A vacuum storage system comprises a vacuum pump subsystem (4) comprising a motor (120), a vacuum pump (126, 128) and a nozzle (150) at an outlet of the vacuum pump and a storage container subsystem (2) comprising a bowl (10), a lid (30) and a valve (32) disposed in the lid. The valve (32) comprises a rotatable valve actuator, a linearly movable valve head and a valve seat. The vacuum pump subsystem further comprises a movable arm (8), the nozzle (150) being disposed in the arm.
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VACUUM STORAGE SYSTEM

Background of the Invention

This invention relates to a vacuum storage system.

It is well known that food and other perishables preserve their freshness longer if stored under a relative vacuum. Prior art vacuum storage systems, however, are ineffective and unreliable. What is needed, therefore, is an improved vacuum storage system to effectively store perishable items in a variety of containers.

Summary of the Invention

This invention provides a vacuum storage system comprising a vacuum pump and one or more storage containers. In a preferred embodiment, the vacuum storage system comprises a vacuum pump subsystem comprising a motor, a vacuum pump and a nozzle at an outlet of the vacuum pump and a storage container subsystem comprising a bowl, a lid and a valve disposed in the lid. The vacuum storage system may also include means for aligning the container’s valve with the pump’s nozzle.

The invention also relates to a container for use with a vacuum storage system, the container comprising a bowl, a lid and a valve disposed in the lid, the valve comprising a rotatable valve actuator, a linearly movable valve head and a valve seat. The container may also include a lock engaging the lid and the bowl and a vacuum indicator.

The invention further relates to a vacuum pump system comprising a motor and a reciprocal pump mounted within a housing, the system further comprising a moveable arm and nozzle disposed in the arm and communicating with an outlet of the pump. The vacuum pump system may also
include an automatic pressure switch and means for preventing suction of liquid into the pump.

The preferred embodiment of the invention will be described in more detail with reference to the drawings.

**Brief Description of the Drawings**

Figure 1 is a partial cross-sectional view showing a vacuum storage system according to a preferred embodiment of this invention.

Figure 2 is a cross-sectional view showing the bowl portion of the container of the preferred embodiment of this invention.

Figure 3 is a cross-sectional view of the lip portion of the bowl shown in Figure 2.

Figure 4 is an exploded view of a lid assembly according to the preferred embodiment of this invention.

Figure 5 is a cross-sectional view of the lid assembly of Figure 4.

Figure 6 is a side elevational view of the lid and bowl of this invention.

Figure 7 is a cross-sectional detail view of the interaction between the lid and bowl of this invention.

Figure 8 is a cross-sectional view of the lid assembly showing the vacuum indicator assembly in more detail.

Figure 9 is a cross-sectional view of the lid and bowl of this invention with the valve in its open position.

Figure 10 is a cross-sectional view of the container valve and pump nozzle according to the preferred embodiment of this invention.

Figure 11 is a top view of the lid showing the valve actuator in the open position.
Figure 12 is a cross-sectional view of the lid and bowl of this invention with the valve in its closed position.

Figure 13 is a cross-sectional view of the container lid showing a filter assembly that may be used with this invention to prevent solids from reaching the valve seat area.

Figure 14 is an exploded view of an electrically operated reciprocal pump according to a preferred embodiment of this invention.

Figure 15 is an elevational view of the pump and motor.

Figure 16 is a detail showing the preferred piston seal design.

Figure 17 is a cross-sectional view of a pressure switch assembly according to a preferred embodiment of this invention.

Figure 18 is a cross-sectional view of the vacuum storage system of this invention.

Figure 19 shows an alignment mechanism according to a preferred embodiment.

Figure 20 shows another alignment mechanism according to a preferred embodiment of this invention.

**Detailed Description of the Preferred Embodiments**

Figure 1 shows a vacuum storage system according to a preferred embodiment of this invention. It should be understood that many features of the embodiment of Figure 1 may be used in alternative embodiments apart from the other features of this embodiment.

The vacuum storage system of Figure 1 includes a storage container 2 and a vacuum pump assembly 4 which may be operated to remove air or other gases from container 2. The system is designed to sit on a flat
surface. Pump assembly 4 is provided with suction pads 6 to hold the assembly in place on a surface. Pump assembly 4 has a moveable arm 8 which may be raised or lowered to match the height of the container used.

Figures 2-13 show a container design according to a preferred embodiment of this invention. Other containers could be used with the vacuum pump assembly of this invention, and this container may be used with other vacuum pump assemblies, without departing from the invention.

Figure 2 shows the bowl portion of the container of the preferred embodiment. Bowl 10 is preferably formed from a food grade polycarbonate material. The bottom 12 of bowl 10 has a spherical shape to give the bowl structural rigidity. Bottom 12 is thicker than the side wall 14 in order to use the polycarbonate material more efficiently and to minimize the bowl's weight while still maintaining the necessary strength to contain the vacuum within the bowl. A ring 16 surrounds the domed bottom 12 to provide stability.

Figure 3 shows the bowl's lip 18 in more detail. Lip 18 has a channel 20 to provide a retainer for a seal. A pair of ridges 22 and 24 surround channel 20. It is expected that the bowls will be inverted on a drying surface after washing. Ridges 22 and 24, in addition to retaining the seal, also prevent the formation of radial scratches across the lip surface that could compromise the integrity of the vacuum formed in the container. A ridge 26 on the underside of lip 18 is designed to engage with a locking mechanism, as discussed below.

Figure 4 is an exploded view of a lid assembly according to the preferred embodiment of this invention. Other lid designs may be used with the vacuum storage system of this invention. As shown in Figure 4, the lid
assembly includes a lid 30, a valve assembly 32, a vacuum indicator assembly 34, and a lock 36. Each of these elements is described below.

Figure 5 is a cross-sectional view of lid 30 and lock 36. Lid 30 is shaped as a dome or partial sphere to withstand implosion from the vacuum forces within the container. Lid 30 provides threads 40 for attachment of the valve assembly and a valve seat 42. Lid 30 also provides threads 44 for attachment of a valve filter assembly and threads 46 for attachment of the vacuum indicator assembly. Integral guides 48 (shown in Figure 4) provide a mount for the lock. Lugs 50 are provided as legs for when the lid is set on a surface.

Figure 6 shows lid 30 mounted on bowl 10. The lock 36 keeps lid 30 in place on bowl 10 whether or not vacuum is being maintained in bowl 10.

Figure 7 is a detail view of the interaction between lid 30 and bowl 10. Lock 36 has an inwardly facing lip 52 with an upwardly facing surface 54 that interacts with ridge 26 of bowl lip 18. Lip 52 also has a cam surface 56 that facilitates outward movement of lock 36 when lid 30 is pressed down on bowl 10. A plastic spring 37 fitted on lid 30 with one end rigidly clamped on the lock 36 provides a spring force which pulls lock 36 inward after lip 52 clears ridge 26. An upwardly extending ridge 58 provides proper spacing between the lid 30 and bowl 10.

A seal 60 is mounted in the outer edge of lid 30. In the embodiment shown in Figure 7, seal 60 is a gasket with three ridges 62 on one side to ensure effective sealing. Seal 60 has a pair of upwardly extending areas 64 and 66 disposed in corresponding channels 68 and 70, respectively, in lid 30. A third channel 72 is also formed in lid 30. When a vacuum is formed in the interior of bowl 30, seal 60 is compressed.
During compression, air trapped in channels 68-72 and between ridges 62 acts as a balancing force for seal 60 and improves the seal by increasing the sealing edge pressure. The seal is preferably made from a material which has high resistance to aging and oxidation. Other seals may be used with the vacuum storage system without departing from the scope of this invention.

Figure 8 shows the vacuum indicator assembly in more detail. A molded silicon rubber part 74 is disposed on the underside of lid 30. Part 74 has a button portion 76 disposed in an aperture 78 in lid 30. Part 74 and lid 30 interact to form a chamber 80 communicating with the exterior of the container through aperture 78 around button portion 76.

A cap 82 is mounted on lid 30 beneath part 74. Cap 82 interacts with part 74 to form a chamber 84 which communicates with the interior of bowl 10 through a passage 86. Cap 82 is preferably attached to lid 30 via threads 46 for easy removal and cleaning.

During operation of the vacuum storage system of this invention, the combination of the low pressure on the undersurface 88 of part 74 and the higher ambient atmospheric pressure on the upper surface 90 of part 74 creates a net force downward on part 74. While the outer edges of part 74 are supported by a circumferential wall 92, the center portion in and around button 76 is supported only by upward-sloping frustoconical region 94.

When the pressure within bowl 10 drops below ambient atmospheric pressure by a predetermined amount, the downward force on part 74 overcomes the resiliency of region 94 and button 76 moves downward to the position shown in Figure 12. In the preferred embodiment, the dimensions and material of part 74 are chosen so that this movement occurs when the pressure within bowl 10 is 30% of atmospheric pressure (i.e., 70% vacuum). In this
downward position, a conical region 96 beneath button 76 rests on a seat 98 formed at the outlet of passage 86 into chamber 84.

If vacuum within bowl 10 were to be released or compromised, the resiliency of region 94 of part 74 will move button 76 back up to the position shown in Figure 8. This feature therefore provides an indication of the vacuum condition within bowl 10.

Figure 9 is a cross-sectional view of lid 30 and bowl 10. As shown in more detail in Figure 10, valve assembly 32 includes an actuator 100 mounted on threads 40. Movably mounted within actuator is a valve head 102 on a stem 104. When valve actuator is in the position shown in Figure 9, valve head 102 is lifted off the valve seat 42 formed in lid 30 through the interaction between a cross-piece 106 of valve stem 104 and a shoulder 108 formed in valve actuator 100 so that air can flow between the interior and exterior of bowl 10 around crosspiece 106 and past valve seat 42. A top view of the position of valve actuator 100 in this open position is shown in Figure 11.

Figure 12 is a cross-sectional view of lid 30 and bowl 10 with the valve assembly 32 in its closed position. When the valve actuator is turned to the closed position, the bottom surface 111 of actuator 100 presses against the top surface 110 of valve head 102 to form a seal. In addition, this action presses the bottom surface 112 of valve head 102 into valve seat 42 to form a second seal. This arrangement ensures sealing over a long period of storage and protects against movement of the valve (and compromise of the vacuum) during transportation of the container.

Referring to Figure 11, a third position of valve actuator 100 - the vacuum position -- is located between the open and closed positions. In this position,
as in the open position, air can pass between the interior and exterior of bowl 10. The top surface of valve actuator 100 is provided with indentation 114 so that the actuator can be gripped by a user. Indentations 114 also may serve as a guide to insure that valve actuator 100 is in the proper position for the application of vacuum, as explained further below.

Figure 13 shows a filter assembly that may be used with this invention to prevent solids from reaching the valve seat area. The filter assembly includes a cap 116 and a filter 118 attached beneath the valve assembly. As shown in Figure 13, air rushing into bowl 10 will be deflected upward by cap 116 to prevent the air from splattering the contents of bowl 10. Filter 118 prevents any solid contents of bowl 10 from being drawn into the valve area during the application of vacuum. This filter assembly may be removed for cleaning.

Figures 14-20 show a preferred vacuum pump according to this invention. Figure 14 is an exploded view of an electrically operated reciprocal pump. An electrical motor 120 turns an eccentric block 122 mounted on a pump chassis 124. As block 122 rotates, it raises and lowers a piston 126 reciprocally within a cylinder 128. Cylinder 128 is preferable formed from a self-lubricating engineering plastic material. Other elements of the reciprocal pump include a cylinder manifold 130, manifold spacers 132, a flap valve 134 and an outer manifold 136. Motor 120 is mounted on a mounting bracket 138 which also contains a fan 140 for cooling the motor.

Figure 15 shows these elements assembled.

Figure 16 is a detail showing the preferred piston seal design. Circumferentially surrounding the head 142 of piston 126 is a sliding seal 144. Ambient atmospheric pressure on the shaft side 146 of piston 126 and lower-than-ambient atmospheric pressure on the other
side presses seal 144 tighter against the wall of cylinder 128. The piston and cylinder are preferably formed from self-lubricating engineering plastic. The seal is made from a wear-resistant low friction plastic.

As shown in Figure 1, the reciprocal pump draws air from container 2 through a suction line 148 and nozzle 150. In the preferred embodiment, an automatic pressure switch assembly 152 is used to automatically switch off the pump when the air pressure within the container drops to a predetermined level. This assembly is shown in more detail in Figure 17.

The pressure switch assembly includes a chamber 154 surrounded by a collapsible bellows 156. A lever arm 158 attached at fulcrum point 160 connects with the top of the bellows through an adjustment screw 162. In the position shown in Figure 17, a spring 164 within chamber 154 maintains bellows 156 in its expanded state. As the pressure within suction line 148 drops, however, bellows 156 collapses and spring 164 compresses, thereby drawing arm 158 down at screw 160. At a certain point, arm 158 goes down far enough to depress motor switch 166 to stop the electric motor. The pressure at which this occurs is controlled by the physical arrangement of these elements, the strength of spring 164, the position of adjustment screw 160, and the position of a spacer 168 at the end of lever arm 158.

The preferred pump nozzle 150 is shown in detail in Figure 10. Nozzle 150 has a resilient spherical head 170 surrounding a central tube 171. Head 170 mates with a corresponding surface 172 within valve actuator 100. This arrangement provides an effective seal at vacuum levels of 500-600 mm Hg. In the preferred embodiment, a passageway 174 within nozzle 150 leads to a liquid suction prevention assembly 180, as shown in more detail in Figure 18.
Liquid suction prevention assembly 180 includes a well 182 communicating with nozzle 150 through a well inlet 184. Suction is applied at suction inlet 186 which communicates with suction line 148 (not shown in Figure 10). Suction inlet communicates with the upper portion of well 182 through a filter 188. In the event any liquid is accidentally drawn out of bowl 10, it will remain in well 182 (as shown) and will not be drawn into suction line 148 or the pump.

Figure 19 shows an alignment mechanism according to a preferred embodiment. A pair of tabs 190 extend down from the pump's movable arm 8. These tabs fit into the indentations 114 formed in valve actuator 100 only when the valve actuator is in the appropriate position for receiving the vacuum source.

Figure 20 shows another alignment mechanism according to a preferred embodiment of this invention. Vacuum pump assembly 4 has a geometrical shape on the front side 192 of its housing that is designed to mate with a corresponding geometrical shape on the container (preferably on the lock or other portion of the lid) when the container is in the proper position.

In use, a container comprising a lid 30 and bowl 10 is placed in the proper position against the pump housing, and the pump's movable arm is lowered to make contact between the nozzle and the container's valve. Once in place, the user depresses switch 194 to start the vacuum pump. The vacuum pump removes air from the container until the pressure within the container reaches a predetermined level, such as 80% vacuum. At this point, the pump's pressure switch stops the pump's motor. The nozzle may then be removed from the container and the container valve turned to the closed position for storage.
Containers of different sizes and shapes may be used with the vacuum storage system of this invention so long as the container valve position remains the same.

Modification to the system described above will be apparent to those skilled in the art. For example, while the bowl shown in the drawings and described above is substantially circular in cross-section, any shaped bowl may be used.
CLAIMS

1. A vacuum storage system comprising:
   a vacuum pump subsystem comprising a motor, a vacuum pump and a nozzle at an outlet of the vacuum pump; and
   a storage container subsystem comprising a bowl, a lid and a valve disposed in the lid.

2. The vacuum storage system of claim 1, wherein the vacuum pump is a reciprocating pump.

3. The vacuum storage system of claim 1 or claim 2, wherein the storage container subsystem further comprises a vacuum indicator.

4. The vacuum storage system of any one of the preceding claims, wherein the storage container subsystem further comprises a lock engaging the lid and the bowl.

5. The vacuum storage system of any one of the preceding claims, wherein the vacuum pump subsystem further comprises an automatic pressure switch communicating with the vacuum pump outlet.

6. The vacuum storage system of any one of the preceding claims, further comprising means for aligning the valve with the nozzle.

7. The vacuum storage system of claim 6, wherein the means for aligning comprises a tab attached to the vacuum pump subsystem adjacent the nozzle and a slot in the container subsystem for receiving the tab.

8. The vacuum storage system of claim 6, wherein the means for aligning comprises a geometrical shape formed
in the pump subsystem and a corresponding geometrical shape formed in the container subsystem.

9. A container for use with a vacuum storage system, the container comprising a bowl, a lid and a valve disposed in the lid, the valve comprising a rotatable valve actuator, a linearly movable valve head and a valve seat.

10. The container of claim 9, wherein the valve seat is integral with the lid and the valve actuator has threads mating with corresponding threads formed in the lid.

11. The container of claim 9 or claim 10, further comprising a vacuum indicator.

12. The container of claim 11, wherein the vacuum indicator comprises a movable member having a surface exposed to ambient atmospheric pressure outside of the bowl and a surface exposed to air pressure within the bowl.

13. The container of any one of claims 9 to 12, further comprising a lock engaging the bowl and the lid.

14. The container of any one of claims 9 to 13, further comprising a resilient seal disposed between the lid and the bowl, the seal having a plurality of ridges forming channels in the seal.

15. The container of any one of claims 9 to 14, further comprising a filter disposed within the bowl adjacent the valve seat.

16. The container of claim 15, wherein the filter comprises a cap surrounding the filter and disposed between
the filter and the bowl.

17. A vacuum pump system comprising a motor and a vacuum pump mounted within a housing, the system further comprising a movable arm and nozzle disposed in the arm and communicating with an outlet of the pump.

18. The vacuum pump system of claim 17, further comprising an automatic pressure switch communicating with the vacuum pump outlet.

19. The vacuum pump system of claim 17 or claim 18, further comprising means for preventing suction of liquid into the pump.
FIG. 14

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**A. CLASSIFICATION OF SUBJECT MATTER**

**IPC 6** B65B31/04

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

**IPC 6** B65B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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Date of the actual completion of the international search

29 July 1996

Date of mailing of the international search report

- 9. 08. 96

Name and mailing address of the ISA

European Patent Office, P.B. 518 Patentlaan 2
NL-2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl
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Jagusiak, A

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