

March 9, 1937.

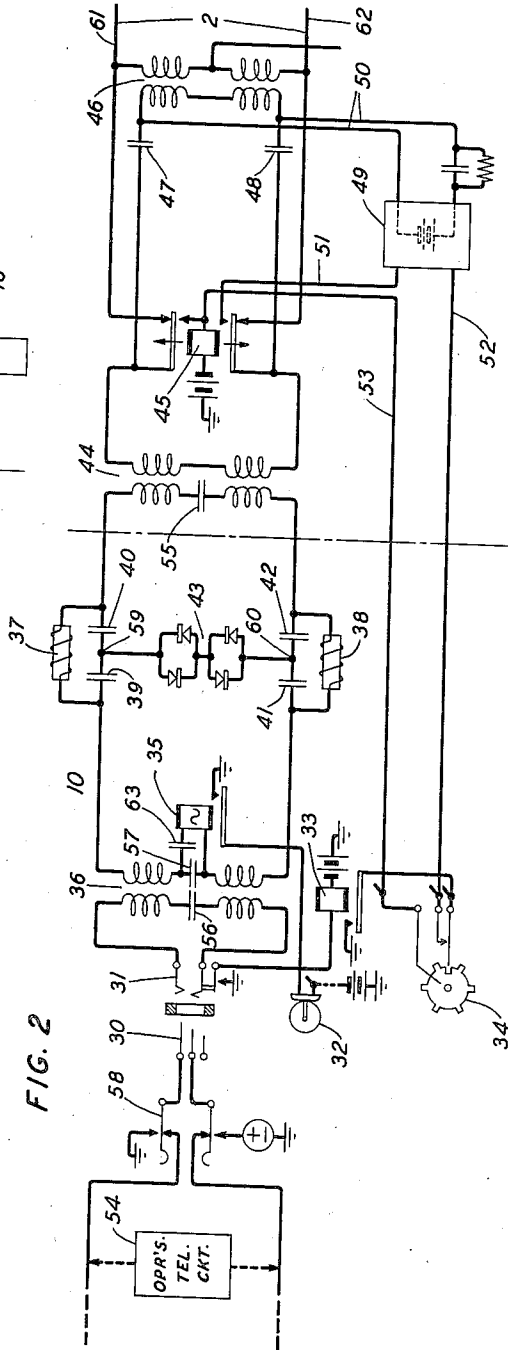
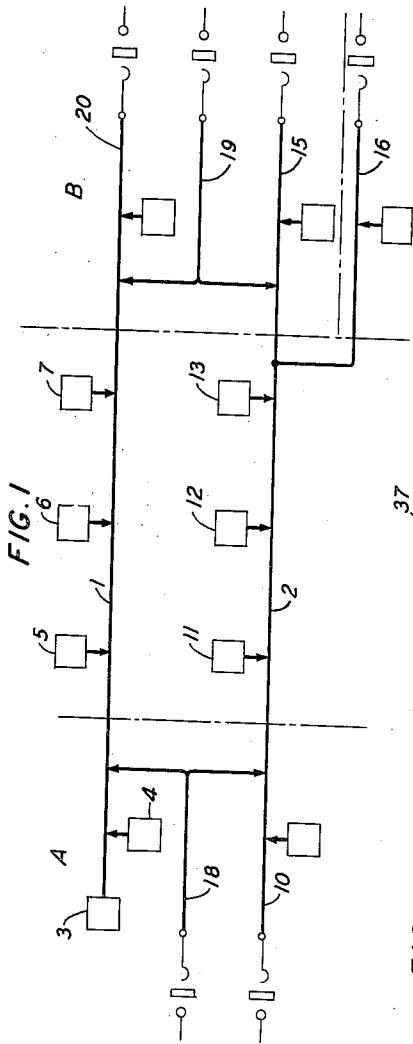
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2,072,940

TELEPHONE SYSTEM

Filed Dec. 29, 1934

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

FIG. 3

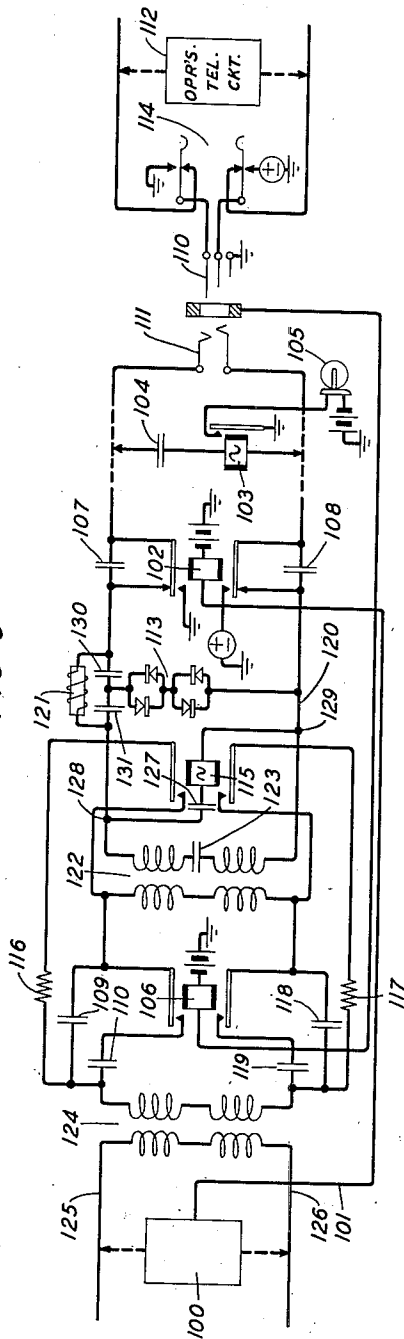
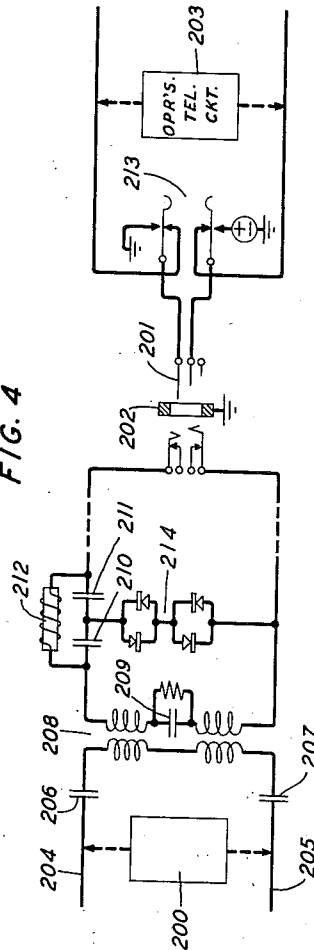


FIG. 4



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TELEPHONE SYSTEM

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18 Claims. (Cl. 179—78)

This invention relates to telephone systems and particularly to arrangements for preventing acoustic shocks or high potential signals from penetrating to operators' or subscribers' apparatus.

5 An object of the invention is to simplify a telephone system in which terminal apparatus is to be protected against acoustic shock caused by high potential signals from external sources or
10 that are transmitted over telephone lines for other signaling purposes, for example, when said telephone lines are used in railway train dispatching systems.

Heretofore systems have been provided in
15 which telephone lines have been equipped with shock absorbing means to protect terminal equipment from excessive voltages and yet permit signaling currents of the usual telephone signal voltages to be transmitted out over the line. A
20 system along these lines has been disclosed in my Patent No. 1,987,430 of January 8, 1935. In this patent a system is shown in which shock absorbing means are provided for the terminal apparatus against train dispatching signals and other
25 excessive high voltage disturbances incoming on a line while ordinary ringing signals having voltages usual in telephone circuits are permitted to be repeated past the said protecting means from the terminal apparatus out over the line.

30 It is a feature of the present invention to provide in systems of this kind protecting means for the terminal apparatus against disturbing voltages such as high potential low frequency signals, used in train dispatching systems or excessive
35 voltages caused by speech currents of abnormal levels or from other sources, while ordinary ringing signals having voltages usual in telephone circuits are permitted to pass through the circuit from the terminal apparatus to the line without interference from the shock absorbing means. The shock absorbing means includes condensers
40 and a regular repeating coil employed for transmission purposes in the circuit, and the arrangement is such that the signals by-pass the
45 condensers but not the repeating coil.

Another feature is the arrangement of the usual repeating coil and condensers in series with one set of windings thereof of such characteristics that said condensers and repeating coil will
50 serve as the shock absorbing means for high voltage low frequency signals incoming over the line.

Another feature is the arrangement of an alternating current relay bridged across the other
55 set of windings of the repeating coil which is responsive to ringing current outgoing from the terminal apparatus and circuit connections controlled by said relay to shunt the condensers through resistances to by-pass the ringing signals
60 across the condensers so that such signals may be

repeated through the repeating coil out over the line without being affected by said condensers.

Another feature is the arrangement of other condensers in series with a line conductor and shunted by a retardation coil and a plurality of
5 non-linear resistance elements arranged in cascade formation bridged across the line conductors with one side of said elements connected at a point between said other condensers, said
10 elements comprising non-linear resistances of the kind in which the resistance decreases with rising potential, such as copper-oxide rectifiers or other similar devices. Said arrangement of condensers and resistance elements serves to shunt
15 abnormal voltages within the voice frequency range occurring in the speech currents transmitted in either direction over the line, while speech currents within the normal levels pass unobstructed through the condensers, and the arrangement of the shunting retardation coil serves
20 as a path for ringing current signals in either direction unobstructed by the condensers and resistance elements.

A modification of this latter feature is an arrangement of condensers in series in each conductor, each series shunted by a retardation coil and resistance elements connecting a point between the condensers in one conductor with a point between the condensers in the other conductor.
25

Referring now to the drawings:

Fig. 1 shows in a general diagrammatic form the invention applied to a train dispatching system using telephone lines;

Fig. 2 shows the terminating telephone equipment at the calling end of a telephone line;

Fig. 3 shows the terminating telephone equipment at the called end of a telephone line used for train dispatching; and

Fig. 4 shows the terminal telephone equipment at the called end of a dispatcher's line, said equipment being arranged for installation in a telephone switchboard.

Referring now particularly to Fig. 1, the various features have been applied as stated to a
45 train dispatching system using telephone lines for the connecting line between terminating stations and way stations comprising a train dispatching apparatus. In the particular system illustrated in this figure, 1 represents a so-called
50 dispatcher's line while 2 represents a so-called message line. The message line is ordinarily used for dispatching purposes only when the dispatcher's line is temporarily disabled. The dispatcher's line is provided at the calling station A
55 with the train dispatcher's telephone set 3 and the usual train dispatching calling apparatus 4 represented in diagrammatic form and employed by the train dispatcher for selecting way stations. Such systems usually comprise a key for
60

sending code signals and selectors and suitable circuit arrangements for the transmission of code signals. At the way stations, such as 5, 6 and 7, train dispatching signaling selector apparatus is provided, while at the receiving station B, the line is equipped with train dispatching selector apparatus and suitable circuit arrangements for terminating the dispatcher's line on a telephone switchboard with the necessary acoustic shock absorbing means which is a feature of this invention. If the message line 2 is to be used to call between the stations, it is so arranged that a code calling key equipment is provided at 10 for calling the way stations 11, 12 and 13 or the terminating apparatus at the called station B as shown at 15. The way station apparatus 11, 12 and 13 may be the same as way station apparatus 5, 6, or 7. A terminating station 16, similar to station 15, may also be provided for the establishing of telephone connections between station A and this station 16, or between station B and this station 16. The dispatcher's line 1 and the message line 2 may be connected and serve as side circuits of a phantom line circuit terminating at stations A and B in terminal apparatus 15 and 13, respectively. This phantom arrangement is not shown in detail, but is merely indicated to illustrate the possibilities of the application of the features of this invention to various types of systems. The various features of this invention are embodied in the terminal apparatus at stations A and B at 10, 15, 16 and 20.

When the message line 2 is used for telephone purposes, the terminal apparatus has to be protected against acoustic shocks, caused by the train dispatching signals that may affect this line either by the sending of the calling signal from station A to call any of the way stations 11, 12, 13, 15 or 16 or by disturbing influences that may be caused when line 1 is used for train dispatching purposes that may be transmitted or effective on line 2 possibly by some disorder due to the connection of the phantom line or any other disturbances. Likewise, the terminal apparatus at 15 and 16 must be arranged to prevent train dispatching signals of the same character from affecting the terminal apparatus. The terminal apparatus at 15 is also arranged so that it may be called by train dispatching signals transmitted from station A and equipment 10 and these signals are translated into ordinary ringing signals for the calling of the terminal apparatus at this end. Shock absorbing equipment may also be provided at 15 for the prevention of train dispatching signals affecting this terminal apparatus. The terminating station 16 is equipped with these protective and translating devices the same as station 15. Terminal apparatus 10 and 19 are not shown in detail, but may be arranged for sending and transmitting ordinary ringing signals over the phantom derived from the side circuits. If either of the side circuits are used for train dispatching signals, then these phantom terminal apparatus may be protected from acoustic shock from such signals by shock absorbing means.

The arrangement of the invention as shown in Figs. 2, 3 and 4 will now be described. Figs. 2 and 3 show the terminal apparatus of the message line 2 at stations A and B respectively. Fig. 2 illustrates the equipment 10 of Fig. 1, while Fig. 3 serves to illustrate both the equipments at 15 and 16 of Fig. 1. Fig. 4 shows the apparatus at 20 and illustrates a circuit method of terminating the dispatcher's line 1 on a telephone switch-

board including the necessary shock absorbing equipment. To illustrate the features of this invention, there will be described first a call from the calling station A at 10 over line 2 to call the terminal apparatus 15 at station B and the various functions caused thereby such as the translation of the train dispatching signals into ordinary ringing signals at the terminal apparatus 15 and the ringback signal caused thereby to be received at the calling station A by the terminal apparatus of line 2. A description will also be given of signaling between terminal apparatus at stations 15 and 16 after said stations have been connected up for telephone purposes, of a call from station B to station A, and also of the operation of the terminating circuit Fig. 4 at 20.

Referring now to Figs. 2 and 3, if the call is made from the calling station A at 10 over line 2 the calling operator inserts plug 30 into jack 31 and thereby causes the operation of relay 33 over an obvious circuit closed by the contacts of jack 31. Relay 33, in operating, provides a connection from ground for the lower spring of the train dispatching key 34 by means of which the operator may signal out over the line. The operator may now ring the desired station or terminal apparatus at station B by operating the key 34 to send the desired code. Although only one key has been shown, it should be understood that in ordinary equipment of this kind, a number of keys may be supplied, each one having a different code. The operation of this key is such that the connections between the contacts are established on the return of the key to normal when a circuit is completed for the operation of relay 45 from battery through the winding of relay 45 and upper and lower contacts of key 34 to ground on the contacts of relay 33. Relay 45 is slow in releasing so that it will remain operated while the code pulses are being sent. Relay 45 in operating closes a circuit from ground on the contacts of relay 33 through the lower and upper springs of key 34 over conductor 53 through upper operated make contacts of relay 45, right-hand windings of repeating coil 44, lower operated make contacts of relay 45 to conductor 51 which terminates in the usual special signal apparatus arrangement merely shown in diagrammatic form as a rectangle 49. Ground is also connected to lead 52 which also terminates in the signalling apparatus 49, via middle and lower springs of the key 34. These ground connections on leads 51 and 52 cause the signal apparatus 49 to connect high potential signals to leads 50 in accordance with the code selection on key 34 controlled through the opening and closing of the connection for lead 52 through the two lower contacts of key 34. Relay 45 in operating also disconnects the right-hand windings of repeating coil 44 from line 2. Current impulses over leads 50 are transmitted through the left-hand windings of repeating coil 46 by induction to the right-hand windings of this coil to line 2.

A part of said current impulses transmitted to line 2 is shunted through condensers 47 and 48 to the operator's telephone set 54 so that the operator may listen to the code signal that is being sent out. This shunt path may be traced from condensers 47 and 48, inductively through the windings of repeating coil 44 including condenser 55, retardation coils 37 and 40, shunted, respectively, by condensers 39 and 40 in series, and by condensers 41 and 42 in series, by induction through the windings of repeating coil 36 including condensers 55 and 57, thence over the

tip and ring conductors of jack 31 and plug 30 and through the normally closed contacts of ringing key 53 to operator's telephone circuit 54. The protecting means for preventing the audible components of the high potential low frequency signals from being transmitted to the operator's telephone set 54 in excessive volume to produce undesirable acoustic shocks, resides in the use of the non-linear resistance elements 43 bridged across the tip and ring conductors, and the circuit arrangement hereinafter described. The said elements, as hereinbefore stated, may be composed of rectifiers of the kind in which the resistance decreases with rising potential arranged in cascade formation. Since this decrease in resistance is a unidirectional effect, the non-linear resistances are composed of parallel elements poled oppositely so as to be effective for current impulses in either direction. Assuming that an impulse of audible frequency and of an undesirable high potential is transmitted through repeating coil 46 towards operator's telephone circuit 54, said impulse will be first transmitted through condensers 40 and 42 to the mid-points 50 and 50 between condensers 39 and 40, and 41 and 42, respectively. At this point, the high potential will cause the normal resistance of the elements 43 to decrease rapidly, thereby effectively shunting the said high potential current impulse and preventing it from reaching the operator's telephone set in sufficient magnitude to be disturbing. Rectifier unit 43 is, however, so constituted that it acts as a high resistance shunt to the low potentials of the voice currents of ordinary conversation and accordingly causes only a negligible attenuation. The retardation coils 37 and 38, which bridge condensers 39 and 40, and 41 and 42, respectively, are of comparatively low impedance to low frequency signaling currents, but of high impedance to currents of audible frequency and consequently are an effective barrier to the transmission of the aforesaid high potential disturbances. The equipment of Fig. 2, in addition to suppressing excessive amounts of audible frequency components of the train dispatching signaling current that may be transmitted to the operator 54, as hereinbefore explained, is also arranged to prevent an excessive amount of low frequency components reaching said operator. This is accomplished by the use of low capacity answer-back condensers 47 and 48 and of repeating coil 36, all of which are of high impedance to low frequency signaling currents. The high potential low frequency code signals incoming at station B to the terminal apparatus 15 will be received in the usual train dispatching signal apparatus shown by means of a box 100 (Fig. 3). This apparatus is so arranged that the code causes a ground to be applied to the lead 101, thereby operating relay 102 over an obvious circuit from battery. Relay 102 connects ground and ringing current through its operated front contacts to relay 103 through condenser 104. Relay 103 operates and closes an obvious circuit through lamp 105 which lights. It should be noted here that the train dispatching signals have no effect on the terminal apparatus as the tip and ring conductors are open at contacts of relays 106 and 115 and connected by high impedance answer-back condensers 109 and 110. Relay 102 releases at the end of the signaling period as the ground connection on lead 101 is removed from the train dispatching signaling apparatus as it is restored to normal. Audible ringing tone is sent back from this circuit via condensers 107, 108, 109, 110,

conductor 120, repeating coil 122, including condenser 123, condensers 109 and 110, and repeating coil 124 to line conductors 125 and 126 of line 2. This audible answer-back signal is returned over line 2 to the sending station at A through the back contacts of relay 45, repeating coil 44, including condenser 55, condensers 39, 40, 41 and 42, repeating coil 36, including condensers 53 and 57, jack 31, plug 30, key 53 to operator's telephone set 54. The rectifier unit 43 has no appreciable attenuating effect on this answer-back signal as the impressed potential of the signaling current in this case is insufficient to cause a breakdown of the resistance of said rectifier unit 43.

To answer this call, the operator on seeing the lamp 105 lighted, inserts a plug 110 in the jack 111 and thereby closes the circuit through the sleeve terminals for the operation of relay 106 which connects the tip and ring conductors through for talking, completing the conversational circuit between operators 54 and 112. In case any disturbing high voltage signals are received over the line while this connection exists, such as, for example, might happen in case of signaling a way station by train dispatching signals, the operator's telephone set 112, if connected at this time, will be protected from acoustic shocks by the non-linear resistance elements 113, which are similar to the non-linear resistance elements 43 of Fig. 2, and the function of which was hereinbefore described.

The terminal apparatus 15 is provided for sending low potential ringing signals. If the operator at 112 desires to call, he will operate his usual ringing key 114 and thereby cause the operation of the ringing relay 115 over a circuit traceable from the made contacts of key 114, through contacts of plug 110 and jack 111, upper and lower back contacts of relay 102, retardation coil 121 and over ring conductor 120, through condenser 127 and winding of relay 115. Relay 115, in operating, connects through its upper and lower contacts resistance shunts 116 and 117 around condensers 109 and 110 in multiple and 118 and 119 in multiple, respectively, thereby providing low impedance paths for the low frequency signaling current.

From junction points 128 and 129, the low frequency signaling current that operated relay 115 passes by induction through the windings of repeating coil 122 and condenser 123, thence through shunting resistances 116 and 117, windings of repeating coil 124 to conductors 125 and 126 of line 2.

If the operator at 112 is to be recalled by a re-ringing signal from, for example, the terminal equipment 16, the signal current is transmitted over the line and causes the functioning of a signal which is observed by the operator at 112. This signal current comes in over conductors 125 and 126, passes by induction through the windings of repeating coil 124, condensers 109 and 110, and 118 and 119, each pair in multiple through the operated contacts of relay 106, by induction through windings of repeating coil 122 including condenser 123, winding of relay 115 and condenser 127. Relay 115 operates and shunts with resistances 116 and 117, multiple condensers 109 and 110, and 118 and 119. The signaling current now passes through resistances 116 and 117 and condensers 109 and 110, and 118 and 119. From junction points 128 and 129 said signaling current passes through retardation coil 121, over conductor 120, through normally closed

contacts of relay 102, through condenser 104 and winding of relay 103, which operates and lights lamp 105 through an obvious circuit. The operator now responds as hereinbefore described in connection with the operation of the circuit with train dispatching signals. Non-linear elements 113 are ineffective in shunting the ringing current that operates relay 103, since condensers 130 and 131 are of such high impedance to the low frequency signaling current that the voltage impressed across the elements 113 is not sufficiently high to break down its resistance.

The description hereinbefore given in connection with the apparatus at 10 as shown by Fig. 2 covered a call outgoing over the line toward the apparatus at 15 as shown by Fig. 3. A call proceeding from Fig. 3 to Fig. 2 will now be described. The operator 112, desiring to signal the operator 54, operates the ringing key 114 which causes the apparatus of Fig. 3 to function as hereinbefore described to cause low frequency ringing current to be transmitted over conductors 125 and 126 of line 2 to the apparatus at 10 as shown by Fig. 2. The current from line 2 comes in on conductors 61 and 62 and passes through the back contacts of relay 45, thence by induction through the windings of repeating coil 44 and condenser 55. From repeating coil 44 the ringing current passes through retardation coils 37 and 38, which are of low impedance to the low frequency current. However, condensers 39 and 40 and 41 and 42 are of comparatively high impedance to said ringing current. Consequently, the ringing current voltage applied across junction points 59 and 60 is so reduced by the afore-said combination of retardation coils and condensers as to be ineffective in causing an appreciable reduction in the resistance of the rectifying device 43, and thus as described also hereinbefore in connection with Fig. 3, the shunting effect of rectifier 43 on the ringing current is negligible. The ringing current now passes through the right-hand windings of repeating coil 36, condenser 63 and the winding of relay 35, which operates and closes an obvious circuit through the lamp 32, which lights. The operator at 54 now responds by inserting plug 30 into jack 31, thereby establishing a conversational connection with the operator 112.

The operation of the equipment shown in Fig. 4 will now be described. This arrangement is installed at 20 (Fig. 1) to enable an operator at station B to answer and originate calls in connection with the dispatcher's line 1. On an incoming call the train dispatching selector apparatus diagrammatically shown as a rectangle 200 will function and cause the bell associated with it to operate and signal the operator. In response to this signal operator 203 inserts plug 201 into jack 202, thereby establishing a conversational connection with the calling operator on line 1. This connection may be traced from conductors 204 and 205, which connect to the corresponding conductors of line 1, through condensers 206 and 207, repeating coil 208 and condenser 209, condensers 210 and 211 shunting retardation coil 212, thence through the contacts of jack 202, plug 201 and ringing key 213 to the operator's telephone circuit 203. During the interval that the operator 203 is thus conversing over the dispatcher's line, high potential disturbances of audible frequency from said line may pass through repeating coil 208 toward the operator 203. These disturbances, however, do not produce acoustic shocks because of the attenuating

effect of the shunting non-linear resistance elements 214 which consist of a non-linear resistance such as the elements 43 or 113 and which decreases in value rapidly with increase in voltage, and functions in the manner hereinbefore described in connection with Figs. 2 and 3. If the operator 203 desires to originate a call over the dispatcher's line 1, plug 201 is inserted into jack 202. The operator then listens on the line and finding that it is not busy talks directly to the sending station or dispatcher. If the call is for another station on line 1, the sending station on the request of the operator 203 signals the required station. During the period of signaling operator 203 continues to listen until the called station answers. Repeating coil 208 is so designed that it effectively blocks the passage of the low frequency train dispatching signaling current and the elements 214 absorb any high potential currents of audible frequency that may be present, thereby enabling the operator 203 to listen without experiencing discomfort from acoustic shocks.

What is claimed is:

1. In a signaling system, an exchange, a line terminating at said exchange, means in said line for protecting said exchange against high potential low frequency current signals and against abnormally high potentials within the voice frequency range and for passing normal potentials within the voice frequency range to or from the exchange, and means responsive to low potential ringing frequency signals from the exchange for partially eliminating said protective means from the line to permit the free passage of said ringing frequency signal out over the line.

2. In a signaling system, an exchange, a line terminating at the exchange, means in said line for protecting said exchange against high potential low frequency current signals on the line and means responsive to low potential high frequency current signals from the exchange for partially eliminating said protective means from the line to permit the free passage of said low potential high frequency signals to the line.

3. In combination, a transmission line, a protective device associated therewith for disabling high potential low frequency signals incoming over the line, and means responsive to low potential current signals of a higher frequency for partially shunting said protective device.

4. In combination, a transmission line, a protective device associated therewith for disabling high potential low frequency signals incoming over the line, resistances, and means responsive to low potential high frequency current signals for shunting a portion of said protective device with said resistances.

5. In combination, a transmission line, a protective device comprising a repeating coil and condensers in series with one set of windings of said repeating coil, and means responsive to low potential high frequency signals for shunting said condensers.

6. In combination, a transmission line, a protective device comprising a repeating coil and condensers in series with one set of windings of said repeating coil, resistances, and means responsive to low potential high frequency signals for shunting said condensers with said resistances.

7. In combination, a transmission line, a protective device associated therewith for disabling high potential low frequency signals incoming over the line, a relay associated with said line

responsive to low potential alternating current signals of higher frequency, and means responsive to the operation of said relay for partially shunting said protective device to permit free passage of said low potential signals over said line.

8. In a transmission system, a line having two incoming and two outgoing conductors, a repeating coil having primary windings in series with said two incoming conductors and secondary windings in series with said two outgoing conductors, condensers in series with said incoming conductors, the windings of said repeating coil and the condensers having such electrical characteristics that high voltage low frequency signals incoming over the incoming line conductors will induce a negligible current in the secondary winding of the repeating coil and the two outgoing conductors.

9. In a transmission system, a line having two incoming conductors and two outgoing conductors, a repeating coil having primary windings in series with said two incoming conductors and secondary windings in series with said two outgoing conductors, condensers in series with said incoming conductors, the windings of said repeating coil and the condensers having such electrical characteristics that high voltage low frequency signals incoming over the incoming conductors will induce a negligible current in the secondary windings of the repeating coil and in the two outgoing conductors, and means for shunting said condensers responsive to low potential high frequency signals on said outgoing conductors to permit the free passage of said low potential high frequency signals through said repeating coil out over the incoming conductors.

10. In a transmission system, a line having two incoming conductors and two outgoing conductors, a repeating coil having primary windings in series with said two incoming conductors and secondary windings in series with said two outgoing conductors, condensers in series with said incoming conductors, the windings of said repeating coil and the condensers having such electrical characteristics that high voltage low frequency signals incoming over the incoming line conductors will induce a negligible current in the secondary windings of the repeating coil and in the two outgoing conductors, a relay bridged across said outgoing conductors responsive to low potential high frequency signals and means responsive to the operation of said relay for short-circuiting said condensers to permit the free passage of said low potential high frequency signals through said repeating coil out over said incoming conductors.

11. In a transmission system, a line having two incoming conductors and two outgoing conductors, a repeating coil having primary windings in series with said two incoming conductors and secondary windings in series with said two outgoing conductors, condensers in series with said incoming conductors, the windings of said repeating coil and the condensers having such electrical characteristics that high voltage low frequency signals incoming over the incoming line conductors will induce a negligible current in the secondary windings of the repeating coil and in the two outgoing conductors, resistances, and means for shunting said condensers through said resistances responsive to low potential signals of higher frequency on said outgoing conductors

to permit the free passage of said low potential high frequency signals through said repeating coil and out over said incoming conductors.

12. In combination, a transmission line having line conductors, condensers in series with said line conductors, non-linear resistance elements connected across from a point between the condensers in one conductor to a point between the condensers in the other conductor, and an inductance connected in shunt of the series condensers.

13. In combination, a transmission line having two conductors, an acoustic shock preventing means comprising condensers in series in the conductors, inductances in shunt of the condensers and non-linear resistance elements in shunt of the conductors and connected across from a point between the condensers of one conductor to a point between the condensers of the other conductor, said elements being conductive to abnormal high potentials within the voice frequency range, said condensers being conductive to normal potentials within the voice frequency range and said inductances being conductive to lower potential ringing frequency currents.

14. In a protective device the combination with line conductors of condensers inserted in series in one of said line conductors, an inductance inserted in said line conductor in shunt of said condensers, and non-linear resistance elements arranged for the passage of current in either direction inserted at the mid-point between said condensers and the other conductor.

15. In a transmission system, a line, means in said line for blocking abnormally high potentials within the voice frequency range and for passing normal potentials within the voice frequency range and for passing lower potentials of ringing frequency, said means including capacity, inductance and non-linear resistance elements of the rectifier type.

16. In a transmission line, means including capacity, inductance and non-linear resistance for blocking abnormally high potentials within the voice frequency range and the ringing frequency range and for passing normal potentials within the voice frequency range and for passing normal potentials of the ringing frequency range incoming from either end of said means.

17. In a signaling system, an exchange, a transmission line terminating in said exchange, means including a repeating coil and condensers in series with one set of windings of said repeating coil for protecting said exchange against high potential low frequency current signals in said line, and means responsive to low potential ringing frequency current signals from the exchange for shunting said condensers to permit the free passage of said low potential ringing frequency current signals out over the line through the repeating coil.

18. In a signaling system, an exchange, a transmission line terminating in said exchange, means in said line including condensers, repeating coils and non-linear resistance elements for protecting said exchange against abnormally high potentials within the voice frequency range and the ringing frequency range and for passing normal potentials within the voice frequency range incoming to or outgoing from the exchange and for passing normal potential ringing frequency signals from the exchange.

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