N° 4803 A.D. 1900

(*Under International Convention.*)

Date claimed for Patent under Sect. 103 of Act, being date of first Foreign Application (in United States), } *25th Aug., 1899*

Date of Application (in United Kingdom), 13th Mar., 1900

Complete Specification Left, 13th Mar., 1900—Accepted, 23rd Feb., 1901

COMPLETE SPECIFICATION.

Improvements in Electric Incandescent Lamps.

I, REGINALD AUBREY FESSENDEN, of Lafayette Street, City of Allegheny, County of Allegheny, State of Pennsylvania, United States of America, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed to be particularly described and ascertained in and by the following statement;—

The invention described herein relates to certain improvements in pencils for that class or kind of electric lamps in which is employed a pencil formed of a material non-conducting at low temperatures, but conductive when heated, the conductivity increasing with increase in temperature. As these pencils must be heated to a high temperature in order to obtain sufficient light, it has been necessary to form the terminals of a material, such as platinum, indestructible except at excessively high temperatures. The great expense of that character of terminals has nearly prohibited the use of this form of lamp.

The object of the present invention is to provide for the use of terminals formed of a material other than such as is non-oxidizable at high temperatures.

This invention also relates to means for forming a path for the electric current along the surface of the pencil and provides for such a regulation of the current as will prevent any greater flow of current through the pencil than is necessary to maintain it at the desired point of incandescence.

In the accompanying drawings, forming a part of this specification, Figure 1 is an elevation of my improved pencil. Figure 2 is a sectional view of the same. Figure 3 is a sectional view of a modified form of terminal. Figure 4 is a detail view of the terminal shown in Figure 3. Figure 5 is a side elevation of a pencil having its terminals formed of graphite, and Figure 6 is a sectional view of the same.

Figure 7 is a sectional elevation of a lamp made in accordance with this invention. Figures 8 and 9 are sectional detail views of parts of the structure shown in Figure 7. Figure 10 is an enlarged detail view of one form of current regulator, and Figure 11 is a similar view illustrating another form of regulator.

In the practice of my invention the body or central portion 1 of the pencil is formed of a material—as, for example, thoria, magnesia, or kaolin—which at normal temperatures will not conduct electric currents, but when heated becomes conductive, the conductivity increasing with increase in temperature. The ends 2 of the pencil are formed of a composition which becomes a conductor at a lower temperature than the other material—as, for example, a mixture of thoria, and

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magnesium chloride or magnesia and magnesium chloride or a mixture of thoria and magnesia. It is preferred to so prepare the end portions that the quantity of the material which becomes a conductor at lower temperatures shall increase gradually from the point of junction with the body portion and that there shall be an excess of such material at the ends of the portions 2. In such a pencil, the conductivity will increase gradually from its body portion to the ends. While it is preferred to graduate the material composing the portions 2 in the manner stated, these portions may be made of uniform composition throughout. A mixture consisting of ten *per cent.* of chloride of magnesium and ninety *per cent.* of magnesia for the portions 2, while the body portion 1 is formed of magnesia, gives very good results; but I do not limit myself to these proportions nor to the materials stated, as I have obtained very good results in using other materials having the characteristics stated. By thus increasing the conductivity at lower temperatures of the ends of the pencil these portions will not become so highly heated, and terminals formed of nickel or an alloy of nickel and iron or copper or other materials which are oxidizable at high temperatures may be employed, as the ends 2 of the pencil will not, by reason of their conductivity at the lower temperatures, be heated sufficiently high to destroy the metal terminals.

The metal terminals may be made in the form of flat strips 3, having one end embedded in the end portions 2 of the pencil. At least a portion of these strips should be made of a width equal to the width of the end portions or otherwise so constructed that an edge of the strip will be flush with the surface of the pencil in order that the terminals may be connected by a strip or film of conducting material laid along the surface of the pencil. As the path or film of conducting material is preferably formed by rubbing a block of such material along the pencil, the block would not come in contact with the edges of the metal terminals if they are materially within the surface of the pencil, and if such edges should project materially beyond the surface of the pencil the block of conducting material would be raised from the surface of the pencil when passing over the projecting edges of the terminals.

In lieu of the construction shown in Figures 1 and 2 the metal terminals may be made in the form of a split washer or ring 4, which is bent to form a spiral, as shown in Figures 3 and 4. The ring or washer is made of an external diameter equal to the external diameter of the pencil, so that its edge will be exposed and flush with the surface of the pencil. The terminals may be connected in any suitable way to the wires of the circuit; but in using the rings or washers it is preferred to form axial holes or sockets 5 in the end portions 2 for the reception of pins 6, said holes extending beyond the rings or washers. The hole or opening through the washer is made of such a size or shape that the ends of the pins will bear against and have electric contact with the washer.

In lieu of the metal the terminals may be formed of graphite, which may be made in the form of short rods 7 and connected to the end portions in any suitable manner—as, for example, by forming a boss 8 on one of the parts to be connected, preferably the graphite terminal, and embedding the boss in the other part, preferably the end portions 2, as shown in Figures 5 and 6.

If desired, electrical connection between the terminals and the end portions may be made by adding graphite to the material of such end portions in increasing quantities, the ends being entirely of graphite. The graphite terminals may be constructed in any desired manner for connection to the circuit— as, for example, sockets may be formed in the terminals 7 for the reception of rods 6, forming the terminals of the circuit.

Referring to Figure 7, the pencil supporting pins 6, are mounted in suitable bearings 18, preferably formed of insulating material and secured to the sides of the dome-shaped shell 19, which has its inner surface highly polished. One of the pins, projects through the case or shell and is so mounted in its bearings as to be capable of longitudinal as well as rotary movement and is held in normal

position, so as to support one end of the pencil 1 by a spring 21, surrounding the pin and bearing at its ends against the bearing 18, and a disc 22, formed of insulating material and secured on the pin.

If spiral washers are used for the terminals the pitch of the spiral preferably corresponds with the pitch of the threads on a shaft 24, which has its ends mounted in bearings 25, secured to the shell 19, and has an internally threaded carrier block 26, mounted thereon. A block 27, formed of graphite or other conducting material neutralizable as regards its capability of conducting electric currents at high temperatures, is attached to the carrier block preferably by a spring 28 or by any other suitable means, whereby the connecting material may be held in rubbing contact with the pencil. The shaft 24 may be rotated so as to cause the block of conducting material to traverse the pencil by any suitable means; but as it is preferred to cause the pencil to rotate during the traverse of the block pinions 29 and 30 are secured, respectively, on the shaft 24 and one of the pins 6, said pinions intermeshing with a driving pinion 31, secured on one end of a shaft 32, which projects through a suitable bearing 33 and has a knob 34 secured to its outer end. As shown in Figure 9, the pinion 30 is insulated from the pin 6. The carrier block may be held against rotation with the shaft 24 by any suitable means—as, for example, by a rod 35, secured at its ends to the shell 19 and passing loosely through an upward extension of the carrier-block.

The feed wires 36 are attached to contact plates 37 and 37ª, secured to insulating blocks attached to the shell, and corresponding contact plates 38, 38ª are attached to the discs 22 and 22ª on the pins 6. As the pins 6 are electrically connected to the contact plates 38, 38ª, the rotation of the pins will complete the circuit through the pencil. The contact plates 37, 37ª and 38, 38ª are so constructed and arranged that the latter can slide past the plates 37, 37ª when the discs 21 and 22 are rotated.

By the rotation of the driving pinion 31 the block 27, of graphite, will be caused to move along the pencil, which is also rotated, so that a spiral band or, if the block 27 is sufficiently long, a complete coat of graphite will be applied to the pencil. As the edges of the metal terminals 23 are exposed and flush with the surface of the pencil, a conductor will be formed along the surface of the pencil from terminal to terminal. The passage of the current along the conductor will heat the pencil sufficiently to render it conducting. As soon as the pencil is raised to a high heat the material used to form a conducting path will be destroyed or rendered neutral, so that the entire current will pass through the pencil.

Although it may require several rotations of the shaft 24 to effect the end to end traverse of the carrier block, the meeting of the contact plates will not close the circuit, as no current can pass until a conducting path is formed from terminal to terminal.

It is preferred to place the blocks 39, formed of non-conducting material, on the pins 6, adjacent to the ends of the pencils, to serve as supports for the block 27.

In order to prevent any increased flow of current beyond that necessary to maintain the pencil at the desired incandescence, a portion 40 of the circuit is formed of a material whose conductivity will be suddenly and abnormally reduced by the passage of a greater current than that which such portion of the conductor is proportioned to carry. It is immaterial what change, molecular or otherwise, is produced in such portion, provided that after the flow of current is reduced to or below normal such portion of the circuit will resume its original condition.

In the form illustrated in Figure 10 the portion 40 of the circuit is formed by a piece of lead wire of suitable size to permit, without material molecular or other elemental change, the necessary passage or flow of the amount of current for maintaining the desired incandescence of the pencil. As soon as the pencil is heated to the desired point, and thereby assumes a condition permitting of

a greater flow of current, the wire will become softened by such increased flow and present a greatly and suddenly increased resistance, so that less current will flow through the pencil, thereby permitting a cooling down of the pencil. Such cooling down of the pencil will further increase the resistance in the circuit, thus reducing the current flowing through the portion 40, thereby permitting it to resume practically its normal condition and the consequent restoration of practically the normal flow of current through the pencil and its restoration to normal incandescence. In order to prevent the rupture of the lead section when softened by an increased flow of current, it is enclosed in a tube 42, formed of a material, such as glass, which will not serve as a conductor and capable of withstanding the temperature to which the lead is heated. In lieu of the lead any other material which will be so changed elementally or molecularly by a slightly abnormal flow of current as to present an abnormally and suddenly increased resistance may be employed. Such a material is found in an alloy of nickel 20 parts iron 10 parts and copper 70 parts. It is characteristic of this alloy that its resistance increases abnormally at a certain point when heated, so that if a portion, as 40 (see Figure 11) of the circuit be formed by a wire of alloy it will operate to prevent any abnormal flow of current to the pencil. As under the conditions of use the current will be restored to practically normal conditions in the manner heretofore stated before the wire 40 can be melted, no protecting or retaining tube need be employed. The portion 40 of the circuit is so proportioned that with a normal flow of current its resistance will not be abnormally affected—that is to say, the increase in resistance with normal flow will not be greater than that calculated by using the temperature coefficient of resistance as given in the text books; but it will be so raised in temperature or otherwise affected by the normal current that a slight increased flow of current will produce a softening or such other molecular change that there will be a sudden increase in the temperature coefficient of resistance due to such increased flow.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed I declare that what I claim is:—

1. A pencil for incandescent lamps having its body portion formed of a material which will be conductive only when heated, and its end portions formed of a material which becomes conductive at a lower temperature than the body portion, substantially as set forth.

2. A pencil for incandescent lamps having its body portion formed of thoria, and its end portions of a mixture of thoria and chloride of magnesium, substantially as set forth.

3. A pencil for incandescent lamps having its body portion formed of a material conductive only when heated, and its ends formed of a material conductive at a lower temperature than the body portion, the conductivity of the end portions gradually increasing from the junction with the body portion outward, substantially as set forth.

4. A pencil for incandescent lamps formed of a material conductive only when heated and provided with metal terminals embedded in the pencil, a portion of the terminals being exposed and flush with the surface of the pencil, substantially as set forth.

5. A pencil for incandescent lamps having its body portion formed of a material conductive only when heated, and its end portions formed of a material conductive at a lower temperature than the body portion, and provided with terminals formed of a metal oxidizable at high temperature, substantially as set forth.

6. A pencil for incandescent lamps formed of a material conductive only when heated, in combination with spirally shaped discs formed of metal and embedded in the pencil, the edges of the disc being exposed and flush with the surface of the pencil, substantially as set forth.

7. A pencil for incandescent lamps consisting of a body portion, conductive only when heated, intermediate of portions conductive at a lower temperature than the body portion and provided with terminals formed of graphite, substantially as set forth.

8. In an incandescent lamp, the combination of a pencil non-conductive at low temperatures, but conductive at high temperatures, a carrier for a conducting material neutralizable at high temperatures, and means for causing the carrier to move along the pencil, substantially as set forth.

9. In an incandescent lamp, the combination of a pencil non-conductive at low temperatures, but conductive at high temperatures, a carrier for a conducting material neutralizable at high temperatures, and means for simultaneously rotating the pencil and shifting the carrier along the pencil, substantially as set forth.

10. In an incandescent lamp, the combination of two rotatable pins adapted to support and rotate a pencil, a threaded shaft, a carrier-block mounted on the shaft and means for simultaneously rotating the shaft and pins, substantially as set forth.

11. In an incandescent lamp, the combination of a pencil or body adapted to be highly heated by the passage of an electric current, and a resistance automatically increasable to an abnormal extent by a slight increase of current above the normal, connected in series with the pencil, substantially as set forth.

12. In an incandescent lamp, the combination of a pencil or body adapted to be highly heated by an electric current, and a circuit therefor, a portion of said circuit being formed by a conductor adapted to carry a normal current without material change and to present abnormally-increasing resistance on a slight increase of current above the normal in the circuit, substantially as set forth.

13. In an incandescent lamp, the combination of a pencil or body adapted to be highly heated by an electric current and a circuit therefor, a portion of said circuit being formed of lead adapted to carry the normal current without material change and to be so heated as to present an abnormally-increased resistance on a slight increase of current above normal substantially as set forth

Pittsburg, Pa., U.S.A., January 31st 1900.

REGINALD AUBREY FESSENDEN.

Signed in the presence of:
DARWIN S. WOLCOTT.
F. E. GAITHER.

Redhill: Printed for His Majesty's Stationery Office, by Malcomson & Co., Ltd.—1901.

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FESSENDEN'S Complete Specification.

(4 SHEETS)

SHEET 1

FIG. 1.

FIG. 2.

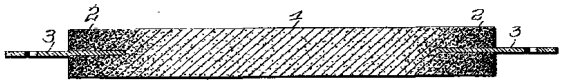

FIG. 3.

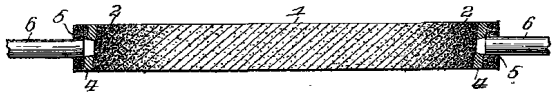

FIG. 4.

SHEET 2

FIG. 5.

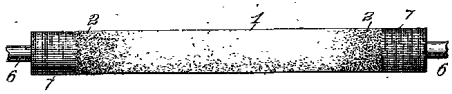

FIG. 6.

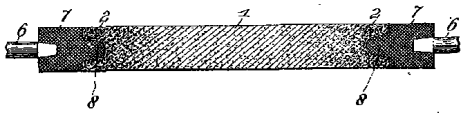

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FIG.1.

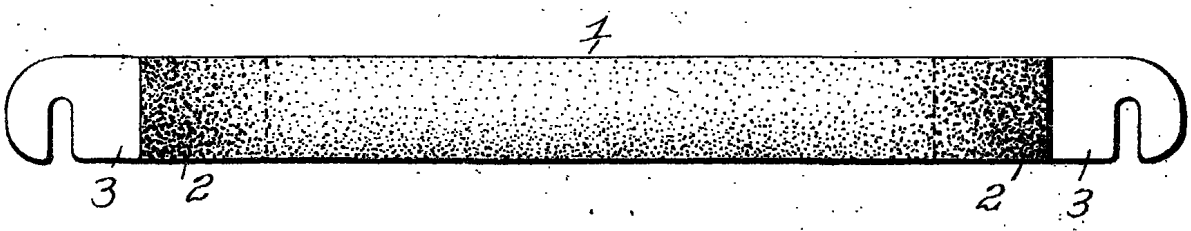


FIG.2.

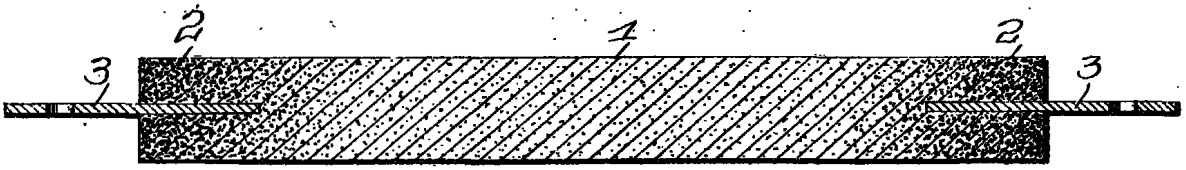


FIG.3.

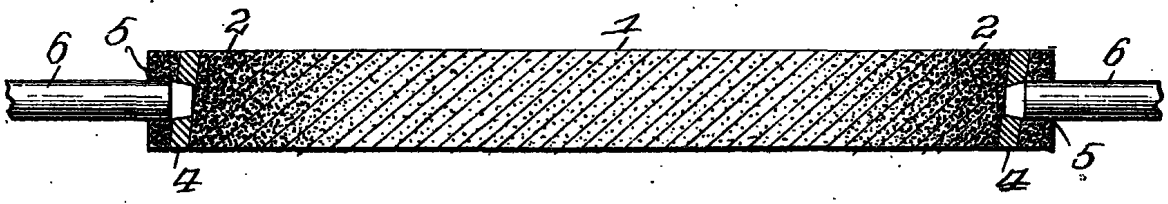


FIG.4.

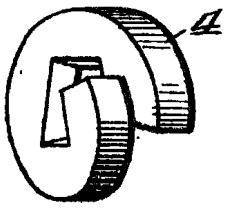


FIG. 5.

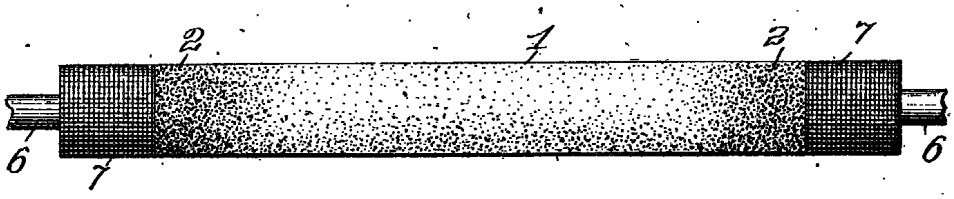
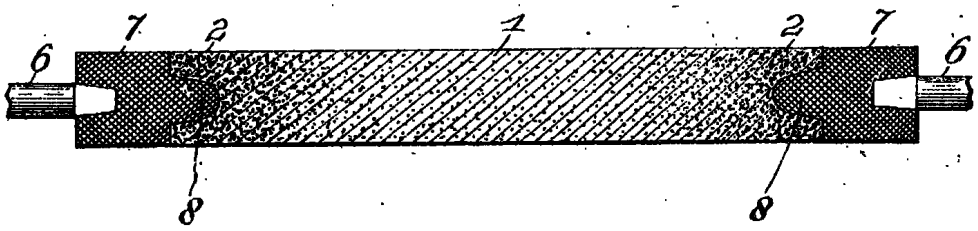


FIG. 6.



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FESSENDEN'S Complete Specification.

SHEET 3

FIG. 7

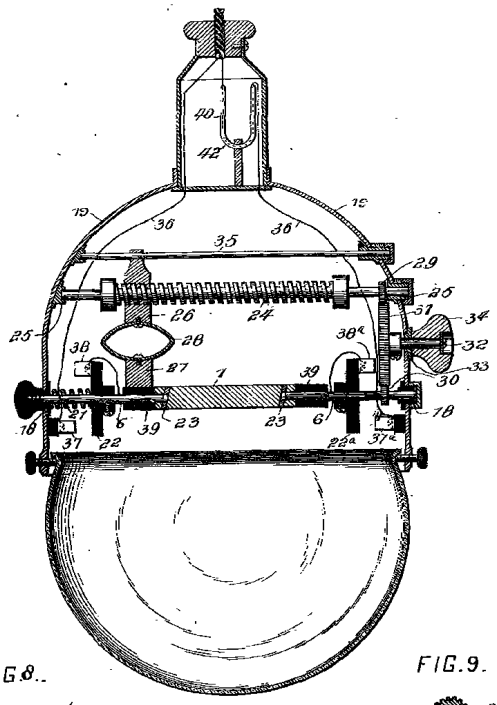

FIG. 8.

FIG. 9.

SHEET 4

FIG. 10.

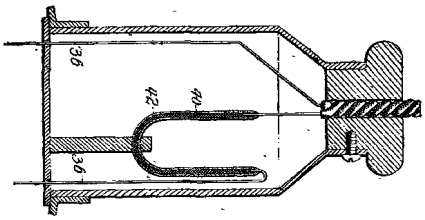

FIG. 11.

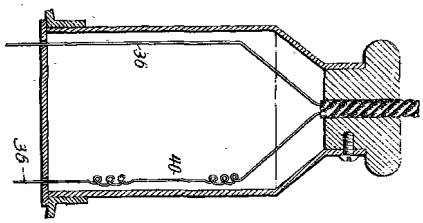

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FIG. 7.

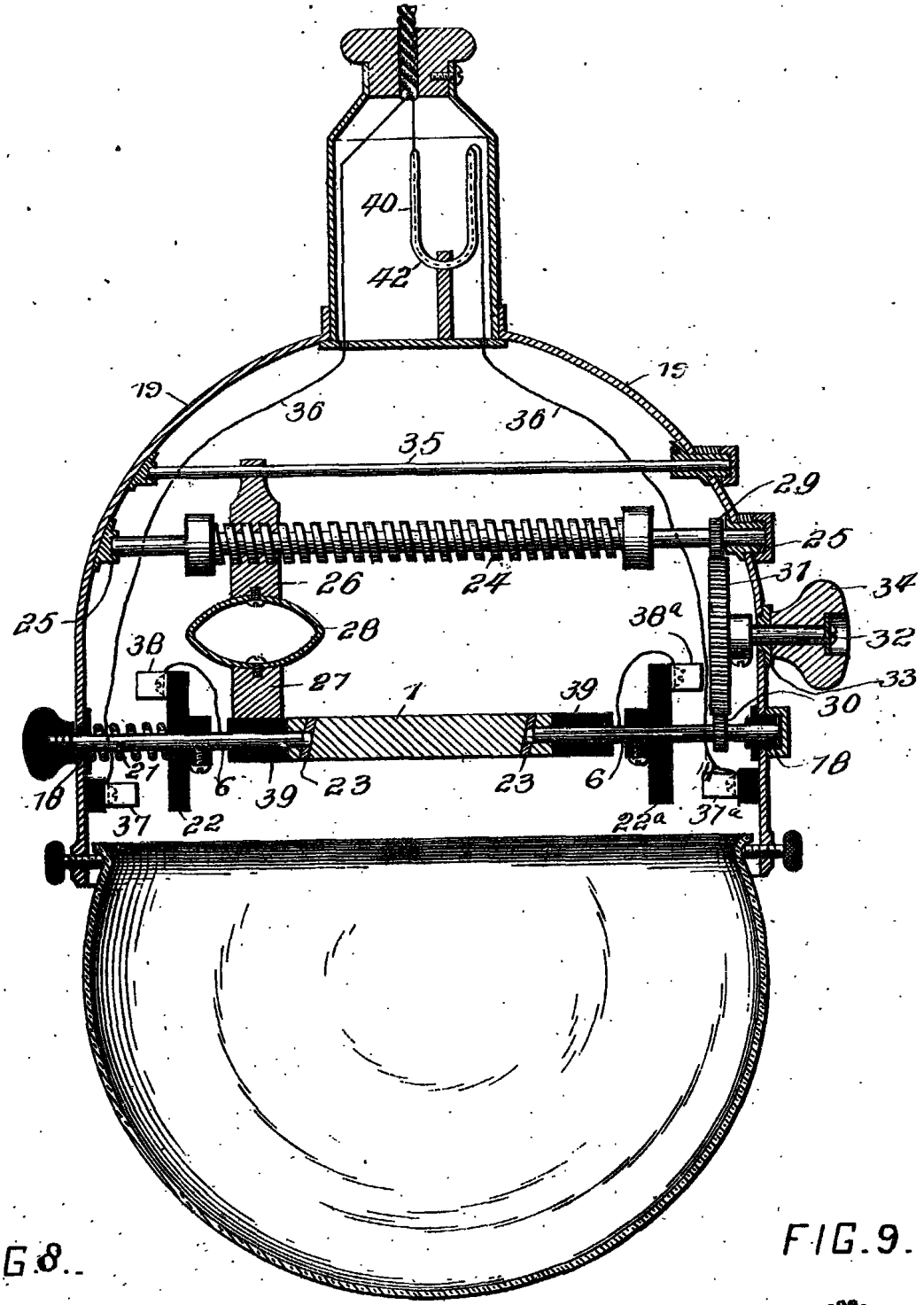


FIG. 8.

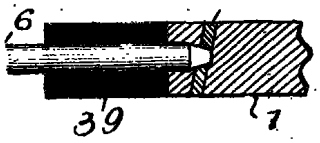


FIG. 9.

FIG.10.

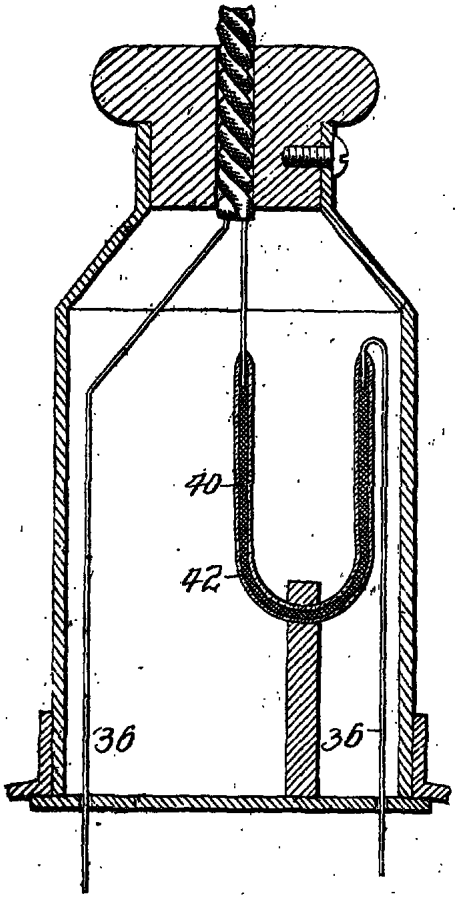
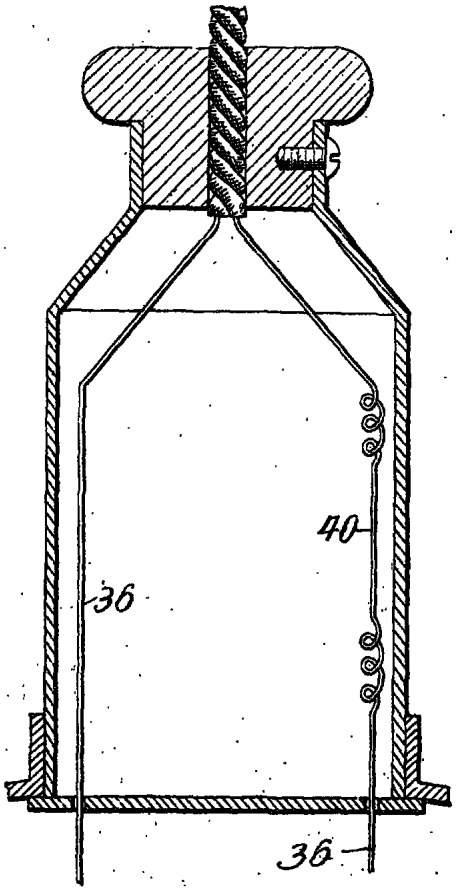


FIG.11.



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