(No Model.)

E. F. DWYER.

PROCESS OF PRODUCING HIGH VACUUMS.

No. 596,654. Patented Jan. 4, 1898.

Fig. 1.

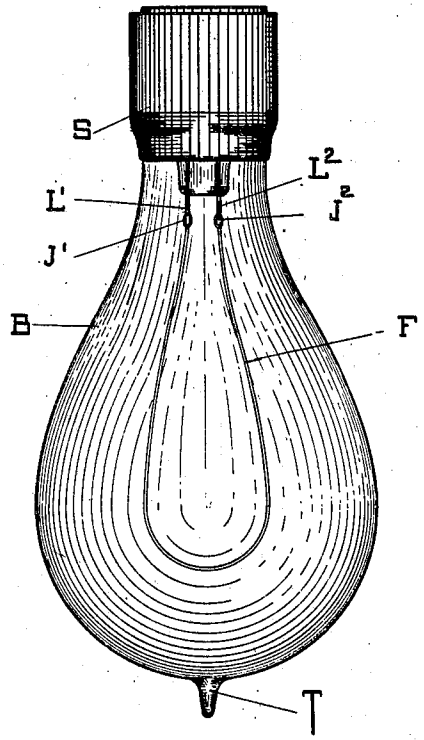


Fig. 2.

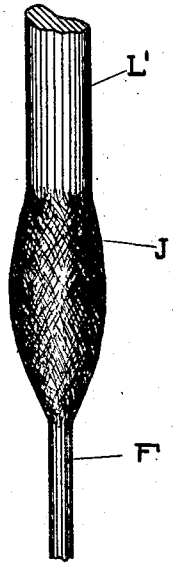
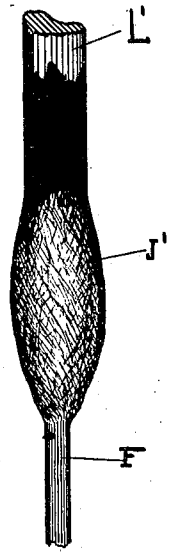


Fig. 3.



WITNESSES.

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PROCESS OF PRODUCING HIGH VACUUMS.

SPECIFICATION forming part of Letters Patent No. 596,654, dated January 4, 1898.

Application filed October 26, 1897. Serial No. 656,420. (No specimens.)

To all whom it may concern:

Be it known that I, ELMER F. DWYER, a citizen of the United States, residing at Lynn, in the county of Essex and Commonwealth of Massachusetts, have invented certain new and useful Improvements in Processes of Producing High Vacuums, of which the following is a description.

My present invention relates especially to a process for exhausting air and other gases from incandescent electric lamps or similar receptacles during their manufacture and repair; and its object is to render this operation speedy and with a minimum of attention required on the part of the operator, while the production of the high vacuum required in an incandescent lamp is assured, and discoloring of the lamp-bulb is largely reduced. In the past such lamps have been exhausted by mechanical pumps having cylinders and pistons, by mercury-pumps of the Geissler and Sprengel types and their modifications, by chemical processes involving the displacement or absorption of the gases contained in the lamp, or by combinations of these processes. A partial or incomplete vacuum, but one not carried sufficiently high to serve the purposes of the best grade of incandescent lamps, is readily obtained by a good mechanical or mercurial pump, but it is in the removal of the residual gases remaining after such exhaustion that the greatest difficulty is encountered, since that part removed by each stroke of the pump or by the successively-falling drops of mercury in the case of the Sprengel pump becomes continually smaller and smaller, being simply a certain fraction of the expanding remaining gases; and soon a limit is reached, which is, however, still below the desired vacuum, beyond which no further exhaustion by this means is possible. To carry the vacuum still higher, it has been a common practice to heat the lamp-bulb by either an external source of heat, such as a gas-flame, or by an electric current passed through the lamp-filament, or by both of these means combined, so as to expand the gases in the lamp, and also to drive off from the lamp-filament itself and its supports, more particularly the joint between the leading-in wires and the filament, which joint is usually made of some form of hydrocarbon paste, gases occluded therein, while continuing the pumping operation. It is possible to make commercial lamps in this way, and they have been so made for a number of years, but the process is prolonged and costly, and therefore to obtain greater rapidity and economy in this work the method has been practiced of placing a chemical substance in a space connected with the lamp, which gives off vapors or gas when heated, which vapors or gas mingle with or displace the gases remaining in the lamp, and the combined gases are afterward removed by continuing the pumping or by absorbing them by some other substance having a strong affinity therefor. For example, ammonia-gas has been introduced and absorbed by phosphoric anhydrid, or solids—such as mercury-vapor, the vapor of sodium, potassium, iodin, &c.—have been introduced, the pumping continued, and the residue allowed to condense in a cooled auxiliary vessel connected to the lamp during exhaustion. Arsenic has been proposed to be introduced as a vapor and is supposed to form a chemical combination with the residual gases of the lamp and go down as a solid deposit. Still further, it has been proposed to use a substance having in a large degree the power of absorbing gases, such as spongy platinum, which, being heated, gives off retained gases during the process of exhaustion and afterward occludes or takes up the residual gas when the heating has been discontinued and pumping stopped.

I also in my present invention employ a chemical to obtain the condition of highest vacuum, depending mainly on the displacement of the original gases by a gas evolved from the heated chemical, this substance having the property of evolving a condensable gas or vapor which, when the heating is discontinued, goes down as a solid upon the cooler portions of the receptacle and requiring quite a high temperature to be afterward again vaporized.

In my improved process, and according to the theory of action just alluded to, I aim to reduce the amount of this added gas or vapor, so as to limit the ultimate deposition of foreign substance upon the inner surface of the lamp-bulb after the pumping is stopped, and to this same end and for the further purpose

of avoiding the necessity for skilled and close attention on the part of the operator I make the production of the added gas and the disengagement from the filament and its supports of occluded gases simultaneous and automatically so, or at least with such definite relation as to time as will give the best results with the minimum of attention required on the part of the operator and in the shortest time. By "best results" I refer to a lamp having the very high vacuum required in an incandescent lamp to insure a long life and one having the least possible or least permissible amount of foreign substance deposited as a film upon the inner surface of the lamp-bulb, which deposited film will in most cases tint the lamp.

I will now describe my process, reference also being made to the accompanying drawings, in which—

Figure 1 represents an ordinary incandescent lamp in its completed condition; and Figs. 2 and 3 are magnified representations of the leading-in wires, the joints, and portions of the lamp-filaments.

In Fig. 1, B is the lamp-bulb; S, the socket for attachment to a lamp-fixture; L' L^2, the leading-in wires; F, the lamp-filament, and J' J^2 the joints which unite the filament to the leading-in wires.

The same letters of reference are used in Figs. 2 and 3 for similar parts shown, J' being the joint between the filament and leading-in wire. This joint is usually, if not always, made of a carbon paste or hydrocarbon paste. It is from this joint that by far the larger portion of gases is evolved when it becomes heated, as by passing an electric current through the filament. In my improved process I mix with or place upon this hydrocarbon-paste joint J', Fig. 2, or apply to or paint upon the leading-in wire L', Fig. 3, a substance having the properties of amorphous phosphorus, which when heated gives off its vapor, such chemical being applied, of course, prior to the placing of the lamp upon the pumps. I then place the lamp in connection with any good air-pump, mechanical or mercurial, at its exhaust-passage, as at T, Fig. 1, and make the usual rough exhaustion. I then pass an electric current through the lamp-filament, preferably limiting the current at first, so as not to raise the filament to full incandescence, and continue the pumping. The heat from the filament first expands the gas remaining within the lamp-bulb, permitting its further removal by pumping. Gradually the heat is conducted back to the joints J and to the leading-in wires L, when upon an increase of current the disengagement of the occluded gases and the gases produced by the paste joint is partially effected, while the production or evolution of the condensable or displacing gas, as from phosphorus, begins, and then, lastly, the current passing is still further increased for a short time to or above that required for the normal operation of the lamp in use, when practically all of the occluded or retained gases are driven off from the joint, filament, and leading-in wires, while at the same time the vaporization of the phosphorus is completed, and the volume of gases now permits further pumping, the excess gas being that derived or obtained from the phosphorus. The lamp is now sealed off. The gas now remaining in the lamp is mainly that which has been purposely added, say phosphorus-vapor; but as the lamp cools this gas or vapor condenses upon the cooler portions or goes down as a solid, as an extremely-attenuated film upon the inner side of the lamp-bulb, and will not again arise as a gas unless again subjected to a temperature as high as that which produced it. Having by trial determined quite accurately just what minimum amount of condensable gas is required to be produced in this way to perfect the vacuum to the stage desired, I am enabled to limit the deposit formed by its condensation upon the bulb-surface to the greatest extent and therefore to produce a superior lamp, while at the same time the processes of expanding the free gases in the lamp, driving off the occluded and retained gases from the joints, &c., and evolving the condensable gas follow naturally in their proper order to insure the best results with a minimum of skilled attention and in a very short time. The operator soon learns by simply noting the color within the lamp during exhaustion when to seal it off, and I find in the practice of my invention that I am actually enabled to greatly facilitate the process of exhaustion, so as to produce a greater number of lamps in a given time with less labor and giving a superior product as compared with the processes hitherto known or used. I show no particular form of pump or its connection to the lamp, these things being so well understood.

It is understood, of course, that an external source of heat may be employed for assisting in expanding the gas within the lamp during the pumping operation; but it is evident that such heating has no particular use in producing the condensable or displacing gas, since the source of the latter is far removed from the externally-applied heat. Such external heating is mainly useful in driving off gas from the inner surface of the bulb and preventing predeposition of the condensable gas on the bulb-surface.

Besides phosphorus I have used with greater or less success iodin and ammonium-cuprous chlorid. In general it suffices to employ a substance which will, when sufficiently heated, give off a gas capable of subsequent condensation; but such substance must not again be able to be vaporized by the heat of the lamp in normal operation. I prefer phosphorus to other materials.

Having thus described my invention, what I claim is—

1. The process of producing high vacuums consisting in, removing the main portion of the gases contained within the receptacle to be exhausted by pumping, heating the remaining gas while continuing the pumping, driving off occluded gases and producing or evolving a condensable or displacing gas by an electric current passed through a circuit within said receptacle, and finally sealing said receptacle.

2. The process of exhausting incandescent lamps which consists in, removing the main portion of the gases contained within the lamp by pumping, heating the remaining gases while continuing the pumping, passing an electric current through the lamp-filament whereby occluded or retained gases are disengaged while a condensable or displacing gas is evolved from a suitable substance previously applied in the lamp while still continuing the pumping, and, finally, sealing off the lamp.

3. The process of exhausting incandescent lamps consisting in, removing the bulk of the original gas by pumping, further expanding by heat the remaining gas and continuing the pumping, passing an electric current through the lamp-filament and its connections for disengaging occluded or retained gases therefrom and vaporizing phosphorus previously applied to said connections while continuing the pumping, and then, finally, sealing off the lamp, substantially as described.

4. As an improvement in processes for exhausting incandescent lamps, the method of producing the higher states of vacuums consisting in simultaneously disengaging the occluded or retained gases in the lamp-filament and its connections and producing or evolving a condensable or displacing gas from a suitable substance, such as phosphorus, carried by the filament-supports, by passing an electric current through the lamp during the operation of pumping, and afterward sealing the lamp to perfect the vacuum, substantially as described.

In witness whereof I have hereunto set my hand this 23d day of June, 1897.

ELMER F. DWYER.

Witnesses:
JOHN W. GIBBONEY,
WINIFRED GIBBONEY.