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E. DIETZE

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TELEPHONE SYSTEM

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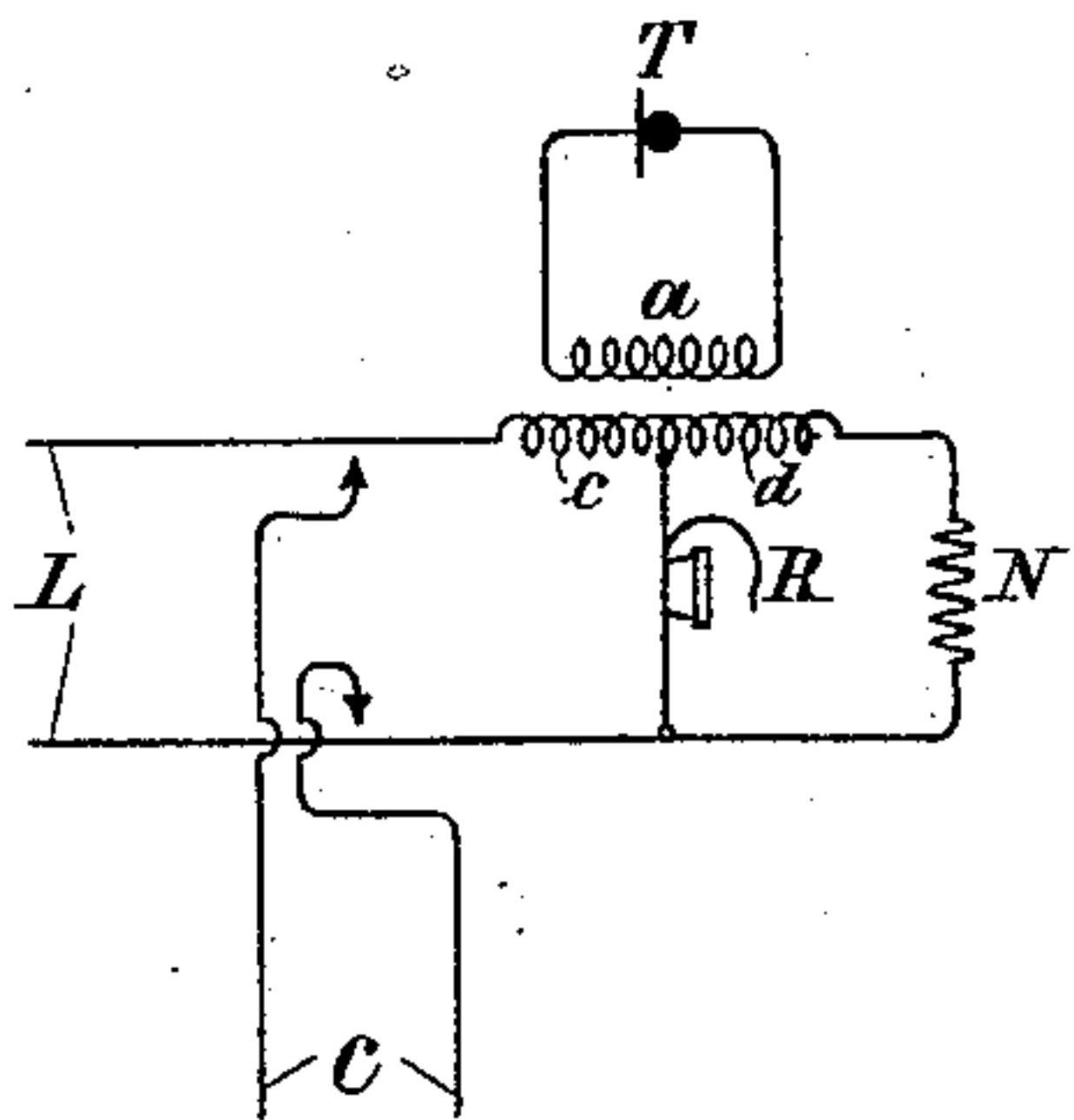


Fig. 1

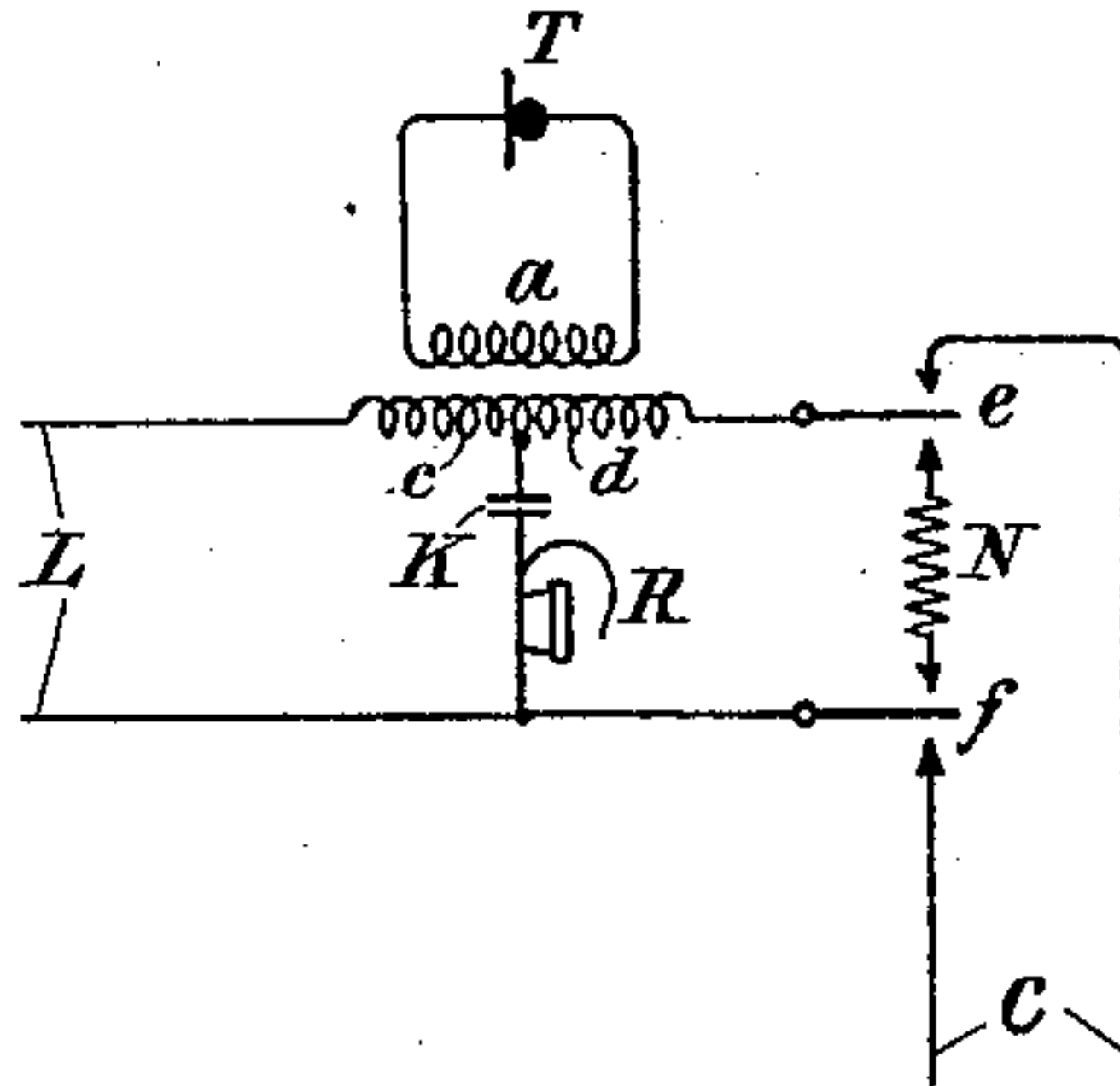


Fig. 2

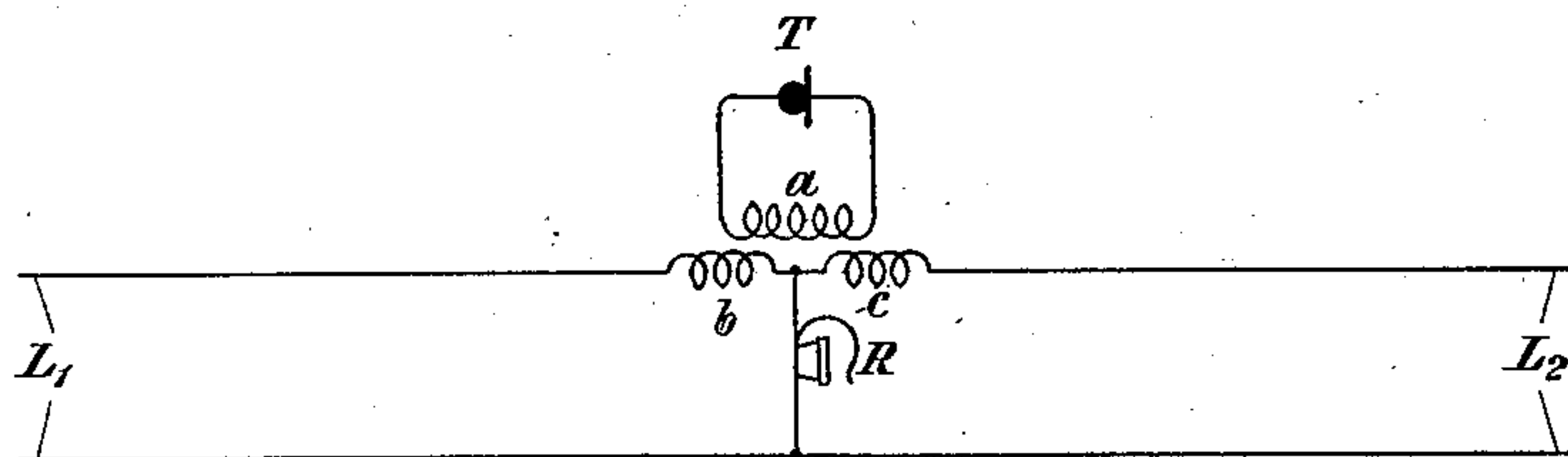


Fig. 3

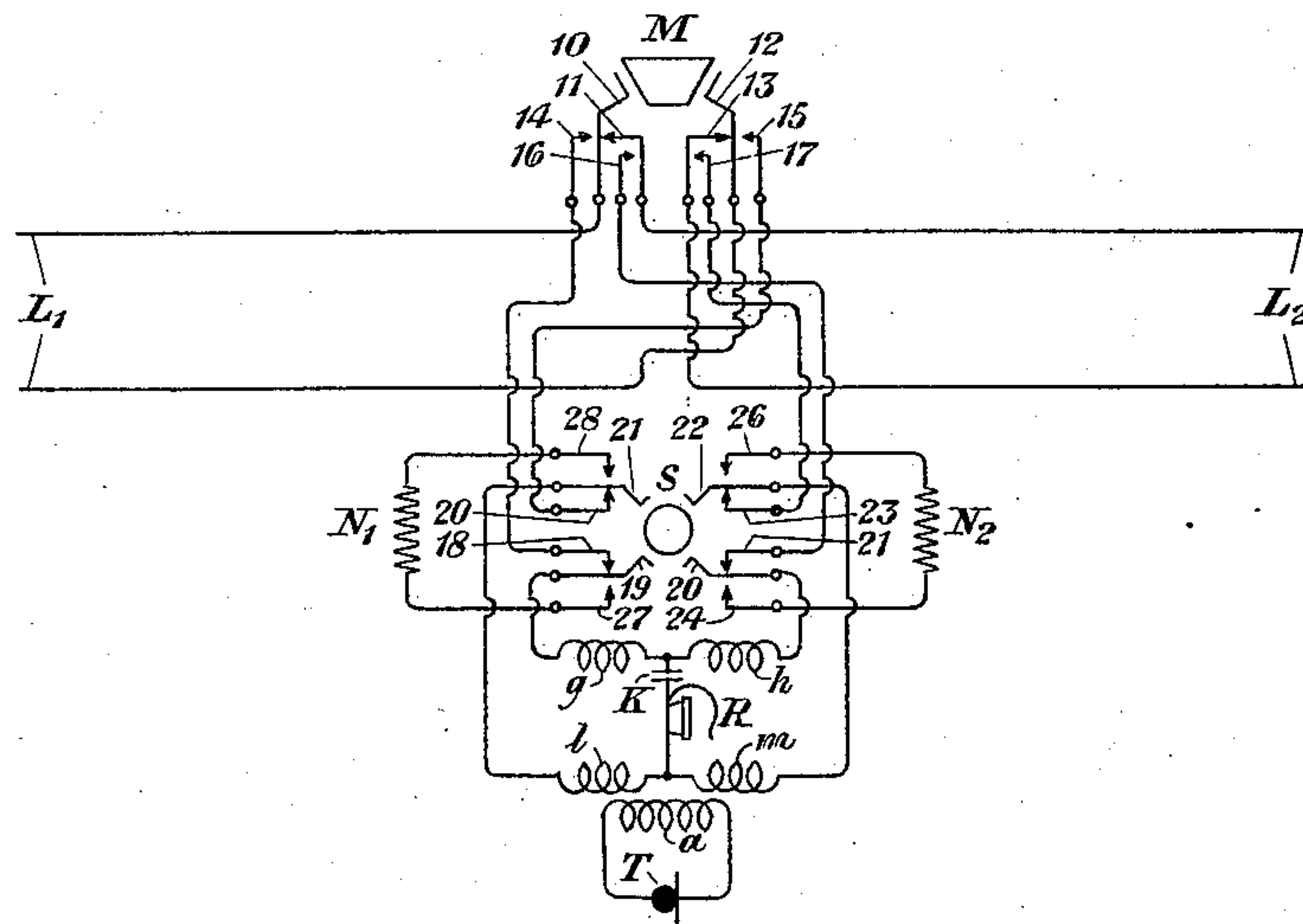


Fig. 4

INVENTOR.
E. Dietze
BY *gerfor*
ATTORNEY

UNITED STATES PATENT OFFICE.

EGINHARD DIETZE, OF WESTFIELD, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK.

TELEPHONE SYSTEM.

Application filed July 6, 1927. Serial No. 203,831.

This invention relates to telephone circuits, and particularly to telephone sets which may be employed for the interconnection of two or more circuits so that telephonic communication may be established thereover.

Several new operating schemes in use at the present time permit a telephone subscriber to ring his operator and remain on the telephone circuit while the operator establishes the proper connection. By these practices, a subscriber is enabled to catch mistakes made by his operator in communicating the telephone number to another operator connected to another circuit. Thus, the subscriber may frequently prevent his operator from connecting his circuit to an undesired circuit. Obviously, this results in faster and more efficient telephone service.

In accordance with these practices, the operator's set is frequently connected to two circuits simultaneously, (1) the trunk circuit extending to the city or exchange which is being called at the end of which there is a B operator and (2) the subscriber's circuit which connects the subscriber with the A operator. If the ordinary operator's telephone set be connected to two such circuits simultaneously, the transmission efficiency, so far as the operator's set is concerned, is considerably reduced because of the fact that one of the circuits introduces a bridged loss for the other. Yet, the subscriber may hear the conversation on the trunk circuit between the A and B operators, because the subscriber's circuit and the trunk circuit are interconnected through the operator's telephone set. To permit the subscriber to hear a conversation between operators over a trunk circuit may, nevertheless, be objectionable for various reasons.

In accordance with this invention, an operator's telephone circuit will be described which, when connected to two or more telephone circuits, will prevent the transmission loss heretofore introduced by bridging one circuit across another circuit. Moreover, the proposed operator's telephone circuit will substantially prevent the transmission of telephonic signals between the subscriber and a party or operator connected to the distant end of the trunk circuit during the period in which circuit connections are being established.

This invention will be better understood from the detailed description hereinafter fol-

lowing, when read in connection with the accompanying drawing in which Figure 1 represents the circuit arrangement of a call circuit and a loop circuit connected through an operator's telephone set, Fig. 2 shows a similar circuit embodying the principles of this invention in which a balancing network or a call circuit may be connected to the trunk circuit through the operator's telephone set, Fig. 3 shows the general arrangement of the elements of a telephone system embodying the principles of the invention, and Fig. 4 shows two telephone circuits either or both of which may be connected to an operator's telephone set.

Referring to Fig. 1 of the drawing, a telephone line L is shown which may be bridged by a call circuit C. The telephone circuit L terminates in an operator's telephone set comprising three windings wound on a common core. The first winding *a* is in series relationship with a telephone transmitter T of any well known type of, for example, the carbon button type, while the second and third windings *c* and *d* are in series relationship with the telephone circuit L. A telephone receiver R of any well known type bridges the telephone circuit L from the point common to the latter windings. A balancing network N which, although shown in the form of a resistance, may in general consist of reactance as well as resistance of suitable magnitudes, is in series relationship with winding *d*.

The circuit arrangement shown in Fig. 1 illustrates a system in which speech repetition on the call circuit or circuits may be restricted. The operator controlling the telephone set having the transmitter T and the receiver R is known as the A operator, while the party or operator at the distant end of the telephone line L is known as the B operator. The subscriber at the distant end of the call circuit C may be connected to the telephone line L by the A operator. When such a connection is established, the subscriber hears the A operator pass his call over the telephone circuit L, the subscriber usually remaining connected to the telephone circuit L. The telephone circuit L is thus bridged by the call circuit C, introducing a substantial loss in efficiency so far as the A operator's telephone set is concerned. Accordingly, the subscriber may converse with the B operator and he may also hear the voices of different operators connected to the telephone circuit.

A modified circuit arrangement based on the principles of this invention is shown in Fig. 2. Here a condenser K is shown in series with the telephone receiver R, bridged across the telephone circuit L from the point common to windings *c* and *d*. When a call circuit key (not shown) is depressed, the armatures, *e* and *f*, which are energized by an electromagnetic winding (not shown) move outwardly so as to connect the call circuit C to the operator's telephone set instead of the balancing network N. When the call circuit key is released, armatures *e* and *f* move inwardly so as to disconnect the call circuit C and then terminate the operator's telephone set with the balancing network N.

It is to be observed that in this invention, the balancing network is disconnected from an anti-side tone telephone circuit of a well known type when the operator's telephone set is being connected to a second circuit or line such as the call circuit C. Thus the second circuit or line, i. e., call circuit C, is substituted in place of the balancing network N. Call circuit C then acts as a balancing network for the first line, i. e., the telephone circuit L. It is obvious that these lines must have a proper impedance relationship for good side tone balance. This relationship will exist in an operator's telephone circuit arrangement which is terminated in the balancing network N if

$$\frac{L}{N} = \frac{c}{d} \quad (1)$$

in which L is the impedance of the telephone line L, N is the impedance of the balancing network and *c* and *d* represent the number of turns on the respective windings. When the call circuit key is depressed so as to connect the call circuit C to the operator's telephone set in place of the balancing network, then N will represent the impedance of the latter circuit.

It can readily be understood that in the telephone substation of the type under consideration, no energy is dissipated in the balancing network when signals are being received, and furthermore, no energy can be transmitted from the balancing network to circuit L if, for example, a transmitter were connected in series relationship therewith. Then

$$\frac{T}{R} = \frac{a^2}{cd}, \quad (2)$$

in which T and R are the impedances of the transmitter and receiver, respectively, *a* is the number of turns on the winding in series with the transmitter T and *c* and *d* are the number of turns on the windings coupled to winding *a*. If the circuit arrangement shown, in which the telephone line L is connected to the call circuit C, were designed to provide the relationship expressed in Equa-

tion (2), then the transmission of signals between the telephone line L and the call circuit C will be practically eliminated. It becomes apparent from Equation (2), however, that the relative magnitudes of the transmitter and receiver impedances must be carefully proportioned and that these elements must also bear a proper phase relationship. Thus, the condenser K is shown in series with the telephone receiver R and this condenser may be used for adjustment so as to bring about the proper phase relationship. Yet, such a condenser will bring about suitable phase equality only over a comparatively narrow band of frequencies. If it is necessary to provide phase equality over a wider band of frequencies, then inductance may be added in series with the transmitter T, instead of a capacity, such as the condenser K in series with the telephone receiver R. It is here to be noted that the condenser in series with the telephone receiver has a practical advantage over the inductance in series with the transmitter, the series inductance introducing a substantial transmission loss while the series condenser provides a transmission gain. Thus, the series condenser is deemed preferable to the series inductance in practical circuits, if satisfactory suppression of signaling currents between the B operator and the subscriber is to be obtained by the phase adjustment which may, for example, be made over a comparatively narrow frequency range by changing the capacity of said condenser.

Referring again to Fig. 2 of the drawing, it will be seen that when the call circuit key is depressed to replace the balancing network by the call circuit C, the telephone line L then acts as a balancing network and does not, of itself, introduce any transmission loss. If, however, the telephone receiver and transmitter are suitably proportioned, a large transmission loss will be introduced between the telephone line L and the call circuit C so that the transmission of speech signals over these circuits while the operator's telephone set is connected will be substantially prevented.

Fig. 3 shows a circuit arrangement in which two lines L₁ and L₂ are shown interconnected by an operator's telephone set. Windings *b* and *c* are in series relationship with lines L₁ and L₂ and a telephone receiver R bridges lines L₁ and L₂ from a point common to windings *b* and *c*. Winding *a* is coupled to windings *b* and *c* and is in series with the transmitter T. In this circuit arrangement one of the lines replaces a balancing network. In the familiar case of local straightforward trunking systems, line L₁ may be considered representative of a subscriber's loop and line L₂ of a trunk circuit extending to an office or station to be called.

Fig. 4 shows a modification of a circuit ar-

rangement shown in Fig. 3 in which a listen-
 ing key M and a splitting key S are employed.
 When the listening key is in its normal posi-
 tion, line L_1 is directly connected to line L_2
 through armature 10 and contact 11, and
 armature 12 and contact 13. By depressing
 listening key M, the armatures 10 and 12 open
 contacts 11 and 13 and close contacts 14 and
 15, respectively. Also, contacts 11 and 13
 become electrically connected to contacts 16
 and 17. The operator's telephone set com-
 prising windings g and h , l and m , telephone
 receiver R and condenser K bridging the
 points common to these windings and a wind-
 ing a coupled to the other windings and in
 series with the transmitter T, is interposed
 between circuits L_1 and L_2 . The upper
 branch of these circuits may be traced
 through armature 10, contact 14, contact 18,
 armature 19, windings g and h , armature 20,
 contact 21, contact 16 and contact 11. The
 lower branch of these circuits may be traced
 from armature 12 through contact 15, con-
 tact 20, armature 21, windings l and m , arma-
 ture 22, contact 23 and contacts 17 and 13.
 The depression of listening key M provides
 a circuit similar to the one shown in Fig. 3,
 in which the windings in series with the tele-
 phone lines L_1 and L_2 are divided between
 the two sides of the interconnected circuit
 primarily for the purpose of symmetry.
 Thus, the operator may converse with a
 party connected to either of the lines. When
 the operator converses over line L_1 , the con-
 versation may be heard over line L_2 . If any
 misstatement is made by the operator, she
 may be interrupted and notified of her mis-
 statement in order that it may be corrected.
 Obviously, this is equally true of conversa-
 tions by the operator over line L_2 .

The operator may talk over either line inde-
 pendently by operating the splitting key S as
 well as the listening key M. When the split-
 ting key S is thrown to the right, the listening
 key M being closed, the armatures 20 and 22
 will close contacts 24 and 26, respectively.
 The operator's telephone set is then connected
 to line L_1 , the operator's set being terminated
 in impedance N_2 . The latter circuit may be
 traced through armature 10, contact 14, con-
 tact 18, armature 19, windings g and h , ar-
 mature 20, contact 24, impedance N_2 , contact
 26, armature 22, windings m and l , armature
 21, contact 20, contact 15, and armature 12.
 Thus, it will be apparent that when the listen-
 ing key is closed and the splitting key is
 thrown to the right, the impedance N_2 re-
 places the line L_2 and the operator may con-
 verse with the party at the other end of the
 line L_1 . Similarly, by closing the listening
 key M and by throwing the splitting key S to
 the left, line L_1 may be disconnected and line
 L_2 connected to the operator's telephone set.
 The latter circuit may be traced through con-
 tacts 11 and 16, contact 21, armature 20, wind-

ings h and g , armature 19, contact 27, imped-
 ance N_1 , contact 28, armature 21, windings l
 and m , armature 22, contact 23 and contacts 17
 and 13. Thus, it will be apparent that when
 the listening key is closed and the splitting
 key is thrown to the left, the operator may
 converse with the party at the other end of line
 L_2 , the balancing network N_1 replacing the
 line L_1 . If networks N_1 and N_2 have imped-
 ances substantially equal to the impedances of
 L_1 and L_2 , respectively, good side tone bal-
 ance will be obtained.

While this invention has been pointed out in
 certain particular arrangements merely for
 the purpose of illustration, it is to be distinct-
 ly understood that the principles of this in-
 vention may be applied to other and widely
 varied organizations without departing from
 the spirit of the invention or the scope of the
 appended claims.

What is claimed is:

1. A telephone system comprising a trunk
 circuit, a subscriber's line, an operator's tele-
 phone set including a telephone transmitter
 and a telephone receiver, means intercon-
 necting the trunk circuit and the subscriber's
 line through the operator's telephone set
 whereby the subscriber may hear the conver-
 sation of the operator over the trunk cir-
 cuit though unable to communicate with any
 one at the distant end of the trunk circuit.

2. In a telephone system, the combina-
 tion of two loops which may be interconnect-
 ed for telephonic communication, means for
 interposing between said loops a telephone
 set comprising a telephone transmitter and
 a telephone receiver, whereby communica-
 tion may be established over either of said
 loops from the telephone set while a large
 transmission loss will be introduced between
 said loops preventing telephonic communica-
 tion over said loops.

3. A telephone system comprising two lines
 over which signals may be transmitted, a
 telephone circuit arrangement comprising an
 inductance in series with said lines, a tele-
 phone receiver connected to the mid-point of
 said inductance and to a terminal common
 to said lines, and a telephone transmitter
 coupled to said inductance, two impedances,
 each simulating the impedance of one of said
 lines, and means whereby the telephone cir-
 cuit arrangement may be connected to one
 of said lines through the impedance simu-
 lating the other of said lines.

4. A telephone system comprising two tele-
 phone loops, a transformer having one wind-
 ing serially connected between said loops,
 a telephone receiver and a condenser con-
 nected in shunt with said loops at the mid-
 point of the serial winding, and a telephone
 transmitter connected serially to the other
 winding of said transformer.

5. A telephone system comprising two lines
 which may normally be interconnected for

telephonic communication, a telephone set comprising a telephone receiver shunting a pair of inductances at their mid-point, said inductances being interposed in series with
5 said lines, and a telephone transmitter electromagnetically coupled to said inductances.

6. An operator's telephone set which may be connected to two telephone lines so that
10 communication may only be established between the operator and the party at either of said lines while no communication may be established between the parties at the ends of said lines, comprising an iron core trans-
15 former, one winding of which is connected in series with said lines, a telephone receiver, a condenser, said telephone receiver and said condenser being connected in shunt with
20 said lines at the mid-point of the winding in series therewith, and a telephone transmitter connected to the other winding of said trans-
former.

7. A telephone system comprising a telephone loop, a first inductance in series with
25 said telephone loop, a telephone receiver, a condenser, said receiver and said condenser bridging said loop between the mid-point of said first inductance and one terminal of said

loop, a second inductance coupled to the first inductance, a telephone transmitter in series
30 with said second inductance, a call circuit, a network having an impedance substantially equal to the impedance of said call circuit, and means for connecting the network or the
35 call circuit between the terminal of the first inductance and the same terminal of the telephone loop to which the receiver and condenser are connected.

8. A telephone system comprising a telephone loop, a first inductance connected to
40 one terminal of said telephone loop, a telephone receiver, a condenser, said receiver and said condenser bridging said loop between the midpoint of first inductance and the other
45 terminal of said loop, a second inductance coupled to the first inductance, a telephone transmitter in series with said second inductance, and a network of suitable im-
50 pedance connected between the second terminal of the loop and the other terminal of the first inductance.

In testimony whereof, I have signed my name to this specification this 5th day of July, 1927.

EGINHARD DIETZE.