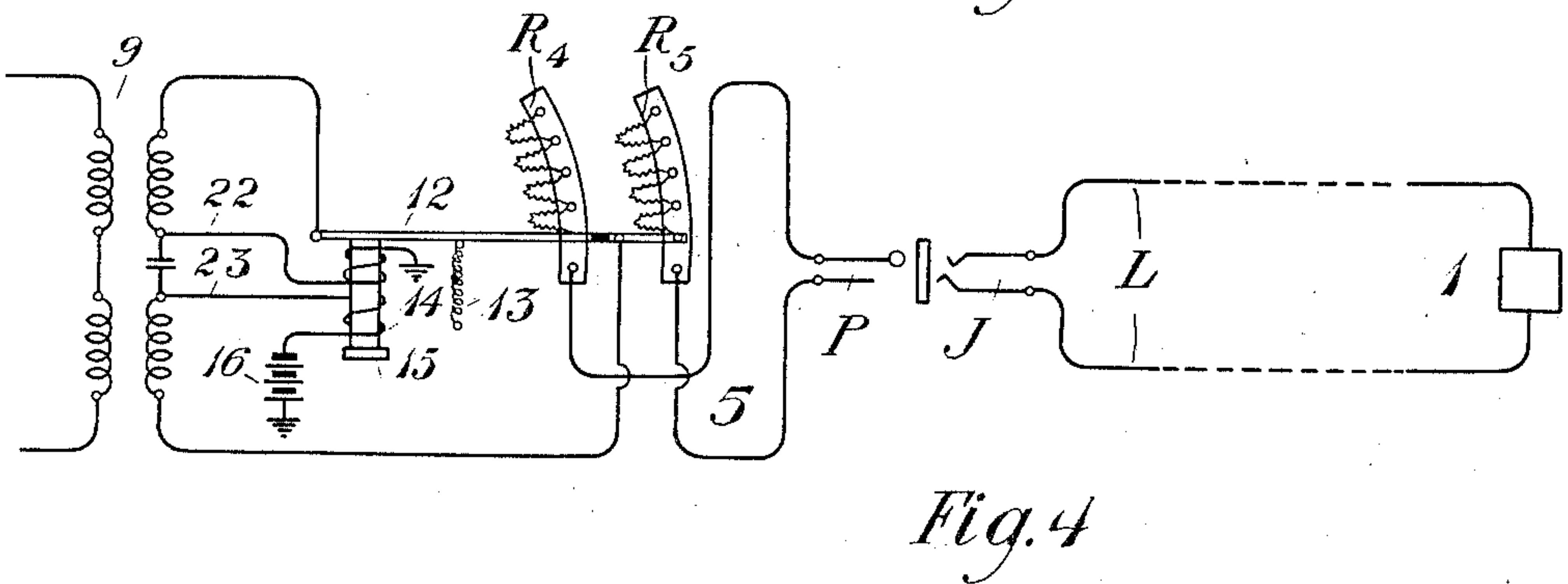
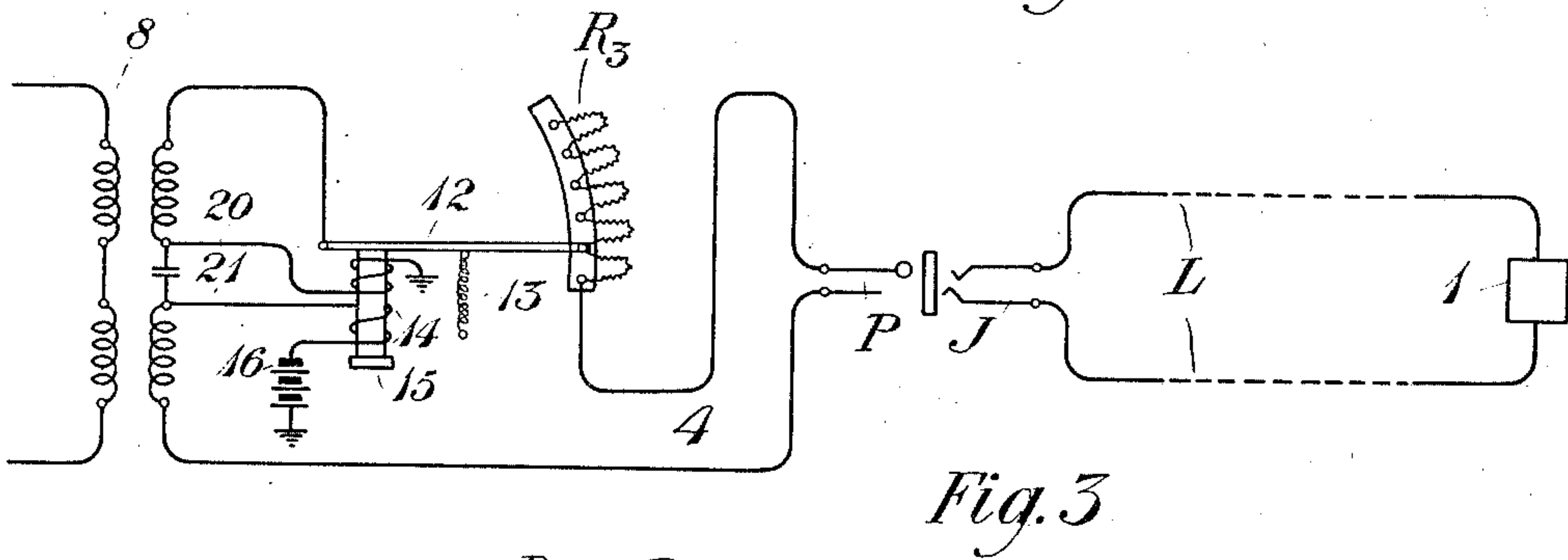
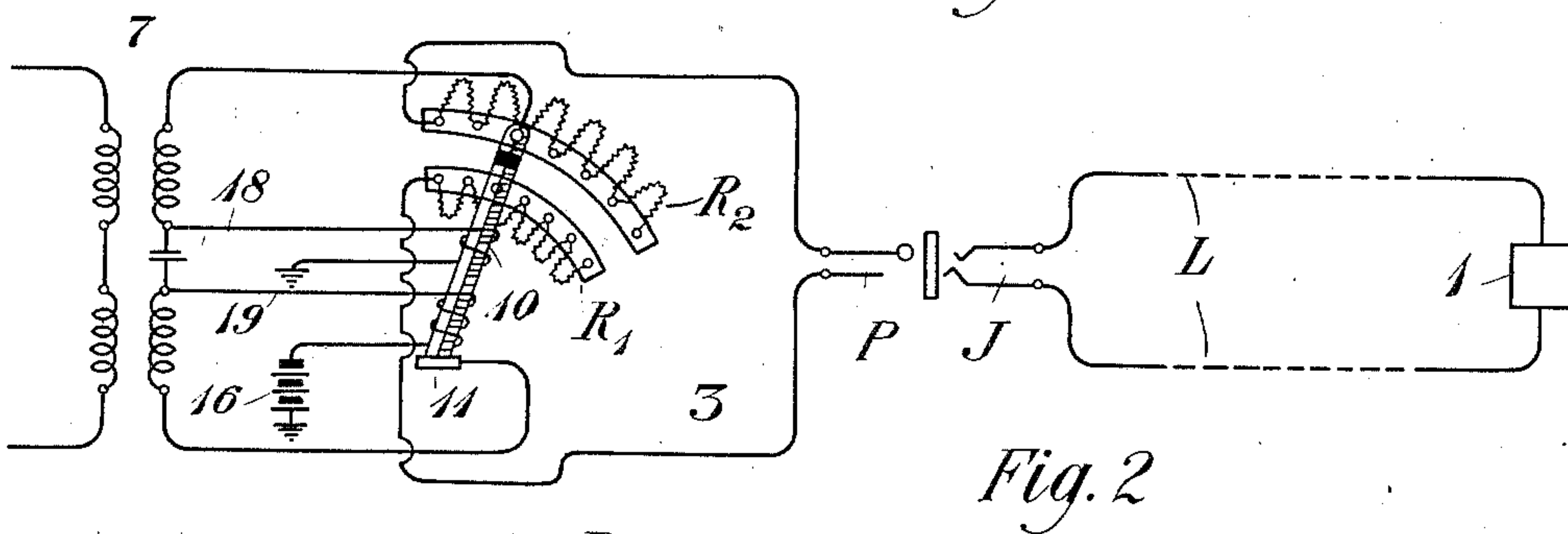
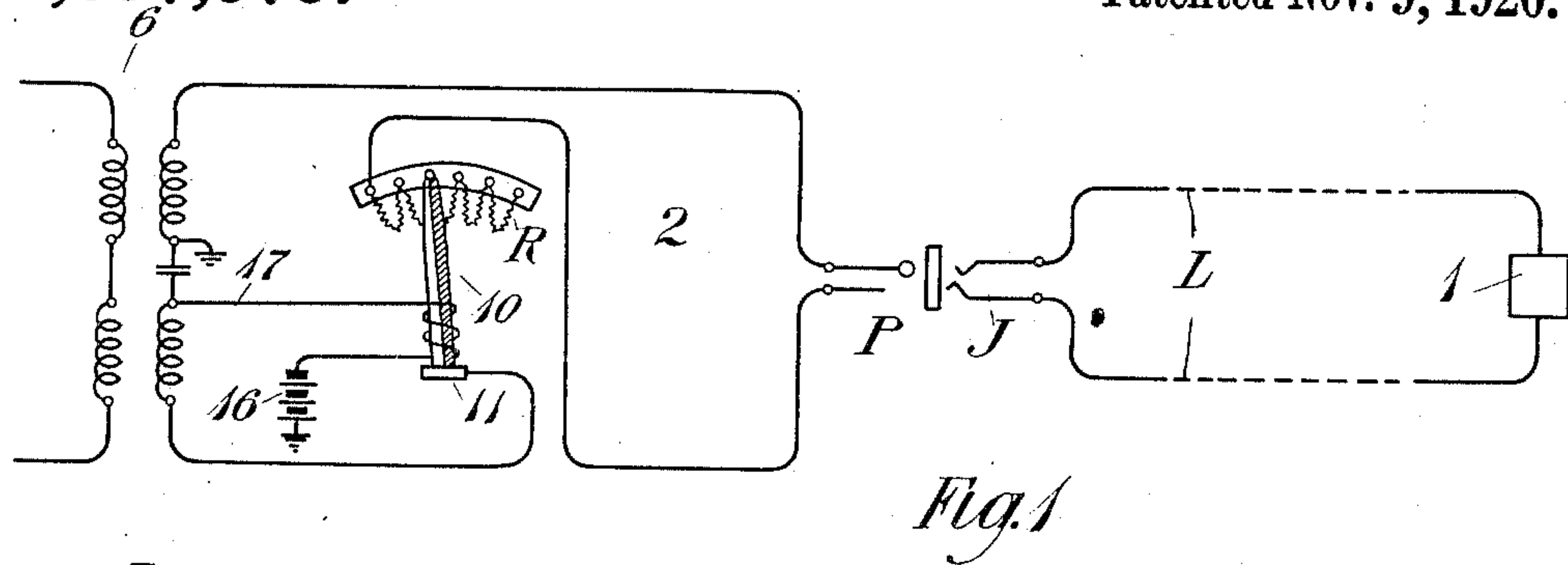


A. U. HARPER.
TRANSMISSION EQUALIZATION ARRANGEMENT.
APPLICATION FILED OCT. 2, 1919.

1,357,979.

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TRANSMISSION-EQUALIZATION ARRANGEMENT.

1,357,979.

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 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 types of lines equal-

ized. 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 consist of thermostatic devices, are associated with connecting circuits by which connections are established with the lines rather than with the lines themselves, as in former arrangements. In one of the arrangements the thermostatic device of the invention is included in a current supply circuit of a cord circuit or other connecting circuit and comprises a bi-metallic strip, such as iron and copper riveted together. This strip is heated by the battery supply current flowing through turns of wire encircling it, thus causing it to bend. One end of the strip upon bending travels across the contacts of a rheostat causing increasing resistance to be inserted in the talking circuit. This movement continues until the device reaches a state of equilibrium. The various parts may be so adjusted that the state of equilibrium is reached when the current flow reaches a predetermined and desirable value. Furthermore, the resistance elements which are cut into the talking circuit may be applied either to one side of the line or to both. In another arrangement of the invention, the thermostatic device in the connecting circuit consists of a bar of metal encircled with turns of wire through which the battery supply current flows. The heat generated in the turns of wire causes the bar to expand and move a contact arm attached thereto over the contacts of a rheostat, thereby cutting in additional resistance elements in the talking circuit. This movement likewise continues until the device reaches a predetermined state of equilibrium and, furthermore, the resistance elements may be added to one side of the line only, or to both sides.

The invention may be more fully understood from the following description together with the accompanying drawing in Figures 1, 2, 3 and 4, of which are illustrated a preferred form and modifications of the invention. Like 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 thermostatic device is shown for purposes of convenience as associated with a cord circuit 2, although it is

understood that the device might equally well be included in other forms of connecting means. The cord circuit 2 terminates in the plug P, adapted to be associated with a jack J of a subscriber's line L. Associated with line L may be any type of sub-station apparatus 1. Only a portion of the cord circuit 2, essential for an understanding of this invention, has been illustrated. The thermostatic device includes a bi-metallic strip 10, such as iron and copper riveted together, although other metals having similar characteristics may be used. Strip 10 is attached to a fixed base 11. Turns of wire connected to the source of current supply 16 for the talking circuit encircle the bi-metallic strip 10. Associated with strip 10 are the contacts of a rheostat mechanism, which includes a plurality of resistance elements, such as R. If a connection is established with a line such as line L, by means of the cord circuit 2, the plug P will be inserted in the jack J, and the current supply circuit for the connection will be completed over the following circuit: from ground, upper right hand winding of transformer 6, tip conductor of cord 2, tip contacts of plug P and jack J, tip conductor of line L, through sub-station apparatus 1, back over ring conductor of line L, ring contacts of jack J and plug P, ring conductor of cord 2, through a portion of the resistance elements R, through the bi-metallic strip 10 and fixed base 11, over the ring conductor of cord 2, lower right hand winding of transformer 6, conductor 17, through the windings encircling strip 10, to battery 16 and ground. If the line L with which a connection is established is of relatively low resistance a greater current will, accordingly, flow through the windings about strip 10 and will generate a greater amount of heat, causing the strip 10 to bend farther to the right. As the strip 10 bends to the right, the extremity of the strip will travel over a greater number of the contacts of the rheostat and include in the above traced circuit a greater number of the resistance elements R, thereby reducing the amount of current flowing over the talking circuit. As the arrangements of the device may be adjusted so that a state of equilibrium will be reached when the current flow over the talking circuit is of a predetermined and desirable value, the device affords a means for automatically maintaining the current flow over subscribers' lines of differing electrical characteristics of equal value and thereby equalizing transmission over such lines.

In the arrangements illustrated in Fig. 2, the thermostatic device is substantially the same as that illustrated in Fig. 1, except that the rheostat mechanism includes two sets of contacts and two sets of resistance elements, such as R_1 and R_2 , and the bi-

metallic strip 1 heated will travel over both sets of contacts. One set of contacts is associated with the tip conductor of the cord circuit 3, and the other set of contacts is associated with the ring conductor of the cord circuit 3. When the cord circuit 3 is connected with a line, such as L, the current supply circuit for the connection is completed over the following circuit: from ground, upper windings about strip 10, conductor 18, upper winding of transformer 7, tip conductor of cord 3, through an insulated contact on strip 10, through a portion of the resistance elements R_2 , tip conductor of cord 3, tip contacts of plug P and jack J, tip conductor of line L, through the sub-station apparatus 1, back over the ring conductor of line L, ring contacts of jack J and plug P, ring conductor of cord 3, through a portion of the resistance elements R_1 , through the bi-metallic strip 10 and fixed base 11, ring conductor of cord 3, lower right hand winding of transformer 7, conductor 19, the lower windings about strip 10, to battery 16 and ground. In the same manner as pointed out with respect to the thermostatic device of Fig. 1, a change in the resistance of the line with which a connection is established will cause a change in the current flowing through the windings about the strip 10, and a consequent change in the heat generated in said windings. The greater the heat generated in said windings the more the strip will be caused to bend to the right. As the strip bends to the right it travels over a greater number of the contacts of the rheostat and includes in the above traced circuit a greater number of the resistance elements such as R_1 and R_2 , thereby tending to reduce the current flow over the circuit and equalize transmission.

In the arrangements illustrated in Fig. 3, the thermostatic device consists of a metal bar 14, of a material such as zinc, attached to a fixed base 15. The windings about bar 14 are included in the current supply circuit of the cord circuit 4. Attached to the metal bar 14 is a contact arm 12, which is in turn associated with the contacts of a rheostat mechanism, including a plurality of resistance elements, such as resistances R_3 . When a connection is established with a line, such as L, by inserting the plug P into the jack J, the talking circuit for the connection will be established over the following circuit: from ground, upper winding about bar 14, conductor 20, upper right hand winding of transformer 8, tip conductor of cord 4, contact arm 12, through a portion of the resistance elements R_3 , tip conductor of cord 4, tip contacts of plug P and jack J, tip conductor of line L, through sub-station apparatus 1, ring conductor line L, ring contacts of jack J and plug P, ring conductor of cord 4, lower

right hand winding of transformer 8, conductor 21, lower winding about bar 14, to battery 16 and ground. If the line with which a connection is established is of relatively low resistance a greater current will flow over the above traced circuit and a greater amount of heat will be generated in the windings about bar 14. The heat generated in the windings about bar 14 will cause the bar 14 to expand, thereby moving contact arm 12 over the contacts of the rheostat. This will include a greater number of the resistance elements R_3 in the above traced circuit and will reduce the current flow over said circuit. The parts of the thermostatic 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 greater the amount of heat generated in the windings about bar 14, the greater will be the expansion of bar 14, and a greater amount of resistance will be added to the talking circuit. As the amount of current flow through the windings about bar 14, and the consequent generation of heat therein is primarily determined by the amount of the resistance of the line with which a connection is made, the device affords a means for regulating the resistance of the talking circuit so that the current flow thereover will be the same although connections may be made with lines of differing electrical characteristics and transmission thereover may be equalized. Attached to contact arm 12 is a spring 13, which will restore the apparatus to normal when the cord circuit 4 is disconnected from the line L. The thermostatic device illustrated in Fig. 4 is substantially the same as that illustrated in Fig. 3, except that the contact arm 12 is associated with a rheostat mechanism including two sets of contacts and two sets of resistance elements, such as the resistance elements R_4 and R_5 . Furthermore, the resistance elements R_4 are associated with and adapted to be included in the tip conductor of the cord circuit 5, while the resistance elements R_5 are associated with and adapted to be included in the ring conductor of cord circuit 5. As the device is in other respects substantially similar to the arrangement illustrated in Fig. 3, no further description thereof will be given.

While the arrangements and thermostatic 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. Furthermore, while

the bi-metallic strip 10 has been referred to as composed of the metals copper and iron, and while the bar 14 has been referred to as composed of zinc, other metals having correspondingly similar characteristics to these may equally well be employed. Accordingly, while the arrangements of 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 element included in said connecting circuit, and a thermostatic device in said connecting circuit controlled by the electrical characteristics of the subscriber's line with which a connection is made for controlling said variable resistance.
2. In a telephone system, subscribers' lines of differing electrical characteristics, a connecting circuit for establishing connections with said lines, and a thermostatic device in said connecting circuit responsive to variations in said electrical characteristics for rendering the transmission over said lines substantially the same.
3. In a telephone system, a plurality of subscribers' lines of differing electrical characteristics, a connecting means for establishing connections with said lines, a variable resistance element associated with the talking circuit of said connecting means, means in said talking circuit for generating heat, said heat generating means being controlled by the electrical characteristics of the line with which a connection is made, and means controlled by said heat generating means for controlling said variable resistance.
4. In a telephone system, a plurality of subscriber's lines of differing electrical characteristics, a connecting means for establishing connections with said lines, a rheostat including a plurality of resistance elements associated with the talking circuit of said connecting means, and a thermostatic device associated with said connecting means, said thermostatic device comprising a bimetallic strip forming a portion of said talking circuit and encircled by windings included in said talking circuit, one extremity of said strip being attached to a fixed base and the other extremity of said strip being adapted to engage the contacts of said rheostat.

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

ALFRED U. HARPER.