G. K. THOMPSON.

TRANSMISSION EQUALIZATION ARRANGEMENT.

APPLICATION FILED OCT. 2, 1919.

1,367,571. Patented Feb. 8, 1921.

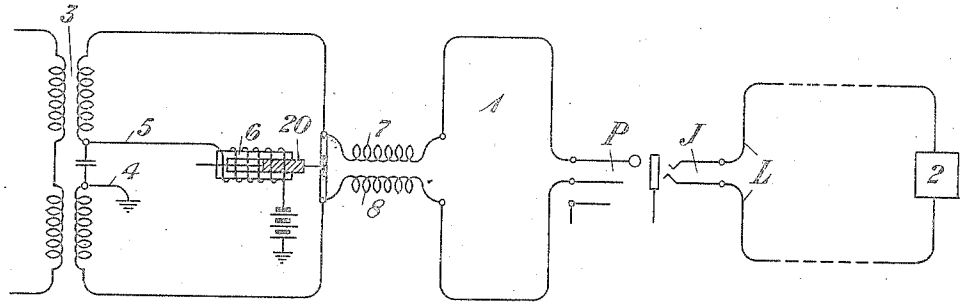



Fig. 1

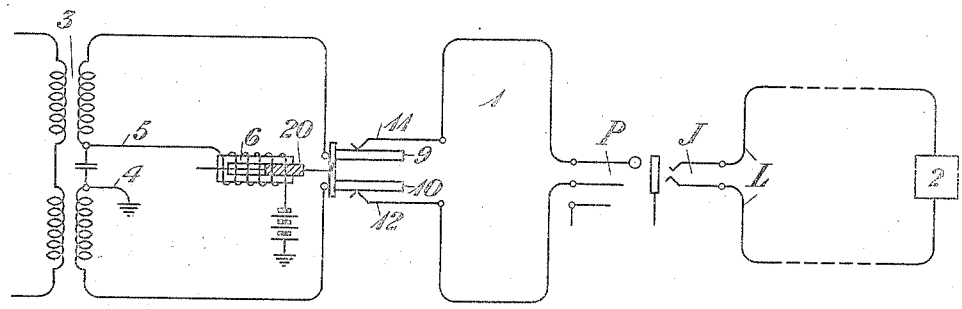



Fig. 2

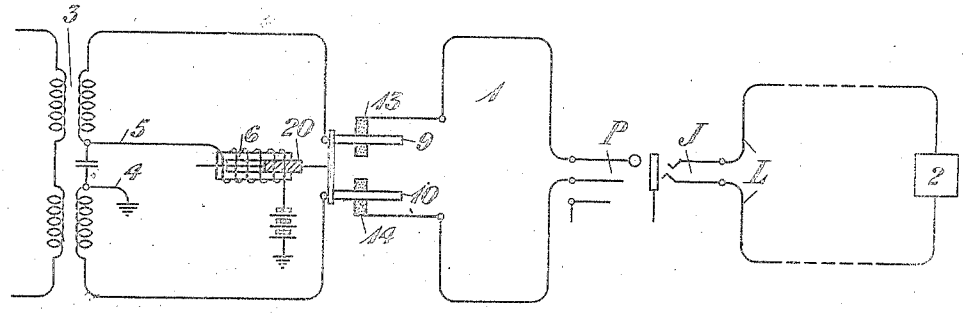



Fig. 3

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## TRANSMISSION-EQUALIZATION ARRANGEMENT.

1,367,571. Specification of Letters Patent. Patented Feb. 8, 1921.

Application filed October 2, 1919. Serial No. 327,993.

*To all whom it may concern:*

Be it known that I, GEORGE K. THOMPSON, residing at Maplewood, in the county of Essex and State of New Jersey, have invented certain Improvements in Transmission-Equalization Arrangements, of which the following is a specification.

This invention relates to telephone systems and more particularly to the provision of means whereby the electrical characteristics of telephone lines may be equalized or rendered more uniform.

Telephone lines have, in general, different electrical characteristics varying with the lengths of the lines. For any particular type of line construction which may be employed the resistance, capacity, inductance and leakage of the circuit increase with the length. These variations in the electrical characteristics of the different subscribers' lines in a telephone system introduce a number of variable effects in the telephone service rendered from different stations. For example the different electrical characteristics result in different degrees of attenuation in the alternating telephone current passing over the subscribers' lines and thus give louder and more effective telephonic communication to subscribers connected by means of short lines than to subscribers connected by means of long lines. As a result, a subscriber having a long line, when connected with any other subscriber, does not receive as good telephone transmission as would a subscriber having a short line similarly connected. Furthermore, in the common battery systems now so generally employed in all but small communities, the resistance of the line causes a further effect on the transmission in that it reduces the amount of direct current which the transmitter receives from the central office battery and so renders it less efficient in the generation of the alternating telephone current. Likewise in common battery systems employing electro-magnetic receivers this variation in current supply introduces changes in the efficiency of the receiver which are undesirable.

In view of the conditions above referred to, it has not been heretofore possible to provide all subscribers with the same grade of transmission and it is one of the objects of this invention to provide means whereby this difficulty may be overcome and transmission over different lines equalized. Other and further features of the invention will appear from the description hereinafter given.

In the arrangements of this invention the transmission equalizing means, which are operated by a solenoid type relay, are associated with connecting circuits by which connections are established with the subscribers' lines rather than with the lines themselves, as in former arrangements. In one of the arrangements of the invention a solenoid relay, which is included in the current supply circuit of the connecting circuit operates to pull apart the windings of coiled spring resistances in each side of the line of the talking circuit whenever the current flow thereover is higher than desirable. As the windings of the coiled spring resistances separate resistance is added to the talking circuit until a state of equilibrium is reached and the relay will stop its operation. As the relay device may be adjusted so that a state of equilibrium will be reached when the current flow over the circuit is of a predetermined and desirable value the device affords a means of automatically equalizing transmission over subscribers' lines of differing electrical characteristics. In another arrangement of the invention the coiled spring resistances may be replaced by graphite resistance rods controlled by the solenoid relay and which move along line contacts in the circuit and cause the resistance in series with the line to change as the solenoid relay operates. In another alternative arrangement the graphite resistance rods are employed but the line contact springs are replaced with granular carbon chambers through which the rods are moved by the solenoid.

The invention may be more fully understood from the following description taken in connection with the accompanying drawings in the Figures 1, 2 and 3, of which are illustrated a preferred form and modifications of the invention. Similar reference numerals have been used to denote like parts in all of the figures of the invention.

In the arrangements of the invention illustrated in Fig. 1 the transmission equalizing device is shown for purposes of convenience as associated with a cord circuit 1, only a portion of which is essential for an understanding of the invention as illustrated. The cord circuit 1 terminates in

the plug P, adapted to coact with a jack J of a subscriber's line, such as L. Associated with the subscriber's line L may be any desirable type of sub-station apparatus 2. Included in the talking conductors of the cord circuit 1 are the coiled spring resistances 7 and 8, the windings of which are normally close together and hence present relatively small resistance to the talking current. The spring resistances 7 and 8 are connected to a plunger 20 of a solenoid operated relay 6, the winding of which is included in the current supply circuit of the cord. If the plug P is inserted in the jack J of a subscriber's line, such as L, the current supply for the connection will be completed over the following circuit; from ground and battery, winding of relay 6, conductor 5, upper right hand winding of transformer 3, tip conductor of cord 1, spring resistance 7, tip conductor of cord 1, tip contacts of plug P and jack J, tip conductor of line L, through the sub-station apparatus 2, over the ring conductor of line 1, ring contacts of jack J and plug P, over the ring conductor of cord 1, spring resistance 8, ring conductor of cord 1, lower right hand winding of transformer 3, over conductor 4, to ground. If the resistance of the line L, with which a connection is made, is smaller than that of a line adopted as a standard, the current flow over the above traced circuit will primarily be greater than desired and, accordingly, will operate the solenoid relay 6. This will cause plunger 20 to be drawn into the core of the relay and will cause the windings of the spring resistances 7 and 8 attached thereto to be separated. As the windings separate, the resistance of the spring resistances 7 and 8 is increased, thereby increasing the resistances in the circuit and decreasing the current flow thereover. As the relay 6 is adjusted to operate only with currents of and above a predetermined desirable value, the relay 6 will continue to operate and increase the resistance of the spring resistances 7 and 8 until the current flow over the circuit has been reduced to the aforementioned predetermined desirable value, at which time relay 6 will stop its operation. As the current flow over the talking circuit is determined primarily by the resistance of the subscriber's line with which a connection is made, the device of the invention affords a means for automatically regulating the current flow to a predetermined and desirable value over lines of differing electrical characteristics, thereby equalizing transmission over such lines.

In Fig. 2 the coil spring resistance elements 7 and 8 are replaced by graphite resistance rods 9 and 10, which are attached to the plunger 20 of the solenoid relay 6 and which move along the line contacts 11 and 12 upon the operation of the solenoid relay 6. The moving of the graphite resistance rods along the line contacts 11 and 12 serves to increase the resistance included in series in the talking circuit. In the arrangements illustrated in Fig. 3 the graphite resistance rods 9 and 10 are employed, but the line contacts 11 and 12 are replaced with granular carbon chambers 13 and 14, through which the rods are moved by the solenoid relay. As the operation of the arrangements illustrated in Figs. 2 and 3 is substantially the same as the operation of the device of Fig. 1, no further description thereof will be given.

While the arrangements and transmission equalizing devices of the invention have been illustrated for purposes of convenience as associated with cord circuits, it is pointed out that they may equally well be associated with other forms of connecting circuits, such as trunk lines, and also may be used in connecting means employed in automatic telephony, such as in district or incoming selectors in such systems. Accordingly, while the arrangements for the invention have been disclosed as embodied in certain specific arrangements which have been deemed desirable, it is understood, that they are capable of embodiment in many and widely varied forms without departing from the spirit of the invention as defined in the appended claims.

What is claimed is:

1. In a telephone system, a plurality of subscribers' lines of differing electrical characteristics, a connecting circuit for establishing connections with said lines, a variable resistance included in the talking circuit of said connecting circuit, and a solenoid operated relay included in the current supply circuit of said talking circuit for varying said resistance in inverse proportion to the resistance of the line with which a connection is established.

2. In a telephone system, a plurality of subscribers' lines of differing electrical characteristics, a connecting circuit for establishing connections with said lines, a variable resistance included in the talking circuit of said connecting circuit, and a solenoid operated relay included in the current supply circuit of said talking circuit and adjusted to operate only with currents of and above a predetermined desirable value for varying said resistance in inverse proportion to the resistance of the line with which a connection is established.

3. In a telephone system, a plurality of subscribers' lines of differing electrical characteristics, a connecting circuit for establishing connections with said lines, a talking circuit included in said connecting circuit, convolutions of resistance wire normally closed included in series in said talking cir-

cuit, a solenoid operated relay included in the current supply circuit of said talking circuit and adjusted to operate only with currents of and above a predetermined desirable value, and means controlled by said solenoid relay for extending said convolutions of resistance wire thereby increasing the resistance of said talking circuit.

4. In a telephone system, a plurality of subscribers' lines of differing electrical characteristics, a connecting circuit for establishing connections with said lines, a solenoid operated relay included in the current supply circuit of said connecting circuit, the operation of said relay being controlled by the electrical characteristics of the subscriber's line with which a connection is made, a variable resistance included in series in said talking circuit, and means controlled by said solenoid relay for increasing said variable resistance.

5. In a telephone system, a plurality of subscribers' lines of differing electrical characteristics, a connecting circuit for establishing connections with said lines, and means in said connecting circuit for rendering the transmission over said lines uniform, said last mentioned means being controlled by a solenoid operated relay included in the current supply circuit of said connecting means, said relay being controlled by the resistance of the line with which a connection is established.

In testimony whereof, I have signed my name to this specification this 30th day of September, 1919.

GEORGE K. THOMPSON.