

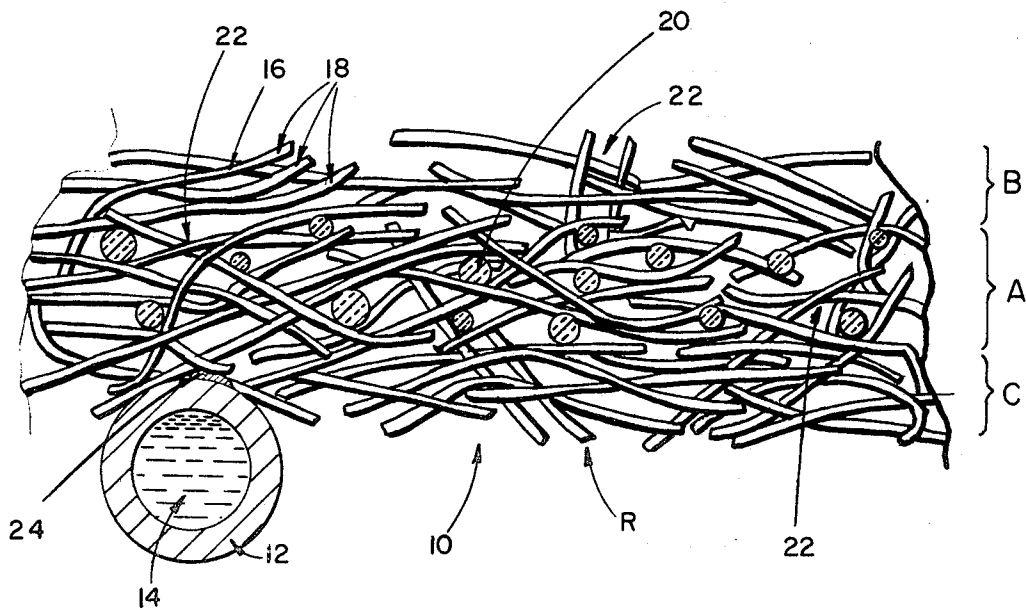
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HIGH VACUUM PUMP WITH CRYOSORPTION PUMPING ELEMENT

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1

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HIGH VACUUM PUMP WITH CRYOSORPTION PUMPING ELEMENT

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ABSTRACT OF THE DISCLOSURE

A cryosorption vacuum pump element with a porous mass of sintered fibers forming tunnels and dispersed sorbent powders in the tunnels.

The present invention relates to vacuum pumps of the cryosorption type; that is, pumps with a pumping element containing sorbent such as activated charcoal or natural or synthetic zeolite.

Background of the invention

The cryosorption vacuum pump has been known since used as a rough pump by Sir James Dewar and Thomas Edison, circa 1875. This form of usage continues to the present day; e.g., Grant et al., Review of Scientific Instruments, May 1963, pp. 587-8. In recent years there has been a great deal of interest in the usage of cryosorption pumps for the high vacuum range.

Cryosorption pumps, like cryogenic pumps, afford the advantage over ion and diffusion pumps of freedom from electrostatic and magnetic fields and freedom from pump generated hydrocarbons such as methane or pump oil. Cryosorption pumps afford the advantage over cryogenic pumps of trapping high vapor pressure gases such as nitrogen at 77° K. and under high vacuum, hydrogen at 20° K., etc., that would escape a cryogenic pump. Cryosorption pumping elements can be used in separate pump bodies or gas pumping elements in, say, an environmental test chamber which may be thought of as a "pump" for purposes of this application.

However, the use of cryosorption in high vacuum pumping requires an effective sorbent mounting arrangement. A cryosorption pumping element must withstand cycling over a substantial temperature range—operating as a pump at 77 or 20 or even 4.2° K. and then baking out at about 573° K. between pumping cycles to regenerate the sorbent. Good bonding of the sorbent to the pumping element is necessary to withstand these wide swings of temperature. Good bonding is also necessary to provide effective heat transfer within the pumping element. Other desiderata of cryosorption pumping elements are freedom from organic components such as conventional epoxy binders, ruggedness, economy of manufacture and exposure of substantially all the contained sorbent to the gas to be pumped.

Object

It is the object of the invention to provide a new cryosorption pumping element for use in high vacuum pumps which affords compatibility with the high vacuum environment and high pumping speed as well as ruggedness, economy and good bonding of its contained sorbent. Other objects, features, and advantages will be stated in or will be apparent from the following description of the invention.

General description

In accordance with the foregoing objects, a new cryosorption pumping element is provided for high vacuum pumps. The element comprises a sintered mass of metallic fibers and sorbent powders. This combination offers

2

improvement over the prior art in several respects. It provides excellent thermal conductivity for a cryosorption pump element, the conductivity through the metal fiber mass being 5-20% of that of the same volume of solid metal. The volume of less conductive sorbent is dispersed by its powder form; the sorbent itself does not substantially impede the necessary heat transfer as in prior art arrangements. This combination also offers a unique interaction of its components. The sintered mass of metal fibers provides a porous structure with tunnels leading to the sorbent powder within. The "walls" of these tunnels are the metal fibers which tend to wick the gas being pumped. That is a statistical majority of gas molecules striking the metal fiber with residual energy preferentially glide along the fiber surface rather than leaving the fiber surface. They glide until they are conducted to sorbent particles where they are pumped by entry into the pores of the sorbent. Some gas molecules striking the metal fibers are cryopumped or cryosorbed by the porous metal fiber mass itself. Furthermore, the use of dispersed powdered sorbent as opposed to bulk sorbent or sintered powder sorbent provides a maximum ratio of external sorbent surface to total sorbent with consequent increase in both pumping speed and total gas capacity.

Specific description

The invention has been generally described above. A preferred embodiment is now described specifically with reference to the accompanying single figure of drawing which is a cross-sectional representation of a portion of a cryosorption element according to a preferred embodiment of the invention.

The cryosorption pumping element 10 has a plate form with forward and reverse surfaces F and R. A coolant pipe 12 carrying a cryogenic coolant 14 such as liquid nitrogen is brazed to the element 10. The element itself is formed of a felted or woven mass of metal fibers 16, preferably copper. The fibers make random contacts with each other and are sintered at these contact points 18. Methods of making such porous metal fiber bodies are disclosed, for instance, in U.S. Patents 2,903,787 and 3,178,280. The properties of a fiber system such as that shown in U.S. Patent 3,178,280 are given in Materials and Design Engineering magazine, October 1964 issue.

In the present combination, the fiber metal system is arranged to provide a density between 20 to 30% of equivalent solid metal. The metal fibers are on the order of about 10 to 100 microns (.004 inch) in diameter and about 1/10 to several inches in length. The mass is constructed to provide a median tunnel diameter on the order of 10-20 microns. Sorbent powders 20 such as Linde 13X synthetic zeolite having an average diameter of 10 microns are incorporated in the fiber metal. In this combination the fibers form intersecting tunnels 22 leading to the sorbent powders therein.

The fiber mass is prepared with an inner layer A containing the sorbent powders and outer layers B, C free of sorbent powders. The outer layers prevent migration of the sorbent powders out of the pumping element. The thickness of the element 10 is about 1/8 to 1/2 inch. In brazing the copper pipe 12 to the element 10, the local surface 24 of the element is ground to weld the fibers together at the contact point, thus providing a barrier to prevent the braze alloy from wicking into the pumping element.

While the invention has been described in terms of its principal usage as a high vacuum pump, it should be understood that other applications are feasible. For instance, a canister can be provided with a stack of plates 10 mounted on a chilled support, or a stack of plates 10 brazed to copper plates which are mounted on a chilled

3

support, for use as a roughing pump. A plate 10 can be mounted as a baffle above the inlet of a diffusion pump or ion pump and used with or without chilling to trap backstreaming gas molecules from the pump and, with cryogenic cooling, to pump the system through the intermediate range of vacuum between rough vacuum; e.g., (10 microns and above) and high vacuum (.1 micron and below).

Several variations can also be made in the cryosorption plate 10 itself within the scope of the invention. The term "plate" as used herein refers to various thin wall members such as cylinders or flat plates. The sorbent metal composite can be formed in a wide variety of curved shapes. Other permissible variations would include the substitution of other conductive metals and sorbents for the copper and metal silicate disclosed above. A solid metal backing plate can be clamped or brazed to the fiber structure of the invention and the density of fibers can be graded to be heaviest adjacent the backing plate and lightest away from the backing to achieve an optimum combination of heat transfer and porosity properties for vacuum pumping.

It is therefore intended that the above description shall be read as illustrative and not in a limiting sense.

What is claimed is:

1. A high vacuum pump containing a composite sorbent-metal pumping element and means for cooling the

4

pumping element to the cryogenic temperature range, the pumping element comprising a porous sintered mass of crossing metal fibers secured to each other at random points of contact by intermetallic bonds to form a network of intersecting tunnels and dispersed sorbent powders disposed in said tunnels.

2. A sorbent-metal composite for cryosorption pumping and the like comprising a porous sintered mass of crossing metal fibers secured to each other at random points of contact by intermetallic bonds to form a network of intersecting tunnels and dispersed sorbent powders disposed in said tunnels.

3. The sorbent-metal composite of claim 2 in plate form.

4. The sorbent-metal composite of claim 3 with the two outer layer portions of the plate being essentially free of sorbent powder in the said tunnels.

5. The sorbent-metal composite of claim 2 with an outer layer of the fiber mass being essentially free of sorbent powders in the said tunnels.

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