Sept. 18, 1945. J. W. FOLEY ET AL 2,385,265

SUBSTATION CIRCUIT

Filed Jan. 26, 1944 3 Sheets-Sheet 1

FIG. 1

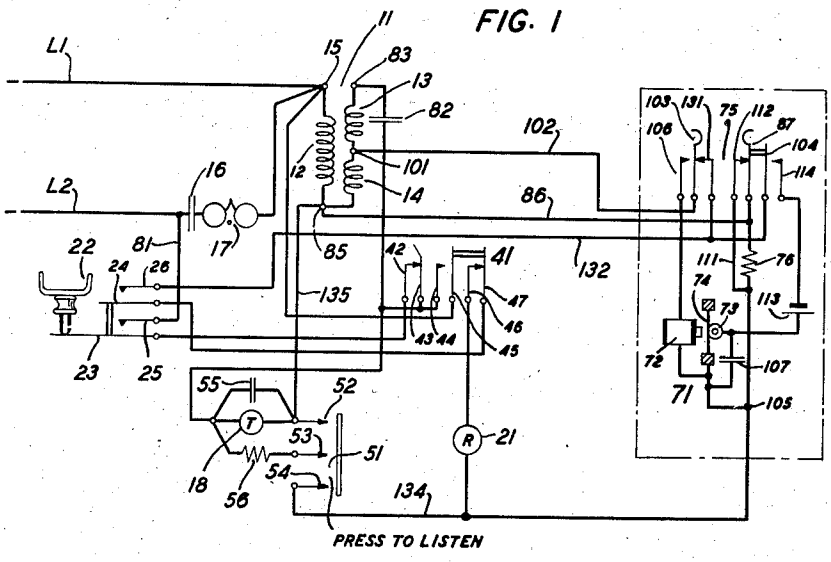
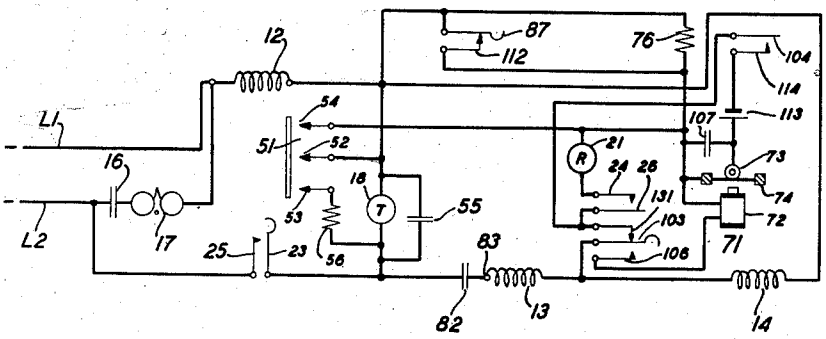


FIG. 2



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SUBSTATION CIRCUIT

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FIG. 3

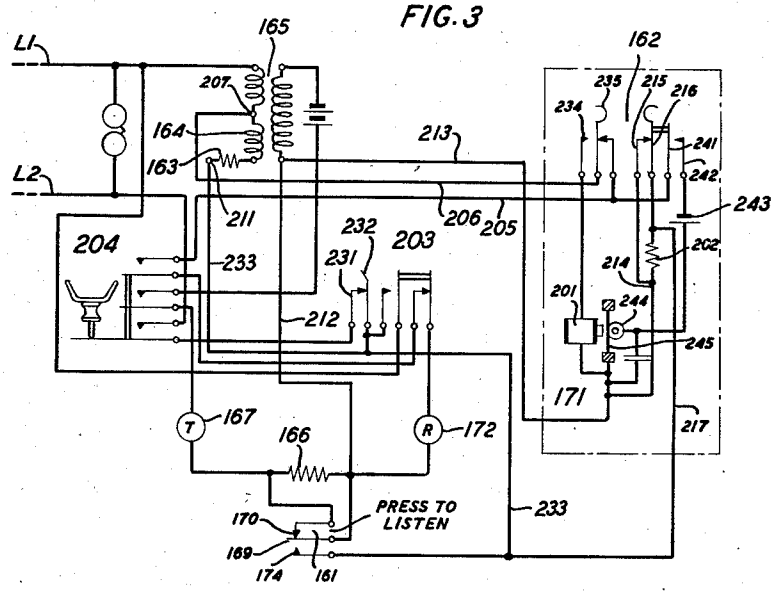
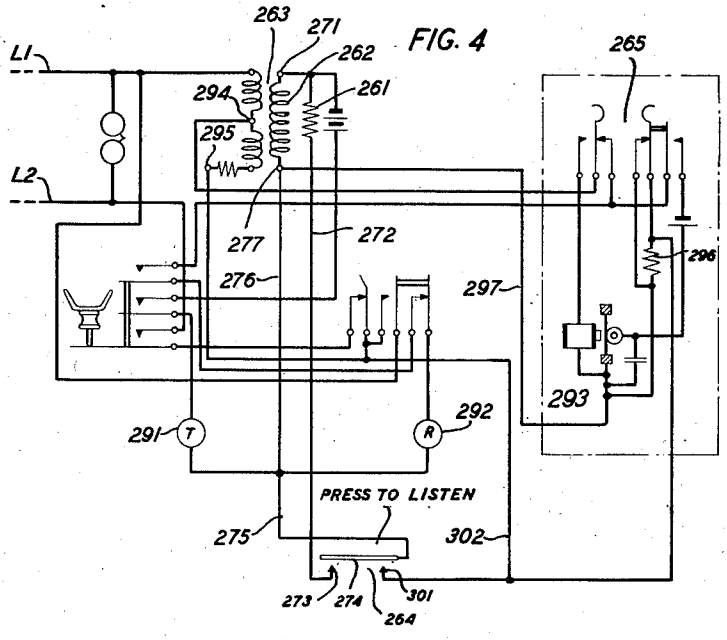


FIG. 4



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SUBSTATION CIRCUIT

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FIG. 5

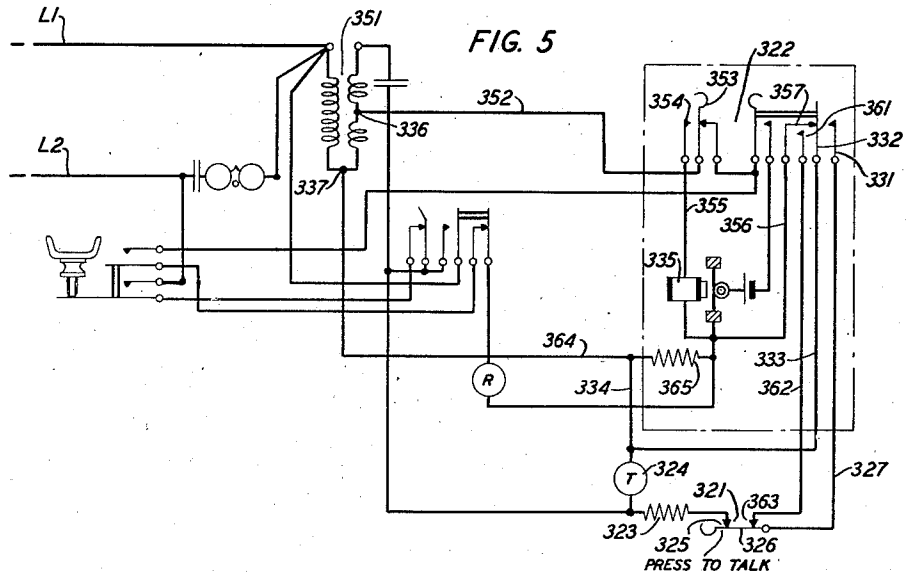
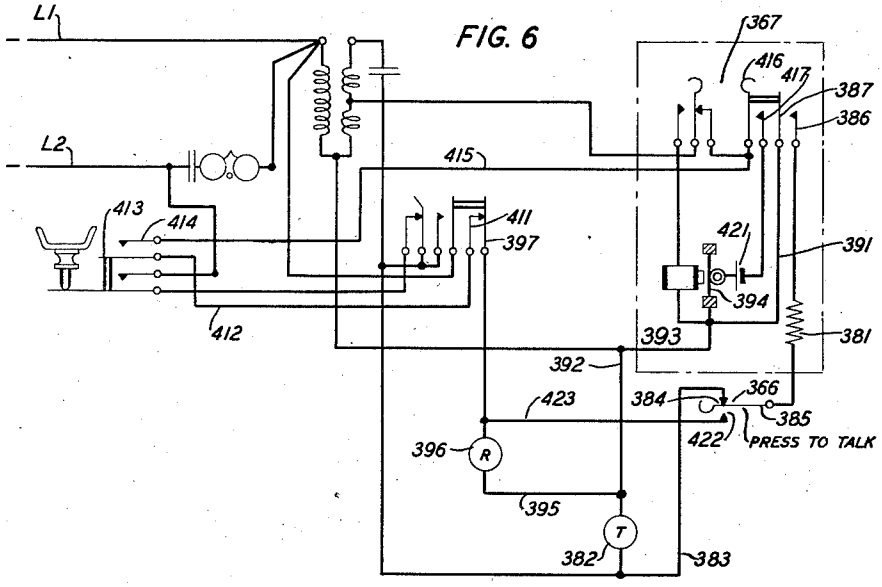


FIG. 6



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UNITED STATES PATENT OFFICE

2,385,265

SUBSTATION CIRCUIT

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Application January 26, 1944, Serial No. 519,762

10 Claims. (Cl. 179—81)

This invention relates to a subscriber's telephone circuit, or substation circuit as it is more commonly called, and, more particularly, to a substation circuit including an amplifier.

It has previously been proposed to provide amplifying means in the receiving circuit of a telephone substation particularly when the substation is located in a noisy area where room noises are of high level or when the equipment is to be used by the hard of hearing. The provision of such amplifying means tends to increase the possibility of the occurrence of sidetone of a level sufficient to produce "howling" or "singing." This sidetone is caused by pick-up of the room noise by the transmitter and transmission thereof through the local telephone circuit to the receiver.

An object of the present invention is to improve the operation of substation circuits of the type provided with amplifiers.

A more specific object of the invention is to prevent the occurrence of howling and other forms of interference resulting from passage of currents in the "sidetone path" of a substation circuit of the type provided with amplifiers.

A feature of the invention is a resistance which, in accordance with one embodiment of the invention, is adapted to be connected in shunt to the transmitter during listening or receiving periods and which is effective to reduce the level of room noise currents generated by the transmitter to a minimum value but not to entirely eliminate such currents.

Another feature of the invention is means whereby, while the level of the received speech is increased substantially, additional loss is inserted in the sidetone path, the net result being a substantial improvement in the receiving efficiency.

In accordance with a specific embodiment of the invention, a substation circuit is provided which includes an amplifier which may be connected in the receiving circuit of the substation upon occasion. A resistance element of relatively low ohmage is provided which may be connected in shunt with the transmitter during listening periods (regardless of whether the amplifier is connected or non-connected) in order to minimize the room noise currents occurring in the "sidetone" circuit, i. e., the currents resulting from room noise picked up by the transmitter and which are transmitted through the local telephone circuit to the receiver. The value of the resistance is so established that the room noise currents are not entirely eliminated, a slight amount of room noise pick-up being intentionally assured in order to avoid a "dead station" effect at the substation of the other party. A second resistance element of relatively high ohmage is provided which is arranged to be inserted in series with the input of the amplifier when it (the amplifier) is first connected in the receiving circuit of the substation. This second resistance element is shorted out of the receiving circuit by subsequent connection of the first-mentioned resistance element in shunt with the transmitter. The initial inclusion of the relatively high resistance in the input circuit of the amplifier is effective to prevent the occurrence of howling due to the initial gain of the amplifier connection which results from the current surge from the amplifier battery and due also to the high level of the room noise disturbances; subsequent connection of the low resistance across the transmitter introduces sufficient loss into the sidetone path of the substation circuit to fully offset the gain which would otherwise be established in the sidetone path by the amplifier.

A complete understanding of the arrangement contemplated by the present invention and appreciation of the various features thereof may be gained from consideration of the following detailed description and the annexed drawings in which:

Fig. 1 is a schematic showing of a substation circuit of the anti-sidetone type provided with amplifier means in accordance with the principles of the present invention, the substation being of the type designed for use as a part of telephone systems of the common battery type;

Fig. 2 is a simplified showing of the circuit of Fig. 1;

Fig. 3 is a schematic showing of a substation circuit similar to that illustrated in Fig. 1 but of a type designed for use as a part of telephone systems of the local battery type;

Fig. 4 is a schematic showing of a substation circuit which is similar to that of Fig. 3 but which embodies a different arrangement for disabling the transmitter;

Fig. 5 is a schematic showing of a substation circuit similar in general to that of Fig. 1 but differing therefrom in that the telephone set is provided with a "press-to-talk" switch instead of a "press-to-listen" switch as in the instance of the circuit of Fig. 1; and

Fig. 6 is a schematic showing of a substation circuit which is similar in general to that of Fig. 5 but which utilizes a different arrangement for preventing excessive sidetone.

Referring now to Fig. 1, the substation circuit illustrated includes induction coil 11 which comprises windings 12, 13 and 14. Subscriber's line conductor L_1 is connected to terminal 15 of winding 12; capacitance 16 and ringer 17 are connected to line conductor L_2.

The telephone instrument is of the so-called handset type and comprises a handset handle (not illustrated) upon one end of which is mounted transmitter 18, which may be of the type disclosed in A. F. Bennett et al. Patent 2,042,822 issued June 2, 1936, and upon the other end of which is mounted receiver 21, which may be of the type disclosed in L. A. Morrison et al. Patent 2,220,942 issued November 12, 1940. When not in use the handset is adapted to be placed in cradle 22 of a handset mounting of suitable type, the weight of the handset in the cradle holding contact springs 23 and 24 in open position, i. e., out of engagement with the respectively associated contact springs 25 and 26. The arrangement is such that, when the handset is removed from the cradle, springs 23 and 25 engage, or make contact, slightly in advance of the engagement of springs 24 and 26.

Calling dial 41 comprises the normally closed, or engaged, pair of impulse springs 42 and 43, the normally open pair of circuit shunting springs 44 and 45, and the normally closed, or engaged, pair of receiver springs 46 and 47.

Transmitter shunting switch 51, which is preferably mounted at a convenient point in the handset handle, is arranged, when operated to conductively connect contacts 52, 53 and 54. Capacitance 55 is normally connected in shunt with transmitter 18 and, when switch 51 is in operated position, resistance element 56, which is of a relatively low resistance value, for example, of the order of 10 ohms, is also connected in shunt with the transmitter. Switch 51 will normally be held in the depressed, or operated, position by the operator while listening and is therefore commonly referred to as a "press-to-listen" switch.

The amplifier circuit per se, which is shown enclosed by dot-dash lines, includes mechanical amplifier 71. The amplifier may be of the type disclosed in A. F. Bennett et al. Patent 2,242,284 issued May 20, 1941, and comprises a combined receiver 72 and microphone 73 having a common diaphragm 74. The amplifier also includes switch 75 and resistance element 76 the latter being of a relatively high resistance value, for example of the order of 1500 ohms.

Line conductor L_2 is connected through conductor 81 and contact springs 23 and 25 (when the handset is removed from cradle 22) to dial impulsing contacts 42 and 43 and thence to one terminal of transmitter 18 as well as through capacitance 82 to terminal 83 of winding 13 of induction coil 11.

Common terminal 85 of windings 14 and 12 of induction coil 11 is connected to the other terminal of transmitter 18 and contact 52 over conductor 135 and also over conductor 86 to one side of resistance element 76 and contact spring 87 of switch 75. Common terminal 101 of windings 13 and 14 is connected over conductor 102 to contact spring 103 of switch 75 and thence when switch 75 is in unoperated position, as illustrated through contact spring 131 to contact spring 104 of the amplifier switch and to contact spring 26 of the cradle operated switch.

As previously pointed out line conductor L_1 is connected to upper terminal 15 of winding 12; terminal 15 is also connected to contact spring 45 of dial 41.

Contact spring 24 of the cradle operated switch is connected through normally closed contacts 46 and 47 of dial 41 to one terminal of receiver 21; the other terminal of receiver 21 is connected to contact 54 of switch 51 and to common terminal 105 of the amplifier circuit.

One terminal of receiver element 72 of mechanical amplifier 71 is connected to contact spring 106 of switch 75 while the other terminal of the receiver element is connected to common terminal 105.

Common terminal 105, in addition to the connections previously mentioned, is connected to one side of common diaphragm 74, one side of capacitance 107, and over conductor 111 to contact spring 112 of switch 75. One terminal of resistance 76 is connected to conductor 111.

Battery 113 is connected between microphone element 73 and normally open contact spring 114 of switch 75.

Fig. 2 shows the same components and circuit as Fig. 1 but in a form that indicates more clearly the character of the amplifier circuit. It is evident that as to the basic circuit arrangement of the transmitter (disregarding the shunt resistance), receiver, induction coil windings; dial springs, switching springs and ringer, the circuit of Fig. 1 is of the anti-sidetone type disclosed in G. A. Campbell Patent 1,254,476 of January 22, 1918, and J. W. Gooderham Patent 1,901,958 of March 21, 1933. Such a basic circuit is combined with the additional means shown to provide amplification for voice currents incoming over line conductors L_1 and L_2.

When the handset is removed from cradle 22, the normal transmitter and receiver circuits are completed by closing of contact springs 23 and 25 and contact springs 24 and 26 of the cradle operated switch.

Assuming that switch 75 is in the normal, unoperated, position illustrated, amplifier 71 is not effective, the circuit of amplifier receiver element 72 being open at contact 106, and the substation circuit operates as a normal anti-sidetone circuit. During listening periods, with the circuit in the condition referred to, it may sometimes occur that sufficient room noise is being picked up by transmitter 18 and transmitted through the "sidetone circuit," i. e., the local telephone circuit, to the receiver to cause an objectionable amount of interference with reception. In such event switch 51 may be operated thereby connecting resistance 56 in shunt with transmitter 18. Connection of resistance 56 in shunt to transmitter 18 cuts down the effective pick-up of the transmitter and will reduce the sidetone by an amount depending upon the value of the resistance. Assuming that the resistance is of the order of 10 ohms as referred to above, the sidetone will be reduced by about 12 decibels in a typical substation circuit. The net effect from this sidetone reduction will be to increase the effective receiving gain of the circuit by from 2 to 4 decibels depending on the existing sidetone of the telephone set and on the noise level.

It should be noted at this point that connection of the resistance in shunt to the transmitter, while accomplishing the desired result of reducing the sidetone sufficiently so that reception is not interfered with appreciably by room noise, still permits a slight amount of room noise pick-up so that the effect of a "dead station" is not conveyed to the calling party. The novel ar-

rangement of the present invention, therefore, offers obvious advantages over the practice of shorting out the transmitter during listening periods.

Let us assume now that switch 75 be operated, switch 51 however being unoperated as illustrated. The effect of the operation of switch 75 is, in general, to connect the input circuit of amplifier 71 (in series with high resistance 76) to those same points in the substation circuit to which receiver 21 was connected before operation of switch 75. That is, before operation of switch 75, one terminal of receiver 21 is connected through contacts 46 and 47 of dial 41, contacts 24 and 26 of the cradle operated switch and contacts 131 and 103 of switch 75 to terminal 101 of winding 13 of induction coil 11 while the other terminal of receiver 21 is connected over conductor 111 and through contacts 112 and 87 of switch 75 to terminal 85 of winding 12 of induction coil 11. Now upon operation of switch 75, one side of the input amplifier 71 (that is, one side of receiver element 72) is connected through contacts 106 and 103 of switch 75 to terminal 101 of induction coil 11 while the other side of the amplifier input is connected through resistance 76 and over conductor 86 to terminal 85 of induction coil 11. Receiver 21 is now (that is, with switch 75 operated) connected in the output circuit of amplifier 71 the path leading from one terminal of the receiver and including contacts 46 and 47 of dial 41, contacts 24 and 26 of the cradle operated switch, conductor 132, contacts 104 and 114 of switch 75, battery 113, microphone element 73 and common diaphragm 74 of amplifier 71, terminal 105 and thence to the other terminal of receiver 21.

Under the conditions just described, i. e., with switch 75 operated and switch 51 in non-operated position, listening conditions are substantially the same as before operation of switch 75 for, while amplifier 71 is now connected to the receiving circuit, the gain of the amplifier is practically offset by the series resistance 76.

Let us assume now that switch 51 be operated, switch 75 remaining in operated position. Operation of switch 51 results in two circuit changes, first, the connection of resistance 56 in shunt to transmitter 18 and, second, the shunting of resistance 76 out of the receiver circuit. That is, one side of receiver element 72 of amplifier 71 is now connected to terminal 101 of induction coil 11 through contacts 106 and 103 of switch 75 while the other side of the amplifier input is connected to terminal 85 of induction coil 11 through conductor 134, contacts 54 and 52 of switch 51 and conductor 135.

Under the conditions just described, therefore, i. e., with switches 75 and 51 both operated, the full gain of amplifier 71 which in the present instance we will assume is of the order of 12 decibels is effective both in the receiving and the sidetone branches of the substation circuit but the sidetone is at the same time decreased 12 decibels by resistance 56 shunting transmitter 18. The net result is that the sidetone is left at the original value while the volume of incoming speech is increased 12 decibels, thereby improving the receiving efficiency by this amount.

It will be understood that the quantity "12 decibels" has been mentioned merely for illustration and as typical of representative substation circuits; this is true also of the magnitude of resistances 56 and 76, the mentioned values of which are also merely illustrative.

It will be observed that, in accordance with the novel arrangement contemplated by the invention, control of the amplifier action, once switch 75 has been moved to operated position, passes to transmitter shunt controlling switch 51. In view of the fact that the high resistance element 76 is included as a series element in the amplifier input circuit until the shunt has been placed around the transmitter, "howling" which might otherwise occur due to the initial gain of the amplifier is prevented. At such times as the amplifier is rendered effective in the receiver circuit due to operation of switch 51 and consequent shorting of resistance 76, the sidetone is held at its normal level by the connection of resistance 56 in shunt to transmitter 18.

Referring now to Fig. 3 the substation circuit illustrated, while similar in general to that described above, differs therefrom in certain minor details inasmuch as it is designed for use in connection with telephone systems of the local battery type while the circuit of Figs. 1 and 2 is intended for use in connection with telephone systems of the common battery type.

The general method of operation of the circuit of Fig. 3 is the same as that of Fig. 1 described above. That is, with shunting switch 161 and amplifier switch 162 in normal, unoperated position, the circuit operates as a normal anti-sidetone circuit. (Balancing resistance 163, which is shown externally connected in series with winding 164 of induction coil 165 may, if desired, be incorporated or built into the coil itself by modification of the characteristics of winding 164; in an actual commercial installation the balancing resistance will usually be incorporated in the coil as stated.) A change in the connection of transmitter resistance 166 has been made in the present circuit, however, in order to avoid the excessive current drain that would be caused by bridging transmitter 167 by a relatively low value of direct current resistance. With switch 161 in the normal position illustrated in Fig. 3, i. e., with lever 169 in engagement with contact 170, resistance 166 is, obviously shorted out of the "sidetone circuit" path.

As in the instance of the circuit previously described, it may happen that, when the circuit of Fig. 3 is being used as a normal anti-sidetone circuit, i. e., with amplifier 171 inoperative, sufficient room noise may be picked up by transmitter 167 during listening periods and transmitted through the "sidetone circuit" to receiver 172 to be objectionable. In such event, lever 169 of switch 161 may be moved into engagement with contact 174 of the switch thereby connecting resistance 166 as a series element in the "sidetone circuit" between transmitter 167 and receiver 172, this is effective to reduce the room noise transmitted to receiver 172 to an unobjectionable level. The function of resistance 166, therefore, is the same as that of resistance 56 of the circuit of Fig. 1 but the specific manner in which it is associated with other elements of the circuit is preferable to that of Fig. 1 when dealing with substation circuits of the type designed for use in connection with telephone systems of the local battery type as the excessive current drain, that would be likely to result from bridging the transmitter by a relatively low resistance, is avoided.

The operation of amplifier 171 is the same, in general, as that of amplifier 71 of Fig. 1. That is, with key 162 in operated position and key 161 in the normal, unoperated position, receiver element 201 of amplifier 171 will be connected (in

series with resistance 202) to those same points in the circuit to which receiver 172 was connected before operation of key 162.

Before operation of key 162, one terminal of receiver 172 was connected through contacts of calling dial 203 and cradle operated switch 204 and over conductors 205 and 206 to terminal 207 of induction coil 165 while the other terminal of the receiver was connected to terminal 211 of the induction coil over a path which includes conductors 212, 213 and 214, contacts 215 and 216 of switch 162, and conductors 217 and 233.

Now upon operation of switch 162, one terminal of receiver element 201 of amplifier 171 is connected to terminal 207 of induction coil through contacts 234 and 235 of key 162 and over conductor 206 while the other terminal of element 201 is connected to terminal 211 of the coil over a path which includes the lower portion of conductor 214, resistance 202 and conductors 217 and 233. It will be observed that, at this time, resistance 202, which is of relatively high ohmage, is connected in series with the receiver path of the amplifier. Listening conditions are substantially the same as they were before operation of switch 162, therefore, as the gain of amplifier 171, now connected in the circuit, is practically offset by series resistance 202.

Receiver 172, at this time, i. e., with switch 162 operated and switch 161 unoperated, is connected in the output of amplifier 171 over a path which includes contacts of calling dial 203 and plunger operated switch 204, conductor 205, contacts 241 and 242 of switch 162, battery 243, microphone element 244 and common diaphragm 245 of amplifier 171, conductor 213 and conductor 212.

Let us assume now that switch 161 be operated, i. e., lever 169 be moved into position to engage contact 174, switch 162 remaining in operated position. This operation of switch 169 results in two circuit changes, first the removal of the shunt path from around resistance 166 so that this resistance is now brought into the sidetone path as an effective series element and, second, the shunting of high resistance 202 out of the receiver circuit. This last-mentioned action results from the fact that the one side of the amplifier receiver element which was previously connected to terminal 211 of induction coil 165 over a path which included resistance 202 as a series element is now connected to terminal 211 over a path which includes conductors 213 and 212, lever 169 and contact 174 of key 161, and conductor 233.

Under the conditions just described, therefore, i. e., with both switches 162 and 161 operated, the 12 decibel gain of amplifier 171 is effective both in the receiving and the sidetone branches of the substation circuit but the sidetone is at the same time decreased 12 decibels by the connection of resistance 166 therein. The net result is that the sidetone is left at the original value while the incoming speech is increased 12 decibels, thereby improving the receiving efficiency by that amount.

As in the instance of the arrangement of Fig. 1 described above, the present embodiment of the invention is effective in preventing "howling" which might otherwise tend to occur due to the initial gain of the amplifier. The specific arrangement of Fig. 3 is preferred for use in substation circuits used in connection with telephone systems of the local battery type as excessive current drain around the transmitter is avoided.

The substation circuit illustrated in Fig. 4 is similar generally to that of Fig. 3 being also intended for use with telephone systems of the local battery type. Specifically, the circuit differs from that of Fig. 3 in the fact that resistance 166 of Fig. 3 is omitted from the circuit of Fig. 4; resistance 261 which is included in the circuit of Fig. 4, being connected in shunt to winding 262 of induction coil 263 (when key 264 is in operated position) fulfills a similar function to that of resistance 166.

It is not believed necessary to trace the various circuits of the arrangement of Fig. 4 which are set up by the different operations of switches 264 and 265 in view of the similarity of the arrangement to that of Fig. 4 described above. However, a few of the circuit conditions will be described.

When switch 264 is moved to operated position, resistance 261 is effectively connected across winding 262 of induction coil 263 through a circuit from terminal 271, resistance 261, conductor 272, contact 273 and spring 274 of switch 264, conductor 275 and conductor 276 to terminal 277. The connection of resistance 261 across winding 262 is effective to cut down the transmission from transmitter 291 to receiver 292 by an amount approximately equal to the loss caused by connection of resistance 166 (Fig. 3) into the transmitter to receiver sidetone circuit.

With switch 265 operated and switch 264 in non-operated position, the receiver element of amplifier 293 is connected between terminals 294 and 295 of induction coil 263 over a circuit which includes resistance 296 as a series element. Upon operation of switch 264, however, resistance 296 is effectively cut out of the circuit just referred to as that portion of the path which led through resistance 296 is now replaced by a low resistance portion comprising conductors 297, 276 and 275, spring 274 and contact 301 of switch 264 to conductor 302.

Referring now to Fig. 5, the substation circuit illustrated is, in general, similar to that illustrated in Fig. 1 and described in detail above. However, the present circuit differs from that of Fig. 1 in the fact that the telephone set is provided with a "press-to-talk" switch instead of the "press-to-listen" switch (switch 51) provided in the circuit of Fig. 1. In other words the substation circuit of Fig. 5 is normally in condition for listening (so far as the transmitter switch is concerned) instead of being normally in condition for talking as in the instance of the circuit of Fig. 1. The circuit of Fig. 5 might be used, for example, in connection with a telephone system of the so-called conference type wherein a number of telephone sets are on the same circuit at the same time and it is desirable that the telephone transmitters be "disabled" except during actual talking periods.

In view of the general similarity of the circuit of Fig. 5 to the circuits previously described, it will not be described in detail. However, it should be kept in mind in considering the circuit of Fig. 5 that transmitter switch 321 is left in the normal position illustrated and that amplifier switch 322 is moved to the operated position when the circuit is to be used for listening; when the subscriber is actually speaking he moves switch 321 to open position, switch 322 being left in closed position.

Assuming now that switch 321 is in closed position as illustrated and that switch 322 is moved to closed position, resistance 323 will be connected in shunt to transmitter 324 over a path lead-

ing from one side of the transmitter, through resistance 323, break contact 325 and contact spring 326 of switch 321, conductor 327, contacts 331 and 332 of spring 322, conductor 333 and lower portion of conductor 334 to the other side of transmitter 324. As in the instance of the arrangements previously described the connection of the resistance element in shunt to the transmitter is effective to cut down the sidetone (that might be caused by pick-up of room noise) during the listening periods.

At this same time, i. e., when switches 321 and 322 are in closed position, receiving element 335 of the amplifier is connected between terminals 336 and 337 of induction coil 351 (the "receiver terminals" of the coil) over a path including conductor 352, contacts 353 and 354 of switch 322, conductor 355, receiver element 335, conductor 356, contacts 357 and 361, conductor 362, contact 363 and contact spring 326 of switch 321, conductor 327, contacts 331 and 332 of switch 322, conductors 333, 334 and 364. It will be noted that at this time, that is, when the circuit is in condition for listening, resistance 365 is not effectively connected in the amplifier circuit.

Let us assume now that the subscriber, wishing to talk, moves transmitter switch 321 to open position, amplifier switch 322 being left in the operated position just described. It will be obvious that when switch 321 is opened, the shunt path around transmitter 324, which included resistance 323, will be removed as the circuit will be opened at break contact 325 of switch 321. It will be obvious also, that resistance 365, which is of relatively high ohmage, will be effectively connected in series with the receiver element 335 of the amplifier at the time as the path which was previously effective to shunt this resistance is now open at break contact 363 of switch 321.

Referring now to Fig. 6 the substation circuit illustrated is similar to that of Fig. 5 except for the fact that in the present instance a single resistance is utilized both to reduce sidetone during receiving and to offset the amplifier gain during transmitting.

Assuming first that the circuit is being used for listening, transmitter switch 366 will be left in the "up" position illustrated and amplifier switch 367 will be moved to the operated position.

Under the above conditions, resistance 381 will be connected in shunt to transmitter 382 over a path including conductor 383, break contact 384 and contact spring 385 of switch 366, resistance 381, contacts 386 and 387 of switch 367, conductors 391 and 392. For the listening condition of the circuit therefore resistance 381 acts to reduce the sidetone caused by noise pick-up by transmitter 382 but has no effect on the action of amplifier 393.

Now let it be assumed that the subscriber, wishing to talk, moves transmitter switch 366 to the "down" position, amplifier switch 367 being left in the operated position just described. The shunting path through resistance 381 is now removed from transmitter 382, the path being opened at break contact 384 of switch 366. Resistance 381 is now connected in the output circuit of amplifier 393 (which circuit includes receiver 396), whereby to effectively reduce the amplifier gain as did the series resistances of the circuits previously described. The output circuit of amplifier 393 includes microphone-diaphragm 394, conductors 392 and 395, receiver 396, contacts 397 and 411 of the calling dial, conductor 412, contacts 413 and 414 of the plunger operated switch, conductor 415, contacts 416 and 417 of switch 367 and battery 421. Now with switch 366 in "down" position the gain in this output path is effectively reduced by a path which partially shunts receiver 396 out of said amplifier output path and which may be considered to include conductor 391, contacts 387 and 386 of switch 367, resistance 381, contact spring 385 and make contact 422 of switch 366, and conductor 423. A portion of the gain which would otherwise be transmitted through receiver 396 is thus diverted through the path just traced so that under "talking" conditions, resistance 381 is effective to offset the gain of the amplifier the required amount.

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 these embodiments. The embodiments described should be looked upon as illustrative of the invention and not as restrictive thereof.

What is claimed is:

1. A substation circuit adapted to be connected to a telephone line comprising a receiver circuit including a receiver, a transmitter circuit including a transmitter, an amplifier having an input circuit and an output circuit, a first switching means for substituting the amplifier input circuit for the receiver in said receiver circuit and for simultaneously connecting the receiver in the output circuit, a second switching means for causing, when in a first position, a substantial reduction in the efficiency of the transmitter circuit and for restoring, when in a second position, the efficiency of the transmitter circuit to normal value and means, effective when said second switching means is in said second position, for reducing the gain of the amplifier by a substantial amount.

2. A substation circuit adapted to be connected to a telephone line comprising a receiver circuit including a receiver, a transmitter circuit including a transmitter, an amplifier having an input circuit and an output circuit, a first switching means for substituting the amplifier input circuit for the receiver in said receiver circuit and for simultaneously connecting the receiver in the output circuit, a first resistance of relatively high value, a second resistance of relatively low value, means for connecting said first resistance in gain reducing relationship to said amplifier, and means for connecting said second resistance in gain reducing relationship to said transmitter circuit and for simultaneously short-circuiting the gain reducing connection of said first resistance.

3. A substation circuit adapted to be connected to a telephone line comprising a receiver circuit including a receiver, a transmitter circuit including a transmitter, an amplifier having an input circuit and an output circuit, switching means for substituting the amplifier input circuit for the receiver in the receiver circuit and for simultaneously inserting gain-reducing resistance in the amplifier input circuit and connecting the receiver in the amplifier output circuit, and means for reducing the efficiency of the transmitter circuit to a relatively low value and simultaneously short-circuiting said gain-reducing resistance in the amplifier input circuit.

4. A substation circuit adapted to be connected to a telephone line comprising a receiver circuit including a receiver, a transmitting circuit including a transmitter, an amplifier having an input circuit and an output circuit, means for substituting the amplifier input circuit for the re-

ceiver in said receiver circuit while simultaneously connecting the receiver in the amplifier output circuit and adjusting the amplifier output to a level not in excess of the input to the receiver prior to such substitution, and means for reducing the efficiency of the transmitting circuit to a relatively low value and simultaneously adjusting the amplifier output to a level substantially in excess of the input to the receiver prior to the before-mentioned substitution.

5. A substation circuit adapted to be connected to a telephone line comprising a receiver circuit including a receiver, a transmitter circuit including a transmitter, an amplifier having an input circuit and an output circuit, a first resistance of relatively high value, a second resistance of relatively low value, a first switching means for substituting the amplifier input circuit for said receiver and for simultaneously connecting said first resistance in the amplifier input circuit, whereby to reduce the over-all amplifier gain, and connecting said receiver in the amplifier output circuit, and a second switching means for connecting said second resistance in shunt with said transmitter and for simultaneously short-circuiting said first resistance in the amplifier input circuit.

6. A substation circuit adapted to be connected to a telephone line comprising a receiver circuit including a receiver, a transmitter circuit including a transmitter, an amplifier having an input circuit and an output circuit, a receiver element in the amplifier input circuit, a microphone element in the amplifier output circuit, a first resistance of relatively low value, a second resistance of relatively high value, switching means for substituting the amplifier receiver element for said receiver in said receiver circuit and for simultaneously connecting said receiver in the amplifier output circuit and connecting said second resistance in series with the amplifier receiver element whereby to reduce the input thereto.

7. A substation circuit adapted to be connected to a telephone line comprising a receiver circuit including a receiver, a transmitter circuit including a transmitter, an amplifier having an input circuit and an output circuit, a receiver element in the amplifier input circuit, a microphone element in the amplifier output circuit, a first resistance of relatively high value, switching means effective when in operated position to simultaneously substitute the amplifier receiver element for said receiver in said receiver circuit, to connect said receiver in the amplifier output circuit and to connect said resistance in gain reducing relationship to said amplifier, a second resistance of relatively low value, and means effective when in operated position to connect said second resistance in shunt with said transmitter in the transmitter circuit, said last-mentioned means when in operated position being effective also to short-circuit said first resistance in the event that said switching means is at the same time in operated position.

8. A substation circuit adapted to be connected to a telephone line comprising a receiver circuit including a receiver, a transmitter circuit including a transmitter, an amplifier having an input circuit and an output circuit, a switch for connecting, when operated, the amplifier input circuit in the receiver circuit and the receiver in the amplifier output circuit, a second switch having a normal position and an off-normal or operated position, a first gain-reducing means and a second gain-reducing means, said first gain-reducing means being effective to cause a substantial reduction in the efficiency of the transmitter circuit whenever said second switch is in operated position regardless of the position of the first-mentioned switch, said second gain-reducing means being effective to cause a substantial reduction in the gain of said amplifier when, and only when, the first-mentioned switch is in operated position and the second switch is in normal position.

9. A substation circuit adapted to be connected to a telephone line comprising a receiver circuit including a receiver, a transmitter circuit including a transmitter, an amplifier having an input circuit and an output circuit, a receiver element in the amplifier input circuit, a microphone element in the amplifier output circuit, a first resistance of relatively high value, switching means effective when in operated position to simultaneously substitute the amplifier receiver element for said receiver in said receiver circuit, to connect said receiver in the amplifier output circuit and to connect said resistance in gain reducing relationship to said amplifier, a second resistance of relatively low value, and means effective when in operated position to connect said second resistance effectively in series with said receiver and said transmitter whereby to substantially reduce the transmission gain characteristic of the path between said receiver and said transmitter, said last-mentioned means when in operated position being effective also to short-circuit said first resistance in the event that said switching means is at the same time in operated position.

10. A substation circuit adapted to be connected to a telephone line comprising a receiver circuit including a receiver, a transmitter circuit including a transmitter, an amplifier having an input circuit and an output circuit, a receiver element in the amplifier input circuit, a microphone element in the amplifier output circuit, a first resistance of relatively high value, switching means effective when in operated position to simultaneously substitute the amplifier receiver element for said receiver in said receiver circuit, to connect said receiver in the amplifier output circuit and to connect said resistance in gain-reducing relationship to said amplifier, a second resistance of relatively low value, and means effective when in operated position to connect said second resistance effectively in shunt with a predetermined portion of the transmitter circuit whereby to substantially reduce the transmission gain characteristic thereof, said last-mentioned means when in operated position being effective also to short-circuit said first resistance in the event that said switching means is at the same time in operated position.

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