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APPARATUS FOR HIGH EVACUATION

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Fig. 1

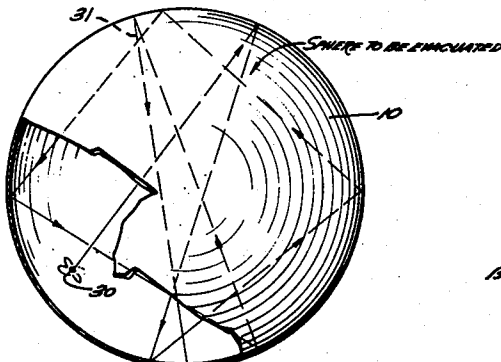
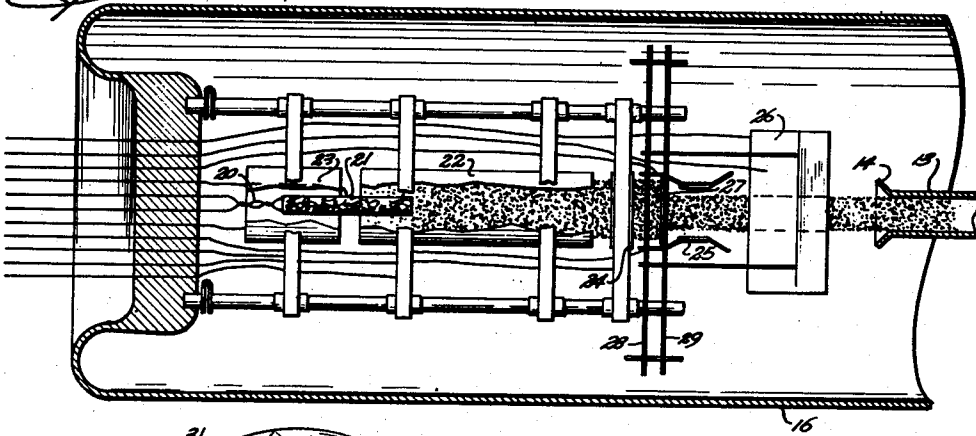
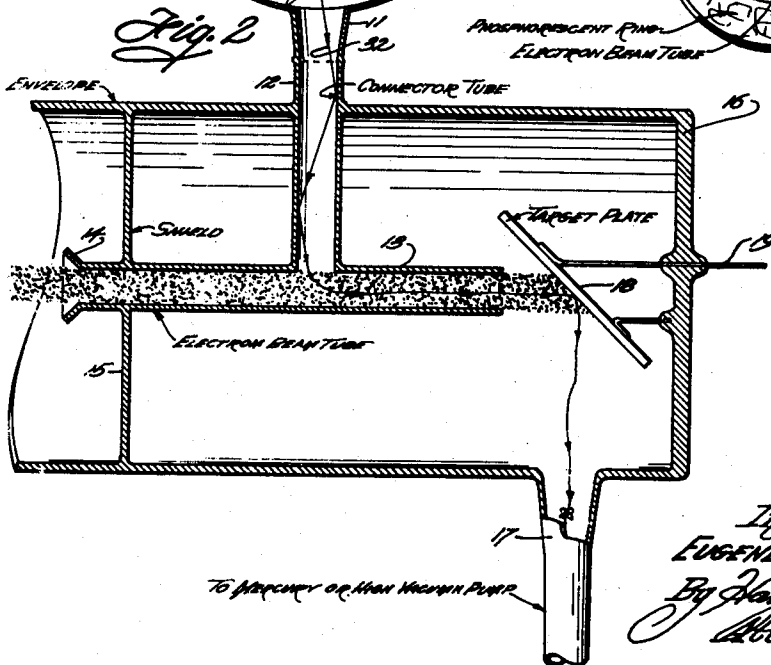
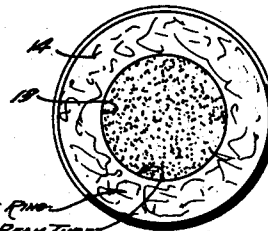


Fig. 3



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APPARATUS FOR HIGH EVACUATION

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3 Claims. (Cl. 230—69)

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This invention relates to an apparatus for highly evacuating radio, television, and like tubes, and is applicable to any situation wherein it is desirable to evacuate the interior of a tube or envelope to a very high degree.

In the construction of radio and television tubes for example, it is highly desirable to obtain a perfect vacuum in that remaining particles of gas tend to retard and disperse the flow of electrons in the radio or electronic tube. The filaments contained therein are damaged also by the remaining gas even though the amount of remaining gas may be very small. If it were possible to remove all remaining molecules of gas within the radio tube or other electronic tube their efficiency would be greatly increased in that the flow of electrons would not be retarded or dispersed and the filament life would be greatly prolonged. Consequently, for a given rated power smaller tubes could be employed and there would be a substantial decrease in the construction and maintenance costs.

Heretofore, vacuums of high degree have been obtained by the use of mercury pumps and other devices designed to pump out or evacuate the envelope of electronic tubes. However, although these devices are reasonably efficient they fall far short of obtaining a perfect vacuum due to the impossibility of creating a sufficient differential in pressure between that existing in the electronic tube and absolute zero to cause the few remaining atoms or molecules of gas to flow out of the tube.

An object of the present invention is to provide an apparatus designed to enable evacuating of a chamber to a much higher degree than that capable of being accomplished heretofore whereby a vacuum closely approaching a perfect vacuum may be developed within the chamber. In its broad aspect, the present invention contemplates exhausting air or gas from the envelope or chamber to as high a degree as is possible by any conventional method or apparatus such as a mercury pump. Although a high degree of vacuum is developed within the chamber or envelope because of the limitations of the mercury pump or other vacuum producing means, there will still remain in the chamber a number of gas particles which exert their pressure which may be only a very small amount above absolute zero by reason of the fact that these remaining gas particles are continually moving and bombarding the walls of the chamber. The conductor or connector tube leading off from the chamber and through which the chamber has been

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mainly evacuated by the mercury pump or other vacuum pump being left open, these remaining particles will in the course of time find their way into the conductor or connector tube. By raising the temperature in the chamber the speed of movement of the remaining gas particles will, of course, be increased and the probabilities of their finding their way into the connector tube will, of course, be increased. These particles that enter the connector tube could, of course, return to the chamber or envelope if no means were provided for permanently removing them from the connector tube after they have once entered it. The present invention contemplates discharging a beam of electrons across the connector tube so that when the particles of gas have entered the connector tube they will be picked up by the electron beam and carried away from the connector tube so that they can no longer return to the chamber or envelope. Consequently, during the elapse of a sufficient but relatively short period of time all particles of gas remaining in the envelope after it has been evacuated by the vacuum pump will eventually due to their own movements find their way into the connector tube and will be removed therefrom by the electron beam so that they can not return to the chamber that is to be evacuated.

With the foregoing and other objects in view, which will be made manifest in the following detailed description and specifically pointed out in the appended claims, reference is had to the accompanying drawings for an illustrative embodiment of the invention, wherein:

Figure 1 is a sectional view of an electron gun forming one part of the apparatus employed in conjunction with the present invention;

Fig. 2 is a sectional view of the remainder of the apparatus illustrating a spherical envelope as having been applied thereto to have its interior evacuated in accordance with the present invention; and

Fig. 3 is a view in elevation of the entrance to the electron beam tube.

Referring to the accompanying drawings wherein similar reference characters designate similar parts throughout, 10, indicates an envelope that is to be highly evacuated in accordance with the present invention. This envelope is illustrated as being spherical and as having been formed of glass. It will be understood, however, that the envelope may be formed of other materials and that it may be given any desirable shape. Electrodes, grids, filaments, and other articles may be positioned in and sealed in the

envelope, none of which have been illustrated. The envelope is shown as having an integral extension 11 fused to a connector or conductor tube 12 forming a part of the present apparatus so as to be hermetically sealed therewith. At the lower end of the connector or conductor tube there is disposed an electron beam tube 13 which is angularly arranged with respect to the connector tube 12. This electron beam tube preferably has a flared mouth indicated at 14 that is preferably coated with phosphorescent zinc sulphite to facilitate focusing of an electron beam therethrough. The electron beam tube 13 is suitably supported on a shield or partition 15 within a suitable housing or envelope 16, the interior of which is connected through an outlet 17 to a mercury pump or other high vacuum producing means.

Opposite the rear end of the electron beam tube 13 there is a target 18 which may be constructed of highly polished chromium. This target plate has a conductor 19 connected thereto so that it may have placed thereon a high protective charge. Within the housing or envelope 16 on the opposite side of partition or shield 15 from the target plate 18 there is an electron gun. Any conventional or preferred means for emitting and controlling a beam of electrons may be employed for this purpose.

In the construction illustrated there is a filament 20 which, when heated by passing an electrical current therethrough will heat the cathode 21. The cathode 21 which is an oxide-coated cylinder will, when heated, emit electrons. 22 indicates a focusing plate which by the positive attraction of a negative particle will cause the electrons emitted from the cathode to move forwardly toward the target plate 18. A grid 23 controls the number of electrons that pass from the electron gun to the focusing plate and thence to the target plate by varying the voltage imposed upon it with respect to the cathode 21. Adjacent the anode 24 there are deflecting plates both horizontal and vertical, indicated at 25 and 26. These deflecting plates direct the beam of electrons by negative repulsion and positive attraction. When a positive charge is placed on one plate the beam will be attracted toward it and by use of the four plates and imposing correct charges on the plates of each pair, it is possible to direct the beam of electrons in the desired manner. 27 indicates a nozzle consisting of a metal disc with an aperture therethrough equal in size to the interior size of the electron beam tube 13. It is supported on one of a pair of mica strengthening washers 28 and 29. Any other suitable electron-emitting devices capable of having its beam of electrons focused through the electron beam tube 13 toward the target plate 18 may be employed. In focusing the beam of electrons, the presence or absence of glow of the phosphorescent zinc sulphite coating on the mouth 14 of the electron beam tube is noted and adjustment is made so that a parallel beam of electrons, that is a beam which neither increases nor decreases in diameter, is caused to pass through the electron beam tube substantially filling it.

The operation and advantages of the above-described apparatus are as follows: With the tube or envelope 10 connected to the connector tube 12 the mercury or other high vacuum pump is started up which will evacuate to a high degree of rarification the interior of the housing or envelope 16, beam tube 13, connector tube 12, and

the interior of the envelope 10. The space surrounding the electron gun will also be highly evacuated inasmuch as the electron beam tube 13 is in constant communication therewith. While a high degree of vacuum may be produced within these spaces by the vacuum pump there will still remain in the envelope 10 a number of gas particles which it is desirable also to remove in obtaining as perfect a vacuum as possible. If 30 may be regarded as a typical one of such particles, the dotted lines 31 may be taken as representative of the path taken by such particle. This particle will bound and rebound from the walls of the envelope and in the course of time will eventually pass through the neck or extension 11 into the conductor tube 12 as is indicated by the pathline 32. By heating the envelope 10 and its contents the speed of the particle 30 may be increased as the speed of movement of the remaining particles in the envelope is directly related to their temperature. These particles on passing downwardly through the conductor tube 12 will encounter the stream of electrons emitted from the electron gun and flowing through the electron beam tube 13 toward the target 18. The electrons are carried off through the conductor or buss 19 and the gas particles on encountering the inclined target will be deflected downwardly toward the outlet 17 and may eventually find their way into the vacuum pump. However, if these should remain in the space surrounding the electron beam tube 13 they can not return back to the envelope 10. It will, of course, be appreciated if the envelope 10 is made non-spherical in form and that if it contains filaments, grids, or other elements that the presence of these other elements may cause the particle 30 to encounter them and thus prolong somewhat the amount of time required for the particles to find their way into the conductor tube 12. This may be compensated for somewhat by enlarging the cross-sectional areas of the neck 11 and the conductor tube 12. Although the mass of a molecule of gas such as a molecule of oxygen is about four million times that of an electron the electrons that are emitted by the electron gun are flowing toward the target 18 at extremely high velocity being proportional to the square root of the voltage applied to the circuit. As a large number of electrons are flowing from the electron gun towards the target 18 and at high velocity these electrons although they have very small mass will collectively have the effect of picking up the molecule that has entered the beam tube 13 from connector tube 12 and accelerating it in a direction toward the target plate. Thus, in a relatively short time all or virtually all of the remaining molecules of gas in envelope 10 will find their way into the beam tube 13 and be picked up by the electron beam and carried away so that they can not return to the envelope. It is, of course, to be understood that the higher the plate voltage that is applied the higher the velocity of electrons will be and the higher will be the resulting current. The higher the current the more electrons will be liberated from the electron gun. It is undesirable to have too large a number of electrons emitted nor to have the velocity given them too high. If the velocity and number of electrons passing through the beam tube 13 is extremely high the beam may present a "solid wall" which the slower-moving atoms or molecules or gas may fail to penetrate because of their lack of inertia. They may consequently fail to enter the beam tube 13 from connector tube 12. By proper ad-

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justment of the voltage applied to either the target plate 18 or the focusing plates or the grid 23, the number and velocity of the electrons that are passed through the electron beam tube 13 may be adjusted so that gas particles may enter the stream in the beam tube and be picked up by it and carried toward the target plate.

When the tube is evacuated by permitting remaining gas particles to pass from the envelope 10 to the beam tube 13 and thus be carried away for an adequate length of time, the neck or extension 11 may be heated to a molten condition to seal the envelope 10 in the conventional manner. Thereafter, a new envelope 10 may have its extension 11 fused to the connector tube 12 and it may be evacuated also. Where the envelope 10 contains various metallic elements, these elements are frequently heated electrically to drive off occluded gases. The present invention permits this step to be taken while the interior of the apparatus is being evacuated by the mercury pump through the outlet 17. The envelope 10 should, of course, be made of adequately strong glass to resist external pressures that may be imposed thereon and should also be capable of withstanding high temperatures without becoming molten inasmuch as heating the envelope will, of course, speed up the travel of remaining gas particles 30 and thus reduce the time required to completely evacuate envelope 10.

From the above-described apparatus it will be appreciated that by means of the present invention a very high degree of vacuum can be obtained which is much higher than that which is capable of being accomplished by means of the ordinary mercury pump, or other similar vacuum-producing means. When tubes or thermionic valves are evacuated in accordance with the present invention due to the high degree of rarification within the tube, the efficiency and life of the tube is materially increased.

Various changes may be made in the details of construction without departing from the spirit and scope of the invention as defined by the appended claims.

I claim:

1. An apparatus for evacuating a chamber or envelope comprising a housing, an electron gun at one end of the housing, a target plate at the

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other end of the housing, a partition in the housing between the electron gun and the target plate, a conductor tube leading into the housing to which the chamber or envelope to be evacuated may be connected, and a beam tube extending through the partition and connected to the conductor tube adapted to have an electron beam from the electron gun pass therethrough to the target.

2. An apparatus for evacuating a chamber or envelope comprising a housing, an electron gun at one end of the housing, a target plate at the other end of the housing, a partition in the housing between the electron gun and the target plate, a conductor tube leading into the housing to which the chamber or envelope to be evacuated may be connected, and a beam tube extending through the partition and connected to the conductor tube adapted to have an electron beam from the electron gun pass therethrough to the target, said housing having an outlet to which a vacuum pump may be connected.

3. An apparatus for evacuating a chamber or envelope comprising a housing, an electron gun at one end of the housing, a target plate at the other end of the housing, a partition in the housing between the electron gun and the target plate, a conductor tube leading into the housing to which the chamber or envelope to be evacuated may be connected, and a beam tube extending through the partition and connected to the conductor tube adapted to have an electron beam from the electron gun pass therethrough to the target, said housing having an outlet to which a vacuum pump may be connected, the entrance to the beam tube having a coating of phosphorescent zinc sulphide.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,587,321	Hunter	June 1, 1926
1,950,008	Mutscheller	Mar. 6, 1934
2,182,751	Reitherman	Dec. 5, 1939