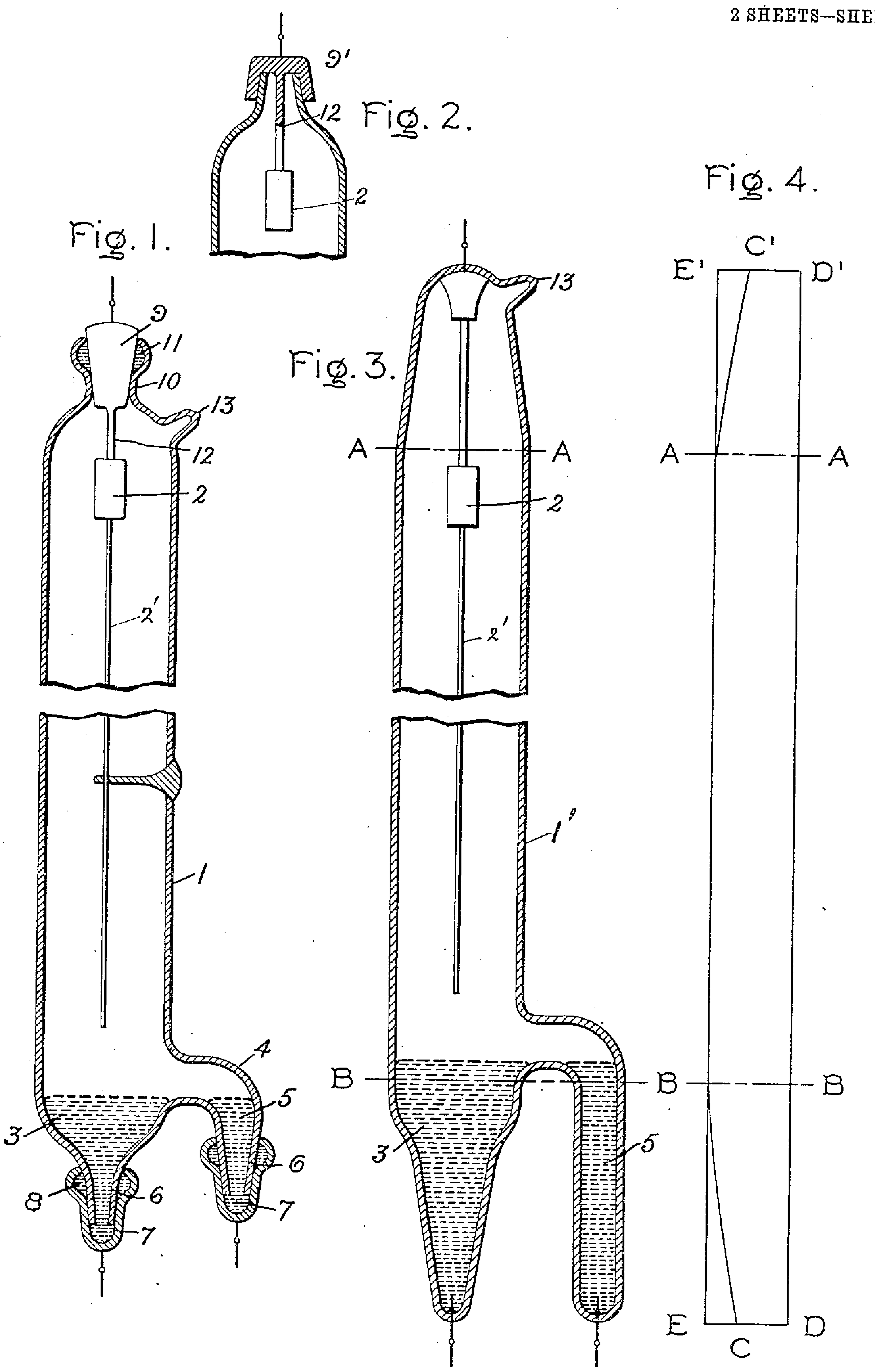
C. P. STEINMETZ.

ELECTRIC LAMP AND METHOD OF MAKING THE SAME.

APPLICATION FILED NOV. 17, 1902.

910,736. Patented Jan. 26, 1909.

2 SHEETS—SHEET 1.



Witnesses.

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2 SHEETS—SHEET 2.

Fig. 5.

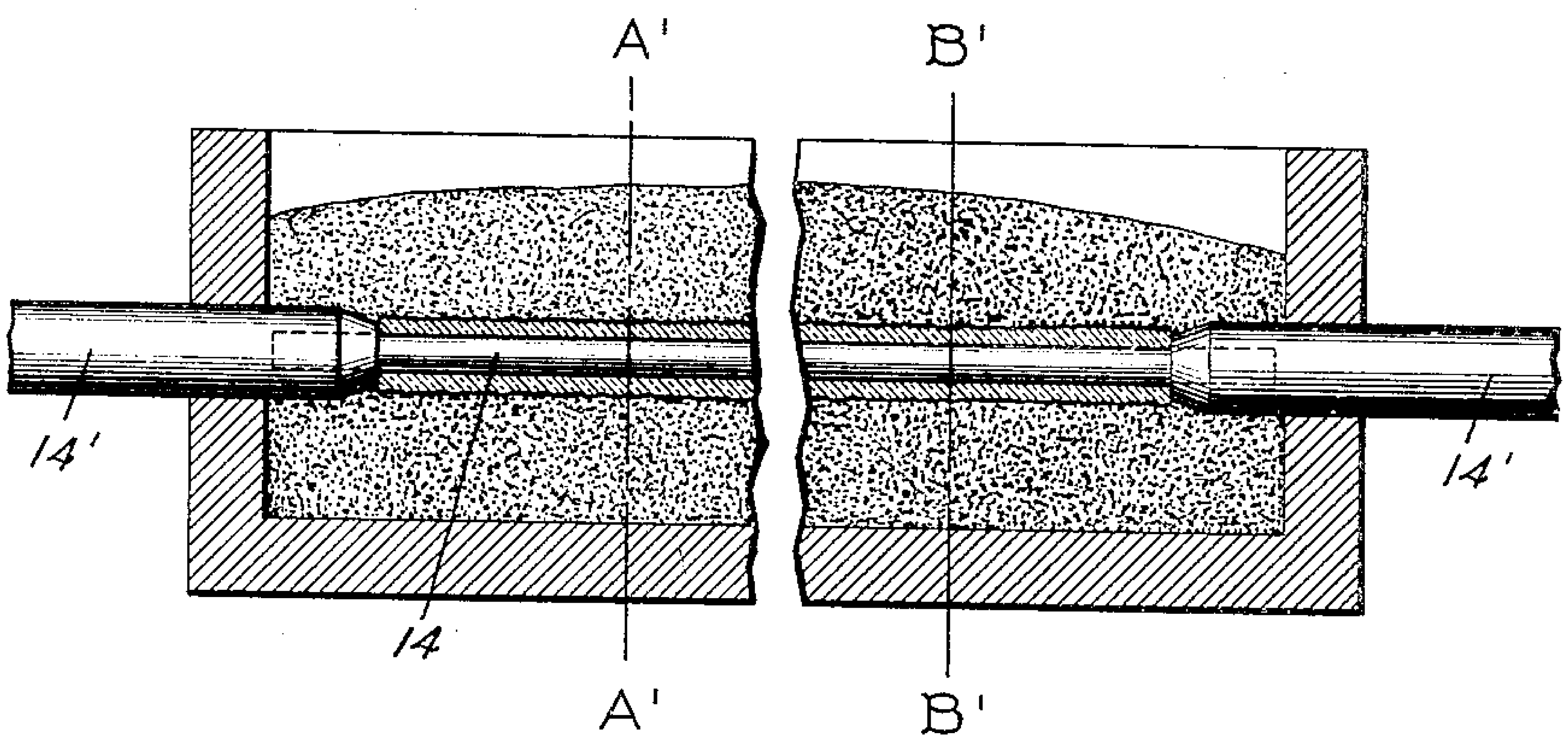
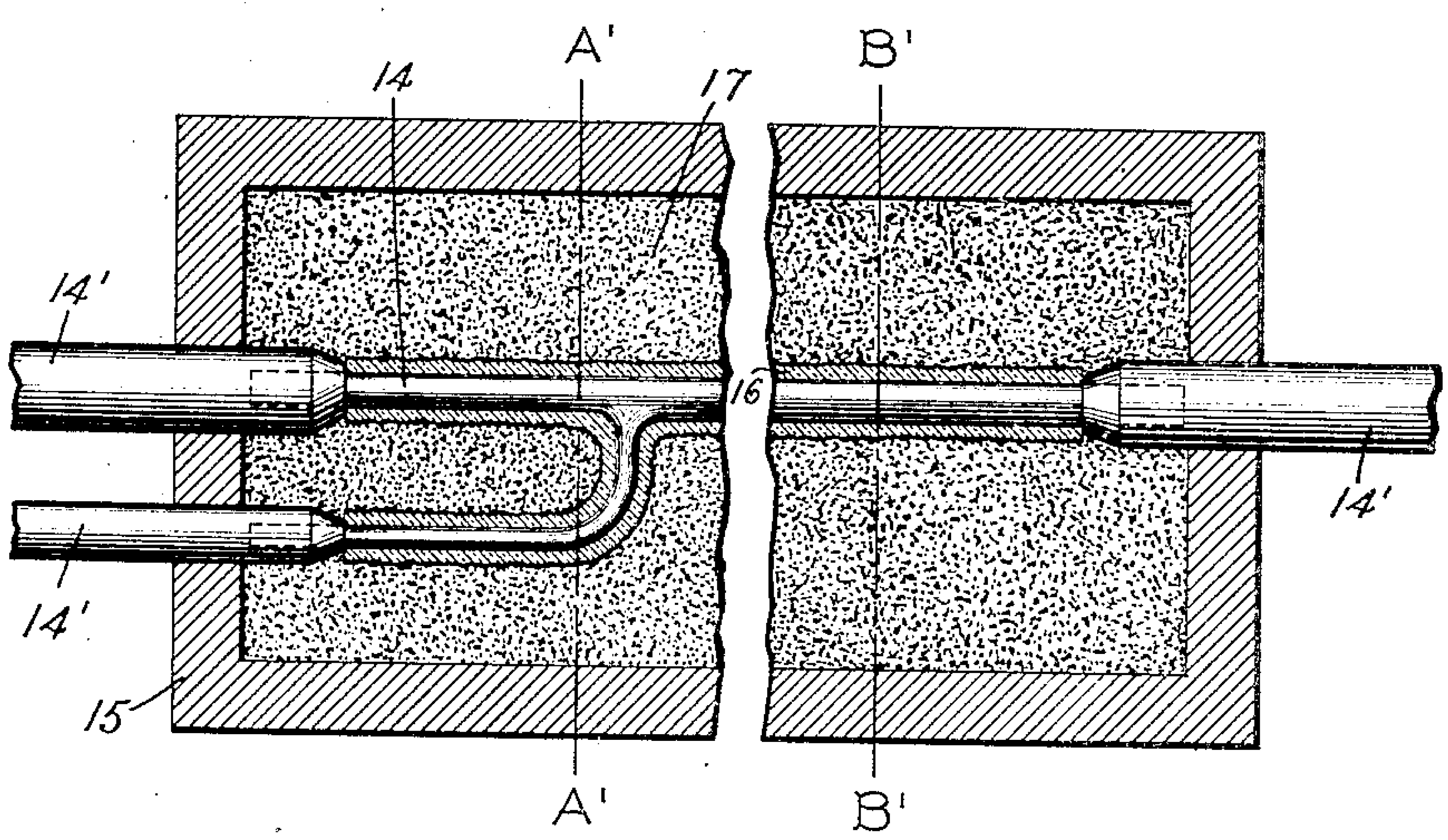


Fig. 6.



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UNITED STATES PATENT OFFICE.

CHARLES P. STEINMETZ, OF SCHENECTADY, NEW YORK, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

ELECTRIC LAMP AND METHOD OF MAKING THE SAME.

No. 910,736. Specification of Letters Patent. Patented Jan. 26, 1909.

Application filed November 17, 1902. Serial No. 131,650.

To all whom it may concern:

Be it known that I, CHARLES P. STEINMETZ, a citizen of the United States, residing at Schenectady, county of Schenectady, State of New York, have invented certain new and useful Improvements in Electric Lamps and Methods of Making the Same, of which the following is a specification.

I have found that the operation of electric lamps of that type of which the so-called mercury arc lamp is the best known example is much improved if they are run at higher temperatures than those which have heretofore been practiced. If mercury be employed as the volatile electrode the color of the light improves as the temperature of the lamp increases. Moreover, if the lamp is run at a higher temperature other substances, such as lithium, potassium, magnesium, sodium, and various combinations of these metals may be added to the mercury by which the quality of the light can be still further improved. In place of using mercury or substances containing mercury, other materials having a comparatively low boiling point may be employed to form the vaporizing electrode of the lamp. If these substances are employed in the vapor arc lamp running at the temperatures which have heretofore been commonly employed, the advantages due to their light-giving power are only partially obtained as the temperature is not high enough to volatilize them in sufficient quantities. Another advantage, which results from the employment of high temperatures in lamps of this character, is due to the fact that with such temperatures, the drop in voltage between the lamp terminals necessary in order that the lamp may be used on ordinary circuits can be obtained with a tube which is considerably shorter than those heretofore employed. The limit to the temperature at which it has heretofore been possible to run these lamps has been given by the heat-resisting power of the glass tube forming the walls of the exhausted chamber in which the terminals of the lamp are placed. I have found that if the wall or walls of the exhausted chamber, or at least of that portion of it surrounding the light giving arc, are made out of fused quartz, the temperature at which the lamp can be operated is greatly increased, and that thereby the above noted advantages due to such an increase in temperature can be obtained. Tubes formed of fused quartz will stand heating to a much higher temperature without softening than will glass tubes, moreover rapid and extreme changes of temperature do not have the tendency to crack the tubes which exists with glass tubes under such conditions.

In the accompanying drawings I have illustrated several embodiments of my invention.

In the drawings Figure 1 is a sectional elevation showing one construction of lamp; Fig. 2 is a partial sectional elevation showing a slightly modified construction; Fig. 3 is a sectional elevation showing a somewhat different construction of lamp; Fig. 4 is a diagram showing the relative proportion of the different materials composing the lamp tube shown in Fig. 3; Fig. 5 is a sectional elevation showing apparatus employed in the manufacture of lamp tube shown in Fig. 3; and Fig. 6 is a plan view showing the same apparatus.

In the construction shown in Fig. 1, a light-transmitting tube 1 made out of fused quartz forms the inclosing chamber of my lamp. A solid terminal 2 is placed at the upper end of the tube. At the lower end of the tube a mass of material 3, such as mercury, or a mercury amalgam containing various substances which vaporize at the temperature employed, or the like, is placed and forms the other main electrode. The tube 1 is provided at its lower end with an off-shoot 4 and in this off-shoot 4 is placed another mass 5, similar to the mass 3, forming an auxiliary or starting electrode. The lower end of the tube 1 and the off-shoot 4 are shaped to form comparatively small tapered necks 6, and on the outside of these tapered necks are fitted caps of metal 7. The outer surface of the necks 6 and the interior surface of the caps 7 may be ground to form air-tight joints. The metal caps are in electrical contact with the mercury and have suitable current-carrying leads connected to them. The metal out of which I form the caps 7 is a mixture of nickel with iron or steel, the amount of nickel in the composition being about 35% to 37%. I employ this mixture as its thermal coefficient of expansion is approximately equal to the thermal coefficient of expansion of the quartz, which is very small, being much less than that of glass.

I employ the joint described owing to the difficulty of making a sealed joint such as is employed with glass tubes due to the effect on the metal of the very high temperature which it is necessary to employ to fuse the quartz. I have shown the caps 7 provided at their upper ends with a space 8 in which a quantity of mercury may be placed. This forms a mercury seal which tends greatly to improve the tightness of the joint made at this point. The solid electrode can be formed of a mass of iron or carbon and is carried by a tapered plug 9 of metal of the same composition as that employed to form the caps 7. The tube is ground interiorly at 10 and the plug 9 is inserted to make a tight fit. Above the portion 10 the end of the tube may be flared to form a chamber 11 in which a quantity of mercury is placed to seal the joint. The terminal 2 may or may not be integral with the tapered plug 9. Preferably the terminal 2 and the plug 9 are connected by a portion 12 considerably smaller in diameter than the terminal 2 in order that the heat conducted from the terminal 2 to the plug 9 may be diminished. The tube 1 is exhausted in the same manner as has heretofore been employed in exhausting glass tubes. At 13 I have indicated the fused off exhaust tube.

In Fig. 2 I have shown a slightly different method of closing the upper end of the tube. In this construction a cap 9′, similar to the cap 7 shown at the lower end of Fig. 1, is employed at the upper end of the tube. The solid terminal 2 is connected thereto by a slender portion 12 as in Fig. 1. The upper end of the quartz tube may be shaped to receive a mercury seal, if desired.

Instead of forming the tube entirely of quartz and forming metallic end connections as above described, the tube may be made with its body portion of fused quartz and its end portions of some different substance into which metallic leading-in wires can be fused in the ordinary manner heretofore practiced in making tubes for lamps of this character. In Fig. 3 I have shown a lamp of this character similar in its general arrangement to the lamp shown in Fig. 1, but in which the portion of the lamp tube 1′ between the lines A A and B B is formed of fused quartz, while the terminal portions beyond the lines A A and B B respectively are formed of a material containing silica, united with various other substances; for instance, potassium and calcium hydroxid may be added to the fused quartz to make the terminal portions of the lamp. The potassium and calcium hydroxid or other substances, which are united with the silica to form the terminal portions of the tube, should be added in such manner that the proportion of these substances should vary from zero at the lines A A and B B respectively to an amount sufficient to form a glass into which a platinum wire can readily be sealed, as shown, and having practically the same thermal coefficient of expansion as platinum at the end.

In Fig. 4 I have shown a diagram illustrating the proportion of the materials in the composition of the tube 1′. In this diagram the line D D′ is equal to the length of the tube 1′ and the amount of quartz which is found in the tube at any point along its length is proportional to the distance between the line C B A C′ and the line D D′ at the corresponding point. The amount of other materials employed to form the terminal portions of the tube are indicated by the distance between corresponding points on the line C B A C′ and on the line E B A E′. It will of course be understood that the quartz and other materials are intimately mixed and are not separated by any distinct line of cleavage as might appear from the diagram. With a tube as thus constructed, the mechanical resiliency of the tube is sufficient to take up the difference in the thermal expansion of the tube at the lines A A and B B respectively and the points where the terminal wires are sealed in.

In forming the lamp tubes above described, the following method may be followed: A refractory conductor such as carbon may be embedded in a mass of quartz granules or silica in other finely divided states. On the passage of a heavy electric current through the conductor, heat is produced sufficient to fuse the quartz in the vicinity of the conductor, whereupon when the conductor is cooled a shell of fused quartz is formed surrounding the conductor. In Figs. 5 and 6 I have illustrated an arrangement by which such tubes may be formed. In these drawings the carbon-heating conductor 14 has substantially the shape which it is desired to give the inside of the tube. The conductor 14 is connected at its ends to heavy metallic conductors 14′ which are mounted in the wall 15 of the furnace chamber. Filling the lower part of the chamber 15 and surrounding the conductor 14 is a mass of the material which it is desired to fuse in order to form a tube. At 16 I have indicated the appearance of such a tube after forming.

When the tube is formed entirely of fused quartz as in Fig. 1 it will of course be understood that the material 17 surrounding the conductor or core 14 is all silica, but when it is desired to form a tube like that in Fig. 3 the material surrounding different portions of the core will be different. Only that portion of the heating chamber between the lines A′ A′ and B′ B′, which correspond in position with reference to the tube to the lines A A and B B of Fig. 3, will be filled with quartz alone. Portions between the lines A′ A′, B′ B′ and the adjacent ends of the casing will be filled with a mixture containing other materials: That is, with the tube above described, the quartz will be mixed with potassium and calcium hydroxid and the mass of potassium and calcium hydroxid will be graduated in the space between the lines A′ A′ and B′ B′ and the adjacent ends of the casing as indicated in Fig. 4

The rough tube-blank obtained in the heating chamber may have the carbon core burned out and be worked into a finished form by heating in the electric arc or other source of great heat.

The operation of the lamp is as follows: At starting, the solid terminal 2 and the vaporizing terminal 5 are connected to one side of the supply circuit, while the main vaporizing terminal is connected to the other side of the line. If, now, the tube be agitated slightly so as to cause the metal forming the terminal 3 to contact with metal forming the terminal 5, an initial vaporization takes place and the vapor thus formed enables the current to pass from the terminal 3 to the terminal 2. After starting, the auxiliary terminal may be cut off if desired. The terminal 2 may have an extension 2′ preferably formed of a carbon filament depending from it to a point slightly above the surface of the mercury 3 to assist in starting the arc if desired.

If the substance employed to form a vaporizing compound is not fluid at ordinary temperatures, other means for starting the lamp may be employed, as for example those shown in British Patent #5545 of 1903.

While I have illustrated and described the best form of my invention which is now known to me, I do not intend to be limited to the details of construction shown and described as I consider my invention in its broader aspects to be independent of such features of construction and to consist in an inclosing chamber for electric lamps made out of fused quartz.

In a divisional application, Serial No. 455,110, filed September 28, 1908, claims are made on an envelop having a body portion of fused quartz and an end portion of a different material.

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

1. In a vapor electric device, an inclosing chamber formed out of fused quartz and provided with means for conducting current thereinto.

2. In a vapor electric device, an inclosing chamber formed out of fused quartz, and connections therefor formed out of a composition of nickel and steel.

3. In a vapor electric device, an inclosing chamber formed out of fused quartz, and connections therefor formed out of compositions of nickel and steel or iron, the nickel forming about 37% of the composition.

4. In a vapor electric device, an inclosing chamber having the portion subjected to the heating action of the vapor arc formed out of fused quartz.

5. In a vapor electric device, an exhausted chamber the light-transmitting walls of which are made of fused quartz, said chamber having means for conducting current thereinto.

In witness whereof, I have hereunto set my hand this 15th day of November, 1902.

CHARLES P. STEINMETZ.

Witnesses:

BENJAMIN B. HULL,

HELEN ORFORD.