No. 760,075. PATENTED MAY 17, 1904.

G. I. LEONARD.

ELECTRICAL RESISTANCE.

APPLICATION FILED OCT. 27, 1902.

NO MODEL.

Fig. I

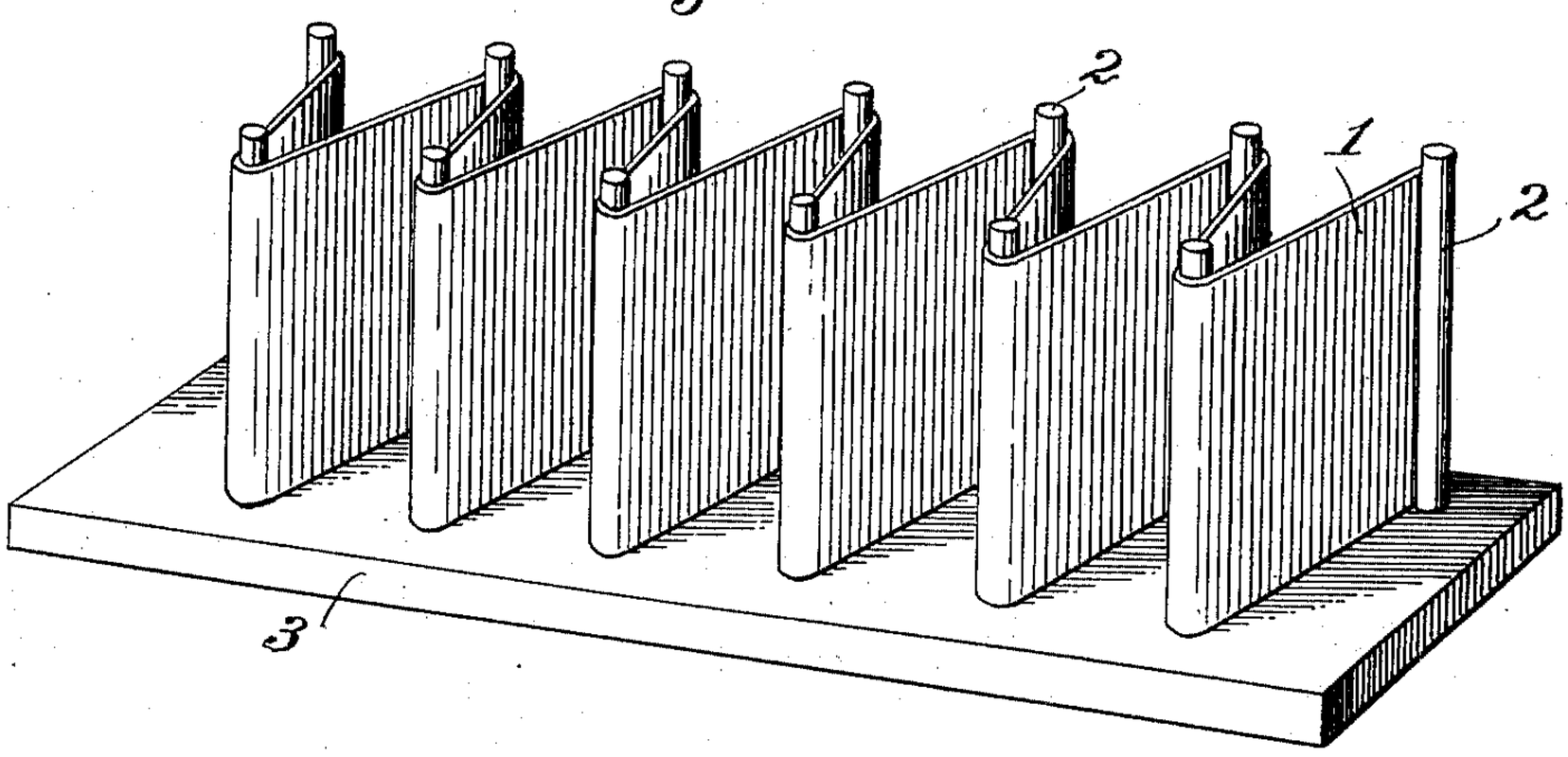


Fig. II

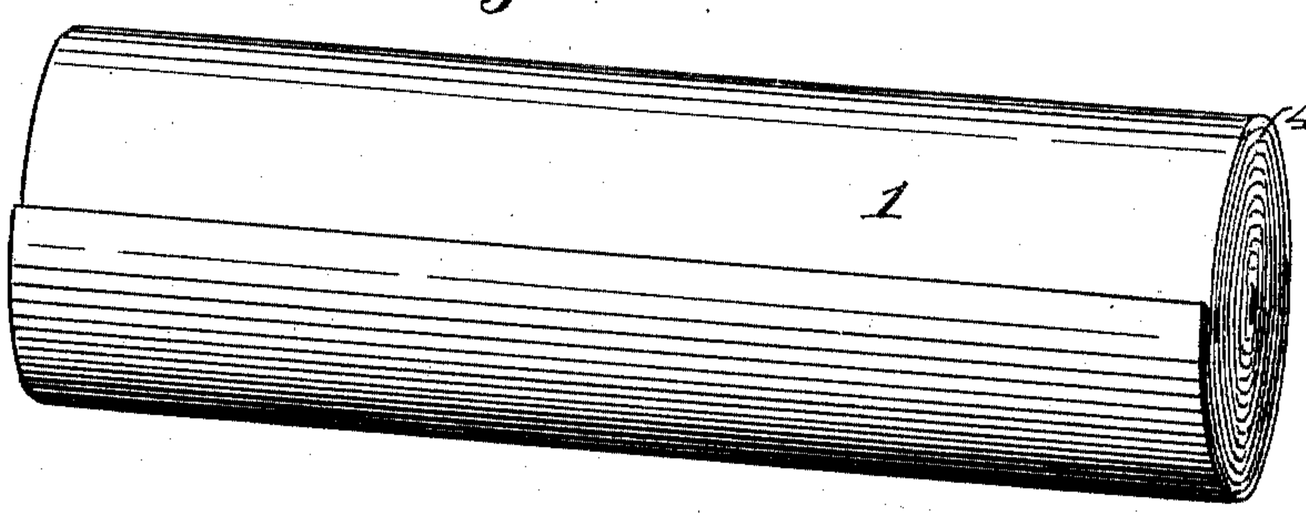


Fig. IV

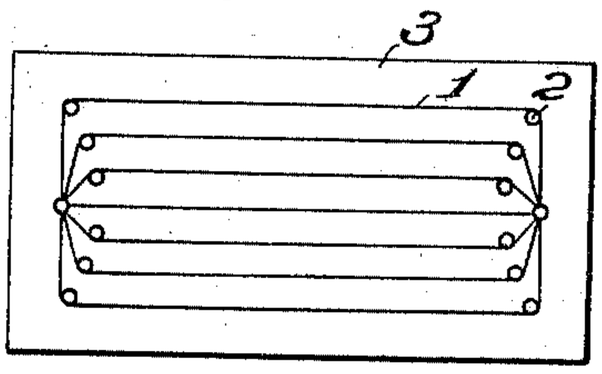


Fig. III

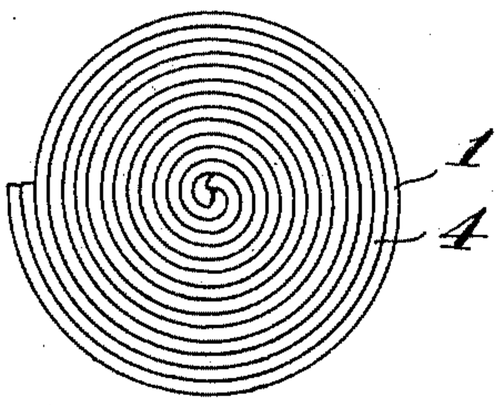
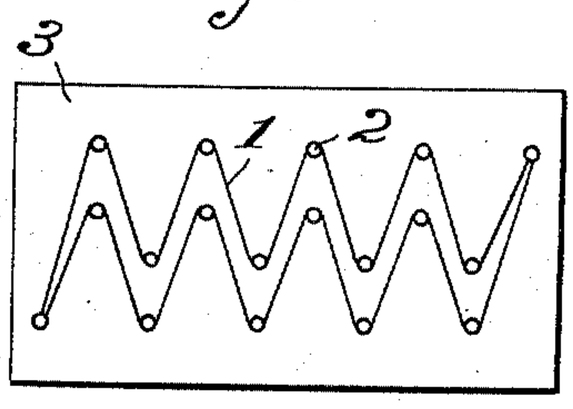


Fig. V



Witnesses
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Inventor
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by *J. W. Wilson & Bro.*
his attys.

No. 760,075. Patented May 17, 1904.

UNITED STATES PATENT OFFICE.

GEORGE I. LEONARD, OF PASADENA, CALIFORNIA.

ELECTRICAL RESISTANCE.

SPECIFICATION forming part of Letters Patent No. 760,075, dated May 17, 1904.

Application filed October 27, 1902. Serial No. 129,039. (No model.)

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 Electrical Resistance, of which the following is a specification.

My invention relates to an appliance which may be used in the electrical arts as a conductor of relatively high resistance adapted for rheostats, heaters, electrical instruments, and other devices, and for practically all purposes for which known resistances are used.

One object of my invention is to produce an electrical resistance which will have little variation in its temperature and will therefore be of especial value for constructing electrical heaters.

Another object is to provide an electrical resistance which may be very economically produced and which is extremely light in weight.

Another object is to produce an electrical resistance which is fireproof and flexible and which has a large radiating-surface to minimize the variation in its temperature when an electric current is passed through it, so that in computing the amount of the resistance to be used little allowance need be made for variations in its effective conductivity due to heating.

Another object is to produce an electrical resistance which when used in an electrical heater will be very economical in the amount of electricity required and will heat a larger amount of air-space with a given amount of current than any other of which I know.

The drawings illustrate some forms in which the resistance may be applied.

Figure I is a perspective view of one form of arranging the resistance. Fig. II is a perspective view of another form of arranging the resistance. Fig. III is an end elevation of what is shown in Fig. II. Figs. IV and V show other ways of disposing the resistance which are particularly advantageous when the resistance is used as an electric heater.

My invention comprises an electrical resistance which is composed of a sheet of a non-conducting fireproof material the sides of which are covered with a coating of carbonaceous substance. The materials which preferably I employ are for the non-conducting fireproof material asbestos and for the carbonaceous substance graphite. I preferably employ graphite of the powdered form and mix it with a small per cent. of sugar and water to make a paste. I preferably use a ribbon or sheet of thin pliable asbestos and paint, preferably, both sides of the asbestos with the mixture, thereby forming a film or skin of conducting material thereon. The sugar in the mixture serves to form a binder and causes the powdered graphite to stick together and adhere to the asbestos. Other materials might be used in place of the sugar—for instance, gum-arabic or asphaltum might answer the purpose. The use of the asbestos is preferred, for the reason that it is a material which is practically non-conducting, fireproof, very light in weight, cheap, flexible, and easily handled. Furthermore, the asbestos while being pliable does not stretch. Therefore cracking of the coating is avoided. The graphite being spread on the asbestos in a thin film affords a large radiating-surface, and the temperature is thereby kept down. When the resistance is to be used for purposes of electrical measurements when very small currents are used, I prefer to first saturate the asbestos paper in a weak solution of rubber, which enters the pores thereof and when dry renders the paper very pliable. Before the rubber has entirely dried and while it is yet sticky I rub in dry powdered graphite or plumbago and polish it down, preferably with a brush, so that the graphite lies in a film over the rubber surface. The resistance when thus prepared is capable of being readily bent or rolled up into very small space without cracking. It would appear that the graphite compounds to a certain extent with the outer film of rubber, and some tests of the resistance have shown, with a strip of material one inch wide and twelve inches long, a resistance of twelve thousand ohms. On account of the extreme thinness of the conducting skin or material and on account of the large amount of radiating-surface exposed to the air a high efficiency of the resistance when

used as an electrical heater is attained by the use of much less current than is necessary in producing an equal amount of heat with other known resistance. By reason of the graphite being applied externally to the ribbon or sheet to form a film I am enabled to perfectly control the application of the graphite and secure the exact degree of conductivity desired. In another application of mine, filed February 31, 1903, Serial No. 141,748, is set forth a desirable method of applying the graphite.

The difference between the action of this resistance as a heater and wire-wound heaters is that in the case of the latter the heat of the wire is so intense that side radiation occurs, while in the present invention the heat is spread out over a large surface and is brought into contact with a greater amount of air, so that the air absorbs the heat produced as fast as it is generated. Thus the material forming the resistance does not become heated to any appreciable degree above the temperature of the heated air. Furthermore, by arranging the thin sheets in an upright manner the heat being thrown off horizontally will be more readily taken up by the air, and rapidly-ascending currents of highly-heated air are thus produced within a very narrow space, so that by providing sheets of considerable vertical extent the air issuing at the top of the heater may be very highly heated without producing any approximation of such heat in the material of the heater.

Practical tests have demonstrated that when properly designed and when giving off the maximum amount of heat consistent with safety to the apparatus the heat of the conductor is scarcely sufficient to burn the bare hand, thus insuring freedom from any decomposition of the substance composing the resistance.

It should be understood that when a heavy current is to be utilized the capacity of the resistance should be sufficient to carry the same without becoming heated sufficiently to cause the rubber or binder to be carbonized.

Fig. I shows a strip or ribbon 1 of the resistance which is woven over pegs 2, the pegs being supported by a base 3. It will be seen that when the resistance is arranged in this way the graphite coating is freely exposed to the air which serves to help keep the temperature of the resistance low and is a usual method of arranging resistance for ordinary purposes.

Fig. II shows the resistance in sheet form and rolled into a cylindrical body which is a very compact arrangement of the resistance and might be a desirable form in which to use the resistance where great economy of space is required. When rolling up the resistance in this form, it may be desirable to also roll a plain sheet of uncoated asbestos next to the coated sheet, which will serve to separate and insulate the coatings from each other. This construction will be readily understood from Fig. III, in which 4 designates the plain sheet of asbestos and 1 designates the coated sheet.

The film of graphite may be of any thickness desired. By spreading on a thick coating of the mixture the conductivity will be greater, while a thinner coating will give less carrying power. This mixture should be evenly spread in order to produce a uniform film.

Having described my invention, what I claim, and desire to secure by Letters Patent of the United States, is—

1. An electrical resistance comprising a non-conducting sheet of material which is coated with a film of rubber and a film of graphite over the rubber.

2. An electrical resistance comprising a sheet of asbestos which is coated with a film of rubber and a film of graphite over the rubber.

3. An electrical resistance comprising a sheet of asbestos which is sized with rubber, and having an external skin of graphite.

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 20th day of October, 1902.

GEORGE I. LEONARD.

Witnesses:

GEORGE T. HACKLEY,

F. M. TOWNSEND.