

No. 753,716.

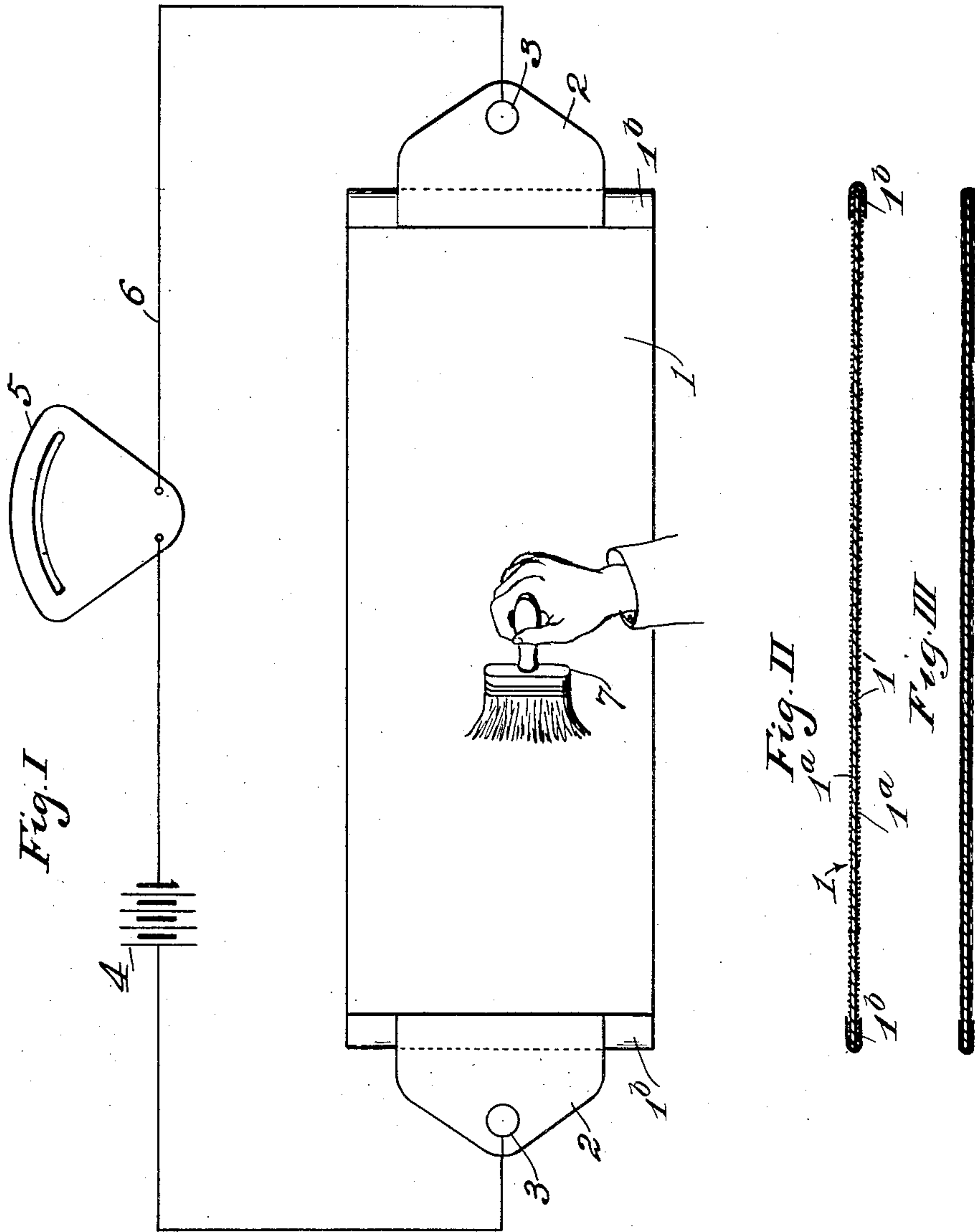
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G. I. LEONARD.

CARBON RESISTANCE AND METHOD OF PRODUCING AND ADJUSTING SAME.

APPLICATION FILED FEB. 3, 1903.

NO MODEL.



Witnesses

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## UNITED STATES PATENT OFFICE.

GEORGE I. LEONARD, OF PASADENA, CALIFORNIA.

CARBON RESISTANCE AND METHOD OF PRODUCING AND ADJUSTING SAME.

SPECIFICATION forming part of Letters Patent No. 753,716, dated March 1, 1904.

Application filed February 3, 1903. Serial No. 141,748. (No specimens.)

To all whom it may concern:

Be it known that I, GEORGE I. LEONARD, a citizen of the United States, residing at Pasadena, in the county of Los Angeles and State of California, have invented a new and useful Carbon Resistance and Method of Producing and Adjusting Same, of which the following is a specification.

This invention relates to a method of producing and definitely adjusting or regulating a resistance composed of graphite or similar material used in rheostatic devices, such as electric heaters and current-controllers.

The invention also relates to the product of such method.

One object of the invention is to provide a method of influencing and controlling the resistance of such material which shall not depend on the addition or removal of material or on the application of permanent pressure.

In the manufacture of resistance elements for rheostats it is found convenient to apply a coating or layer of plumbago to one or both sides of a suitable insulating supporting sheet or plate, and for such application the plumbago must be mixed with a suitable binder. As such mixture has a resistance very different from the plumbago in its eventual dried condition, it is evidently impracticable to produce accurately a definite resistance by the simple application of the coating.

An object of my invention is therefore to subject the coating when it is in or nearly in its final dried condition to a treatment that will accurately adjust and permanently fix its resistance according to a determined standard.

Another object of my invention is to render the coating of greater conductivity, so that a smaller amount of coating material will suffice to carry the current. This not only results in economy of material, but the coating being thinner than would otherwise be necessary it is less liable to flake off.

My invention is based on the discovery made by me that the resistance of a coating or layer of plumbago or carbon may be lowered to a considerable extent by the application of frictional pressure. By the application of ordinary static pressure the resistance of carbon

conductors may be decreased in proportion to the pressure exerted; but in such cases the change has generally been temporary, the carbon increasing in resistance as soon as the pressure was removed. By subjecting the carbon or plumbago layer to a frictional pressure, as by rubbing, it may be permanently lowered in resistance, and my invention is based on this new discovery. My invention also includes the product consisting of the insulating-support, with the coating thereon compacted and polished by rubbing.

I will now describe my newly-invented method, reference being had to the accompanying drawings, wherein—

Figure I is a diagram showing apparatus and electrical connections required in carrying out my method. Fig. II is a vertical section of the resistance element. Fig. III is a vertical section of the resistance in its final condition.

The resistance element 1 comprises a supporting or core plate or sheet 1', with coatings 1<sup>a</sup> on each side thereof and with terminal strips 1<sup>b</sup> of metal at the ends.

2 2 indicate terminal clamps connected by binding-posts 3 3 with an electric circuit 6, which includes a battery 4 and ammeter 5.

A sheet or core plate 1', desirably of asbestos or similar insulating refractory material, is coated, preferably from end to end on both faces, with plumbago or carbon 1<sup>a</sup>, the thickness of each coating being made so slight that without the subsequent treatment the resistance would be higher than required. The plumbago is desirably applied in the state of a paint or paste with water and sufficient sugar or similar binder to cause it to adhere to the support, and it may be applied with a brush or similar means. After the plumbago coating is dry or nearly so it is ready for treatment according to my method to control or adjust its resistance. The terminal strips first having been fastened on the ends of the resistance element, the latter is connected, by means of terminals 2 2 in the electrical circuit 6, with the battery 4 and ammeter 5, as shown, and the deflection of the ammeter will show the conductivity or conductance of the resistance



element, which for the purpose of adjustment, as above stated, will be considerably lower than required in the final product. Then by means of any suitable implement—such as the brush 7 (indicated in the drawings) or a scraper or roller or any object which will produce a requisite polishing and compacting effect—the coating of plumbago is subjected to frictional or rubbing pressure, and thereby measurably compacted and polished, which effects an increase in the conductivity of the coating, as will be indicated by the increased deflection of the ammeter. If the supporting-sheet is coated on both sides, it is desirable to rub one side only enough to bring the conductivity part way up to the required amount, the resistance element being then inverted and the other side rubbed until the resistance is lowered to the required standard, as shown by the ammeter. The resistance element may then be removed from the clamps 3 3 and inserted in a rheostat, and it will be found that the increased conductivity imparted to it will be substantially permanent. The process therefore affords a means of accurately controlling the resistance of the rheostat element, as the rubbing may be stopped just as soon as the ammeter shows that the proper resistance has been reached. Inasmuch as the coating or coatings will be much thinner than if they are simply laid on wet and then dried and used without my special treatment, it follows that less plumbago will suffice, and the coating will adhere more strongly and be less apt to flake off. Moreover, the heat generated in the coating will be more readily conducted away and thrown off, as the layer it has to pass through is thinner and also a better conductor of heat.

It may be assumed that the increased conductivity of the carbon is due to a rearrangement of the particles under the frictional pressure, they being caused to lie in closer arrangement and contact. As stated, mere pressure does not produce any such result, it appearing that the disturbance or shifting of the particles is necessary to their arrangement in closer or more compact order; nor is any considerable pressure necessary when the frictional feature is present, as will appear from the fact that an ordinary brush-pressure is sufficient.

My invention is not necessarily limited in its application to plumbago, but may be applied to any carbon resistance material and generally to any material that presents the necessary features of a fine state of division and of a conductivity depending on closeness of contact; nor do I confine myself to measuring the resistance in the manner herein

specified, as it may be measured in any similar manner.

What I claim, and desire to secure by Letters Patent of the United States, is—

1. The method of adjusting the resistance of graphite or similar material which consists in subjecting same to a frictional pressure until the resistance is reduced to the required amount.
2. The method of adjusting the resistance of a carbon layer which consists in subjecting the layer to frictional pressure until the resistance is reduced to the required amount.
3. The method of controlling the resistance of a carbon rheostatic material which consists in subjecting the same to frictional pressure.
4. The method of producing a carbon rheostat of definite resistance which consists in coating a suitable surface with plumbago and subjecting the coating to frictional pressure.
5. The method of producing a carbon rheostat of definite resistance which consists in coating a suitable support with plumbago paste or paint, allowing same to dry and subjecting the dry or nearly dry coating to frictional pressure.
6. The method of producing a carbon rheostat of definite resistance which consists in coating a suitable non-conducting support with a paint or paste composed of plumbago, water and a binding agent, allowing the coating to dry and subjecting the dry or nearly dry coating to frictional or rubbing pressure until the required resistance is obtained.
7. The method of adjusting the resistance of a carbon rheostatic device which consists in measuring the resistance of said device, and while continuing to measure the resistance, subjecting the carbon in the rheostatic device to frictional pressure until the resistance is reduced to the required amount.
8. The method of adjusting the resistance of a carbon rheostatic device which consists in passing an electric current through said device, and measuring by means of said current the resistance of said device, and while continuing to so apply the current and measure the resistance, subjecting the carbon in the rheostatic device to frictional pressure until the resistance is reduced to the required amount.

In testimony whereof I have signed my name to this specification, in the presence of two subscribing witnesses, at Los Angeles, in the County of Los Angeles and State of California, this 19th day of January, 1903.

GEORGE I. LEONARD.

Witnesses:

FREDERICK D. LYON,  
JULIA TOWNSEND.