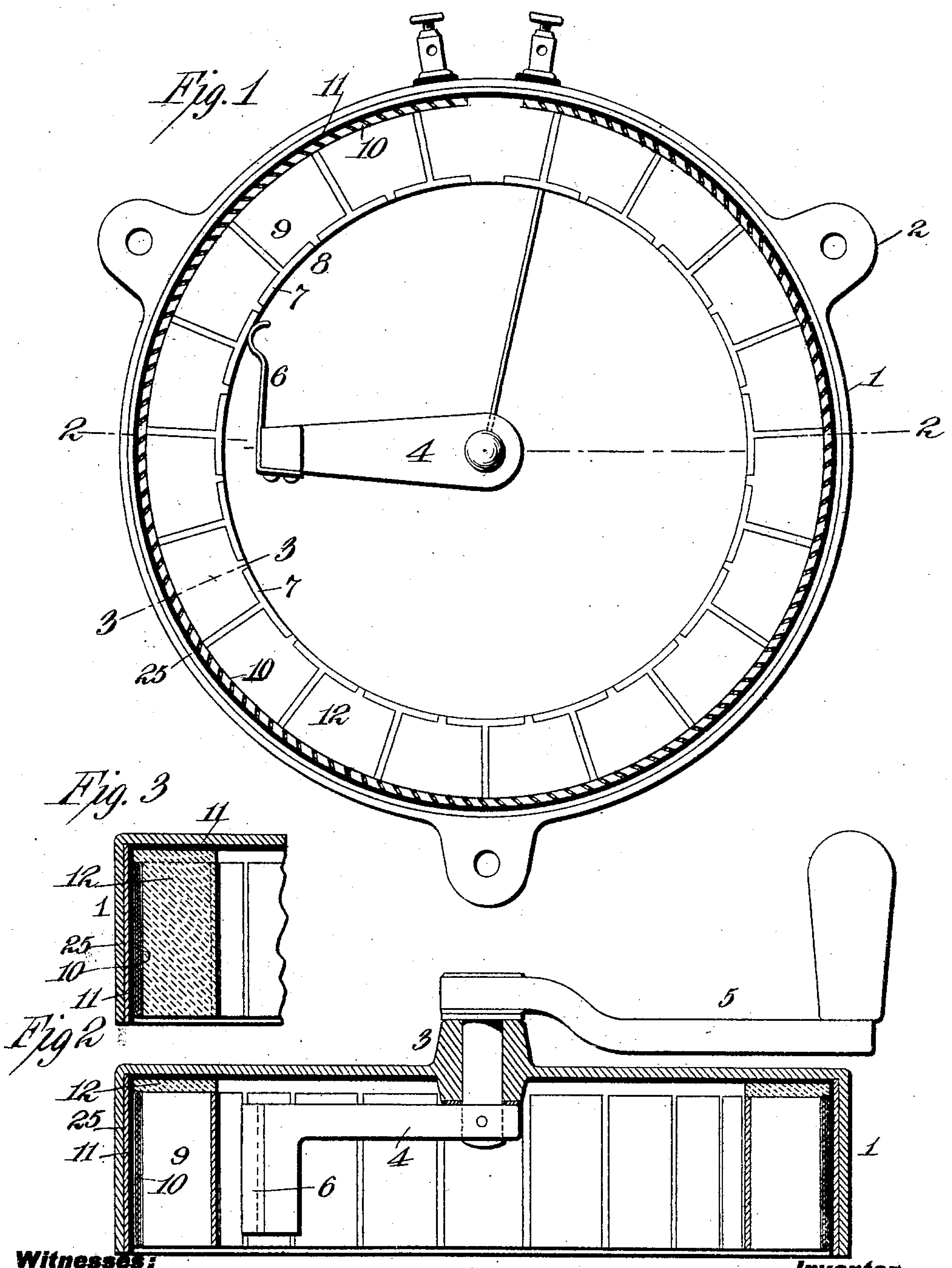
No. 764,651. PATENTED JULY 12, 1904.

C. WIRT.

RHEOSTAT.

APPLICATION FILED NOV. 6, 1903.

NO MODEL. 3 SHEETS—SHEET 1.



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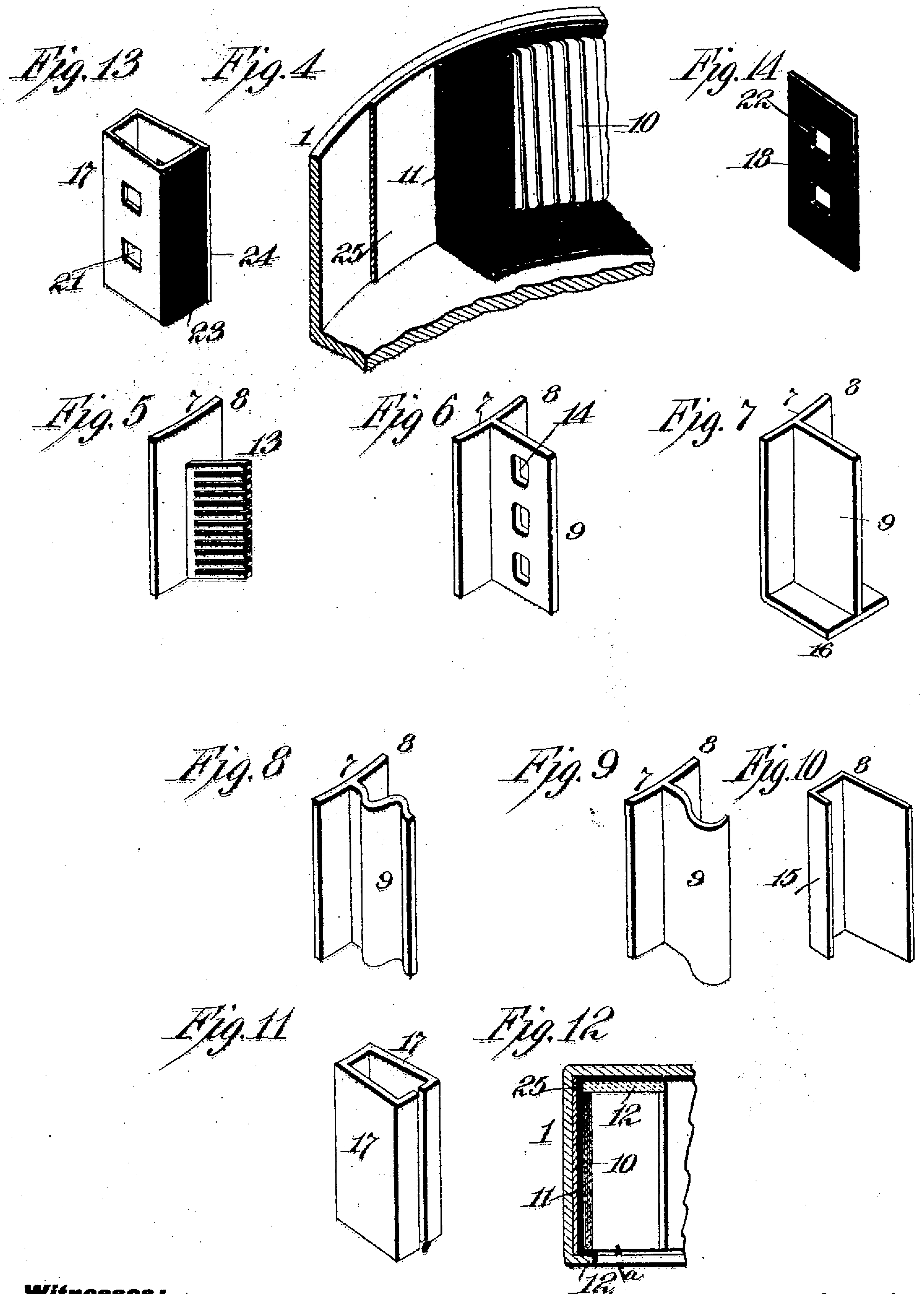
NO MODEL. 3 SHEETS—SHEET 2.



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NO MODEL. 3 SHEETS—SHEET 3.

Fig. 15

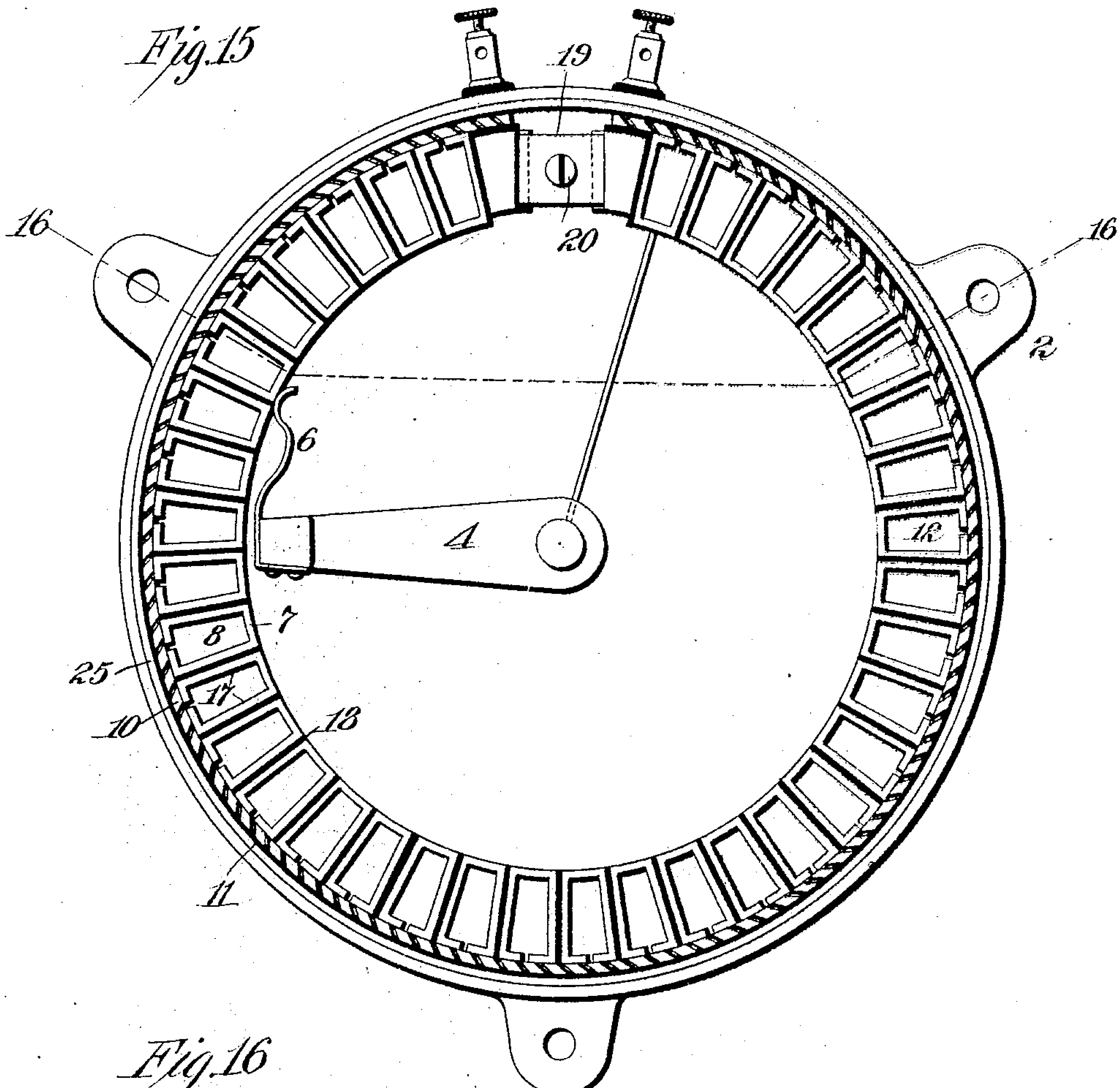
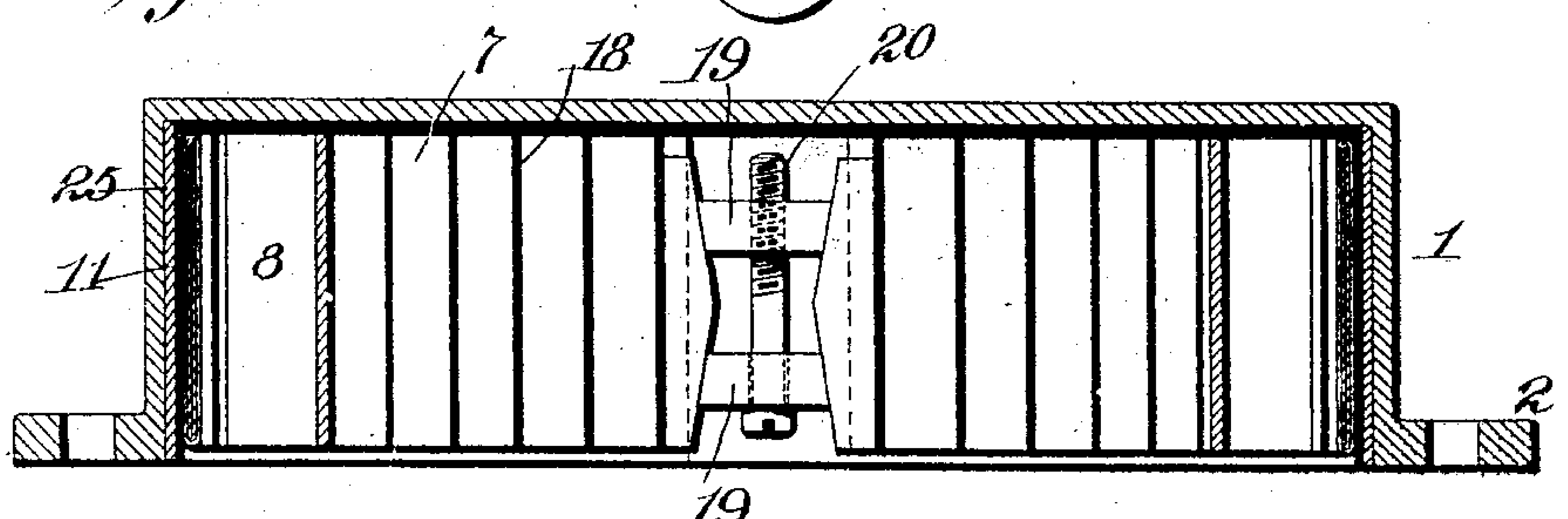


Fig. 16



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UNITED STATES PATENT OFFICE.

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RHEOSTAT.

SPECIFICATION forming part of Letters Patent No. 764,651, dated July 12, 1904.

Application filed November 6, 1903. Serial No. 180,137. (No model.)

To all whom it may concern:

Be it known that I, CHARLES WIRT, a citizen of the United States, residing in the city of Philadelphia, State of Pennsylvania, have invented a certain new and useful Improvement in Rheostats, of which the following is a description.

The present invention relates to rheostats and to improvements in their design and construction, but more particularly to the connections and arrangement of the commutator segments or sections and to means for equalizing the temperature of the resistance.

The objects of the invention are, first, to simplify the construction of the commutator-sections whereby the cost of the rheostat both as to the material and labor employed will be reduced; second, to increase the number of points without a proportionate increase in cost and by means of which very close regulation can be secured, and, third, provide means whereby a portion of the heat generated within the resistance will be transmitted to the unused portion of the resistance, so that the temperature of the rheostat as a whole will be equalized.

The invention consists generally in locating the resistance within a cylindrical shell, which may be cheaply made of sheet-steel "drawn up" to shape, or of cast or malleable iron. The resistance can be of any well-known form, either strip, plate, or sheet, and is laid against the inner surface of the shell with the thinnest possible interposed insulation. The commutator-sections are of metal and preferably of T-section, with the head and stem generally at right angles to one another, the bases of the stems engaging with the resistance and the heads separated by short intervening spaces and disposed together to form a path for the traverse of the contact-brush. The commutator-sections are held in place and in close engagement with the resistance by having the space occupied by their stems packed with cement or other suitable insulating substance, so that the resistance will be electrically joined to the sections of the commutator and the heads of the latter will form a continuous rim of separated insulated segments.

In lieu of T-shaped sections the commutator may be formed of box-sections with inclined abutting sides. In this modification the binding material is not necessary; but the segments are forced together and into intimate contact with the resistance by means of an expanding-wedge interposed between the periphery of the circle of segments.

My improved form of rheostat is most suitable where a large number of contact-pieces is required for the purpose of close regulation. Dynamo-field rheostats, theater-dimmers, and photometer-rheostats belong to this general class. It also has points of superiority for another class where intermittent work is the rule and a rheostat is required which will stand a high rate of work for a short time—for example, a motor-starter.

The separating insulation between the resistance and the outside shell is as thin as possible, and interposed between the insulation and the steel shell is a strip of copper or other good heat-conducting material. By this means the heat generated within that part of the resistance through which the current is flowing will pass through the lining of good heat-conducting material and be transferred to the unused portion of the resistance and to that portion of the casing which is adjacent thereto.

In order to better understand the nature of my invention, attention is directed to the accompanying drawings, which illustrate several embodiments of my inventian, and in which—

Figure 1 is a bottom view of one form of rheostat employed in my invention. Fig. 2 is a sectional view thereof, taken on the line 2 2 of Fig. 1. Fig. 3 is a fragmental section taken on the line 3 3 of Fig. 1. Fig. 4 is a perspective view of a detail of the casing, insulation, and resistance. Figs. 5 to 10, inclusive, are views of different forms of commutator-sections. Fig. 11 is a view of a commutator-segment to be used in a modified form of rheostat. Fig. 12 is a sectional view of a fragment of the casing, showing a turned-over edge on the latter. Fig. 13 is a view of a modified form of segment. Fig. 14 is a view of the sheet of separating insulation thereof. Fig. 15 is a bottom view of a modified form of rheostat which employs the segments illustrated in Fig. 11, and Fig. 16 is a sectional view taken on the line 16 16 of Fig. 15.

In all of the several views like parts are designated by the same numerals of reference.

The resistance, insulation, commutator-segments, and switch of the rheostat are all contained within a circular casing 1, which may be formed of steel drawn up either by stamping or spinning or by other suitable means or of cast-iron or malleable iron and is provided with the usual fastening-lugs 2 2 and a bearing 3 for the switch-arm 4 and the operating-crank 5, all of the usual construction.

The switch 6 is in engagement with the faces 7 of the commutator-sections 8, the bars 9 of which abut against the resistance 10.

The resistance 10 bears against the inside surface of the box and is separated therefrom by an insulation 11, such as a thin sheet of mica.

The resistance may be made in any well-known form, the illustration showing one made of ribbon wound helically on a tube and flattened. Ribbon will ordinarily be preferred for this resistance-winding; but round wire may be employed, particularly if high resistance is required. The resistance is preferably of such form as to be more or less flexible, so that it will be forced into intimate contact with the interior of the casing and will also make good electrical contact with the lugs of the contact-sections as the latter are forced thereagainst.

I do not limit myself to the kind of resistance shown, for any other form may be used—as, for example, a sheet of fibrous flexible carbon formed by carbonizing paper or canvas at a high temperature, or for lower resistance a plain sheet of resistance-alloy may be used.

The resistance and commutator-sections are retained in position by means of a suitable cement 12, which fills all the space between the commutator-bars 9 and holds them in close engagement with the resistance, so as to form electrical contact therewith. Any form of cement may be used; but I prefer to use Portland cement; but any other form of material may be introduced, whether in powder, plastic, or granular form and which can be solidified by the ordinary setting process or by pressure or otherwise. As the filling material serves as an insulation between contiguous sections, a very high degree of insulation is not essential. It is to be observed that the cement does not serve to insulate the space between the resistance and the case, mica 11 or other material of high insulating quality being used, as before described. If desired, the resistance may be further retained in place within the casing by providing the latter with a flange, as illustrated in Fig. 12 at 12^a. It will be seen that any number of commutator-sections may be used, provided they be disposed so that no two will engage with the same turn of resistance material. In assembling this particular embodiment of my invention pressure is to be applied to the contact-faces of the commutator-sections by means of an expanding ring or otherwise, forcing each bar 9 in its place and into electrical contact with the resistance. This supporting-pressure will be allowed to remain until after the filling has been introduced and solidified, whereupon, as described, the sections will be rigidly held in electrical contact with the resistance.

In addition to the pressure of the bars against the resistance holding the latter in firm mechanical contact with the shell the filling will also serve to hold the resistance against the shell. This feature is of great importance, as the cooling effect of the shell—*i. e.*, the capacity of the shell to carry away the heat generated in the coil—depends very much upon the intensity of contact. For the same object it is desirable to use an insulating-layer 11 of material as thin as possible and formed of a material of good heat conductivity. As before explained, mica fulfils these conditions fairly well.

To assist in perfecting the contact between the commutator-bars 9 and the resistance, the contact edge of the former may be subdivided, as at 13, Fig. 5, whereby diagonal prongs or teeth are formed. In Fig. 8 the leg 9 is corrugated, and in Fig. 9 it is coiled. This is to create an elastic connection with the resistance and to improve the electrical contact therewith.

In Fig. 6 the bar is provided with perforations 14 for the purpose of increasing the mechanical engagement with the filling. In Fig. 10 the section of the bar is L-shaped, with a short lip 15 on one edge, and in Fig. 7 a bottom plate 16 connects the plate and bar, these modified structures being for the purpose of increasing the surface in contact with the filling material. These sections may be cheaply made of steel or other metal, and as there is no other connection with the resistance than one of direct pressure many sections can be employed, thus making the apparatus capable of great refinement of regulation.

A modified form of rheostat is illustrated in Figs. 15 and 16. In these views the cement filling 12 is shown, but may be omitted, if desired. The commutator-sections are segment-shaped, as shown in Fig. 11, (each with two legs 17,) being employed to act in mutual relation, like the stones of an arch, sustaining and transmitting pressure circularly and radially. Between each segment is a thin strip of mica or other insulation 18, and the segments are forced into place against each other and the inside of the shell by any suitable device, as an expanding key-block 19, placed adjacent to the electrical terminals. The block is tightened as desired by a suitable screw 20.

In lieu of the bars shown other forms may be used which may have some advantages. If desired, when the filling-cement in Fig. 1 is used with this form of rheostat better mechanical contact is secured by providing the legs 17 with perforations 21, which will register with corresponding perforations 22 in the separating-sheets of insulation 18.

With commutator-segments of the character illustrated in Fig. 11 more or less short-circuiting may occur. This is not necessarily undesirable, although in the case where the resistance-winding is narrow and the turns close together the segments, if there be many of them, will engage with several turns of resistance, causing a waste of resistance material. To reduce this short circuit and still at the same time to give a firm and close electrical contact with the resistance and to force it into engagement with the shell, the segments may be of the form shown in Fig. 13. In this instance the bearing-face is covered by a thin strip of insulation 23—mica, for example—with a protruding edge 24 of metal, which produces the contact-surfaces.

Sheet-steel is suitable for the commutator-sections described, and as the contact-surfaces are internal and not exposed to view and are partly protected against atmospheric action and corrosion no finish or plating will be required, thus reducing the cost of manufacture.

To increase the capacity of the rheostat when used constantly with only a portion of the resistance in circuit, means is provided for transferring the heat generated in that portion of the resistance in use to the portion not in use. This means may consist of a sheet of copper 25, (shown in detail in Fig. 4,) interposed between the insulation 11 and the shell 1. Copper is preferred to be used when the shell is formed of a material of lower heat conductivity, as of cast-iron or sheet-steel. The heat conductivity of metals and alloys is relatively about the same as their electrical conductivity, which bears in the case of copper and commercial sheet-steel a ratio of about eight or ten to one. The relative conductivity of copper to cast-iron might be as high as thirty to one, cast-iron being extremely variable in conductivity, according to the proportion of carbon and the materials usually found, such as silicon, phosphorus, sulfur, &c. By interposing a sheet of material of good heat conductivity between the insulation and the casing and making the insulation as thin as possible the heat generated in that portion of the resistance in use will be transmitted around the rheostat and transferred to the unused portion of the resistance and to the outside shell, thus equalizing the temperature of the rheostat. This portion of the invention is of great importance in rheostats in which but a portion of the resistance is generally used and that portion is subjected to heavy currents.

In a rheostat of the type above described and in some commercial types in common use this item of heat conductivity from the hotter to the colder portion of the rheostat is very important as affecting the ultimate capacity of the size required to do a given amount of work, the other things being equal.

It is customary in designing a rheostat to work with a varying ampere capacity to vary the cross-section of the conductor. The calculation in this case is for the purpose of giving an equal heating effect in different parts of the rheostat. Where the heat conductivity from one portion of the working surface to another is low, this method is very desirable and in some cases is absolutely necessary. It is open to the disadvantage, however, that when the larger part of the resistance is in circuit the initial resistances—*i. e.*, those first brought into action—which have high ampere capacity, are not then working at their proper maximum, the result being on the whole a loss of effective capacity.

Within certain limited sizes the rheostat may be made of my improved design with the winding straight or uniform regardless of the variation of the amperes carried, because the first steps which go into circuit, although carrying a relative overload, are kept within the proper temperature limits by the escape of the heat to the cooler portions which are not in circuit, a portion of the heat being radiated therefrom, as already described.

In a rheostat of this description, having a "tapered" ampere capacity, but with a "straight" winding, the steps may be of equal area and of uniform resistance and surface, so that when all of the resistance is in circuit each part of the rheostat is working at its proper maximum rate, the result being that the smallest possible size will be allowed. The limits of the size referred to above must not be overlooked, because when a certain size is reached the distance necessary for the heat to be transferred may be too great to allow for an equalization sufficient for practical purposes. This again will also depend, of course, upon the degree of "taper" or variation of the amperes passing through the resistance between the initial and final steps.

Having now described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In a rheostat, the combination with a casing, of a resistance therein and contact-sections bearing directly against the resistance, means for forcing said contact-sections against said resistance, and means for rigidly holding the sections in place, substantially as set forth.

2. In a rheostat, the combination with a casing, of a resistance therein and contact-sections bearing directly against the resistance, means for forcing said contact-sections against said resistance, and a cement or other filling for rigidly holding the sections in place, substantially as set forth.

3. In a rheostat, the combination with a cas-

ing, of a resistance therein and contact-sections circularly disposed and bearing directly against the resistance, means for forcing said contact-sections against said resistance, and means for rigidly holding the sections in place, substantially as set forth.

4. In a rheostat, the combination with a casing, of a resistance therein and contact-sections circularly disposed and bearing directly against the resistance, means for forcing said contact-sections against said resistance, and a cement or other filling for rigidly holding the sections in place, substantially as set forth.

5. In a rheostat, the combination with a casing, of a resistance therein and contact-sections bearing directly against the resistance, means for forcing said contact-sections against said resistance, and means for producing and sustaining a circular pressure between adjacent sections, whereby said sections are secured in position, substantially as set forth.

6. In a rheostat, the combination with a casing, of a resistance therein and contact-sections bearing directly against the resistance, means for forcing said contact-sections against said resistance, and means for producing and sustaining a circular pressure between adjacent sections, whereby said sections are secured in position, and additional means for holding the sections in place, substantially as set forth.

7. In a rheostat, the combination with a metallic shell, of a resistance therein and a separating-plate, the said plate being of metal of better heat conductivity than the casing, substantially as set forth.

8. In a rheostat, the combination with a metallic shell, of a resistance therein, insulation, and a separating-plate, the said plate being of metal of better heat conductivity than the casing, substantially as set forth.

9. In a rheostat, the contact member therefor, the said member having an elastic portion adapted to make sustaining electrical contact with the resistance-coil, substantially as set forth.

10. In a rheostat, the combination with a circular casing, of a resistance therein, the said resistance being in the form of a flexible sheet, and a multiplicity of contact-sections circularly disposed within the casing, the casing forming the exterior, the resistance the intermediate, and the contact-sections the interior members, respectively, substantially as set forth.

This specification signed and witnessed this 4th day of November, 1903.

CHARLES WIRT.

Witnesses:
LEONARD H. DYER,
JNO. ROBT. TAYLOR.