Jan. 31, 1939. G. A. ESPERSEN 2,145,830

METHOD AND APPARATUS FOR MANUFACTURING GAS-FILLED DISCHARGE TUBES

Filed Oct. 19, 1937

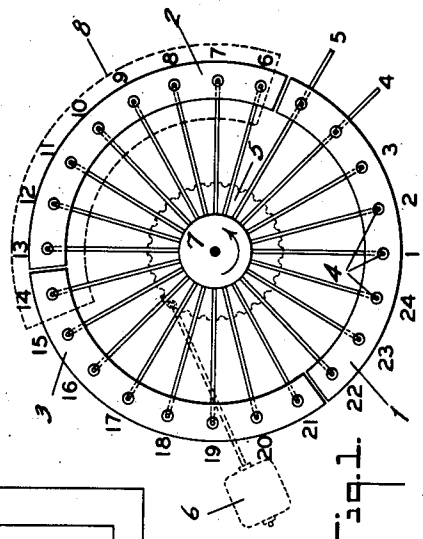


Fig. 1.

Fig. 2.

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Patented Jan. 31, 1939

2,145,830

UNITED STATES PATENT OFFICE

2,145,830

METHOD AND APPARATUS FOR MANUFACTURING GAS-FILLED DISCHARGE TUBES

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Application October 19, 1937, Serial No. 169,760

3 Claims. (Cl. 176—2)

This invention relates to gaseous type electric discharge devices and more particularly to processes and apparatus for controlling the admission of gases to such devices.

In certain devices for example the cold cathode gaseous discharge tubes, it has been the practice of filling the gases at prescribed pressures through the use of manual type controls. I have found that by accurately and automatically controlling the pressure of the inert gas used in the filling operation within predetermined desirable limits of pressure, and by accurately controlling the duration of the gas filling operation, it is possible to fill discharge tubes on the usual automatic exhaust and sealing machines. As a result it is possible to produce great quantities of discharge tubes with a very high degree of uniformity existing between the various tubes.

An object of the present invention is to provide an improved method of filling electric discharge devices such as cold cathode rectifiers, voltage regulators, gas type photocells, gas type triodes, with a gas or vapor which is later employed in the tube to sustain an ionizing discharge.

Another object is to provide an automatic mechanism for controlling with a high degree of accuracy the various factors encountered in the filling of the gaseous devices named above.

A further feature relates to an improved automatic valve whose operation is controlled by a three contact manometer which allows gas to enter within predetermined limits of pressure. Thus the manometer may be adjusted to admit gas at a minimum value of 3 m. m. of mercury pressure and a maximum value of 5 m. m. of mercury pressure.

A further feature relates to the novel organization of an interlocking system of relays which are effective in controlling the flow of gas so that at no time does the pressure fall below a predetermined minimum value or does the pressure rise above a predetermined maximum value of pressure.

Other features and advantages not specifically enumerated will be apparent after a consideration of the following detailed descriptions and the appended claims.

While the invention will be described herein as embodied in one well-known type of exhaust and sealing machine it will be understood that it is equally applicable to other forms of exhaust and sealing machines. Furthermore, inasmuch as automatic exhaust and sealing machines for lamps, radio tubes, and the like are quite well-known in the art, the drawing is intended to be merely diagrammatic as to details of structure of the machine as a whole. Accordingly in the drawing,

Fig. 1 is a schematic diagram of certain parts of any well-known form of automatic exhaust machine embodying the invention.

Fig. 2 is a detailed composite schematic diagram of the devices and circuits used in conjunction with the automatic exhaust machine to effect the gas filling.

Referring to Fig. 1, there is schematically illustrated an automatic exhaust machine such for example as illustrated in detail in Patent No. 996,936. In general, the machine includes a rotatable spider carrying a series of arcuate hollow sectors 1, 2 and 3 each sector being provided with a plurality of ports 4 to receive the tubes to be processed. The spider is rotated in a step-by-step manner in the direction of the arrow by any suitable mechanism, for example by the Geneva gear 5, which is operated from the main driving motor 6, it being understood that the Geneva movement has the same number of teeth as the number of ports 4. Each of the ports 4 is connected by suitable piping to the central rotary valve designated generally by the numeral 7 the rotary valve being provided in the well-known manner with a series of ports equal in number to the ports 4 so that as each tube is advanced to successive positions the particular processing for that position is effected. In the particular machine illustrated the tubes are indexed to twenty four successive positions which are indicated in the drawing by the numerals 1 to 24 inclusive. In positions 1, 2, 3 and 4 the ports 4 are either opened or closed, depending upon the type of tube to be processed. In positions 5 to 10 inclusive the ports are connected through a rotary valve 7 with the first exhaust pump. In position 6 the tube is tested for leaks by any well-known mechanism. From positions 6 to 15 there is provided a suitable oven for baking out the glass and other parts of the tube. In positions 12 to 22 inclusive the tubes are connected to the final exhaust pump and while passing from positions 12 to 23 the various operations are performed. Suitable lighting arrangements are provided in positions 1 to 4 inclusive and 15 to 23 inclusive which may be used for degassing the filaments of types having filaments. In the case of cold cathode or non-thermionic type tubes this latter feature is not necessary. In position 24 the automatic gas filling mechanism (Fig. 2) operates to admit the inert gas (preferably argon, neon, or helium or suitable mixtures of these gases) at a pressure

which shall not be less than a predetermined minimum value or greater than a predetermined maximum value. In positions 15 to 23 the filament may be lighted and the bombarding coil is lowered over the tube to raise the temperature of the metal parts to drive out occluded gases and in position 23 the bombarding coil acts to flash the getter material within the tube. Position 24 is the gas filling and tip off position where the exhaust tube is sealed off after the gas has entered the tube. For convenience of understanding, the sequence of operations may be according to the following schedule:

Port No.	Gas filled rectifier types having filaments	
1	Opened—tube loading	Lighting positions
2	Opened	
3	Do.	
4	Do.	
5	Manifold	Exhaust pump
6	Leak detector	
7	Manifold	
8	Do.	
9	Do.	
10	Do.	
11	Do.	
12	Single pump	Position in oven
13	Do.	
14	Do.	
15	Do	Lighting positions
16	Do.	
17	Do.	
18	Do.	
19	Do.	
20	Do.	
21	Do.	
22	Do.	
23	Single pump—getter flash coil	
24	Closed—gas filling—tip off	

Port No.	Gas filled cold cathode types (no filaments)	
1	Closed—tube loading	
2	Closed	
3	Do.	
4	Do.	
5	Manifold	Exhaust pump
6	Leak detector	
7	Manifold	
8	Do.	
9	Do.	
10	Do.	
11	Do.	
12	Single pump	Position in oven
13	Do.	
14	Do.	
15	Do.	
16	Do.	
17	Single pump—bombarding coil	
18	Single pump	
19	Single pump—bombarding coil	
20	Single pump	
21	Single pump—bombarding coil	
22	Single pump	
23	Single pump—getter flash coil	
24	Closed—gas filling—tip off	

The above exhaust schedules may be varied considerably in accordance with the various technics known in the art of radio tube manufacture. Other schedules have been found to be equally as desirable as the above but the above schedules are the preferable ones.

Referring to Fig. 2, a detailed description will now be given of the apparatus which comes into operation as the tube reaches position 24. Port number 24 is connected by a piping system preferably of Pyrex glass tubing to the gas supply tank 25, containing the desired inert gas, vapor or mixture of gas and vapors, whose pressure is to be set between a minimum and maximum value by the controls to be described. Preferably the gas from source 25 is a pure inert gas or gases, and the pressure of the supply tank is controlled by conventional pressure regulators. The tank 25 is connected to the apparatus through the intermediary of a rubber tubing 27 which has associated therewith a manually adjustable constriction control device or clamp 26, and a similar electromagnetically controlled constriction device 29. These devices are provided with suitable pinching jaws which when moved towards each other control the effective opening through the rubber tubing. By means of the manually adjustable device 26, the desired flow of gas is controlled. The electromagnetic valve 29 is provided with an operating electromagnet 29*a* which when energized, effects a complete closure of the tubing 27. A similar electromagnetic valve 28 is associated with the rubber tubing 28*a* which connects the apparatus to the vacuum pump (not shown). The valve 28 is provided with an electromagnet 28*b* which is energized from the electrical supply line through the switches 30, 31.

Associated with the system is an indicating mercury manometer comprising a bulb 32 and a side arm 33. Three contacts 34, 35, 36 are sealed into the manometer and a suitable quantity of liquid mercury is provided within the manometer, the level of the mercury being normally below the contact 35. As the pressure of the gas flowing through the system increases it causes a corresponding rise in the mercury in the arm 33 thus connecting the contacts 35, 36 successively in circuit. The manometer is sealed to the glass tubing of the system as indicated, and connected in the system is a suitable Geissler tube 37 having the usual electrodes 38, 39, whereby the proper flow and composition of the desired gases can be visually determined by spectral examination at periodical intervals. The glass system also includes a suitable liquid air trap 40 whereby moisture, oil vapor and mercury vapor, are trapped in the well known manner before the gases enter the reservoir 41. The reservoir 41 is of sufficient capacity to stabilize the pressure in the system whereby the number of relay contacts required is at a minimum. For the purpose of controlling the gas supply valve 29, there are provided a pair of relays 42, 43, and for the purpose of energizing the Geissler tube there is provided a high voltage transformer 44, the primary of which is connected to the electric supply line through the switch 45.

Before filling the system with a gas, it is completely evacuated by closing the valve 26 while maintaining valve 28 open. When the system has been properly exhausted, the valve 26 is opened and the gas flows through tube 27, tube 37, trap 40 and into the reservoir 41. As the pressure in the system rises, the mercury in the manometer 32 rises until a connection through the mercury is made between contacts 34 and 36. Under these conditions, a circuit is completed from the supply line 46 through the winding of relay 43, conductor 47, contact 36, contact 34 to line conductor 48. Relays 42 and 43 are preferably of the 110 volt A. C. operating type. Relay 43 when thus energized operates its armatures 49, 50 away from the associated back contacts 51, 52 and into engagement with the respective front contacts 53, 54. Armature 49 when it engages contact 53 connects the neon lamp indicator 55 in the line circuit as a visual indication that relay 43 is operated. The engagement between armature 50 and contact 54 completes a circuit from line conductor 46 through the winding of relay 42, contact 54, armature 50, conductor 56, contact 35, contact 34 to line conductor 48. Relay 42 when thus energized moves its armatures 57 and 58 away from the associated back contacts 61, 62 into engagement with respective front contacts 59, 60.

A circuit thereupon is closed from line conductor 46 through the armature 58, contact 60, conductor 63, winding of electromagnet 29a to line conductor 48. Valve 29 thereupon operates to shut off the gas supply. The relay 42 when operated has a locking circuit completed for itself traceable from the line conductor 46, winding of relay 42, contact 59, armature 57, conductors 64, 65, contacts 35, 34 to line conductor 48. Relay 42 therefore remains operated so long as the pressure in the system is sufficient to maintain the mercury at the level of contact 35. Thus contact 35 controls the minimum pressure of gas in the system and contact 36 controls the maximum pressure of gas in the system, it being understood of course that these two contacts are so positioned and the dimensions of the manometer are such that the desired maximum and minimum pressures are controlled.

Should the pressure in the system drop below the predetermined minimum, as for example when a tube to be filled reaches port 24, the level of the mercury in the manometer drops below the contact 35. Under these conditions the circuit for relay 43 is broken and the previously described locking circuit for relay 42 is also broken causing the release of both these relays. The release of relay 42 causes the valve 29 to be reopened thus admitting gas to the required pressure into the system. Should the pressure in the system rise above the predetermined maximum the operating circuit for relay 43 is again closed as described above thus preventing further entry of gas into the system. Relay 42 may also have associated therewith through contacts 58 and 62 a neon lamp indicator 66 to indicate the condition of relay 42. Thus an attendant is able to determine from the sequence of operations of the lamps 55 and 66 whether the control system is functioning properly. Preferably a condenser 67 is connected across the contacts 58 and 60 to reduce sparking thereat and likewise condensers 68, 69 are provided across the manometer contacts for a similar purpose.

With the foregoing type of control, it is possible to fill lamps, radio tubes and the like, with inert gas between accurately predetermined pressure thus enabling such devices to be produced in large quantities with uniformity between the different lamps or tubes, and by employing any well known exhaust machine such for example as the "Sealex" machine or the like. The process of gas-filling, is entirely automatic once the initial adjustments have been made as above described and enables tubes to be evacuated, gas-filled and tipped off at a speed of approximately 300 per hour whereas with the ordinary control methods a maximum speed of 50 per hour is obtainable. It will be understood of course that after the tube or lamp has been filled with gas as above described, the usual exhaust tubulation above is sealed-off and the tube is removed from the machine in any wellknown manner, it being understood that the above described cycle of operations is represented for each tube that is loaded into the machine.

Various changes and modifications may be made herein without departing from the spirit and scope of the invention.

What I claim is:

1. In an automatic exhaust machine of the character described, the combination of a platform to carry a bulb having a plurality of electrodes, means to index said platform in a step-by-step motion to a plurality of successive positions, means effective in one of said positions to admit an inert gas into said bulb at a pressure between a predetermined upper limit and a predetermined lower limit, the last-mentioned means including a mercury manometer having an upper and a lower contact corresponding respectively to said upper and lower limits, a first relay energized only when the mercury engages said upper contact, a second relay initially energized only when the first relay is operated and the mercury engages said lower contact, a locking circuit for said second relay independent of the first relay but controlled by said lower contact, and a valve for controlling the admission of the inert gas into the bulb, said valve being controlled conjointly by said pair of relays.

2. In an automatic exhaust machine of the character described, the combination of a platform to carry a bulb which is to contain a filling of an inert gas, means to index said platform in a step-by-step motion to a plurality of successive positions, means effective in one of said positions to admit an inert gas into said bulb at a pressure between a predetermined upper limit and a predetermined lower limit, the last-mentioned means including a mercury manometer having upper and lower contacts corresponding respectively to said upper and lower limits, and an intermediate contact, a first relay energized only when the mercury engages said upper contact, a second relay initially energized only when the first relay is operated and the mercury engages said lower contact, a locking circuit for said second relay independent of the first relay but controlled by said lower contact and said intermediate contact, and a valve for controlling the admission of the inert gas into the bulb, said valve being controlled conjointly by said pair of relays.

3. In an automatic exhaust machine of the character described, the combination of a platform to carry a bulb which is to contain a filling of an inert gas, means to index said platform in a step-by-step motion to a plurality of successive positions, means effective in one of said positions to admit the inert gas into said bulb at a pressure between a predetermined upper limit and a predetermined lower limit, the last-mentioned means including a pressure responsive relay having three contacts, two of which correspond respectively to the upper and lower pressure limits, a pair of relays operated when a circuit is closed through said two contacts, a locking circuit for one of said relays controlled conjointly by the other relay and the third contact, and a valve for controlling the admission of the inert gas into the bulb, said valve being controlled conjointly by said pair of relays.

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