United States Patent

[11] 3,625,481

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[21] Appl. No. **879,725**
[22] Filed **Nov. 25, 1969**
[45] Patented **Dec. 7, 1971**

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[54] **SELF-LOCKING VALVE ASSEMBLIES**
16 Claims, 6 Drawing Figs.

[52] **U.S. Cl.** **251/356**
[51] **Int. Cl.** **F16k 21/00**
[50] **Field of Search** 251/356, 357, 337, 358

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ABSTRACT: Self-locking valve assemblies including a resilient valve facing having a peripheral edge gripping the outer rim of a backup plate and a central portion engaging the head of a valve stem, the backup plate having a keyhole slot therein for receiving the head of the valve stem and permitting the valve stem to be centrally disposed with respect to the backup plate when a neck of the valve stem is aligned with the backup plate. Various embodiments include backup plates having arcuate and radial strengthening ribs, L-shaped keyhole slots and keyhole slots having a link with a small width and a valve stem having a small diameter sliding portion and a larger diameter alignment portion.

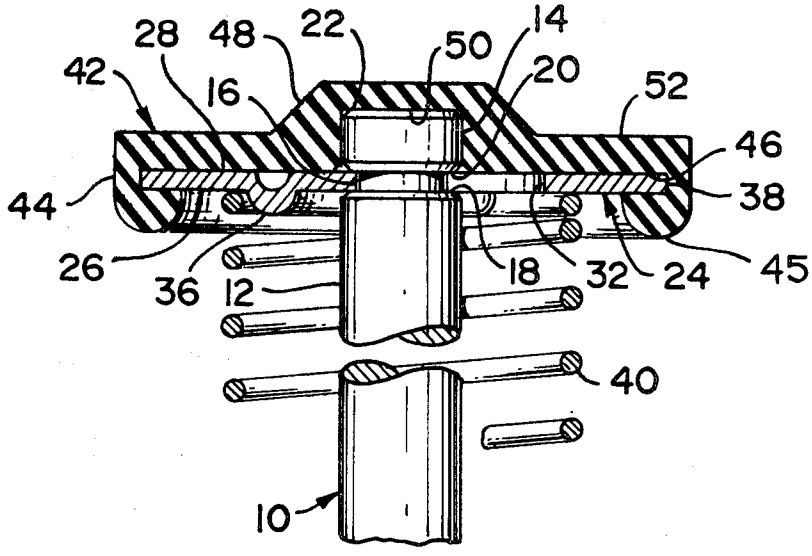


FIG. 1

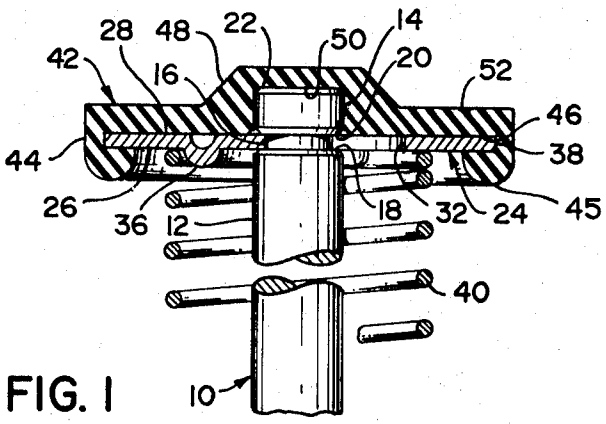


FIG. 2

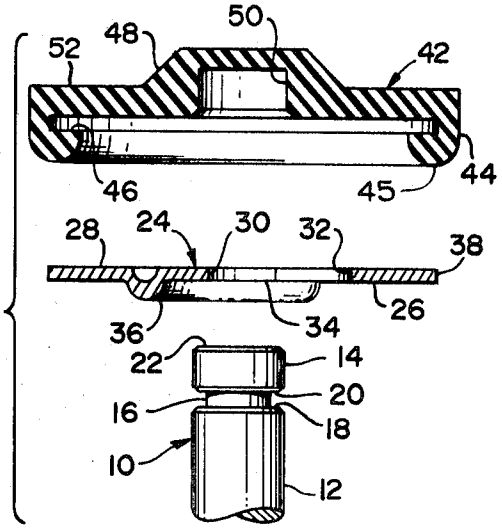


FIG. 3

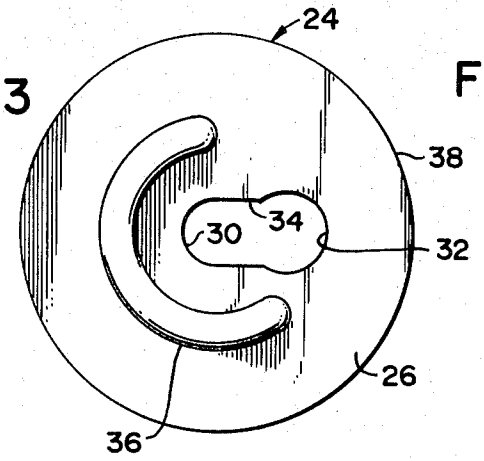


FIG. 4

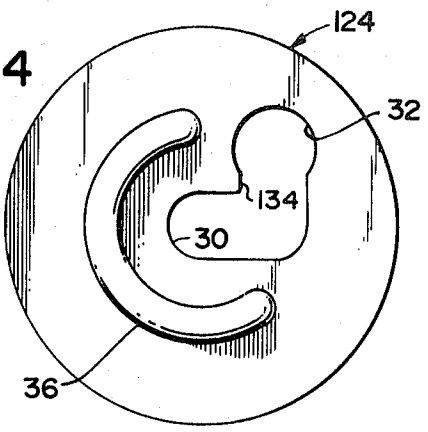


FIG. 5

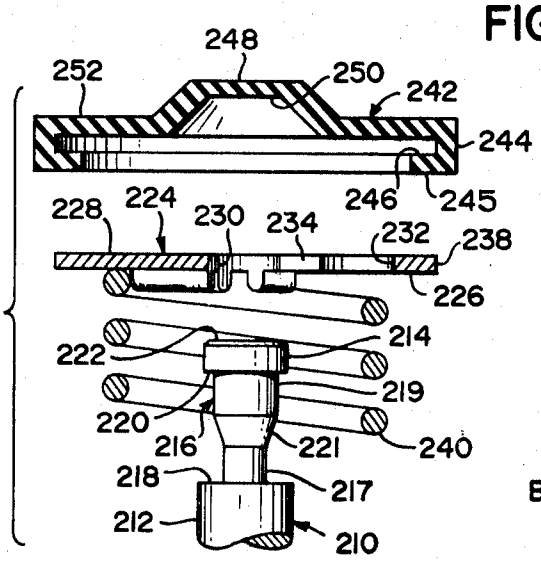
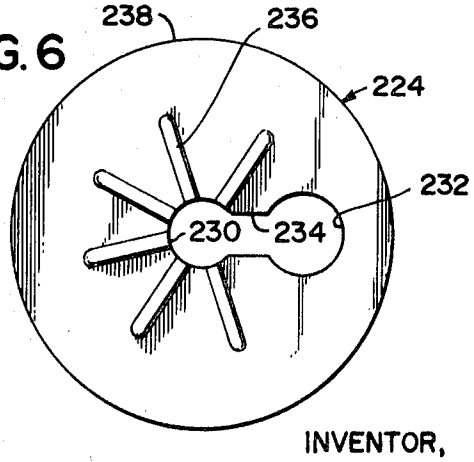


FIG. 6



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SELF-LOCKING VALVE ASSEMBLIES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention pertains to valve assemblies and more particularly to self-locking valve assemblies.

2. Description of the Prior Art

Valves having a valve stem and a backup plate connected with a resilient valve facing have been difficult and expensive to assemble in the past due to the requirement of the use of cross pins to secure the valve stem with the backup plate and the valve facing. The labor cost involved in such assembly is extremely high due to the precision required, and the valves cannot be conveniently disassembled for reworking. Attempts to overcome the high labor costs have been hampered by the requirement of a high degree of free valve alignment to provide accurate and reliable operation. Furthermore, the possibility of accidental disassembly of the valve cannot be comprised in order to permit inexpensive assembly.

SUMMARY OF THE INVENTION

Accordingly, it is an object of the present invention to construct a self-locking valve assembly having a high degree of free valve alignment.

Another object of the present invention is to construct a self-locking valve assembly not subject to accidental disassembly.

A further object of the present invention is to utilize a keyhole slot in a backup plate to permit self-locking of a valve assembly.

The present invention has another object in that a self-locking valve assembly includes a valve stem having a neck portion which must be aligned with a keyhole slot in a backup plate for centering of the valve stem with respect to the backup plate.

Another object of the present invention is to utilize a resilient valve facing having a peripheral cup-shaped edge in a self-locking valve assembly such that a backup plate may be easily mounted with the valve facing by forcing the outer rim of the backup plate into the peripheral cup-shaped edge.

Some of the advantages of the self-locking valve assemblies of the present invention over the prior art are that assembly costs are reduced, free valve alignment is permitted, accidental assembly is prevented and reliable and accurate operation is provided.

The present invention is generally characterized in a self-locking valve assembly including a valve stem having a head, a body and a neck having a smaller diameter than the head, a resilient valve facing having a central portion engaging the head of the valve stem, and a backup plate having an outer rim engaging the periphery of the valve facing, a first centrally disposed aperture having a diameter smaller than the diameter of the head of the valve stem and slightly larger than the diameter of the neck of the valve stem to receive the neck while preventing movement therethrough of the head, and a second aperture displaced from and linked with the first aperture and having a diameter slightly larger than the diameter of the head of the valve stem whereby the head may be inserted through the second aperture to engage the central portion of the valve facing and the valve stem may be centrally positioned with respect to the backup plate by aligning the neck with the backup plate and laterally moving the valve stem to the first aperture.

Further objects and advantages of the present invention will become apparent from the following description of the preferred embodiments taken in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a broken side elevation, partially in section, of a self-locking valve assembly according to the present invention.

FIG. 2 is an exploded view of the self-locking valve assembly of FIG. 1.

FIG. 3 is a bottom plan view of the backup plate used with the self-locking valve assembly of FIG. 1.

FIG. 4 is a bottom plan view of another backup plate for use with the self-locking valve assembly of FIG. 1.

FIG. 5 is an exploded view of another embodiment of a self-locking valve assembly according to the present invention.

FIG. 6 is a bottom plan view of the backup plate for use with the self-locking valve assembly of FIG. 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A self-locking valve assembly according to the present invention is illustrated in FIGS. 1 and 2 and includes a cylindrical valve stem, indicated generally at 10, having a body 12 and a head 14 connected by a neck 16. The upper edge of body 12 is beveled to form a shoulder 18, and the lower and upper edges of head 14 are similarly beveled to form a shoulder 20 and an end 22, respectively. End 22 is flat and disposed in a plane transverse to the axis of valve stem 10.

In assembly, as illustrated in FIG. 1, neck 16 of valve stem 10 extends through an annular, disclike backup plate, indicated generally at 24, such that shoulders 18 and 20 engage a lower surface 26 and an upper surface 28 of backup plate 24, respectively. A keyhole slot is provided in backup plate 24, as shown in FIG. 3, and includes a centrally disposed, small diameter aperture 30 and a large diameter aperture 32 linked with aperture 30 through a slot 34 having a width corresponding to the diameter of aperture 30. An arcuate strengthening rib 36 is disposed in lower surface 26 concentrically with aperture 30 and an outer rim 38 of backup plate 24. A coiled bias spring 40 is disposed around valve stem 10 and is mounted in compression such that one end seats on the lower surface 26 of backup plate 24 in abutment with the outer edge of rib 36.

The head 14 of valve stem 10 is firmly gripped by a molded resilient valve facing, indicated generally at 42. Valve facing 42 has an arcuate peripheral cup-shaped edge 44 with a hemispherical lower lip 45 defining an annular groove 46 and a thickened raised central portion 48 having a central recess 50 therein which receives head 14 of valve stem 10. An upper annular surface of valve facing 42 has a flat portion 52 adapted to cooperate with a valve seat, not shown; and raised central portion 48 is adapted to be received within the valve seat.

The diameter of head 14 is desirably the same as the diameter of body 12 of valve stem 10, and the diameter of neck 16 is smaller than the diameter of body 12 and head 14 such that the valve stem may be simply formed from a single cylindrical rod. The diameter of aperture 32 in backup plate 24 is slightly greater than the diameter of head 14 to permit the valve stem to pass therethrough while the diameter of recess 50 in valve facing 42 is essentially the same as the diameter of head 14 to permit valve facing 42 to firmly grip the valve stem. The diameter of aperture 30 and the width of slot 34 are slightly greater than the diameter of neck 16 of valve stem 10 but smaller than the diameter of head 14 such that the valve stem can be centered with respect to backup plate 24 only when neck 16 is aligned therewith, as will be explained hereinafter.

In order to assemble the valve, backup plate 24 is mounted in valve facing 42 such that outer rim 38 is inserted in groove 46 in cup-shaped peripheral edge 44. the resiliency of the cup-shaped peripheral edge 44 along with the extension of lower lip 45 only a short distance toward the center of the valve facing to define groove 46 between flat portion 52 and lower lip 45 facilitates the mounting of backup plate 24. That is, backup plate 24 is easily forced into valve facing 42 due to the flexibility of the cup-shaped peripheral edge 44 which is distorted radially outwardly under the force from backup plate 24 to receive outer rim 38 in groove 46 such that lower lip 45 firmly grasps the outer rim. Head 14 of the valve stem 10 is then inserted through aperture 32 in backup plate 24; and, due to its resilience, valve facing 42 will flex under the force on valve stem 10 until head 14 is inserted in recess 50 such that end 22 engages the bottom of the recess. Backup plate 24 is then aligned with neck 16 of the valve stem; and, since neck 16 has

a smaller diameter than the diameter of aperture 30 and the width of slot 34, the valve stem is laterally moved into aperture 30 with self-locking action so as to be centered with respect to backup plate 24. Thus, it may be seen that the valve assembly is completed in a self-locking manner readily adaptable for automatic assembly requiring no additional securing components.

The valve assembly may be used in any type of control; however, considering the valve assembly to be used as an automatic pilot valve with an electromagnetic operator, for exemplary purposes, valve stem 10 may be an armature or may be attached to an armature. Bias spring 40 normally forces valve facing 42 against a valve seat; and, once the electromagnet is energized, the armature is pulled in to move valve stem 10 down against the force of bias spring 40. The force on valve stem 10 is transmitted to backup plate 24 through the abutting of shoulder 20 against the upper surface of the backup plates, and the movement of valve stem 10 moves valve facing 42 away from the valve seat to open the valve. If the electromagnet is energized by a small current, such as the current from a thermocouple it may be required that valve facing 42 be manually or otherwise moved away from the valve seat since the electromagnet is not strong enough to pull in the armature but is strong enough to hold the armature in the pulled in position. Once the electromagnet is deenergized the valve is closed by the force of bias spring 40 against backup plate 24 which moves valve facing 42 up against the valve seat.

It may be seen that, while the valve is assembled in a self-locking manner, accidental disassembly during operation is prevented since valve stem 10 must be laterally moved to aperture 32 for the head 14 of the valve stem to pass through backup plate 24. The valve assembly is self-aligning and controlled with respect to perpendicularity by the length of neck 16 relative to the thickness of backup plate 24. Arcuate rib 36 serves to strengthen backup plate 24 and also acts as a seating and centering means for bias spring 40.

A modification of the backup plate used with the valve assembly of FIG. 1 is illustrated in FIG. 4 and indicated generally at 124. Those features of backup plate 124 which are identical to features of backup plate 24 are given identical reference numbers and are not described again. Those features of backup plate 124 which are similar to features of backup plate 24 are given reference numbers with 100 added.

The large diameter aperture 32 is linked with the centrally disposed, small diameter aperture 30 through an L-shaped slot 134 having a width slightly larger than the diameter of the neck 16 of valve stem 10 and equal to the diameter of aperture 30. The assembly of the valve using backup plate 124 is the same as that previously described with respect to backup plate 24; however, once the valve stem is inserted through the aperture 32 and the neck 16 is aligned with backup plate 124, movement in two, transverse directions is required to position neck 16 in aperture 30. Thus, while movement during assembly is slightly more complex, added assurance is gained that the valve assembly will not be accidentally disassembled during operation.

Another valve assembly according to the present invention is illustrated in FIG. 5 and those parts similar to parts in FIG. 1 are given reference numbers with 200 added.

A cylindrical valve stem is indicated generally at 210 and includes a body 212 and a head 214 connected by a neck generally indicated at 216. Neck 216 includes a small diameter sliding portion 217 extending from a shoulder 218 on body 212 and connected with a large diameter alignment portion 219 through a tapered collar 221. The lower portion of head 214 defines a shoulder 220, and the top of head 214 is beveled to form a flat end 222 disposed in a plane transverse to the axis of valve stem 210.

In assembly, valve stem 210 extends through an annular disclike backup plate indicated generally at 224, such that shoulder 220 of head 214 abuts an upper surface 228 of the backup plate. A keyhole slot is provided in backup plate 224, as shown in FIG. 6, and includes a centrally disposed, small diameter aperture 230 and a large diameter aperture 232 linked with aperture 230 through a slot 234 having a width smaller than the diameter of aperture 230. A plurality of equal radially extending ribs 236 are disposed in a lower surface 226 of backup plate 224 such that their outer ends are concentrically arranged with aperture 230 and an outer rim 238 of backup plate 224. A coiled bias spring 240 is disposed around valve stem 210 and adapted to be mounted in compression such that one end seats on the lower surface 226 of backup plate 224 in abutment with the outer ends of ribs 236.

The head 214 of valve stem 210 abuts a molded resilient valve facing indicated generally at 242. Valve facing 242 has a squared, peripheral cup-shaped edge 244 with a lower lip 245 defining a groove 246 and a raised central portion 248 defining a recess 250 which receives head 214 of valve stem 210. An upper, flat, annular surface 252 of valve facing 242 is adapted to cooperate with a valve seat, not shown.

The diameter of head 214 is desirably the same as the diameter of body 212 such that the valve stem may be simply formed from a single cylindrical rod, and the diameter of alignment portion 219 is smaller than the diameter of body 212 and head 214 but larger than sliding portion 217. The diameter of aperture 232 is slightly greater than the diameter of head 214 to permit the valve stem to pass therethrough while the diameter of the bottom of recess 250 is essentially the same as the diameter of end 222 of head 214. The diameter of aperture 230 is slightly greater than the diameter of alignment portion 219 but smaller than the diameter of head 214. The width of slot 234 is slightly larger than sliding portion 217 such that the valve stem can be centered with respect to backup plate 224 only when sliding portion 217 is aligned with slot 234, as will be explained hereinafter.

In order to assemble the valve of FIG. 5, backup plate 224 is mounted in valve facing 242 such that outer rim 238 is inserted in groove 246 in cup-shaped peripheral edge 244. As previously mentioned with respect to assembly of the valve of FIG. 1, the resiliency of the cup-shaped peripheral edge 244 along with the extension of lower lip 245 only a short distance towards the center of the valve facing permits backup plate 224 to be easily forced into valve facing 242 such that lower lip 245 firmly grasps outer rim 238. Head 214 of valve stem 210 is inserted through aperture 232 in backup plate 224; and, due to its resilience, valve facing 242 will flex under the force on valve stem 210 until the end 222 of head 214 engages the bottom of recess 250 of valve facing 242. Backup plate 224 is then aligned with sliding portion 217 of the valve stem; and, since sliding portion 217 has a diameter smaller than the width of slot 234, the valve stem is laterally moved into aperture 230 so as to be centered with respect to backup plate 224. Once valve stem 210 is centrally aligned the valve stem is lowered such that alignment portion 219 is aligned with aperture 230. Thus, it may be seen that the valve assembly is completed in a self-locking manner readily adaptable for automatic assembly.

The valve assembly is not subject to accidental disassembly since the sliding portion 217 must be aligned with backup plate 224 in order to move the valve stem laterally with respect to the backup plate. Thus, to disassemble the valve assembly, the valve stem must be pushed up against the resilient force of valve facing 242 to align the sliding portion 217 with backup plate 224 to permit lateral movement through slot 234 to aperture 232, and such movement is highly unlikely during normal valve operation. The tapered collar 221 permits valve stem 210 to center itself easily in aperture 230 of backup plate 224 during assembly. Since the diameter of aperture is slightly larger than the diameter of alignment portion 219 of valve stem 210, the valve stem is self-aligned within the valve assembly. Ribs 236 serve to strengthen backup plate 224 and act as seating and centering means for bias spring 240 which concentrically seats at the outer ends thereof. Ribs 236 also limit tilting of the valve stem from the perpendicular due to the extra thickness added at their abutment with aperture 230.

Inasmuch as the present invention is subject to many variations, modifications and changes in detail, it is intended that

all matter contained in the foregoing description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. A self-locking valve assembly comprising

a valve stem including a head having a first diameter, a body, and a neck portion connecting said head and said body and having a second diameter smaller than said first diameter;

a resilient valve facing having a central portion engaging said head of said valve stem and peripheral securing means; and

a backup plate having an outer rim engaging said peripheral securing means of said valve facing, and aperture means receiving said valve stem and including a first aperture centrally disposed in said backup plate and having a third diameter smaller than said first diameter and slightly larger than said second diameter to receive said neck portion of said valve stem while preventing movement therethrough of said head, and a second aperture displaced from said first aperture and having a fourth diameter slightly larger than said first diameter,

said first aperture being linked with said second aperture whereby said head of said valve stem may be inserted through said second aperture to engage said central portion of said valve facing and said valve stem may be centrally positioned with respect to said backup plate by aligning said neck portion of said valve stem with said backup plate and laterally moving said valve stem to said first aperture.

2. The invention as recited in claim 1 wherein said backup plate has an upper surface abutting said valve facing and a lower surface with rib means therein adapted to receive and center a bias spring.

3. The invention as recited in claim 2 wherein said rib means includes an arcuate rib concentrically disposed about said first aperture.

4. The invention as recited in claim 2 wherein said rib means includes a plurality of ribs extending radially from said first aperture and having outer ends concentrically disposed about said first aperture.

5. The invention as recited in claim 1 wherein said peripheral securing means includes a cup-shaped outer edge defining an annular groove, said outer rim of said backup plate being inserted in said annular groove.

6. The invention as recited in claim 5 wherein said central portion has a recess therein having a fifth diameter essentially the same as said first diameter whereby said valve facing firmly grips said head of said valve stem.

7. The invention as recited in claim 1 wherein said first aperture is linked with said second aperture through a slot having a width equal to the third diameter of said first aperture.

8. The invention as recited in claim 7 wherein said slot is L-shaped whereby said valve stem must be moved in transverse directions from said second aperture to said first aperture.

9. The invention as recited in claim 1 wherein said neck portion of said valve stem includes an alignment portion having said second diameter and a sliding portion having a fifth diameter smaller than said second diameter, and said first aperture through a slot having a width slightly larger than said fifth diameter and smaller than said first and second diameters.

10. The invention as recited in claim 9 wherein said sliding portion is connected with said alignment portion through a tapered collar.

11. A self-locking valve assembly comprising

an annular backup plate having aperture means therein and an outer rim;

a valve stem having a neck portion aligned with said backup plate and extending through said aperture means to a head having a diameter larger than the diameter of said neck portion; and

a valve facing made of a resilient material and including an upper surface having a flat outer portion and a raised central portion, said raised central portion having a lower surface abutting said head of said valve stem, said valve facing further including a cup-shaped peripheral edge with a lower lip defining an annular groove with said flat outer portion,

said outer rim of said backup plate being inserted in said annular groove and grasped by said lower lip whereby said backup plate may be mounted in said valve facing by forcing said backup plate against said cup-shaped peripheral edge to distort said cup-shaped peripheral edge such that said annular groove receives said outer rim,

said aperture means receiving said valve stem and including a first aperture centrally disposed in said backup plate and having a diameter smaller than the diameter of said head and slightly larger than the diameter of said neck portion to receive said neck portion of said valve stem while preventing movement therethrough of said head, and a second aperture displaced from said first aperture and having a diameter slightly larger than said head,

said first aperture being linked with said second aperture whereby said head of said valve stem may be inserted through said second aperture to engage said central portion of said valve facing and said valve stem may be centrally positioned with respect to said backup plate by aligning said neck portion of said valve stem with said backup plate and laterally moving said valve stem to said first aperture.

12. The invention as recited in claim 11 wherein said aperture in said annular backup plate is a keyhole slot.

13. The invention as recited in claim 11 wherein said lower lip is hemispherical in cross section.

14. A self-locking valve assembly comprising

an annular backup plate having a centrally disposed aperture therein and an outer rim,

a valve stem having a neck portion aligned with said backup plate and extending through said aperture to a head having a diameter larger than the diameter of said neck portion,

a valve facing made of a resilient material and including an upper surface having a flat outer portion and a raised central portion, said raised central portion having a lower surface abutting said head of said valve stem, said valve facing further including a cup-shaped peripheral edge with a lower lip defining an annular groove with said flat outer portion,

said outer rim of said backup plate being inserted in said annular groove and grasped by said lower lip whereby said backup plate may be mounted in said valve facing by forcing said backup plate against said cup-shaped peripheral edge to distort said cup-shaped peripheral edge such that said annular groove receives said outer rim, and

said backup plate having an upper surface abutting said valve facing and a lower surface with rib means therein adapted to receive and center a bias spring.

15. The invention as recited in claim 14 wherein said rib means includes an arcuate rib concentrically disposed about said aperture.

16. The invention as recited in claim 14 wherein said rib means includes a plurality of ribs extending radially from said aperture and having outer ends concentrically disposed about said aperture.

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