No. 652,607. Patented June 26, 1900.

M. W. HANKS.

ELECTRIC LIGHTING APPARATUS.

(Application filed Mar. 24, 1899. Renewed Jan. 9, 1900.)

(No Model.)

FIG. 1

FIG. 2

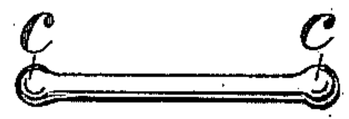


FIG. 3

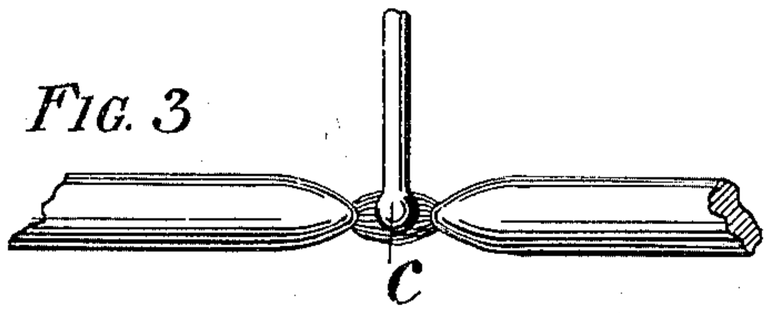


FIG. 4

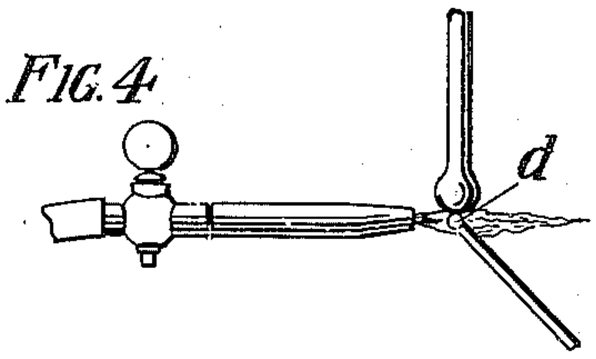


FIG. 5

FIG. 6

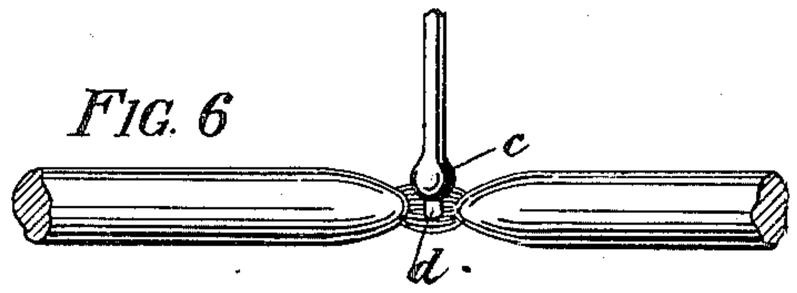


FIG. 7

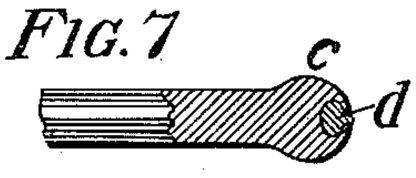


FIG. 8

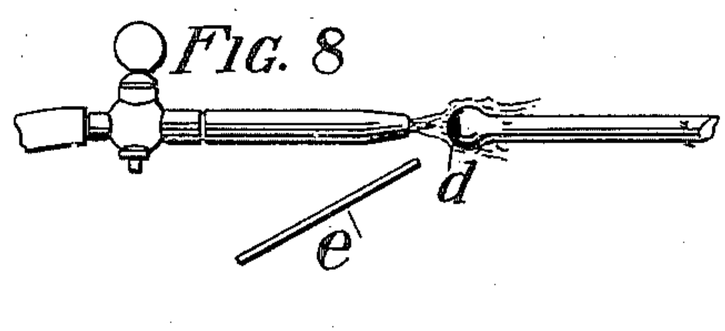
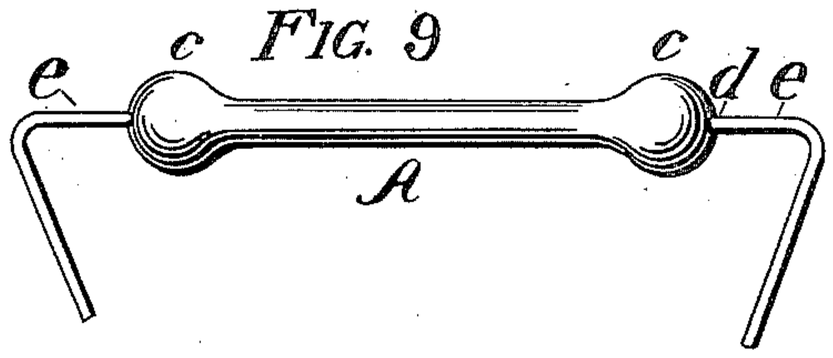


FIG. 9



Witnesses
J. H. Jones
M. A. Esselstyn

Marshall W. Hanks
Inventor

By his Attorney
Charles A. Terry

UNITED STATES PATENT OFFICE.

MARSHALL W. HANKS, OF PITTSBURG, PENNSYLVANIA, ASSIGNOR TO GEORGE WESTINGHOUSE, OF SAME PLACE.

ELECTRIC-LIGHTING APPARATUS.

SPECIFICATION forming part of Letters Patent No. 652,607, dated June 26, 1900.

Application filed March 24, 1899. Renewed January 9, 1900. Serial No. 897. (No model.)

To all whom it may concern:

Be it known that I, MARSHALL W. HANKS, a citizen of the United States of America, and a resident of Pittsburg, in the county of Allegheny and State of Pennsylvania, have invented certain new and useful Improvements in Electric-Lighting Apparatus, of which the following is a specification.

My invention relates to the class of electric-lighting apparatus in which light is emitted by an illuminant or glower composed of a material which is a so-called "non-conductor" when cold, but will conduct electricity when hot and will be maintained in a state of incandescence by the passage of electric currents therethrough. The illuminants or glowers of lamps of this character are composed of the rare earths or mixtures thereof—such, for instance, as zirconium, cerium, yttrium, and the like. These bodies, while offering too great a resistance in a cold state to permit the passage of electric currents at ordinary differences of potential, become, when heated to a dull cherry-red, sufficiently good conductors to receive current at ordinary pressures. In some instances it may be preferable to heat the glowers to a brilliant red, although in ordinary cases the lower heat is sufficient. When once heated to the degree determined upon, the passage of the current itself then rapidly increases their temperature and their conductivity and causes them to give out an intense light. Lamps of this character are now known as "Nernst" lamps, and they will operate in the open air—that is to say, the glowers do not have to be placed in exhausted chambers. In practice it is found desirable to operate them at extremely-high temperatures, for which reason great difficulty has hitherto been experienced in obtaining good and durable electrical connections with the lead-wires. It is the object of the present invention to provide glowers of this sort with terminals having the most intimate connection with the glowers themselves and being at the same time capable of being readily joined to the lead-wires, the whole being of such a nature as to make the connection both lasting and efficient. It has heretofore been proposed to wind a fine platinum wire about each end of the glower and to cover this small coil of platinum wire with a paste formed of materials similar to those of the glower itself. Such terminals are not always reliable and they frequently break away from the glower.

I have found that by heating the ends of the glower in some suitable manner, as by means of an oxyhydrogen flame or an electric arc and melting a small quantity of platinum or other suitable conducting material against the heated end and then subjecting the end with the platinum attached to a very high temperature—as, for instance, in an electric arc—the small body of platinum will embed itself within the end of the glower and form a good electrical as well as a firm mechanical union therewith. The leading-in wires are then readily attached to the glower by causing the embedded conductor to be melted and plunging the ends of the said wires into the melted globule. Before attaching the leading-in wires in this manner, and indeed before causing the little bead of platinum or other conducting material to become embedded in the ends of the glower, I prepare the said ends for the reception of the small bodies of conducting material in some convenient manner. For this purpose I commonly provide the ends of the glowers with enlargements for the purpose of receiving the beads of metal which are to constitute the terminal attachments whereby the glowers are connected up with the lead-wire. These enlargements may be made either by making the glowers in the first instance somewhat longer than they are intended to be when ready for use and afterward shaping the ends up into balls or globules by subjecting them to intense heat, or by applying a paste to the glowers, the paste being composed of one or more of the rare earths, or by molding the balls or globules apart from the glowers and then pressing them into shape on the ends thereof, or finally by electrolytically applying to the ends of the glowers suitable materials for forming the enlargements.

In the drawings which accompany this specification, Figures 1, 2, 3, 4, 5, 6, 7, 8, and 9 illustrate different stages in the manufacture of the glowers and in the process of applying the terminals and attaching the lead-wires.

Referring to the drawings, A, Fig. 1, represents such a glower as has been referred to, this glower being in the present instance made somewhat longer than the completed glower is designed to be. It is made of a mixture of rare earths—such, for instance, as zirconium and yttrium—carefully ground and mixed together to form a paste and then suitably shaped into a small thin rod and afterward subjected to an intense heat. The ends of this rod are then enlarged, preferably by heating the ends of the strip A to a melting condition under the heat, say, of an electric arc, as indicated in Fig. 3, and causing them to gather into balls or globules C, as shown, which constitute enlargements of the glower ends. When the glower illustrated in Fig. 1 has been treated in this way, it appears substantially as shown in Fig. 2, being somewhat shorter in the form illustrated in the last-named figure by reason of the fact that a portion of the material at the ends of the original glower has been built up into the balls or globules appearing as enlargements in the said Fig. 2.

Instead of forming the enlarged ends in the manner just described I may make the original glower of substantially the same length it is intended to have when completed, and I may then apply to the ends thereof a paste composed of one or more of the rare earths. In this manner a bead or enlargement is formed, which is then melted in the electric arc and suitably shaped, as shown in Fig. 3.

Still another mode of supplying the glower ends with enlargements is to prepare the balls, globules, or beads from compounds of the rare earths or mixtures thereof independently of the glower and then press them into shape on the glower, subjecting them to a melting heat upon the ends of the glower, as illustrated in Fig. 3.

The fourth method of preparing a glower for the reception of the conducting-terminal, as above set forth, consists in applying the materials for forming the balls, globules, or beads by an electrolytic process. For this purpose an electrolytic bath is prepared from a solution formed of the compounds of the rare earths, such as the nitrates or the sulfates. The electrolyte is coupled to the positive side of a direct constant-current dynamo, the negative side of which is joined to the glower. The latter is now heated to conductivity and quickly brought into contact with the electrolyte, thus completing the circuit. Naturally the ends only of the glower will in this case be plunged into the bath. By the process described a spongy deposit of the rare earths is formed upon the ends of the glower and the enlargements thus constituted are melted in the arc, as shown in Fig. 3.

Thus far I have described mainly the various methods whereby I prepare the glowers for receiving the conducting-terminals. I may now take any one of the described glowers and complete the process forming the chief subject of the present invention in the following manner: The glower, with its two melted or sintered ends, is now held in an oxyhydrogen flame to be tipped with a bead of platinum or some other good conducting material. Of course this operation may be performed in the electric arc, if so desired. The process of tipping a glower end with a platinum bead is illustrated in Fig. 4, and the glower tipped at both ends with such beads is shown in Fig. 5. When the glower ends have thus been tipped with beads *d d*, of platinum or some other conducting material, as shown in Fig. 5, the said ends, with the platinum attached, are held within the electric arc (see Fig. 6) and thus subjected to intense heat, whereupon the platinum bead assumes the position shown at *d* in Fig. 7—that is to say, the metallic bead has entered into the material constituting the enlarged end of a glower and has become socketed therein in such a manner as to have a very close and intimate connection, serving the purposes both of a strong mechanical union and of an intimate electrical contact. In order to join the leading-in wire *e* to the end of the glower, it is now only necessary to heat the bead *d* of metal within its socket to a molten state and to plunge the end of the lead-wire *e* into the molten globule. This process is illustrated in Fig. 8. When the process has been applied to both ends of the glower, the latter, with the attached lead-wires, has the appearance illustrated in Fig. 9.

As to the employment of platinum for the terminal of the glower, I have found it generally preferable; but in some instances, particularly where relatively-large current densities are used, I have found it advantageous to alloy the platinum with other metals, such as nickel, copper, iridium, manganoxid, and the like. It is also true that under the same conditions I have found it of advantage to mix one or the other of the metals named with the melted bead itself, which forms the enlargement upon the glower end, and this either when the platinum bead is used alone or in alloy with another metal. I have found that terminals attached in this manner form excellent connections with the glower and are very durable and are not easily broken away from the ends of the glower. The platinum or other metal or alloy is partly surrounded by the material of the glower, and any tendency to expand on the part of the platinum under the influence of heat, as well as any tendency to shrink on the part of the glower, only serves to make the union more perfect.

The process of enlarging the ends of the glowers by heating the ends and causing some of the material of the glower itself to form the enlargement is found to be particularly advantageous, inasmuch as when the process is completed there is no undue resistance between the enlarged ends and the body of the glower, whereas if the ends are built up in either of the ways hereinbefore

described there is a possibility of an increased resistance being formed at the junction. The danger of this possibility becoming actual is greatly reduced, if not entirely removed, by the described process of melting the enlargements, as shown in Fig. 3, after they are in place upon the ends of the glowers. When the enlargement is formed out of the glower itself, the total length of the glower becomes somewhat less; but by gaging the length of the glower it may be made of the total proper resistance. The cause of the peculiar action of the globule or bead of platinum or other metal or alloy in passing into the interior of the enlarged end and socketing itself therein when heated in the electric arc I do not here attempt to explain; but by repeated experiments and trials I have found it to be a fact, and the phenomenon is one which lends itself most successfully to the purposes to which I have applied it.

I claim as my invention—

1. A terminal for glowers for incandescent lamps composed of one or more rare earths, the said terminal consisting of a solid body of metal socketed in the end of the glower.

2. A terminal for an incandescent-lamp glower composed of one or more rare earths, the said terminal consisting of a metallic globule socketed within the end of the glower, and a conducting-wire united with the said globule.

3. A glower for incandescent electric lamps, consisting of a central portion composed of one or more rare earths, and enlarged ends having a solid body or bead of metal socketed within each end thereof.

4. A glower for incandescent electric lamps which is a conductor when hot but a non-conductor when cold and having a solid body or bead of metal socketed within each of its ends.

5. In an electric incandescent lamp, a glower composed of a material which is a non-conductor when cold and a conductor when hot, an enlarged end of the glower, a body of conducting material socketed within said end, and a conducting-wire united with said body of conducting material.

6. A glower for incandescent electric lamps consisting of a central portion composed of one or more rare earths and having enlarged ends homogeneous therewith, the said enlarged ends being composed of material which originally constituted isometric prolongations of the central portion and a solid body of metal socketed within each of said enlarged ends.

7. The hereinbefore-described process of attaching lamp-glowers to the lead-wires which consists in securing conducting material to the end of the glower, heating the same in contact with the said end and thus causing the same to embed itself within the glower to form a terminal, and attaching a leading-in conductor to the said terminal.

8. The hereinbefore-described process of forming terminal connections with glowers composed of materials which are non-conductors when cold and conductors when hot, which consists in attaching a conducting material to the end of the glower and causing the said conducting material to socket itself within the said end by applying intense heat to the said conducting material and the glower end.

9. The hereinbefore-described method of attaching a lead-wire to a glower having a solid body or bead of metal socketed in its end, which consists in bringing the said bead or body by heat to a state of complete or partial fusion within its socket, and plunging the end of the lead-wire into the melting or molten metal and permitting the same to cool.

10. The hereinbefore-described process of preparing glowers of non-conducting material for attachment to the leading-in wires which consists in forming enlargements upon the ends of the said glowers, socketing within said enlargements solid bodies of conducting material and attaching to the said solid bodies terminals of good conducting material.

Signed by me at Pittsburg, Pennsylvania, this 21st day of March, 1899.

MARSHALL W. HANKS.

Witnesses:

WESLEY G. CARR,

H. C. TENER.