

June 30, 1942.

R. J. TILLMAN ET AL

2,288,049

TELEPHONE SET CIRCUIT

Filed June 10, 1939

2 Sheets-Sheet 1

FIG. 1

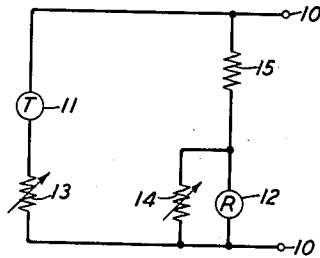


FIG. 2

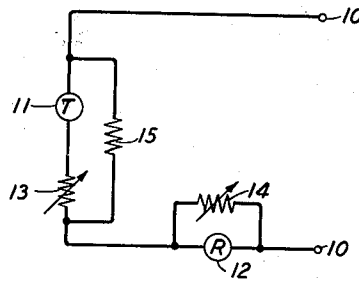


FIG. 3

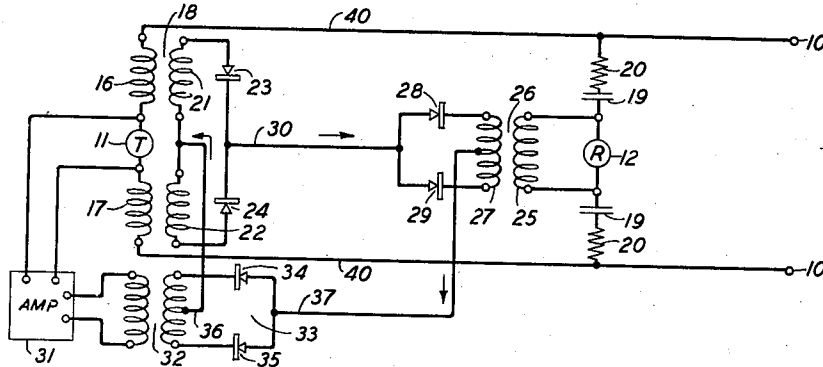
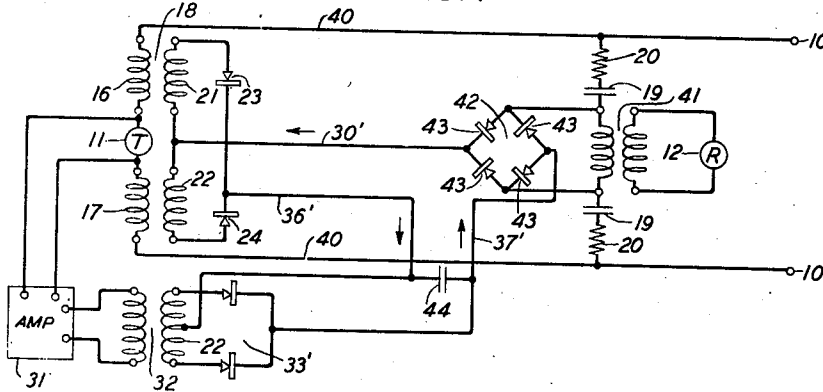


FIG. 4



INVENTORS: R. J. TILLMAN
M. K. ZINN

BY

R. J. Fluskey
ATTORNEY

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FIG. 5

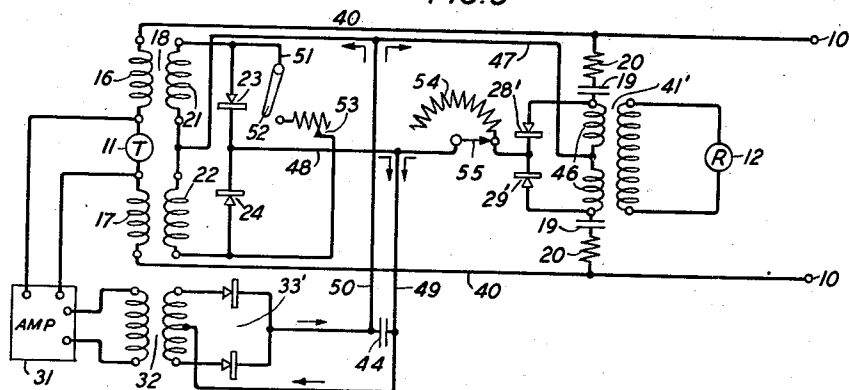


FIG. 6

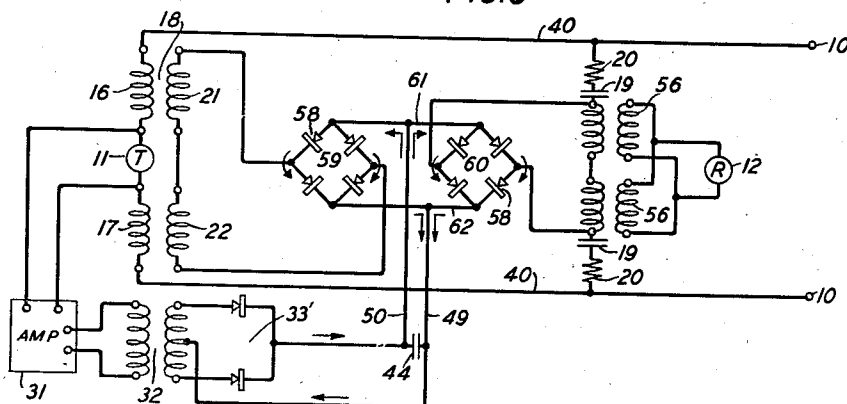
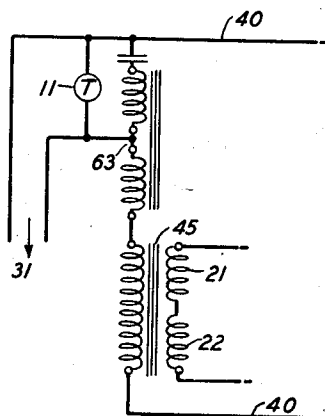


FIG. 7



INVENTORS: **R. J. TILLMAN**
BY **M. K. ZINN**

BY

R. J. Fluskey
ATTORNEY

UNITED STATES PATENT OFFICE

2,288,049

TELEPHONE SET CIRCUIT

Richard J. Tillman, Brooklyn, and Manvel K. Zinn, Manhasset, N. Y., assignors to Bell Telephone Laboratories Incorporated, New York, N. Y., a corporation of New York

Application June 10, 1939, Serial No. 278,398

18 Claims. (Cl. 179—81)

This invention relates to telephone set circuits.

In subscribers' substation set circuits, telephone operator set circuits, and in interoffice communication or conference systems or circuits, in which a single pair of wires is used for intercommunication, room or the like noises picked up by the transmitter during the listening or receiving period and appearing in the receiving circuit to interfere with the weak incoming voice currents, and side-tone in the receiving circuit during the talking period, may interfere seriously with the efficient and comfortable use of such circuits, and with the quality and clarity of the messages being transmitted and received. It would be desirable, therefore, if side-tone during the talking period or interfering currents during the receiving period could be markedly reduced, or completely eliminated, or eliminated to a preassigned degree.

An object of the invention, therefore, is to make available a telephone set circuit in which side-tone is completely eliminated or eliminated to a preassigned degree, and in which interference with incoming voice currents arising from room or other noises picked up by the transmitter is precluded.

A feature of this invention comprises arranging a telephone set circuit so that during receiving thereat only the incoming voice currents have access to the receiver of the circuit.

A further feature of the invention comprises arranging a telephone set circuit so that during transmitting therefrom no voice currents generated in the transmitter are effective on the receiver of the circuit, this being accomplished by having the transmitter control impedance means associated with the transmitter and receiver to provide, for voice currents, a low impedance path through the transmitter and a low impedance path around the receiver.

Other and further features will be evident, and a more complete understanding of the invention will be obtained, from the detailed description which follows, taken in conjunction with the appended drawings, wherein:

Figs. 1 and 2 are simplified showings of telephone set circuits embodying the invention;

Fig. 3 shows a specific telephone set circuit embodying the invention;

Figs. 4, 5 and 6 show modifications of the circuit of Fig. 3; and

Fig. 7 illustrates an alternative circuit arrangement of the transmitter in the circuits of Figs. 3 to 6.

The basic character of the invention will be

evident from Figs. 1 and 2. Fig. 1 shows in schematic a telephone set circuit comprising line terminals 10, a transmitter 11, which may be of the granular carbon type, such as is disclosed in A. F. Bennett et al., Patent 2,042,822, issued June 2, 1936, a telephone receiver 12, which may be of the electromagnetic type, such as is disclosed in L. A. Morrison et al., United States Patent No. 2,220,942, issued Nov. 12, 1940, a variable impedance means or element 13 in series with the transmitter, and a variable impedance means or element 14 in parallel with the receiver. These variable impedance means, the specific nature of which will be developed more fully hereinafter, have a high impedance while telephone signals or voice currents are being received through the terminals 10, but are caused to become of a very low impedance automatically when the transmitter is being talked into, i. e., during transmission of voice currents through the line terminals to a line that may be connected to the terminals. The circuit element 15, which may be a resistance, is connected in series with the receiver so that, in operation of the transmitter during a talking period, the low value of the impedance means 14 will not unduly shunt the talking currents. At the same time, element 15 should not be of so large a value that the receiving efficiency is unduly decreased.

Whereas Fig. 1 shows the transmitter and the receiver connected in parallel circuits across the line terminals 10, Fig. 2 shows them connected in series with the line terminals, and with the variable impedance means 13, 14 connected in series with the transmitter and in parallel with the receiver, respectively. Circuit element 15 in the series circuit arrangement of Fig. 2 is connected in parallel with the series-connected transmitter and impedance means 13. For the normal or listening condition of the circuit of Fig. 2, the impedances of the elements 13, 14 are of very high value. Voice currents received, therefore, pass through the receiver and the element 15 in series with the line terminals. Room or the like noises acting on the transmitter are ineffective to produce interfering currents in the receiver because of the very high impedance in series with the transmitter. When the transmitter is talked into, the impedances of the elements 13, 14 are caused to become of very low value so that a path for talking currents is provided that comprises the transmitter and the elements 13, 14 in series across the line terminals, the receiver being effectively by-passed. As in the arrangement of Fig. 1, the element 15 should be proportioned to

give the best compromise of receiving and transmitting efficiency.

In each of Figs. 1 and 2, talking current for the transmitter would be supplied from a suitable source, for example, over the telephone line to which the line terminals provide connection.

With reference now to Figure 3, there is shown a preferred arrangement of a telephone set circuit embodying the invention. The transmitter 11 is connected in series with the windings 16, 17 of the primary of a transformer or repeating coil 18, across the line terminals 19. The receiver 12 is also connected across the line terminals in series with the blocking condensers 19 and the resistances 20. Talking current for the transmitter may be received over conductors 43 from a central office, over the telephone line to which the telephone set circuit is adapted to be connected through the line terminals. The series-connected windings 21, 22 of the secondary of the transformer 18 have their outer terminals connected together through a pair of elements or devices 23, 24 having a non-linear current resistance characteristic, for example, a pair of copper oxide rectifier discs or units, arranged in opposition. The primary winding 25 of a transformer or repeating coil 26 is connected in parallel with the receiver, and the terminals of its secondary winding 27 are connected together through devices 28, 29 similar to the devices 23, 24, connected in opposition. The common terminal of the devices 28, 29 is connected by the conductor 30 to the common terminal of the devices 23, 24. The input terminals of an amplifier 31, which are high in impedance with respect to the transmitter for both alternating and direct current, are connected across the terminals of the transmitter. The amplifier 31 may be of the electron discharge device type or of the so-called mechanical type. The output terminals of the amplifier are connected through a transformer or repeating coil 32 to a rectifier 33, which may comprise a pair of devices 34, 35 similar to devices 23, 24. The mid-point of the secondary winding of the transformer 32 is connected to the inner or common terminals of the windings 21, 22, through a conductor 36, and the common terminal of the rectifier units 34, 35 is connected through a conductor 37 to the mid-point of the winding 27 of transformer 26.

The gain of the amplifier is so adjusted that during the normal or receiving condition of the circuit there is no output therefrom to be rectified by the rectifier 33 and to be supplied to the secondary winding circuits of the transformers. For this condition, the non-linear devices 23, 24 and 28, 29 are of very high resistance or impedance. Although the primary windings 16, 17 of transformer 18 are of low direct current resistance to facilitate flow of transmitter talking current, they have high alternating current impedance, because of the high impedance of elements 23, 24, across the secondary windings 21, 22. Similarly, the impedance into the primary winding 25, of the transformer 26, is high, owing to the high impedance of the elements 28, 29, connected across the secondary 27. There is, therefore, during the listening period, a high impedance effectively, i. e., from a transmission standpoint, in series with the transmitter, and a high impedance in shunt with the receiver. Hence, when the weak voice currents are incoming to the circuit, they will pass through the receiving branch and the receiver unaffected by any interfering currents, which in circuits of the prior art

would be present because of room and other noise pick-up by the transmitter, the impedance of the transmitting circuit being so high that, although the transmitter diaphragm may be agitated by the room or other noises, no currents corresponding thereto are generated in the transmitting circuit and transferred to the receiving circuit.

On the other hand, when it is desired to talk or to transmit, the agitation of the transmitter by the user's vocal sounds generates large voice currents in the transmitting circuit. Since the amplifier is connected in parallel with the transmitter, its output will be increased. The output of the amplifier is rectified by the rectifier 33, and the circuit connections are such that the rectified current flows in the direction indicated by the arrows. The current flow through the devices 23, 24 and 28, 29 breaks down their resistance or impedance to a very low value with the effect that a very low impedance appears across the secondaries of the transformers 18 and 26, and effectively, or from a transmission standpoint, a very low impedance appears in series with the transmitter and in parallel with the receiver. An efficient transmitting circuit is thereby obtained, and at the same time the receiver is effectively by-passed as to voice currents whereby side-tone, due to talking currents, is not evidenced in the receiver. When the user or speaker ceases to talk, the circuit reverts to its original condition, and is again ready for efficient, interference-free receiving.

The telephone set circuit of Fig. 4 involves the same principle of operation as that of Fig. 3, but embodies a modified receiver circuit enabling matching the impedance of the receiver to that of the line. The receiver is connected across the secondary winding of a transformer or repeating coil 41, and a bridge arrangement 42 of non-linear devices 43, for example, copper oxide rectifier units, is connected across the primary winding of the transformer 41. The polarity of the rectifier 33' is shown reversed from that of the rectifier 33 in Fig. 3, and a condenser 44 is connected across the rectifier output and functions as a low-pass filter; this condenser, of course, could be included in the circuit arrangement of Fig. 3. As in the case of Fig. 3, however, during receiving, the amplifier output, if any, is not sufficient to break down the high resistance of the non-linear elements 23, 24 and 43, and there is effectively a very high impedance in series with the transmitter and in shunt with the primary of transformer 41 to enable efficient and interference-free receiving. When a speaker or user talks into the transmitter, on the other hand, the rectified output of the amplifier is sufficient to break down the resistance of the elements 23, 24 and 43 and to provide very low impedances effectively in series with the transmitter and in shunt with the receiver transformer primary.

Fig. 5 shows another telephone set circuit embodying the invention, elements thereof similar to the circuits of Figs. 3 and 4 bearing like identifying numerals. In Fig. 3, the transformer windings 21, 22 and devices 23, 24 and the transformer winding 27 and devices 28, 29 are connected in a series circuit with the rectifier 33' through conductors 30, 35 and 37. In the circuit of Fig. 5, however, the networks of windings 21, 22 and devices 23, 24, and the primary windings 46 of receiver transformer 41' and devices 28', 29' are connected in parallel by the

conductors or connections 47, 48, and are connected to rectifier 33' through conductors 49, 50. In the normal or listening condition of the telephone set circuit, the devices 23, 24, 28', 29' are in their high impedance condition; during transmitting the flow of direct current resulting from the rectified talking currents output of the amplifier 31, causes them to assume their low impedance condition. Hence during receiving, room or the like noises acting on the transmitter would not be effective in the receiver, and during transmitting side-tone would not be effective in the receiver. Independent control of transmitting suppression is obtained by providing the shunt connection 51 across the secondary of transformer 18, including a normally-open switch 52 and a variable resistance 53 but with no change being made in the amplifier gain which would interfere with maximum transmitting. This is psychologically desirable with respect to the far end listener. For the particular preassigned adjustment of the resistance 53, under such circumstances, some room or the like noise would be transmitted at the telephone set. Independent control of receiving suppression, i. e., of side-tone, may be obtained by connecting a resistance 54 in series with that part of conductor 48 which connects the rectifier 33' to the variable impedance element or network for the receiver. The contact or switch 55 permits none or all or an adjustable amount of resistance 54 to be connected in the series circuit. This control of suppression of side-tone in the receiving circuit may be desirable because some side-tone is a more natural condition for the user or speaker than complete elimination.

In the circuit arrangement of Fig. 6, the secondary windings 56 of the receiver transformer 57 are connected in parallel; and non-linear devices 58 of the same type as devices 23, 24 are arranged in bridges 59, 60 and connected in shunt of the secondary windings of transformer 18 and the primary windings of the receiver transformer. The bridges 59, 60 are connected in parallel by conductors 61, 62 and are connected to the rectifier 33' through conductors 49, 50. For the normal or listening condition of the circuit of Fig. 6, the bridges 59, 60 are in their high impedance condition, hence room or the like noises acting on the transmitter are not effective on the receiving circuit and the receiver. For the talking or transmitting condition, the impedance of the bridges becomes very small because of the direct current flow resulting from the rectified output of amplifier 31, and the receiver is effectively by-passed with respect to side-tone.

In each of Figs. 3-6, if the transmitter is of low impedance, for example, 50 ohms, and the line impedance is substantially high, for example, 600 ohms, the transformer arrangement of Fig. 7, embodying an autotransformer 63 and repeating coil type of transformer 45, may replace that of Figs. 3-6, to enable satisfactory impedance matching.

With the arrangements described, it is possible to reduce, or to eliminate completely, side-tone in the receiver during transmitting, and interference with receiving because of room or other noises agitating the transmitter, in subscribers' substation circuits, telephone operator set circuits, and in interoffice communication or conference systems.

In practice, telephone set circuits usually include parts that, for a complete understanding of this invention, it has not been necessary to

show in the circuit arrangements of the drawings, for example: a switchhook and switching springs, or other switching means; signaling or ringer means; a calling device or dial, when the circuit is to be used in an automatic telephone system. These may be supplied, of course, in accordance with telephone practice with reference to telephone set circuits.

What is claimed is:

1. A telephone set circuit comprising line terminals, a transmitting circuit including a transmitter and a transformer winding in series across said terminals, a transformer winding coupled to said first winding and having variable impedance means connected across its ends, a receiving circuit connected across said terminals, and including a receiver, a transformer winding in parallel with said receiver, a transformer winding coupled to said third-mentioned winding and having variable impedance means connected across its ends, said impedance means in the listening condition of said telephone set circuit being of high impedance, and means responsive to voice currents generated by the transmitter when talked into for causing said impedance means to become of low impedance.
2. An automatically variable telephone set circuit comprising a transmitting circuit and receiving circuit connected in parallel across line terminals, said transmitting circuit including a transmitter and a variable impedance means effectively in series with said transmitter, and said receiving circuit including a receiver and a second variable impedance means effectively in parallel with said receiver, both of said variable impedance means becoming of low impedance during transmitting through said line terminals and being of high impedance during receiving through said line terminals.
3. An automatically variable telephone set circuit comprising line terminals, a transmitter and a receiver connected in a series circuit across said terminals, a variable impedance means effectively in series with said transmitter, and a second variable impedance means effectively in parallel with said receiver, both of said variable impedance means becoming of low impedance during transmitting through said line terminals and being of high impedance during receiving through said line terminals.
4. A telephone set circuit comprising line terminals, a transmitting circuit including a transmitter, a receiving circuit including a receiver, variable impedance means in said transmitting circuit, and a second variable impedance means in said receiving circuit, said means being of such impedances during transmitting of telephone currents through said line terminals as effectively to disable said receiving circuit and of such impedances during receiving of telephone currents through said line terminals as effectively to disable said transmitting circuit, both of said impedances being of high impedance during receiving and both of said impedances being of low impedance during transmitting.
5. A telephone set circuit comprising line terminals, a transmitting circuit including a transmitter, a receiving circuit including a receiver, variable impedance means in said transmitting circuit and effectively in series with the transmitter, and a second variable impedance means in said receiving circuit and effectively in parallel with the receiver, said transmitting circuit and said receiving circuit being connected in series across said line terminals, said variable imped-

ance means being of such impedances during transmitting of telephone currents through said line terminals as effectively to disable said receiving circuit and of such impedances during receiving of telephone currents through said line terminals as effectively to disable said transmitting circuit, both of said variable impedance means being of high impedance during receiving and both of said variable impedance means being of low impedance during transmitting.

6. A telephone set circuit comprising line terminals, a transmitting circuit including a transmitter, a receiving circuit including a receiver, variable impedance means in said transmitting circuit and effectively in series with the transmitter, and a second variable impedance means in said receiving circuit and effectively in parallel with the receiver, said transmitting circuit and said receiving circuit being connected in parallel across said line terminals, said variable impedance means being of such impedances during transmitting of telephone currents through said line terminals as effectively to disable said receiving circuit and of such impedances during receiving of telephone current through said line terminals as effectively to disable said transmitting circuit, both of said variable impedance means being of high impedance during receiving and both of said variable impedance means being of low impedance during transmitting.

7. A telephone set circuit comprising line terminals, a transmitting circuit including a transmitter, a receiving circuit including a receiver, variable impedance means in said transmitting circuit, a second variable impedance means in said receiving circuit, said means being of such impedances during transmitting of telephone currents through said line terminals as effectively to disable said receiving circuit and of such impedances during receiving of telephone currents through said line terminals as effectively to disable said transmitting circuit, and means enabling, during receiving, the transmitting to a predetermined degree of room or other noises acting on the transmitter.

8. A telephone set circuit comprising line terminals, a transmitting circuit including a transmitter, a receiving circuit including a receiver, variable impedance means in said transmitting circuit, a second variable impedance means in said receiving circuit, said means being of such impedances during transmitting of telephone currents through said line terminals as effectively to disable said receiving circuit and of such impedances during receiving of telephone currents through said line terminals as effectively to disable said transmitting circuit, and means enabling, during transmitting, the introduction to a predetermined degree of side tone in the receiver.

9. A telephone set circuit comprising line terminals, a transmitting circuit including a transmitter, a receiving circuit including a receiver, variable impedance means in said transmitting circuit, a second variable impedance means in said receiving circuit, said means being of such impedances during transmitting of telephone currents through said line terminals as effectively to disable said receiving circuit and of such impedances during receiving of telephone currents through said line terminals as effectively to disable said transmitting circuit, and means enabling, during receiving, the transmitting to a predetermined degree of room or other noises acting on the transmitter, and, during transmitting,

the introduction to a predetermined degree of side tone in the receiver.

10. A telephone set circuit comprising line terminals, a transmitting circuit including a transmitter and connected with said line terminals, a receiving circuit including a receiver and connected with said line terminals, an impedance element effectively in series with said transmitter, and a second impedance element effectively in parallel with said receiver, each of said elements being of high impedance when voice currents are being received over said receiving circuit and of low impedance when voice currents are being generated in said transmitting circuit.

11. A telephone set circuit comprising a transmitter, a receiver, a first transformer, a second transformer, an amplifier, a rectifier, a plurality of unidirectional current-passing devices, a pair of terminals, said transmitter and a winding of said first transformer being connected in series across said line terminals, said first transformer having a second winding, said receiver being connected in series with a winding of said second transformer, a second winding of said second transformer being connected across said terminals, said amplifier having its input connected across said transmitter and its output connected to the input of said rectifier, at least two of said unidirectional devices being connected across each of said second windings, and connections from said rectifier to supply said devices with rectified amplified voice currents generated in said transmitter during transmitting.

12. A telephone set circuit comprising a transmitter, a receiver, a first transformer, a second transformer, an amplifier, a rectifier, a plurality of unidirectional current-passing devices, a pair of terminals, said transmitter and a winding of said first transformer being connected in series across said line terminals, said first transformer having a second winding, said receiver being connected in series with a winding of said second transformer, a second winding of said second transformer being connected across said terminals, said amplifier having its input connected across said transmitter and its output connected to the input of said rectifier, a pair of said unidirectional current devices connected in opposed-pole relation across each of said second windings, a connection between said second windings at a point on each intermediate its ends, a connection between the junctions of said pairs of oppositely-poled devices, and connections from said two last-named connections to the output of said rectifier.

13. A telephone set circuit comprising a transmitter, a receiver, a first transformer, a second transformer, an amplifier, a rectifier, a plurality of unidirectional current-passing devices, a pair of terminals, said transmitter and a winding of said first transformer being connected in series across said line terminals, said first transformer having a second winding, said receiver being connected in series with a winding of said second transformer, a second winding of said second transformer being connected across said terminals, said amplifier having its input connected across said transmitter and its output connected to the input of said rectifier, a pair of said unidirectional current devices connected in opposed-pole relation across each of said second windings, a connection between said second windings at a point on each intermediate its ends, a connection between the junctions of said pairs of oppositely-poled devices, a variable resistance in said last-named connection, a variable resistance connected

in shunt with the second winding of said first transformer, and connections from said two last-named connections to the output of said rectifier.

14. An automatically variable telephone set circuit comprising a transmitting circuit and a receiving circuit connected in parallel across line terminals, said transmitting circuit including a transmitter and a variable impedance means effectively in series, and said receiving circuit including a receiver and a second variable impedance means effectively in parallel with said receiver, both of said variable impedance means being of high impedance during receiving and both of said variable impedance means being of low impedance during transmitting, and a resistance connected in series with said parallel-connected receiver and variable impedance means.

15. An automatically variable telephone set circuit comprising line terminals, a transmitter and a receiver connected in a series circuit between said terminals, a variable impedance means effectively in series with said transmitter, a resistance connected in parallel with the series-connected transmitter and variable impedance means, and a second variable means effectively in parallel with said receiver, both of said variable impedance means being of high impedance during receiving and both of said variable impedance means being of low impedance during transmitting.

16. A telephone set circuit comprising line terminals, a transmitting circuit including a transmitter and connected with said line terminals, a receiving circuit including a receiver and connected with said line terminals, impedance means effectively in series with the transmitter, a second impedance means effectively in parallel with the receiver, said respective impedance means being of high impedance relative to said transmitter and said receiver, respectively, when voice currents are being received over said receiving circuit, means to derive an impedance control current from voice currents generated in said transmitting circuit during transmitting out through said line terminals, and means to apply said control current to said impedance means to reduce their respective impedances to low values relative to said transmitter and said receiver, respectively, during such transmitting.

17. A telephone set circuit comprising line terminals, a transmitting circuit including a transmitter and connected with said line terminals, a receiving circuit including a receiver and connected with said line terminals, impedance means effectively in series with the transmitter, a second impedance means effectively in parallel with the receiver, said respective impedance means being of high impedance relative to said transmitter and said receiver, respectively, when voice currents are being received over said receiving circuit, amplifying means in circuit with said transmitter, said amplifying means being adjusted so that, during the receiving period, room and other noises picked up by said transmitter and generating currents therein are discriminated against by said amplifier, and so that, when voice currents are generated in said transmitting circuit during transmitting out through said line terminals, a portion of such generated voice currents is amplified by said amplifying means, means to derive an impedance control current from the output of said amplifying means, and means to apply said control current to said impedance means to reduce their respective impedances to low values relative to said transmitter and said receiver, respectively, during the transmitting period.

18. A telephone set circuit comprising line terminals, a transmitting circuit including a transmitter and connected with said terminals, a receiving circuit including a receiver and connected with said terminals, impedance means effectively in series with said transmitter, a second impedance means effectively in parallel with said receiver, said respective impedance means being of high impedance relative to said transmitter and said receiver, respectively, in the listening condition of said set circuit, and means responsive to audio frequency currents generated by the transmitter when talked into, for reducing the respective impedances of said impedance means to values low relative to said transmitter and said receiver, respectively.

RICHARD J. TILLMAN,
MANVEL K. ZINN.