No. 731,209. PATENTED JUNE 16, 1903.

E. F. NORTHRUP.

RESISTANCE SET.

APPLICATION FILED MAR. 20, 1903.

NO MODEL.

FIG. 1.

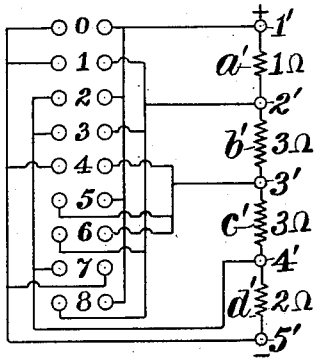


FIG. 2.

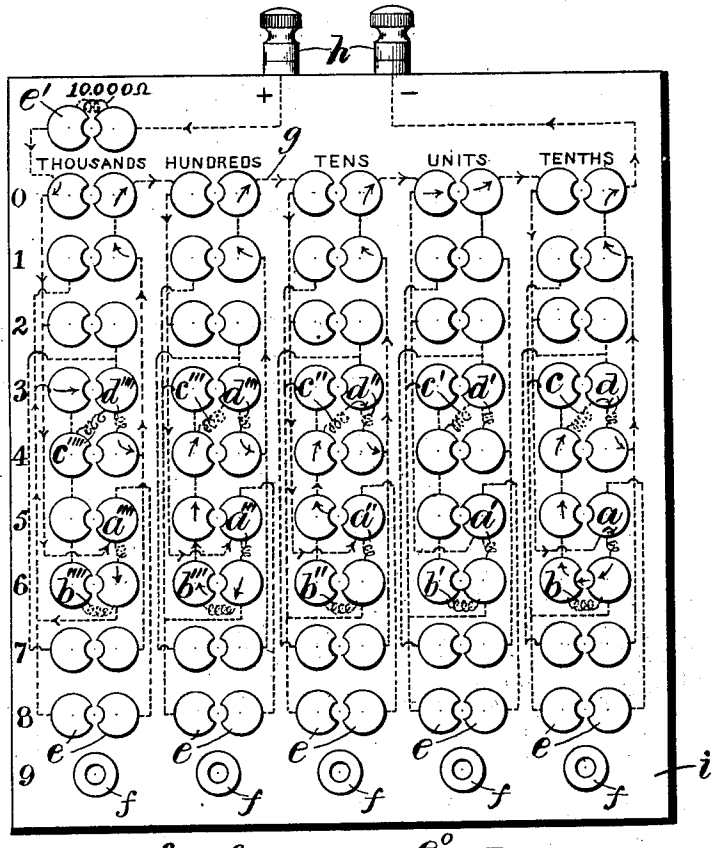


FIG. 3.

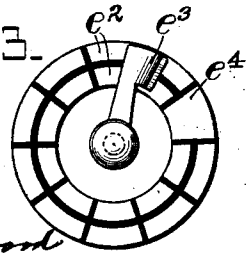
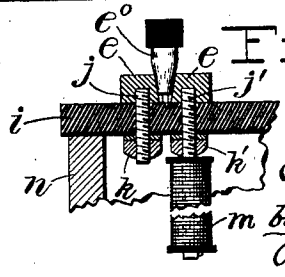


FIG. 4.



Witnesses

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No. 731,209. Patented June 16, 1903.

UNITED STATES PATENT OFFICE.

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RESISTANCE SET.

SPECIFICATION forming part of Letters Patent No. 731,209, dated June 16, 1903.

Application filed March 20, 1903. Serial No. 148,782. (No model.)

To all whom it may concern:

Be it known that I, EDWIN F. NORTHRUP, a citizen of the United States, residing at Philadelphia, in the county of Philadelphia and State of Pennsylvania, have invented certain new and useful Improvements in Resistance Sets, of which the following is a specification.

The objects of this invention are to provide means whereby a comparatively large number of regularly-increasing values of resistance may be obtained from a small number of resistances and to provide means for simplifying and expediting the obtaining of these values by the user.

To these ends the said invention consists in the novel combination and arrangement of parts herein described, and more particularly pointed out in the accompanying claims.

Referring to the accompanying drawings, Figure 1 is a diagram illustrating the principle of the invention; Fig. 2, a top plan view of a resistance-box or rheostat embodying this invention; Fig. 3, a top plan view of a circular rheostat embodying this invention, and Fig. 4 is a detail sectional view taken through a portion of the top of the resistance-box shown in Fig. 2.

In carrying out the form of my invention herein shown I employ only four resistances, from which I obtain ten regularly-increasing resistance values, nine of which—that is, zero to the ninth value, inclusive—are obtained by short-circuiting the resistances independently and in combinations, while the tenth value is obtained by merely connecting all of the resistances in series without short-circuiting any of them. Each of the short circuits so established gives a different value of resistance and is formed by connecting two points only at a time in the circuit of said resistances by means of a single contact-maker. The principle of the form of my invention herein described is best illustrated in the diagram Fig. 1, where a', b', c', and d' represent four resistances connected in series between the points 1′, 2′, 3′, 4′, and 5′. In the case illustrated these resistances have the values of one ohm, three ohms, three ohms, and two ohms, respectively, and from these resistances I may obtain ten values—that is, I may obtain naught, one, two, three, four, five, six, seven, and eight ohms by interconnecting the points 1′, 2′, 3′, 4′, and 5′ in certain combinations and nine ohms by allowing the current to pass directly through the resistances in series. Thus for naught ohms, or in case no resistance is required, points 1′ and 5′ are connected; for one ohm, points 2′ and 5′; for two ohms, points 1′ and 4′; for three ohms, points 2′ and 4′; for four ohms, points 3′ and 5′; for five ohms, points 1′ and 3′; for six ohms, points 2′ and 3′; for seven ohms, points 4′ and 5′; for eight ohms, points 2′ and 1′, and for nine ohms the current simply passes through all of the resistances in series and no points are connected.

From the foregoing it will be seen that the respective resistance values are obtained by establishing short circuits around the end resistances in the series independently and in combination with the intermediate resistances and around the intermediate resistances alone, each of said short circuits giving a different value of resistance. Obviously, then, if I connect the contacts 0 to the points 1′ 5′, contacts 1 to points 2′ 5′, contacts 2 to points 1′ 4′, contacts 3 to points 2′ 4′, contacts 4 to the points 3′ 5′, and so on in the same combinations as set forth above by simply connecting together the pairs of contacts 0 we obtain naught ohms, by connecting together the pair 1 we get one ohm, and so on through the series, and by connecting together none of the contacts 0 to 8 the current simply flows through all the resistances in series, when we get nine ohms.

To illustrate, suppose six ohms are required. In this case the contacts indicated 6 should be electrically connected. Then if current enters at the point 1′, which we will assume is the positive-terminal binding-post, the current will pass through the one-ohm resistance a', thence to the point 2′, through the contacts 6 to the point 3′, and then through the three-ohm and two-ohm coils c' and d' to the negative terminal 5′, passing through a total of six ohms of resistance.

The connecting together of the contacts constituting the pairs 0 to 8 may be effected in any desired manner—as, for example, by a plug or by a brush—and these contacts may obviously be disposed in any suitable man-

ner, whether in a straight line, as shown, or in a circle or semicircle or otherwise.

From the foregoing it will be seen that only four-tenths as many resistances are employed as there are regularly-increasing values and that these values are obtained by the operator by simply connecting a series of contacts, which may be done by a single contacting member, and, further, that each pair of contacts that he connects represents a definite quantity and may be so indicated. Therefore no thought or work on the part of the person using the resistances is required to effect the combinations of resistances to give a required value. Moreover, when it is considered that in making resistance sets each resistance has to be very accurately adjusted and tested the vast amount of saving in time, labor, and expense accomplished by this invention in so greatly reducing the number of resistances required will at once be apparent to any one familiar with this class of devices.

The illustrative case given above deals with ten values only; but the invention is by no means confined to this quantity nor to the specific values given the resistances in the case illustrated. For example, by the same method of connecting as above described I may use five resistances and obtain eleven values or seven resistances and obtain fifteen values. Resistances of one, three, three, two, and one ohms, respectively, when connected in series in the order set forth may by the method of connecting above described be made to give eleven values, and likewise other values of five resistances may be made to give eleven values, and resistances of one, one, three, one, three, three, and two ohms connected together in series in the order given may be made to give fifteen regularly-increasing values. In this manner I may increase the values almost indefinitely and never use more than fifty per cent. as many resistances as there are values obtained.

One other combination of resistances by which ten regularly-increasing values may be gotten with four resistances only by connecting two points at a time, as herein described, is the combination of one ohm, one ohm, four ohms, and three ohms connected in series in the order set forth.

In Fig. 2 I have shown my invention as applied to a decade resistance-box or rheostat, where $a\ b\ c\ d$, $a'\ b'\ c'\ d'$, $a''\ b''\ c''\ d''$, $a'''\ b'''\ c'''\ d'''$, and $a''''\ b''''\ c''''\ d''''$ represent the resistances, and the five vertical double rows of contacts e represent contacts for short-circuiting the resistances corresponding to the contacts 1 to 8 of Fig. 1. In Fig. 2 these contacts are shown as adapted to be connected together by plugs, and $f\ f$ represent sockets to receive the plugs when not inserted between the above-mentioned contacts.

For each double row of contacts e may be obtained ten values of resistance. In the case illustrated the resistances a, b, c, and d of the first double row of contacts e on the right are of .1, .3, .3, and .2 of an ohm, respectively; the resistances a', b', c', and d' of one, three, three, and two ohms; the resistances $a''\ b''\ c''\ d''$ of ten, thirty, thirty, and twenty ohms; the resistances a''', b''', c''', and d''' of one hundred, three hundred, three hundred, and two hundred ohms, and the resistances a'''', b'''', c'''', and d'''' are of one thousand, three thousand, three thousand, and two thousand ohms, respectively. Therefore from the first vertical double row of contacts e on the right may be gotten values from 0 to .9 of an ohm by steps of .1 of an ohm; from the next row, naught to nine ohms by steps of one ohm; from the next row, naught to ninety ohms by steps of ten ohms; from the next row, naught to nine hundred ohms by steps of one hundred ohms, and from the next row, naught to nine thousand ohms by steps of one thousand ohms. The several resistances of each of said rows of contacts e are connected in series and to the several contacts e upon the same principle as illustrated in Fig. 1; but by the manner of effecting the connections in Fig. 2 many of the wires shown in Fig. 1 are eliminated.

The several rows of contacts e are connected in series, as by conductors g, while the uppermost outside of these contacts are connected to the binding-posts h.

As thus far described the maximum resistance of the set is 9999.9 ohms; but obviously the set may be extended either way—that is to say, other rows of contacts may be added with resistances of smaller values than .1 of an ohm, and likewise others may be added with resistances higher than ten thousand ohms. If desired, I may add a ten-thousand-ohm coil between contacts e, when the capacity of the set will be raised to 19,999.9 ohms.

By inserting a plug in the contacts e' and by inserting plugs in all contacts across the horizontal rows of contacts e opposite the naught on the left the current will enter at the positive binding-post and pass out at the negative without traversing any appreciable resistance. Then if all of the plugs are removed current from the positive binding-post will traverse 19,999.9 ohms.

Suppose we wish to get 3,950.6 ohms. For the three thousand ohms place a plug in the contacts of the thousands row opposite the number "3." For the nine hundred ohms remove the plug entirely from the contacts of the hundreds row and place it in the socket "9" of that row. For the fifty ohms place a plug in the contacts of the tens row opposite the number "5," and for the .6 of an ohm place a plug in the contacts of the tenths row opposite the number "6." As there happened to be no units in the number required, a plug should be placed in the contacts of the units row opposite the "0." A plug is supposed to remain between the contacts e' unless ten

thousand or more ohms are required. With the contacts plugged as indicated the current entering at the plus binding-post will traverse 3,950.6 ohms, taking the course indicated by the arrow-heads, by which it may be readily traced.

The ease with which a given value may be obtained will be at once apparent, requiring no time whatever in thinking out the various resistances to be added together to give the required value. The numbers making up the required value of resistance are readily gotten from the vertical row of ordinals on the left, while the decimal places are indicated at the top of each vertical double row of contacts *e*. Moreover, it will also be readily seen that the number of values obtainable vastly exceeds the number of resistance-coils. In the case illustrated all values between naught and 19,999.9 ohms may be obtained with only twenty-one separate resistances or values between naught and 9,999.9 ohms with only twenty coils. Of course this means all values between those limits which do not involve fractional parts smaller than .1 of an ohm.

The ten-thousand-ohm resistance-coil shown between the contacts *e'* may or may not be used, as desired, and does not constitute an essential part of my invention.

The contacts *e* are preferably mounted on a plate *i*, of hard rubber or other insulating material, and may be secured thereto, as shown in Fig. 4, by the bolts *j j'* and nuts *k k'*. In this figure I have shown also one of the connecting-plugs e^0.

The resistances may be in the form of coils, as indicated by the coil *m*, and when of this character may be conveniently mounted on the bolt *j'*, which is made long to accommodate the coil. The plate *i* is preferably made to form the cover of a box *n*, in which the coils and connections are inclosed.

Instead of arranging the contacts *e* in vertical rows and connecting them by plugs I may arrange these in circles and connect them successively by a rotatable contact-maker, as shown in Fig. 3, where e^2 represents the contacts corresponding to contacts *e*, and e^3 a rotary contact-maker adapted to pass over and make contact successively with the segments forming the contacts e^2. The segment e^4 corresponds to sockets *f*—that is to say, when the brush *e* rests upon that segment all of the resistances are supposed to be in circuit.

While I have selected as a specific application of my invention the rheostat shown in Fig. 2, I do not wish to be understood as confining my invention to this single application, since the principle thereof is applicable to many sorts of electrical apparatus—such, for example, as Wheatstone bridges, potentiometers, and a variety of other instruments. Moreover, the system of connections herein shown and described may be used also for connecting up standard coils of self-induction by simply substituting for the ohmic resistance-coils shown standard coils of self-induction. I therefore do not confine my invention to ohmic resistances alone.

What I claim as my invention is—

1. The combination with a plurality of series-connected electrical resistances, of circuit connections and means for short-circuiting the end resistances in the series independently and in combination with the intermediate resistances, and for short-circuiting intermediate resistances alone, whereby a different value of resistance is obtained for each short circuit so established.

2. The combination with a plurality of series-connected electrical resistances, of means for obtaining from said resistances a series of regularly-increasing resistance values greater in number than the resistances employed, comprising circuit connections and means for establishing short circuits around the end resistances independently and in combination with the intermediate resistances, and around intermediate resistances alone, each of said short circuits so established giving a different value of resistance.

3. The combination with a plurality of series-connected electrical resistances, of circuit connections and means for short-circuiting the end resistances independently and in combination with the intermediate resistances, and for short-circuiting intermediate resistances alone, by connecting, for each short circuit, two points only at a time, in the circuit of said resistances, whereby a different value of resistance is obtained for each short circuit so established.

4. The combination with a plurality of series-connected electrical resistances, of a plurality of conducting contact-pieces, circuit connections adapted to operate in conjunction with said contact-pieces to short-circuit the end resistances in the series independently and in combination with the intermediate resistances, and to short-circuit intermediate resistances alone, and means for connecting said contact-pieces together two at a time in establishing each of said short circuits.

5. The combination with a plurality of series-connected electrical resistances, of a double row of conducting contact-pieces, circuit connections adapted to operate in conjunction with said contact-pieces to short-circuit the end resistances in the series independently and in combination with the intermediate resistances, and to short-circuit intermediate resistances alone, and a single contact-maker for connecting said contact-pieces together two at a time in establishing each of said short circuits, whereby a series of resistance values may be obtained greater in number than the resistances employed.

6. In a decade resistance set, the combination with a plurality of double rows of conducting contact-pieces, a double row for each decade, of a set of series-connected resist-

ances for each double row of contacts and decade, the number of resistances in each set being less in number than the decade values derived therefrom, circuit connections between each set of resistances and its corresponding double row of contacts and adapted to operate in conjunction with said contacts to short-circuit the end resistances in each respective set independently and in combination with the intermediate resistances, and to short-circuit intermediate resistances alone, a single contact-maker for each double row of contact-pieces for connecting said contact-pieces of the respective double rows together, two at a time, for each of said short circuits so established, and terminal connections for connecting all of said resistances in series, substantially as described.

7. In a resistance set, the combination with four electrical resistances, of circuit connections and means whereby nine successive resistance values may be obtained from said four resistances.

8. In a resistance set, the combination with four electrical resistances, of circuit connections and means for electrically connecting together two points at a time in the circuit of said resistances in nine combinations whereby nine successive resistance values may be obtained from the four resistances employed, each final resistance value corresponding to a different combination of two connected points.

9. In a resistance set, the combination with four series-connected electrical resistances, of circuit connections and means whereby nine successive values of resistance may be obtained by short-circuiting the said resistances in predetermined order.

10. In a resistance set, the combination with four series-connected electrical resistances, of a plurality of conducting contact-pieces connected to said resistances, and means for connecting together two of said contact-pieces at a time in nine combinations, and circuit connections between said contact-pieces and resistances whereby a different resistance value is obtained from each combination of contacts so connected.

In testimony whereof I affix my signature in presence of two witnesses.

EDWIN F. NORTHRUP.

Witnesses:
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WALTER H. FENIMORE.