July 4, 1944. W. HASENBERG 2,352,711

COMMUNICATION SYSTEM

Filed July 15, 1941 4 Sheets-Sheet 1

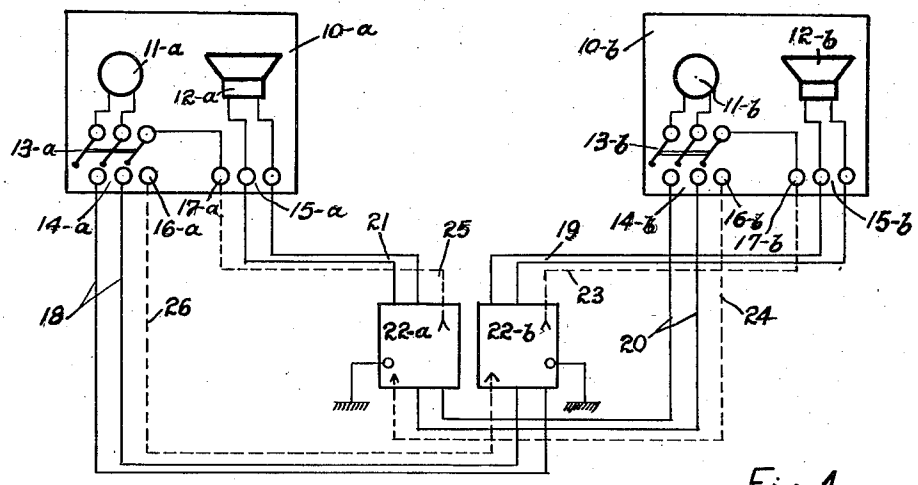


Fig. 1

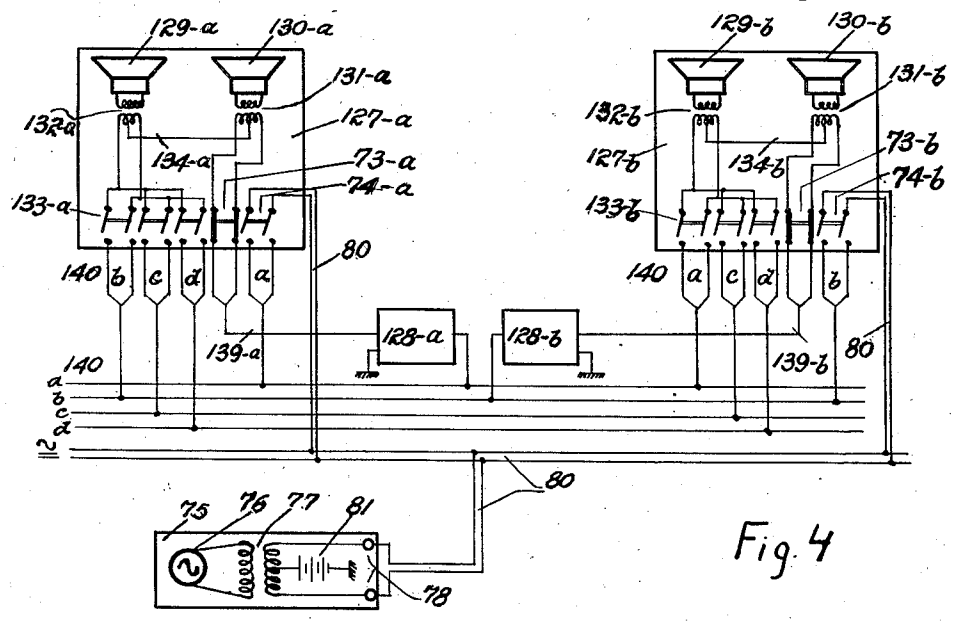


Fig. 4

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COMMUNICATION SYSTEM

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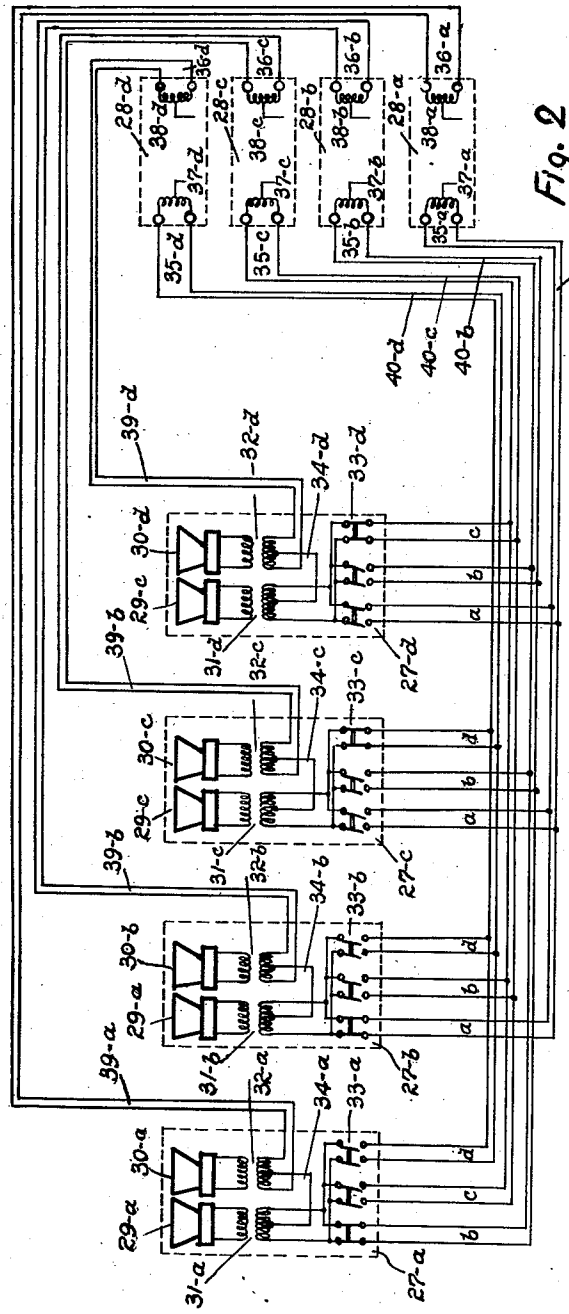


Fig. 2

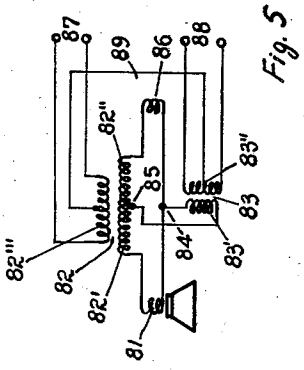


Fig. 5

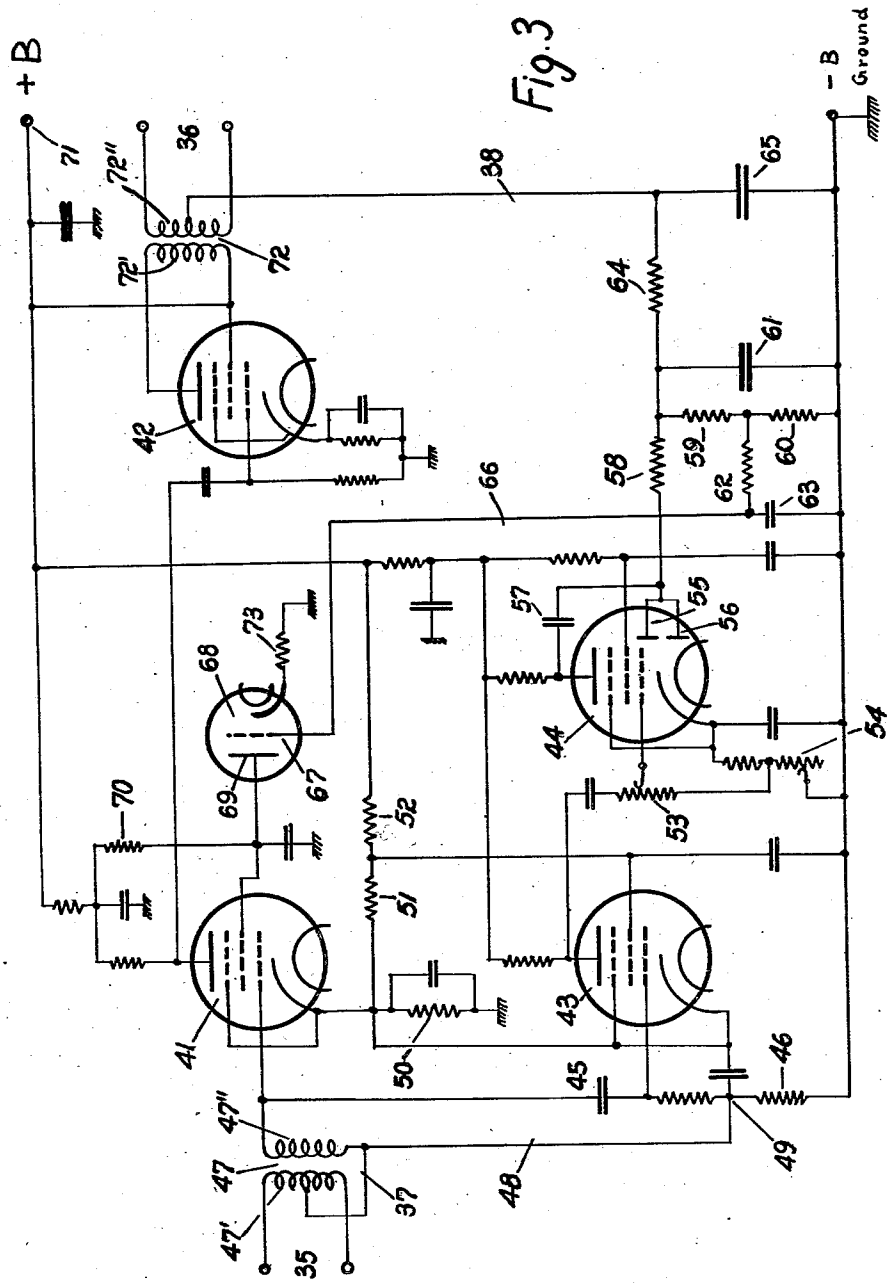
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COMMUNICATION SYSTEM

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Fig. 3



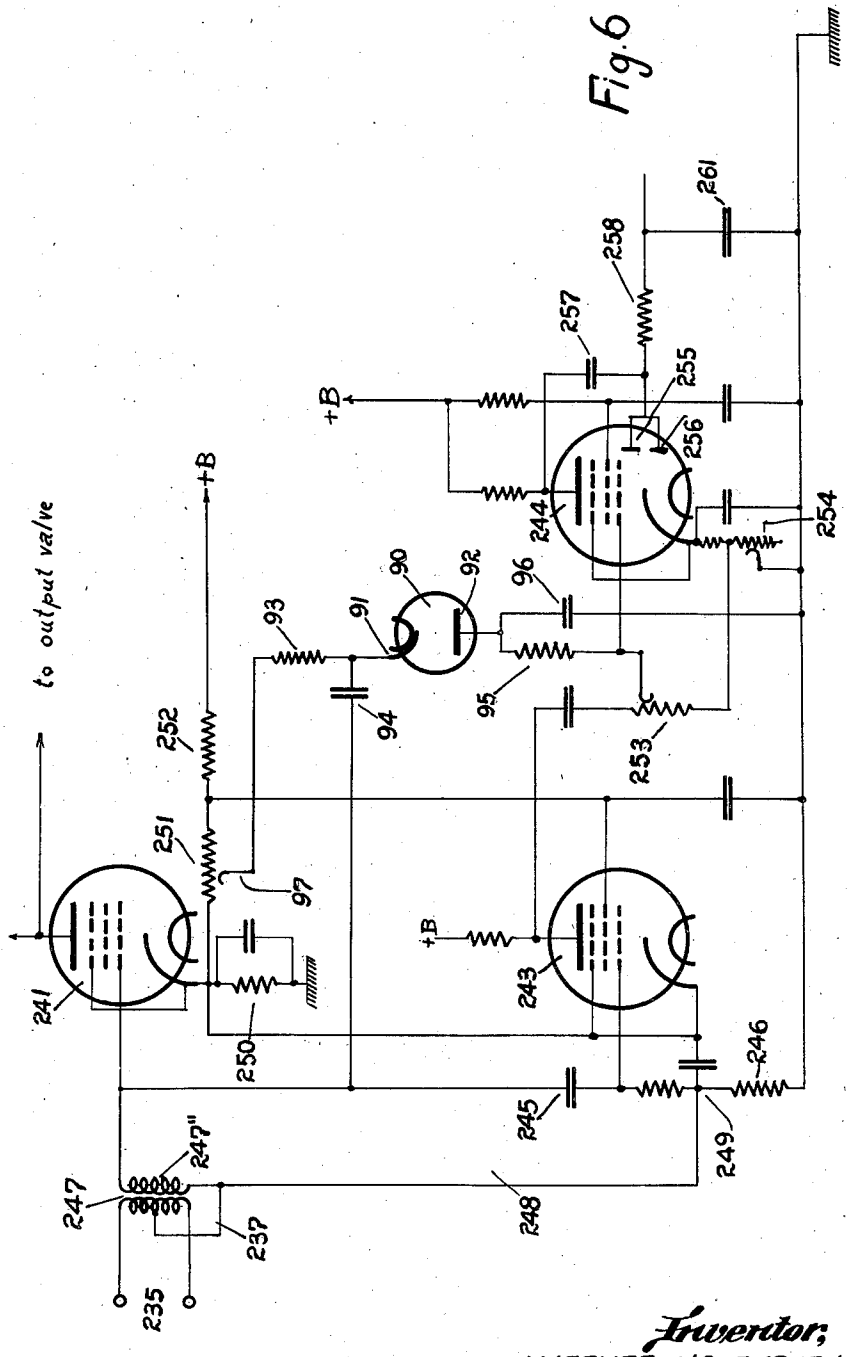
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Fig. 6



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2,352,711

UNITED STATES PATENT OFFICE

2,352,711

COMMUNICATION SYSTEM

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Application July 15, 1941, Serial No. 402,510

7 Claims. (Cl. 179—1)

The invention relates to loudspeaking communication systems and particularly to systems comprising a plurality of stations each equipped with transmitting and receiving means, and wherein the sound waves impressed on the communication channels provide the controlling means for eliminating the acoustic phenomena, known as singing or howling or alike, due to feed-back.

Loudspeaking communication systems are known to the art which avoid feed back phenomena by cutting down the volume of sound reception in both directions, but in my invention does away with such limitation and permits amplification to any desired degree. Another known loudspeaking communication system avoids feed back by means of control switches, apart from or combined with the line-selector switch, to be hand- or hand-relay-operated by the user or by the operator of a master station, who may thus interrupt or commutate the connections of a channel. In one variant of that system the electronic device, consisting of a mere amplifier, may also be made part of the control system by connecting or disconnecting its power supply and thereby making the amplification respectively operative or non-operative. In contradistinction to this system, my system is of the voice controlled type and does not require any switching except closing a line-selector switch; my electronic device comprises amplifying as well as control means, the latter being operated exclusively by the sound induced currents.

One object of my invention is to provide a system wherein any station or any number of stations may establish and maintain a two-way loudspeaking communication with any other station or any number of other stations without interference of feed-back effects. This result is attained without any regard to the characteristics of the communication lines and in so far my invention is to be distinguished from systems which are based on a balanced repeater circuit.

One important feature of my invention is to assign to each channel its own voice operated amplifying and controlling means independent of those of other channels. The invention is thus to be distinguished from systems wherein the means for controlling a two-way loudspeaking communication between two stations are common to the two transmission channels of opposite direction, so that a two-way communication system of this kind represents a rigid unit not capable of being broken up into smaller units. Consequently, when such system is to be extended to more than two, say n stations, and is to provide a two-way communication between any two of them, each of the n stations must be equipped with the whole outfit of a complete two-way system less the receiving and transmitting element of the counter-station, including n channels leading to the own receiving element and again n channels leading to the own transmitting element, and, when a station has established actual communication with another station, part of the outfit either of the two destined to lay idle. A further inherent drawback of that system is that the station selecting another one can alone complete the two-way communication path without any active cooperation from the part of the counter-station, so that the latter may be connected with and overheard by a station without even noticing it. In contradistinction thereto, the present invention is based on the conception of independent "station units," each self-contained with the outfit of a one-way transmitting or a one-way receiving system only plus a receiving element (loudspeaker) or transmitting element (microphone) respectively, so that in a system of n such units n—1 channels lead to the one element, but one channel only to the other element, and any such station unit may start a one-way transmission to any other selected, while the opposite station has to complete the circuit into a two-way communication path, thereby enabling mutual control currents to reach their opposite amplifiers over an interconnecting auxiliary channel. It is another feature of my invention to reduce to a minimum the length and the cost of said auxiliary channel by utilizing the sound transmitting channels for simultaneously conveying the control potentials. Thus, the interconnecting channel can be reduced to a small bridge provided within each station unit, and any desired extension can be incorporated in a communication system by simply connecting the channels of the new station unit or units without additional interconnecting lines or coupling devices.

The flexibility and adaptability thus afforded by my system permits of its connecting with the public local or long distance telephone or radio telephone system without affecting their operative conditions or performance, by simply removing the microtelephone of the standard telephone set and introducing the free ends into one of my station units so as to transform the latter into a terminal of the public system.

While amplifying and controlling means for suppressing feed-back effects are conventional to

the prior art, the specific arrangement and coordination of these means which will be described later on in detail, is novel and characteristic of my present invention. One of its features is that all transmission paths of the system are normally inactive being blocked by their own controlling means, in the manner and for the purpose to be fully explained later on.

Another object of the invention is to overcome the restrictions heretofore imposed on the spatial arrangement of the microphone and loudspeaker of the station relative to each other by the necessity of avoiding acoustic coupling or feed-back. As practice has proved the means employed in my invention for suppressing any kind of feed-back are so effective that microphone and loudspeaker may be arranged or assembled in the closest proximity without resorting to acoustic expedients, such as, for instance, phase shifting of the acoustic waves which has been suggested by others, and the elements may even be combined into one loudspeaking transducer unit. The specific means for incorporating this unit in a communication system are another object of my invention.

When my invention is carried into effect it may happen that the called-up station to which it is up to complete the two-way communication circuit by means of its selecting switch, may desire to convey a signal to the calling station before the two-way path is, or can be, established as, for instance, in the case of being unaware of the identity of the calling station and, consequently, unable to respond to the call. It is a special object of my invention to provide adequate means for using the one existing transmission path for the back transmission of signals or the like. Another object of my invention is to enable either party of the two-way communication established to cut-in or interrupt the talking of the other station.

These and other objects and advantages of my invention will be better understood from the following detailed description when read in connection with the accompanying diagrammatic drawings of which

Fig. 1 shows a two-way communication between two stations wherein an auxiliary channel is used as interconnecting path for the mutual control currents exchanged between the station.

Fig. 2 shows a complete communication system comprising 4 stations wherein any two may simultaneously establish and maintain a two-way communication in the manner of Fig. 1 and the channels are serving as transmission paths for sound induced currents as well as for control currents and a small bridging lead provided within each station unit takes the place of the auxiliary channel.

Fig. 3 shows the kind of electronic device preferably employed in my invention and associated with the station units in the manner shown in Figures 1 and 2.

Fig. 4 illustrates the means for enabling a station called-up to convey signals back to the calling station over the one existing path, and further means for cutting-in or interrupting the talk of the other station after the completion of the two-way communication path.

Fig. 5 represents a transducer element and means for incorporating it in a communication system, and

Fig. 6 illustrates a further improvement of the electronic device shown in Fig. 3 by adding an automatic amplitude responsive gain reducer.

In dealing with each figure in detail I shall first explain the significance of its numerals and then proceed to describing the operation of the system or arrangement represented by the figure. As far as practicable the same numerals have been used to denote corresponding elements in the different figures, and the same letter indices to denote elements belonging to the same station. When, however, such elements are discussed under their typical aspect, without reference to an individual station to which they belong, the letter indices will readily be omitted and it will be understood that the numeral under discussion is represented in the figure by any one of its like numerals bearing a letter index.

In Fig. 1 10—*a* and 10—*b* represent two stations comprising microphone 11—*a*, 11—*b*, loudspeakers 12—*a* and 12—*b*, switching devices 13—*a* and 13—*b* and terminals 14—*a*, 15—*a*, 16—*a*, 17—*a* and 14—*b*, 15—*b*, 16—*b*, 17—*b*. Between the two stations are running channels 18, 19, 20 and 21 for transmitting from and receiving at a station, with electronic devices 22—*a* and 22—*b* inserted in these channels. The electronic devices which will be described in detail later on in connection with Fig. 3, comprise amplifiers and voice operated control means necessary for eliminating all kinds of feed-back effects and maintaining a two-way communication in an orderly way. The output of the electronic device 22—*a* is in fixed connection with the receiving channel 21 of station 10—*a* and correspondingly the output of electronic device 22—*b* with the receiving channel 19 of station 10—*b*, while the microphone 11—*a* of station 10—*a* may be connected by means of switch 13—*a* through channel 18 to the input of electronic device 22—*b*, and correspondingly the microphone 11—*b* of station 10—*b* by means of switch 13—*b* through channel 20 to the input of electronic device 22—*a*. The general character of the arrangement is so far conventional were it not for the interconnecting channels indicated by the dotted lines 23, 24, 25 and 26.

The operation is as follows: When station 10—*a* wishes to start a two-way communication with station 10—*b*, switch 13—*a* is to be closed. The sound waves impressed on microphone 11—*a* are transformed into voice induced currents which travel along channel 18 to the input of the electronic device 22—*b*, where they are amplified and farther from its output travelling along channel 19 reach loudspeaker 12—*b*, thus constituting a one-way transmission from station 10—*a* to station 10—*b*. It is now up to station 10—*b* to turn the one-way transmission so far established into a two-way communication by completing the circuit which is done by closing switch 13—*b*. As soon as the two-way path is established and energy can be transmitted along that path from station 10—*a* it becomes necessary to prevent that any part of it is fed back to that station. This is accomplished by the electronic device inserted in the communication path. In a manner which will be explained later on, device 22—*b* amplifying on one hand the sound induced current which is then carried on thru channel 19 to the receiving station 10—*b*, simultaneously produces a control potential which is conveyed thru auxiliary channel 23 to terminal 17—*b* and over the switch 13—*b*, now closed, to terminal 16—*b*, from there thru auxiliary channel 24 to the input of electronic device 22—*a* where it operates to block any transmission from station 10—*b*. Analogously, when station 10—*b*

has started transmitting sound to 10—*a*, a control potential is produced by electronic device 22—*a* and conveyed to device 22—*b* thru the auxiliary channels 25 and 26 by the intermediary of the now closed switch 13—*a*. As soon as the transmitting station stops talking, the initial condition is automatically re-established, and the path free again for a transmission to be started from the other station.

Summarizing, the control potential which is produced at one electronic device and intended to act upon the other electronic device so as to block its transmitting path of which it is forming part itself, is conducted from one to the other by mutual auxiliary channels which are connected only when the counterstation completes the two-way communication. This is an important feature of my invention inasmuch as it permits building up of a system comprising a plurality of stations in the simple way which will be more fully explained in connection with Fig. 2, and to establish and maintain a loud-speaking two-way communication between any two of these stations by means of switch 13 to be equipped with the corresponding number of contacts for selecting the respective channels. Each station proper, circumscribed in the figure by a rectangle, together with its electronic device and that of the two channels which provides the fixed connection without inserted switch between the station and its electronic device, constitute what may be defined as a "station unit." It will be understood that either station unit is self-contained in so far as it affords its own amplifying and control means and the combination of two such independent station units into a two-way communication system requires nothing but a few simple line connections without addition of a linking device apart from that of the interconnecting auxiliary channels. The latter, however, which obviously involve an expenditure increasing in proportion to the number of station units combining, may still be eliminated to a large extent by using the proper communication channels as transmission paths for the control currents as well as for the sound induced currents. This part of my invention is explained in Fig. 2 together with the application of my system to a plurality of 4 stations or station units between any two of which the two way communication may at any time be established.

The system of Fig. 2 comprises 4 stations 27—*a* to 27—*d* and 4 electronic devices 28—*a* to 28—*d*. Each station consists of microphone 29 and loud-speaker 30, either of which are connected to transformer 31 and 32 respectively, and switching device 33 provided with contacts for 3 different channels. The center taps of the line-side windings of these transformers are interconnected by lead 34.

The electronic devices 28—the system of which will be described later on in connection with Fig. 3—are represented in Fig. 2 by their input and output elements. The input terminals 35 and the output terminals 36 are connected to the ends of the respective transformer windings tapped at their centers where wires 37 and 38 are leading respectively to and from the inner ciruits of the device not shown in this figure. Station 27—*a* is represented as being in a two-way communication with 27—*b* and likewise station 27—*c* with 27—*d*, but it is obvious that other combinations are possible corresponding to other positions of the switching devices 33.

Transformer 32—*a* of station 27—*a* is in fixed connection with the output terminals 36—*a* of the electronic device 28—*a* over channel 39—*a* and the corresponding elements of the other stations alike. The input terminals 35—*a* of the electric device 28—*a* are connected to channel 40—*a* leading to the switching device of station 27—*b* and so on. It will be noticed that the auxiliary channels of Fig. 1 are lacking here, being partly superseded by the bridges 34 which interconnect the center tap of the line-side transformer windings 31 and 32 and thereby the transmitting channel 40—*b* with the receiving channel 39—*a*, which take over the other part played by the auxiliary channel in Fig. 1.

The two-way communication shown in Fig. 2 operates as follows:—

When station 27—*a* happens to be transmitting to station 27—*b*, the first is making use of channel 40—*b* leading to the input terminals 35—*b* of the electronic device 28—*b*, where the sound induced currents are amplified and also produce a control potential. This potential is delivered by lead 38—*b* to the center tap of the transformer and its output terminals 36—*b* and from there, always together with the amplified sound currents, conveyed into channel 39—*b*, which is the receiving channel of station 27—*b* leading to transformer 32—*b* of that station. The sound induced currents are received here and re-transformed into sound by loud-speaker 30—*b*, whereas the control potential is conveyed farther on over the bridge 34—*b* and transformer winding 31—*b* into the opposite channel 40—*a* of the two-way path thru which it finally reaches the input terminals 35—*a* of the electronic device 28—*a* and over wire 37—*a* can act upon the elements of its inner circuit.

When vice-versa station 27—*b* is transmitting to station 27—*a*, the process is analogous, the path along the control potential is conveyed being 38—*a*, 27—*a*, 32—*a*, 34—*a*, 31—*a*, 40—*b*, 35—*b*, 28—*b*, 37—*b*.

It will thus be understood that the control potential introduced into one station thru its receiving channel together with the sound currents is automatically conveyed farther on over the bridge to the other channel which completes the path of the two-way communication with the other station. Suitable means must, of course, be provided for preventing any coincidence of oscillations between the sound induced and the control currents along their common path, preferably by rectifying and filtering the sound induced currents in the way illustrated in Fig. 3.

Fig. 3 illustrates the arrangement of coordination of the amplifying and controlling means embodied in the electronic device. A device to this description has given good results and is, preferably used when this invention is carried into effect although I do not limit myself to any of the details given herewith.

The device comprises a primary circuit or main path, and a secondary circuit or by-path. The primary circuit comprises valves 41 and 42 which constitute a two-stage sound amplifier, the secondary circuit valves 43 and 44, the latter valve being of twin-diode-pentode type. For simplicity the conventional heater circuits of the thermionic valves have been omitted. Both, the primary and the secondary circuits have a common input, the control grids of the input valves being shunted for alternating current by a capacitor 45 and a common grid leak resistor 46 for bias

voltage. The input transformer 47 has its primary 47' connected to the input terminals 35 and its center tap to lead 37, which is connected to the junction of the secondary 47'' and lead 48. Lead 48 also connects with point 49 of the by-path. The upper end of the secondary 47'' of transformer 47 leads to the control grid of valve 41 in the main path. The cathodes of valves 41 and 43 are joined and thus charged with the same positive potential over a voltage divisor consisting of the resistances 50, 51 and 52.

The secondary circuit further comprises conventional means for controlling the gain, such as a potentiometer 53 in the control grid circuit of the second valve 44 and a variable resistor 54 in the cathode circuit of that valve, the resistor being designed for determining the threshold conductivity of the diodes 55 and 56.

I shall now describe what is taking place either when sound induced currents or when a control potential are introduced in the electronic device.

When sound induced currents reach the input terminal 35 of the electronic device and follow the path of the secondary circuit, they are first amplified by the valves 43 and 44 and then after passing thru capacitor 57, are rectified by the shunted diodes 55 and 56 so that a rectified D. C. potential is supplied for charging condenser 61 over resistance 58 with a negative value. This potential is farther conveyed over the RC-filter 64, 65 and wire 38 to the center tap of the windings 72'' of the output transformer 72 and thus to the output terminals 36 of the electronic device. The output circuit of diodes 55—56 further comprises a voltage divisor consisting of the resistances 59 and 60 shunted by condenser 61. The junction of these two resistances supplies the control potential proper which over the filter 62, 63 and wire 66 is conveyed to the control grid 67 of valve 68. Wire 66 and valve 68 thus connect the by-path back to the main path. It is the function of valve 68 to block and unblock the main-path in the following way. Anode 69 of valve 68 is connected directly to the second grid of valve 41 and fed over resistance 70 and conventional filter elements from a conventional power supply of which only the terminals are shown in the figure, its positive pole being connected to terminal 71, its negative pole grounded. The cathode resistance 73 provides the normal bias potential adjusted to about 1 volt for grid 67 of valve 68. Under these conditions a voltage drop caused along resistor 70 by the plate current from anode 69 reduces the positive potential at the second grid of valve 41 to a limit where this valve becomes practically unoperable, in other words, is blocked. The unblocking of valve 41 takes place as soon as valve 68 is blocked due to a control potential biasing grid 67. The rate at which the main-path or primary circuit is unblocked in response to the sound induced currents impressed on the input of the electronic device, apart from the adjustment of the RC-time-constant elements substantially depend upon both, the gain of the secondary circuit amplifier and the threshold value of the rectifier. By appropriately adjusting these limits, the controlling means can be made unresponsive to room noises and the like, so as to make the electronic device operative exclusively for the transmission of the proper sound currents.

When a control potential reaches the input terminals 35 of the electronic device and follows the path of the secondary circuit, it is conveyed over leads 37 and 48 to junction point 49, grounded over resistance 46, and biasing the control grids of valves 43 and 41. The gain of valve 43 is thereby reduced to complete blocking making the by-path inoperative. The reason for biasing the control grid of valve 41 in the main-path simultaneously with that of valve 43 in the by-path is that I prefer this method for making the overhanging time long enough to keep the gain relatively constant during the intervals between the syllables, and insuring a smooth overcoming when the first station ceases talking and the second starts immediately after. Valve 41 thus becomes inoperative in less time than if the blocking should be determined only by the decrease of the potential charging grid 67 of valve 68.

I shall now describe the function which the electronic device has in the operation of the two-way communication established between stations 27—*a* and 27—*b* according to Fig. 2 wherein electronic devices 28—*a*—*b*—*c*—*d* must now be understood as embodying the full diagram of Fig. 3. When the user of station 27—*a* starts a conversation, the currents induced by his voice reach the input 35—*b* common to the primary and secondary circuit of the electronic device 28—*b*, and are carried on, as shown in Fig. 3, over the transformer 47—*b* to the control grids of both valve 41—*b* in the primary and 43—*b* in the secondary circuit. Valve 41—*b* is in a state of non-conductivity, amplification of the sound currents is, therefore, possible only along the secondary circuit by valves 43—*b* and 44—*b*. The diodes 55—*b*/56—*b* of valve 44—*b* become conductive and charge the upper plate of condenser 61—*b* negatively. Over the back connection 66 to the primary circuit this charge is applied to grid 67—*b* of valve 68—*b*, the bias potential of which is increased, so that valve 41—*b* is unblocked and amplification of the sound currents can now take place in the primary circuit being opened for transmission and delivering the amplified currents thru the output 36—*b* of the electronic device into channel 39—*b*. Simultaneously the charge of the upper plate of condenser 61—*b* is conveyed to winding 72''—*b* of the output transformer 72—*b* and into the receiving channel 39—*b* where it joins the amplified sound induced current whose path so far has just been described, and both together are conducted to station 27—*b* over the receiving channel 39—*b* being their common transmission path. At station 27—*b* the sound induced currents are retransformed into sound by the loudspeaker 38—*b* while the control current is carried farther on over lead 34—*b* and the line side winding of transformer 31—*b* into the transmitting channel 40—*a* and reaches the input 35—*a* of the other electronic device 28—*a*. Within this device, the D. C. control potential is conveyed from winding 47'—*a* of the input transformer 47—*a* over leads 37—*a* and 48—*a* along resistor 49—*a* to the ground common to all electronic devices of the system. The voltage drop produced along resistor 49—*a* has the effect of biasing the control grids of both, valve 43—*a*, thereby blocking the secondary circuit, and valve 41—*a*, thereby insuring against unblocking of the primary circuit. The path over which sound energy should be transmitted from station 27—*b* to station 27—*a* in reply to the latter's call, thus remains inactive being blocked as long as station 27—*a* is talking. This has the advantage that the objectional effects of feed-back, et cetera, are en-

tirely eliminated, but is also a handicap insofar as it does not permit the user at station 127—b to interrupt or cut-in while the other is talking since his own transmission path is still blocked. In these circumstances interrupting would only be possible when the intervals or pauses between the syllables or words or sentences happened to be relatively large. For enabling the receiving station to cut-in or interrupt at will, I have provided additional arrangements which will be described later on in connection with Fig. 4.

The function of the electronic device in the operation of the system when used in the opposite direction, is analogous to that in the direction described.

The time which takes the unblocking of the initially blocked primary circuit from the very moment of sound induced current reaching the input of the electronic device, can be made so small as to be practically unnoticeable, i. e., 0.08 to 0.12 second. The control potential which makes the secondary circuit of the other electronic device inoperative may be adjusted at an average value of two or three times that required for the cutting-off point of the respective input valve. Although I do not limit myself to any definite figure, with the arrangement of Fig. 3 this value may amount to 18 to 22 v. so as to afford an ample safety factor. If, however, I consider it desirable to increase the safety factor, I may add to the by-path an automatic amplitude responsive gain reducer, the arrangement of which is shown in Fig. 6.

Fig. 6 represents a detail out of the total system shown in Fig. 3, whereof those elements and connections have been omitted which are not required for the understanding of this detail. The elements denominated in Fig. 6 as 235, 247, 248, etc., correspond to those denominated 35, 47, 48 in Fig. 3. The secondary circuit is indicated by the valves 243 and 244, the primary circuit only by valve 241. Additional to the circuit shown in Fig. 3 is diode 90 whose anode 92 is connected over a resistor or choke 95 to the control grid of valve 244 and also grounded for A. C. over the capacitor 96. Cathode 91 of diode 90 is connected over a capacitor 94 to the control grid of the input valve 241 of the primary circuit and over resistor or choke 93 to the movable arm 97 of potentiometer 251.

The circuit operates as follows. Cathode 91 is charged with a positive potential which can be so adjusted as to make the diode conductive when the voice talking into the microphone connected to the input terminals 235 becomes too loud, but for all amplitudes not exceeding a predeterminable level of sound intensity, the diode 90 remains non-conductive. When the sound energy exceeds such limit and diode 90 becomes conductive, a continuous current can flow along resistor or choke 95 and charge the control grid of valve 244 more negatively. This operates to reduce the gain of this valve up to complete blocking and has the consequence that no D. C. control current can be delivered from diodes 255/256.

Supplementary to the control exerted on the control grid of valve 243 by the D. C. control voltage the automatic amplitude responsive gain reduction controls the by-path so as to keep amplified sound induced currents from reaching the diodes 255/256 whenever the input valve 243 tends to change from a type A-amplifier to a B or C type.

Fig. 4 represents modified details of Fig. 2 with those elements and connections reproduced only en bloc or omitted which are not required for the understanding of the modifications. The elements denominated 129, 130, 140 in Fig. 4 correspond to those denominated 29, 30 and 40 in Fig. 2. For simplicity, two-wire channels have been represented by one single line wherever admissible. The following additions have been made to the elements of each station 127: two switches 73 and 74, both preferably of the momentary press button type, however, differing in that in the normal position switch 73 is closing and 74 opening its circuit. Switch 73 is inserted in the receiving channel 139, switch 74 is arranged for connecting a line 80 to the transmitting channel leading to that electronic device whose output is in fixed connection with the station embodying the switches that is in the example shown by Fig. 4, to transmitting channel 140—a leading to electronic device 128—a the output of which is in fixed connection with station 127—a thru the receiving channel 139—a. Line 80 represents a distribution system branched towards all stations of the communication system and is permanently energized by both a sound-signal generator 76 and a constant D. C. current source 81, suitably combined into one unit 75 equipped with an output transformer 77, whereby the D. C. source is grounded at one end and connected to the center tap of the line side coil of transformer 77 at its other end. The function of switch 73 is to enable the called up station to cut-in or interrupt while the calling station is talking. Let 127—b be the calling station just transmitting to the called-up station 127—a. When the latter desires to cut-in, all he has to do is to press the button of switch 73—a start talking and then again release the press button. This short interruption of the receiving channel cuts off the sound current, but at the same time, the control current due to the talking of station 127—b, since both currents have been entering station 127—a on the common path 139—a, so that electronic device 128—b is no more reached by the blocking potential, the formerly blocked transmission path 140—b—primary circuit of 128—b—139—b is opened for transmission from 127—a to 127—b and electronic device 128—b can now freely send out the control potential which blocks electronic device 128—a. The result of the momentary interruption is a shifting-over of the command of the transmission path from the talking to the interrupting station, and the system is now normally operating in the reverse sense, i. e., under same conditions as if 127—a had been the calling station and 127—b been called-up.

In other conditions, the interruption of a channel while a station is talking, may well affect the stability of a system by giving rise to feed-back effects and dangerous peaks in the opened transmission path, but in my invention both are suppressed by the immediately and automatically effected reversal of the operation of the control system, provided the interrupting switch is associated with the receiving channel.

In order to explain the function of switch 74 I shall exemplify one of its possible applications with reference to Figure 4.

Assuming that station 127—b has called up station 127—a. Microphone 129—b which may preferably be of the moving coil or another reversible type, is then switched on to channel 140—a leading to the input transformer of the electronic device 128—a. The call has been re-

ceived by station 127—*a*, but for some reason or the other, station 127—*a* has not become aware of the identity of the calling station, therefore in order to respond to the call, would have to try out by calling up one station after the other. Instead of this complicated and time-taking procedure station 127—*a* is enabled to transmit back a preconcerted signal to station 127—*b* over the one existing one-way path by pushing the button of switch 74—*a* and thereby connecting channel 140—*a* to line 80. The microphone 129—*b* thus becomes the receiving element for the sound signal conducted thru this channel and the electronic device 128—*a* becomes non-operative since the D. C. voltage simultaneously conveyed thru channel 140—*a* has a blocking effect on the secondary circuit of device 128—*a*. The signal can only be received by that station which has established the one-way path but not by any other station and ceases when the switch button is released. The user of station 127—*b* when receiving this preconcerted signal will understand that he is asked thereby to reveal his identity.

It will be understood that the value of the D. C. voltage supplied by source 81 must exceed the sum of the cut-off bias potential of valve 43 in the secondary circuit plus the peak value of the signal, otherwise valve 43 may change from an A type into a B type or C type amplifier and, as such fail to effect total blocking. Numerically this value may be about 25 v. being negative with respect to the line.

Figure 5 shows the transducer 81 which is a combination of the receiving and transmitting element into one unit and the means for incorporating this unit in the communication system. The moving coil of transducer 81 constitutes one leg of a bridge-network. The second and third leg are formed each by one-half 82' and 82'' respectively of the station-side winding of transformer 82, the line-side winding being connected to the terminals 87 of the receiving channel. The fourth leg is formed by the induction coil 86. The balanced points 84 and 85 of the bridge are connected to the station-side windings 83' of the transformer 83 whose line-side winding 83'' is connected to the terminals 88 of the transmitting channel. Lead 89 represents the bridge which is identical with the one denominated 34 in Figure 2.

The operation is as follows: Accoustic waves impressed on transducer 81 and transformed into sound currents are conducted over transformer 83 and terminals 88 into the transmitting channel. The problem of incorporating the transducer unit in the communication system is to avoid feed-backs from the receiving channel owing to both, the receiving and transmitting element, being electrically connected to each other within the transducer. This is achieved by the bridge-network. It is evident that if the bridge-network is balanced, no sound currents from the receiving channel 87 can reach the transmitting channel. The balancing may be carried out by adjusting coil 86 or in any other conventional way. The stability of the two-way communication system is thus maintained even with slight deviations from perfect balancing provided that the highest resultant A. C. amplitude sent into the transmitting channel does not exceed the value of the D. C. control voltage conveyed thru the same channel. False operation due to excess values may be avoided by making use of the automatic amplitude responsive gain reducer circuit illustrated in Fig. 6.

Modifications of the systems of my invention described and illustrated above, may be apparent to persons skilled in the art. I wish to make it clear that all details are given by way of examples only and do not limit in any way the spirit of the invention and the scope of the appendent claims.

I claim:

1. In an arrangement for establishing and maintaining a simultaneous two-way communication of the loud-speaking type in a network of independent one-way transmitting channels, thereby preventing any kind of feed back, a loudspeaking reproducer and a voice transmitting element, belonging to different and remotely located stations operatively associated with each channel, each channel having its own amplifying and electronic controlling means for providing transmission of sound above a predetermined threshold level, thereby producing a control current which enters the channel simultaneously with the amplified sound current, and disabling means responsive to control current for providing and maintaining the initial non-conductivity of the channel for transmission even for sound intensity above said predetermined threshold level, which comprises separate receiving and transmitting circuits at the stations adapted to be connected to transmitting channels of opposite direction for simultaneous two-way communication, interconnecting means between said two circuits at the stations constituting a bridge for control current to pass over from one into the other circuit, so that control current impressed together with amplified sound current at the receiving circuit at the station enters the channel of opposite direction which has been connected to said transmitting circuit of that station.

2. In a voice controlled, loudspeaking intercommunicating system, the combination including, an equal number of stations, one-way transmitting channels and electronic devices, each electronic device having means responsive to sound induced current impressed on its input, including thermionic valves, for amplifying and rectifying, providing amplification of sound current and producing a control current respectively, gain controlling means responsive to sound induced current signals above a predetermined energy level operatively associated with said first mentioned means, said gain controlling means being also responsive to control current impressed on said input of the device for disabling said first mentioned means, an output circuit adapted to be fed simultaneously with control and amplified sound currents produced by said amplifying and rectifying means in response to sound induced current input signals above a predetermined energy level, said electronic device itself not being conductive for transmission of sound of input signals below a predetermined energy level nor of those above said predetermined energy level since there is simultaneously a control current impressed on said input of the device, each of said transmitting channels being associated with its own electronic device, each station including separate receiving and transmitting circuits leading to a loudspeaking reproducer and a voice transmitting element respectively, means interconnecting said receiving and transmitting circuits constituting a bridge for control current to pass over from one into the other circuit, the re-

ceiving circuit being permanently connected to the end of that of the channels to which it belongs, and switch means at the station for selectively connecting said transmitting circuit to selected transmitting channels for transmitting to selected stations.

3. In a voice controlled, loudspeaking communication system, the combination including, a number of stations, each having separate receiving and transmitting circuits leading to a loudspeaking reproducer and a voice transmitting element respectively, interconnecting means between said two circuits constituting a bridge for control current to pass over from one into the other circuit, and switch means for selectively connecting said transmitting circuit to selected communication channels; communication channels associated with electronic devices, each electronic device having amplifying and rectifying means, including thermionic valves, for delivering simultaneously amplified sound current and a control current at the output of the device in response to sound induced current signals above a predetermined energy level impressed on the input of the device, and for maintaining the initial non-conductivity even for transmission of sound input signals above said predetermined energy level during the period of presence of control current at said input, said stations and communication channels operatively associated with each other so that a two-way loudspeaking communication may be established between any two stations over two of said channels, the two-way communication itself being maintained and controlled by mutual control currents flowing from the output of the electronic device of that of the two channels which is actually transmitting sound, over the bridge at the station into the second channel and on to the input of the second electronic device, the channels themselves serving as a transmission path to sound induced currents as well as control currents.

4. In a voice controlled, loudspeaking communication system, the combination including a number of stations each having separate receiving and transmitting circuits leading to a loudspeaking reproducer and a voice transmitting element respectively, interconnecting means between said two circuits constituting a bridge for control current to pass over from one into the other circuit, switch means for selectively connecting said transmitting circuit to selected communication channels, communication channels associated with electronic devices, each electronic device having amplifying and rectifying means, including thermionic valves, for delivering simultaneously amplified sound current and a control current at the output of the device in response to sound induced current signals above a predetermined energy level impressed on the input of the device, and maintaining the initial non-conductivity for transmission of input signals above said predetermined energy level during the period of presence of control current at said input, said stations and communication channels operatively associated with each other so that a two-way loudspeaking communication may be established between any two stations over two of said channels, the two-way communication itself being maintained and controlled by mutual control currents flowing from the output of the electronic device of that of the two channels which is actually transmitting sound, over the bridge at the station into the second channel and on to the input of the second electronic device, the channels themselves carrying control as well as sound induced currents, a break-in switch at the station inserted in said receiving circuit ahead of said interconnecting means for momentarily interrupting reception of both control and amplified sound currents and re-establishing conductivity of the other channel while transmitting to the other station and consequently providing non-conductivity of the first channel which has been transmitting.

5. An electronic device, including in combination, two parallel circuits operatively associated with each other, the primary circuit constituting a sound amplifier for amplifying the sound to be transmitted, said amplifier having at least the input valve on the pentode type, one of its grids being connected both directly through a lead to the plate of an associated three-electrode valve and over a high resistance to the power supply, while the control grid of said associated valve is connected over filter means to a voltage divisor in the output circuit of a rectifier belonging to the secondary circuit of the electronic device, the secondary circuit itself constituting a detector amplifier, including a diode, and means for adjusting the gain of the amplifier part therein as well as for establishing a predetermined conductivity threshold value of said diode, connecting means including filter means between the output circuits of both the detector and the sound amplifier for delivering simultaneously amplified sound current and a control current at the output terminals of the device in response to sound induced current signals above a predetermined energy level impressed on the input terminals, means associated with the input circuits of both the sound amplifier and the detector amplifier responsive to control current impressed on the input terminals of the device for disabling production of control current by said detector amplifier and consequently providing non-conductivity of the device itself for transmission of sound, even for sound current input signals above said established predetermined energy level.

6. A station for use in an intercommunicating system, including in combination, separate receiving and transmitting circuits responsive to voice currents as well as to interstation control currents, means interconnecting said two circuits constituting a bridge for control current to pass over from one into the other circuit, a loudspeaking reproducer operatively associated with said receiving circuit, and a voice transmitting element operatively associated with said transmitting circuit, switch means for selectively connecting said transmitting circuit to selected communication channels for transmitting thereof, and a break-in switch inserted in said receiving circuit ahead of said interconnecting means for momentarily interrupting reception of incoming control and amplified sound currents, thereby preventing that control current enters said transmitting circuit.

7. A station for use in an intercommunicating system, including in combination, separate receiving and transmitting circuits responsive to voice currents as well as to inter-station control currents, said two circuits constituted substantially by the line side windings of transformers, means interconnecting the centertaps of said transformer windings for conveying control current from one into the other of said two circuits, a single transducer unit of the moving coil type serving as loudspeaker and microphone, an inductance coil having an impedance equal to that

of the moving coil of the transducer, a balanced bridge network, the four legs of which being constituted by the moving coil, said inductance coil and the symmetrical halves of the station side winding of the receiving circuit transformer, the station side winding of the transmitting circuit transformer being connected to the centertaps of the station side winding of the receiving circuit transformer and to the junction of said two coils respectively, switch means for selectively connecting said transmitting circuit to selected communication channels for transmitting thereover, a break-in switch inserted in said receiving circuit ahead of said interconnecting means for momentarily interrupting of incoming control and amplified sound currents, thereby preventing that control current enters said transmitting circuit.

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