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VALVING METHOD WHICH INCLUDES REFORMING THE SEAT MATERIAL

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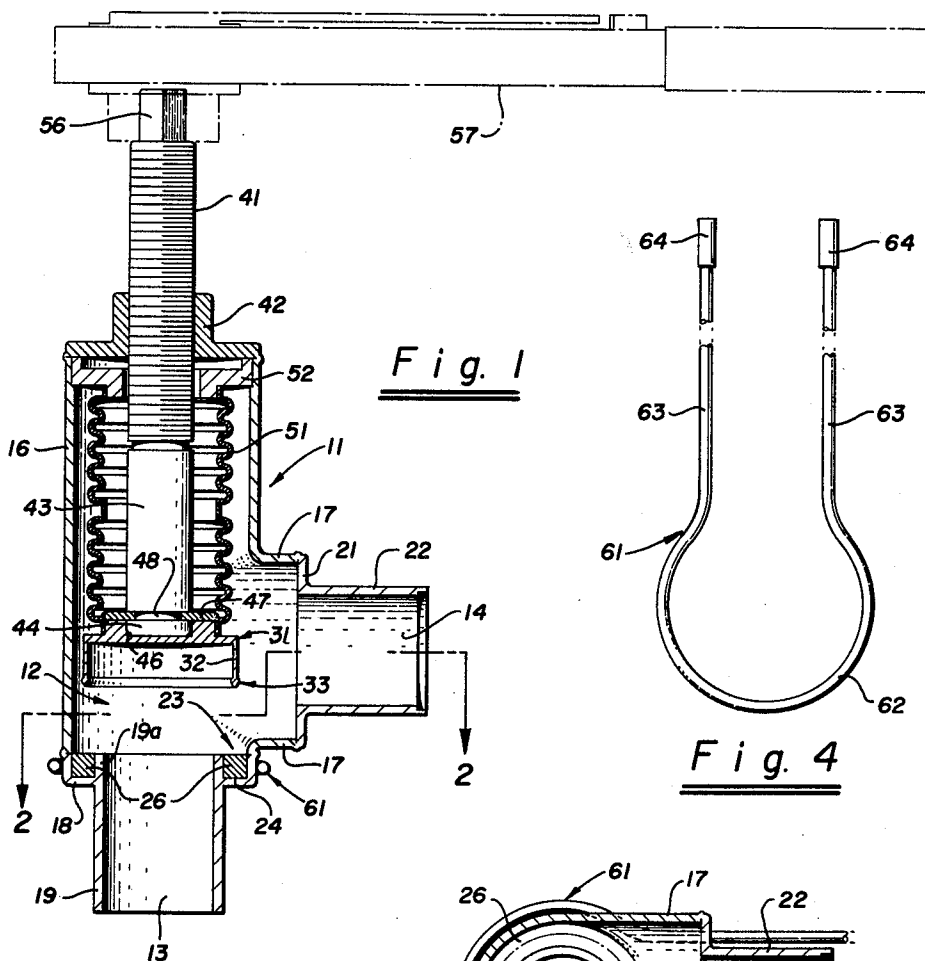


Fig. 1

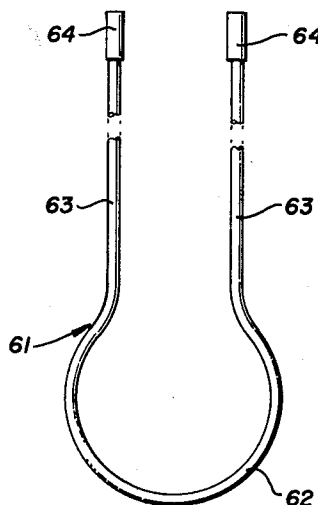


Fig. 4

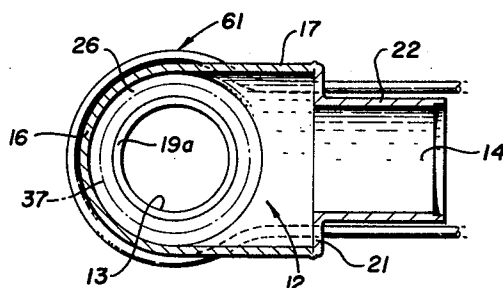


Fig. 2

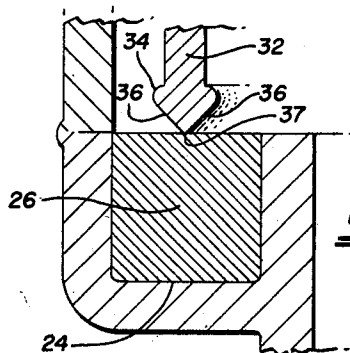


Fig. 3

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**VALVING METHOD WHICH INCLUDES
REFORMING THE SEAT MATERIAL**
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This invention relates to an all metal valve and more particularly to an all metal valve for use in vacuum systems.

Valves heretofore provided in high vacuum systems have often included parts such as valve seats which consist of organic material which during the bake-out cycle in a vacuum system begin outgassing to substantially reduce the vacuum in the system. All metal valves heretofore provided utilized a seat of soft material such as copper, silver or gold having relatively high melting points, into which the valve was seated. After the valve would cut through the seating material, the valve would have to be dismantled and re-worked to provide a new seat in the valve. From the foregoing, it can be seen that there is a need for a new and improved all metal valve.

In general, it is an object of the present invention to provide an all metal valve which overcomes the above named disadvantages.

Another object of the invention is to provide an all metal valve having a seat of soft material which can be re-flowed at a relatively low temperature.

Another object of the invention is to provide an all metal valve of the above character which provides an unlimited number of vacuum-tight closures.

Another object of the invention is to provide an all metal valve of the above character which is particularly applicable to ion gettering pumps and oil diffusion type vacuum systems.

Another object of the invention is to provide an all metal valve of the above character which is particularly adaptable for use in systems having ultra-high vacuums.

Another object of the invention is to provide an all metal valve of the above character in which preliminary vacuum outgassing of the seating metal is unnecessary.

Another object of the invention is to provide an all metal valve of the above character which can be operated at a relatively low temperature and can be baked out at a relatively high temperature.

Another object of the invention is to provide an all metal valve of the above character which can be furnished with conventional fittings.

Another object of the invention is to provide an all metal valve of the above character which can be economically manufactured.

Another object of the invention is to provide an all metal valve of the above character in which it is unnecessary to remove the valve from the system during re-flowing of the seating material.

Additional objects and features of the invention will appear from the following description in which the preferred embodiment is set forth in detail in conjunction with the accompanying drawing.

Referring to the drawing:

FIGURE 1 is a side elevational view in cross-section of an all metal valve incorporating my invention.

FIGURE 2 is a cross-sectional view taken along the line 2-2 of FIGURE 1.

FIGURE 3 is an enlarged detailed view of the valve and valve seat.

FIGURE 4 is a plan view of the heater utilized for re-flowing the seating material.

In general, my present invention consists of a valve which has a body provided with a passageway and inlet and outlet ports connected to the passageway. An annular recess is formed within the body and encircles the

passageway. A relatively soft metallic seating material having a relatively low melting point is disposed in the recess. A valve member movable into and out of engagement with the seating material is provided for opening and closing the passageway. Means is provided for reheating the metallic seating material after repeated closings of the valve have caused the valve to move through the seating material.

As shown in the drawings, my valve consists of a body 11 which is fabricated from a suitable material such as stainless steel. The body 11 forms a passageway 12 for the fluids and is provided with ports 13 and 14 connected to the passageway 12.

As shown, the body 11 consists of a cylindrical portion 16 which is provided with a right angle annular flange 17. A cup-shaped member 18 is affixed to the lower portion of the cylindrical member 16 by suitable means such as by inert gas welding commonly called "Heliarc." The cap is provided with a cylindrical extension 19 which defines the port 13. A cap 21 is welded in a similar manner to the annular flange 17 and is provided with a cylindrical extension 22 which defines the port 14.

A valve seat 23 is formed within the body 11 and consists of an annular valve seat recess 24 which is formed by the outer wall of the cap 18, the bottom wall of the cap 18 and an extension 19a of the cylindrical extension 19. A seating material 26 is disposed within the recess 24. The seating material is a material which is relatively soft for a purpose hereinafter described and also which has a relatively low melting point. It also should have a relatively low vapor pressure. For example, it should have a melting point from 100° C. to 700° C. and a vapor pressure below 10⁻⁶ mm. Hg at 20° C. One material which I found to be particularly satisfactory is indium which is inherently relatively soft in its natural state. Preferably, it should be non-work hardened. It has a vapor pressure which is relatively low, that is, less than 10⁻¹⁰ mm. Hg at 20° C. and less than 10⁻⁹ mm. Hg at 450° C. It has a relatively low melting point in that it melts at 157° C.

A valve member 31 is movable into and out of engagement with the seating material 26. As shown in the drawing, it is substantially cup-shaped and is provided with an annular depending flange 32 terminating in knife edge-like portion 33 lying in a plane which is substantially parallel to the plane of the surface of the seating material 26. As shown, the knife edge portion 33 of the flange is substantially heart-shaped in cross-section and is provided with a root portion 34 which is substantially wider than the depending flange 32. The root portion tapers inwardly and downwardly as shown at a suitable angle as, for example, 45°, to provide inclined tapered surfaces 36 which join to form the knife edge 37.

Means is provided for moving the valve member 31 into and out of engagement with the seating material 26 and consists of a lead screw 41 which is threadedly mounted in a flanged cap 42 affixed to the upper extremity of the body 11 by suitable means such as welding. The lead screw 41 extends downwardly into the body of the valve and is provided with a stem 43 which has a rounded lower portion 44 rotatably mounted in a stem recess 46 centrally disposed in the upper portion of the valve member 31. The stem 43 is secured to the valve member 31 by a washer 47 that is affixed to the valve member 31 by suitable means such as welding and which engages an annular groove 48 provided in the lower extremity of the stem 43 as shown.

Means is provided for preventing the passage of air between the valve member 31 and the upper portion of the body 11 and consists of a bellows 51 coaxially disposed on the lead screw 41 and the stem 43 and having its lower end affixed to the valve member 31 by suitable

means such as brazing and having its upper end affixed to a flanged member 52 by suitable means such as brazing. The flanged member 52 is provided with a hole through which the lead screw 41 extends. The outer extremity of the flanged member 51 is affixed to the outer wall of the body 11 by suitable means such as welding to provide an air-tight connection.

The upper end of the lead screw 41 is provided with a squared portion 56 which is adapted to be engaged by a suitable tool such as a torque wrench 57, as shown in dot and dash lines in FIGURE 1, for opening and closing the valve in a manner as hereinafter described.

Means is provided for reflowing the seating material 26 and consists of a heater 61 of a suitable type such as an electrical heater shown in FIGURE 4 of the drawing. Such a heater consists of a circular portion 62 which is adapted to be mounted around the portion of the body of the valve which forms the seat of the valve and, as shown in the embodiment of FIGURE 1, about the portion of the cap 18 which forms the recess 24 containing the seating material 26. The heater 61 is provided with a pair of extensions 63 which are formed integrally with the circular portion 62. The extensions are connected to terminals 64 of a conventional type which are adapted to be connected into a conventional outlet to a supply of electrical energy for the heater 61. The heater 61 is formed in such a manner that it can be readily slipped on and off the cap 18 so that it only need be applied to the valve when it is desired to reflow the seating material. However, it is readily apparent that, if desired, the heater can be incorporated as an integral part of the valve.

The cylindrical extensions 19 and 22 which form the ports 13 and 14 can be provided with flanges of a conventional type, if desired, so that the valve can be readily incorporated into any vacuum system.

Operation and use of my valve in performing my method may now be briefly described as follows: Let it be assumed that the valve is connected to a vacuum system and that it is desired to vacuum fire a piece of metal. As is well known to those skilled in the art, the metal would be placed in the vacuum chamber and the chamber and system would be baked out to remove the impurities. During all this time, the impurities which are outgassed by the metal would pass through the valve and be removed by the vacuum pump. In such a system, the valve could be mounted so that the port 14 is connected to the vessel and the port 13 is connected to a suitable vacuum pump such as an oil diffusion pump. Since such a bake-out normally is performed at a relatively high temperature as, for example, 450° to 650° C., which may be substantially above the melting point of the seating material 26, it is necessary that the valve seat be in a horizontal position so that the pool of seating material will not flow from the annular recess 24.

After the bake-out is completed, the system is allowed to cool down so that the seating material 26 will again solidify. As soon as it has solidified, the lead screw 41 is rotated in the proper direction by suitable means such as a torque wrench 57 to close the valve member 31 against the valve seat 23. The bellows 51 permits relative movement between the valve member 31 and the valve body 11, while at the same time maintaining a vacuum-tight seal between the valve member 31 and the body 11. The lead screw 41 is rotated until the valve member 31 comes into engagement with the seating material 26 and thereafter rotation is continued until the knife edge 37 has seated a sufficient distance in the seating material 26 to provide a vacuum-tight seal. For example, it has been found that a vacuum-tight seal can be obtained by applying a torque of 50 inch pounds to the lead screw 41 to obtain the required amount of penetration of the seating material. By way of example, we have found that a penetration of approximately one mil provides a vacuum-tight seal.

The valve is normally moved to a closed position after

the bake-out is completed so that the oil diffusion pump will not be let down to air. As is well known to those skilled in the art, such a practice is not desirable. After the valve has been closed, the vacuum chamber can be let down to air and the metal which has been baked out can be removed. Thereafter, another charge of metal can be placed in the vacuum chamber and another bake-out completed in a manner similar to that hereinbefore described.

It can be seen that when the valve is utilized in a vacuum bake-out system, the seating material is reflowed during each bake-out so additional heating means for reflowing the seating material is not required. However, if the valve is utilized in an environment in which there is no bake-out cycle, repeated opening and closing of the valve will eventually cause the knife edge portion 33 of the valve to penetrate through the seating material. For example, it has been found that an indium seat of approximately 200 mils in thickness will provide at least 200 vacuum-tight closures because a vacuum-tight closure can be obtained each time by pressing the knife edge-like portion 33 approximately one mil deeper into the seating material.

After repeated closures and after the knife edge-like portion 33 has been moved through substantially all of the seating material, the heater 61 is placed around the cap 18 as shown in FIGURE 1 and connected to a suitable source of power to melt the seating material within a period of approximately ten minutes. During this time, the valve seat must be in a horizontal position so that the pool which is formed in the seat 24 will be substantially level and will not flow from the recess. Thereafter, the seating material can be allowed to cool, after which it is ready again for use for a large number of vacuum-tight closings.

It will be noted that in this reflowing operation it is unnecessary to remove the valve from the system because the heater can be readily slipped onto the cap portion of the valve by passing the extension 63 around the extension 19 and then raising the cylindrical portion 62 into engagement with the cap 18. However, it should be pointed out that this reflowing of the seating material should be accomplished in a vacuum condition such as 10⁻⁴ mm. Hg to prevent oxidation of the seating material.

Although the valve shown in the drawing is conventionally referred to as a T-type valve, it is readily apparent that, if desired, the same teaching can be utilized in conjunction with a cross valve in which an additional port is provided in a body 11 diametrically opposite the port 14. This makes it possible to utilize two different types of pumps in the vacuum system. For example, the additional port could be connected to a vacuum test chamber, port 13 connected to an ion gettering pump of conventional manufacture and port 14 could be connected through a shut-off valve to a mechanical roughing pump. When the test chamber is roughed down, the cross valve is closed allowing the ion gettering pump to remain in continuous operation thereby eliminating any starting problems. The mechanical pump withdraws the air around bellows 51. This is not objectionable because the bellows does not greatly impede the flow of the small amount of air withdrawn from the vacuum chamber. The mechanical pump line is then closed by the shut-off valve and the cross valve is opened allowing the ion gettering pump to reduce the test chamber pressure to the desired value.

Although the valve member 31 has been shown in only a partially open position, it is readily apparent that it can be moved to a fully opened position so that the knife edge portion 33 is flush with the upper edge of the port 14 to provide full porting for the valve.

It is apparent from the foregoing that I have provided a new and improved all metal valve which is particularly adapted for high vacuum use. It is particularly useful for applications where organic material cannot be tol-

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erated. It can be used with either ion gettering pumps or oil diffusion type vacuum systems. It can be manually operated to provide a reliable vacuum seal with a minimum amount of pressure.

I claim:

1. In a method for performing opening and closing of a passageway with a valve disposed in the passageway having a metal valve member closing against a relatively soft metal seat having a relatively low melting point, opening and closing the valve member by repeatedly moving the valve member into engagement with the seating material so that the valve member progressively deforms the seating material to form a recess and to provide vacuum-tight seals as the valve member is repeatedly closed, and reflowing the seating material by heating above said melting point to remove the recess formed in the seating material.

2. A method as in claim 1 wherein said reflowing of

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the seating material is accomplished while the seating material is in a substantially horizontal plane.

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