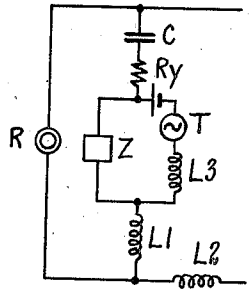
Nov. 16, 1937. E. R. WIGAN 2,099,381

TELEPHONE INSTRUMENT CIRCUIT

Filed Jan. 11, 1935

FIG. 1.



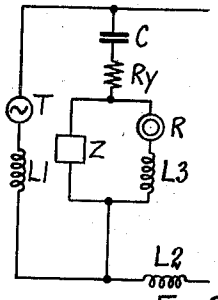


FIG. 2.

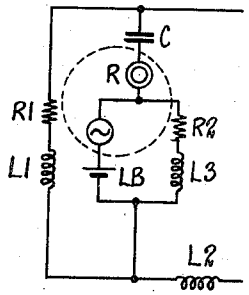


FIG. 3.

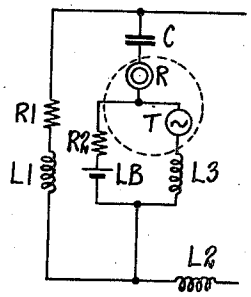


FIG. 4.

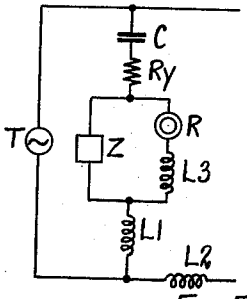


FIG. 5.

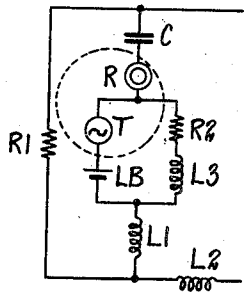


FIG. 6.

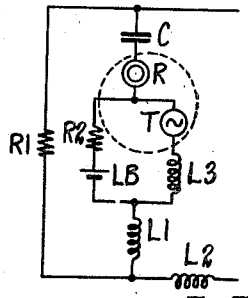
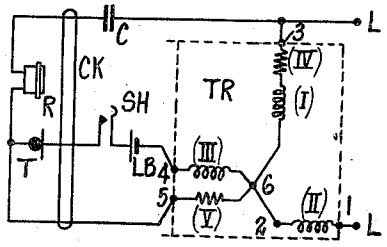


FIG. 7.

FIG. 8.



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2,099,381

UNITED STATES PATENT OFFICE

2,099,381

TELEPHONE INSTRUMENT CIRCUIT

Edmund Ramsay Wigan, London, England, assignor to Siemens Brothers & Company Limited, London, England

Application January 11, 1935, Serial No. 1,318
In Great Britain January 31, 1934

1 Claim. (Cl. 179—81)

The invention relates to telephone instrument circuits for telephone systems and more particularly to an improvement in or modification of a telephone instrument of the nature of that forming the subject matter of my Patent No. 1,919,314 granted 25th July 1933.

In this patent telephone instrument circuits embodying three-winding induction coils are shown, the circuits being arranged so that side-tone may be readily controlled. A mathematical exposition of the behaviour of the instruments is given with a view to facilitating design, and attention is especially directed to the fact that the extent to which side-tone is suppressed in any anti-side-tone system or circuit depends, not on the instrument circuit alone, but also on the line impedance and on the frequency of the currents involved. It is pointed out that, in general, the line impedance is variable even as regards a particular instrument and frequency since the impedance of the line as seen from the instrument depends, not only on the local line (that is the line to the exchange), but also on any junction or trunk line in a connection between two telephone instruments. It is further pointed out that it is not considered that total suppression of side-tone is desirable except in the noisiest situations, as the absence of sound in one ear and the presence of external sound in the other is disturbing since it gives a feeling of deafness in that ear to which sound does not reach and side-tone serves, to some extent, as a guide to a telephone user in regulating the loudness of his speech.

The telephone instrument circuit disclosed in the prior patent is one in which a side-tone controlling part comprises two impedances in series these two impedances forming a branch connected in parallel with the transmitter and a winding (L1) of the induction coil being included either in this branch or in series with the transmitter. Another winding (L2) of the induction coil is traversed by the whole of the line current, and the third winding (L3) and the receiver are connected in series across one of the said impedances.

It is shown in British Patent No. 407,808 that the transmitters and receivers of the instrument circuits of the prior patent may be transposed so that a telephone instrument circuit having an anti-side-tone controlling part which comprises two impedances in series is produced, the two impedances of which form a branch connected in parallel with the receiver (instead of with the transmitter), and a winding (L1) of the induction coil is included either in this branch or in series with the receiver (instead of with the transmitter). Another winding (L2) of the induction coil is traversed by the whole of the line current, and the third winding (L3) and the transmitter (instead of the receiver) are connected in series in a circuit which is bridged across one of the said impedances.

It is stated in the British specifications that an important consequence of the interchange of transmitter and receiver in these circuits is that a circuit arrangement is obtained which is readily adaptable to local battery working, and it is pointed out that this adaptability to local battery working arises from the fact that the transmitter is connected in a local closed direct-current circuit which includes the transmitter itself, a winding (L3) of the induction coil, and one of the two impedances (it being assumed that this is of such a character that it will conduct direct current), and that the insertion of a comparatively low-resistance local battery does not materially affect the anti-side-tone properties of the instrument circuit as a whole.

The instrument circuit resulting from the interchange above noted, whilst being readily adaptable to local battery working, is not thereby rendered unsuitable for common battery working. It is not, however, the best arrangement for common battery working since, in that arrangement when so used, the receiver is in the direct current circuit.

It may, however, be desirable to use an anti-side-tone circuit in conjunction with a lengthy common battery line. The fact that the line is lengthy renders the instrument circuit of the prior patent not the most suitable since the resistance of the long line reduces the transmitter direct-current supply, and, for the reason noted above, the fact that the line is a common battery line renders the instrument circuit of the British specification not the most suitable. It thus appears desirable, for the production of an anti-side-tone telephone instrument circuit for use on lengthy common battery, or central battery working, to produce a telephone instrument circuit the transmitter of which shall work with a local battery but which shall be so organized that direct current from the line shall not pass through the receiver.

Figs. 1 to 8 show old and new modifications of telephone instrument circuits.

The mere removal of condenser C, Fig. 1 of the British specification, reproduced as Fig. 1 herein, from its position in the branch which is con-

nected in parallel with the receiver R and the inclusion of a condenser in series with the receiver is not sufficient since, although direct current would not pass through the receiver, the direct current circuit provided by way of R*y*, L*1*, and L2 would be of too high a resistance for signalling purposes.

To overcome this difficulty, a telephone instrument circuit according to my prior patent is modified by the transposition of the transmitter and one of the impedances and the receiver and the other impedance so that the third winding (L3) of the induction coil and one of the impedances are connected in series with the transmitter to form a closed circuit which includes only one winding of the induction coil, a line winding (L2) of the induction coil is traversed by the whole of the line current, and the closed circuit and the receiver, connected in series, form a branch connected in parallel with the other impedance whether or not the remaining winding of the coil is connected in series with that branch or in series with the said other impedance. The closed circuit includes a local battery. Since the resistance of this local battery is low in comparison with the other elements, it does not materially affect the anti-side-tone properties of the instrument as a whole. A condenser may be connected in series with the receiver. This condenser prevents the flow of direct current in the receiver.

Figs. 3 and 4 of the accompanying drawing show forms of telephone instrument circuit according to the present invention this circuit being derived from Fig. 7 of the prior patent reproduced, for comparison, herein as Fig. 2. For convenience the references R*y* and Z are not used for the two impedances but, instead, the references R*1* and R2 are used. The impedance R2 must be of such a character that it will conduct direct current. Other forms of the instrument circuit according to the invention are obtained when the circuit shown in Fig. 5 of the prior patent and reproduced herein as Fig. 5, is modified in a similar manner. These modifications are shown in Figs. 6 and 7 hereof.

In general the mathematical consideration which is given of the behaviour of the circuits of the prior patent still holds when the changes referred to above have been made. Care must, however, be taken in applying the formulae to use the values of the ratio P/*a* and K/*c* and of the impedance Z*c* appropriate to the changed circuit conditions. For a given set of components when the interchanges are effected the Q locus in the diagrams of the prior patent remains substantially unaltered. The circles may change somewhat in position and their diameters may alter depending upon the values of Z*c*, P/*a*, and K/*c* which, as before, can be ascertained by direct measurement.

As in the instrument circuit of the prior patent so in the instrument circuit of the present invention, the whole or part of one or the other of the two impedances may, where circuit conditions permit, be included in a winding (L*1*) of the induction coil by arranging that this winding is a high resistance winding, that is a winding the effective resistance of a turn of which is designedly large compared with the effective resistance of a turn of the other windings.

The manner in which the circuits may be arranged to enable a three-conductor cord to be used for connecting the transmitter-receiver combination to the remainder of the instrument may readily be understood. The encircled parts in the circuit diagrams are the parts which have to be so connected. In practice, a switch-hook contact SH Fig. 8, would be included in the closed circuit containing the transmitter. This contact may be at either end of the three-conductor cord, depending on whether the switch-hook is associated with the transmitter receiver combination (that is the encircled parts) or with the remainder of the apparatus.

Under certain circumstances, for example in quiet situations, the attainment of a high degree of side-tone suppression may become of lesser importance than the obtaining of a large alternating line current for a given acoustic input to the transmitter. The induction coil and the two impedances of the side-tone controlling part for a telephone instrument circuit according to the invention may be so designed and proportioned that the instrument circuit may be made especially suitable for use under such circumstances by altering the winding or connections so as to short-circuit or remove one of the impedances (R2). The forms taken by the circuits of Figs. 3, 4, 6 and 7, when such modification is effected may readily be understood.

Fig. 8, which may be compared with Fig. 4, shows, by way of example, a circuit diagram of a specific instrument circuit according to the invention, the induction coil and side-tone controlling parts of which have been so designed and proportioned that the instrument circuit may be modified for use in a quiet situation as described.

In Fig. 8, T and R are respectively the transmitter and receiver of a hand micro-telephone. TR is the induction coil, having windings (I), (II), and (III), and the side-tone controlling parts, consisting of windings (IV) and (V), which, for convenience, consist of non-inductive resistances and are formed by windings on, but which are not to be considered as being windings of, the induction coil. Winding (I) and resistance (IV) are permanently connected in series, the series combination being terminated on terminals 3 and 6. Windings (II) and (III) and resistance (V) are terminated respectively on terminals *1* and 2, 4 and 6, and 5 and 6, L, L are line terminals, CK is a three-conductor cord, SH is a switch-hook contact, and C and LB are respectively the condenser and local battery. It must be understood that parts such as bells which are of no importance as regards the invention have been omitted from all the figures of the drawing. Condenser C, and resistances (IV) and (V) correspond respectively to condenser C, and resistances R*1* and R2 of Fig. 4, and windings (II) and (III) correspond respectively to windings L2 and L3 of Fig. 4. In practice when the Fig. 8 arrangement is used in a noisy situation, the lower line current produced for a given acoustic input is counteracted by the fact that the user of the instrument naturally tends to raise his voice owing to the noise and to the lower level of side tone.

For a telephone instrument circuit giving a satisfactory performance in accordance with the invention the three windings L*1*, L2, L3 have inductances of the order of 65, 85, and 9 millihenrys respectively and resistances of the order of 32, 16 and 1.5 ohms respectively. The starts of these windings are respectively 3, 4 and 5, the windings being wound in the same direction round the core and the term start having the well understood meaning. Resistance (IV) is 320 ohms and resistance (V) 18 ohms. Con-

denser C is 2 microfarads. The receiver impedance is of the order of 295/60° ohms at a frequency of 796 cycles per second. The transmitter has a resistance of the order of 50 ohms.

By the use of an instrument so constituted an efficient anti-side-tone central battery signalling local battery talking telephone instrument circuit is produced the resistance of which, measured at the line terminals, does not exceed 200 ohms. This may be further decreased, if desired, by the connection across the line terminals of a high impedance choke having an inductance of 2 henrys at 796 cycles per second and a direct current resistance of approximately 135 ohms.

I claim:—

In a telephone instrument, a transmitter, a receiver, two impedances, an induction coil having three windings, a local battery and a line, a closed local circuit including one winding of said induction coil, one impedance, a transmitter and said battery, another winding of said induction coil connected in series with said line so that all line current passes therethrough, a bridge across said line including said receiver connected in series with said closed circuit, another bridge across said line in parallel with said first bridge including said other impedance, said third winding connected in series with one of said parallel bridges and a condenser connected in series with and included in said first bridge.

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