

A. U. HARPER.
TRANSMISSION EQUALIZATION ARRANGEMENT.
APPLICATION FILED OCT. 2, 1919.

1,407,028.

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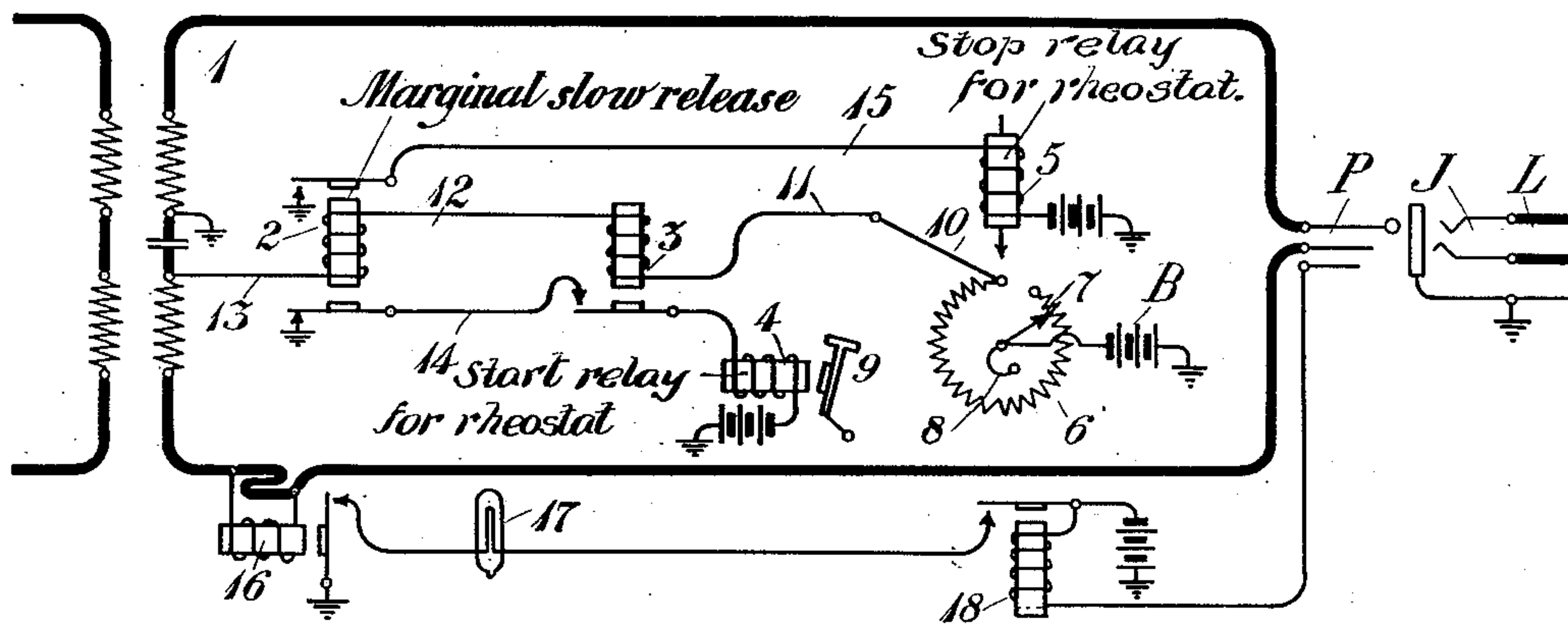


Fig. 1

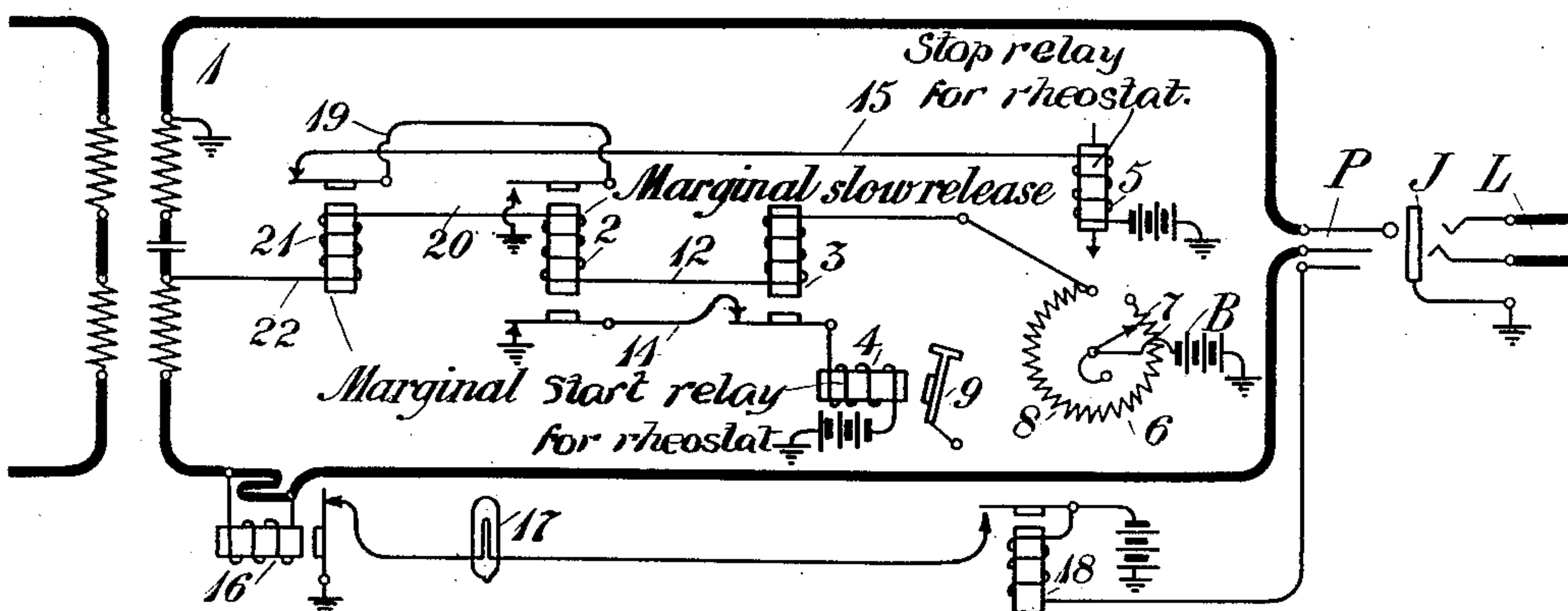


Fig. 2

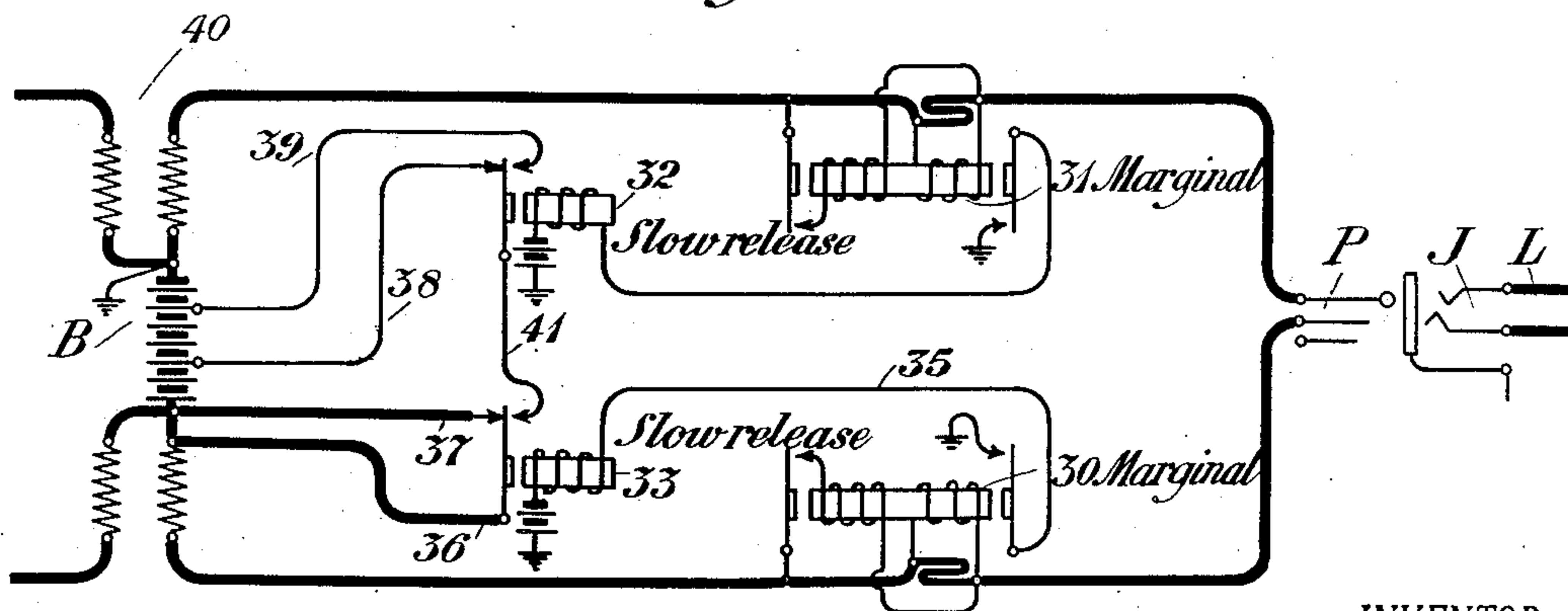


Fig. 3

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TRANSMISSION-EQUALIZATION ARRANGEMENT.

1,407,028.

Specification of Letters Patent.

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To all whom it may concern:

Be it known that I, ALFRED U. HARPER, residing at Evanston, in the county of Cook and State of Illinois, have invented certain
5 Improvements in Transmission-Equalization Arrangements, of which the following is a specification.

This invention relates to telephone systems and more particularly to the provision
10 of means for automatically obtaining a predetermined current flow on subscriber's telephone lines, irrespective of the line resistance, and thus to obtain approximately uniform transmission over such lines.

15 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.
20 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,
25 the different electrical characteristics result in different degrees of attenuation in the alternating telephone current passing over the subscriber's lines and thus give louder
30 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
35 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
40 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
45 in the generation of the alternating telephone current. Likewise in common battery systems employing electromagnetic receivers this variation in current supply introduces changes in the efficiency of the receiver which
50 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
55 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
60 transmission equalizing means are associated with the cord circuits by which connections are established with the lines, rather than with the lines themselves as in former arrangements. The talking current for the
65 connection is applied to the talking conductors of the cord circuit from a battery connected with one terminal of a rheostat and after passing through a part of the rheostat the current is transmitted about the wind-
70 ings of a plurality of relays. One of these relays is marginal and adjusted to operate only with current of a predetermined value and of a value desirable for transmission through the telephone apparatus at the sub-
75 scriber's sub-station. The other relay will operate on currents of very low values and controls means for starting the rheostat in operation. The rheostat is normally set at maximum resistance, and when a connection
80 is made with a subscriber's line by the cord circuit the low resistance relay operates to set the rheostat mechanism in operation. The rheostat mechanism will continue to operate and thus gradually decrease the re-
85 sistance in the talking circuit until the current flowing thereover has reached the aforementioned predetermined desirable value, at which point the marginal relay will operate and stop the rheostat mechanism from
90 operating further. Additional means are provided, controlled by the marginal relay, for locking the rheostat in position at this point. With this arrangement approx-
95 imately uniform transmission over subscribers' lines of differing electrical characteristics may be obtained and, furthermore, the current supplied to the telephone apparatus at the sub-stations may be reg-
100 ulated to any desired value.

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

In the arrangement illustrated in Fig. 1 110

is shown a portion of a cord circuit terminating in the plug P and adapted for establishing connections with subscribers' lines, such as the line L terminating in the jack J. Only a portion of the cord circuit essential for the arrangements of this invention has been illustrated, as the cord circuit may be one of many types of cord circuits well known in the art. Furthermore, only a portion of the line L has been illustrated, as the arrangements of the invention are adapted for use with lines of different types and differing electrical characteristics. The talking current for a connection is supplied from the battery B, connected to the contact 7 of rheostat mechanism 6. The rheostat mechanism 6 is held at maximum resistance by the retractile spring 8. Included in the current supply circuit is a relay 3 which operates with currents of very low value. Controlled by the relay 3 is the relay 4 which controls the clutch mechanism 9. The clutch mechanism 9 is associated with the contact 7 of the rheostat. Contact 7 is associated with a continuously revolving shaft and motor (not shown), and the clutch mechanism 9 when operated serves to so connect the contact 7 with the revolving shaft that the contact 7 will rotate and decrease the resistance of the rheostat. Included in the talking circuit is the marginal relay 2 which is adjusted to operate on currents of a predetermined value. Marginal relay 2 exercises secondary control over relay 4 and rheostat 6 and, furthermore, controls the relay 5 whereby the rheostat may be locked in position upon the operation of relay 2. Supervisory relay 16 and a sleeve relay 18 are shown which control the supervisory signal 17 in the usual well known manner.

The operation of the arrangements illustrated in Fig. 1 is as follows: To establish a connection with a line such as line L, the plug P is inserted in the jack J. The talking current for such a connection will be supplied over the following circuit: from ground, battery B, contact 7, resistance of rheostat 6, conductor 10, conductor 11, winding of relay 3, conductor 12, winding of marginal relay 2, conductor 13, ring conductor of cord 1, ring contacts of plug P and jack J, ring conductor of line L, through the telephone apparatus at the subscribers' station on the line L, tip conductor of line L, tip contacts of jack J and plug P, tip conductor of cord 1, to ground. As has been formerly pointed out, when this circuit is completed the rheostat 6 is set at maximum resistance by means of the retractile spring 8, and accordingly the talking current supplied over the circuit will be of small value. However, the relay 3 will be operated and the following circuit closed: from ground, contact and armature of relay 2, conductor 14, contact and armature of relay 3, winding

of relay 4, to battery and ground. This will operate relay 4, which in turn will operate the clutch mechanism 9 and cause the contact 7 to rotate, thereby gradually decreasing the resistance of rheostat 6 and increasing the flow of current over the talking circuit. When the resistance of the rheostat has been sufficiently reduced so that the current flow over the talking circuit has reached a predetermined desirable value, the marginal relay 2 which is adjusted to operate with current of this value will operate and open at its lower contact the previously traced circuit about the winding of relay 4, thereby stopping the rheostat from operating further. At the same time the operation of relay 2 will close the following circuit: from ground, upper contact and armature of relay 2, conductor 15, winding of relay 5, to battery and ground. The closing of this circuit will operate relay 5, which will lock the rheostat mechanism in the condition in which it was when the relay 2 was operated. No matter how the resistance or electrical characteristics of the lines with which connections are made may differ, if the relay 2 is adjusted to operate only when currents of a predetermined and desirable value are flowing over such lines, the arrangements of the invention will automatically continue to operate until the resistance of the talking circuit has been regulated so that the desired current is flowing over the line. With this arrangement a predetermined current flow may be obtained over subscribers' lines of differing electrical characteristics and uniform transmission rendered over such lines. Should the subscriber on the line move his switch hook up and down in order to signal the operator, there might be a tendency for the circuit arrangements described to be restored to normal, and, accordingly, to obviate this difficulty the marginal relay 2 is made slow releasing.

In the arrangement illustrated in Fig. 2 is shown an arrangement of the invention which is substantially the same as the arrangement illustrated in Fig. 1, with the exception that an additional marginal relay 21 is included in the talking circuit for the following purposes: If a connection had been established with a party line with which are associated a number of subscribers, and if, when one subscriber had answered and the mechanism had automatically operated until the desired talking current was being supplied to the subscriber, another subscriber should remove his receiver from the switch hook, the additional resistance of the second subscriber's receiver connected in parallel with the first subscriber's receiver would reduce the total resistance of the line, and a greater current than desired would flow over the line. Accordingly the relay 21 is included in the talking circuit and is adjusted

to operate with currents of slightly greater value than the operating currents for the marginal relay 2. Accordingly when both subscribers' receivers were removed from their respective switch hooks and a greater current than desired was flowing over the talking circuit, the relay 21 would operate. This will open the following circuit which was closed upon the operation of relay 2: from ground, upper contact and armature of relay 2, conductor 19, armature and contact of relay 21, conductor 15, winding of relay 5, to battery and ground. The opening of this circuit will deenergize the locking relay 5 and allow the retractile spring 8 to restore the rheostat mechanism 6 to maximum resistance thereby deenergizing relay 2. The apparatus will now begin to function again in a normal manner as formerly described, and will regulate the current flow over the talking circuit to the desired value under the new conditions.

In Fig. 3 is a further modification of the invention in which the marginal relays 30 and 31, which are included in the talking circuit and adjusted to operate with currents of different values, serve to control the voltage at the source of current supply and thereby regulate the current transmitted through the sub-stations. If the plug P of the cord circuit illustrated in Fig. 3 is inserted in the jack J of a line of relatively high resistance and one with which it is accordingly desirable to furnish a relatively large supply of talking current, the talking circuit will be completed over the following circuit; from ground, upper right hand winding of transformer 40, tip conductor of the cord and right hand winding of marginal relay 31, tip conductor of the cord, tip contacts of plug P and jack J, tip conductor of the line and through the sub-station apparatus associated therewith, ring conductor of the line, ring contacts of jack J and plug P, ring conductor of the cord, right hand winding of marginal relay 30, ring conductor of the cord, lower right hand winding of transformer 40, conductor 36, armature and contact of relay 33, conductor 37 and through battery B, to ground. As the resistance of the line with which the connection is made is relatively high, the marginal relays 30 and 31 will not be operated. However, if a connection should be made with a line of lower resistance, the marginal relay 30 would be operated and be locked up over its left hand contact and armature. The operation of marginal relay 30 will close the following circuit; from ground, right hand contact and armature of relay 30, conductor 35, winding of relay 33, to battery and ground. This will operate relay 33. Upon the operation of relay 33 the talking circuit for the connection will be completed from the lower right hand winding of transformer

40, over conductor 36, armature and make contact of relay 33, conductor 41, armature and normal contact of relay 32, conductor 38 and through a smaller portion of the battery B to ground. Accordingly a decrease in the resistance of the line with which a connection is made will automatically cause a reduction in the amount of current supplied for the talking circuit and will thereby equalize transmission. If a connection is made with a line of still smaller resistance than in the two previous instances, the larger current transmitted over the talking circuit will cause the operation of marginal relay 31 as well as marginal relay 30, the marginal relay 31 being adjusted to operate with currents of greater value than marginal relay 30. Upon the operation of marginal relays 30 and 31 the talking circuit for the connection will be completed from the lower right hand winding of transformer 40, over conductor 36, armature and contact of relay 33, conductor 41, armature and contact of relay 32, conductor 39 and through a still smaller portion of battery B to ground. Accordingly a further decrease in the resistance of the line with which a connection is made will cause a still further decrease in the amount of current supplied for the connection and will thereby tend to equalize the transmission. The relays 32 and 33 are made slow releasing so that the voltage regulating apparatus will not be restored to normal every time the subscriber moves the switch-hook up and down while signaling the operator.

While it has been deemed desirable to illustrate the arrangements of the invention as included in a portion of a cord circuit, the arrangements may equally well be employed in other connecting means or connecting circuits such as trunk lines, or district or incoming selectors in automatic telephone systems. Accordingly, while the arrangements of the invention have been disclosed in certain specific arrangements which are 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, subscribers' telephone lines of differing electrical characteristics, a cord circuit adapted to be connected with said lines, resistance varying means in the current supply circuit of said cord circuit, and a marginal relay included in the current supply circuit of said cord circuit, said marginal relay controlling said resistance varying means and being adjusted to operate with current of a predetermined value.

2. In a telephone system, subscribers' telephone lines of differing electrical charac-

teristics, a cord circuit for establishing connections with said lines, resistance varying means in the current supply circuit of said cord circuit, a relay in said current supply circuit exercising primary control over said resistance varying means, and a marginal relay in said current supply circuit exercising secondary control over said resistance varying means and being adjusted to operate with current of a predetermined value.

3. In a telephone system, subscribers' telephone lines of differing electrical characteristics, a cord circuit for establishing connections with said lines, a rheostat normally set at maximum resistance included in the current supply circuit of said cord circuit, a relay in said current supply circuit and normally operating when said rheostat is set at maximum resistance, means controlled by said relay for decreasing the resistance of said rheostat, and a marginal relay in said current supply circuit controlling said last mentioned means and being adjusted to operate with current of a predetermined value.

4. In a telephone system, subscribers' telephone lines of differing electrical characteristics, a cord circuit for establishing connections with said lines, a rheostat included in the current supply circuit of said cord circuit, means for normally maintaining said rheostat at maximum resistance, a relay in said current supply circuit normally operating when said rheostat is set at maximum resistance and said cord is connected with one of said lines, means controlled by said relay for decreasing the resistance of said rheostat, a marginal relay in said current supply circuit controlling said last mentioned means and being adjusted to operate with current of a predetermined value, and means controlled by said marginal relay for locking said rheostat in an operated position.

5. In a telephone system, subscribers' telephone lines of differing electrical characteristics, a cord circuit for establishing connections with said lines, a rheostat normally set at maximum resistance included in the current supply circuit of said cord circuit, a relay in said current supply circuit normally operating when said rheostat is set at maximum resistance and said cord is connected with one of said lines, means controlled by said relay for decreasing the resistance of said rheostat, and a marginal relay in said current supply circuit controlling said last mentioned means, said marginal relay being adjusted to operate with current of a predetermined value and being slow releasing.

6. In a telephone system, subscribers' telephone lines of differing electrical charac-

teristics, a connecting circuit for establishing connections with said lines, a resistance varying mechanism normally set at maximum resistance included in the talking circuit of said connecting circuit, a relay in said talking circuit operating with currents of low value to start said resistance varying mechanism in operation, a second relay in said talking circuit operating with currents of a predetermined and greater value than the operating currents of said first relay, and means controlled by said second relay for stopping the operation of said resistance varying mechanism.

7. In a telephone system, subscribers' telephone lines of differing electrical characteristics, a connecting circuit for establishing connections with said lines, a resistance varying mechanism normally set at maximum resistance included in the talking circuit of said connecting circuit, a relay in said talking circuit operating with currents of low value to start said resistance varying mechanism in operation, a second relay in said talking circuit operating with currents of a predetermined and greater value than the operating currents of said first relay, means controlled by said second relay for stopping the operation of said resistance varying mechanism and for locking said resistance varying mechanism in operated position, a third relay in said talking circuit operating with currents of greater value than the operating currents of said second relay, and means controlled by said third relay for restoring said resistance varying mechanism to normal.

8. In a telephone system, subscribers' telephone lines of differing electrical characteristics, a cord circuit for establishing connections with said lines, a source of current supply in said cord circuit, means for varying the amount of current supplied from said source to said cord circuit, and a marginal relay included in the talking circuit of said cord and controlling said current varying means.

9. In a telephone system, subscribers' telephone lines of differing electrical characteristics, a connecting means for establishing connections with said lines, resistance varying means in the talking circuit of said connecting means, a relay in said talking circuit exercising primary control over said resistance varying means, and a marginal relay in said talking circuit exercising secondary control over said resistance varying means and being adjusted to operate with current of a predetermined value.

In testimony whereof, I, have signed my name to this specification this 26th day of September 1919.

ALFRED U. HARPER.