Dec. 8, 1936. C. W. HANSELL 2,063,250

ELECTRICAL VACUUM PUMP

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Fig. 1

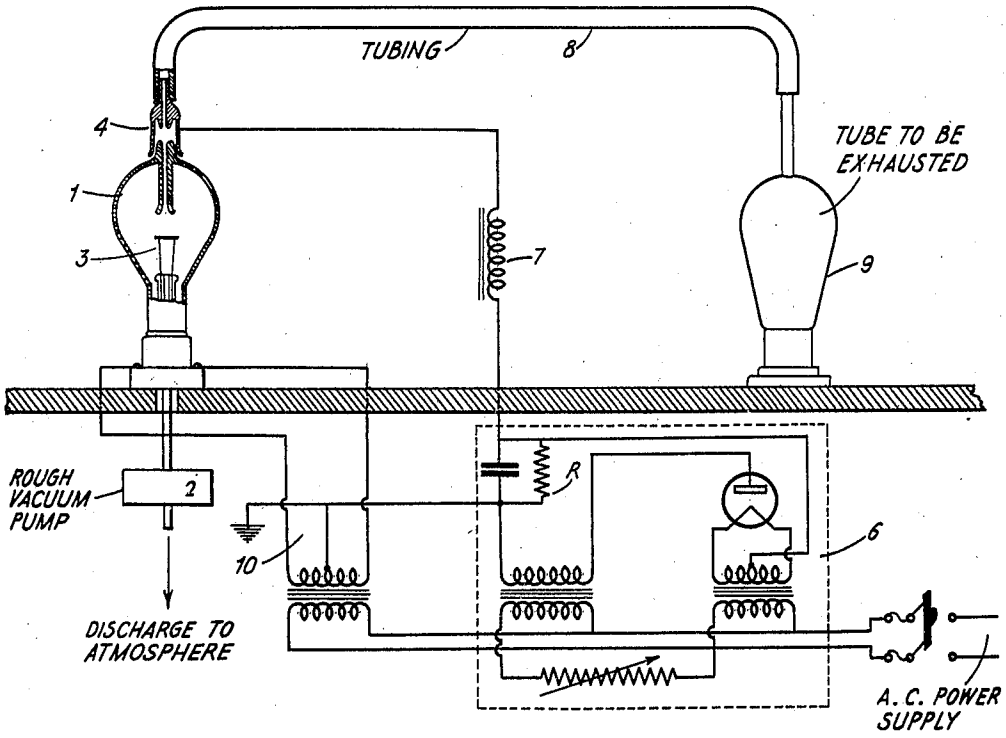
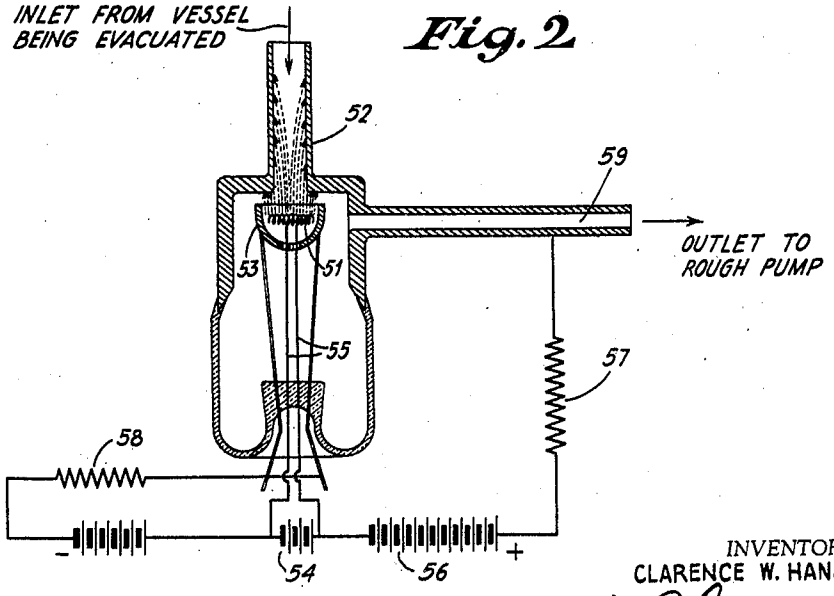


Fig. 2



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ELECTRICAL VACUUM PUMP

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Original applications December 14, 1932, Serial No. 647,189 and September 29, 1934, Serial No. 746,060. Divided and this application October 28, 1935, Serial No. 47,091. In Germany and Belgium December 14, 1933

7 Claims. (Cl. 230—69)

This invention is a division of United States Patent No. 2,022,465, granted November 26, 1935, and of application Ser. No. 746,060, filed September 29, 1934, and relates to apparatus for producing high vacua in closed receptacles, such as bulbs, electron discharge devices and the like, and has for its object to provide a simplified and improved type of vacuum pump.

In present day evacuation processes it is customary to use some form of rotating or reciprocating mechanical pump sealed with oil for producing an initial or rough vacuum. In manufacturing electron discharge devices for receiving purposes, the final evacuation is ordinarily accomplished by means of a "getter" inside the device, which, when heated, will absorb gases by chemical reaction. In the case of electron discharge devices for transmitting purposes, the usual method of producing the final vacuum is to employ a Langmuir mercury vapor condensation pump of the type described in United States Patent No. 1,393,550, granted October 11, 1921, to I. Langmuir, which is operated in series with a mechanical pump. It is common practice, in both of these cases, to heat up the elements of the discharge device during the evacuation process for the purpose of driving out occluded gases from the parts of the vacuum tube. Although these methods are successful, they require parts which are expensive and difficult to construct, with the result that they do not lend themselves readily to construction and operation by amateurs or to use in small laboratories. The present invention, however, by its simplicity of construction overcomes these difficulties and enables its use by amateurs, besides providing for obtaining faster evacuation and higher vacua. Another advantage of the present invention is that it is readily adaptable to large scale production of vacuum devices with the aid of automatic machines.

More specifically, the present invention comprises a vacum pump wherein electrical forces are utilized for effecting the evacuation process. This is accomplished by producing a direct current discharge through a tube or orifice between a vessel to be exhausted and the inlet to the rough pump, the discharge consisting chiefly of a flow of electrons in one direction and a flow of gas ions and molecules in the other direction. This flow of ions continues until the vessel is exhausted. To initiate the discharge and make starting easier it is proposed to use, in a preferred embodiment, a hot cathode and a relatively low voltage supply. If desired, however, there may be used relatively cold electrodes, the arc between them being established by the momentary application of very high voltages to directly ionize the gas in the discharge path.

Although the present invention will be hereinafter described with special regard to vacuum pumps, it should be distinctly understood that it is not limited thereto since the principles thereof may be used for producing pressure as well as obtaining a vacuum.

The following is a detailed description, accompanied by a drawing, wherein Figs. 1 and 2 illustrate simple forms of the present invention.

Referring to Fig. 1, there is shown a closed vessel 1 of a shape similar to an ordinary electric light bulb and having a connection from the inside thereof to a rough vacuum pump 2 of any suitable type for producing a partial vacuum within the bulb. Mounted inside the bulb is a cathode 3, which may be in the form of an ordinary electric light filament, which is arranged when heated to emit electrons. A metal electrode or anode 4, which is supplied with a positive potential from a high voltage rectifier arrangement 6 through an inductance 7, is adapted to attract the electrons emitted by the filament through a tube of insulating material 5. A suitable tubing 8 is arranged to extend from electrode 4 to vessel 9 which it is desired to exhaust. Inductance 7 is of comparatively large value and serves, once the arc has been established at the beginning of the pumping process, to increase the potential as the current in the arc tends to decrease as the vessel is evacuated, thus making it possible to obtain a higher vacuum than would otherwise be possible.

Any desired type of electrical circuit, such as 10, may be provided for lighting the filament in the bulb to produce electronic emission, and any well known source of direct current such as the rectifier arrangement shown in the drawing, may be used to place a positive potential on the anode 4, which is located at the end of the tubing 8.

The operation of the device is as follows:

When filament 3 is heated, a stream of electrons will flow from 3 to the positive anode 4, colliding on the way with molecules of gas in the vicinity of the anode and causing them to be ionized. This ionization will set up a discharge through the tube 5 having electrons moving from filament 3 to the anode 4 and ions moving from anode 4 to filament 3. The moving ions constitute a movement of the gas fom the vicinity of anode 4 to the bulb 1 containing the filament 3. So long as the discharge takes place through

a tube of small diameter such as 5, it is impossible for ions which have passed through the tube and been neutralized at the filament 3 to return again to the vicinity of anode 4. Consequently, by causing a high potential discharge between anode 4 and filament 3 there will be a movement of gas through the tube which will cause a vacuum to be produced in the vessel which is to be evacuated.

Fig. 2 shows a second embodiment of my invention in which the tubing 5, of insulating material, illustated in Fig. 1 is dispensed with. In Fig. 2, a hot cathode 51 is surrounded by a shielding element 53 and is placed near the opening of a metal inlet tube 52 which also acts as the anode. In operation, the cathode 51 is heated by an electrical current from source 54 over leads 55. A positive potential is applied to the metal anode element 52 by a source of potential 56 over a circuit in series with a resistance 57, thus causing the setting up of a flow of electrons from the cathode 51 to the anode 52. A portion of these electrons enter the inlet tube before striking the tube walls. The shield member 53 may have the same potential as the cathode or it may have a negative potential applied to it through a resistance 58 in the manner shown in the drawing to increase the proportion of the total number of free electrons which enter the inlet tube of metal part 52.

To start the pump, a fair degree of vacuum is first established in the system by means of a rough pump, not shown, which may be connected to opening 59. The cathode is then heated to a temperature where electrons are emitted and the potentials are applied to the other electrodes. Immediately, electrons traveling from the cathode 51 to the anode 52 begin to ionize the gases by collision, and the ions, being positively charged, are forced toward the negatively charged cathode 51 and shield 53. If the shield is more negative than the cathode, most of the ions will strike the shield. This will reduce disintegration of the cathode and prolong the life of the device.

The ions produced in the inlet tube of part 52, in passing toward the cathode and shield, constitute a flow of gas out of the tube. They are replaced by molecules diffusing out of the vessel to be evacuated and consequently a very high degree of vacuum will finally be obtained.

It should be distinctly understood that the present invention is not limited to the precise arrangements and design features shown since these have merely been illustrated for the purpose of setting forth clearly the principles of the present invention. The proportions and dimensions of parts may, and undoubtedly will, be altered to obtain optimum operation with different designs.

What is claimed is:

1. Apparatus for removing gas from a receptacle having, in combination, a bulb containing a filament adapted to emit electrons, an anode for receiving said electrons, a tube intermediate said filament and said anode and providing a passage for electrons between said filament and said anode, a closed receptacle which is to be exhausted, a conduit leading from said receptacle to said anode and communicating with said tube, a source of positive potential, a connection from said source to said anode, and a passage from said bulb to the atmosphere.

2. Apparatus for removing gas from a receptacle having, in combination, a bulb containing a filament adapted to emit electrons, a circuit for heating said filament, an anode external of said bulb for receiving said electrons, a tube intermediate said filament and said anode and providing a passage for electrons between said filament and said anode, a closed receptacle which is to be exhausted, a conduit leading from said receptacle to said anode and communicating with said tube, means for supplying a positive potential to said anode, an inductance intermediate said means and said anode, and a passage from said bulb to the atmosphere.

3. Apparatus for producing a vacuum comprising a tube having within a container an electron emitting cathode, an anode located externally of and communicating with the inside of said container, a vessel to be evacuated, said anode also communicating with said vessel, whereby there is a passage between said vessel and the inside of said container, and means for applying a positive potential to said anode with respect to said cathode.

4. Apparatus for producing a vacuum comprising an electron emitting cathode, a shield on one side of the cathode, an anode on the other side of said cathode, a vessel to be evacuated, said anode having an opening therethrough connecting with said vessel, and means for applying a positive electrical potential to said anode and a much lower potential to said shield with respect to said cathode.

5. Apparatus for producing a vacuum comprising an electron emitting cathode, a semi-circular shield surrounding part of said cathode, an anode facing the opening of said shield and adapted to collect electrons emitted from said cathode, a vessel to be evacuated, said anode having an opening therethrough connecting with said vessel, and means for applying a positive electrical potential to said anode and a much lower potential to said shield with respect to said cathode.

6. Apparatus for producing a vacuum comprising a tube having within a container an electron emitting cathode, an anode located externally of and communicating with the inside of said container, a vessel to be evacuated, said anode also communicating with said vessel, whereby there is a passage between said vessel and the inside of said container, means for applying a positive potential to said anode with respect to said cathode, and a passage from said container to the atmosphere.

7. Apparatus in accordance with claim 6, characterized in this that said last passage to the atmosphere includes a rough pump.

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