E. A. GIMINGHAM.

ARC INCANDESCENT ELECTRIC LAMP.

APPLICATION FILED OCT. 15, 1915.

1,374,647. Patented Apr. 12, 1921.

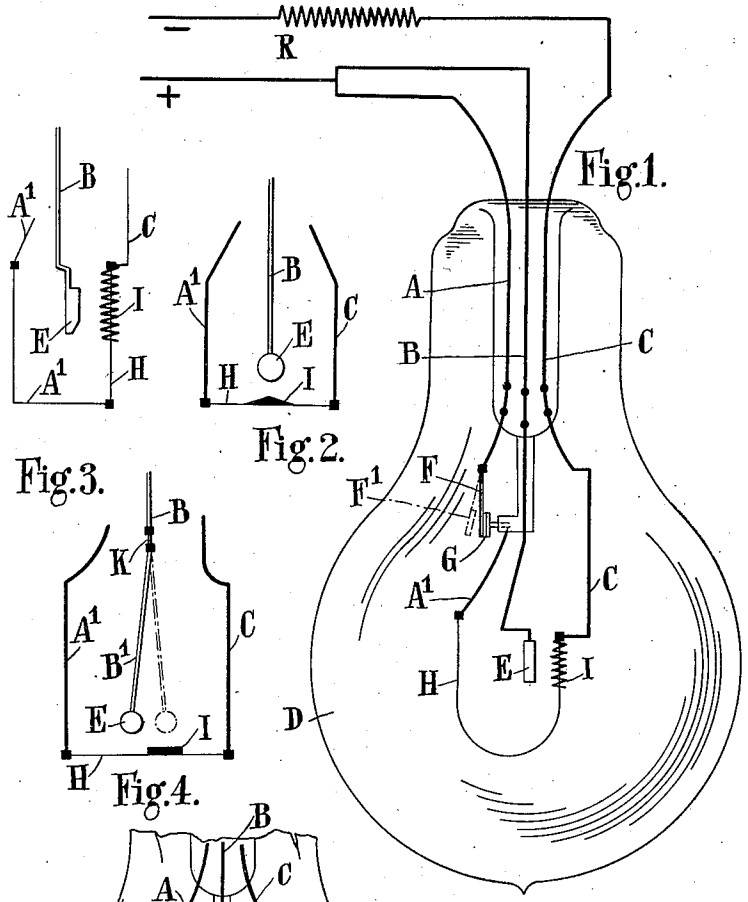


Fig.1.

Fig.2.

Fig.3.

Fig.4.

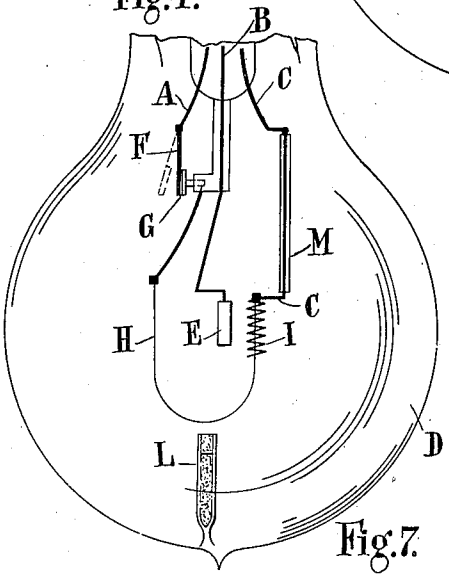


Fig.7.



Fig.5.

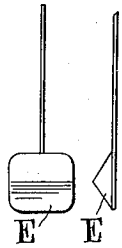


Fig.6.

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1,374,647. Specification of Letters Patent. Patented Apr. 12, 1921.

Application filed October 15, 1915. Serial No. 56,016.

To all whom it may concern:

Be it known that I, EDWARD ALFRED GIMINGHAM, a subject of the King of Great Britain and Ireland, of 123 Queen Victoria street, London, England, have invented new and useful Improvements in Arc Incandescent Electric Lamps, of which the following is a specification.

This invention relates to improvements in arc incandescent lamps, that is to say lamps which have substantially the outward appearance and construction of the ordinary incandescent electric lamp and a bulb which is of such form and is so closed as to allow of its being properly exhausted; while the lamp is furnished with means for forming or maintaining an arc within the bulb between two poles of tungsten or other suitable highly refractory material, such means being of simple construction which will allow of the complete exhaustion of all oxygen from the bulb. In hitherto known constructions of lamps with tungsten pole pieces in an inclosed globe the poles have been moved apart or held apart by mechanism within the globe which have made complete exhaustion impossible. The invention relates more particularly to lamps of the type specified which after exhaustion are filled with an inert gas such as nitrogen or argon for example. A minute quantity of oxygen may be constantly supplied within the lamp by heating some suitable substance such as barium chlorate by exposing it to the heat of the arc. This facilitates the starting of the arc.

In one construction of nitrogen filled lamp of the type referred to two poles or electrodes are fixed permanently apart and the gas in the neighborhood of the poles is ionized by passing a current through a heater, whereupon an arc can readily be formed between the poles with low tension currents as commonly in use for ordinary lighting. According to the present invention, the heater which serves to ionize the gases also serves to carry one pole of the arc and, on ionization being completed, the arc is formed between an electrode in parallel with one end of the heater and a point on the heater or an electrode in parallel with the other end of the heater. According to one form of this invention the heater is arranged in close proximity to one electrode and it has upon it a shield, of tungsten for example, at a point suitable to form another electrode, so that an arc of the desired size may be formed between the two electrodes. The heater therefore serves first as in ionizer and then at one point as one of the electrodes. Instead however of the shield above referred to being actually formed upon the heater, it may be carried upon one of the leading in wires of the heater so as to be electrically in one piece therewith, and in such proximity thereto that the gas between the electrodes is properly ionized. In either case the current passed through the heater for the purpose of ionizing the gas and starting the arc is cut off, either automatically or by a hand operated switch, after a few moments, and the current then passes from one electrode to the other across the arc gap.

The invention as applied to a lamp on a direct current circuit is illustrated in the accompanying drawings.

Figure 1 shows in elevation one construction of lamp, with an expansion strip for breaking the ionizer circuit inside the lamp,

Figs. 2, 3 and 4 show alternative constructions, or arrangements of the parts between which the arc is struck,

Figs. 5 and 6 are detail views of modified forms of pole pieces, for use in lamps made according to this invention, and

Fig. 7 shows another construction of lamp, in which a means of supplying oxygen is furnished.

In the construction shown in Fig. 1, three leads A, B, C, are introduced into a globe D containing an inert gas by means of the ordinary Edison stem. Outside the globe the two leads A and B are connected together in parallel with the + main lead, and the lead C is connected through a suitable resistance R with the — main lead. The lead B is brought down through the stem and terminates in an electrode E, of tungsten, molybdenum or other suitable highly refractory substance. The other + lead A terminates in an expansion strip F, (formed for example of two metal strips having different co-efficients of expansion such as molybdenum and nickel or molybdenum and nickel copper alloy fused together) the head of which F′ normally makes contact with a head G on a lead A′ carried by an extension of the Edison stem. The lower end of the lead A′ is connected with one end of the heater H, which is looped and at its other

end joins the — lead C. Around the end of the heater H which is nearest to the electrode E is arranged a spiral I of stout wire, of tungsten for example, which is secured to the lead C at the same point as the heater H.

The operation of the lamp is as follows:— The current passes through the leads A, A^1, and the expansion strip F, to the heater H and thence to the lead C. Immediately the heater is incandescent the gas between it and the positive pole is ionized and a small current passes between the + pole E and the heater. Upon the expansion strip becoming heated by the hot gas rising from the heater it warps and breaks the contact between F^1 and G. This has the effect of allowing the current at the full potential of the external supply to operate in breaking down the resistance of the arc gap, and the current forming the arc flows by means of the lead B through the electrode E across the gap to the coil or shield I. The current now passes no longer through the heater H proper. The heater H and the shield I are however practically one, as they are both carried by the end of the lead C, this being one convenient method of mounting the shield instead of directly on the heater H.

In the arrangement of heater and electrodes shown in Fig. 2 the electrode E is a solid sphere of fused tungsten, which when incandescent will give practically equal illumination in all directions, and the heater H between the leads A^1 and C is straight and has a thickened portion I of tungsten for example to serve as protection and form the negative electrode in the middle.

In the arrangement shown in Fig. 3 the ionizer H is also straight, but here it is surrounded by a coil I as in Fig. 1 serving as a shield and forming the negative electrode. The positive electrode E is here again of the flat form shown in Fig. 1.

In Fig. 4 is shown another arrangement, somewhat similar to that of Fig. 2, but having an additional device for insuring that the arc shall burn between the actual thickened or heavy portions forming the electrodes E, I. The positive electrode E in the form of a sphere is carried upon a portion B′ of the lead B, which is connected with the lead B by an expansion strip K. On the arc being struck in the manner described in connection with Fig. 1, the expansion strip warmed by the heat conducted from the hot electrode warps and moves the electrode E away from its normal position shown in full lines, into the position shown in dotted lines. It is found that there is sometimes a tendency for the arc to form in the first place between the electrode E and the heater H, instead of between E and the thickened portion I, owing to the latter being less hot than the heater of smaller section. The movement of the electrode E toward the negative electrode I on the arc being formed draws the arc with it until it is maintained between E and I as desired.

This expansion strip may be set at such an angle with the heater that while the arc is drawn along to the desired position between E and I, the length of the arc gap is also increased. Such an arrangement enables the + electrode to be placed nearly touching the heater when the lamp is out and facilitates the starting of the arc by reason of the short gap to be ionized. By careful construction of the expansion strip any desired length of arc may be formed.

In Fig. 5 is shown a positive electrode in the form of a hollow sphere having a thickened portion which is intended to act as a protection against premature burning through at the point of arcing. This form may be made in two or more parts fused together. The two halves are molded and the edges held together and fused in an electric arc for example. By careful construction of the thickened portion the whole surface of the sphere is by conduction brought to approximately uniform temperature.

The electrode shown in Fig. 6 has flat surfaces and is triangular in section; such an electrode would when incandescent throw the maximum beam in a direction at right angles to its largest flat surface, the arc striking at the apex of the triangular shaped electrode.

The electrode may also be rectangular in section, as in Fig. 1, in which case the maximum beam will be in a direction at right angles to the face opposite that on which the arc strikes.

In Fig. 7 is shown a lamp similar in construction to that shown in Fig. 1, but furnished with a tube L in position and containing barium chlorate or similar chemical which at the temperature of the lamp when burning gives off a minute quantity of oxygen. It is found that this device assists the formation of the arc. The ogygen attacks the surfaces of the electrodes on cooling. When the lamp is again started the slight film of oxid formed on the electrodes is easily volatilized by the passing of the current. It is this action apparently which assists in breaking down the resistance of the arc gap. Probably the resistance of the gas film around the electrodes is lowered by the disturbing action of the volatilized particles of oxid, and the arc is thus more easily established. The presence of the oxid cannot be detected with the naked eye, but its presence on the electrodes is established by the momentary wandering of the arc when the lamp is restarted. The volatilized oxid is not in sufficient quantity to discolor the bulb of the lamp, such thin films which may be deposited on the glass being white in color.

In this figure the lead C is shown fur-

nished with a sleeve of silica M. This has been found to be of advantage when there is any tendency for the arc to run up the leads. The lead B may also be so protected if required. In mercury vapor lamps a quartz sleeve has been used surrounding the lead in wire passing through a body of mercury and carrying the anode, so that the arc may not run to the mercury.

Instead of the expansion strip break F, F′, G described, any other convenient form of break, such as a magnetic break may be employed. The arc may if desired be started by means of a hand operated switch outside the lamp.

It is very necessary that the lamp should be thoroughly exhausted of all traces of water vapor, and gases occluded by the electrodes and leads before the inert gas is admitted.

The heater or ionizer H may consist of tungsten or molybdenum wire, or of tungsten mixed or in combination with refractory earths such as zirconia, thoria, calcium oxid, titanium oxid, tantalum oxid, or other highly refractory substances. Some of these refractory oxids possess the property of ionization to a very high degree when heated. For example, a satisfactory ionizer may be made by mixing zirconia and tungsten in equal parts and forming same into threads or filaments by any of the well known methods. Similar filaments have been previously constructed with the object of obtaining light-giving bodies but in carrying out this invention the object is not to carry the process of reduction too far but to maintain as far as possible within the filament the ionizing properties of the refractory earths, so that the repeated striking of the arc by means of the ionizer during the life of the lamp may be possible. Filaments such as those mentioned above, in which refractory oxids are present in any quantity, are not efficient light giving bodies, as their surfaces when viewed under the microscope show them to be dull and irregular, but they are active ionizers at a much lower temperature than similar filaments constructed of pure metals such as tungsten or molybdenum.

In the construction of the ionizer from mixtures of tungsten and refractory earths, the well known method of using a carbon binder may be employed, which can be removed later by the passing of a current in an atmosphere of hydrogen or other reducing gas, or as only short thick filaments are required they may be formed without the addition of a carbonaceous binder.

The ionizer may be straight or spiral or may be mounted in the form of a loop, having the protection acting as the negative electrode, common with the negative pole of the ionizer as illustrated in Figs. 1 and 3, or it may be straight, having as in Figs. 2 and 4 a protection acting as the negative electrode in the center of the ionizer. The negative electrode may be of hammered or drawn tungsten or any suitable refractory conductor. In fact the same refractory materials may be used for both the ionizer and the protection acting as the negative electrode. The ionizer may be of such dimensions that no protection is required at the point of arcing. It is, however, desirable that the ionizer should be used as far as possible only as a means of starting the arc.

The shield on the heater may also be produced by burning the arc at a high current density until a sufficient quantity of sputtered metal has been deposited on the surface of the ionizer. Each particle of the sputtered metal is a triangular needle and offers good protection to the ionizer at the point of arcing, besides assisting in striking the arc at a normal current.

The positive electrodes from which in direct current lamps the major portion of the light of the lamp is obtained, may be constructed of fused tungsten or tungsten alloyed with other refractory metals, or tungsten mixed or in combination with refractory earths such as those specified above for use in the construction of the ionizer or negative electrodes. By suitably arranging the ionizer the positive electrode may be wholly constructed from a fused oxid such as zirconia, which is a non-conductor when cold, but which when heated conducts electricity.

These positive electrodes may be formed in any desired shape, and may be so arranged in the lamp that the maximum illumination is thrown in any desired direction.

A satisfactory arc may be maintained at a pressure of approximately $\frac{1}{2}$ an atmosphere but I wish it to be understood that the arc may be started and maintained at pressures of gas as low as approximately $\frac{1}{30}$th of an atmosphere or even lower to pressures of 1 atmosphere or higher.

What I claim as my invention is:—

1. In an electric arc incandescent lamp a bulb containing an inert gas, a heater adapted to ionize the gas, an electrode in parallel with one end of the heater, and a second electrode surrounding a portion of the heater.

2. In an electric arc incandescent lamp a bulb containing an inert gas, a heater adapted to ionize the gas, an electrode in parallel with one end of the heater, the other electrode being formed by a shield carried by the heater.

3. In an electric arc incandescent lamp, a bulb containing an inert gas, a heater adapted to ionize the gas, an electrode in parallel with one end of the heater, means adapted to cut out that end of the heater after a cur-

rent has been passed, the other electrode being electrically connected with the heater and being, at least in part, interposed between the first electrode and heater.

4. In an electric arc incandescent lamp, a bulb containing an inert gas, a heater adapted to ionize the gas, an electrode in parallel with one end of the heater, and having means adapted to move it relatively to the other electrode upon a current passing, the other electrode being carried by the heater.

5. In an electric arc incandescent lamp, a bulb containing an inert gas, a heater composed of tungsten and a refractory earth in combination adapted to ionize the gas, an electrode in parallel with one end of the heater, and another electrode located between the first electrode and the heater.

6. In an electric arc incandescent lamp, a bulb containing an inert gas, a heater adapted to ionize the gas, an electrode of tungsten in parallel with one end of the heater, and a second electrode of tungsten located, at least in part, between the heater and said first electrode.

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Witnesses:
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