which may obviously be at some distant point. After the program matter has passed through
115 the amplifier at the control room corresponding to the studio to be monitored, the resistances R_1 and R_2 , and R_1' and R_2' , these resistances being of large and definite magni-
120 tudes, are inserted between outputs of amplifiers CA_1 and CA_2 , at the control room, and the corresponding jacks at studios A and B, respectively, in order that any noise or other disturbance on the monitoring circuits will
125 have but a negligible effect on the program matter being transmitted from the studios.

It has been pointed out hereinabove that visual signals are provided in the control
130 room to indicate to the operator at the control room that a studio is connected to a transmitting station. Similarly, visual signals may be provided to indicate at a transmitting station that some studio is connected to that transmitting station. In other words,

signals may be provided at each transmitting station to indicate when program matter should be coming to that transmitting station. This may be accomplished by having a circuit extend between contacts on the main relays and line relays, so that when a main relay and an associated line relay are operated, and the desired transmitting station is "on the air," this circuit will be closed to operate a relay, for example, R_{13} , at the control room, the operation of this relay controlling the operation of another relay, R_{14} , at the transmitting station, the armature of which controls the illumination of the lamp L_{35} at the transmitting station. In connection with the transmission of program matter from studio A to the transmitting station connected with the channel bus-bar CB_1 , when the main relay R_6 is operated, and when the line relay LR_1 is also operated to connect the output of the amplifier CA_1 to the transmitting station connected to the channel bus-bar CB_1 , a circuit is closed through relay R_{13} , this circuit including armature a of the main relay R_6 , armature d of the line relay LR_1 , the winding of the relay R_{13} , battery B_{30} and ground. Relay R_{13} becomes energized to attract its armature. Current then flows from battery B_{30} through the winding of the relay R_{14} at the transmitting station, this circuit including the battery B_{30} , the armature of the relay R_{13} and its contact, the winding of the relay R_{14} and ground. The armature of the relay R_{14} is attracted, closing a circuit through lamp L_{35} at the transmitting station, current flowing from the battery B_{31} through the lamp L_{35} , through the armature of the relay R_{14} at its contact and ground. Thus, a visual signal is provided at the transmitting station to indicate to the operator at the transmitting station that program matter should be coming to that transmitting station. Similarly, when program matter should be coming to the transmitting stations connected to the channel bus-bars CB_2 and CB_3 , the relays R_{13}' and R_{13}'' at the control room are energized by the flow of current therethrough from batteries B_{30}' and B_{30}'' , which in turn operate relays R_{14}' and R_{14}'' at the associated transmitting stations, illuminating lamps L_{35}' and L_{35}'' by the flow of current therethrough from batteries B_{31}' and B_{31}'' , respectively.

The phrase "transmitting station" or "radio transmitting station", as employed herein designates a radio transmitter, public address equipment, an individually loaded loud speaker or any other suitable signaling device or circuit. The word "studio", as employed herein, designates a place where a program of news, music or any other sound originates, whether it be in a room adjacent to the control room, or at some point distant from the control room, requiring a connection thereto by local or long distance tele-

phone lines, or any other suitable signaling medium.

While only two studios and three transmitting stations have been shown and described herein, it will be understood that the system is adaptable to connect any number of studios and any number of transmitting stations, within the scope of the invention.

While no auxiliary equipment, such as equalizers, repeating coils, artificial lines, etc., are absolutely essential to the operation of the system, as shown herein, it is to be understood that such equipment may be added, as found desirable, in any manner well known to the art, without departing from the spirit of the invention or from the scope of the appended claims.

While this invention has been shown and described in one particular embodiment, merely for the purpose of illustration, it is to be clearly understood that the general principles of this invention may be embodied in other and widely varied organizations without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. In a radio broadcasting system, a plurality of studios wherein programs originate, a plurality of transmitting stations, means for interconnecting the various studios with the various transmitting stations so that the programs originating at any two of the studios may not be simultaneously transmitted by any one of the transmitting stations, and means at each studio for monitoring the output of any desired studio.

2. In a radio broadcasting system, a plurality of studios wherein programs originate, a plurality of transmitting stations, means for interconnecting the various studios with the various transmitting stations so that the programs originating at any two of the studios may not be simultaneously transmitted by any one of the transmitting stations, and means at each studio for monitoring the output of any desired transmitting station.

3. In a radio broadcasting system, a plurality of studios wherein programs originate, a plurality of transmitting stations, a control room including means for interconnecting the various studios with the various transmitting stations so that the programs originating at any two of the studios may not be simultaneously transmitted by any one of the transmitting stations, and means extending from the control room to the various studios to enable the announcers in the various studios to simultaneously and selectively monitor the program transmitted from any of the studios.

4. In a radio broadcasting system, a plurality of studios wherein programs originate, a plurality of transmitting stations, means for interconnecting the various studios with the various transmitting sta-

tions so that the programs originating at any two of the studios may not be simultaneously transmitted by any one of the transmitting stations, and means to enable the announcers in the various studios to simultaneously monitor the outputs of their respective studios.

5. In a radio broadcasting system, a plurality of studios wherein programs originate, a plurality of transmitting stations, means for interconnecting the various studios with the various transmitting stations so that the programs originating at any two of the studios may not be simultaneously transmitted by any one of the transmitting stations, and a plurality of monitoring circuits one extending from each transmitting stations to each studio so that the announcers in the various studios may simultaneously monitor the programs being transmitted by any of the various studios.

6. In a radio broadcasting system, a plurality of studios wherein programs originate, a plurality of transmitting stations each employing a different carrier frequency, a control room through which pass circuits extending from the various studios to the various transmitting stations, means to permit any number of transmitting stations to transmit the program of any one studio, means to prevent the connection of any two studios to any one transmitting station, a plurality of amplifiers at the control room one associated with each studio, and a plurality of monitoring circuits one extending from the output of each amplifier to the corresponding studio to enable the announcer at that studio to monitor the program emanating from his studio.

7. In a radio broadcasting system, a plurality of studios wherein programs originate, a plurality of radio transmitting stations each employing a different carrier frequency, a control room, a plurality of circuits extending from the various studios through the control room to the various radio transmitting stations, means at the control room to connect the various transmitting stations to the various studios and to prevent the connection of any two studios to any one transmitting station, a plurality of amplifiers at the control room one corresponding to each studio, a plurality of monitoring circuits one extending from the output of each amplifier at the control room to each studio, and means to enable the announcer at each studio to monitor through said monitoring circuits the output of any one of said studios.

8. The combination of a plurality of studios wherein programs originate, a distant control room, a plurality of circuits extending from each studio to the control room for the transmission of program matter from the various studios, a plurality of amplifiers at the control room one corresponding to each studio, and a plurality of monitoring circuits

each including resistance of a definite magnitude, the resistance of each monitoring circuit interposing a transmission loss corresponding to the amplification of each amplifier, each monitoring circuit extending from the output of one of the amplifiers at the control room to the associated studio, thereby enabling the announcer in any studio to monitor the program matter originating at his studio and being transmitted through the control room.

9. In a radio broadcasting system, a plurality of studios wherein programs originate, a plurality of transmitting stations each employing a different radio frequency, a control room through which pass circuits interconnecting the various studios with the various transmitting stations so that the programs at the various studios may be simultaneously broadcast by the various transmitting stations, means to prevent the simultaneous transmission of the program matter of two studios through any one transmitting station, a plurality of visual indicating devices one at each studio, and means whereby said indicating devices may indicate to the announcers at the various studios that the control room operator is prepared to transmit the program matter originating in said studios through the various transmitting stations.

10. In a radio broadcasting system, a plurality of studios wherein programs originate, a plurality of transmitting stations each employing a different radio frequency, a control room through which pass circuits interconnecting the various studios with the various transmitting stations, a plurality of visual indicating devices one at each studio, and means extending between the various studios and the control room to operate each indicating device in order to indicate to the announcer at each studio that the carrier frequency characteristic of a particular transmitting station is on the air.

11. In a radio broadcasting system, a plurality of studios wherein programs originate, a plurality of transmitting stations each employing a different radio frequency, a control room through which pass circuits interconnecting the various studios with the various transmitting stations, a plurality of visual indicating devices one at each studio, a plurality of detecting devices one at each transmitting station, each detecting device detecting some of the current of the radio frequency characteristic of the associated transmitting station, and means at each transmitting station whereby the detected current may be transmitted to the indicating device of one of the studios in order to operate that indicating device at the studio from which program matter is being supplied to that transmitting station.

12. In a radio broadcasting system, a plu-

5 rality of studios wherein programs originate,
a plurality of program transmitting stations,
means for connecting any one of the studios
to one or more of the program transmitting
stations, means to prevent two studios from
becoming simultaneously connected to any
program transmitting station, and detecting
means at each program transmitting sta-
tion to detect some of the matter broadcast
10 thereby, and indicating means at each pro-
gram transmitting station operated by the
detecting means to indicate that program
matter should be coming to that program
transmitting station.

15 In testimony whereof, we have signed our
names to this specification this 27th day of
April, 1927.

EDMUND R. TAYLOR.
OSCAR B. HANSON.

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