March 14, 1967 J. S. HETHERINGTON 3,309,010

GETTER ION VACUUM PUMP

Filed Feb. 10, 1964

FIG. 1

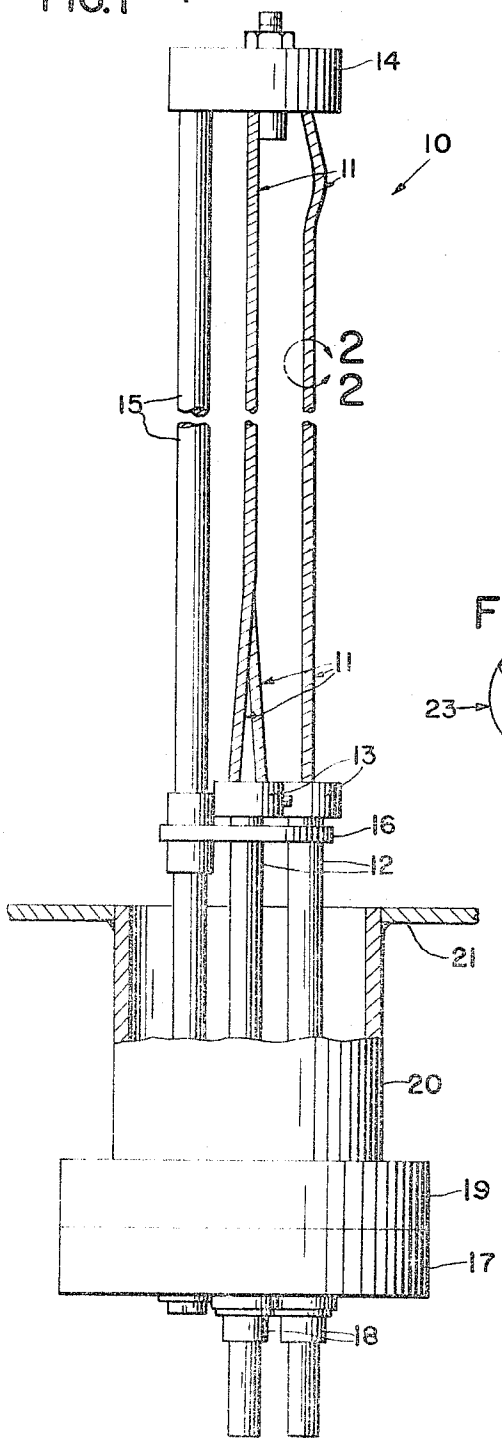


FIG. 2

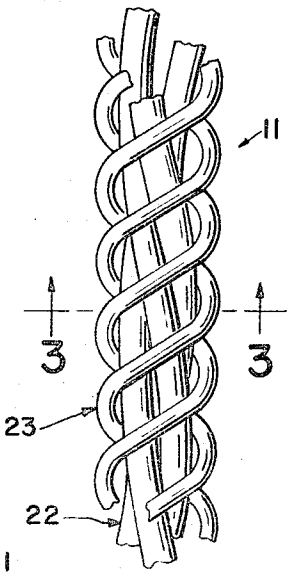


FIG. 3

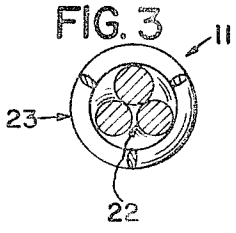
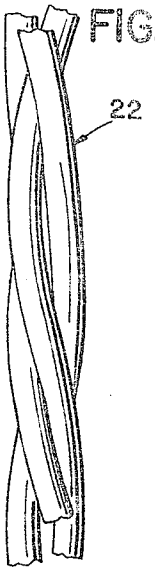


FIG. 4



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GETTER ION VACUUM PUMP

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This invention relates to vacuum pumps of the gettering type and more specifically to novel sublimation means for use in such pumps.

Pumping by thermally evaporating or subliming getter materials onto the walls of a pump housing has been well known for many years. Gas molecules coming into contact therewith combine chemically or physically with the condensed material and are removed from the gaseous state so as to reduce the pressure. Using pumping apparatus of this type extremely high pumping speeds have been achieved, in excess of 3500 liters/sec. for the active gases such as O_2, N_2, CO and CO_2. While such apparatus may not be employed for pumping the noble gases, in combination with a glow discharge vacuum pump, which can pump the noble gases and other inactive gases, an even more practical and useful pump apparatus results.

In the past, the sublimation means ordinarily comprised a filament made of a metal having a high melting point (e.g., refractory metals such as tungsten or tantalum) in the form of a rod, a single strand or a rope, overwound with a coil of wire made of a metal having a lower subliming temperature than the melting point of the filament and having good gettering properties (e.g., reactive metals such as titanium or zirconium). The getter was supported by the filament and initially was in good thermal contact therewith throughout its length. A volage was then applied across the sublimation means. Since the resistivity of the filament was much less than that of the getter most of the power was generated in the filament. The filament was heated by the current passing threthrough until a temperature was reached at which the getter material was caused to sublime.

It was observed, however, that the voltage leads, while providing electrical connection to the filament, additionally served as thermal paths away from the filament, with the result that the filament was not of uniform temperature along its length, the hottest spot generally being near the point farthest removed from the voltage leads. For example, in the case of a filament in the form of a rod having voltage leads connected to opposite ends, a region along the rod midway between the ends of the rod would be at the highest temperature. The getter material wound over this region being heated from the inside out would sublime until so much of the material had sublimed as there would no longer be thermal contact between the filament and getter materials. Thereafter, it would be necessary to raise the temperature of the filament by increasing voltage, to continue heating of the getter material at the mid region by radiation. At this elevated temperature the getter material wound over regions adjacent to the mid region became molten and alloyed with the filament to corrode it and prematurely burn out the sublimation means.

Accordingly, it is the principal object of the present invention to provide an improved sublimation means for use, for example, in getter ion vacuum pumps.

Briefly stated, in accordance with one teaching of the present invention, there is disclosed a sublimation means comprising a getter overwound with a filament. Preferably, the getter is in the form of a short multiple stranded thick rope of a reactive metal, for example, titanium, loosely fitted within the filament which is made up of a long thin coil or plurality of coils of some refractory metal, for example, tungsten. When a voltage is applied

across the sublimation means, the getter is heated along its length by radiation from the outside in by the filament. Also, since the getter is short and thick, while the filament is long and thin, initially power consumption is more evenly distributed between both. As the getter material is sublimed away, voltage requirements remain essentially fixed whereby a constant voltage power supply may be used. The use of a multiple strand of reactive material reduces the occurrence of premature burn-out due to hot spots along the length of getter material. Loosely fitting the getter within the filament releives stress from the getter and further reduces the possibility of premature burn-out due to hot spots.

One feature of the present invention is the provision of novel sublimation means comprising a length of getter material overwound with a length of filament.

Another feature of the present invention is the provision in a getter ion vacuum pump of a novel sublimation cartridge unit including sublimation means of the above type mounted on a flange member and adapted to be sealed in vacuum tight manner to said pump.

These and other objects and features of the present invention and a further understanding may be had by referring to the following description and claims, taken in conjunction with the following drawing in which:

FIG. 1 is a view of the novel sublimation cartridge unit of the present invention partially broken away;

FIG. 2 is an enlarged fragmentary view delineated by the arrows 2—2 of FIG. 1;

FIG. 3 is a cross-section taken along the lines 3—3 of FIG. 2; and

FIG. 4 is an enlarged, fragmentary view of the getter material of the present invention.

Referring now to FIG. 1 there is shown a sublimation cartridge unit **10** employing the novel features of the present invention. Unit **10** includes a plurality of sublimation means **11** which may be individually energized as each one is used up. Sublimation means **11** are each removably held at one end against metal rod leads **12** by set screw clamp means **13** and at the opposite end by a single set screw clamp means **14** supported on rod **15**. Loosening and tightening of these screws is all that is necessary to replace a sublimation means **11**. An apertured ceramic spacer plate **16** prevents shorting out of sublimation means **11**. Support rod **15** and rod leads **12** are supported by and passed through, in vacuum tight manner, an all metal vacuum sealing flange **17**. The rod leads **12** are electrically isolated from flange **17** by ceramic insulator assemblies **18** welded in vacuum tight manner to rod leads **12** on the one hand and flange **17** on the other hand. Flange **17** is adapted to mate with, in vacuum tight manner, another all metal vacuum sealing flange **19** welded on a walled passage **20** leading into the housing of a vacuum pump **21**.

Referring more particularly to FIGS. 2–4 the novel sublimation means **11** includes a getter **22** in the form of a rope of a reactive metal. In a preferred embodiment the metal is titanium. However, any one of a number of materials or alloys may serve as the getter material in the sublimation means of this invention. Zirconium, uranium and other metals particularly in Groups IV and V of the Periodic Table, for example, can be employed. Aluminum, alkaline earth metals and the alkaline metals are still other materials which can be used in the present invention. In a typical embodiment the getter is comprised of three strands of 0.030" diameter titanium wound at two turns per inch to form a rope 6 3/16" long and 0.064" in diameter.

The getter **22** is loosely fitted within a filament **23** of a refractory metal, being spot welded thereto at opposite ends (not shown). Filament **23** is preferably a long, thin coil. In a typical embodiment, the filament is comprised

of three wires of 0.015" diameter tungsten wound at six turns per inch to form a coil 6$\frac{3}{16}$" long.

In operation the pump **21** and the system to be evacuated (not shown) to which pump **21** is connected are partially evacuated (roughed) down to 10 microns with a mechanical pump or a refrigerated sorption pump. A constant voltage power supply (not shown) of, for example, 5–6 volts is connected to one of the sublimation means **11**, and current passed therethrough, for example, 30 amperes, which is insufficient to cause sublimation of any of the getter material, but effects out-gassing of same. The evolved gas is pumped by the roughing means which then may be isolated from the remainder of the system. The power supply is then run at, for example, 35–45 amperes to cause sublimation of the getter material. At higher currents the getter **22** will become overheated, melt, alloy with the filament **23** and corrode same.

For optimum getter material utilization the getter should be sublimed in proportion to the pressure in a system. At high pressures the getter is consumed rapidly and therefore the sublimation means should be operated at 100 percent duty-cycle. At pressures below 10^{-5} torr down to 10^{-8} torr, approximately 25 percent duty-cycle is sufficient to remove gas as fast as it enters the system. As the getter is consumed the current therethrough will fall due to the increase in the resistance of the getter as its cross section decreases. Sublimation means of the type disclosed herein have been made and have an approximate operating life of 6 hours running at 100 percent duty-cycle. When operated in combination with glow discharge pumps they have demonstrated useful pumping speeds from 10^{-2} to 10^{-11} torr.

Since many changes can be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In a getter ion vacuum pump, the improvement which comprises a sublimation cartridge unit including a sublimation means made of a length of getter material and a length of filament wound over said getter material said getter being made up of a thick multiple stranded rope of reactive metal, a flange member supporting said sublimation means, said flange member adapted to be sealed in vacuum tight manner to said pump, and feed-through means for supplying high current low voltage to said sublimation means through said flange member in vacuum tight manner.

2. A sublimation means comprising a length of filament, a length of getter material overwound by and loosely held within said filament, said getter being made up of a thick multiple stranded rope of reactive metal, and said filament being made up of one or more coils of a refractory metal.

3. The means according to claim **2** wherein said getter is titanium and said filament is tungsten.

References Cited by the Examiner

UNITED STATES PATENTS

2,731,581	1/1956	Krefft	313—344
2,804,564	8/1957	Couch	313—180
2,837,680	6/1958	Leferson	313—180
2,986,326	5/1961	Landfors	313—7.3

References Cited by the Applicant

UNITED STATES PATENTS

2,796,555	8/1957	Connor.
2,925,214	2/1960	Gurewitsch et al.
3,007,627	11/1961	Reich.
3,112,864	12/1963	Hall et al.
3,117,210	1/1964	Herb.
3,121,155	2/1964	Berry.

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