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REGULATING SYSTEM

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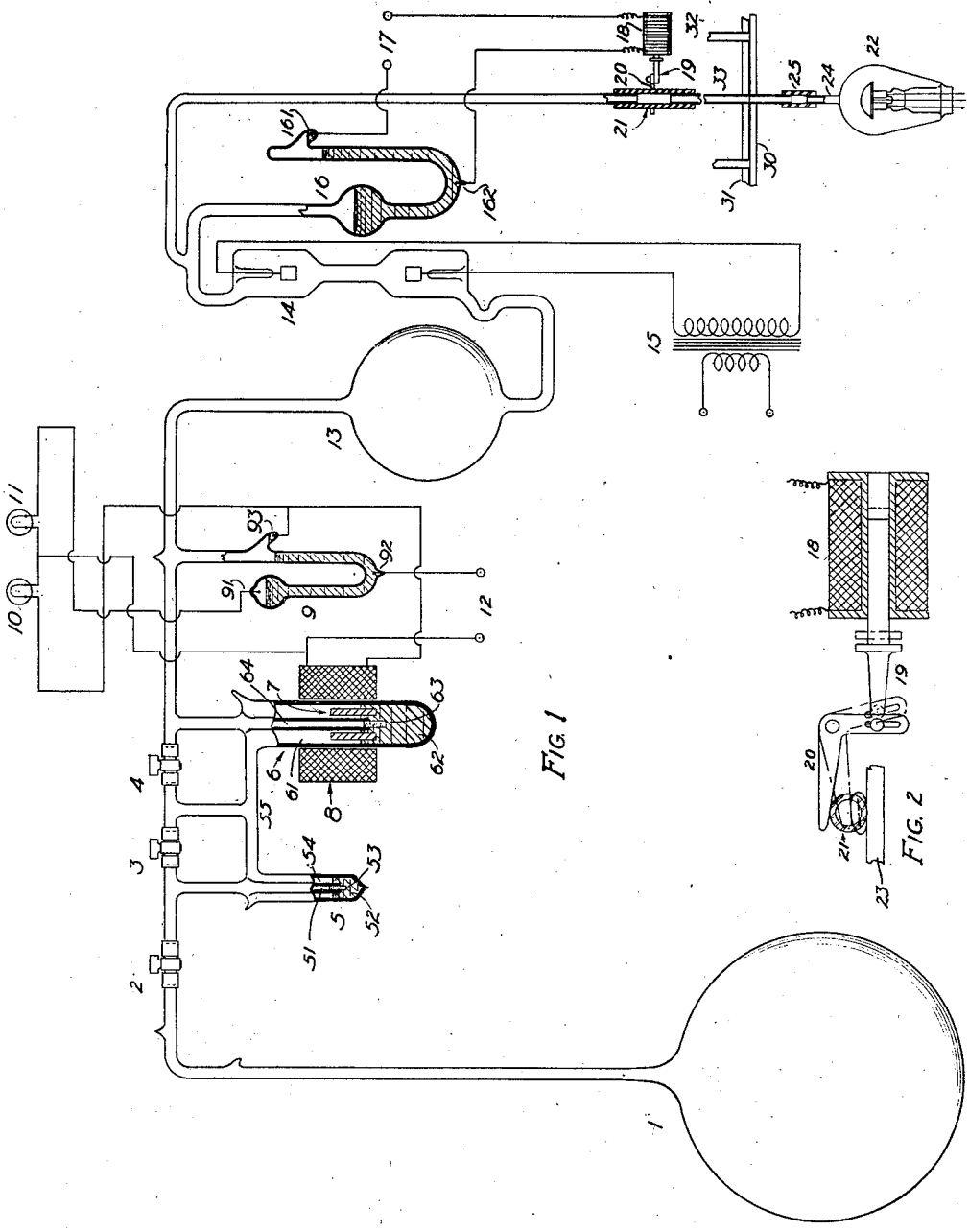


FIG. 1

FIG. 2

JOHN A SPENCER
Inventor

By
Attorney

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JOHN A. SPENCER, OF REVERE, MASSACHUSETTS, ASSIGNOR TO RAYTHEON, INC., OF CAMBRIDGE, MASSACHUSETTS, A CORPORATION OF MASSACHUSETTS

REGULATING SYSTEM

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My invention relates to a regulating system for maintaining a predetermined gas pressure in a supply line. It has particular application to the gas supply system in the manufacture of electrical discharge apparatus but may be used in any other system in which the gas supply must be kept constant.

In the manufacture of electrical discharge apparatus it is customary to remove all foreign gases from the container enclosing the discharge apparatus and to fill this container with a gas or mixture of gases at a certain pressure. In many kinds of devices, especially of the gaseous conduction type, it is very important that the gas filling be as pure as possible and the pressure of the gas be at a predetermined value. Thus in gaseous conduction devices, as glow lamps and rectifiers, the gases customarily used are of the inert monatomic group although other gases may also be used. The pressure of these gases is usually very low compared with atmospheric pressure and may vary from a few centimeters of mercury down to a fraction of a millimeter of mercury.

In the manufacture of electric discharge apparatus, the device is usually exhausted of its air content in one or more stages. Hydrogen is then admitted to wash out the interior or foreign gases. At the same time the apparatus is heated as by baking, or, in the case of the metallic portions, by high frequency induced currents whereby any adsorbed and occluded gases are released. All of these gases, including hydrogen, are pumped out with possibly another washing of hydrogen gas and finally the hydrogen is pumped out. This last exhausting of the hydrogen is usually accomplished in several stages, four or more stages often being the case. The device in its exhausted condition is then connected to a reservoir containing the chemically pure gas or gases used in filling.

All of these operations of exhausting and washing are carried on with the usual well known machines that are in use in the manufacture of thermionic vacuum tubes. In those devices, as is well known, there are two round tables, one of them being stationary, the other one rotating. The rotating table carries the apparatus to be exhausted while the stationary table has connected to it the exhausting pumps, hydrogen supply tanks and gas filling tanks. The apparatus to be exhausted is turned from one operation to the other operation, an oil seal between tables preventing any leaks into or out of the junction between the movable and stationary tables.

In the commercial manufacture of gas filled electric discharge apparatus, it often happens that a leak develops in the exhaust system whereby the tube or other envelope containing the electric apparatus is either not exhausted at all or is insufficiently exhausted. In any event, under such conditions, when a tube finally comes to the position for filling with the gas, it may happen that there is more pressure in the tube than in the gas supply line in which case the impure gases from the tube will contaminate the gases used for filling purposes.

Since the gases used for filling are costly, especially so because of the great purity required and since the entire gas supply system must be cleaned out and reexhausted if it is contaminated, it may readily be seen that an improperly exhausted bulb may ordinarily cause considerable trouble.

The pressure in the electric discharge apparatus, as for example the tube, may also be too low to do the above in which case the apparatus itself will be defective because of its impure gas contents. Furthermore, the gas filling of the tube must be adjusted to the predetermined value within rather close limits. It is commercially impractical to use any of the ordinary valves or have an operator turn off the gas supply when the filling is completed.

My invention aims at providing means whereby any impure gases in the electric discharge aparatus, because of defective exhaustion, will not contaminate the gas supply system and also provides means whereby the discharge apparatus is automatically filled to the correct pressure by means of a supply line which is automatically maintained at the correct gas pressure. My in-

vention further provides means whereby if the gas pressure in the supply tank becomes too low, a visible signal is given. Other and further advantages of my invention will become manifest as it is described in further detail.

Referring to the drawings, Figure 1 shows my improved regulator in detail with certain portions in section.

Figure 2 is a detailed view of a valve in the system.

Numeral 22 is the electric discharge apparatus which is exhausted, washed out, and then filled as described in general terms above. Tube 22 has the tubulature 24 inserted into the rubber connected pipe 25 of movable table 30 of any of the well known thermionic vacuum tube machines. Table 30 rotates 22 from one position to another step by step, stopping at every position. Assuming that the tube has been exhausted of its air content and washed with hydrogen, freed of the occluded and adsorbed gases, tube 22 is now shown in this figure as in the filling position and connected to supply pipe 33, having just moved from its previous exhausted position 32. With the tube in the position shown, gas comes from container or primary gas supply 1, through cock 2, through diffusion tubes 5 and 6, then on to reservoir or secondary gas supply 13, through Geissler tube 14 and down to supply pipe 33 into tube 22. The course of the gas through diffusion tubes 5 and 6 is determined by the closing of cocks 3 and 4.

Diffusion tube 5 comprises an inner tube 51, a plug of porous carbon 53 closing the end of tube 51, and a pool of mercury 52 in outer tube 54. This pool of mercury is just deep enough so that the surface is above the bottom of inner tube 51. This prevents any back flow of air or other gases into primary source 1. The gas in primary source 1, being at somewhat less than atmospheric pressure, may readily diffuse through plug 53, through the mercury pool, and into outer tube 54.

Diffusion tube 6 comprises outer tube 61 connected by tube 55 to the outer tube 54 of diffusion tube 5. The outer tube 61 has a pool of mercury 62 at the bottom. Inner tube 64 has its end closed up with a porous carbon plug 63. 7 is a steel or iron ring floating in the mercury pool. The mercury pool and inner tube 64 are so adjusted that as ring 7 floats in the mercury, the surface of the mercury will be above the bottom of inner tube 64, thus cutting off any gaseous communication from tube 55 to inner tube 64.

Manometer 9 has contacts 91, 92, and 93 as shown. This manometer is so adjusted that at the pressure of the gas filling desired in 22, contacts 92 and 93 are broken. If, however, the pressure in supply line 33 which is directly connected to secondary gas supply 13 should fall below the desired value, preferably about 15 mm. of mercury, the open ended mercury column is sucked up and makes contact between 92 and 93. This results in a circuit being established through solenoid 8, which is around diffusion tube 6 and so placed that when energized it will tend to pull up ring 7. The terminals 12 of this circuit are connected to any suitable source of energy, as for example, a battery. When contacts 92 and 93 are thus connected and electro-magnet 8 is energized, ring 7 is pulled up, allowing the level of the mercury to drop below the bottom of inner tube 64. Thus gas from primary source 1, which of course is at a suitable pressure, is allowed to go through diffusion tubes 5 and 6 and into the supply line. When the solenoid 8 is energized, a parallel circuit leading to lamp 10 is energized. This lamp which may be colored, lights up and thus visually indicates that the supply line 33 and secondary supply 13 need more gas. When the desired pressure in the supply system beyond diffusion tube 6 has been built up, the mercury column drops separating contacts 92 and 93 and opening the solenoid and lamp circuits. Magnetic ring 7, being released, drops into mercury pool and raises its level sufficiently to cut off the gas supply. At the same time lamp 10 is extinguished.

The secondary supply 13 may be as large as desired and is customarily made so that at least two or more tubes 22 may be filled before its pressure drops very much. The gas goes from secondary supply 13 through Geissler tube 14 where a discharge fed by high potential transformer 15 is maintained.

This discharge may be maintained continuously, or the tube may be so connected in the circuit of solenoid 8 or 18 as to maintain the discharge only when the solenoid is energized. The tube might also have an ordinary switch so the operator could start it whenever he wanted. This discharge by its color visually indicates the purity of the gas if one gas alone is used. Thus, in the case of helium, the peculiar bluish green color characteristic of that gas is given. Any impurity in the gas, however slight, causes a change in the color in the Geissler tube 14.

In case tube 22 has been improperly exhausted so that its gas content is higher than the gas filling should be, it may readily be seen that as soon as this tube is connected to the supply line gas from 22 will flow back into the supply line. This will result in a greater pressure in manometer 16 which is shown as connected between Geissler tube 14 and tube 22. Manometer 16 has contacts 161 and 162 with a mercury column so adjusted that a slight increase above the pressure desired in 22 will cause an increase in height of the closed end of the mercury column on the right hand side of the manometer and thus estab-

lish a connection between contacts 161 and 162. A battery or other source of electricity is connected at terminals 17, a circuit through solenoid 18 will be established and causing this solenoid to be energized. This will cause core 19 to be sucked in. Core 19 is connected to bell crank lever 20 by means of a pin and slot as shown, so that when core 19 is pulled into the solenoid, bell crank lever 20 is turned on its pivot so as to compress rubber tube 21 against plate 23. Hence, the gas supply line will be cut off upon the slightest increase in pressure. The action is so quick that very little gas can go back into the supply system to contaminate the gas for filling.

If desired, a one way valve similar to diffusion tube 5 may be inserted into the supply line between Geissler tube 14 and the junction of manometer 16 and the supply line. In this way, any back current of impure gas from tube 22 could never get to Geissler tube 14. However, in practice manometer 16 is so sensitive that the supply line is cut off before any appreciable amount of gas can flow into it. Then it takes an appreciable pressure to get the gas through the porous carbon plug. To utilize as much of the gas in 1 and 13 as possible, it is desirable that when there is a gaseous flow from 1 to 13 and also from 13 to 22, the flow be as unimpeded as possible.

In case the supply line beyond diffusion tube 6 should break or in case manometer 16 fails to function quickly enough or fails to function at all, the increased pressure due to the outside atmosphere in case of a break or its back flow from 22, would cause mercury in manometer 9 to rise up toward contact 91 and establish a contact between 91 and 92. This would close the circuit to lamp 11 which might be colored red and would serve to indicate the state of affairs. With cocks 3 and 4 closed, it may readily be seen that no gas impurity could ever get by diffusion tube 5. Hence, no matter what may happen, primary source 1 is always protected against the influx of contaminated gases.

In case the pressure in primary source 1 has fallen to a very low value and in case the suction pressure in tubes 5 and 6 is too great so that the supply line after diffusion tube 6 is at too low a pressure maintaining solenoid 8 and lamp 10 energized, it is possible to open cocks 3 and 4 and provide a direct path. Such a procedure would, of course, be very uncommon and in practice would only be used when 1 was almost exhausted. In case a new primary source 1 were connected to the supply system, cock 2 would be closed while cocks 3 and 4 would be open and the entire system would be exhausted so as to free it from the air rushing in when the old primary source was disconnected and a new one connected. The container itself has a glass seal not shown, so when it is fused to the supply line, the gas therein will not escape. As is customary a magnetic plug is raised and allowed to break this seal.

While I have described and illustrated my invention with respect to a sub-atmospheric pressure gas supply system in connection with an exhausting machine, it may be used independently thereof. Thus, primary source 1 and secondary supply 13 may well be replaced by any sort of a gas container and any sort of a reservoir in a supply system in which it is desirable to maintain the gas at a substantially constant pressure within very narrow limits. My invention could very well be applied to gas systems in which the pressure is greater than atmospheric pressure.

It will thus be seen that I have devised a simple, yet extremely sensitive system for controlling the gas pressure in a gas system which protects against leaks and which gives a visual indication of any abnormal condition.

I claim:

1. In a gas supply system for preexhausted electric discharge devices which have been substantially exhausted of undesirable gases and which are to be filled with gas of a predetermined quality and pressure, a gas supply, controlling means for maintaining said supply at the predetermined pressure, means for cutting off the flow of gas in either direction between the controlled supply and the device upon connection with a device containing gas at a greater pressure than that in the supply, and means interposed between said supply and said pressure responsive means for continually indicating the quality of the gas flowing between said device and said supply.

2. In the system set forth in claim 1, means operative in the event the pressure in said controlled supply drops below a predetermined value for indicating the pressure condition in said controlled supply.

3. In the system set forth in claim 1, a primary gas supply, a gas pipe connecting said primary supply to said controlled gas supply and means responsive to the variations in pressure of said controlled supply from the predetermined pressure for varying the gas flow from said primary source to said controlled supply for maintaining said controlled supply at said predetermined pressure value.

4. In the system set forth in claim 1, a primary gas supply, a gas pipe connecting said primary supply to said controlled supply and means operative in the event the pressure in said controlled supply changes from the predetermined value for preventing gas flow to said primary source.

5. In the system set forth in claim 1, a primary gas supply, a gas pipe connecting said primary source to said controlled supply, means responsive to the variations in pressure of said controlled supply from the

predetermined pressure for varying the gas flow from said primary source to said controlled supply for maintaining said controlled supply at said predetermined value and further means in said gas pipe connection operative to prevent gas flow from said controlled source to said primary source.

In testimony whereof I have signed my name to this specification March, 1928.

JOHN A. SPENCER.