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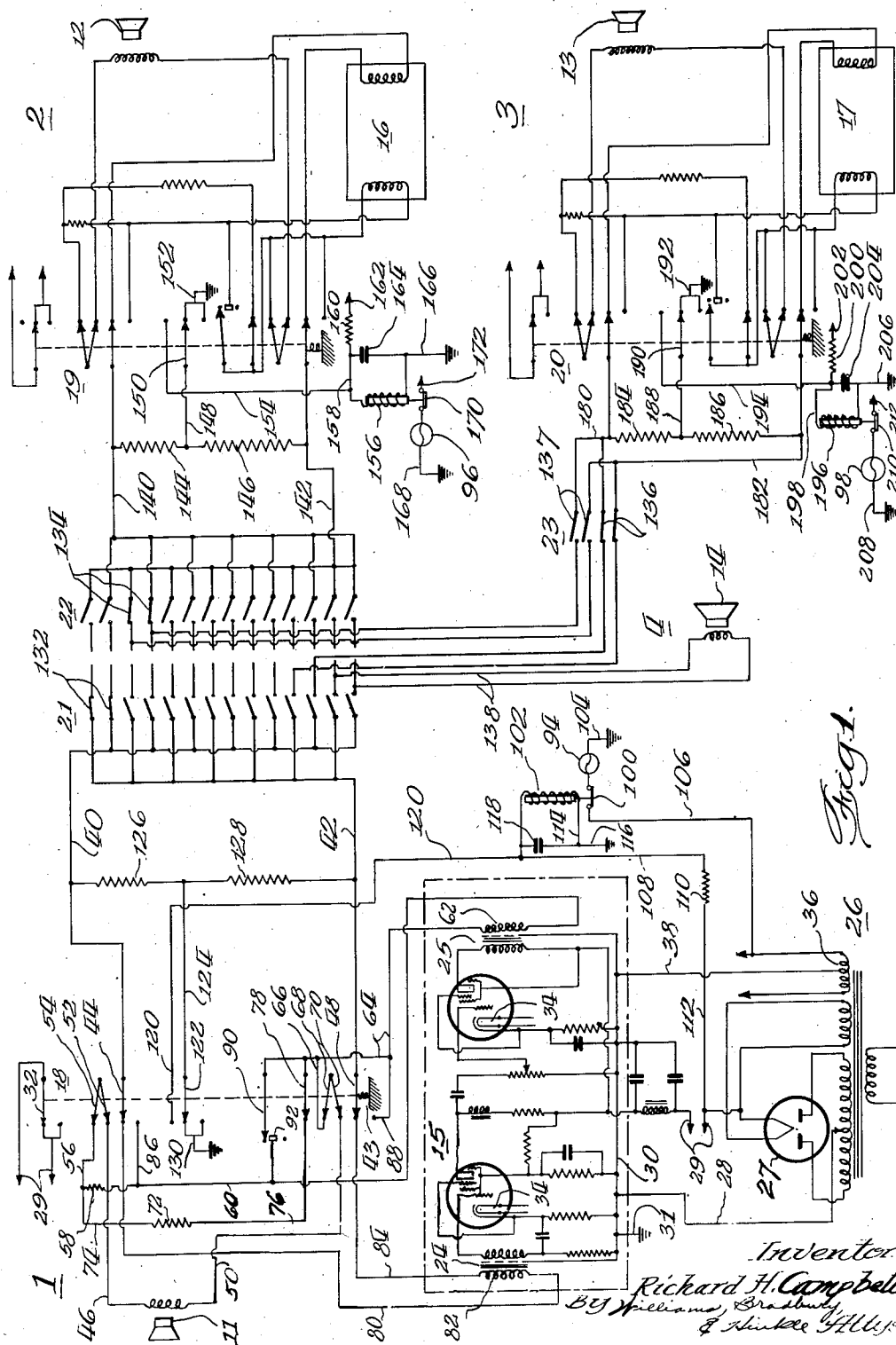
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COMMUNICATION SYSTEM

Filed June 28, 1940

3 Sheets-Sheet 1



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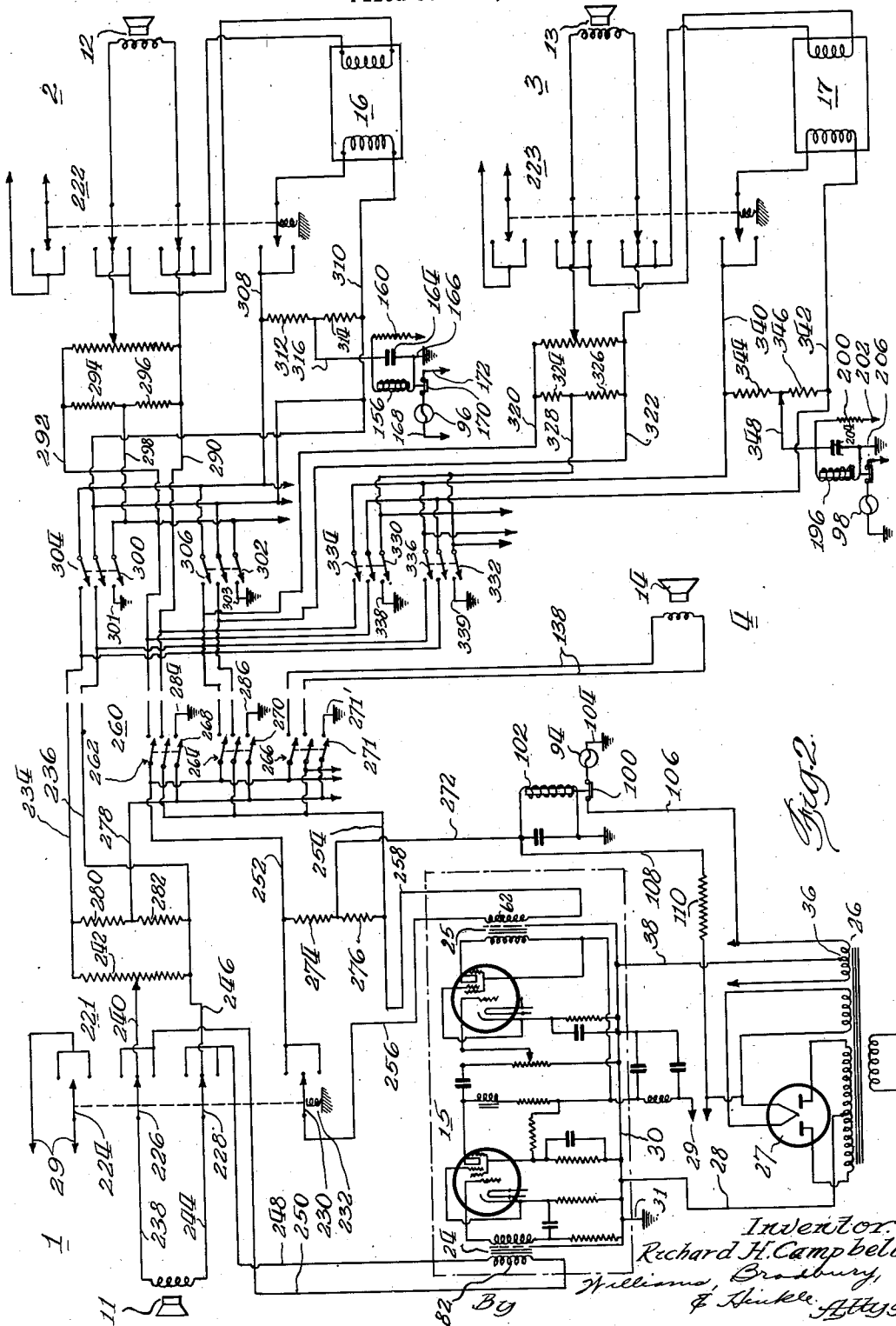
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COMMUNICATION SYSTEM*

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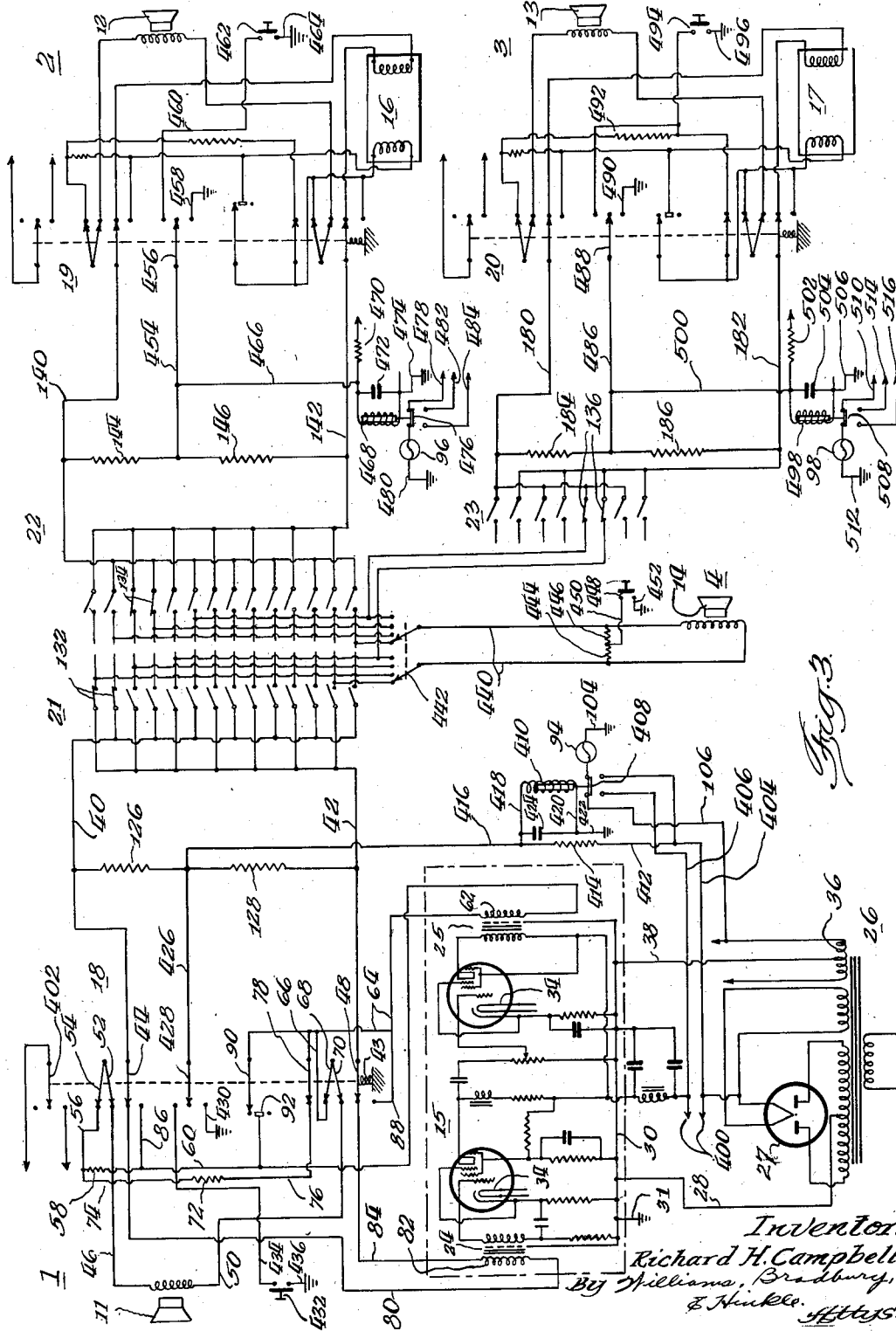
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COMMUNICATION SYSTEM

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3 Sheets-Sheet 3



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UNITED STATES PATENT OFFICE

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COMMUNICATION SYSTEM

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Application June 28, 1940, Serial No. 342,835

43 Claims. (Cl. 179—38)

The present invention relates to communication systems, and particularly to the provision of new and improved circuit arrangements for indicating whether or not the system is in use. Other inventions directed to other circuit arrangements for this and other purposes are disclosed and claimed in my contemporaneously filed applications having Serial Nos. 342,836 and 342,837.

It is an object of the present invention to provide a new and improved communication system comprising a busy signal which is operatively controlled through the interstation communication circuits so that no additional interstation conductors are required.

A further object of the invention is the provision of an arrangement wherein the busy signal is a normally energized device, such as an electric light, whereby the light may be utilized also as a pilot light.

A further object of the invention is the provision of a communication system comprising one or more master stations with a signaling arrangement operable to give an indication at each master station when another station is listening to the conversation thereat; that is, eavesdropping.

A further object of the invention is to provide a new and improved communication system comprising a busy signaling arrangement operative to give a busy signal at the calling stations when several stations simultaneously call a busy station.

A further object of the invention is to provide a signaling system having a small power consumption.

A further object of the present invention is to provide a new and improved communication system comprising a busy signaling arrangement wherein undesirable cross talk and hum is prevented.

A further object of the present invention is to provide a communication system comprising master stations having amplifiers and substations having no amplifiers, with combined signal and power control circuits whereby a substation may call a master station and simultaneously operate a signal at the latter and to render operative the amplifier thereat.

A further object of the present invention is to provide a new and improved communication system of the loudspeaking type in which undesirable clicks are obviated during the time that the circuit connections are being changed.

Other objects and advantages of the present

invention will become apparent from the ensuing description, in the course of which reference is had to the accompanying drawings, in which:

Fig. 1 represents schematically one embodiment of the invention;

Fig. 2 represents a modification of the invention; and

Fig. 3 represents a further modification of the invention.

In the modification of Fig. 1, there is illustrated an intercommunication system of the loudspeaking type wherein communication is carried on alternately in opposite directions between a plurality of master stations under the control of manually operable communication direction control switches, and wherein communication may be carried on between a master station and one or more substations under the control of a communication direction control switch at the master station.

The master stations are indicated by reference characters 1, 2 and 3, and the substation by reference character 4. These stations are provided with translating devices capable of being utilized both as microphones and loudspeakers, such as the loudspeakers 11 to 14, inclusive, which may be of the well-known permanent magnet type. The master stations 1, 2 and 3 are provided with amplifiers 15, 16 and 17, communication direction control switches 18, 19 and 20, and station selector switches 21, 22 and 23, all respectively.

The amplifiers may be of any well-known construction and from the figure it may be seen that only the amplifier 15 at station 1 has been illustrated in detail. In brief, the amplifier comprises an input transformer 24 and an output transformer 25 interconnected by two stages of amplification. Power is supplied to the amplifier from a suitable source of alternating current through a transformer 26 and in part through a rectifier tube 27. The supply of rectified current (the B supply) is directed to the amplifier through conductors 28 and 29, the former of which is connected directly to a common conductor 30 of the amplifier which is grounded, as indicated by reference character 31, and the latter of which has interposed therein a power switch 32 operable simultaneously with the communication direction control switch 18. The B supply circuit to the amplifier is completed when the communication direction control switch is operated to condition the station for either talk-

ing or listening, and the power is cut off when the station is in idle condition.

The amplifier is conditioned to be ready for instantaneous use whenever the communication direction control switch is operated simultaneously to condition the station for talking or listening and complete the B supply circuit, by reason of the fact that the cathode heaters 34 of the two tubes of the amplifier are continuously supplied with heating current from a secondary winding 36 of the transformer 26, the midpoint of which is connected to the common ground conductor 30 by a conductor 38.

The communication direction control switch 18 is a manually operable multi-pole three position switch. In a first position (the up and idle position), the loudspeaker 11 is connected directly to a communication circuit comprising conductors 40 and 42 for the reception of calls from other stations provided with amplifiers; that is, from other master stations. In a second position (the intermediate and listening position), the loudspeaker is connected to the output and the communication circuit to the input of the amplifier. In a third position (the down and talking position, from which the switch is biased by a spring 43 into its intermediate position upon release), the loudspeaker is connected to the input and the communication circuit to the output of the amplifier.

The connection of the loudspeaker to the communication circuit in the idle position of the communication direction control switch is as follows: From conductor 40 through switch blade 44 and conductor 46, and from conductor 42 through switch blade 48 and conductor 50. In passing, it may be noted that in the idle position of the communication control switch, the B supply to the amplifier is disconnected by reason of the fact that the circuit through conductor 29 is interrupted by switch blade 32.

The connection of the loudspeaker to the output and the communication circuit to the input of the amplifier in the intermediate position of the communication direction control switch (in which position the switch is illustrated) is effected in the following manner: The loudspeaker 11 is connected to the output of the amplifier through conductor 46, switch blades 52, 54, conductor 56, a volume control resistor 58, and conductor 60 leading to one terminal of the secondary winding 62 of the output transformer 26, and thence back to the loudspeaker through conductor 64, branch conductor 66, switch blades 68 and 70, and conductor 50. At the same time, resistor 72 is connected in parallel with the loudspeaker 11, in order to maintain substantially constant the impedance of the receiving circuit, through a conductor 74 connected to conductor 56 and resistor 58, conductor 76, and switch blade 78. The connection of the communication circuit to the input of the amplifier is effected through switch blade 44, conductor 80 leading to one terminal of the primary winding 82 of the input transformer 24, and from the other terminal of this primary winding to conductor 42 through conductor 84 and switch blade 48.

The connection of the loudspeaker to the input and the communication circuit to the output of the amplifier in the third position of the communication direction control switch is effected in the following manner: The loudspeaker is connected to the input through conductor 46, switch blades 54 and 52 and conductor 80 leading to one terminal of the primary winding 82, and from

thence back to the other terminal of the loudspeaker through conductor 84, switch blades 70 and 68, and conductor 50. The communication circuit is connected to the output of the amplifier through switch blade 44, branch conductor 86, and conductor 60 leading to one terminal of the secondary winding 62, and from thence to the other communication conductor 42 through conductor 64, branch conductor 68 and switch blade 48.

In order to avoid undesirable clicking noises while reversing the connections of the loudspeaker and communication circuit to the input and output of the amplifier, there is provided a switch blade 90 and an elongated contact 92 connected, respectively, to the output conductors 64 and 60 so as to short-circuit the output when the communication direction control switch is operated from its listen to talk positions, or vice versa.

One of the important features of the present invention resides in the provision of a busy signal. In the instant embodiment, the signal device is an electric light, the lights at stations 1, 2 and 3 being indicated by reference characters 94, 96 and 98, respectively. The light 94 at station 1 is normally energized whenever the transformer 26 is connected to a source of alternating current, so that the light acts also as a pilot light. Control of the energization of the light to perform the signaling function will be described in greater detail hereinafter.

The supply of energy to the lamp is controlled by a switch 100 operated by a normally energized solenoid winding 102. When the solenoid winding 102 is energized, the light 94 is connected across a portion of the secondary winding 36 of the transformer 26 through a circuit including ground connection 104, the lamp 94, switch 100 in its closed position, and conductor 106 leading to one terminal of the transformer, and the circuit being completed through conductors 38, 30 and ground connection 31. The solenoid winding 102 is normally supplied with energy from the rectifier through a circuit including the conductor 108, a resistor 110, and a conductor 112 leading therefrom to the active portion of conductor 22.

The other terminal of the solenoid winding is connected by conductors 114 and 116 to ground, and the winding is shunted by a condenser 118.

The control of the solenoid winding is effected, in part, through a conductor 120 leading from the winding to the communication direction control switch where it is adapted to be engaged by a switch blade 122, when the communication direction control switch is in its idle position. The switch blade 122 is connected by a conductor 124 to a point between resistors 126 and 128 of equal ohmic value connected in series across the communication conductors 40 and 42. The switch blade 122 also has associated with it a grounding circuit 130, which is adapted to be closed whenever the switch blade is in its intermediate or lowermost positions.

By connecting the conductor 124 to a point between the two resistors 126 and 128 (or for that matter, to the center point of a single resistor) a balanced circuit is obtained. The balanced circuit arrangement prevents cross talk and the undesirable hum that would otherwise result from uneven signal voltage (the voltage from the rectifier used in operating the signal means) drops in the communication circuit.

The selector switch 21 at station 1 includes

a number of switches, as, for instance, the two indicated by reference character 132, which are termed the station No. 1 switches and which are ordinarily maintained in closed position in order that the other stations may communicate with station 1. Each of the master stations is provided with as many pairs of switches as there are stations in the system so that each station may communicate with the others. Thus, the selector switch 22 at station 2 is illustrated as having the same number of switches as selector switch 21, and the switch blades 134 thereof are closed in order to connect station 2 to the system for the reception of calls from other stations. The selector switch 23 at station 3 has not been illustrated in full and has been shown as including only the two pairs of switches 136 and 137, the former of which may be considered as being the switch associated with station 3. The loudspeaker 14 at station 4 is connected directly by conductors 138 to one pair of interstation conductors so that it may be placed in communication with any of the master stations whenever the proper selector switches are operated at the master stations.

The apparatus at stations 2 and 3 corresponds identically with that at station 1, and for this reason it is not deemed necessary to describe the various circuit connections in detail. However, the signaling circuits to which the present invention primarily pertains will be described in order that a better understanding may be had thereof.

The communication circuit conductors at station 2 are indicated by reference characters 140 and 142. Connected across these in series are the resistors 144 and 146 and from between them there extends a conductor 148 to switch blade 150, which, in the listen position, in which it is indicated, and in the talk position, completes a circuit to ground through the grounding connection 152. The switch is operable to complete a connection through conductor 154 to the solenoid winding 156. The winding is connected through conductor 158, resistor 160, and conductor 162 to the rectifier in the same manner as the solenoid winding 102 at station 1, although lack of space has made it expedient not to illustrate the connections in detail. The solenoid winding is shunted by a condenser 164 and connected to ground by conductor 166. One terminal of the lamp 96 at station 2 is connected to ground through conductor 168 and the other terminal is connected to a suitable source of potential by a solenoid operated switch 170 and conductor 172, which preferably leads to a transformer winding similar to that indicated by reference character 26 at station 1.

The communication circuit at station 3 comprises the conductors 180 and 182 across which are connected in series the resistors 184 and 186 from between which leads a conductor 188 to switch blade 190. In the indicated listen position of the switch blade and in the talk position, it completes a circuit to ground through the grounding connection 192. The switch blade is also operable upwardly to complete a circuit through conductor 194 to the solenoid winding 196, which is supplied with energizing current through a circuit including conductor 198, resistor 200, and conductor 202 leading to the rectifier, not shown, of the amplifier 17.

The solenoid winding is shunted by a condenser 204 and is connected to ground through a conductor 206. The light 98 has one of its ter-

minals connected to ground through a conductor 208 and its other terminal connected to a suitable source of potential through the relay operated switch 210 and a conductor 212.

In the operation of the system described above in detail, it is contemplated that each of the amplifiers will normally be supplied with power from a suitable alternating current source through the transformers and that, as a result, the solenoid windings will normally be energized and the electric lights supplied with energy, whereby these lights will act as pilot lights in addition to acting as signaling devices. The communication direction control switches at the various stations will normally be in their idle positions, at which time the solenoid windings of the signaling systems are connected between the midpoints of resistors. The station selector switches individual to the respective stations are closed so as to condition the stations for the reception of calls from other stations.

Assuming now that the operator at station 2 desires to listen to the conversation at station 1, even though the latter station not be in communication with station 2 or with any other station, then under these circumstances the signal light 94 at station 1 will be de-energized to give the operator thereat an indication that someone is eavesdropping. To do this it is necessary for the operator at station 2 to manipulate one of the selector switches in order to connect the communication circuit 40-42 to the communication circuit 140-142. This is done by closing the uppermost pair of switches of selector switch 22 and manipulating the talk-listen switch at station 2 into the listen position (in which position it is illustrated). As a result, the point between the resistors 144 and 146 is connected to ground to effect a decrease in the current flowing through the solenoid winding 102, one terminal of which is likewise connected to ground. The resistors are so proportioned that this decrease in current is sufficient to permit switch 100 to open, thereby to discontinue the supply of power to the light 94.

Satisfactory results have been obtained by connecting the solenoid windings to B supply potentials of approximately 250 volts through resistors (the resistors 110, 160 and 200) having resistances of 150,000 ohms. The solenoid windings have resistances of about 12,000 ohms and each of the resistors 126, 128, 144, 146, 184 and 186 have resistances of approximately 500 ohms.

The operation of the signal lamp is substantially the same as that described above when station 2 calls station 1, the only difference being that the communication direction control switch at station 2 is depressed into its talking position, at which time, however, the point between the resistors 144 and 146 is grounded through the grounding connection 152 the same as in the listening position of the communication direction control switch. The operator at station 1 is apprised visually of the fact that someone is either listening or calling station 1. In case the station is being called, the call can be heard, of course, through the loudspeaker 11 thereat.

The operator at station 1 responds by talking into loudspeaker 11 after the operator at station 2 has released communication control switch 19 to its intermediate listen position. Thus, the direction of communication is controlled by the operator at station 2 and the operator at station 1 does not need to operate the communication control switch 18 thereat. As a matter

of fact the operator at station 1 should not operate switch 18 to its intermediate position when the operator at station 2 is talking, as this would result in double amplification; i. e., the output of amplifier 16 at station 2 would be connected to the input of amplifier 15 at station 1. If, for any reason, the operators so desire, communication between the two stations can also be carried on by alternate operation of switches 18 and 19 thereat from their upper idle positions and lower talk positions.

Assuming now that stations 1 and 2 are communicating with each other according to either of the modes described, then if station 3 selects, for instance, station 2, the signal light 98 at station 3 will be de-energized. When stations 1 and 2 are in communication with each other, the points between resistors 126 and 128 and between 144 and 146 are grounded through the grounding connections 130 or 152, depending upon the mode of operation and the direction of communication. Then, when the selector switch 137 at station 3 is closed to connect that station to the line individual to station 2, the communication circuit 180—182 of station 3 is placed in parallel with the interstation circuit connecting stations 1 and 2. As a result, it being assumed that the communication direction control switch at station 3 is in its upper or idle position, then a portion of the current flowing through the solenoid winding 196 is shunted to ground. As explained above, the decrease in current flowing through the solenoid winding is sufficient to permit opening of switch 210, with the result that the lamp 98 is de-energized to give the operator at station 3 an indication that station 2 is busy.

If a number of stations call stations 1 and 2 simultaneously when the latter stations are communicating with each other, then the operation of the signal lights at these stations would be substantially the same as that indicated above when station 3 selected station 2.

In case one of the master stations is in communication with the substation 4 and another station, for example, station 2, selects either of these stations for communication, then the light at station 2 will be de-energized as a result of the fact that a portion of the current flowing through the solenoid 156 will be shunted to ground.

In the modification of Fig. 2, the invention is shown applied to a slightly different type of intercommunicating system. In this system communication between master stations is carried on over two pairs of interstation circuits, one of which is used for communication in one direction and the other for communication in the opposite direction. The modification of Fig. 2 also differs somewhat from that in Fig. 1 in that a slightly different form of communication direction control switch is illustrated. In this case the communication direction control switch is of a type that is adapted to be operated from its intermediate and listen position to a lower and talk position and likewise to an upper and talk position. The switch is biased to return upon release from the lower talk position to the listen position, but remains in the upper talk position when actuated thereinto for the purpose of providing a system adapted particularly for use in installations where the communication may be predominantly in one direction, as for instance between an executive and his secretary.

Referring now in detail to Fig. 2, it may be

seen upon inspection that the amplifiers, the signal devices and control solenoids therefor are identical with those of the previous modification. For this reason it is believed unnecessary to describe them in detail and identical reference characters have been applied to indicate these portions of the equipment.

As in the previous modification, the illustrated system comprises four stations, 1 to 4, inclusive, each of which is provided with loudspeakers 11 to 14, respectively, and the master stations 1, 2 and 3 are provided with communication direction control switches 221, 222 and 223, respectively.

Referring now more particularly to the apparatus at station 1, it may be seen that the communication direction control switch thereat is a manually operable three-position switch comprising four switch blades 224, 226, 228 and 230, respectively, all operable simultaneously and biased from the lowermost position to the intermediate position in which it is shown by a spring 232. In the indicated or listen position, the loudspeaker 11 is connected to an interstation circuit comprising conductors 234 and 236 that is individual to station 1. The connection to these conductors is effected through conductor 238, switch blade 226, a potentiometer connection 240, a volume control resistor 242 forming part of the potentiometer connection to one conductor and through conductor 244, switch blade 228 and conductor 246 leading to the other interstation conductor. In this position of the communication direction control switch the B supply to the amplifier is cut off by switch blade 224.

In the lower position of the communication direction control switch the loudspeaker is connected to the primary winding 82 of the input transformer 24 of amplifier 15, through conductors 248 and 250 by means of the switch blades 226 and 228. At the same time the secondary winding 62 of the output transformer 25 of the amplifier is connected to another pair of interstation conductors 252 and 254 through conductor 256 and switch blade 230, and by a conductor 258.

In the upper talk position, the loudspeaker 11 is connected to the input of the amplifier through the same conductors and switch blades as previously and the output of the amplifier is likewise connected to the interstation conductors 252 and 254 in the same manner.

The output from amplifier 15 is adapted selectively to be connected to the other stations in the system, that is, in the present instance, to stations 2, 3 or 4, through the intermediary of a selector switch, indicated generally by reference character 260, and comprising multi-blade selector switches 262, 264 and 266, respectively. The selector switches serve not only to complete the connection of the interstation circuits, but also serve to complete the signal circuits through switch blades 268, 270 and 271 associated with the selector switches 262, 264 and 266, respectively, in a manner to be described in detail shortly.

The signal device controlling solenoid 102 is connected by a conductor 272 to a point intermediate a pair of resistors 274 and 276 connected in series across the output conductors 252 and 254. The switch blades 268 and 270, which are associated with the switches for selecting the other master stations 2 and 3 of the system, and switch blade 271, which is associated with the switch for selecting substation 4, are connected

by a conductor 278 to a point between resistors 280 and 282 of equal ohmic value (to prevent cross talk) connected in series across conductors 234 and 236. These switches serve to ground the point between the resistors through the conductor 278 and grounding connections 284, 286 and 287 associated, respectively, with the selector switches 276, 264 and 266.

The communication direction control switches 222 and 223 at stations 2 and 3 are identical in all respects with the communication direction control switch 221 at station 1, both as to the construction of the switch and the circuit connections therefrom to the loudspeaker, amplifier and interstation circuits. For this reason, it is deemed expedient only to describe in detail the features of the signaling circuit to which the present invention pertains primarily.

Station 2 has associated therewith a pair of interstation conductors 290 and 292 illustrated as connected to the loudspeaker 12. A pair of resistors 294 and 296 are connected in series across these conductors and from a point intermediate the two there leads a conductor 298 to the grounding switch blades 300 and 302 associated with selector switches 304 and 306, respectively, by means of which the output of amplifier 16 may be directed to either station 1 or station 3, respectively. The ground connection is effected through grounding connections 301 and 303 associated with blades 300 and 302, respectively. The third selector switch for connecting the output of the amplifier to substation 4 has been omitted for the purpose of clarity and because of space requirements.

The output of amplifier 16 is led to the selector switches through a pair of conductors 308 and 310 across which is connected in series a pair of resistors 312 and 314. The solenoid winding 156 at station 2 is connected to a point intermediate these resistors by a conductor 316.

In identical manner the interstation conductors individual to station 3, indicated by reference characters 320 and 322, have connected thereacross in series a pair of resistors 324 and 326. The point intermediate the two resistors is connected by a conductor 328 to switch blades 330 and 332 associated with the selector switches 334 and 336, respectively, by means of which the output of amplifier 17 may be directed to station 1 or station 2. The switches 330 and 332 are adapted to complete connections to ground through the grounding connections 338 and 339, respectively.

The output conductors 340 and 342 have connected thereacross a pair of resistors 344 and 346, the point intermediate the two being connected by a conductor 348 to the solenoid winding 196.

In use, it is contemplated that the communication direction control switches will be left in the positions indicated, that is, in their listen positions, at which time the "B" supply to the amplifier is disconnected to render the amplifiers inoperative but ready for instantaneous use. The solenoid windings 102, 156, and 196 will be energized and power is supplied to the lights 94, 96 and 98 so that these lights act both as signal devices and pilot lights.

In a system of the type described, a master station cannot listen to another station by reason of the fact that the listening circuit cannot be connected, except to the loudspeaker at that station. Therefore, the signal device functions

to serve as a busy signal and pilot light and will not give any indication of eavesdropping.

Assuming now that station 1 desires to communicate with station 2, the operator at station 1 operates the selector switch 262 to connect the output of amplifier 15 to the interstation conductors 290 and 292 and simultaneously to ground the point between resistors 280 and 282 through switch blade 268 and ground connection 284. When the operator at station 2 responds, he operates the selector switch 304 thereat to connect the output of amplifier 16 to the communication circuit 234, 236 individual to station 1. At the same time, the mid-point between resistors 294 and 296 is connected to ground through switch blade 300 and ground connection 301. When both the selector switches have been operated into circuit establishing position, the solenoid windings 102 and 156 are connected to ground through the resistors and communication circuits. As a result, the flow of current through the solenoid windings is decreased and the lights 94 and 96 are both de-energized.

When any other station, such, for instance, as station 3, attempts to call either station 1 or station 2, when the latter are in communicating relationship with each other, the light 98 thereat is extinguished. This results from the fact that the operation of either selector switch 334 or 336 into circuit establishing position results in connecting the solenoid winding 196 at station 3 to ground through the selector switches at the station selected. Consequently, the operator at station 3 is apprised of the fact that the selected station is busy, whenever the light 98 thereat is extinguished.

When master station 1 is paging a substation, as, for instance, substation 4, and another master station, for instance, master station 2, selects station 1, then the signal light 96 at station 2 is de-energized to indicate that master station 1 is busy. This results from the fact that the mid-point between resistors 280 and 282 at station 1 is grounded through switch blade 271 and ground connection 271' when station 1 is placed in communication with station 4 by operation of selector switch 266. Consequently, when selector switch 304 at station 2 is operated to select station 1, then the current flowing through solenoid winding 156 is decreased by reason of the fact that part of it is shunted to ground through the resistors and a circuit including interstation conductors 234, 236, conductors 308, 310 and the resistors 312 and 314 at station 2.

The modification of Fig. 3 is in many respects similar to the modification of Fig. 1. It differs from the former in that provision is made for the calling of master stations by the substation and also in that the master stations may call other master stations merely by operation of a push button. In order to effect these modes of operation, the circuits are so arranged that the substation may render operative the amplifier at the called master station and that a calling master station may render operative the amplifier at a called master station. Use is made of the signal controlling solenoids at the master stations to control the supply of power to the amplifiers and thereby to control the operative-ness of the amplifiers.

As in the modification of Fig. 1, the master stations are indicated by reference characters 1, 2 and 3, and the substation by reference character 4. These stations are provided with loudspeakers 11 to 14, respectively, and the master

stations are provided with amplifiers 15, 16 and 17, and communication control switches 18, 19 and 20 and station selector switches 21, 22 and 23, all respectively. The amplifier 15 at station 1 comprises the input transformer 24 and the output transformer 25 interconnected by two stages of amplification. Power is supplied to the amplifier from a suitable source of alternating current through a transformer 26, and in part through a rectifier tube 27. The supply of rectified current (the B supply) is directed to the amplifier through conductors 28 and 400, the former of which is connected directly to the common conductor 30 of the amplifier, which is grounded through conductor 31, and the latter of which has interposed therein a power switch 402 operable simultaneously with the communication direction control switch and adapted to connect the B supply to the amplifier when in its lowermost position, that is, when station 1 is conditioned for talking to other stations. The power is cut off in the other positions of the communication control switch, that is, when the switch is in its uppermost position, or in its intermediate or idle-listen position. The B supply to the amplifier is adapted to be completed also through a circuit including conductors 404 and 406 and contactor 408, whenever the signal controlling solenoid 410 is de-energized in a manner to be described hereinafter. Whenever the B supply circuit is completed either by operation of the communication direction control switch or the de-energization of the solenoid winding, the amplifier is instantaneously rendered operative by reason of the fact that the cathode heaters 34 of the two tubes of the amplifier are continuously supplied with heating current from the secondary winding 36 of the transformer 26, the midpoint of which is connected to the common ground conductor by a conductor 38.

The communication direction control switch 18 is a manually operable multi-pole three position switch. In a first position (the up position), the loudspeaker 11 is connected directly to the communication circuit comprising conductors 40 and 42 for calling other stations provided with amplifiers; that is, other master stations. In a second position (the intermediate and idle-listen position), the loudspeaker is connected to the output and the communication circuit to the input of the amplifier for reception from both the other master stations and the substation. In a third position (the down and talking position, from which the switch is biased by a spring 43 into its intermediate position upon release), the loudspeaker is connected to the input and the communication circuit to the output of the amplifier, and the B supply is connected to the amplifier.

The connection of the loudspeaker to the communication circuit in the up position of the communication direction control switch is effected in the same manner as in the modification of Fig. 1, that is, conductor 40 is connected to the loudspeaker through switch blade 44 and conductor 46 and conductor 42 is connected to the loudspeaker through switch blade 48 and conductor 50.

The connection of the loudspeaker to the output and the communication circuit to the input of the amplifier in the intermediate idle-listen position of the communication direction control switch (in which position the switch is illustrated) is likewise effected in the same manner

as in the modification of Fig. 1. Thus, loudspeaker 11 is connected to the output of the amplifier through conductor 46, switch blades 52 and 54, conductor 56, a volume control resistor 58, and conductor 60 leading to one terminal of the secondary winding 62 of the output transformer 25, and thence back to the loudspeaker through conductor 64, branch conductor 66, switch blades 68 and 70, and conductor 50. At the same time, resistor 72 is connected in parallel with the loudspeaker 11, through the conductor 74 connected to conductor 56 and resistor 58, conductor 76, and switch blade 78. The connection of the communication circuit to the input of the amplifier is effected through switch blade 44, conductor 80 leading to one terminal of the primary winding 82 of the input transformer 24, and from the other terminal of this primary winding to conductor 42 through conductor 84 and switch blade 48.

The connection of the loudspeaker to the input and the communication circuit to the output of the amplifier in the third position of the communication control switch is also effected in the same manner as in the modification of Fig. 1. The loudspeaker is thus connected to the input through conductor 46, switch blades 54 and 52 and conductor 80 leading to one terminal of the secondary winding 62, and from thence back to the other terminal of the loudspeaker through conductor 84, switch blades 70 and 68, and conductor 50. The communication circuit is connected to the output of the amplifier through switch blade 44, branch conductor 86, and conductor 80 leading to one terminal of the secondary winding 62, and from thence to the other communication conductor 42 through conductor 64, branch conductor 88 and switch blade 48.

In order to avoid undesirable clicking noises while reversing the connections of the loudspeaker and communication circuit to the input and output of the amplifier, there is provided the switch blade 90 and an elongated contact 92 connected, respectively, to the output conductors 64 and 60 so as to short-circuit the output when the communication direction control switch is operated from its intermediate to lowermost positions, or vice versa.

In the instance embodiment, the signal devices at stations 1, 2 and 3 are again indicated by reference characters 94, 96 and 98. The light 94 at station 1 is normally energized whenever the transformer 26 is connected to a source of alternating current, so that the light acts also as a pilot light. Control of the energization of the light to perform the signaling function will be described in greater detail hereinafter.

The supply of energy to the lamp is controlled by the contactor 408 operated by the normally energized solenoid winding 410. When the solenoid winding is energized, the light 94 is connected across a portion of the secondary winding 36 of transformer 26 through a circuit including the ground connection 104 and the conductor 106 leading to one terminal of the transformer—the circuit being completed through conductors 38, 30 and ground connection 31. The solenoid winding 410 is normally supplied with energy from the rectifier through a circuit including conductors 404, 412, resistor 414, and conductors 416 and 418.

The other terminal of the solenoid winding is connected to ground through conductors 420 and

422, and the winding is shunted by a condenser 424.

Control of the solenoid winding is effected, in part, through a conductor 416 connected to a point intermediate the resistors 126 and 128 connected in series across the interstation conductors 40 and 42. The point intermediate the resistors is also connected by a conductor 426 to switch blade 428 operable simultaneously with the communication control switch. The switch blade is effective to ground the midpoint through a conductor 430 in the lowermost position of the communication direction control switch and to condition that point for grounding by a push button switch 432 utilized in calling other master stations and conductors 434 and 436 in the uppermost position of the switch.

The selector switch 21 at station 1 includes a number of switches, as, for instance, the two indicated by reference character 132, which are termed the station No. 1 switches and which are ordinarily maintained in closed position in order that the other stations may communicate with station 1. Each of the master stations is provided with as many pairs of switches as there are stations in the system so that each station may communicate with the others. Thus, the selector switch 22 at station 2 is illustrated as having the same number of switches as selector switch 21, and the switch blades 134 thereof are closed in order to connect station 2 to the system for the reception of calls from the other stations. The selector switch 23 at station 3 has not been illustrated in full and has been shown as including four pairs of switches, of which switches 136 may be considered as being the switch associated with station 3.

The loudspeaker 14 at station 4 is connected by conductors 440 to a selector switch 442 of the rotary type and adapted to be operated into a number of positions equal to the number of stations and illustrated as being connected to the lowermost pair of interstation conductors. Conductors 440 are interconnected by the series connected resistors 444 and 446 of equal ohmic value, and the point intermediate the two is adapted to be connected to ground by a push button switch 448 and conductors 450 and 452, for purposes to be described in greater detail hereinafter. The apparatus at stations 2 and 3 corresponds identically with that at station 1 and will, therefore, be described only briefly.

The communication circuit conductors at station 2 are indicated by reference characters 140 and 142. Connected across these in series are the resistors 144 and 146 and from a point intermediate the two there extends a conductor 454 to switch blade 456. The latter is adapted in its lowermost position to connect conductor 454 to ground through conductor 458 and in its uppermost position to condition the connection of conductor 454 to ground through conductor 460, push button switch 462 and conductor 464. The point intermediate resistors 154 and 156 is connected by conductors 454 and 466 to solenoid winding 468, which winding is adapted to be connected to the rectifier associated with amplifier 16 through the resistor 470 in a manner identical with the connection of solenoid 410 at station 1, although this connection has not been illustrated fully. The solenoid winding is shunted by a condenser 472 and one terminal thereof is connected to ground through conductor 474. The solenoid winding is normally energized and the switch 476 associated therewith normally com-

pletes an energizing circuit for the light 98 through conductor 478 and ground connection 480. When the solenoid is de-energized, the "B" supply to amplifier 16 is completed through conductors 482 and 484.

The communication circuit at station 3 comprises the conductors 180 and 182 across which are connected in series the resistors 184 and 186, from between which leads a conductor 486 to switch blade 488. Switch blade 488 is adapted in its lowermost position to connect conductor 486 to ground through conductor 490, and in its uppermost position to condition the connection of conductor 486 to ground through conductor 492, push button switch 494 and conductor 496. The point intermediate resistors 184 and 186 is connected to solenoid winding 498 by conductor 486 and a conductor 500. The solenoid winding is adapted normally to be energized with current supplied thereto from the rectifier associated with the amplifier 17, through a circuit including resistor 502 in the same manner as the solenoid windings at the other master stations. The solenoid winding is shunted by condenser 504 and connected to ground through a conductor 506. The solenoid winding is normally energized and when energized, the contactor 508 associated therewith completes an energizing circuit for light 98 through conductors 510 and 512. When de-energized, the contactor 508 completes the connection of the "B" supply to amplifier 17 through conductors 514 and 516.

In operation, the communication direction control switches are left in the positions indicated, i. e., in their idle-listen positions, wherein the interstation circuits are connected to the inputs of the amplifiers and the loudspeakers are connected to the outputs. Assuming that one of the master stations, for instance, master station 2, desires to communicate with master station 1, then the uppermost pair of switches at station 2 are operated to connect the interstation conductors 140 and 142 of station 2 to the interstation conductors 40 and 42 of station 1. Operation of the selector switch in this manner does not affect the energization of solenoid 410 or 468, because these are connected to points of equal potential and the points intermediate resistors 126 and 128 and 144 and 146 are ungrounded.

The operator at station 2 can then call station 1 by operating the switch 18 thereat to its uppermost position and depressing push button switch 462. If this mode of operation is followed, then the loudspeaker 12 at station 2 is connected to the input of amplifier 15 at station 1, and the output of that amplifier is connected to loudspeaker 11. The amplifier 15 is rendered operative by reason of the grounding of solenoid 410 through the interstation circuit and push button switch 462. Amplifier 16 is also rendered operative by the grounding of solenoid 468 but it is not utilized. The operator at station 1 then has only to operate the communication control switch 18 thereat between its intermediate and lowermost positions to control the direction of communication, while the operator at station 2 needs only to maintain depressed push button switch 462.

If the operator at station 3 desires to communicate with either station 1 or station 2, he is given a busy signal if these stations are in communication with each other, immediately upon operation of the selector switch thereat. In this event, the solenoid winding 498 at station 3 is grounded through the interstation circuits and

the push button switch 462, or this switch and switch 428.

A substation is able to call a master station whenever the communication control switches at the master station are in their intermediate idle-listen positions. For instance, substation 4 may be placed in communication with master station 1 by operation of selector switch 442 to connect conductors 440 to conductors 40 and 42 through the normally closed selector switch blades 132 at station 1. If this is done, loudspeaker 14 at station 4 is connected to the input of amplifier 15, the output of which is connected, as previously described, to loudspeaker 11 at station 1. Then, upon closure of push button switch 448 at station 4, amplifier 15 is rendered operative by reason of the fact that solenoid 410 is grounded through a circuit including the interstation conductors, the resistors 444, 446, and conductors 450 and 452. The operator at station 1 may thereafter control the direction of communication as long as push button switch 448 at station 4 is maintained in its closed position.

When stations 1 and 4 are in communication with each other, then, if station 2 desires to communicate with station 1, the signal light 96 at station 2 is de-energized as soon as station 1 is selected by operation of the proper selector switch. The reason for this is, as previously explained, that solenoid 468 is connected to ground through the interstation circuits and through either switch blade 428 at station 1 or push button switch 448 at station 4, or both.

It is to be noted that while only a comparatively few stations have been shown in each of the embodiments of the invention illustrated, it should be understood that the number of stations may be multiplied to any extent desired.

Although the invention has been disclosed with the specific details of preferred embodiments thereof, it should be understood that such details are not intended to be limitative of the invention, except in so far as set forth in the accompanying claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. In a multiple station intercommunicating system, the combination including, signal means at each station, current responsive means normally occupying a predetermined position controlling the signal means at each station, a station selector switch at each station, and means operable by the station selector switch at each station for changing the position of the current responsive means thereat upon selection of a station already in communication with another station to indicate whether or not the selected station is busy.

2. In a multiple station intercommunicating system, the combination including, signal means at each station, a source of energy at each station, and means including a solenoid normally energized from said source and a station selector switch at each station for indicating whether or not the selected station is busy.

3. In a multiple station intercommunicating system, the combination including, signal means at each station, a source of energy at each station, a solenoid normally energized from said source for controlling the signal means, and means including a station selector switch for shunting said solenoid to deenergize the latter upon establishment of communication circuits with another station.

4. In a multiple station intercommunicating system of the loudspeaking type, the combination including, an amplifier, signal means, signal control means normally energized from the amplifier, communication control switch and station selector switches at each station, and interstation circuits, said signal control means at each station being so connected in circuit that they are grounded when the stations are in communication with other stations, whereby when another station selects a station already in communication with another the signal controlling means thereat is grounded to operate the signal to indicate that the selected station is busy.

5. A unit for use in a multiple station intercommunicating system, including in combination, signal means, current responsive means normally occupying a predetermined position controlling the signal means, and means including a station selector switch for changing the position of said current responsive means upon selection of another station already in communication with a further station to indicate whether or not the selected station is busy.

6. A unit for use in a multiple station intercommunicating system, including in combination, signal means, a source of energy, a station selector switch, and means including a solenoid normally energized from said source operable by the station selector switch for indicating whether or not the selected station is busy.

7. A unit for use in a multiple station intercommunicating system, including in combination, signal means, a source of energy, a solenoid normally energized from said source for controlling the signal means, and means including a station selector switch for shunting said solenoid to de-energize the same upon establishment of communication circuits with another station.

8. A unit for use in a multiple station intercommunicating system of the loudspeaking type, including in combination, an amplifier, signal means, signal control means normally energized from the amplifier power supply, a communication control switch, and station selector switches, said signal control means being so connected in circuit that it is grounded when the station is in communication with another station, whereby when the station selects a station already in communication with another the signal controlling means is grounded to operate the signal to indicate that the selected station is busy.

9. In a multiple station intercommunicating system of the type wherein each station comprises an amplifier, a loudspeaker adapted to be utilized both as a microphone and a receiver, a communication control switch operable in one position to connect the station for reception of calls from other stations, station selector switches, and a single pair of wires leading from the communication control switch to the selector switches, the combination including, signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it into a predetermined position, and switch means operable by said communication control switch when the latter is operated to said one position to connect said signal controlling means to said pair of wires for control by other stations.

10. A unit for use in a multiple station intercommunicating system wherein each unit comprises an amplifier, a loudspeaker adapted to be utilized both as a microphone and a receiver, a communication control switch operable in one

position to connect the station for reception of calls from other stations, station selector switches, and a single pair of wires leading from the communication control switch to the selector switches, including in combination, signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it into a predetermined position, and switch means operable by said communication control switch when the latter is operated to said one position to connect said signal controlling means to said pair of wires for control by other units.

11. In a multiple station intercommunicating system of the type wherein each station comprises an amplifier, a loudspeaker adapted to be utilized both as a microphone and a receiver, a communication control switch operable in one position to connect the station for reception of calls directly from other stations and in a second position for reception of calls from other stations through the amplifier, station selector switches, and a single pair of wires leading from the communication control switch to the selector switches, the combination including, signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it into a predetermined position, a pair of resistors connected across said wires, and switch means operable by said communication control switch when the latter is operated to said one position to connect said signal controlling means to a point between said resistors and to connect said point to ground in said second position, whereby when the communication control switch at one station is in said one position and another station selects that station and operates the communication control switch thereat to its second position the signal controlling means is grounded to operate the signal to give an indication that another station is listening to the one station.

12. A unit for use in a multiple station intercommunicating system of the type wherein each unit comprises an amplifier, a loudspeaker adapted to be utilized both as a microphone and a receiver, a communication control switch operable in one position to connect the unit for reception of calls directly from other units, and in a second position for reception of calls from other units through the amplifier, unit selector switches, and a single pair of wires leading from the communication control switch to the selector switches, including in combination, signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it into a predetermined position, a pair of resistors connected across said wires, and switch means operable by said communication control switch when the latter is operated to said one position to connect said signal controlling means to a point between said resistors and to connect said point to ground in said second position, whereby when the communication control switch of the unit is in said one position and another similar unit selects that unit and operates the communication control switch thereat to its second position the signal controlling means is grounded to operate the signal to give an indication that another unit is listening to said unit.

13. In a multiple station intercommunicating system of the type wherein each station comprises an amplifier, a loudspeaker adapted to be utilized both as a microphone and a receiver, a

communication control switch operable in its normal position to connect the station for reception of calls directly from other stations, in a second position for reception of calls from other stations through the amplifier, and in a third position to transmit calls to other stations through the amplifier, station selector switches, and a single pair of wires leading from the communication control switch to the selector switches the combination including, signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it into a predetermined position, a pair of resistors connected across said wires, and switch means operable by said communication control switch when the latter is operated to its normal position to connect said signal controlling means to a point between said resistors and to connect said point to ground in said second and third positions, whereby when the communication control switch at one station is in its normal position and another station selects that station and operates the communication control switch thereat to its second position, the signal controlling means is grounded to operate the signal to give an indication that another station is listening to the one station, and when a third station selects one of two stations communicating with each other by alternate operation of the communication control switches thereat between the first and third positions when the communication control switch at the third station is in its normal position, the signal controlling means at the third station is grounded to indicate that the selected station is busy.

14. A unit for use in a multiple station intercommunicating system of the type wherein each unit comprises an amplifier, a loudspeaker adapted to be utilized both as a microphone and a receiver, a communication control switch operable in its normal position to connect the unit for reception of calls directly from other units, in a second position for reception of calls from other units through the amplifier, and in a third position to transmit calls to other units, unit selector switches, and a single pair of wires leading from the communication control switch to the selector switches, the combination including, signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it into a predetermined position, a pair of resistors connected across said wires, and switch means operable by said communication control switch when the latter is operated to its normal position to connect said signal controlling means to a point between said resistors and to connect said point to ground in said second and third positions, whereby when the communication control switch at one unit is in its normal position and another unit selects that unit and operates the communication control switch thereat to its second position the signal controlling means is grounded to operate the signal to give an indication that another unit is listening to the unit, and when the unit selects a unit in communication with another by alternate operation of the communication control switches between their first and third positions when the communication control switch at the unit is in its normal position, the signal controlling means at the unit is grounded to indicate that the selected unit is busy.

15. In a multiple station intercommunicating system of the type wherein first and second stations comprise an amplifier, a loudspeaker

adapted to be utilized both as a microphone and a receiver, a communication control switch operable in its normal position to connect the station for reception of calls directly from other stations, in a second position for reception of calls from other stations through the amplifier and in a third position to transmit calls to other stations through the amplifier, station selector switches, and a single pair of wires leading from the communication control switch to the selector switches, and a third station comprising a loudspeaker adapted to be utilized both as a microphone and a receiver, the combination including, signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it into a predetermined position, a pair of resistors connected across said wires, and switch means operable by said communication control switch when the latter is operated to its normal position to connect said signal controlling means to a point between said resistors and to connect said point to ground in said second and third positions at said first and second stations, whereby when either said first or second station is communicating with the third station by operation of the communication control switch thereat to its second and third positions and the other of said stations selects either of the stations communicating with each other with its communication control switch in its normal position, the signal control means at the other station is grounded to indicate that the selected station is busy.

16. In a multiple station intercommunicating system of the type wherein each station comprises an incoming line, an outgoing line, and selector switches adapted to connect the outgoing line to other stations, the combination including, signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it to a predetermined position, and switch means operable with the selector switches so constructed and arranged that when two stations are connected for communication with each other the signal controlling means are grounded.

17. A unit for use in a multiple station intercommunicating system, including in combination, an incoming line, an outgoing line, signal means, signal controlling means connected to said outgoing line, means normally supplying said controlling means with sufficient energy to operate it to a predetermined position, and switch means in said outgoing line for grounding the incoming line when the unit is conditioned for communication with another unit.

18. In a multiple station intercommunicating system of the type wherein each station comprises an incoming line, an outgoing line, and selector switches adapted to connect the outgoing line to other stations, the combination including, signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it into predetermined position, a pair of resistors connected across the outgoing line, a connection from between said resistors to said signal controlling means, a pair of resistors connected across the incoming line, and means including switches operable with the selector switches for grounding a point between said last-mentioned resistors whenever a selector switch is operated.

19. A unit for use in a multiple station intercommunicating system, including in combination, an incoming line, an outgoing line,

signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it into a predetermined position, a pair of resistors connected across the outgoing line, a connection from between said resistors to said signal controlling means, a pair of resistors connected across the incoming line, and means including a switch operable with the selector switch for grounding a point between said last-mentioned resistors whenever the selector switch is operated.

20. In a multiple station intercommunicating system of the type wherein each station comprises an incoming line, an outgoing line, selector switches adapted to connect the outgoing line to other stations, a loudspeaker adapted to be utilized both as a microphone and a receiver, an amplifier, and a communication control switch operable in one position to connect the loudspeaker to the incoming line for the reception of calls from other stations, the combination including, signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it into a predetermined position, and switch means operable with the selector switches so constructed and arranged that when two stations are connected for communication with each other the signal controlling means thereat are grounded.

21. In a multiple station intercommunicating system of the type wherein each station comprises an incoming line, an outgoing line, selector switches in the outgoing line to connect the line to other stations, a loudspeaker adapted to be utilized both as a microphone and a receiver, an amplifier, and a communication control switch operable in one position to connect the loudspeaker to the incoming line for reception of calls from other stations, the combination including, signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it into a predetermined position, a pair of resistors connected across the outgoing line, a connection from between said resistors to said signal controlling means, a pair of resistors connected across the incoming line, and means including a switch operable with the selector switch for grounding a point between said last-mentioned resistors whenever the selector switch is operated to select a station.

22. In a multiple station intercommunicating system of the type wherein each station comprises an incoming line, an outgoing line, selector switches in the outgoing line for connecting it to other stations, a loudspeaker adapted to be utilized both as a microphone and a receiver, an amplifier, and a communication control switch operable in one position to connect the loudspeaker to the incoming line for reception of calls from other stations, and in another position to connect the loudspeaker to the input of the amplifier and the outgoing line to the output of the amplifier for the transmission of calls to the other stations, the combination including, signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it into a predetermined position, a pair of resistors connected across the outgoing line, a connection from between said resistors to the signal controlling means, a pair of resistors connected across the incoming line, switches operable simultaneously with the selector switches for grounding the midpoint between the resistors connected across the incom-

ing line, whereby when two stations are placed in communication with each other the signal controlling means at said stations are grounded to operate the signal means, and when a selector switch of a third station is operated to select a busy station the signal controlling means at the third station is grounded to operate the signal means.

23. A unit for use in a multiple station intercommunicating system, including in combination, an incoming line, an outgoing line, signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it into a predetermined position, a pair of resistors connected across the outgoing line, the midpoint of which is connected to the signal controlling means, a pair of resistors connected across the incoming line, unit selector switches in the outgoing line, switches operable simultaneously with the selector switches for grounding a point between the last-mentioned resistors, whereby the signal controlling means are grounded when two units are placed in communication with each other and when a busy unit is selected to operate the signal means.

24. In a multiple station intercommunicating system of the type wherein a station comprises an incoming line, an outgoing line, selector switches in the outgoing line to connect the line to other stations, a loudspeaker adapted to be utilized both as a microphone and a receiver, an amplifier, and a communication control switch operable in one position to connect the loudspeaker to the incoming line for reception of calls from similar stations and into a second position for connecting the loudspeaker to the input of the amplifier and the output of the amplifier to the outgoing line, and wherein another station comprises a loudspeaker utilizable both as a microphone and a receiver, the combination including, signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it into a predetermined position, a pair of resistors connected across the outgoing line, a connection from a point therebetween to the signal controlling means, a pair of resistors connected across the incoming line, a switch operable simultaneously with the selector switch for grounding a point between the last-mentioned pair of resistors, whereby the signal controlling means at other stations similar to the first are grounded to operate the signal means upon selection of the first station.

25. In a multiple station intercommunicating system of the type wherein each station comprises an amplifier, a loudspeaker adapted to be utilized both as a microphone and a receiver, a communication control switch operable in one position to connect the station for reception of calls from other stations and operable in a second position to connect the station for transmission of calls to other stations, station selector switches, and a single pair of wires leading from the communication control switch to the selector switches, the combination including, signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it into a predetermined position, a pair of resistors connected across said wires, a connection from the signal controlling means to a point between said resistors, and switch means operable with the communication control switch for grounding said connection when the latter is operated to its second position.

26. A unit for use in a multiple station intercommunicating system, including in combination, signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it into a predetermined position, a communication circuit, a pair of resistors connected across said circuit, and a connection from the signal controlling means to a point between said resistors.

27. In a multiple station intercommunicating system, the combination including, an amplifier at each station, signal means at each station, a source of energy at each station, a communication circuit and station selecting means at each station, and means including a solenoid normally energized from said source, a pair of resistors connected across the circuit, and means including a grounding switch grounding the communication circuit through the resistors at each station and deenergizing the solenoid for indicating whether or not the selected station is busy and for rendering operative the amplifier at the selected station.

28. A unit for use in a multiple station intercommunicating system, including in combination, an amplifier, signal means, a source of energy, a solenoid normally energized from said source, a communication circuit, a pair of resistors connected across said circuit, a connection from said solenoid to a point between said resistors, and switch means operated by said solenoid for controlling said amplifier and signal means.

29. In an intercommunicating system of the type comprising a plurality of stations, each provided with an amplifier, a pair of conductors over which communication may be carried on in opposite directions under the control of a communication control switch, the combination including, signal means, signal controlling means, a pair of resistors connected across said conductors, a connection from between said resistors to said controlling means, means normally supplying said controlling means with energy sufficient to operate the same to a predetermined position, and switch means associated with said communication control switch for grounding the point between said resistors upon operation of the communication control switch to a position to condition the station for transmitting calls to other stations, whereby when a station selects a busy station the signal controlling means at the selecting station is grounded to operate the busy signal thereat.

30. In a multiple station intercommunicating system of the type wherein each station comprises an amplifier, a loudspeaker adapted to be utilized both as a microphone and a receiver, a communication control switch operable in its normal position to connect the station for reception of calls directly from other stations, in a second position for reception of calls from other stations through the amplifier, and in a third position to transmit calls to other stations through the amplifier, station selector switches, and a single pair of wires leading from the communication control switch to the selector switches, the combination including, signal means, signal controlling means, means normally supplying said controlling means with sufficient energy to operate it into a predetermined position, a pair of resistors connected across said wires, and switch means operable by said communication control switch when the latter is operated to its normal position to connect said signal controlling means to a point between said

resistors and to connect said point to ground in said second and third positions, whereby when the communication control switch at one station is in its normal position and another station selects that station and operates the communication control switch thereat to its second position, the signal controlling means is grounded to operate the signal to give an indication that another station is listening to the one station, and when a third station selects one of two stations in communication with each other by operation of the communication control switch at one station between its second and third positions when the communication control switch at the third station is in its normal position, the signal controlling means at the third station is grounded to indicate that the selected station is busy.

31. In an intercommunicating system of the type comprising a plurality of stations, each provided with an amplifier, a loudspeaker adapted to function both as a microphone and a receiver, a pair of conductors over which communication may be carried on in opposite directions under the control of a communication control switch adapted in a normal position to connect the loudspeaker to the output and the conductors to the input of the amplifier, in a second position to reverse the connections and render operative the amplifier, and in a third position to connect the loudspeaker directly to the conductors and station selector switches, the combination including, signal means, signal and amplifier controlling means, a pair of resistors connected across said conductors, a connection from between said resistors to said controlling means, means normally supplying said controlling means with energy sufficient to operate the same to a predetermined position, switch means associated with said communication control switch for grounding the point between said resistors upon operation of the communication control switch to its second position and for conditioning the connection of said midpoint to ground when operated into its third position, a normally open push button switch for completing the connection to ground when the communication control switch is in its third position, whereby one station can call another by operation of the communication control switch thereat to its third position and closing the push button switch, and communication may be carried on between the calling and called stations by manipulation of the communication control switch at the called station between its normal and second positions while the push button switch at the calling station is maintained closed, and whereby when a third station selects either of the two stations in communication with each other the signal controlling means thereat is grounded to operate the signal means to give an indication that the selected station is busy.

32. In an intercommunicating system of the type comprising a station provided with an amplifier, a loudspeaker adapted to function both as a microphone and a receiver, a pair of conductors over which communication may be carried on in opposite directions under the control of a communication control switch adapted in a normal position to connect the loudspeaker to the output and the conductors to the input of the amplifier, and in another position to reverse the connections and render operative the amplifier, and a second station comprising a loudspeaker adapted to function both as a microphone and

a receiver, the combination including, signal means, signal and amplifier controlling means, a pair of resistors connected across said conductors, a connection from between said resistors to said controlling means, means normally supplying said controlling means with energy sufficient to operate the same to a predetermined position, and switch means associated with said communication control switch for grounding a point between said resistors upon operation of the communication control switch to its second position to condition the first station for transmitting calls to other stations, a pair of conductors leading to the second station, a pair of resistors connected in series thereacross and means including a normally open push button switch adapted for grounding a point between said resistors, whereby when the communication control switch at said one station is in its normal position the second station may call the first station by operation of the push button switch to ground the signal and amplifier controlling means at the first station thereby to render the amplifier operative, and whereby communication may be carried on between said first and second stations by operation of the communication control switch at the first station between its normal and second positions as long as the push button switch at the second station is maintained closed.

33. In an intercommunicating system of the type comprising a plurality of stations each provided with an amplifier, a loudspeaker adapted to function both as a microphone and a receiver, a pair of conductors over which communication may be carried on in opposite directions under the control of a communication control switch adapted in a normal position to connect the loudspeaker to the output and the conductors to the input of the amplifier, and in another position to reverse the connections and render operative the amplifier, and another station comprising a loudspeaker adapted to function both as a microphone and a receiver, the combination including, signal means, signal and amplifier controlling means, a pair of resistors connected across said conductors, a connection from between said resistors to said controlling means, means normally supplying said controlling means with energy sufficient to operate the same to a predetermined position, and switch means associated with said communication control switch for grounding the point between said resistors upon operation of the communication control switch to its second position to condition any of said plurality of stations for transmitting calls to other stations, selector switch means, a pair of conductors leading to the other stations, a pair of resistors connected in series thereacross and means including a push button switch adapted to ground a point between said resistors, whereby when the communication control switch at one of said plurality of stations is in its normal position others of said plurality of stations and the other station may call said one station by operation of the push button switch to ground the signal and amplifier controlling means at said one station thereby to render the amplifier operative, and whereby communication may be carried on between said one and said other station between its normal and second positions as long as the push button switch at the other station is maintained closed, and whereby the signal means at any others of said plurality of stations is op-

erated by the grounding of the signal controlling means upon selection of said one station.

34. A unit for use in an intercommunicating system, including in combination, a communication circuit, an amplifier, a multi-position communication and amplifier control switch, a solenoid and a switch operable thereby between two circuit closing positions, a signal light adapted to be energized when said switch is in one circuit closing position, means to energize the amplifier when said switch is in the other of its circuit closing positions, a pair of resistors connected across said circuit, a connection from between said resistors to said solenoid, means normally supplying said solenoid with energy sufficient to operate it to a position in which the switch associated therewith is in said one circuit closing position, switch means associated with said communication control switch for grounding a point between said resistors upon operation of the communication control switch to a position wherein the amplifier control means associated with said switch is in a position to render the amplifier operative, and for conditioning the connection of said point to ground when operated to a position wherein the amplifier is rendered inoperative, and a normally open push button switch for completing the connection to ground when the communication control switch is in said last mentioned position.

35. An intercommunicating system comprising a plurality of stations, each having a source of power, a signal lamp, a normally operative signal lamp controlling means adapted to connect the lamp to said source of power, whereby said lamp serves as a pilot light, station selector switches, and means for rendering said controlling means inoperative to connect said lamp to said source when a busy station is selected, whereby said lamp serves also as a busy signal.

36. In a unit for use in an intercommunicating system, the combination including, an amplifier, a loudspeaker adapted to serve both as a microphone and a receiver, a communication direction control switch for controlling the connection of said speaker to the input and output of said amplifier, and means operable simultaneously with said switch for short-circuiting the output of the amplifier while the connections of said speaker to the amplifier are being changed.

37. In a multiple station intercommunicating system, the combination including, a first station including a loudspeaker adapted to be utilized as a microphone connected to an interstation communication circuit and signal means, a second station including an amplifier having input and output connections, a loudspeaker and a communication control switch operable to a position wherein said communication circuit is connected to the input and the loudspeaker to the output of said amplifier, and means operable by said control switch to operate the signal means at the first station when said switch is operated to said position.

38. In apparatus of the class described, a pair of stations adapted to be connected by a communication circuit, switch means at said stations for connecting them to said communication circuit, signal means at one of said stations, and means including said communication circuit, a pair of resistors of equal value connected across said circuit at each station, and a connection from a point between said resistors at said one station to said signal means for controlling said signal means.

39. In a multiple station intercommunicating system, the combination including, an amplifier at each station, a source of energy at each station, a communication circuit and station selecting means at each station, and means including a solenoid normally energized from said source, a pair of resistors connected across the circuit, and means including a grounding switch grounding the communication circuit through the resistors at each station and deenergizing the solenoid for rendering operative the amplifier at the selected station.

40. A unit for use in a multiple station intercommunicating system, including in combination, an amplifier, a source of energy therefor, a solenoid normally energized from said source, a communication circuit, a pair of resistors connected across said circuit, a connection from said solenoid to a point between said resistors, and switch means operated by said solenoid for controlling the connection of said amplifier to said source of energy.

41. In an intercommunicating system of the type comprising a station provided with an amplifier, a loudspeaker adapted to function both as a microphone and a receiver, a pair of conductors over which communication may be carried on in opposite directions under the control of a communication control switch adapted in a normal position to connect the loudspeaker to the output and the conductors to the input of the amplifier, and in another position to reverse the connections and render operative the amplifier, and a second station comprising a loudspeaker adapted to function both as a microphone and a receiver, the combination including, amplifier controlling means, a pair of resistors connected across said conductors, a connection from between said resistors to said controlling means, means normally supplying said controlling means with energy sufficient to operate the same to a predetermined position, and switch means associated with said communication control switch for grounding a point between said resistors upon operation of the communication control switch to its second position to condition the first station for transmitting calls to other stations, a pair of conductors leading to the second station, a pair of resistors connected in series thereacross and means including a normally open push button switch adapted for grounding a point between said resistors, whereby when the communication control switch at said one station is in its normal position the second station may call the first station by operation of the push button switch to ground the amplifier controlling means at the first station thereby to render the amplifier operative, and whereby communication may be carried on between said first and second stations by operation of the communication control switch at the first station between its normal and second positions as long as the push button switch at the second station is maintained closed.

42. A unit for use in an intercommunicating system, including in combination, a communication circuit, an amplifier, a multi-position communication and amplifier control switch, a solenoid and a switch operable thereby into a predetermined position for energizing the amplifier, a pair of resistors connected across said circuit, a connection from between said resistors to said solenoid, means normally supplying said solenoid with sufficient energy to operate it to a position wherein said switch is effective to de-

energize the amplifier, switch means associated with said communication control switch for grounding a point between said resistors upon operation of the communication control switch to a position wherein the amplifier control means associated with said switch is in a position to render the amplifier operative, and for conditioning the connection of said point to ground when operated to a position wherein the amplifier is rendered inoperative, and a normally open push button switch for completing the connec-

tion to ground when the communication control switch is in said last mentioned position.

43. In an intercommunicating system, the combination including, a pair of stations adapted to be connected by a communication circuit, an amplifier at one station, a solenoid controlling the operation of said amplifier, and means at the other station for controlling said solenoid over said communication circuit to energize said amplifier.

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