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Aug. 5, 1930. E. R. TAYLOR ET AL 1,772,165

MULTIPLEX BROADCAST SYSTEM

Filed Aug. 17, 1926 3 Sheets-Sheet 1

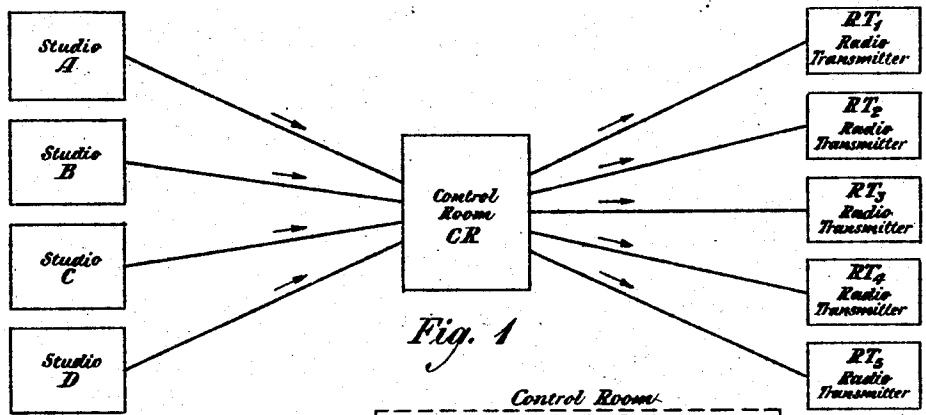


Fig. 1

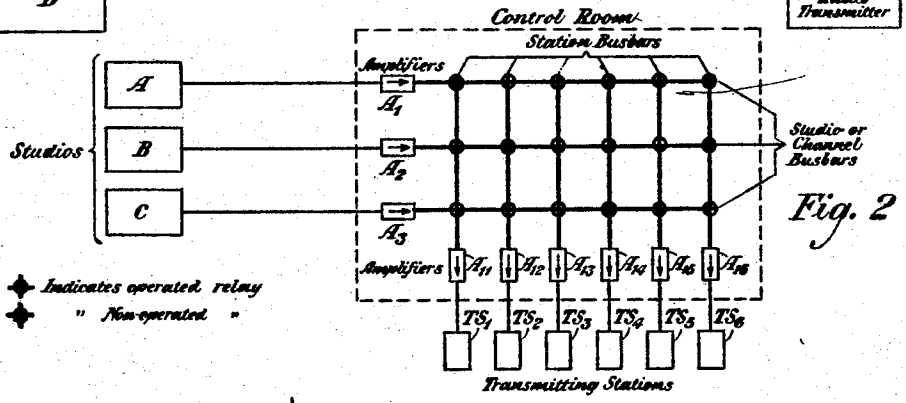


Fig. 2

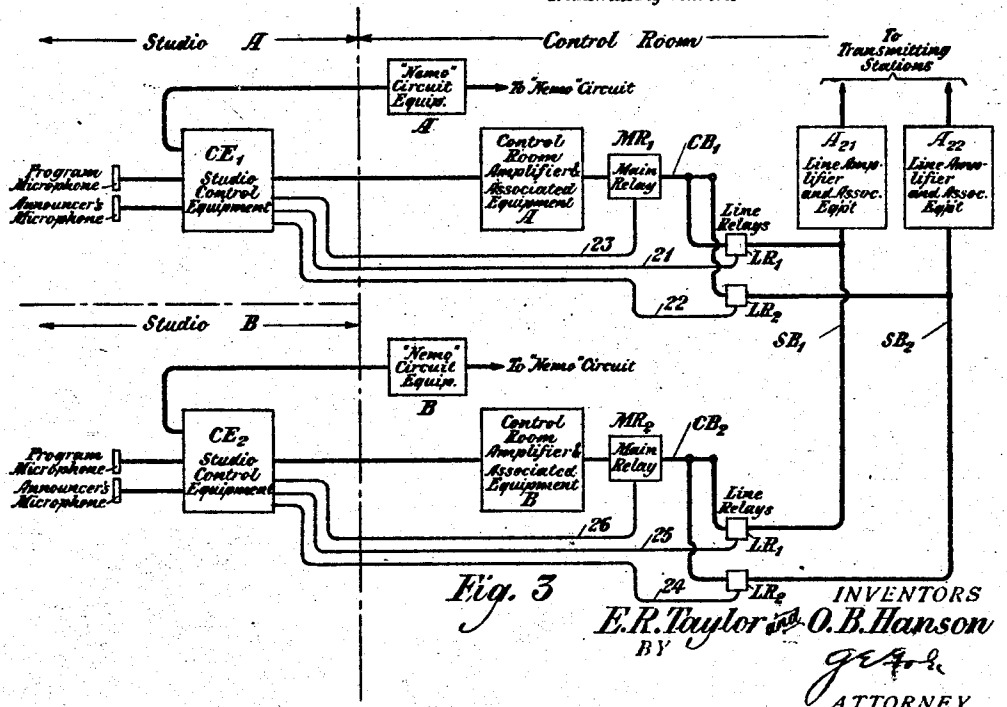


Fig. 3

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MULTIPLEX BROADCAST SYSTEM

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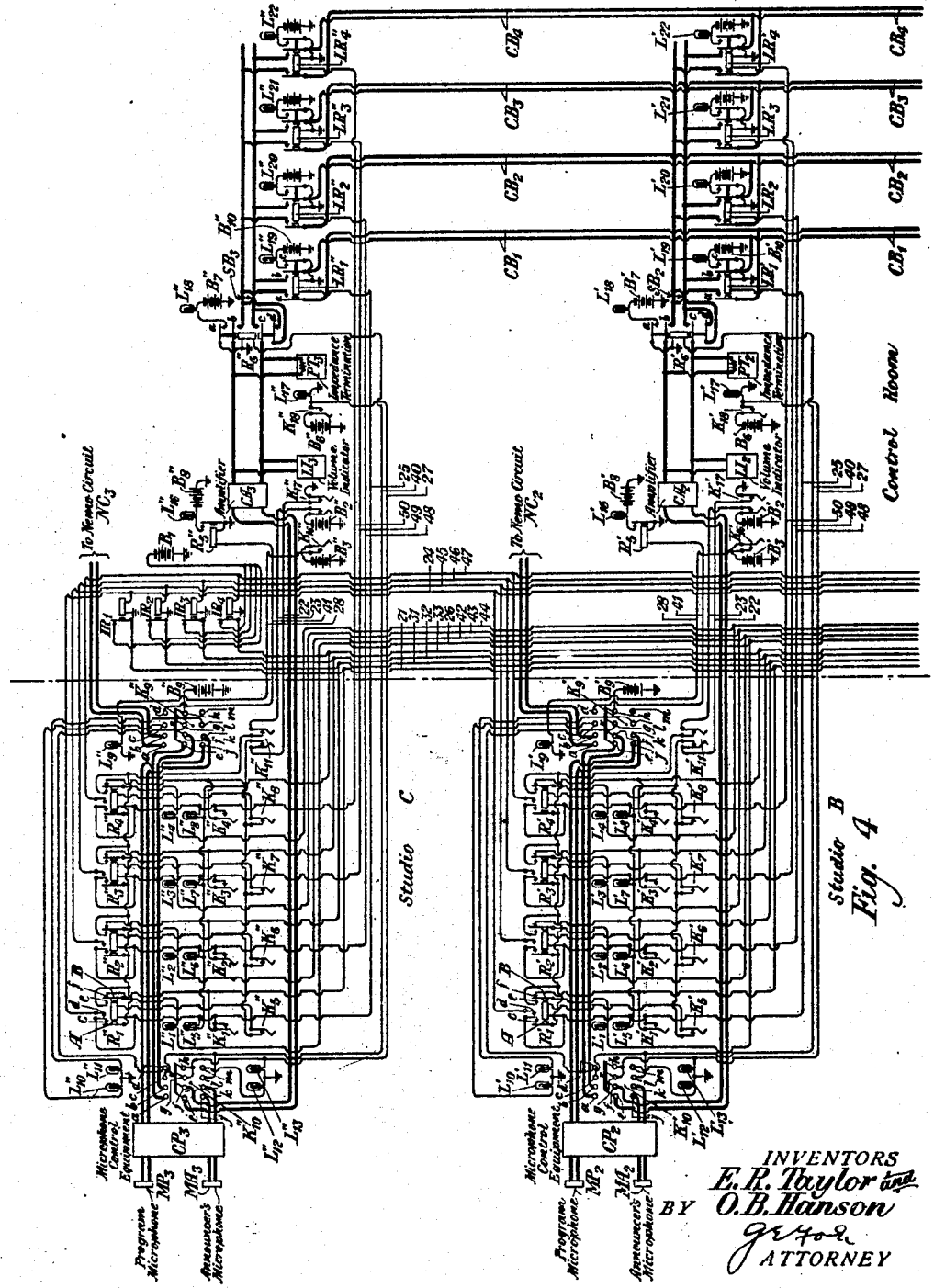


Fig. 4

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MULTIPLEX BROADCAST SYSTEM

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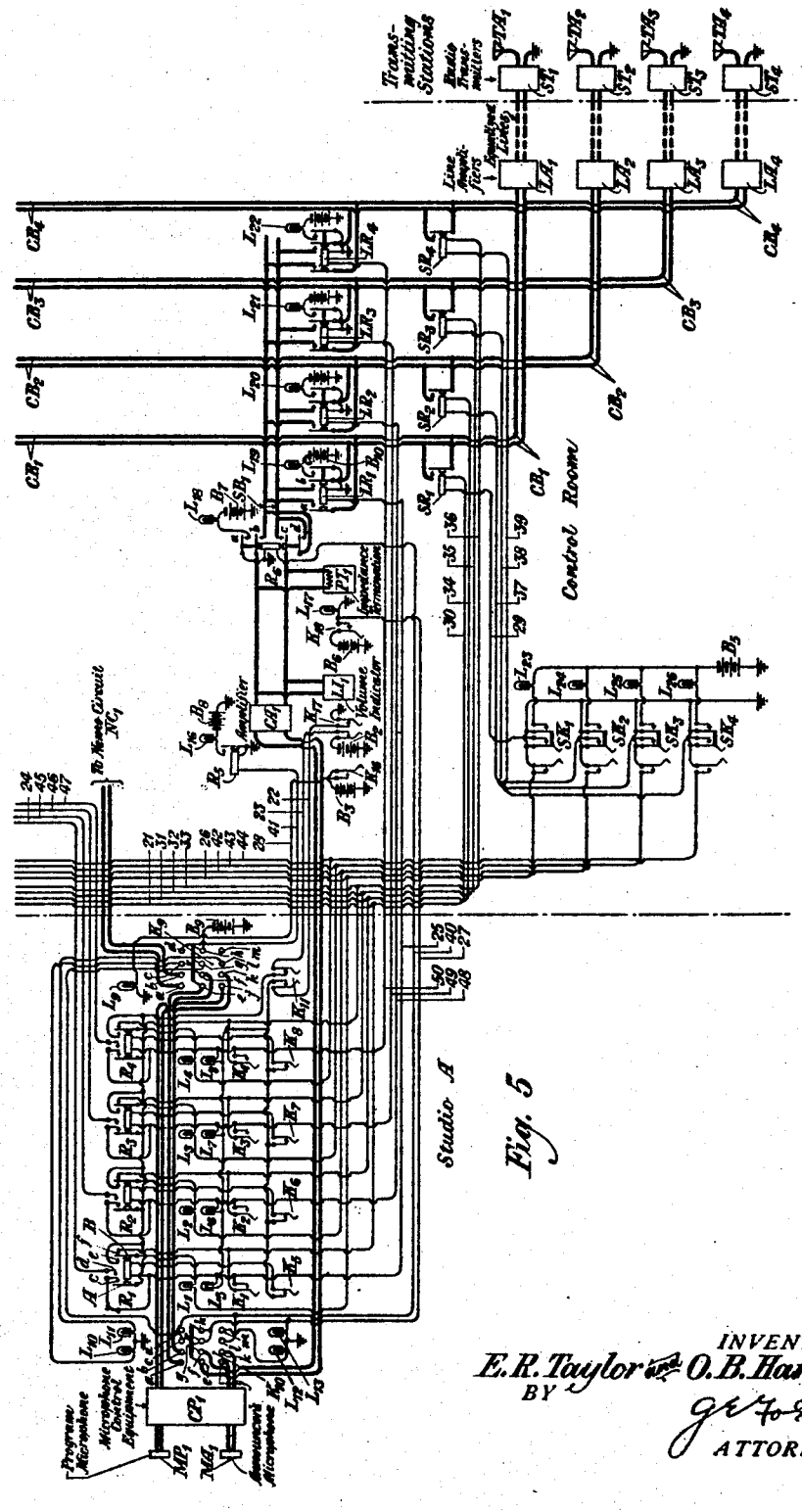


Fig. 5

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UNITED STATES PATENT OFFICE

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MULTIPLEX BROADCAST SYSTEM

Application filed August 17, 1926. Serial No. 129,834.

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 with a plurality of transmitting stations so that the programs originating at said sources may be simultaneously broadcast by said transmitting stations.

This invention results from long-continued experimentation with broadcasting systems. The first broadcasting system involved but one studio or program source and one transmitting station. These were permanently connected so that when the transmitting station was in operating condition all the sounds which were made in the studio were audible to the radio audience. This was soon found to be objectionable because certain sounds incidental to arranging the artists, etc., proved to be both disconcerting and displeasing. Accordingly a single and control arrangement was evolved which disconnected the studio from the transmitting station when it was not desired that the sounds in the studio be heard by the radio audience. This was found to result in objectionable delays while one group of artists was leaving the studio and another was entering and preparing for the transmission of the next program. At a later time, this led to the provision of two or more adjacent studios so arranged that while one group of artists was broadcasting another group of artists could be arranging themselves in another studio and preparing to broadcast.

Almost from the beginning of the period of experimentation it was felt desirable to broadcast programs originating in one location simultaneously through two or more transmitting stations. At any given time all of the transmitting stations might be transmitting the same program, i. e., the program originating at one studio, and at other times various transmitting stations might be transmitting different programs, i. e., programs originating at different studios. At first, this resulted in a rather complicated switching mechanism betwen studios and transmitting stations. The switching of studios and transmitting stations was accomplished mainly by means of mechanically interlocking switches. This system soon proved to be inadequate as the number of studios and transmitting stations increased, and moreover, it was difficult to operate. It brought about a considerable loss of time when different groups of stations and studios were being set up, and furthermore, it resulted in the broadcasting of objectionable switching noises due to the complexity of the system. At times it also resulted in the broadcasting by one transmitting station of a program intended for another transmitting station, occasionally simultaneously with the proper program. The system described herein results from improvements made while experimenting with the old systems, and is designed to overcome the difficulties of the old systems some of which are mentioned hereinabove. The present system is simple so that a non-technical man, such as an announcer, may operate it rapidly and smoothly.

Whereas the system is primarily designed to inter-connect a plurality of studios and a plurality of transmitting stations, it is equally applicable whenever a number of sources of sound are to be connected electrically to a number of other points. Obviously these points may be radio transmitters, public address systems, wire broadcast systems, etc. For the sake of convenience these will all be referred to herein as transmitting stations.

It will be understood that this system is particularly applicable where such connections must be made without appreciably changing the gain-frequency characteristics of the circuits involved.

In accordance with the present practice it is often desirable to operate several broadcasting studios in connection with a number of transmitting stations. The interconnecting system to accomplish this is described herein merely for the sake of illustration, and is so arranged that any one of the studios may be connected to any one of the transmitting stations, no two of the studios being connected to any one transmitting station at the same time. This is accomplished in a manner such that the audiences of the trans-

mitting stations do 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 station except the one the audiences are scheduled to receive.

It will be understood that one or more of the studios may be located in close proximity to the switching point and that one or more of the other studios may be located at a point or points widely remote therefrom and connected thereto by suitable signaling circuits, or by other transmission paths. It will be further understood that the studios, control room and transmitting stations shown herein may be widely separated from each other and may be connected by any suitable medium or media, such as wire lines or radio circuits, within the scope of this invention.

While the nature of the invention will be pointed out with particularity in the appended claims the invention itself, both as to its objects and features, will be better understood from the detailed description hereinafter following when read in connection with the accompanying drawing, in which Figures 1, 2 and 3 schematically disclose the general principles of the invention, and in which Figs. 4 and 5, when placed side by side, show one application of the principles of the invention to a multiplex broadcasting system.

Referring to Fig. 1, there are shown four studios, A to D, inclusive. The circuits from these studios converge in a control room CR, which may be, for example, adjacent to the studios. In this room the signals from the studios are amplified and distributed to the various radio transmitters RT_1 to RT_5, inclusive. The arrows on the circuits between the studios A to D, the control room CR and the radio transmitters RT_1 to RT_5 indicate the direction of transmission of the program matter. Obviously the studios A to D and the ratio transmitters RT_1 to RT_5 may be adjacent to the control room CR and may be connected thereto by local or, perhaps, by long distance telephone lines or other transmitting media. Whenever it becomes desirable to supplement a program originating at a studio with material originating at a remote point known as a pick-up point, such as a theater, the circuits from the remote pick-up point may be brought into the control room CR and then into one of the studios, so that the circuits may be controlled at that studio and appropriate announcements made whenever necessary by the announcer in that studio. These circuits from pick-up points have become known as "nemo" circuits, and they will be described in greater detail hereinafter. Although the system has been shown to include four studios and five radio transmitters, it will be understood that the invention is not to be limited in that respect, but that any number of studios may be connected to any number of radio transmitters so that the programs from the various studios may be simultaneously broadcast by the various radio transmitters.

Fig. 2 shows three studios, A, B and C and the corresponding signaling circuits terminating in channel (horizontal) bus bars having the amplifiers A_1, A_2 and A_3 associated with these bus bars, respectively. These channel (horizontal) bus bars may be connected by relays (not shown) to station (vertical) bus bars and the associated amplifiers A_{11} to A_{16}, inclusive, one of these amplifiers corresponding to each of the station (vertical) bus bars. The station (vertical) bus bars are connected to the transmitting stations TS_1 to TS_6, inclusive. Each relay, as will be shown in greater detail hereinafter, is so arranged that it may be controlled from the studio associated therewith, and is further arranged so that no two channel (horizontal) bus bars may be connected to the same station (vertical) bus bar and the corresponding amplifier and transmitting station at the same time. In other words, the system is so arranged that any studio may be connected to any transmitting station whenever that transmitting station is not already connected to some other studio. Moreover, means (not shown) are provided so that the operating condition of any transmitting station is constantly indicated in the studios and in the control room. Thus as soon as the program is finished in one studio the transmitting station may be connected to receive the program of another studio without any appreciable loss of time.

In Fig. 2 a number of dotted and undotted circles are shown to represent the various relays, the dotted circles indicating operated relays and the undotted circles indicating unoperated relays. In this particular arrangement the studio A is connected to the transmitting station TS_1 through the corresponding amplifier A_{11}. The studio B is connected to the transmitting stations TS_2 and TS_6 through the corresponding amplifiers A_{12} and A_{16}, respectively. And studio C is connected to the transmitting station TS_4 through the corresponding amplifier A_{14}. No studio is connected to the transmitting stations TS_3 and TS_5. It is to be particularly noted that no one of the transmitting stations TS_1 to TS_6, inclusive, is connected to more than one studio.

In Fig. 3 the system is shown schematically in somewhat greater detail. In this figure only two studios A and B are shown, merely for the sake of simplicity, and the studios may be connected to either one of two transmitting stations. In studio A there are shown, for the sake of simplicity, only two

transmitters or microphones, one for the program and one for the announcer, and control equipment CE_1 for connecting the output of either of these transmitters to a control room amplifier A, corresponding to studio A and its associated equipment. The studio control equipment will be described in greater detail in connection with Figs. 4 and 5. While the control room amplifier A has been shown as located at the control room this amplifier may, however, be located at the studio. This control room amplifier A has a main relay MR_1 associated therewith in order to place the output of the control room amplifier A upon a channel bus bar CB_1. There are also two line relays LR_1 and LR_2, one corresponding to each transmitting station, so that the channel bus bar CB_1, and hence the output of the control room amplifier A, may be connected to either of the transmitting stations. Moreover line amplifiers A_{21} and A_{22} are shown, each of these amplifiers corresponding to one of the transmitting stations. The line relays LR_1 and LR_2 are connected to the studio control equipment CE_1 through the channels 21 and 22, respectively. By means of these channels the output of the control room amplifier A, and consequently the output of studio A, may be controlled through interlocking devices (not shown) so that the output of the control room amplifier A may be connected to either or both of the transmitting stations, if that transmitting station, or stations, is not connected to another studio, such as studio B. In other words, the interlocking devices (not shown) prevent the connection of more than one studio to one transmitting station at the same time. The control equipment in each studio may, of course, be located on a suitable control panel in that studio so as to be readily accessible to the announcer thereat. The main relay MR_1 is connected to the studio control equipment CE_1 through a channel 23 so that the entire output of studio A may be quickly cut off. A "nemo" circuit is also provided in this arrangement for connecting an outside pick-up point with the studio control equipment so that the program of the pick-up point may be controlled at the studio. The apparatus for studio B is similar to that for studio A and therefore the description of the apparatus for studio B need not be repeated herein.

Figs. 4 and 5 show one embodiment of a multiplex broadcasting system to which the principles of this invention have been applied. In this system there are shown a plurality of studios A, B and C, and a plurality of transmitting stations comprising radio transmitters ST_1 to ST_4, inclusive, and a plurality of radio antennæ TA_1 to TA_4, inclusive, corresponding, respectively, to radio transmitters ST_1 to ST_4. These studios and transmitting stations are interrelated so that the programs originating at these studios may be simultaneously broadcast by the transmitting stations, the system being so interlocked that no two studios may be connected to any one transmitting station at the same time. Each studio has a plurality of control relays, one corresponding to each of the transmitting stations. Accordingly, there are four control relays R_1 to R_4, R_1' to R_4' and R_1'' to R_4'' at the studios A, B and C, respectively. Some of the apparatus for connecting one studio 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 and an announcer's microphone. 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. The program microphone MP_1, MP_2, MP_3, the announcer's microphones MA_1, MA_2, MA_3, and the "nemo" circuits NC_1, NC_2 and NC_3 correspond, respectively, to studios A, B and C. Switches K_9 and K_{10}, K_9' and K_{10}', 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 microphone at some pick-up point connected to the corresponding "nemo" circuit. Studios A, B and C terminate in studio bus bars SB_1, SB_2 and SB_3, respectively, and the transmitting stations are connected through line amplifiers LA_1 to LA_4, inclusive, to corresponding channel bus bars CB_1 to CB_4, inclusive.

For the sake of convenience the course of transmision from one of the studios, such as studio A, to one of the transmitting stations, such as that associated with the channel bus bar CB_1, will now be considered in greater detail. A microphone control panel CP_1 is located at studio A, this control panel adjoining the program microphone MP_1 and the announcer's microphone MA_1. Suitable means are associated with the microphone control panel CP_1 for feeding current from a battery (not shown) to either or both of these microphones and other means are 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, such as, for example, a carbon transmitting microphone or a condenser microphone with its associated amplifier.

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}. However it will be understood that equip-

ment at studios B and C is similar to that at studio A and the description of equipment at studio A applies equally well to studios B and C. 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 an amplifier CA_1 at the control room.

Three lamps, L_{10}, L_{11} and L_{12} at studio A are also operated 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. This will be described in 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 made by armatures *b* and *c* of the 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 that which is taking place at the studio. A volume indicator LI_1 is bridged across the main transmission path between the output of the amplifier CA_1 and the terminating impedance PT_1 to indicate the transmission volume after amplification. The value of the impedance PT_1 is low as compared to the impedance of input of the amplifiers LA_1 to LA_4 inclusive. Thus, when one amplifier, as, for example, the amplifier LA_1, is connected to the studio bus bar SB_1, other amplifiers, such as LA_2, LA_3 or LA_4, may be connected thereto, or disconnected therefrom, without appreciably affecting the energy transmitted by the amplifier LA_1. This is so because most of the power transmitted by the amplifier CA_1 is being expended in the low impedance PT_1 and very little 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 studio bus bar SB_1 is disconnected from the amplifier CA_1, a contact is closed by an armature *d* of the main relay R_6, which puts a short circuit across the studio bus bar SB_1, so that when the main relay R_6 is not energized the line relays LR_1 to LR_4, inclusive, similarly become short-circuited so that these line relays are unable to receive any program, thus preventing any voltages, which may be induced in these circuits, from being impressed upon the input of any line, amplifier, and hence amplified, causing objectionable cross-talk or interference. The operation of the line relays LR_1 to LR_4 will be given in greater detail in the description hereinafter following.

The system is so laid out that any studio may be connected with one or more transmitting stations simultaneously, and similarly, any transmitting station may be connected with any studio. One of the distinguishing features of the invention is an interlocking arrangement which prevents any one transmitting station from being connected to more than one studio at the same time. This is absolutely essential to prevent confusion between programs, and is an essential feature of the entire control system. It seems hardly necessary to state that failure to provide an interlocking arrangement would permit the tying together of two or more studio bus bars and corresponding studios to the same transmitting station. Moreover, line relays LR_1 to LR_4, LR_1' to LR_4', LR_1'' to LR_4'', associated with the studios A, B and C, respectively, are so arranged as to prevent any one transmitting station from being connected to more than one studio at the same time. Failure of operation, or improper operation of the relays LR_1, LR_1' and LR_1'' would permit the transmitting station associated with the channel bus bar CB_1 to be connected to the studios A, B and C, simultaneously. Similar undesirable effects follow the failure of the other line relays.

Another feature of this invention is the provision of a signaling system throughout the studios and the control room to keep the announcers at the various studios and the operator at the control room continuously advised of the manner in which the studios are connected with the various transmitting stations. It is another feature of this invention to provide means for the announcer at any studio to be able to connect his studio to one or more of the transmitting stations so that after his studio has been connected to these transmitting stations no other studio can be connected to the same transmitting stations at the same time. Thus, the announcer at any studio has at his disposal apparatus for picking up and releasing the various transmitting stations, and he has also a signaling system which keeps him continuously advised as to whether or not these transmitting stations are already connected to his studio or to one of the other studios. These features will be described in greater detail hereinafter.

In studio A the keys K_1 and K_5, which are momentary contact keys, control the operation of relay R_1. By closing key K_1 the relay R_1 becomes energized by the flow of current through the winding of said relay from a battery B_1, the circuit including the armature of the relay IR_1, conductor 21, key K_1, the winding of the 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 armature A closes a contact *c* so that the winding of the relay R_1 receives current also from a battery B_2, this circuit including 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 closed by the 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 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, key K_{11}, the armature A of the relay R_1, contacts c and d of relay R_1, conductor 24, the winding 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 so that its armature opens the contact associated therewith, disconnecting 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 key K_{17}, the conductor 23, the key K_{11}, the armature A, the contact c and 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 keys K_1' and K_1'' in the studios B and C, respectively, only when the relay IR_1 is deenergized. After relay R_1 has operated to close contact d and after relay IR_1 has become energized, the relays R_1' and R_1'' in the studios B and C cannot become operated by keys K_1' and K_1'' in studios B and C, respectively until the relay IR_1 has become deenergized again.

The winding of the relay LR_1 is in parallel relationship with the winding of the relay R_1 through the conductor 25, and therefore the energization or deenergization of the relay R_1 causes a corresponding action of the relay LR_1. The armatures a and b of the relay LR_1 are connected through the channel bus bar CB_1 to the line amplifier LA_1, the radio transmitter 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. Furthermore the 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 also operated. The circuit of lamp L_{19} includes the battery B_{10}, lamp L_{19}, the armature c of the 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, R_3 and R_4, and hence are the studio and control room master release keys, respectively.

In order that the announcer at studio A may know that one or more of the transmitting stations are ready to receive a program, lamps L_1 to L_4, inclusive, are provided. These are located in the studio, each lamp being associated with one of the transmitting stations, each lamp being also associated with one of the relays R_1 to R_4, inclusive. Lamps L_1 to L_4 at studio A, lamps L_1' to L_4' at studio B and lamps L_1'' to L_4'' at studio C are controlled by signal keys SK_1 to SK_4, respectively, which are located in the control room, and which are under the supervision and control of the operator at the control room. Furthermore, means are provided so that by the operation of one of the relays, such as relay R_1 in studio A, the lamps L_1' and L_1'' in studios B and C, corresponding to the relays R'_1 and R_1'', respectively, in these studios, will become extinguished. Thus the light 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 system to that transmitting station is ready for service from studio A. By operating one of the signal keys such as key SK_1, the lamp L_{23} associated with this key becomes illuminated by the flow of current from battery B_5 through the lamp L_{23}, the key SK_1 and ground. The lamp L_1 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, conductor 21, contact f and armature B of the relay R_1, the lamp L_1, key SK_1 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, the key K_{11}, contact e and armature B of the relay R_1, lamp L_1, key SK_1 and ground. Similarly the lamps L_1' and L_1'' are operated by the key SK_1 with current from battery B_1, when the corresponding relays R_1' and R_1'' in studios A and B, are deenergized. Yet when the winding of the relay R_1 in studio A becomes energized the corresponding lamps L_1' and L_1'' in studios B and C, respectively, become extinguished, while lamp L_1 in studio A remains illuminated. This therefore indicates to the announcers in studios B and C that the transmitting station corresponding to the channel bus bar CB_1 is not available for transmission from studios B and C. Obviously when relay R_1 again becomes deenergized, all of the lamps L_1, L_1' and L_1'' in the various studios again become illuminated, therefore indicating that the transmitting station corresponding to the channel bus bar CB_1 is again available for transmission from any one of these studios.

Keys K_{11} and K_{17}, K_{11}' and K_{17}', K_{11}'' and K_{17}'' are the master release keys, keys K_{11}, K_{11}' and K_{11}'' being under the supervision

and control of the announcers in studios A, B and C, respectively, and keys K_{17}, K_{17}' and K_{17}'' being under the supervision and control of the operator at the control room. The keys at the various studios permit the announcers at these studios to release any one or more of the transmitting stations from the studio under the control of a particular announcer. The keys K_{17}, K_{17}' and K_{17}'' at the control room break the circuits of the batteries B_2, B_2' and B_2'', thereby releasing the relays R_1 to R_4, R_1' to R_4' and R_1'' to R_4'' in the studios A, B and C, respectively. The keys K_{11}, K_{11}' and K_{11}'' at the various studios operate in a similar manner. This 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.

The apparatus at the studios A, B and C accomplish primarily the following: First, a suitable arrangement is provided whereby the amplifiers CA_1 to CA_3, inclusive, at the control room may be connected to the corresponding announcers' microphones MA_1 to MA_3, the program microphones MP_1 to MP_3 or to the microphones at distant points to which the "nemo" circuits NC_1 to NC_3, respectively, are connected; second, the announcers at the various studios are equipped to pick up or release any one or more of the transmitting stations which are connected to the channel bus bars CB_1 to CB_4, inclusive; third, lamps are provided in the various studios so that the announcers in these studios may know what transmitting stations are available to transmit the program matter; and fourth, lamps are provided throughout the studios and the control room to indicate to the studio announcers and the control room operator whether or not the relays have properly operated.

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}, whereas 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 input of the amplifier CA_1. By throwing the switch K_{10} upwardly to engage contacts *a* and *b*, and switch K_9 downwardly to engage contacts *j* and *k*, the program microphone MP_1 is then connected to the input of the amplifier CA_1. By throwing both switches K_9 and K_{10} to the upward positions, the "nemo" circuit NC_1 is then connected to the input of the amplifier CA_1. By leaving switch K_9 in its upward position, by operating switch K_{10} the announcer at studio A may connect the announcer's microphone MA_1, or the "nemo" circuit NC_1, to the input of the amplifier CA_1.

A lamp L_{13} is located in 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. It will be understood that this lamp L_{13} may, if desired, be a colored lamp to distinguish this lamp from all the other lamps. By closing key K_{18}, the control room operator sends current from battery B_6 through the lamp L_{13}, the circuit including 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 lamp L_{17} similarly indicates to the operator at the control room that the apparatus at the control room corresponding to the studio A is in readiness for operation. The circuit of the lamp L_{17} includes the battery B_6, key K_{18}, lamp L_{17} and ground. It is to be noted that the winding of the main relay R_6 can not become energized unless the key K_{18} in the control room has first operated. This therefore prevents the announcer at studio A from transmitting his program to one or more of the transmitting stations before the proper connections have been made in the control room.

A lamp L_9 is located at studio A and provides a visible means of indication to the announcer at that studio that he is wanted on a telephone intercommunicating system (not shown). This lamp L_9 is operated by key K_{16} at the control room. By operating key K_{16} current flows from the battery B_3 through key K_{16}, the conductor 28, lamp L_9 and ground.

Relays SR_1 to SR_4, inclusive, are provided at the control room so that when the corresponding line amplifiers LA_1 to LA_4 are ready for use but are not connected to a studio bus bar the inputs of these line amplifiers will be short-circuited. In other words, when the relays LR_1 to LR_4, inclusive, are not energized, relays SR_1 to SR_4, inclusive, will be operated. More specifically the relays SR_1 to SR_4 will be operated when the line relays corresponding to the various studios are not energized, these line relays being LR_1, LR_5 and LR_9, LR_2, LR_6 and LR_{10}, LR_3, LR_7 and LR_{11}, LR_4, LR_8 and LR_{12}, respectively.

The relays SR_1 to SR_4 are interlocked with the relays IR_1 to IR_4 and the keys SK_1 to SK_4 so as to permit their operation, respectively, only when the corresponding keys SK_1 to SK_4 are operated and when the corresponding relays IR_1 to IR_4 are unoperated. For

the sake of simplicity the operation of only one of the relays, SR_1, will be considered. One terminal of the winding of the relay SR_1 is connected to ground through conductor 29 through the middle contact of the key SK_1. The other terminal of the winding of the relay SR_1 is connected to the battery B_1 through conductor 30, conductor 21 and the armature of the relay IR_1. Therefore upon the operation of the key SK_1 current flows from battery B_1 through the winding of 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 amplifier LA_1. The relay SR_1 is always operated to put a short circuit on the input of the amplifier LA_1, when the key SK_1 is operated, and when, also, the winding of the relay IR_1 is not energized. When the winding of the relay IR_1 becomes energized, as, for example, when relay R_1 in studio A becomes energized, the circuit connecting battery B_1 and the winding of the relay SR_1 is opened, deenergizing the winding of relay SR_1, removing the short-circuit from the input of the amplifier LA_1 and placing this channel in an operative condition. Similarly relays SR_2, SR_3 and SR_4 are energized by current from battery B_1 through the armatures of relays IR_2, IR_3 and IR_4 the conductors 31, 32 and 33, the conductors 34, 35 and 36, the windings of the relays SR_2, SR_3 and SR_4, the conductors 37, 38 and 39, the middle contacts of keys SK_2, SK_3 and SK_4, respectively, and ground.

The main relays R_6, R_6' and R_6'' open the main transmission paths between studios A, B and C, and the studio bus bars SB_1, SB_2 and SB_3, respectively, when it is considered undesirable to transmit that which is taking place in these studios. Confining the description of the apparatus at the control room corresponding to the studio A and to that in studio A it is apparent that one terminal of the winding of the relay R_6 is grounded and that the other terminal of the winding of the relay R_6 is connected through conductor 40 to the contacts *c* and *e*, of the switch K_{10}. The blade *g* of the switch K_{10} is connected to the battery B_6 through conductor 27 and key K_{18}, when key K_{18} is closed. Furthermore, when key K_{18} is closed, the operation of switch K_{10} to close either of contacts *c* or *e* permits current to flow from battery B_6 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 battery B_7 through lamp L_{18}, the armature *a* of the relay R_6 and ground. This lamp indicates to the operator at the control room whether or not the relay R_6 has operated. Moreover the contacts *b* and *c* of the relay R_6 control the main transmission path between the amplifier CA_1 and the studio bus bar SB_1. When the winding of the relay R_6 is not energized the armature *d* of said relay short-circuits the studio bus bar SB_1, thereby short-circuiting the line amplifiers connected thereto.

When key K_{18} is operated, causing lamp L_{18} to be illuminated as an indication to the announcer in studio A that everything in the control room is in readiness for transmission from studio A, and when switches K_9 and K_{10} are operated to connect the program microphone MP_1, the announcer's microphone MA_1 or the "nemo" circuit NC_1, to the input of the amplifier CA_1, either lamp L_{11}, L_{12} or L_{10} is illuminated to indicate to the announcer whether the program microphone MP_1, the announcer's microphone MA_1, or the "nemo" circuit NC_1, respectively, is connected to the input of the amplifier CA_1. The circuit for lamp L_{11} is as follows: battery B_6, key K_{18}, conductor 27, blade *h* and blade *d* of switch K_{10}, blade *g* and blade *e* of switch K_9, lamp L_{11} and ground. The circuit for lamp L_{12} is as follows: battery B_6, key K_{18}, conductor 27, blade *h* and blade *m* of switch K_{10}, lamp L_{12} and ground. Similarly the circuit for lamp L_{10} is as follows: battery B_6, key K_{18}, conductor 27, blade *h* and blade *d* of switch K_{10}, blade *g* and blade *c* of switch K_9, lamp L_{10} and ground.

A relay R_5 controls a signal lamp L_{16} which is a visible indication to the operator at the control room that the anouncer at studio A has set up his equipment so as to transmit the program coming over the "nemo" circuit NC_1. The winding of the relay R_5 is connected to a battery B_9 through a conductor 41 and the blades *d* and *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 will thereupon become energized, illuminating the lamp L_{16} by the flow of current therethrough from the batery B_8. Similar arrangements are provided in the control room in connection with studios B and C.

The line relays LR_1 to LR_{12}, inclusive, are so arranged that the input of the amplifiers LA_1 to LA_4, inclusive, may be switched from one studio bus bar, such as SB_1 to any one or the other of the studio bus bars, such as SB_2 and SB_3. This has been explained hereinabove. Yet in each of these line relays, such as, for example, LR_1, one terminal of the winding of this relay is connected to the armature *c* of said relay, both being grounded. The contact with which the armature *c* engages connects a lamp L_{19} to a battery B_{10}, thus illuminating lamp L_{19}. This lamp therefore indicates that the relay LR_1 has operated. Moreover the armatures *a* and *b* of this relay control the transmission path between the studio bus bar SB_1 and the amplifier LA_1. The other terminal of the winding of the relay LR_1 is connected to the wind-

ing of the relay R_1 in studio A. These windings are in parallel relationship with each other and consequently are simultaneously energized or deenergized.

The phrase "transmitting station" as employed herein designates a radio transmitter, public address equipment, an individually located loud speaker or any other suitable signaling 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 distant telephone lines or any other suitable signaling medium.

While only three studios and four transmitting stations have been shown and described in Figs. 4 and 5, 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, jacks, artificial lines, etc., not absolutely essential to the operation of the system, are shown herein, it is to be understood that they may be added, as they are found desirable, in any manner well known to the art without departing from the spirit of the invention or the scope of the appended claims.

While the invention has been disclosed in certain particular embodiments herein merely for the purpose of illustration, it is to be understood that the general principles of this invention may be applied to other and widely varied organizations without departing from the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. In a multiplex broadcasting system, a plurality of studios wherein programs originate, a plurality of transmitting stations, a control room interconnecting said studios and said transmitting stations wherein may be controlled the transmission of the programs of said studios through said transmitting stations, and a plurality of indicating devices to indicate in said control room and in each studio which transmitting stations are available for program transmission.

2. In a multiplex broadcasting system, a plurality of studios wherein programs originate, a plurality of transmitting stations, a control room for controlling the transmission of the programs of said studios through said transmitting stations, a plurality of indicating devices in said control room and in each studio to indicate which transmitting stations are available for program transmission, and means for preventing the simultaneous transmission of the programs of more than one studio through any one transmitting station.

3. In a radio broadcasting system, a plurality of studios wherein broadcasting programs originate, a plurality of transmitting stations, a plurality of groups of relays one group corresponding to each studio, one relay in each group corresponding to each transmitting station, means for energizing said relays so as to transmit the programs of said studios simultaneously through said transmitting stations, and means whereby not more than one of said relays corresponding to one of the transmitting stations may be energized at the same time.

4. In a multiplex broadcasting system, a plurality of program sources, a plurality of transmitting stations, means for interconnecting said program sources and said transmitting stations so as to control the transmission of the programs of said program sources through said transmitting stations, and a plurality of groups of indicating devices, one group corresponding to each transmitting station, one indicating device in each group appearing at each program source, said indicating devices indicating which transmitting stations are available for program transmission, said indicating devices also indicating which program sources are available to said program transmitting stations for transmission of the programs thereof.

5. In a multiplex broadcasting system, a plurality of program sources, a plurality of transmitting stations, means for interconnecting said program sources and said transmitting stations so as to control the transmission of said programs through said transmitting stations, and a plurality of indicating devices located at the various program sources so that those people working with any particular program source may know at any time what transmitting stations are associated with that program source.

6. In a multiplex broadcasting system, a plurality of program sources, a plurality of transmitting stations, and means interconnecting said program sources and said transmitting stations so as to control the transmission of the programs of said program sources through said transmitting stations, and a plurality of indicating devices one located at each program source and one located at the control room so that the people working at said program sources and at said control station may know which program sources are transmitting programs and which transmitting stations are transmitting the programs of said program sources.

7. In a multiplex broadcasting system, a plurality of program sources, a plurality of transmitting stations, a control room including means for interconnecting said program sources and said transmitting stations so as to control the transmission of said programs through said transmitting stations, and a sig-

naling system interconnecting said program sources and said control room so that the operator at any program source may signal the operator at the control room without disturbing the transmission between said program sources and said transmitting stations, and vice versa.

In testimony whereof, we have signed our names to this specification this 16th day of August 1926.

EDMUND R. TAYLOR.
OSCAR B. HANSON.

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