(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 277 956 A2

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
22.01.2003 Bulletin 2003/04

(51) Int Cl.[7]: **F04B 35/04**, F04B 39/12, F04B 39/00

(21) Application number: **02255062.8**

(22) Date of filing: **19.07.2002**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR IE IT LI LU MC NL PT SE SK TR
Designated Extension States:
AL LT LV MK RO SI

(30) Priority: **21.07.2001 GB 0117834**

(71) Applicant: **Archfact Limited**
Waterlooville, Hampshire PO7 7XU (GB)

(72) Inventors:
- **McGrath, Stephen Michael**
Hampshire PO9 6EP (GB)
- **McGrath, Michael Chalton**
Hampshire PO11 OJP (GB)

(74) Representative: **Lomas, Geoffrey Michael et al**
Barker Brettell
Medina Chambers,
Town Quay
Southampton SO14 2AQ (GB)

(54) Compressor housing gasket

(57) A head gasket (5) is disclosed for a reciprocating compressor (1) that comprises a cylinder head (3) and a main body (2) containing a piston assembly (16) and piston valve means (22), the head gasket (5) being formed with fluid channel means (40,91), the arrangement being such that, in use, the fluid channel means (40,91) substantially prevents the piston valve means (22) becoming stuck.

In a first embodiment of the invention the fluid channel means is a recess (40) formed by a cut-out (30) extending through the head gasket(5) and a portion of an inner surface of the cylinder head (3).

In a second embodiment of the present invention the fluid channel means is formed by a raised portion (91) that extends in a direction away from a planar surface of the head gasket (5).

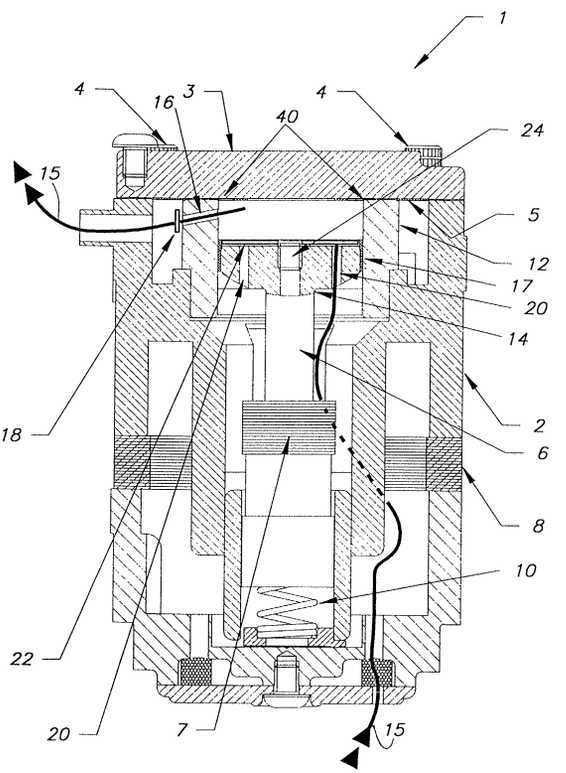

Figure 1

EP 1 277 956 A2

Description

[0001] The present invention relates to a gasket and is concerned particularly with a head gasket for an electromagnetic reciprocating compressor for transferring gases such as air.

[0002] The term compressor will be used generally hereafter to describe both a positive pressure pump and a vacuum pump.

[0003] Existing electromagnetic compressors include a cylinder head and a main body formed with a cylinder. The cylinder head is attached to the main body by bolts and a thin lamina sealing head gasket is clamped there between. Within the main body there is a piston assembly comprising a piston head. The piston assembly reciprocates within the cylinder due to an electromagnetic field generated by an electrical coil and a return spring. The piston head is formed with a number of channels that provide fluid communication through the body of the piston head. A one-way flexible flap valve secured to the face of the piston head covers the channels. An example of this known type of compressor is described in the PCT Patent Specification No. WO 94/28308.

[0004] When the piston head is at the top end of the stroke the piston head is closest to the cylinder head. We have found that as the piston head begins a downward stroke, moving in a direction away from the cylinder head, there is a tendency for the one-way flexible flap valve to become momentarily stuck. When the one-way flap becomes momentarily stuck a vacuum will form in the upper portion of the cylinder. We have found that the flap valve can be completely pulled off the piston head due to the sticking action and the build-up of the vacuum.

[0005] When a positive pressure pump is required air is normally drawn into the compressor casing through various ports in the compressor casing. The air preferably passes through a filter medium before entering a piston cylinder.

[0006] According to a first aspect of the present invention there is provided a head gasket for a reciprocating compressor that comprises a cylinder head and a main body containing a piston assembly and piston valve means, the head gasket being formed with fluid channel means, the arrangement being such that, in use, the fluid channel means substantially prevents the piston valve means becoming stuck.

[0007] The piston valve means is preferably a flap valve.

[0008] Preferably, the fluid channel means is disposed at a radially outermost edge of the flap valve.

[0009] The fluid channel means preferably extends across the radially outermost edge of the flap valve.

[0010] In a first embodiment of the invention the fluid channel means is preferably a recess formed by a cut-out extending through the head gasket and a portion of an inner surface of the cylinder head.

[0011] The cut-out preferably forms a hole that extends through the gasket.

[0012] The head gasket is preferably formed with a plurality of holes that each extends through the head gasket.

[0013] The holes preferably each have a circular shaped horizontal cross-section.

[0014] The head gasket is preferably formed with four holes that are spaced at 90-degree intervals about the vertical central axis of the gasket.

[0015] In a second embodiment of the present invention the fluid channel means is preferably formed by a raised portion that extends in a direction away from a planar surface of the head gasket.

[0016] Preferably, the fluid channel means comprises a plurality of raised portions forming ribs that extend in a direction away from the planar surface of the head gasket.

[0017] The ribs preferably extend radially across the planar surface of the head gasket.

[0018] The raised portions forming the ribs are also preferably formed on a second planar surface of the head gasket.

[0019] The raised portions on one planar surface preferably mirror the raised portions of the second planar surface.

[0020] A compressor assembly may be adapted so that a main compressor body may be used for different piston and cylinder assemblies, each piston may have a different cross-sectional diameter. The different sizes of piston and cylinder assemblies may be housed within a common main compressor body.

[0021] In a third embodiment of the present invention the head gasket comprises fluid channel means according to the first embodiment and fluid channel means according to the second embodiment of the present invention.

[0022] The cut-out recess of the fluid channel means according to the first embodiment is preferably disposed substantially radially outermost of the raised portion of the second embodiment of the present invention.

[0023] The arrangement of the head gasket of the third embodiment of the present invention is such that in use the fluid channel means according to the first embodiment is used for a first piston arrangement and the fluid channel means according to the second embodiment is used for a second piston arrangement.

[0024] Preferably the diameter of the first piston is greater than the diameter of the second piston.

[0025] According to a second aspect of the present invention there is provided a compressor comprising a head gasket according to the first aspect of the present invention, the arrangement being such that in use fluid is drawn through the fluid channel means of the head gasket by the reciprocating action of the piston assembly.

[0026] In an embodiment of the second aspect of the present invention it is preferable that the compressor comprises a piston cylinder formed with fluid duct

means, the arrangement being such that a portion of the fluid duct means aligns with a portion of fluid channel means of the head gasket such that there is fluid communication there between.

[0027] It is preferable that the fluid channel means of the gasket aligns with a portion of fluid duct means formed in a cylinder head of the compressor.

[0028] The present invention may be carried into practice in various ways, but an embodiment will now be described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is an axial cross-sectional view of a first embodiment of the present invention and shows an electromagnetic linear compressor and shows the route of the airflow through the compressor;

Figure 2 is a detailed axial cross-sectional view of the upper portion of the compressor of Figure 1 and shows the piston assembly on a downward stroke;

Figure 3 is a detailed axial cross-sectional view of the upper portion of the compressor of Figure 1 and shows the piston assembly at the top of the stroke;

Figure 4a is a plan view of the compressor of Figure 1 with the cylinder head removed;

Figure 4b is a plan view of the compressor of Figure 5 with the cylinder head removed;

Figure 5 is a further embodiment and shows a compressor comprising a smaller piston assembly than the piston assembly of the compressor shown in Figure 1;

Figure 6 is an axial cross-sectional view of a second embodiment of the present invention and shows an electromagnetic linear compressor;

Figure 7 is a detailed axial cross-sectional view of the upper portion of the compressor of Figure 6 and shows the piston assembly on a downward stroke;

Figure 8 is a detailed axial cross-sectional view of the upper portion of the compressor shown in Figure 6 and shows the piston assembly at the top of the stroke;

Figure 9 is a plan view of the compressor of Figure 1 with the cylinder head removed and the compressor comprising a gasket according to the second embodiment of the present invention; and

Figure 10 is a plan view of the compressor of Figure 6 with the cylinder head removed and the compressor comprising a smaller piston assembly than the piston assembly of the compressor shown in Figure 9.

[0029] Referring to the Figures 1 to 3, an electromagnetic reciprocating compressor 1 comprises a main body 2 of square exterior cross-section transverse to the central axis of the compressor 1 and a cylinder head 3. The cylinder head 3 is bolted onto the main body 2 using threaded bolts 4 with a thin flexible head gasket 5 interposed there between.

[0030] The compressor 1 comprises a piston assembly 6 that carries an armature 7 and the main body 2 carries stator laminations 8 and electromagnetic coils (not shown). The piston assembly 6 moves in one direction as the armature 7 is driven linearly by the stator laminations 8 and the coils (not shown) and is moved linearly in an opposing direction by the spring 10 in a well-known manner. The reciprocation of the piston assembly 6 is well known to the skilled addressee and therefore further details of the arrangement will not be described.

[0031] The main body section 2 comprises a piston cylinder section 12. The piston cylinder section 12 is formed with a gas outlet nozzle 16 that extents through the wall of the piston cylinder section 12. Disposed over the outermost end of the outlet is a one-way valve 18. Arrow 15 in Figure 1 diagrammatically shows the path travelled by air which is transported by the compressor 1.

[0032] A piston head 14 is axially reciprocatingly movable within the cylinder section 12. The radially outermost surface of the head 14 is formed by an annular sleeve 17 of low friction plastics material bonded thereto. The sleeve 17 acts as a piston ring. The piston head 14 is formed with a series of air ducts 20 that extend axially through the piston head 14. The ducts 20 are covered at the face of the piston head 14 by a conventional flexible one-way flap valve 22. The flap valve 22 is a flat annular shape formed with a central circular hole. The flap valve 22 is secured to the face of the piston head 14 by a flat-headed bolt 24. The sleeve 17 extends beyond the piston head 14 and surrounds the radially outermost edge of the flap valve 22.

[0033] With reference to Figure 2, when the piston assembly 6 is moving in a downward direction 26 away from the cylinder head 3 air is forced through the ducts 20 following the paths 28. The air passing through the ducts 20 forces the radially outermost portion of the flap valve 22 away from the face of the piston head 14. When the piston assembly 6 is moving in an upward direction, opposite to the direction 26, the flap valve 20 is forced against the face of the piston head 14 and provides an airtight seal over the ducts 20. When the piston head 14 moves in an upward direction towards the cylinder head 3 the air contained within the cylinder 12 is forced through the outlet nozzle 16.

[0034] With reference to Figures 4a and 4b, the head gasket 5 is a substantially square shape and is formed with a central hole 29 that has a circular cross-section

and; four slots 30 that each extend there through. The four slots 30 have a circular cross-section. The four slots 30 are spaced at intervals of 90-degrees about the central axis 34 of the gasket 5. Located at each corner of the gasket 5 there is a circular hole 36.

[0035] In the assembled state the bolts 4 that secured the cylinder head 3 to the main body 2 extend through the holes 36. The slots 30 and portions of the face surface of the cylinder head form channel recesses 40. The recesses 40 extend across the edge of the radially inner rim of the piston cylinder section 12.

[0036] With reference to Figure 4a, the radially outermost edge 22' of the flap valve 22 and the uppermost surface of the sleeve 17 can be seen through the slots 30

[0037] With reference to Figure 3, the piston head 14 is at the end point of an upward stroke. The flap valve 22 is disposed substantially adjacent the head gasket 5. The head of the flat-headed bolt 24 is received into a circular recess 42 formed by the hole 29 and the face of the cylinder head 3.

[0038] When the piston head 14 begins to descend in the direction 26 there is a tendency for the flap valve 22 to become momentarily stuck to the head gasket 5, however, this is prevented by the recesses 40. The recesses 40 provide air channels through which air can pass so preventing a substantial vacuum build-up forming within the cylinder section and above the piston head 14. The recesses 40 are adjacent the radially outermost edge 22' of the flap valve 22. As the piston head 14 begins to descend air travels through the ducts 20 between the flap valve 22 and the face of the piston head 14 and the radially outermost edge 22' of the flap valve 22 is forced away from the face of the piston head 14. The air then travels around the radially outermost edge 22' of the flap valve 22 into the recesses 40 and the piston cylinder section 12.

[0039] The various compressor assemblies described herein comprise features common to all the respective compressor assemblies and the same reference numbers have been used throughout the description to identify these features.

[0040] Figure 5 shows an electromagnetic reciprocating compressor 50 comprising a piston assembly 52 and a piston cylinder section 53. The piston assembly 52 comprises a piston head 54 that has a smaller horizontal diameter compared with the horizontal diameter of the piston head 14 shown in the Figures 1 to 3. The piston cylinder section 53 shown in Figure 5 has a greater wall thickness than the wall thickness of the cylinder section 12 shown in Figures 1 to 3. It is known to use a standard casing or other standard parts for various different compressor designs. The compressor 50 comprises many features and parts that are the same as compressor 1. The same reference numerals have been used in Figure 5 for these common parts and no further description for the common parts is necessary.

[0041] The gasket 5 can be used for the compressor 1 and the compressor 50.

[0042] The electromagnetic reciprocating compressor 50 comprises the main body 2 containing a cylinder head 55. The cylinder head 55 is bolted onto the main body 2 using threaded bolts 4 with the thin flexible head gasket 5 interposed there between.

[0043] The cylinder head 55 is formed with a network of channels to provide fluid communication to the reciprocating piston arrangement. Contained within the channels of the cylinder head 55 is a filter element 56. The filter element 56 is disposed over an interconnecting duct 58 that forms part of the network of channels that provide fluid communication to the reciprocating piston arrangement.

[0044] A flat circular closure plate 60 is bolted onto the cylinder head 55 using a central threaded bolt 62. The plate is formed with a radial inlet port 64.

[0045] The cylinder section 53 is formed with four channels 66 that extends through the vertical length of the section 53 and provides fluid communication between the duct 58 and an inner chamber 70 formed in the main body 2. One end of the channel 66 aligns with one of the slots 30 such that fluid communication is provided there between.

[0046] With reference to Figure 4b, the channels 66 are shown aligned with the four slots 30.

[0047] The piston head 54 is formed with an air duct 72 that extends axially through the piston head 54. The air duct 72 is formed with a lower entry hole 76 that extends radially towards the central axis of the piston head 54. The duct 72 is covered at the face of the piston head 54 by a conventional flexible non-return flap valve 74. The flap valve 74 is secured to the face of the piston head 54.

[0048] Arrow 80 in Figure 5 diagrammatically shows the path travelled by air that is transported by the compressor 50.

[0049] With reference to Figures 6 to 8 and 10, there is shown a compressor 89 comprising a head gasket 90 according to a second embodiment of the present invention. The head gasket 90 is a substantially square shape and is formed with four slots 30 that each extend there through and a central hole 29 that has a circular cross-section. The four slots 30 have a circular cross-section. The four slots 30 are spaced at intervals of 90-degrees about the central axis 34 of the gasket 90. Located at each corner of the gasket 90 there is formed a circular hole 36. A circular raised rim 91 surrounds each hole 36. A raised rib 93 extends between each neighbouring rim 91 substantially parallel to the perimeter edge of the gasket 90.

[0050] Each slot 30 is formed with an annular recess 92 disposed at each end of the slot 30. Surrounding each recess 92 there is a raised circular rim 94. An arcuate raised rim 96 extends between respective neighbouring rims 94. Four raised ribs 98 extend radially inward from the respective circular rims 94 and four raised ribs 99 extend radially inward from the middle point of

the respective arcuate rims 96. The raised rims 91, 94, 96 and raised ribs 98, 99 are formed on both sides of the gasket 90.

[0051] The four ribs 98 and ribs 99 on the lower surface of the gasket adjacent to the cylinder 12 form fluid channel means for a piston assembly comprising a piston head 100 as shown in Figures 6 to 8 and 10. Piston head 100 has a smaller diameter than the diameter of the piston head 14 shown in Figures 1 to 3 and 4a. Piston head 100 has a larger diameter than the diameter of the piston head 54 shown in Figures 5 and 4b.

[0052] In the assembled state the four ribs 98 and the ribs 99 partially define air channels through which air can pass so preventing a substantial vacuum build-up forming within the cylinder section 12 and above the piston head 100. The four ribs 98 and ribs 99 extend across the radially outermost edge 22' of the flap valve 22. The ribs 98 and 99 help to prevent the flap valve 22 from sticking in the closed condition when the piston head 100 starts to descend. As the piston head 100 begins to descend air travels through the ducts 20 between the flap valve 22 and the face of the piston head 100 and the radially outermost edge 22'of the flap valve 22 is forced away from the face of the piston head 100. The air then travels around the radially outermost edge 22' of the flap valve 22 into the recesses formed by the ribs 98, 99 and the piston cylinder section 12.

[0053] The slots 30 form fluid channel means for the piston assembly comprising the largest piston head 14 as shown in Figure 9 and as previously described with reference to Figures 1 to 4a.

[0054] It will be appreciated by those skilled in the art that each compressor described may be adapted such that it is supplied air from the opposite end of the compressor to that which is described herein.

[0055] The compressor 1 comprising the largest piston 14 may be supplied with air that is channeled through the cylinder head similar to the arrangement of the compressor 50. The cylinder 12 of the compressor 1 would require a fluid channel formed there through and the gasket 5 would need to be formed with additional holes disposed radially outer of the channel recesses 40. The additional holes would provide fluid communication between the cylinder head and the channel formed in the cylinder 12.

[0056] Also the compressor 89 comprising the medium sized piston 14 may be supplied with air that is channelled through the cylinder head similar to the compressor 50. The cylinder 12 of the compressor 1 would require a fluid channel formed there through and the slots 30 would provide fluid communication between the cylinder head and the channel formed in the cylinder 12.

Claims

1. A head gasket (5, 90) for a reciprocating compressor (1) that comprises a cylinder head (3) and a main body (2) containing a piston assembly (6) and piston valve means (22), the head gasket (5, 90) being formed with fluid channel means, the arrangement being such that, in use, the fluid channel means substantially prevents the piston valve means (22) becoming stuck.

2. A head gasket (5, 90) according to claim 1 wherein the piston valve means is a flap valve (22).

3. A head gasket (5, 90) according to claim 2 wherein, the fluid channel means is disposed at a radially outermost edge (22') of the flap valve (22).

4. A head gasket (5, 90) according to claim 2 or claim 3 wherein the fluid channel means extends across the radially outermost edge (22') of the flap valve (22).

5. A head gasket (5) according to any one of the preceding claims wherein the fluid channel means is a recess (40) formed by a cut-out (30) extending through the head gasket (5) and a portion of an inner surface of the cylinder head (3).

6. A head gasket (5) according to claim 5 wherein the cut-out forms a hole (20) that extends through the gasket (5).

7. The head gasket (5) according to claim 6 formed with a plurality of holes (30) that each extends through the head gasket (5).

8. A head gasket (5) according to claim 6 or claim 7 wherein the hole or holes (30) each have a circular shaped horizontal cross-section.

9. A head gasket (5) according to any one of claims 6 to 8 is formed with four holes (30) that are spaced at 90-degree intervals about the vertical central axis (24) of the gasket (5).

10. A head gasket (90) according to any one of claims 1 to 4 wherein the fluid channel means is formed by a raised portion that extends in a direction away from a planar surface of the head gasket (90).

11. A head gasket (90) according to claim 10 wherein the fluid channel means comprises a plurality of raised portions forming ribs (98) that extend in a direction away from the planar surface of the head gasket (90).

12. A head gasket (90) according to claim 11 wherein the ribs (98) extend radially across the planar surface of the head gasket (90).

13. A head gasket (90) according to claim 11 or claim

12 wherein the raised portions forming the ribs (98, 99) are also formed on a second planar surface of the head gasket (90).

14. A head gasket (90) according to claim 13 wherein the raised portions (98) on one planar surface mirror the raised portions (98) of the second planar surface.

15. A head gasket (90) according to claims 1 to 4 comprising fluid channel means according to claims 5 to 9 and fluid channel means according to claims 10 to 14.

16. A head gasket (90) according to claim 15 wherein the cut-out recess (40) of the fluid channel means of claims 5 to 9 is disposed substantially radially outermost of the raised portion (98) of the fluid channel means of claims 10 to 14.

17. The head gasket (90) according to claim 15 or claim 16 wherein the arrangement is such that in use the fluid channel means according to claim 5 to 9 is used for a first piston arrangement and the fluid channel means according to claim 10 to 14 is used for a second piston arrangement.

18. A head gasket according to claim 17 wherein the diameter of the first piston is greater than the diameter of the second piston.

19. A compressor (1) comprising a head gasket (5, 90) according to any one of claims 1 to 18, the arrangement being such that in use fluid is drawn through the fluid channel mans of the head gasket (5, 90) by the reciprocating action of the piston assembly (6).

20. A compressor (1) according to claim 19 wherein the compressor (1) comprises a piston cylinder formed with fluid duct means, the arrangement being such that a portion of the fluid duct means aligns with a portion of fluid channel means of the head gasket (5, 90) such that there is fluid communication there between.

21. A compressor (1) according to claim 20 wherein the fluid channel of the head gasket (5, 90) aligns with a portion of duct means formed in a cylinder head (3) of the compressor (1).

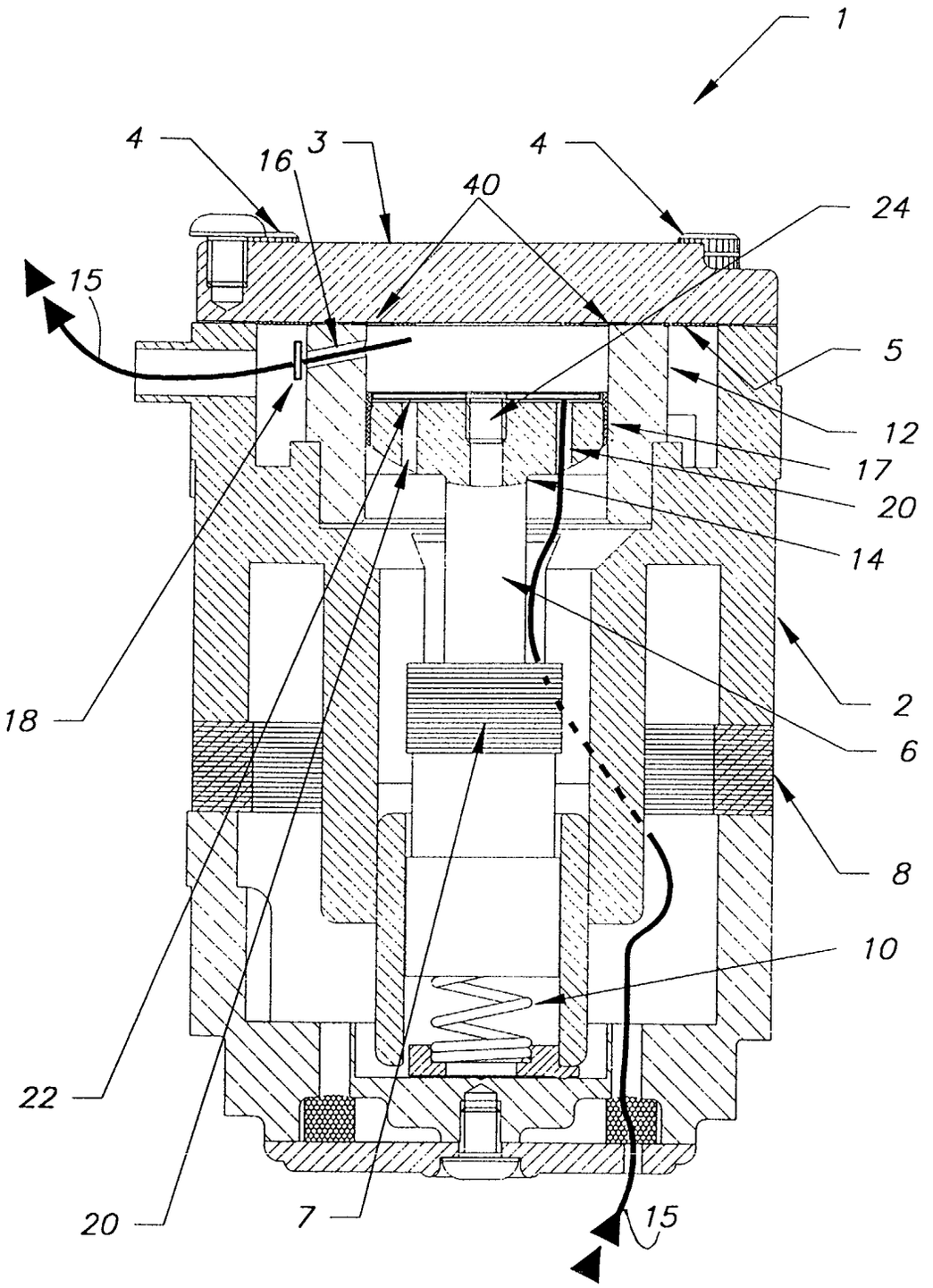

Figure 1

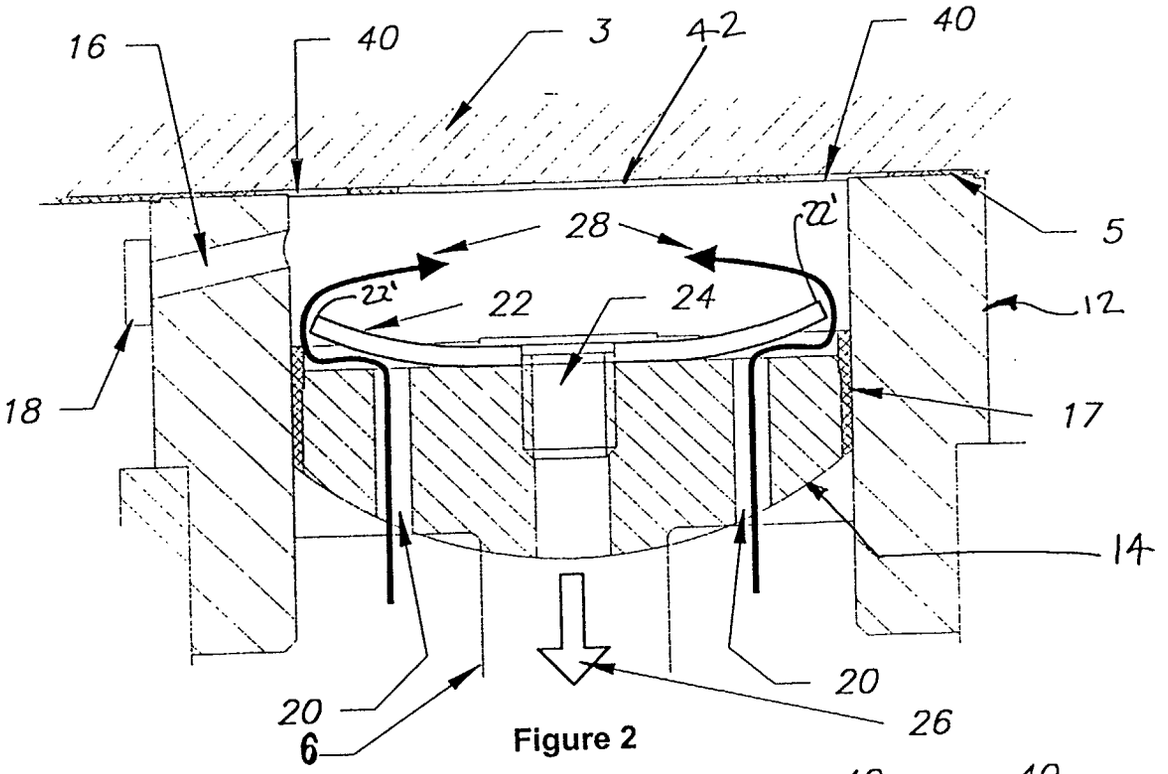

Figure 2

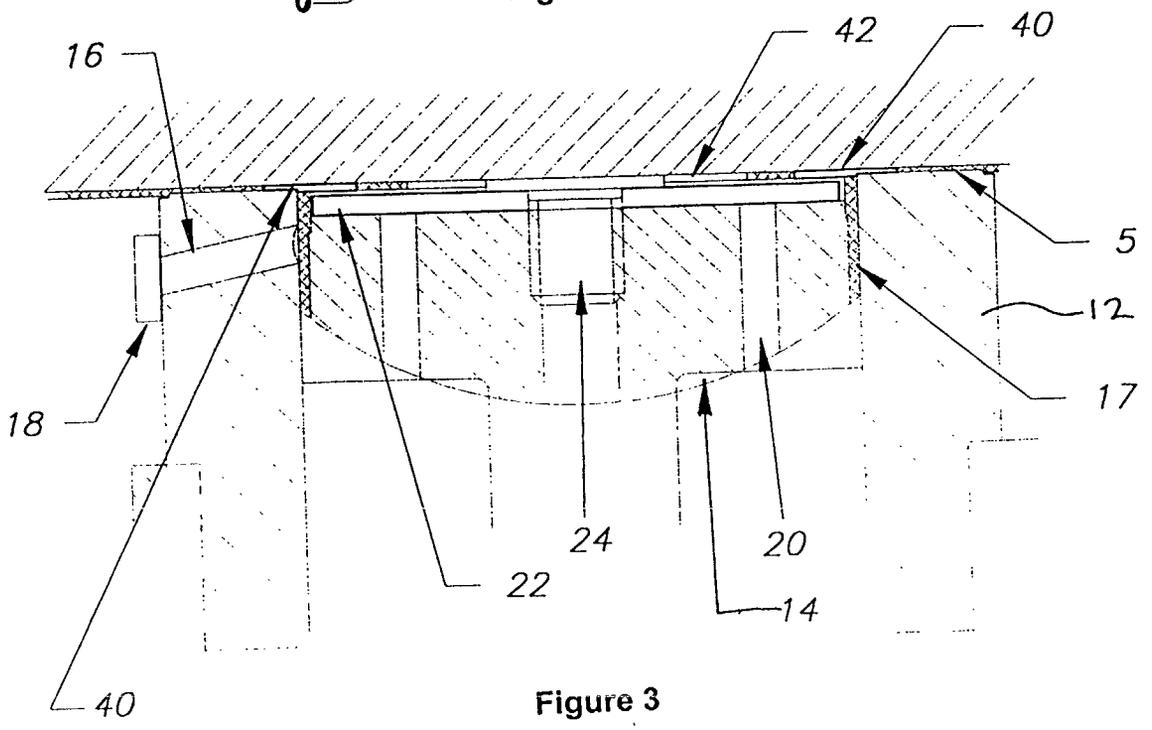

Figure 3

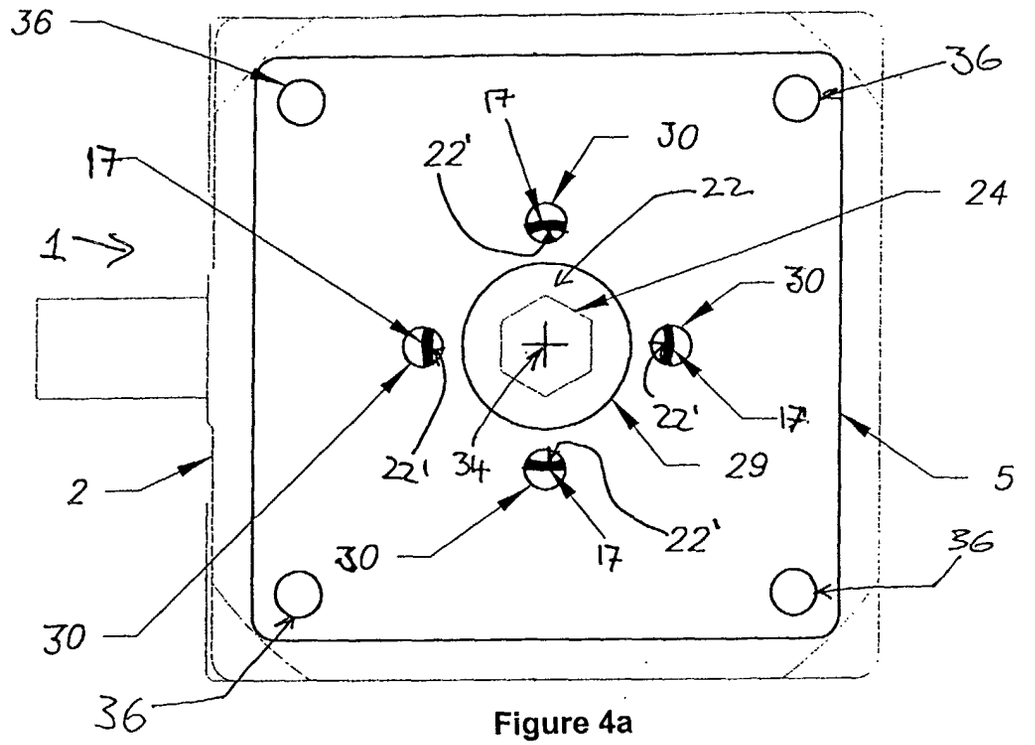

Figure 4a

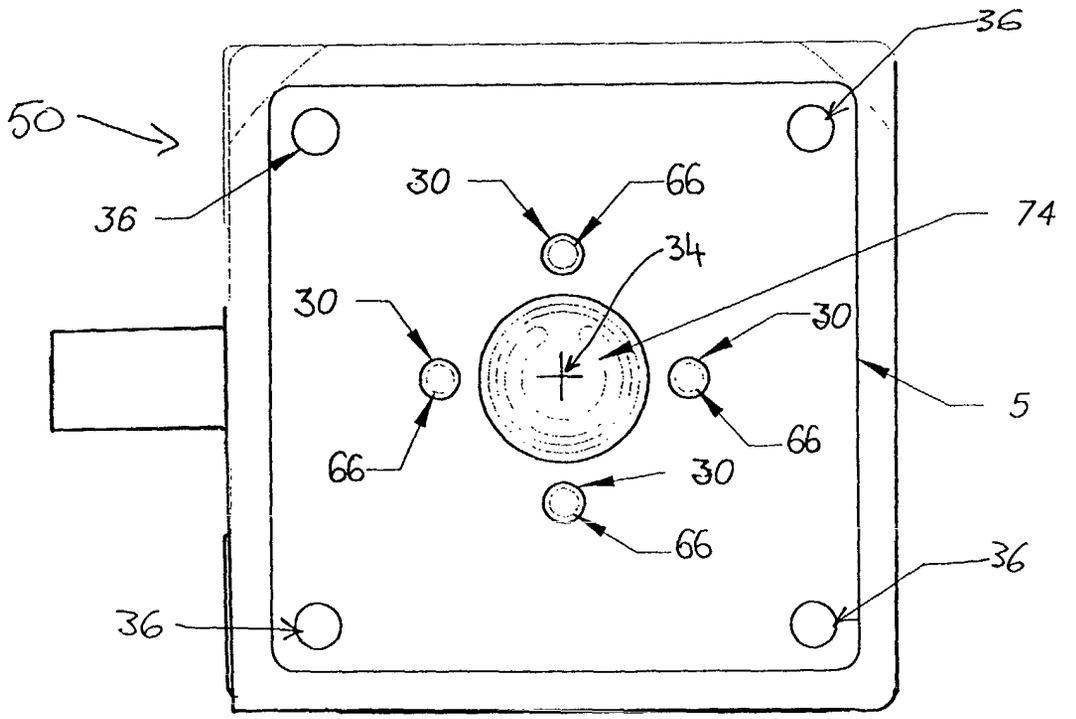

Figure 4b

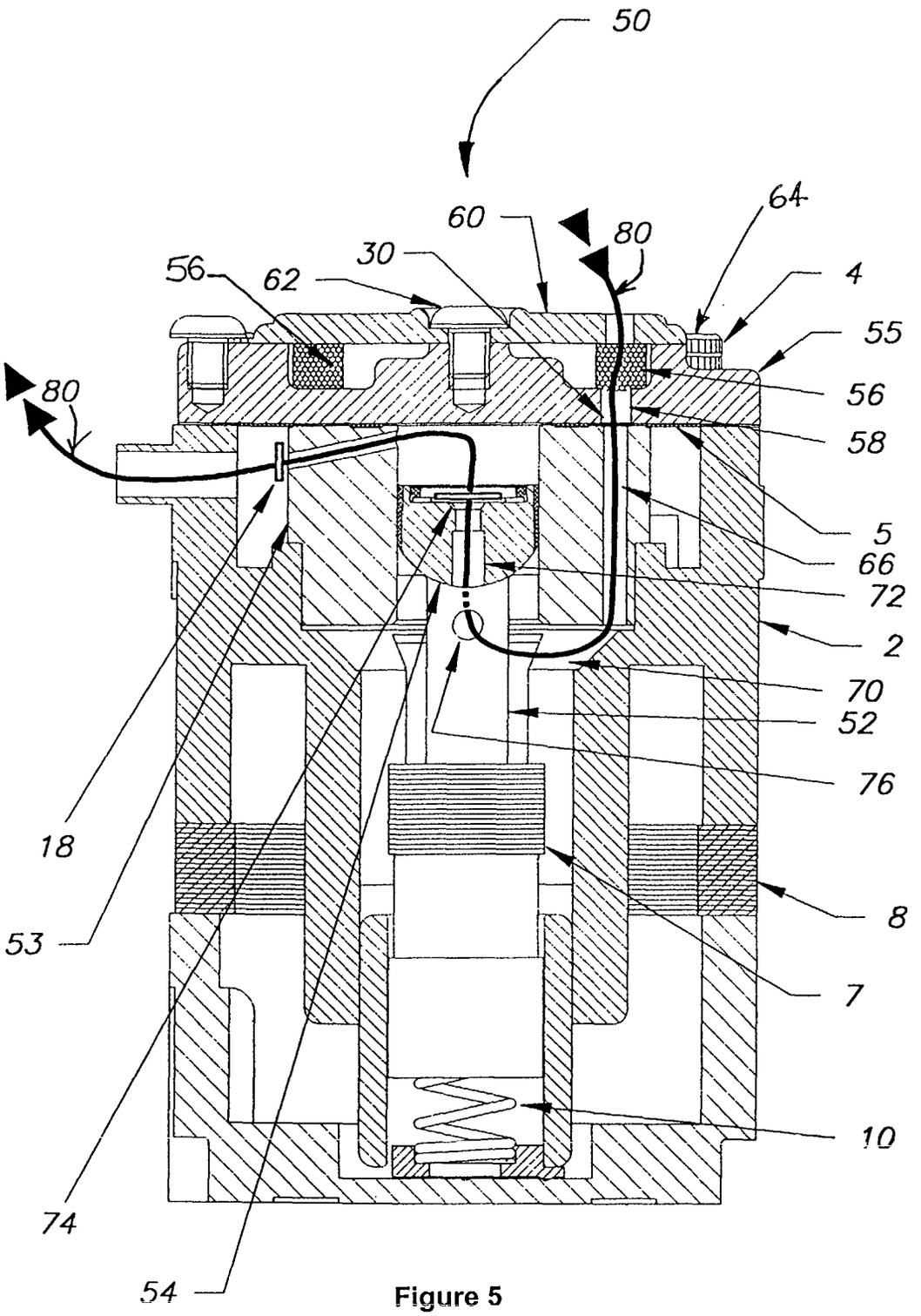

Figure 5

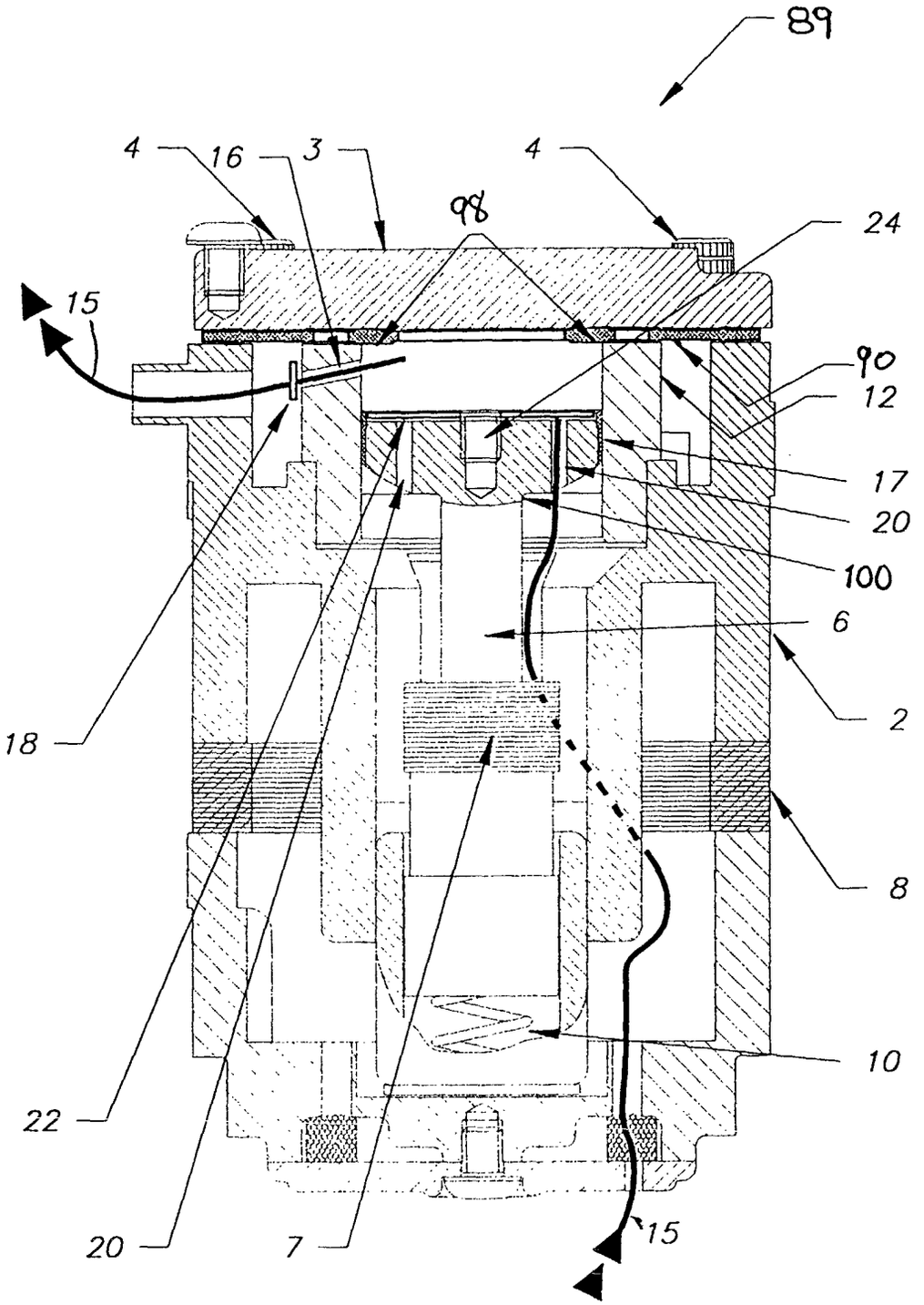

Figure 6

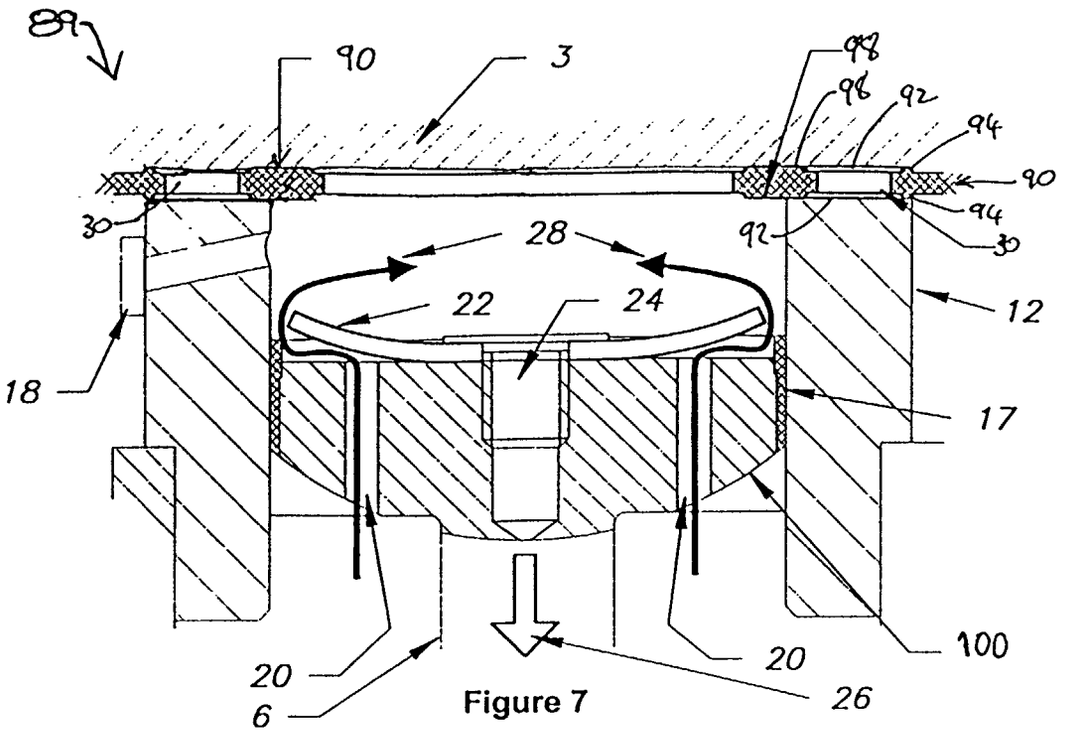

Figure 7

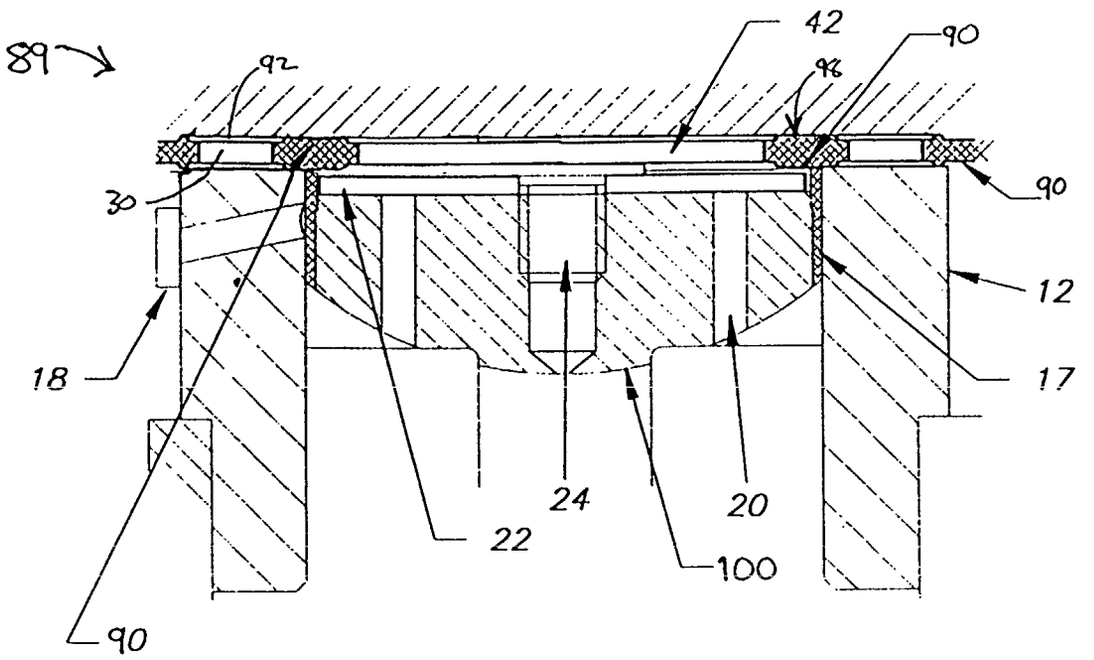

Figure 8

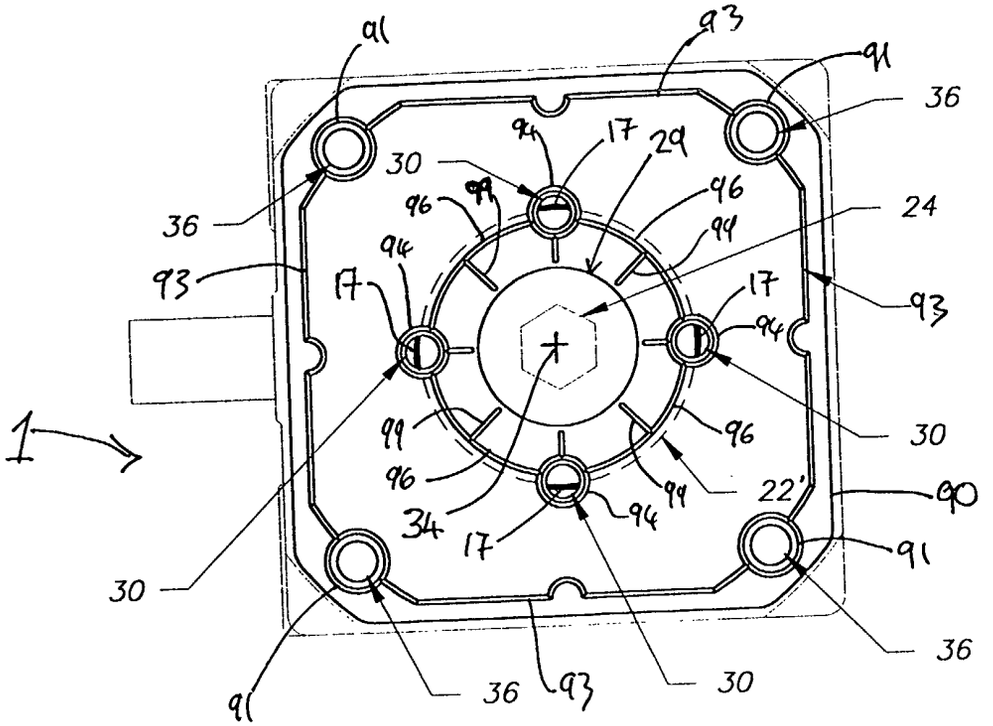

Figure 9

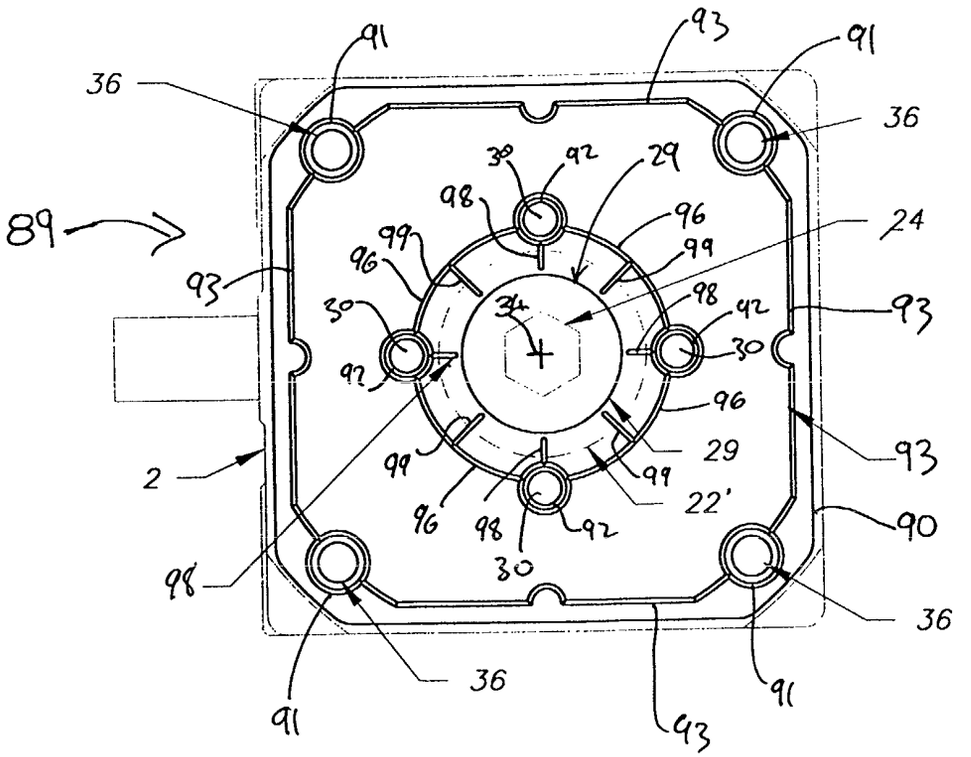

Figure 10