Dec. 25, 1962 L. D. HALL 3,070,283

VACUUM PUMP

Filed June 15, 1959 2 Sheets-Sheet 1

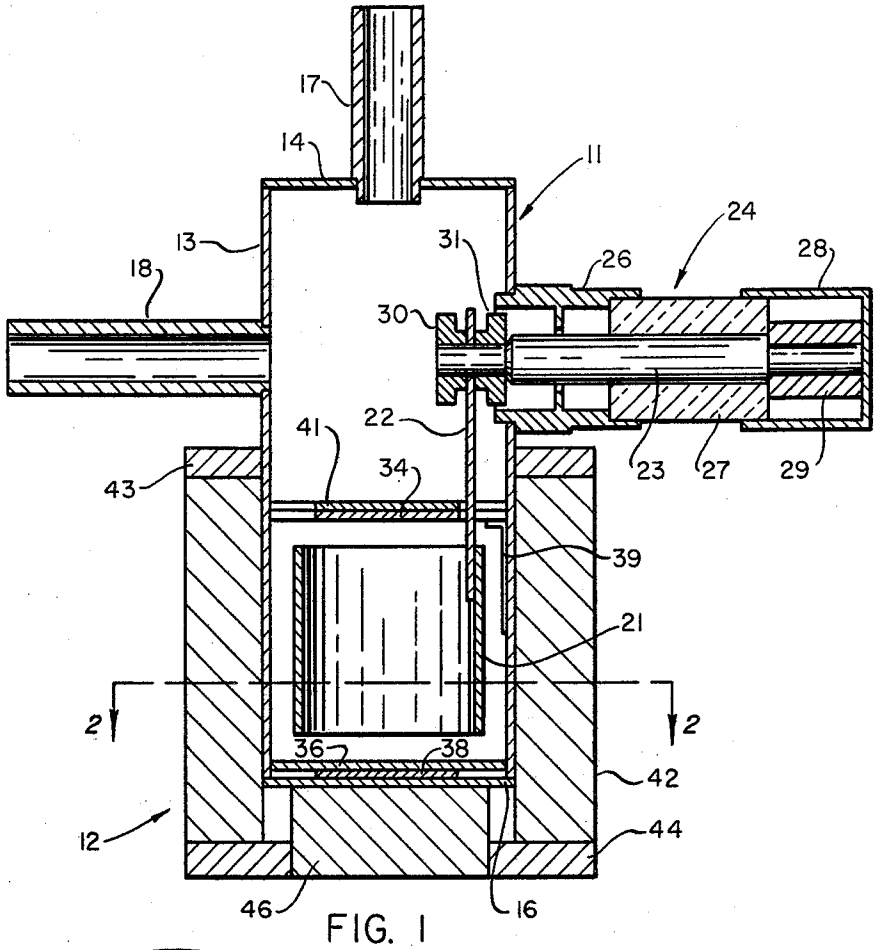


FIG. 1

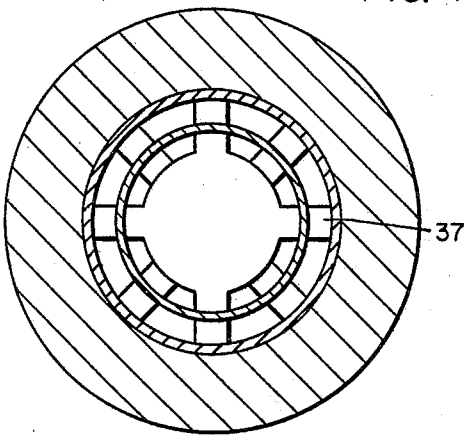


FIG. 2

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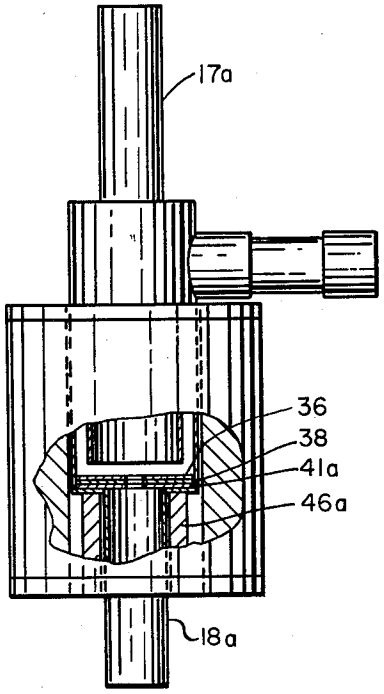


FIG. 3

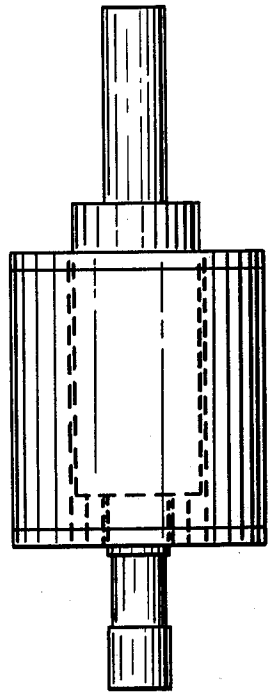


FIG. 4

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VACUUM PUMP

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This invention relates generally to a vacuum pump and more particularly to an electronic vacuum pump.

In many applications it is desirable to have a vacuum pump which has minimum size and weight. For example, such pumps may be permanently attached to a vacuum tube to maintain a high vacuum within the tube. Typical tubes for which pumps of this type are useful are klystrons, travelling wave tubes, X-ray tubes, display tubes, and the like.

Electronic pumps employing arc discharge are well known in the art. In such pumps an electric field is provided between a cathode and anode. A magnetic field is applied substantially parallel to the anode surface. Electrons travelling from the cathode to the anode are deflected by the magnetic field and traverse a relatively long path. These electrons collide with the gas molecules and form atoms (dissociated molecules) and metastable molecules, which are collected on the surface of the anode. The surface of the anode is continuously replenished from the cathode by sputtering of the cathode due to bombardment.

It is an object of the present invention to provide a vacuum pump assembly which is compact and light in construction.

It is another object of the present invention to provide an electronic vacuum pump including an improved magnetic structure.

It is still a further object of the present invention to provide an electronic vacuum pump assembly including a cylindrical magnet which closely surrounds a cylindrical pump and in which the pump contains internal means for concentrating the magnetic fields within the pump.

These and other objects of the invention will become more clearly apparent from the following description when taken in conjunction with the accompanying drawing.

Referring to the drawing:

FIGURE 1 is an elevational view in section of a vacuum pump assembly in accordance with the invention;

FIGURE 2 is a sectional view taken along the line 2—2 of FIGURE 1;

FIGURE 3 is an elevational view, partly in section, of another pump assembly in accordance with the invention in which the tubulations are axial; and

FIGURE 4 is an elevational view of a pump having an axial high voltage lead-in.

As illustrated in the figures, the pump assembly includes a tube portion designated generally by the reference numeral 11 and a magnetic assembly designated generally by the reference numeral 12. The tube portion includes a cylindrical envelope 13 which is made of a nonmagnetic material, such as stainless steel. The envelope is completed by the end discs 14 and 16 which are suitably sealed, as for example, by welding to the ends of the cylindrical portion 13. The disc 14 is adapted to receive a section of tubing 17 which is suitably brazed or welded thereto. A section of tubing 18 is suitably brazed or welded to the cylindrical envelope portion 13. The sections of tubing 17 and 18 are adapted to be connected to the apparatus with which the pump is associated. For example, if the pump is employed as a continuous getter for a vacuum tube, one of the sections, for example 17, may be connected directly to the pump-out tubulation of the vacuum tube and the other tube section used as the pumping tubulation. The tube may then be evacuated by a mechanical pump. When the pressure is sufficiently low, the tubing connected to the pump is pinched off. Subsequently, the electronic vacuum pump is energized and serves to further pump and maintain the vacuum within the electron tube to which it is connected.

A cylindrical anode 21 is carried within the envelope portion 13 and spaced therefrom. The anode is supported within the envelope by means of a strap 22 suitably attached to the lead-in conductor 23 of the high voltage lead-in assembly, designated generally by the reference numeral 24.

The high voltage lead-in assembly illustrated includes a sleeve 26, which is suitably sealed to the envelope 13. A ceramic spacer 27 is attached to the other end of the sleeve 26 and receives a cap 28. The ceramic is suitably brazed to the associated metallic portion to form a vacuum tight connection. The lead-in 23 is supported by a metal sleeve 29 carried between the cap 28 and the adjacent end of the ceramic cylinder 27. Suitable metal washers 30 and 31 serve to hold the strap 22 in position on the lead-in 23. Lower and upper cathode plates 34 and 36 are provided. The cathodes have a disc-shaped configuration with outwardly extending tabs 37 (FIGURE 2) which serves to center the disc portion within the envelope. The lower cathode plate 36 is suitably secured to a spacer 38, as for example, by spot welding, which spacer, in turn, is secured to the lower envelope disc 16.

The spacer may be made of stainless steel or the like. The cathode discs are preferably made of reactive material such as metal or alloys. Sutable metals are titanium and zirconium. The reactive metals or alloys are sputtered to form a film which serves to entrap gas molecules and radicals, as is well known in the vacuum pump art.

The upper cathode disc 34 is held in position by a bracket 39 suitably secured to the side wall 13 and to one of the tabs of the cathode disc. A disc 41 which is made of soft magnetic material, such as soft steel or iron, is secured to the cathode disc 34. As will be presently described, the disc tends to concentrate the magnetic field in the center of the envelope.

The magnetic assembly 12 includes a cylindrical magnet 42 which is adapted to fit over the cylindrical envelope portion 13. The magnetic materials have high coercive forces such as Alnico V or VI. An upper pole piece 43 having low coercive force is attached to the upper end of the cylinder. The pole piece is in the form of a washer made of mild steel or iron.

The other end of the cylindrical magnet receives a washer 44 having low coercive force, which has secured thereto a member 46 also having low coercive force. The member 46 is cylindrical and extends upwardly to abut against the bottom of disc 16 of the tube envelope. The magnetic disc 41 secured to the cathode serves to concentrate magnetic lines extending inwardly from the pole piece 43. A substantially axial magnetic field is set up within the tube.

In operation the envelope is maintained at or near ground potential and a relatively high voltage is applied to the anode. There is an arc discharge and electrons emitted by the cathode are accelerated toward the anode. However, the axial magnetic field causes the electrons to follow a spiral path. This increases the probability of collision with gas molecules. The positive particles formed are attracted by the cathode and bombard it. This causes heating and sputtering of the cathode. The metal which is sputtered off coats the inside of the anode. Thus, the anode getter material is continuously replenished as the pump is operated.

In FIGURE 3 there is illustrated a pump which includes axial sections of tubing 17*a* and 18*a*. The member 46*a*

which acts as a pole piece is bored to receive the tubulation. A second magnetic disc 41*a* is disposed within the envelope adjacent the lower cathode plate 36 to concentrate the magnetic fields. The remainder of the parts is similar to those previously described.

In certain other applications it may be desirable to have an axial high voltage lead-in. Such an assembly is schematically illustrated in FIGURE 4.

It is observed that the complete vacuum pump assembly is relatively compact and light in construction. The vacuum pump may include a pair of tubulations making it relatively easy to connect the pump to associated equipment.

I claim:

1. An electronic vacuum pump including an envelope member, spaced cathode plates and an anode disposed between said plates all disposed in said envelope member, a permanent magnet separate from and outside said envelope member and surrounding said anode and providing a magnetic field substantially perpendicular to the surface of the cathode plates, means within said envelope member and carried adjacent at least one of said cathode plates for concentrating the magnetic field, and means providing communication between the envelope member and associated equipment.

2. A vacuum pump comprising a cylindrical envelope member, a cathode plate spaced from one end of said envelope member, a hollow cylindrical anode carried within said envelope member and defining an ionization space therein, and a second cathode plate spaced from the first cathode plate on the opposite end of said cylindrical anode, magnetic means surrounding the exterior of said envelope member and providing a substantially axial magnetic field, means for concentrating the field and carried within the envelope member, and at least one outlet formed at the other end of said envelope member and providing means for securing the pump to associated equipment.

3. Apparatus as in claim 2 wherein said magnetic means includes a cylindrical magnet adjacent the envelope member, a pole piece disposed at said one end of said cylindrical envelope member, said pole piece including a cylindrical portion extending upwardly and in contact with the adjacent portion of the envelope member.

4. A vacuum pump as in claim 2 which includes a pair of outlets at said one end, one of said outlets disposed axially of the envelope member and the other disposed radially of the envelope member.

5. An electronic vacuum pump including an envelope member, spaced cathode plates and a hollow anode disposed between said cathode plates all placed within said envelope member, a magnet outside said envelope member and surrounding said anode and providing a magnetic field substantially perpendicular to the surface of the cathode plates, means within said envelope member and carried adjacent each of said cathode plates for concentrating the magnetic field, and means providing communication between the envelope member and associated equipment.

6. A vacuum pump comprising a cylindrical envelope member, a cathode plate spaced from one end of said envelope member, an open cylindrical anode carried within said envelope member and defining an ionization space therein, a second cathode plate spaced from the first cathode plate on the opposite end of said cylindrical anode,

a high voltage lead-in extending through the envelope member and making electrical connection with the anode, magnetic means surrounding the exterior of said envelope member and providing a substantially axial magnetic field, means carried within the envelope member adjacent each of said cathode plates for concentrating the field within the anode, and a pair of axially disposed outlets one at each end of the envelope member.

7. A vacuum pump comprising a cylindrical envelope member, a cathode plate spaced from one end of said envelope member, an open cylindrical anode carried within said envelope member, a second cathode plate spaced from the first cathode on the opposite side of said cylindrical anode, magnetic means surrounding the exterior of said envelope member and providing a substantially axial magnetic field means carried within the envelope member for concentrating the field within the anode, at least one outlet disposed at one end of said envelope member, and a high voltage lead-in disposed axially at the other end of said envelope member and providing means for making electrical connection through the envelope member to the anode.

8. An electronic vacuum pump including an envelope member, spaced cathode plates and an open cylindrical anode disposed between said plates all disposed in said envelope member, magnetic means serving to provide a magnetic field substantially perpendicular to the surface of the cathode plates, means carried within the envelope member adjacent at least one of said cathode plates for concentrating the magnetic field within said anode, and outlet means for connecting the interior of the envelope member to associated equipment.

9. A vacuum pump comprising a cylindrical envelope member, spaced cathode plates and an open cylindrical anode disposed between said plates all disposed in said envelope member, magnetic means serving to provide a field substantially perpendicular to the surface of the cathode plates, a high voltage lead-in extending through the envelope member and making electrical connection with the anode, means carried within the envelope member adjacent at least one of said cathode plates for concentrating the magnetic field within said anode, and an outlet communicating with the interior of the envelope member and providing means for securing the pump to associated equipment.

10. An electronic vacuum pump including an envelope member, spaced cathode plates and an open cylindrical anode disposed between said cathode plates all placed within the envelope member, means for providing a magnetic field substantially perpendicular to the surface of the cathode plates, means carried within the envelope member adjacent at least one of said cathode plates for concentrating the magnetic field within said anode, and a pair of outlet means communicating with the interior of said envelope member and providing means for connection to associated equipment.

References Cited in the file of this patent

UNITED STATES PATENTS

2,755,014	Westendorp	July 17, 1956

FOREIGN PATENTS

684,710	Great Britain	Dec. 24, 1952
754,515	Great Britain	Aug. 8, 1956
797,232	Great Britain	June 25, 1958