March 6, 1934. J. McCULLOUGH 1,949,545

MERCURY ARC

Filed July 29, 1932

Fig. 1.

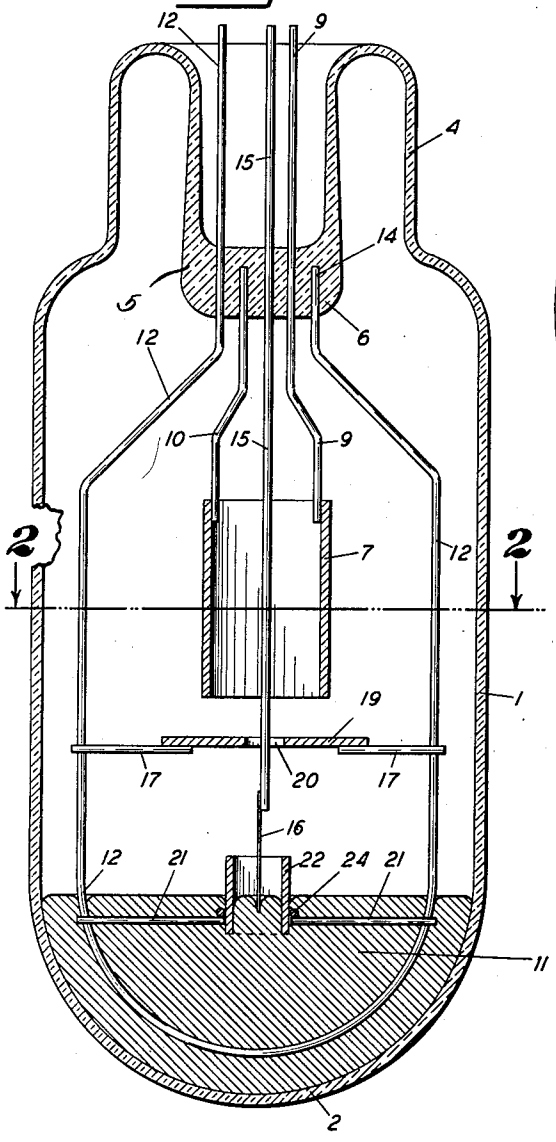


Fig. 2.

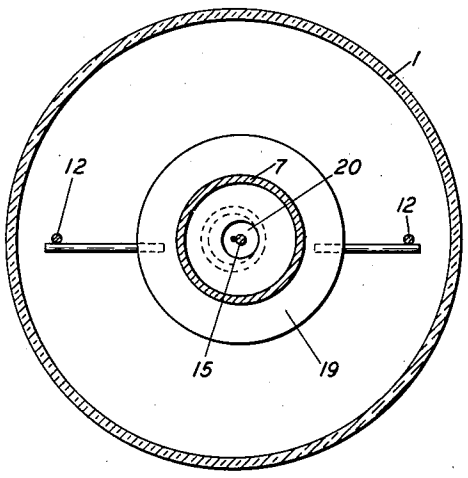
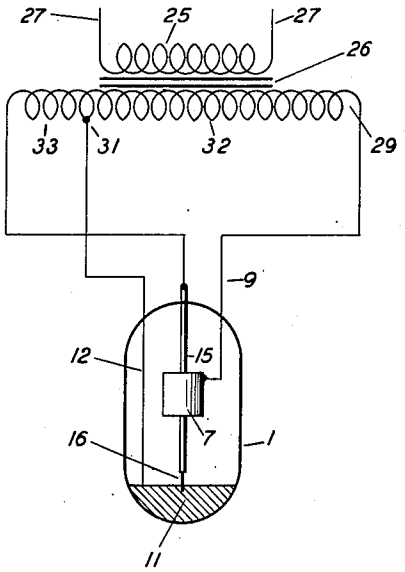


Fig. 3.



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MERCURY ARC

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Application July 29, 1932, Serial No. 625,907

3 Claims. (Cl. 176—49)

My invention relates to a mercury arc and more particularly to a mercury arc which is automatically started and maintained even at low current values.

Among the objects of my invention are: To provide an automatic ignitor for a mercury arc operating independently of the arc current; to provide a means for maintaining an arc at low current densities; to provide a starting device for a mercury arc which requires no mechanical shaking; and to provide a simple and inexpensive starting device for a mercury arc.

Other objects of my invention will be apparent or will be specifically pointed out in the description forming a part of this specification, but I do not limit myself to the embodiment of my invention herein described, as various forms may be adopted within the scope of the claims.

Referring to the drawing, showing a preferred embodiment of my invention:

Figure 1 is a longitudinal sectional view indicating the location of the electrodes.

Figure 2 is a cross sectional view taken in the plane indicated by the line 2—2 in Figure 1.

Figure 3 is a schematic diagram of a circuit in which my tube may be used.

Mercury arcs operating between an anode and a mercury pool cathode will not start when energized. Various expedients, such as shaking the arc to break auxiliary contacts, passing a high frequency spark into the pool, or other devices have been used for starting, the arc maintaining its circuit until the current becomes too low when the arc goes out and must be re-started.

In its broadest aspect, my invention comprises a mercury arc tube in which there is a mercury pool and an anode energized from a source of current. Dipping into the surface and making contact with the mercury is an electron-emitting filament, current for which is supplied through the mercury from a source operable independently of the anode current flow. The heat of the filament vaporizes mercury at the point of contact, boils it away and breaks the current. This break, combined with the electrons from the filament starts the arc, which is then maintained by the anode current. I also prefer to surround the point of filament contact with an insulating sleeve, and to provide a shield to prevent liquid mercury from splashing on the anode.

Referring to the preferred form shown in the figures, a cylindrical bulb 1 is molded with a spherical end 2 and a skirt 4. Fused to the skirt is a reentrant stem 5 having various leads sealed in a pinch 6. The entire envelope is preferably formed from boro-silicate, or other heat resistant glass. If the device is to be used as a source of ultra-violet light, the container may be of quartz or heat-resistant glasses passing a substantial portion of the ultra-violet spectrum.

A cylindrical anode 7 is welded to an anode lead 9 extending through the pinch, and an anode dummy 10. A relatively large quantity of mercury is inserted in the tube to form a mercury pool 11, to be used as a cathode, and the bulb is placed in an upright position in order that the mercury remain in the spherical end.

A cathode lead 12 is sealed through the pinch and extended downwardly near the outer walls of the bulb to pass through the mercury pool and return again to the pinch at a dummy insertion 14. This frame provides contact with the mercury pool and also serves to support other structures to be described later.

At or near the center of the pinch, an ignitor lead 15 descends to within a short distance of the surface of the mercury pool, and has welded to it, as an extension, a filament 16 dipping into and making contact with the mercury. This filament is of material capable of emitting electrons when heated such as solid tungsten, thoriated tungsten or oxide coated refractory metal.

Welded to the cathode leads 12 between the mercury pool and the anode are shield supports 17 carrying a shield 19 preferably circular in shape, and having a hole 20 through which the ignitor lead may pass with substantial clearance.

Just below the mercury surface, sleeve supports 21 are welded to the cathode leads 12 and extend inwardly to position a heat-insulating sleeve 22 of quartz, lavite or like material, by means of a ring band 24 frictionally applied to the sleeve. This sleeve extends about half its length into the mercury, and completely surrounds the point of contact of the filament 16 with the mercury.

The tube having been assembled as described, is evacuated in an approved manner and sealed off the pumps.

Figure 3, a schematic diagram, reduced to its lowest terms, shows one method of connection as an arc for illumination purposes. Other circuits may be employed as when for instance the tube is to be used as a rectifier, but the general method of operation will be the same regardless of use.

The primary 25 of a transformer 26 is energized by alternating current mains 27. One end of the secondary 29 is directly connected to the anode 7 through the lead 9, the other end con-

necting to the filament 16 through the ignitor lead 15. The filament circuit is completed by connection of the mercury pool 11 to a filament section 33 of the transformer secondary through the lead 12 and a tap 31. The transformer secondary is thus divided into an arc section 32 and the filament section 33.

When current is started through the transformer primary, voltage is applied to the anode and current to the filament passes through the mercury. The filament becomes heated, emits electrons, and boils away the mercury at the point of contact. This action liberates enough mercury vapor to be ionized by the emission and the arc strikes between the anode and the surface of the pool.

With sufficient current passing through the arc and consequent heating of the bulb, to draw down the depth of the pool by evaporation, the circuit through the filament is broken and will stay broken until the tube should cool down enough to raise the level again to make contact. When contact is made, the filament is heated and electrons and mercury vapor are again supplied to keep the arc alive.

Usually such cooling is due to reduction of current through the arc, and I have found that an arc which will not normally operate below 3 amperes, will continue to operate at a current of 1 ampere when the ignitor circuit is intermittently making and breaking at the surface of the pool. The intermittent action of the ignitor circuit does not seem to unbalance or to modulate the arc current when the arc is operated below 3 amperes.

The insulating sleeve around the point of contact aids in the quick vaporization of mercury at the point of contact, and the shield 19 prevents any shorting between anode and cathode due to mercury splashing during operation.

I have also found it unnecessary to provide the ignitor circuit with current limiting devices or reactances, as the contact of the filament with the mercury will be broken by boiling if the filament tends to become too hot. It should also be noted that arc current will flow irrespective of whether or not the ignitor circuit is open or closed.

Arcs made in accordance with the principles and constrictions described above have proved in service to be self-starting without shaking, and the arc may be maintained by continuous action of the ignitor circuit at current densities which will not maintain a circuit in an ordinary arc.

I claim:

1. A mercury arc comprising a cylindrical envelope, a mercury pool cathode in one end of said envelope, a reentrant stem at the opposite end of said envelope, a rigid conductor sealed through said stem and extending to make permanent contact with said cathode adjacent the walls of said envelope, a hollow cylindrical anode supported by said stem placed between said stem and said cathode concentric with the walls of said envelope, a starting electrode extending from said stem through said anode and terminating in an electron emitting tip in contact with the surface of said cathode, and a cylinder of insulating material supported by said rigid conductor surrounding the contact between said electron emitting tip and said cathode.

2. A mercury arc comprising a cylindrical envelope, a mercury pool cathode in one end of said envelope, a reentrant stem at the opposite end of said envelope, a rigid conductor sealed through said stem and extending adjacent one side of said envelope to make contact with said cathode and returning adjacent the opposite side of said envelope to said stem thereby forming a frame, a hollow cylindrical anode supported by said stem placed between said stem and said cathode concentric with the walls of said envelope, a starting electrode extending from said stem through said anode and terminating in an electron emitting tip in contact with the surface of said cathode, and a cylinder of insulating material supported by said frame surrounding the contact between said electron emitting tip and said cathode.

3. A mercury arc comprising a cylindrical envelope, a mercury pool cathode in one end of said envelope, a reentrant stem at the opposite end of said envelope, a rigid conductor sealed through said stem and extending to make permanent contact with said cathode adjacent the walls of said envelope, a hollow cylindrical anode supported by said stem placed between said stem and said cathode concentric with the walls of said envelope, a starting electrode extending from said stem through said anode and terminating in an electron emitting tip in contact with the surface of said cathode, a cylinder of insulating material supported by said rigid conductor surrounding the contact between said electron emitting tip and said cathode, and a circular shield supported by said rigid conductor placed between said cathode and said anode parallel to the surface of said cathode, said shield being pierced to allow the passage of said starting electrode therethrough.

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