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EVACUATION OF BULBS AND OTHER VESSELS

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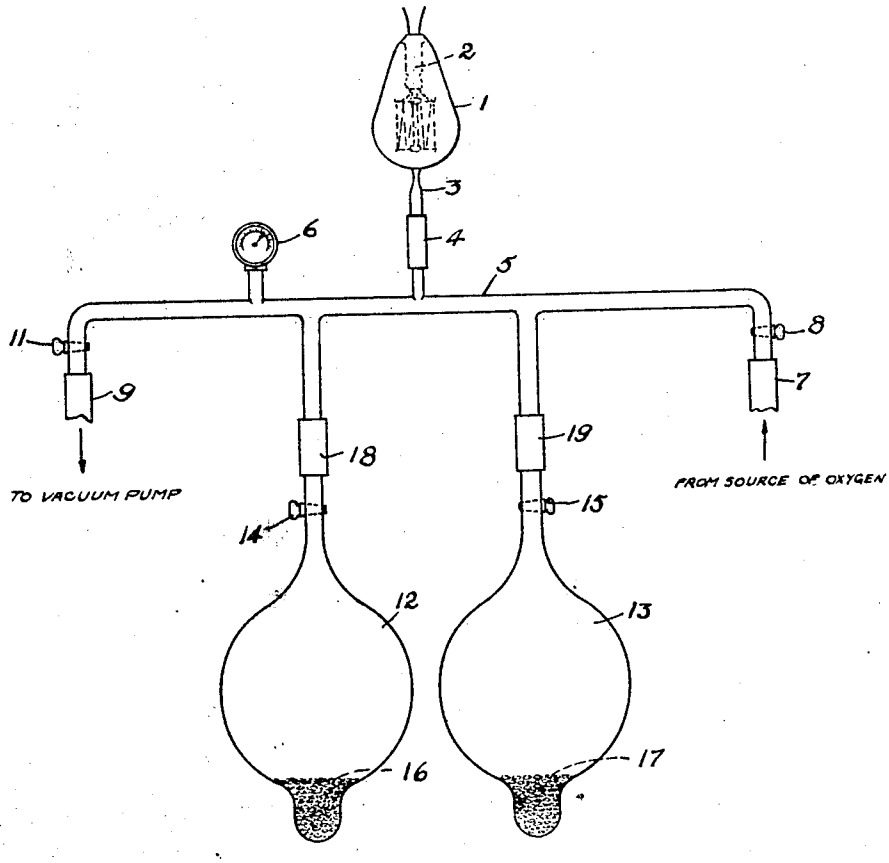

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EVACUATION OF BULBS AND OTHER VESSELS.

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This invention relates to the exhaustion of bulbs and other receptacles and more particularly to the evacuation of incandescent-lamp bulbs.

An object of my invention is the production of the desired degree of exhaust in a vessel by flushing the vessel with an active gas and subsequently removing such gas by absorption or chemical combination in an auxiliary vessel.

Another object of my invention is the replacement of the air normally present in a vessel by oxygen or other chemically active gas, the partial exhaustion of said vessel and the removal of approximately all the residual gas by combination, in an auxiliary vessel, with a substance having a high degree of chemical affinity therefor.

A further object of my invention is the production of a high vacuum in a vessel quickly and by the use of relatively simple and inexpensive exhaust apparatus.

A still further object of my invention is the exhaustion of a lamp bulb by flushing one or more times with oxygen, partially exhausting said bulb and removing substantially all the oxygen remaining by phosphorus, or other substance combining readily with oxygen, in an auxiliary exhausted vessel connected to the lamp bulb.

Other objects and advantages will be apparent as the description proceeds.

It has been customary in the past to produce the proper degree of vacuum in electric lamp bulbs and the like, by several vacuum pumps adapted to successively produce different stages of vacuum, until finally the desired degree of vacuum in the bulb is obtained. This method entails the employment of expensive machinery, and the time required for exhausting is undesirably long.

In practicing my invention, it is possible to employ a vacuum pump such as that used on a preliminary vacuum line, which will not create a better vacuum than a pressure of 5 to 10 mm. of mercury. The bulb, or other container to be exhausted, is heated to free it from moisture, then connected to a vacuum pump and exhausted to a residual air pressure which may be as high as 10 mms. of mercury. The bulb, after disconnecting the pump therefrom, is then connected to a source of oxygen, chlorine or other active gas. This operation may be repeated, preferably a plurality of times, so as to eliminate the last traces of any relatively inert gas, such as nitrogen, from the bulb to be evacuated.

The bulb may then be exhausted to as good a vacuum as possible with the pump being used. The pump is then disconnected and the bulb connected to an auxiliary vessel, preferably evacuated to a different pressure, preferably lower than that in the bulb, and containing phosphorus, magnesium, calcium, or other substance adapted to combine quickly with the gas with which the bulb is charged and form a solid. When the desired vacuum has been produced by combination of substantially all the remaining oxygen with the phosphorus, the auxiliary vessel may be disconnected from the system and the bulb tipped off in the usual manner. Although this method provides a very good vacuum, the usual type of getter is used in the bulb for eliminating the last traces of oxygen therefrom.

Referring to the drawing showing a preferred embodiment of my invention, the single figure represents an incandescent-lamp bulb connected to apparatus suitable for practicing my invention.

An incandescent-lamp bulb 1 is shown provided with a mount 2, which preferably carries a getter of any suitable composition. The bulb 1 is connected, through a contraction or exhaust tube 3 and rubber tubing 4, to tubing system 5 and is preferably heated to a temperature of about 300° to 400° C. to expel moisture. Care must be taken not to raise the temperature high enough to either actuate the getter or oxidize the filament.

For indicating the vacuum in the bulb, tubing system and connections thereto, a vacuum gauge 6 may be connected to the tubing system 5. A source of oxygen (not shown) may be connected, through rubber tubing 7, to the tubing system 5. A valve or stop-cock 8, serves to connect the source of oxygen with, and disconnect it from, the tubing system. A vacuum pump or other means for producing a moderate vacuum (not shown) may be connected to the tubing system 5 through rubber tubing 9. The vacuum pump is adapted to be connected to, and disconnected from, the exhaust tubing 5 by means of a valve or stop-cock 11. Connected to exhaust tubing 5 are also preferably two auxiliary vessels 12 and 13. These

are preferably provided with valves or stopcocks 14 and 15 and each contains a quantity of phosphorus 16 and 17 or other substance adapted to actively and quickly unite with oxygen to form a solid substance.

The phosphorus is preferably placed in the auxiliary vessels 12 and 13 in the following manner. The vessels are first charged with an inert gas, such as nitrogen or argon, and the phosphorus placed therein. The inert gas will prevent the burning of the phosphorus until it is desired to use said vessels.

The vessels 12 and 13 are then evacuated to a different, preferably lower, vacuum than that obtainable from the pump or pumps connected to the tubing 5. A rotary pump or the like may be used to evacuate the phosphorus vessels, and any desired number may be charged with phosphorus, evacuated and stored in a convenient place ready for use. The phosphorus may be heated, while the vessels are being evacuated, to completely drive out the inert gas. The vessels 12 and 13 may then be attached to the exhaust tubing system 5 by means of short rubber tubes 18 and 19, the valves 14 and 15 being closed.

The operation of my invention may be as follows. With the valves 8, 14 and 15 closed and the valve 11 open, the bulb 1 is exhausted. The valve 11 may then be closed and the valve 8 opened so that the bulb 1 is flushed with oxygen. This replaces the air formerly in the bulb by pure oxygen, mixed to a very slight extent with the residual air remaining in the bulb. The impure oxygen in the bulb may then be exhausted and replaced with pure oxygen, as previously described, or the one oxygen flush only may be used.

With the valves 8, 14 and 15 in closed position, the valve 11 is opened and the bulb 1 exhausted to as great an extent as possible with the pump being used. It is assumed, that the pump will only give a vacuum of from 5 to 10 mms. of mercury within the time allowed. The valve 11 may then be closed and the valve 14 opened. This will cause the oxygen remaining in the bulb 1 to flow into the vessel, because of its greater pressure, and combine with the phosphorus in the bulb 12 to form phosphorus pentoxide, which is valuable as an absorbent of moisture.

It is important that there be a difference in pressure between the bulb to be evacuated and the vessel containing phosphorus, so that a rapid movement of gas will take place between the bulb and vessel, to cause a quick elimination of the oxygen in the bulb. The phosphorus vessel pressure is preferably lower, so that the oxygen will be withdrawn from the bulb for absorption, but it may be higher, as would result if the phosphorus therein were heated, in which case phosphorus vapor would flow into the bulb 1 and there combine with the oxygen and leave phosphorus pentoxide in the bulb. If the phosphorus-vessel pressure is initially lower than that of the bulb, it will be so maintained until combination of the oxygen and phosphorus is complete, because, as the oxygen flows to the phosphorus vessel, it immediately combines with the phosphorus to form solid phosphorus pentoxide, without an appreciable increase in pressure. If, on the other hand, the phosphorus-vessel pressure is initially higher than that in the bulb, as would occur if the phosphorus were heated, phosphorus vapor would flow into the bulb and there form solid phosphorus pentoxide with a consequent maintenance of the flow as before.

In practicing this method, it has been found that, in 10 seconds, it is possible to reduce the pressure from 7,000 microns of oxygen to 60 microns. The residual pressure having been reduced to as low as say 60 microns, the bulb may then be tipped off in the usual manner, as no trouble will be experienced in cleaning up such a residual pressure with any usual type of getter. If it is found that the pressure in the bulb, as indicated by a vacuum gauge 6, is not sufficiently reduced by the phosphorus in the auxiliary vessel 12, the auxiliary vessel 13 may also be connected thereto by opening valve 15, so that a fresh supply of phosphorus is available for eliminating more of the remaining oxygen.

The method of exhausting herein described has been tried with the phosphorus kept at different temperatures by means of a water bath or source of moderate heat applied to the auxiliary vessels 12 and 13, but it has been found that the phosphorus will combine as efficiently with the remaining oxygen at ordinary room temperatures as at temperatures either slightly higher or slightly lower.

The following table shows representative results obtained when using my method of exhaust. The first row of figures shows the results obtained by testing some lamps made by the regular process and the following rows show, successively, the test results when two and three oxygen flushes with six second exposures to the phosphorus and when two oxygen flushes with a three second exposure to the phosphorus in one vessel, 12 for instance, and a three second exposure to the phosphorus in another vessel, 13 for instance, are used. The first column of figures shows the relative strength of filament when subjected to shock; the second shows the relation of the average light emitted to the light emitted when the lamp is new; the third shows the average lumens emitted per watt compared with the initial lumens per watt; the fourth shows the actual burn-out life of

the lamp with a starting efficiency of 10.1 lumens per watt, and the last column shows the calculated theoretical burn-out life at an average efficiency of 9.2 lumens per watt.

Feature	Avg. bump test strength	Avg. % lumens	Avg. % L. p. W.	Avg. B. O. life at 10.1 L.p.W.	Avg. life @ 9.2 avg. L.p.W.
Regular process	45	87	91.5	1105	1255
2 Oxygen-flush, 6 Sec. to phos	47	88.6	91.9	1200	1361
3 Oxygen-flush, 6 Sec. to phos	44	90.8	94.5	1091	1486
2 Oxygen-flush, 3 sec. to phos	in 12				
3 sec. to phos	in 13.54	88.1	92.7	1170	1404

It will be apparent that, according to my improved method, a bulb free from inert gas is provided so that a getter in the bulb will cause the almost complete elimination of the residual gas, with the consequent production of a good vacuum. The elimination of residual gas in the bulb results in an efficient and long-burning lamp as the heat of the filament is not dissipated through convection currents and there are no deleterious reactions with the filament material.

While I have described what I now consider a preferred arrangement for practicing my invention, it is to be understood that the same is merely illustrative and modifications may be made therein which fall within the spirit and scope of the appended claims.

What is claimed is:

1. The method of evacuating a vessel comprising flushing with oxygen and connecting said vessel to a source of vacuum containing phosphorus.

2. The method of producing a vacuum in a vessel comprising the use of a vacuum pump to produce a vacuum of the order of about from 5 to 10 mms. of mercury, flushing the evacuated vessel with substantially pure oxygen, again exhausting said vessel to obtain approximately the same vacuum as before, connecting to said vessel a source of vacuum of greater degree than said vessel and having a supply of phosphorus therein, whereby the residual oxygen in said vessel is rapidly eliminated, thus forming a good vacuum therein.

3. The method of producing a vacuum in a vessel comprising the exhaustion of the same and replacement of the gas therein with oxygen, the repetition of this exhaustion and replacement, the final exhaustion of said vessel and the connection thereto of a source of vacuum including phosphorus, so that a rapid combination of the remaining oxygen in said vessel takes place with said phosphorus to produce such a good vacuum that any residual oxygen remaining in said vessel is adapted to be absorbed when a getter therein is actuated.

4. The method of producing a vacuum in a vessel or the like comprising exhausting said vessel and replacing the gas therein with oxygen, repeating this exhaustion and replacement a plurality of times so that no appreciable amount of gas other than oxygen remains in said vessel, again exhausting said vessel to leave oxygen at a moderate pressure therein and connecting to said vessel an auxiliary receptacle exhausted to a different degree and containing phosphorus, so that a flow of gas occurs between the two vessels and the phosphorus rapidly absorbs the residual oxygen from said vessel with the production of a good vacuum therein.

5. The method of vacuating an incandescent lamp comprising heating the bulb thereof to drive off moisture therefrom, partially exhausting the air therefrom, admitting oxygen thereto, partially exhausting the oxygen therefrom and connecting the bulb to a source of vacuum of a different degree from said bulb and containing phosphorus, whereby the pressure of the oxygen in the bulb is further reduced.

6. The method of evacuating an incandescent lamp comprising the application of heat to the bulb thereof to expel moisture therefrom, the connection of the bulb to a vacuum pump to exhaust air therefrom, the disconnection from the pump and connection to a source of oxygen whereby the bulb is flushed therewith, the repetition of the exhaustion and flushing of the bulb with oxygen so that all appreciable traces of inert gas are eliminated therefrom by a plurality of oxygen flushes, the final exhaustion of the bulb and connection thereof to a source of vacuum of a different degree from said bulb and containing phosphorus, whereby the oxygen within the bulb is eliminated by combination with the phosphorus until a low pressure is reached.

7. The method of producing a vacuum in a bulb or the like comprising heating said bulb to eliminate moisture therefrom, exhausting the bulb and flushing with oxygen and again exhausting and flushing with oxygen a plurality of times to eliminate all traces of inert gas from said bulb, finally exhausting and connecting to said bulb a source of vacuum containing phosphorus to absorb a large amount of remaining oxygen from said bulb and connecting to said bulb a second source of vacuum containing phosphorus to reduce the pressure of the residual oxygen therein still further.

In testimony whereof, I have hereunto subscribed my name this 25th day of May 1922.

DANIEL SNYDER GUSTIN.