March 28, 1967 A. REYNDERS 3,311,440

APPARATUS RELATING TO EVACUATING AND FILLING GAS DISCHARGE LAMPS AND THE LIKE

Filed July 6, 1964 2 Sheets-Sheet 1

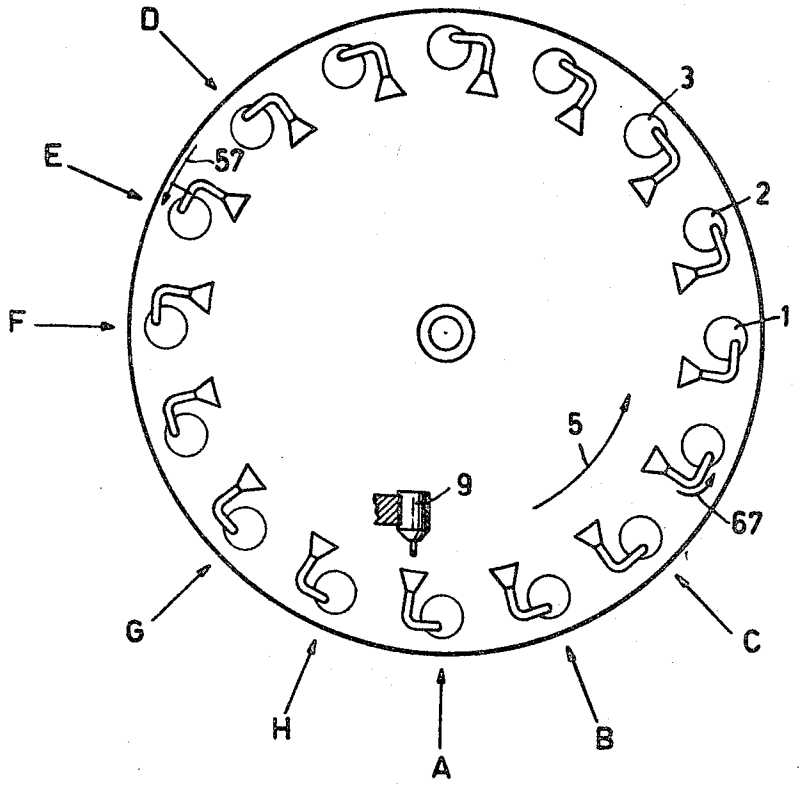

FIG.1

INVENTOR.
ANTON REYNDERS
BY
Frank R. Trifari
AGENT

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Filed July 6, 1964 2 Sheets-Sheet 2

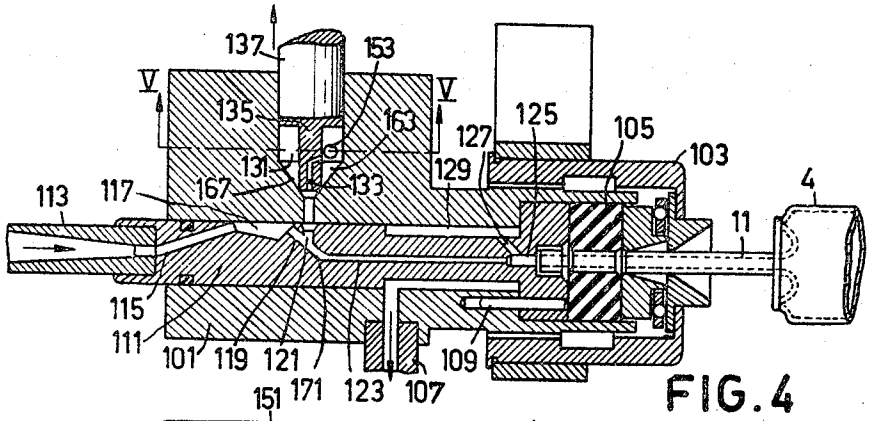

FIG. 4

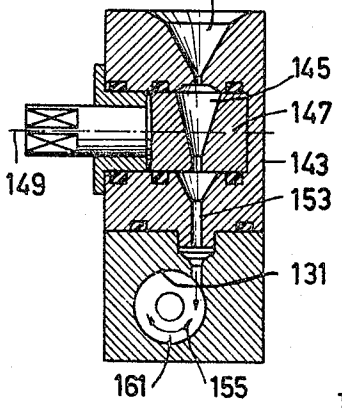

FIG. 5

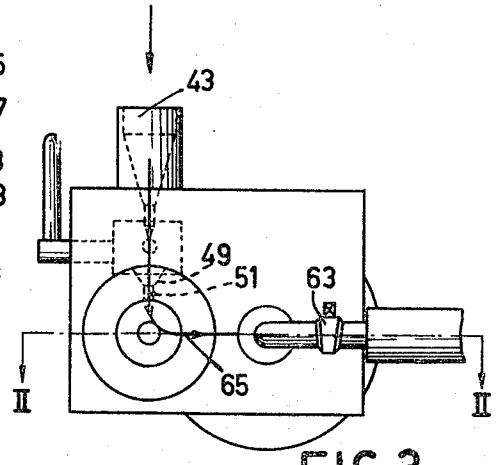

FIG. 3

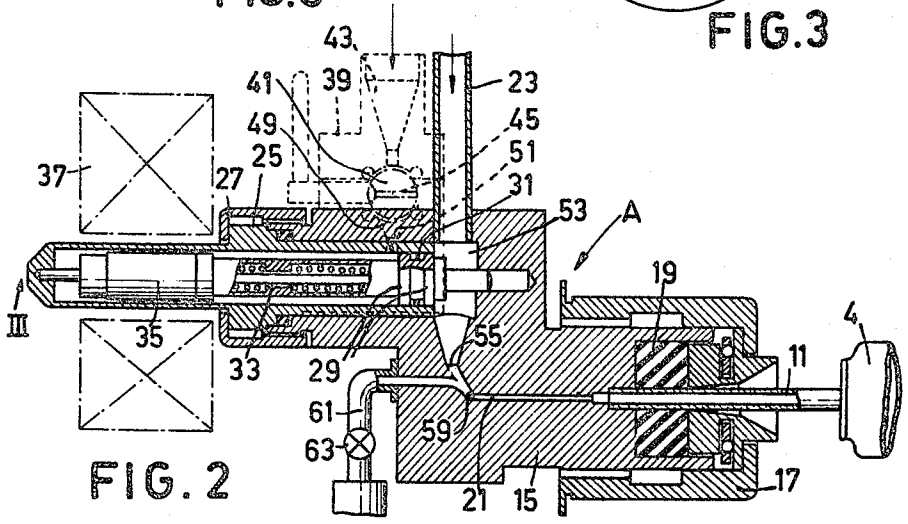

FIG. 2

INVENTOR.
ANTON REYNDERS

BY
Frank R. Trifari
AGENT

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3,311,440

APPARATUS RELATING TO EVACUATING AND FILLING GAS DISCHARGE LAMPS AND THE LIKE

Anton Reynders, Emmasingel, Eindhoven, Netherlands, assignor to North American Philips Company, Inc., New York, N.Y., a corporation of Delaware

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Claims priority, application Netherlands, July 11, 1963, 295,212
5 Claims. (Cl. 316—30)

The invention relates to an apparatus for evacuating gas discharge tubes or the like and introducing an accurately controlled quantity of mercury into each of them. Such apparatus comprises holders by which a plurality of tubes may be conveyed in a horizontal position in a direction at right angles to their longitudinal axes, pairs of heads arranged to follow the movement of the said holders and to be connected to an evacuating system, the exhaust tubes projecting from both ends of a discharge tube: being inserted one into each of a pair of heads, and means for introducing a controlled quantity of mercury into the evacuated tube through one of the exhaust tubes at a desired instant. Such an apparatus is known.

In a known apparatus there is provided for each tube, a moving container filled with mercury and during each revolution of the apparatus a controlled quantity of mercury is separated from the container and supplied to the tube concerned. Separating a controlled quantity of mercury and supplying it to a lamp or tube at a desired instant are operations which take place in the same head during the transport of the lamps. Consequently the construction of such a head is complicated.

It is desirable that exactly the same quantity of mercury should be introduced into each tube. However, to do so involves difficulties when multiple containers of mercury are used serving individual tube positions.

It is an object of the present invention to provide an apparatus which is not subject to difficulties, is of simpler construction, and which is particularly suitable for use with the machine described in co-pending application Ser. No. 380,238 in which I am a co-inventor.

The apparatus in accordance with the invention is characterized in that one head of each pair is provided with a supplying chamber situated adjacent the evacuation path of the tube. The chamber is provided with an inlet and an outlet adapted to be closed in a vacuum-tight manner, and when the said head moves past a stationary mercury dosing device a predetermined controlled amount of mercury for a single tube is supplied to the chamber. Thereafter the inlet is closed and the tube is evacuated. Means are provided by which at a desired instant after the evacuation of the tube the outlet of the supply chamber filled with a controlled amount of mercury for a tube may be opened while blowing means are arranged by which the controlled quantity of mercury, which after opening of the outlet of the supply chamber falls into a prepared position in the evacuation path, may be blown into the tube through the exhaust tube at another desired instant. Thus for each tube there is a supply chamber containing only one quantity of mercury for the said tube. Hence the said apparatus includes only a single mercury dosing device which always delivers an equal quantity of mercury to each of a plurality of sequentially passing heads of the apparatus. Thus the accuracy required for dosage needs only to be set once and can be checked more readily than is the case in the known prior apparatus. By using for each tube a supply chamber containing a controlled quantity of mercury for only a single tube or

lamp, the additional advantage is obtained that the correct mercury dose is prepared outside the evacuation path irrespective of the vacuum conditions. Furthermore, the mercury dose is brought into the evacuation path only at the last moment, that is when the tube has been sufficiently evacuated.

Since the supply chamber contains a dose for a single tube only, a comparatively limited amount of mercury takes part in the operation of the entire apparatus so that the likelihood of oxidation and contamination of the mercury is very small in contradistinction to a construction in which a comparatively large supply of mercury is being conveyed for each tube. A further advantage consists in that the apparatus need not be stopped to replenish the supply of mercury as is the case in the known apparatus. The means for blowing the mercury into the tube preferably consist in momentarily supplying a rare gas, for example, argon.

The supply chamber for each tube may take the form of a space between an annular groove in a piston and in a cylinder enclosing the piston. This space communicates in one of the positions of the piston with the inlet for a controlled quantity of mercury for a tube and in another position with the outlet to a prepared position in the evacuation path of the tube. The piston is preferably controlled electromagnetically. To prevent reciprocating movements of the piston including the groove, in a preferred embodiment the holders and the heads for the tubes are arranged to move with a circular movement in a vertical plane and the supply chambers have a substantially cylindrical shape. The supply to each chamber is effected approximately tangentially through an aperture in the cylindrical wall in a position of the chamber in which its axis extends substantially horizontally while the chamber may be discharged, while being in a rotated position into which it is brought by a movement of the tubes, through an aperture in the base of the chamber which may be closed by a preferably apertured valve. The controlled amount of mercury is conveyed to its prepared position in the evacuation path by the rotary movement of the apparatus.

In order that the invention may readily be carried out, two embodiments thereof will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which:

FIG. 1 is a diagrammatic front elevation of an apparatus for evacuating gas discharge tubes or the like and introducing an accurately controlled quantity of mercury into each of them;

FIGS. 2 and 3 relate to a first embodiment of a head following the movement of each tube: FIG. 2 is a sectional view taken on the line II—II of FIG. 3 and FIG. 3 is an elevation taken in the direction indicated by the arrow III of FIG. 2;

FIGS. 4 and 5 relate to a second embodiment of the head. FIG. 4 is a sectional view analogous to FIG. 2 and FIG. 5 is a sectional view taken on the line V—V of FIG. 4.

FIG. 1 shows schematically an apparatus for evacuating gas discharge tubes and introducing a controlled quantity of mercury into each of them. In the apparatus the tubes (for example **1**, **2**, **3**) are arranged to move along a circular path at a contact speed and in a horizontal position. The direction of movement is indicated in FIG. 1 by the arrow **5**.

The tubes are held in horizontal position and are provided at their ends with open exhaust tubes which are inserted into heads arranged to be also moved in the direction indicated by the arrow **5**. The arrangement is such that the tubes when inserted into the heads are connected to an evacuating system. This is shown in more detail in FIG. 2 for a lamp tube **4**, the exhaust tube or lamp

stem **11** of which is disposed in a lamp closing member. The said closing member or head comprises a housing **15** and a resilient hollow plug **19** enclosed by a nut **17**. By turning the nut **17** the plug may be compressed so as to surround the exhaust tube **11** in a vacuum-tight manner. The housing **15** has a bore **21** connected to an evacuation pipe **23**. At the other end of the lamp tube **4** a similar head is provided which also includes a closure member for the stem in the form of a rubber plug and a bore connected to an evacuating system; this second head is not shown for the sake of simplicity.

One of the heads associated with each tube, for example, the head shown in FIG. 2, is so constructed as to include a supply chamber to which a controlled amount of mercury for only one lamp or tube may be supplied in a manner to be described hereinafter and held until the mercury is to be introduced into the lamp.

The apparatus of FIG. 1 is provided with only a single stationary mercury dosing device **9** so constructed that each time the head of FIG. 2 holding the tube passes under the said device a controlled amount of mercury is delivered. The construction of the dosing device **9** is not described in more detail because it may be of a known type.

The head of FIG. 2 further includes a sleeve **25** secured to the housing **15** by means of a nut **27**. The sleeve forms a guide for a piston **29** containing an annular groove **31**. The piston is connected by a connecting rod **33** to a block **35** acting as a magnet core. The piston is arranged to reciprocate under the influence of a coil **37** shown diagrammatically; the piston is compelled to move to the right in FIG. 2 against spring action. A block **39** as shown by broken lines in FIG. 2 and enclosing a ball stop-cock **41** is secured to the housing **15**. The block **39** which encloses the stop-cock **41** and includes a funnel-shaped part **43**, in actual fact extends at right angles to the drawing (see FIG. 3). The ambient atmosphere may be excluded from bores **49** and **51** provided in the housing **15** and the sleeve **25** respectively by means of the stop-cock **41** which contains a duct **45**. The funnel-shaped part **43** opens into the stop-cock **41**. In the position shown there is no communication between the space within the funnel-shaped part **43** and the bores **49** and **51**; in the position shown of the duct **45** in the stop-cock **41** no such communication is possible. The stop-cock may be turned 90°, however, so that the funnel-shaped part **43** is in direct communication with the bores **49** and **51**. The evacuation pipe **23** secured to the housing **15** opens into a space **53**. When the piston **29** is moved to the right in FIG. 2 it may enter the space **53**. The space **53** is in communication with the bore **21** through a duct **55**. Through the evacuating path constituted by the pipe **23**, the space **53**, the duct **55**, the bore **21** and the exhaust tube or lamp stem **11**, the tube **4** communicates with an evacuating system.

The apparatus operates as follows:

We start from a location in which a head **15** et seq. passes under the dosing device **9**. In this location the funnel-shaped part **43** extends upwards (position A of FIG. 1). The arrangement is such that the duct **45** in the stop-cock **41** (FIG. 2) is turned 90°. Consequently the stop-cock is opened. The piston **29** has been brought into its left-hand position; in this position the groove **31** is exactly below the bores **49** and **51**. At this location an accurately controlled quantity of mercury is introduced by the dosing device **9** into the funnel-shaped part **43** through free fall and under the normal atmospheric conditions. The accurately regulated amount of mercury, for example, one drop of mercury, will descend to the lowest part of the groove **31**. When the piston **29** is moved to the right the groove **31** assumes the position shown in FIG. 2. The drop then is effectively enclosed in a supply chamber consisting of groove **31** and the imperforate wall portion of cylinder **25**. At the position B (FIG. 1) the stop-cock **41** is closed again. Beyond the location C the tube **4** is subsequently evacuated through the pipe **23**. Hence a partial vacuum will also be created in the annular groove **31**. While the tube **4** is being evacuated it moves in the direction indicated by the arrow **5**. At the location D the desired partial vacuum in the tube **4** is achieved. The piston **29** is moved further to the right by suitable energisation of the coil **37**. The funnel-shaped part **43** now points downwards. By the movements of the piston **29** to the right in FIG. 2 the groove **31** enters the space **53**, permitting the enclosed drop of mercury to fall through the duct **55** (in the direction of the arrow **57** in the position E.) The drop then lies before the orifice of the duct **21** which may be considered as a capillary; at this location the drop is designated by **59**. At a subsequent instant, for example at the location F, the drop of mercury **59** is forced into the interior of the tube **4** through the duct **21** with the aid of a momentary supply of a rare gas, for example, argon from a pipe **61** (FIG. 2). For this purpose a valve **63** is momentarily opened. Along the portion F–G of the path of the tube its exhaust tubes or lamp stems **11** are sealed.

At the location G the evacuated tube containing the appropriate amount of mercury is taken from the machine. Hence the evacuating circuit is broken. At a location H between the locations G and A a new tube to be evacuated and provided with a controlled amount of mercury is placed in the machine and the cycle repeated. For the sake of clarity the path taken by the drop of mercury in the head is indicated by a curved arrow **65** in FIG. 3. This path includes a sharp bend; it is also indicated in FIGURE 1, for example, by an arrow **67** near the position C.

FIGS. 4 and 5 show another embodiment. The tube and the lamp stem are again designated by **4** and **11**, respectively. The head of FIG. 4 comprises a housing **101** and a nut **103** by turning which a resilient plug **105** may be compressed so as to surround the exhaust tube **11** in a vacuum-tight manner. A part **111** provided with an insertion piece **113** adapted to be connected to a supply of argon is secured to the housing **101** by studs **109**. The part **111** comprises a bore **115**, a recess **117**, bores **119**, **121**, **123**, **125** and **127** and a recess **129**. The evacuating path of the tube **4** is constituted by a pipe **107** connected to an evacuation pipe, the recess **129**, duct **127**, the bore **125**, the lamp stem **11** and the tube **4**. The housing **101** further contains a cylindrical chamber **131** in which a valve **135** provided with a bore **133** is arranged to reciprocate. The valve **135** has an enlarged part **137** which closes the chamber **131** in a substantially gas-tight manner.

Through the bore **133** in the valve **135** the chamber **131** is in open communication with the aforementioned evacuation path. As FIG. 5 shows, the housing **101** further includes a part **143** having a funnel-shaped collecting chamber **151**. In this part **143** a stop-cock **147** provided with a duct **145** is rotatable about an axis **149**. The communication between the funnel-shaped collecting space **151** for a controlled quantity of mercury and the substantially cylindrical chamber **131** into which the duct **153** opens may be interrupted by the said stop-cock. When closed the chamber **131** constitutes a supply chamber for the amount of mercury to be blown into the tube **4**.

The operation of the said head (FIGS. 4 and 5) is substantially the same as that of the head described with reference to FIGS. 2 and 3. At the location A a controlled quantity of mercury is supplied to the funnel-shaped collecting chamber **151**; the said quantity is supplied through ducts **145** and **153** substantially tangentially to the chamber **131**, performs a rolling movement as indicated by the double arrow **155** and finally lies in the position indicated by **161**. The stop-cock **145** is then rotated, the inlet is closed and the tube is evacuated.

When the head is moved in the direction indicated by the arrow **5** of FIG. 1 to the location D the position of the principal axis of the cylindrical chamber **131** is

changed. In the location A this axis extends substantially horizontally but in the location D it points obliquely downwards, the valve portion 135 with smaller diameter being at the top and the portion 137 having the larger diameter being at the bottom. The drop of mercury 161 will roll along a generatrix of the cylindrical chamber 131 and reach a position designated by 163 in FIG. 4. At the location E the valve 135 is lifted from its conical seating 167 and similarly to what is the case in FIG. 2 the drop of mercury reaches a position designated 171 just in front of the narrow bore 123 in the evacuation path. Similarly to what has been described with reference to the first embodiment the drop 171 is then forced by means of increased pressure into the exhaust tube 11 and the tube 4 through the pipe 113 by a momentary supply of argon.

What is claimed is:

1. Apparatus for manufacturing fluorescent lamps in which lamp-tubes having a lamp-stem at each end are conveyed in a closed path while in a horizontal position, the combination comprising, a wheel defining said closed path, a plurality of head members spaced about said wheel, said head member having means for receiving a lamp-stem in sealed relation, a head body portion having a channel communicating with said lamp-stem at one end, a supply chamber within said head means connected with said head for connecting said channel with an evacuation source, means connected with said head for connecting said channel with a source of discharge gas, and means for supplying a measured quantity of mercury to said channel; said last-named means comprising a supply means communicating with the exterior ambient atmosphere surrounding said head and the interior of said head, said supply means including means defining a supply chamber and a valve for closing said supply chamber from said ambient atmosphere and closure means for communicating said channel and said supply chamber for delivering a quantity of mercury from said supply chamber into said channel.

2. Apparatus for manufacturing fluorescent lamps according to claim 1 wherein said closure means comprises a piston, a cylinder surrounding the said piston; said means defining said supply chamber comprising an annular groove in said piston, means for slidably moving said piston between a first position wherein said annular groove communicates with said supply means, a second position wherein said groove is out of register with said supply means, and a third position in which said groove is in communication with said channel.

3. Apparatus for manufacturing fluorescent lamps according to claim 1, wherein said supply means comprises a body member having duct therethrough, a rotatable stop cock in said body intersecting said duct, said stop cock having an aperture therethrough for registry with said duct in one position thereof and closing said duct upon rotation from said one position.

4. Apparatus for manufacturing fluorescent lamps according to claim 3 wherein said closure means comprises a housing member having a funnel-shaped opening, a valve member axially movable in said opening for blocking and unblocking the exit from said opening, a tangential entrance to said opening, said exit from said opening communicating with said channel, said opening being positioned and arranged in said housing member for gravity discharge of a quantity of mercury in said opening at a determined attitude of said wheel.

5. Apparatus for manufacturing fluorescent lamps according to claim 1 wherein said channel includes a capillary portion, said supply chamber communicating with said channel at the entrance of said capillary portion and said means connecting said channel with a source of discharge gas being connected with said channel remote from the entrance of said capillary portion.

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RICHARD H. EANES, JR., *Primary Examiner.*