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July 25, 1939. L. SCHOTT ET AL 2,167,007

TRANSMISSION CIRCUIT

Filed May 15, 1937 2 Sheets-Sheet 1

FIG. 1

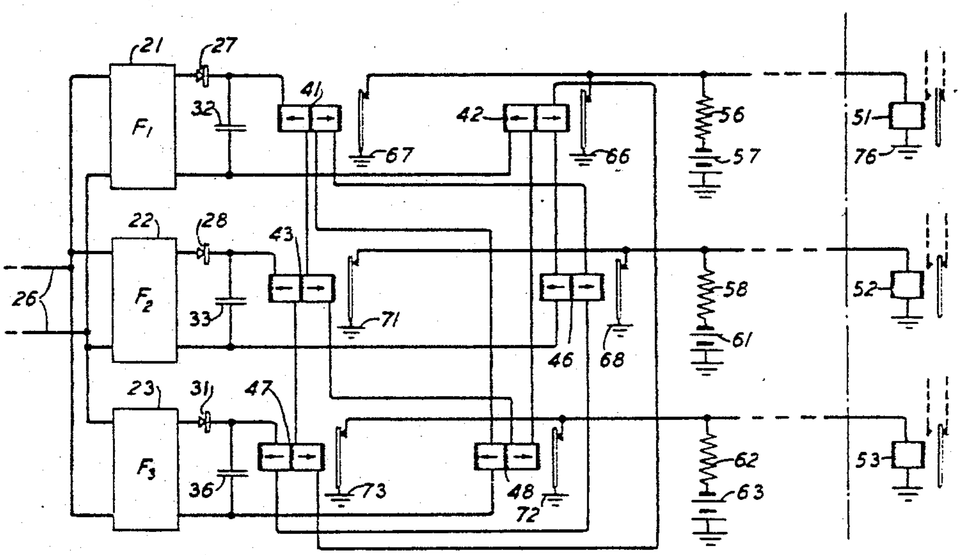
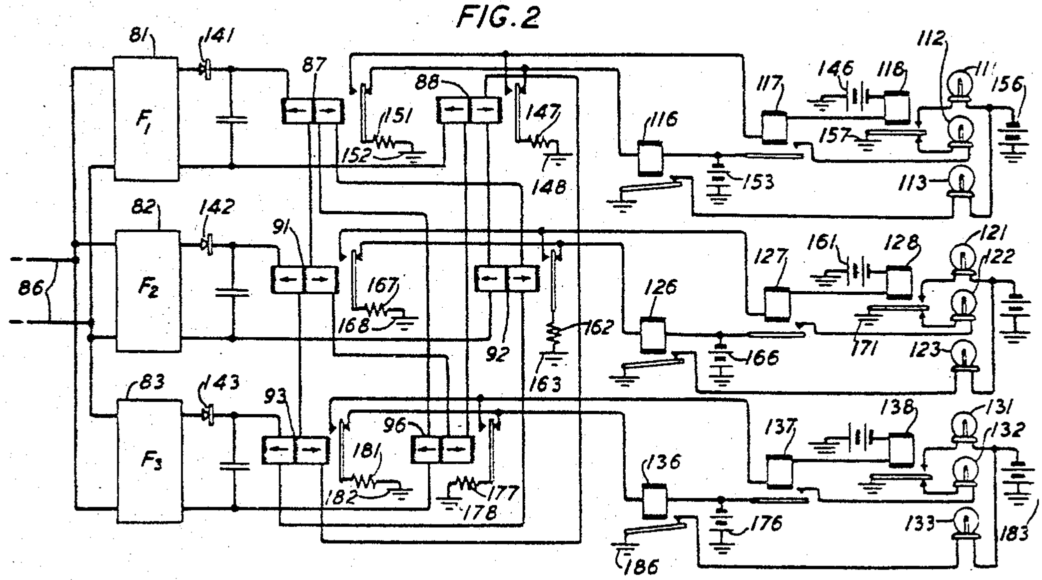


FIG. 2



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ATTORNEY

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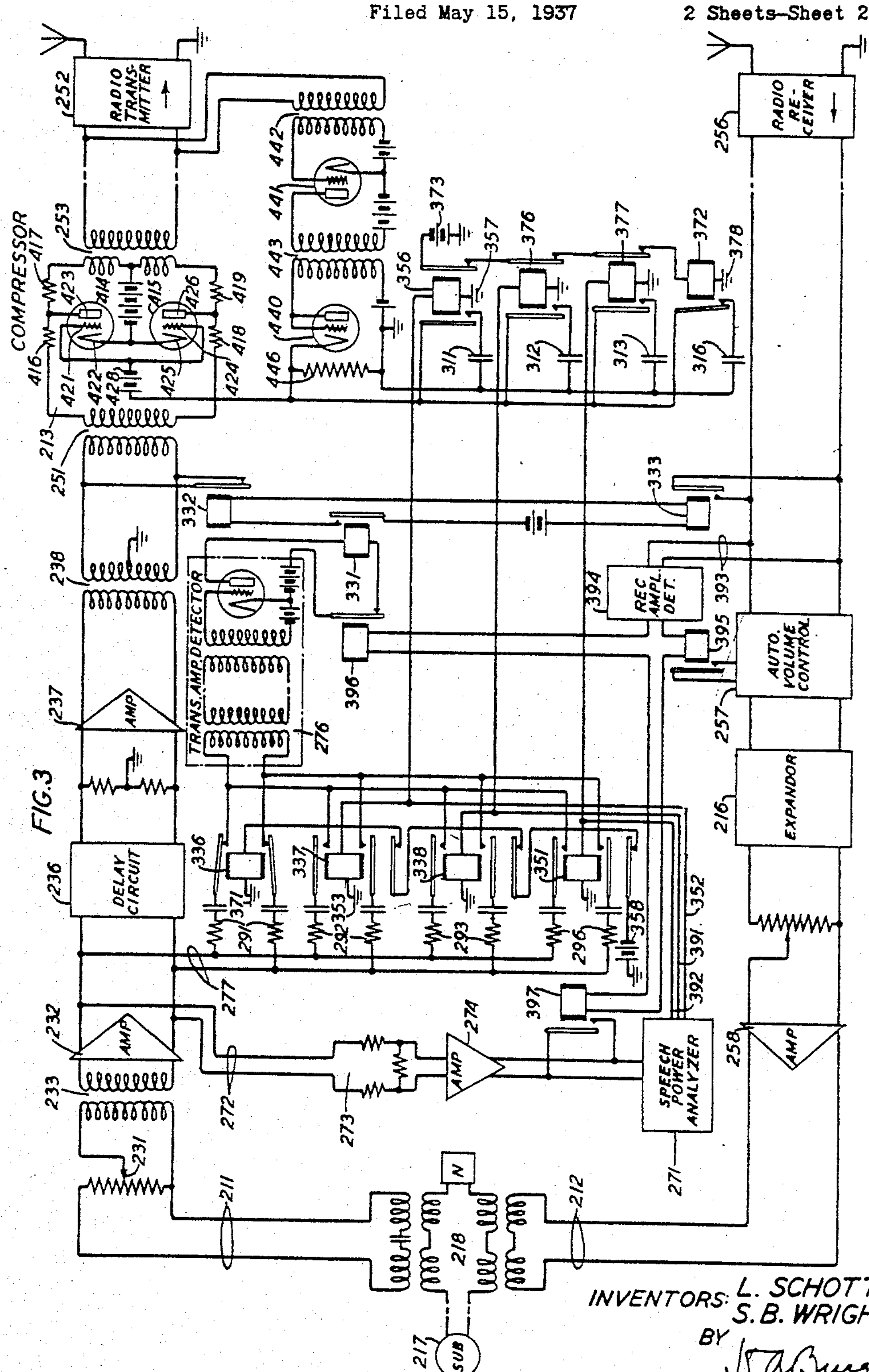
FIG. 3



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Patented July 25, 1939

2,167,007

UNITED STATES PATENT OFFICE

2,167,007

TRANSMISSION CIRCUIT

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Application May 15, 1937, Serial No. 142,832

6 Claims. (Cl. 177—311)

This invention relates to a transmission circuit and particularly to a transmission circuit which includes voice-operated devices.

An object of the invention is to improve the operation of voice-operated devices associated with transmission circuits.

A more specific object of the invention is to automatically adjust the characteristics of voice-operated devices in accordance with certain characteristics of the signal waves applied thereto in order to obtain optimum performance of said devices.

It is common practice, of course, to associate with certain types of speech transmission circuits, voice-operated devices, such as echo suppressors, amplifier-detectors, vogads (gain control device) compandors and the like. It has appeared to applicants that the operation of such devices could in many cases be improved if means were provided for indicating which particular range of frequency of the transmitted band is carrying the greatest power. Having such an indication, that is, that one particular band in the frequency spectrum of waves being transmitted is most prominent, certain adjustments of and connections to the voice-operated device could be made whereby that prominence would be taken advantage of. For example, that particular one of a plurality of input circuits associated with the voice-operated device having most suitable characteristics for the indicated range might be selected and connected to the voice-operated device.

In accordance with a feature of the invention the band of frequencies being transmitted is divided into a plurality of smaller bands and indication is then made of that particular smaller band in which the power is greatest.

In accordance with a further feature of the invention indications are made, not only of the most prominent band, but also of the order of prominence of all the bands, that is for example "maximum power", "intermediate power" and "minimum power".

In accordance with a specific embodiment of the invention three band-pass filters are provided being effective to divide the speech frequency band being transmitted into three smaller bands. The power in each of these three bands is then measured by means which includes a series of relays so poled that the current from the most prominent band, with respect to the power therein, will cause operation of all the relays directly associated with that band and will oppose operation of the relays directly associated with the other bands.

A complete understanding of the arrangements contemplated by the invention and of the various advantageous features thereof will be gained from consideration of the following detailed description and the accompanying drawings in which:

Fig. 1 illustrates a circuit embodying features contemplated by the invention for indicating in which of three frequency bands the power is greatest;

Fig. 2 illustrates a circuit similar to that of Fig. 1 in which means have been provided to indicate the order of prominence of the three frequency bands with respect to the power therein; and

Fig. 3 illustrates schematically one application of the arrangement illustrated in Fig. 1 in connection with the automatic adjustment of certain characteristics of voice-operated devices.

Referring now to Fig. 1, three band-pass filters 21, 22 and 23 are shown connected in parallel across line 26. These filters serve to divide the frequency range received from line 26 into three smaller bands, it being assumed that filter 21 passes the "high" band, filter 22 the "medium" band and filter 23 the "low" band. (Band-pass filters are widely used in transmission circuits and their design and method of operation are described in a number of patents such as, for example, G. A. Campbell Patent 1,227,113, issued May 22, 1917, "Electric wave-filter.")

A rectifier is associated with each of the three filters (rectifier 27 being associated with filter 21, rectifier 28 being associated with filter 22 and rectifier 31 being associated with filter 23) which rectifiers serve to change the alternating current output therefrom into direct current. Condensers 32, 33 and 36 are provided to smooth the current impulses of the rectified waves in order that differential relays 41, 42, 43, 46, 47 and 48 will respond more to the general wave shape of the speech than to the instantaneous values of the current. The small arrows shown on the differential relays referred to indicate by their direction the effect of current passing through the windings. For example, referring to relay 41, current passing through the left-hand winding tends to operate the relay, that is, to move the armature to the left or away from the contact while current in the right-hand winding tends to oppose operation of the relay, that is to hold the armature in engagement with the contact as shown. Casual inspection will reveal that the relays are so arranged that current from each filter passes through one winding of each of four relays and that in each instance the current in two relays tends to operate these relays and in the other two relays tends to oppose operation.

To the right of the broken line, three relays, 51, 52 and 53, are shown, one relay being associated with each pair of the differential relays; that is relay 51 is associated with relays 41 and 42, relay 52 is associated with relays 43 and 46 and relay 53 is associated with relays 47 and 48. These three relays are merely illustrative of one arrangement which may be utilized to provide an indication of the particular range in which the power is greatest. A lamp, or other type of indicator, may, if desired, be controlled by these relays or, in fact, may be directly substituted for the relays. Further, while the circuit arrangement disclosed is such that these relays are normally in nonoperated position when speech is not being applied to the circuit, the arrangement may, if desired, be such that the relays will remain in the condition last obtaining when speech was applied.

Resistance 56 and battery 57 are associated with the line leading to relay 51, resistance 58 and battery 61 are associated with the line leading to relay 52 and resistance 62 and battery 63 are associated with the line leading to relay 52 and resistance 62 and battery 63 are associated with the line leading to relay 53. Relays 51, 52 and 53 are normally shorted by paths leading respectively to grounds 66 and 67, to grounds 68 and 71 and to grounds 72 and 73.

In order to further describe the arrangement of Fig. 1, let us suppose that the range of frequencies being passed by filter 21 is the most powerful and let us see how operation of relay 51 is brought about to indicate this fact, relays 52 and 53 at the same time to remain unoperated. It may be further assumed that the medium power is existent in the range passed by filter 22 and that the lowest power is in the range passed by filter 23.

The current passed by filter 21 after rectification by rectifier 27 passes through the left winding (aiding) of relay 41, right winding (opposing) of relay 43, right winding (opposing) of relay 48, left winding (aiding) of relay 42 and back to the other side of line 26. Now as the direction of the current through relays 41 and 42 is in the aiding direction these two relays will operate while as the direction of the current through relays 43 and 48 is in the opposing direction, the latter two relays do not operate.

Operation of relays 41 and 42 interrupts the short-circuit path of relay 51 to respective grounds 66 and 67 and establishes an effective operating circuit for relay 51 traced from battery 57, resistance 56, winding of relay 51 to ground 76. Relay 51 now operates as an indication that the power in the range passed by filter 21 is greatest.

Now let us see the effect on the circuit of the medium power and the low power currents passed respectively by filters 22 and 23. The medium powered current passed by filter 22, after being rectified by rectifier 28, passes through the left winding (aiding) of relay 43, right winding (opposing) of relay 47, right winding (opposing) of relay 42, left winding (aiding) of relay 46 and back to the other side of line 26. Now while the direction of this medium powered current through relays 43 and 46 is in the aiding direction only one of the relays, i. e., relay 46, operates. Relay 43 does not operate in view of the fact that the aiding effect of the medium powered current is overcome by the opposing effect of the high powered current passing through the right-hand winding. Therefore, while the short-circuiting path of relay 52 to ground 68 is interrupted, the short-circuiting path to ground 71 remains and an effective operating circuit for relay 52 is not set up. The "opposing" effect of the medium powered current passing through the right winding of relay 42 does not, of course, prevent operation of this relay by the more powerful current passing through the left winding in the aiding direction.

Considering now the effect of the low powered current passed by filter 23, this current after rectification by rectifier 31 passes through the left winding (aiding) of relay 47, right winding (opposing) of relay 46, right winding (opposing) of relay 41, left winding (aiding) of relay 48 and back to the other side of line 26. None of the relays is operated by this current, the aiding effect in relays 47 and 48 being offset by the greater opposing effect of the medium power current and the high power current respectively. Neither of the short-circuiting paths of relay 53 is interrupted therefore and the relay remains unoperated. The opposing effect of the low-power current on relays 46 and 41 does not, of course, prevent operation of these relays by the more powerful currents which pass through the relays in the aiding direction.

It will be evident from the above that only one of the indicating relays (51, 52, 53) will operate, namely, the one associated with the filter passing the frequency range in which the power is greatest. Lamps, bells or any other desired type of indicator may be so associated with the contacts of the relays that their operation will be controlled by operation of the respective relays.

It will be understood, of course, that the circuit operates in a similar manner for other distributions of power, for example, should maximum power be existent in the current passed by filter 22, relay 52 will be operated and should maximum power be existent in the current passed by filter 23 relay 53 will be operated.

Referring now to Fig. 2 a modification of the arrangement described above is illustrated in accordance with which indication is given not only of the most prominent band with respect to power but also the order of prominence of all the bands, i. e., which band is most powerful, which band is second in power and which is third in power. Here again as in the instance of the circuit illustrated in Fig. 1, three band-pass filters 81, 82 and 83 are provided which are effective to divide the frequency band being transmitted over line 86 into three smaller bands, it being assumed that filter 81 passes the high band, filter 82 the medium band and filter 83 the low band. As in the circuit of Fig. 1, the output of each filter is connected through one winding of each of four relays, relays 87, 88, 91, 92, 93 and 95 of the present circuit corresponding in general, as to arrangement and operation, to relays 41, 42, 43, 46, 47 and 48 of Fig. 1. Three lamps with relays for controlling the energization thereof have, in accordance with the present modification, been associated with each filter channel, lamps 111, 112 and 113 and relays 116, 117 and 118 being associated with filter 81, lamps 121, 122 and 123 and relays 126, 127 and 128 being associated with filter 82 and lamps 131, 132 and 133 and relays 136, 137 and 138 being associated with filter 83. Each of the three lamps of a group is preferably marked in a distinctive manner in accordance with the order of prominence of power which it is intended to indicate when energized, for example, lamp 111 may be marked "maximum", lamp 112 may be marked "intermediate" and lamp 113 may be marked "minimum" and so on.

Let us assume now for purposes of further description that maximum power is present in the range of frequencies passed by filter 81, that the next to maximum or the intermediate power is present in the range of frequencies passed by filter 82 and that the lowest or minimum power is present in the range of frequencies passed by filter 83. To properly indicate these conditions the "maximum" lamp associated with filter 81, i. e., lamp 111, should be lighted, the "intermediate" lamp associated with filter 82, i. e., lamp 122 should be lighted and the "minimum" lamp associated with filter 83, i. e., lamp 133, should be lighted. Let us trace the operation of the circuit in order to determine how such multiple indication is accomplished.

The operation of relays 87, 88, 91, 92, 93 and 96 is the same as that of the corresponding relays of Fig. 1 described in detail above and will be described only briefly, therefore. The maximum powered current passed by filter 81, after being rectified by rectifier 141, passes through the left winding (aiding) of relay 87, right winding (opposing) of relay 91, right winding (opposing) of relay 96 and left winding (aiding) of relay 88, relays 87 and 88 operating and relays 91 and 96 being held in unoperated position by this current.

The intermediate powered current passed by filter 82 after being rectified by rectifier 142 passes through the left winding (aiding) of relay 91, right winding (opposing) of relay 93, right winding (opposing) of relay 88 and left winding (aiding) of relay 92. Only relay 92 is operated by the intermediate powered current, the opposing effect of the more powerful current in the right winding of relay 91 preventing operation thereof.

The low powered current passed by filter 83 after being rectified by rectifier 143, passes through the left winding (aiding) of relay 93, right winding (opposing) of relay 92, right winding (opposing) of relay 87 and left winding (aiding) of relay 96. None of the relays is operated by the low powered current, however, as in the instance of relays 93 and 96, the more powerful current in the opposing direction prevents operation thereof.

As a result of the currents passed by the three filters therefore, relays 87, 88 and 92 are operated while relays 91, 93 and 96 are held in the unoperated position illustrated.

Operation of relays 87 and 88 completes a path traced from battery 146, through the windings of relays 118 and 117 to ground through two parallel resistance paths, one path through make contact of relay 88, resistance 147 to ground 148 and the other path through make contact of relay 87, resistance 151 to ground 152. In view of the parallel connection of resistances 147 and 151 in the path the current flow is sufficient to cause operation of relays 117 and 118. Operation of relays 87 and 88 also interrupts the energizing path for relay 116 (battery 153, winding of relay 116, and the break contacts of relays 87 and 88 through resistance 147 to ground 148 and through resistance 151 to ground 152 respectively) and relay 116 therefore drops back to unoperated position.

Operation of relay 118 establishes an energizing path for lamp 111 (maximum power indicator) traced from battery 156, lamp 111, make contact of relay 118 to ground 157. Lamp 111 therefore lights to indicate that the maximum powered band is being passed by filter 81. Lamp 112 cannot light as its energizing path is open at the break contact of relay 118 (operated) while lamp 113 likewise cannot light as its energizing path is open at the make contact of relay 116 (unoperated).

Let us see now what happens in the group of lamps (lamps 121, 122 and 123) associated with filter 82. As this filter is passing the medium powered range, lamp 122 should be lighted as this lamp is the "intermediate power" indicator. It will be recalled that relay 92 is operated while relay 91 remains unoperated, i. e., in the position illustrated. We have, therefore, a path traced from battery 161, through the windings of relays 128 and 127, make contact of relay 92, resistance 162 to ground 163. Here we do not have, as in the instance of the operating circuit of relays 117 and 118, parallel resistance paths to ground but only a single resistance path. The current which flows in this path is not as great as in the instance of the parallel resistance path traced above and, while sufficient to operate relay 127, is not sufficient to operate relay 128 which is designed to have a higher operate value than that of relay 127. Likewise the current which flows in the path traced from battery 166, winding of relay 126, break contact of relay 91 (unoperated), resistance 167 to ground 168 is not sufficient to hold relay 126 in operated position and the relay therefore drops back to unoperated position.

Operation of relay 127 establishes an energizing path for lamp 122 traced from battery 166, make contact of relay 127, lamp 122, break contact of relay 128 (unoperated) to ground 171. Lamp 122 therefore lights to indicate that the intermediate power current is being passed by filter 82. Lamp 121 cannot light as its energizing circuit is open at the make contact of relay 128 while lamp 123 cannot light as its energizing path is open at the make contact of relay 126.

Referring now to the group of lamps associated with filter 83 (lamps 131, 132 and 133) we should expect to find lamp 133 operated, this lamp being the "minimum power" indicator. It will be remembered that neither relay 93 nor relay 96 is operated. We have therefore an energizing path for relay 136 traced from battery 176, winding of relay 136 through two parallel resistance paths to ground, one path from break contact of relay 96 through resistance 177 to ground 178 and the other path through break contact of relay 93 through resistance 181 to ground 182. Sufficient current will flow from battery 176 over these parallel resistance paths to ground to cause operation of relay 136 thereby providing an energizing path for lamp 133 traced from battery 183, lamp 133, make contact of relay 136 to ground 186. Lamp 133 lights therefore to indicate that the "minimum power" current is being passed by filter 83. Lamp 131 cannot light as the energizing path thereof is open at the make contact of relay 138 and lamp 132 cannot light as the energizing path thereof is open at the make contact of relay 137.

It will be understood that the circuit will operate in a similar manner for other distributions of power, for example, should the maximum power current be passed by filter 82, the medium power current by filter 83 and the minimum power current by filter 81, lamps 121, 132 and 113 would be lighted.

Referring now to Fig. 3, a practical application of the power analyzer circuit of Fig. 1 is illustrated. There is shown in this figure, in partial schematic, a two-way four wire terminal of a radio telephone system. The four wire line comprises a transmitting channel 211 and a receiving channel 212. Transmitting channel 211 includes a compressor 213 while receiving channel 212 includes an expander 216, the two (compressor and expander) constituting a compandor of the general nature disclosed in Doba Patent 2,018,489 issued October 22, 1935. The application of a compandor to a terminal circuit of the general nature illustrated is described in an article "The Compandor—An Aid Against Static in Radio Telephony", by R. C. Mathes and S. B. Wright, which was published in Electrical Engineering of June 1934, vol. 53, pages 860 to 866.

The output from subscriber's station 217 is coupled to transmitting channel 211 through windings of hybrid coil 218. Potentiometer 231 may be utilized to regulate the volume of this output which is then passed to amplifier 232 by transformer 233. The output of amplifier 232 is connected through relay circuits 236 to amplifier 237. The output of amplifier 237 is connected through transformers 238 and 251 to compressor 213. The portion of the circuit described in this paragraph is similar to that fully disclosed in Patent 2,084,457 issued June 22, 1937, to L. Schott, entitled "Transmission systems".

Compressor 213 is of the type disclosed in Doba Patent 2,018,489 referred to above; three digit numbers in the "400" series used herein are intended to correspond to two digit numbers used in the Doba patent, the last two digits of the three digit numbers of the "400" series used herein being the same as the numbers of the Doba patent with which they are intended to correspond. For example, the vacuum tube of Fig. 3, designated 414, is the same as tube 14 of the Doba patent, the vacuum tube designated 440 of Fig. 3 is the same as tube 40 of the Doba patent, battery 428 of Fig. 3 is the same as battery 28 of the Doba patent, and so on.

The output of compressor 213 is coupled to radio transmitter 252 through transformer 253.

Receiving channel 212 is shown in a more or less schematic manner, the output of radio receiver 256 being coupled to the input of subscriber's set 217 through windings of hybrid coil 218, automatic volume control device 257, expander 216 (as disclosed in Doba Patent 2,018-489) and amplifier 258 being included in the channel.

Speech power analyzer 271, which preferably is of the type illustrated in Fig. 1 and described above, is connected across transmitting channel 211, at the constant volume point beyond repeater 232, by line 272. A bridging pad 273 together with amplifier 274, the gain of which is sufficient to supply the necessary output power, are included in line 272.

Transmitting amplifier-detector 276 is also bridged across transmitting channel 211, at the constant volume point, by line 277.

Heretofore it has been the usual practice in the instance of such voice operated devices as amplifier-detector 276 to tune the input transformer circuit associated therewith rather broadly by means of a series condenser and a resistance, thereby producing a circuit effective at the more important voice frequencies but inefficient at other frequencies. It has appeared to applicants, however, that the operation of such devices will be improved if a plurality of somewhat narrowly tuned circuits be provided and if the input circuit associated with the amplifier-detector at any one time be selected in some accordance with an indication of which band of frequencies is the highest powered. There is disclosed, therefore, in association with amplifier-detector 276 and line 277, a plurality of tuned circuits 291, 292, 293 and 296, each of which is tuned to operate most efficiently with a different band of frequencies. Through operation of speech power analyzer 271 that particular input circuit which is tuned to the particular band of frequencies in which the power is maximum at a particular instant is selected and associated at that instant with the input transformer of amplifier-detector 276. The exact circuit operations involved will be described subsequently.

Heretofore it has been the usual practice in the instance of such devices as compressor 213 to connect a condenser of predetermined magnitude across the input to the rectifier circuit (i. e., referring to Fig. 3 across the input to vacuum tube 440 just to the left of resistance 446) in order to provide a time constant so that the voltage across the resistance will vary according to the syllabic frequency. It has appeared to applicants that here again the operation would be improved if, instead of a single condenser, several condenser circuits of different time constants were to be provided and selected for association with the compressor circuit in coordination with the selection of the tuned input circuits referred to above. Accordingly a plurality of condensers 311, 312, 313 and 316, of different time response characteristics, are provided; the circuit operations involved in their selection and association with the compressor circuit in coordination with selection and association of the tuned input circuits with the amplifier-detector will be described subsequently.

A part of the voice currents originating at substation 217 and passed to transmitting channel 211 through windings of hybrid coil 218, pass through the amplifiers, the delay circuits and the compressor included in the transmitting channel and are transmitted by radio transmitter 252. A part of these voice currents is shunted over line 272 to speech analyzer 271 which is of the type illustrated in Fig. 1 and described in detail above. Still another part of the voice currents is shunted through line 277 and one of the tuned input circuits 291, 292, 293 or 296 to transmitting amplifier-detector 276. These currents cause operation of the amplifier-detector resulting in turn in operation of relay 331. Operation of relay 331 completes an obvious operating circuit for relays 332 and 333. Relay 332 by its operation removes the short circuit previously applied through its break contact to transmitting channel 211, thereby "enabling" the channel for passage of voice currents to radio transmitter 252. Relay 333 by its operation completes a short-circuiting path across receiving channel 212, thereby "disabling" the receiving channel.

A relay is associated with each of the tuned input circuits, relay 336 being associated with input circuit 291, relay 337 with input circuit 292, relay 338 with input circuit 293 and relay 351 with input circuit 296. Input circuit 291 is what may be termed the "normal" input circuit, being connected to the input of amplifier-detector 276 at all times when none of the other three input circuits is so connected. It will be assumed that input circuit 292 is tuned to the band of frequencies passed by the "high" filter of the analyzer circuit, that input circuit 293 is tuned to the band of frequencies passed by the "medium" filter and that input circuit 296 is tuned to the band of frequencies passed by the "low" filter.

It will be assumed, further, that condenser 311 furnishes the best time response for the "high" frequency band, condenser 312 the best time response for the "medium" frequency band, and condenser 313 the best time response for the "low" frequency band. Condenser 316 furnishes the "normal" time response and is connected across the input of the compressor rectifier at all times when none of the other condensers are so connected.

Let us assume for purposes of further description that the speech shunted over line 272 is analyzed by speech power analyzer 271, in the manner described above, and that it be found that the current passed by the "high" filter (corresponding to filter 21 of Fig. 1) is the most powerful. As previously stated we are assuming that input circuit 292 and condenser 311 are most suitable for use with this particular frequency.

The indicator relay associated with the "high" filter of analyzer 271 (corresponding to relay 51 of Fig. 1) will operate and let us assume that by so doing contacts are "made" to connect battery to conductor 352. We have, therefore, a path from battery over conductor 352, winding of relay 337 to ground 353, as well as a path from battery over conductor 352, winding of relay 356 to ground 357, relays 337 and 356 operating over these paths.

Operation of relay 337 connects (through its make contacts) tuned circuit 292 to the input of amplifier-detector 276 and also interrupts (at its break contact) the energizing path of relay 336 (battery 358, break contacts of relays 351, 338 and 337, winding of relay 336 to ground 371), whereupon relay 336 drops back to unoperated position and disconnects "normal" input circuit 291 from amplifier-detector 276.

Operation of relay 356 connects (through its make contact) condenser 311 across the input of the compressor rectifier in parallel to resistance 446 and also interrupts (at its break contact) the energizing path of relay 372 (battery 373, break contacts of relays 356, 376, and 377, winding of relay 372 to ground 378) relay 372 thereupon dropping back to unoperated position and disconnecting "normal" condenser 316 from the input of the compressor rectifier. It will be apparent that the proper tuned input circuit (circuit 292) and the proper time response element (condenser 311) for the band of frequencies in which the power is greatest are selected and associated with the amplifier-detector and the compressor respectively.

It will be understood that the arrangement functions in a similar manner for other current distributions. For example, had maximum power been existent in the band passed by the "medium" frequency band filter of speech analyzer 271 (corresponding to filter 22 of Fig. 1), battery would have been connected to lead 391 and relays 338 and 376 would have operated thereby associating input circuit 293 with amplifier-detector 276 and condenser 312 with the compressor rectifier. Again had maximum power been existent in the frequency band passed by the "low filter" of speech analyzer 271 (corresponding to filter 23 of Fig. 1) battery would have been connected to lead 392 and relays 351 and 377 would have operated connecting tuned circuit 296 to amplifier-detector 276 and condenser 313 to the input of the compressor rectifier. During such times as battery is not applied to leads 352, 391 or 392, "normal" input circuit 291 and "normal" condenser 316 are associated with the amplifier-detector and the compressor rectifier respectively.

Reception of speech waves over receiving channel 212 is in accordance with well understood and previously published methods and need not be described herein. However, it may be pointed out that a part of the received speech waves is passed over line 393 to receiving amplifier-detector 394. Operation of the amplifier-detector by these speech waves results in turn in operation of relays 395, 396 and 397.

Relays 395 when operated acts to increase the gain of automatic volume control device 257 in a manner described in detail in Patent 2,084,457 issued June 22, 1937, to L. Schott entitled "Transmission systems." Relay 396, when operated, interrupts the output circuit of transmitting amplifier-detector 276. Relay 397 when operated completes a short circuiting path across line 272 which is thereby "disabled" for transmission to speech power analyzer 271. This assures that the speech power analyzer will be operated by transmitted speech only and not by received speech. It will be obvious, however, that a separate speech power analyzer may be provided in the receiving channel if desired, operating in a manner similar to that described above for selecting the proper tuned input circuit for association with receiving amplifier-detector 394 and the proper time response element for association with expander 216.

While the arrangement described above and illustrated in Fig. 3 is directed to the specific idea of determining which band is passing the maximum power and then making suitable adjustment in accordance with such determination, it is contemplated also that it may be desirable in certain cases to obtain an indication of that particular band which is passing the greatest power relative to its normal or average transmitted power. By way of example, let us assume that the average power of the band passed by the "high" filter is .2 milliwatt that the average power of the band passed by the "medium" filter is 1 milliwatt and that the average power of the band passed by the "low" filter is .5 milliwatt. Now if the speech wave energy should change for any reason, for example due to a change of the talkers, the power distribution might then be such that the power in the band passed by the "high" filter would be .1 milliwatt, the power in the band passed by the "medium" filter .8 milliwatt, and the power passed by the "low" filter would be .7 milliwatt. The significant change for which it might be desirable to set up special adjustment in the voice-operated device would be the increase of .2 milliwatt above normal in the band passed by the "low" filter even though the band passed by the "medium" filter would still be of maximum power. The circuit illustrated in Fig. 1 may be modified to provide such an indication merely by so preadjusting the sensitivities of the three rectifiers, for example by the use of properly designed attenuators, that the outputs from all three will be the same for the average power distributions first mentioned. That is, we would add a certain resistance in the "medium" band circuit and somewhat less resistance in the "low" band circuit, bringing the output of each down to equal that from the "high" band circuit, where we have the lowest average initial power. Now it is obvious that, having preadjusted for equal outputs with the initial average power distributions, we will receive a "maximum power" indication for that particular band in which the greatest increase above this initial average power distribution occurs.

While certain specific embodiments of the invention have been selected for illustration and detailed description, the invention is not, of course, limited in its application to those embodiments. For example, while means are described for dividing the speech band to be analyzed into three smaller bands it may, of course, be divided into two bands or into more than three bands. Further, other applications of the speech analyzer than those described are, of course, contemplated. The embodiments described and illustrated should be considered as descriptive rather than restrictive.

What is claimed is:

1. In combination, a transmission line, means for applying waves of a comparatively wide frequency range to said line, means for splitting said waves into a plurality of smaller frequency bands, the number of said bands being greater than two, means for measuring the power passed in each of said smaller frequency bands relative to that in the other bands, and means for indicating the order of prominence among said smaller bands with respect to the power passed therein.

2. In combination, a transmission line, means for applying waves of a comparatively wide frequency range to said line, a plurality of band-pass filters for dividing said waves into a plurality of groups of waves of smaller frequency bands, the number of said groups being greater than two, means for measuring the power passed in each of said smaller bands relative to that in the other bands, and means for indicating the order of prominence among said smaller bands with respect to the power passed therein.

3. In combination, a transmission line, means for applying waves of a comparatively wide frequency range to said line, means for splitting said waves into a plurality of groups of smaller frequency bands, the number of said groups being greater than two, and means for indicating in which of said smaller bands the maximum power is passed and in which of said smaller bands the minimum power is passed.

4. In combination, a transmission line, means for applying waves of a comparatively wide frequency range to said line, means for splitting said waves into a plurality of smaller frequency bands, and means for measuring the power passed in each of said smaller bands relative to that in the other bands, said last-mentioned means including a series of relays so poled and connected that current in each of said smaller bands will tend to aid operation of a plurality of said relays and will tend to oppose operation of an equal number of said relays.

5. In combination, a transmission line, means for applying waves of a comparatively wide frequency range to said line, a plurality of channels connected to said line, frequency discriminative means for dividing said waves into a plurality of groups of waves of smaller frequency bands, the number of said bands being greater than two, each of said channels passing one of said smaller bands, a maximum indicator, an intermediate indicator and a minimum indicator associated with each of said channels, and means for measuring the power passed in each of said smaller bands and for causing the operation of one indicator associated with each channel in order to indicate the order of prominence among said smaller bands with respect to the power passed therein.

6. In combination, a transmission line, means for applying waves of a comparatively wide frequency range to said line, three channels connected to said line, a plurality of filters for dividing said waves into a plurality of groups of waves of smaller frequency bands, one of said filters being associated with each of said channels, each of said channels passing one of said smaller bands, a relative energy indicator associated with each of said channels, two relays associated with each channel, operation of both relays being effective to cause operation of the indicator associated with that respective channel, and means whereby the current passed by each of said filters is passed through a winding of the two relays associated with that respective channel and through a winding of one relay associated with each of the other two channels, said current being passed through the first two relays in the direction tending to operate said relays and said current being passed through the other two relays in the direction tending to oppose operation thereof.

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