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

(11) EP 2 525 097 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
21.11.2012 Bulletin 2012/47

(51) Int Cl.:
F04B 39/12 *(2006.01)* ***F04B 53/00*** *(2006.01)*

(21) Application number: **12168574.7**

(22) Date of filing: **18.05.2012**

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME

(30) Priority: **20.05.2011 US 201161488293 P**

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(54) Cylinder head for a pump

(57) A cylinder head for a pump. The pump includes a piston and a cylinder block at least partially defining a cylinder chamber receiving the piston. The cylinder head is couplable to the cylinder block. The cylinder head includes an inlet manifold formed as a single piece, an outlet manifold formed as a single piece separate from the inlet manifold, and a pressure chamber positioned fluidly between the inlet manifold and the outlet manifold formed as a single piece separate from the inlet manifold and separate from the outlet manifold. The pressure chamber is formed of a first material, and at least one of the inlet manifold and the outlet manifold is formed of a second material different than the first material.

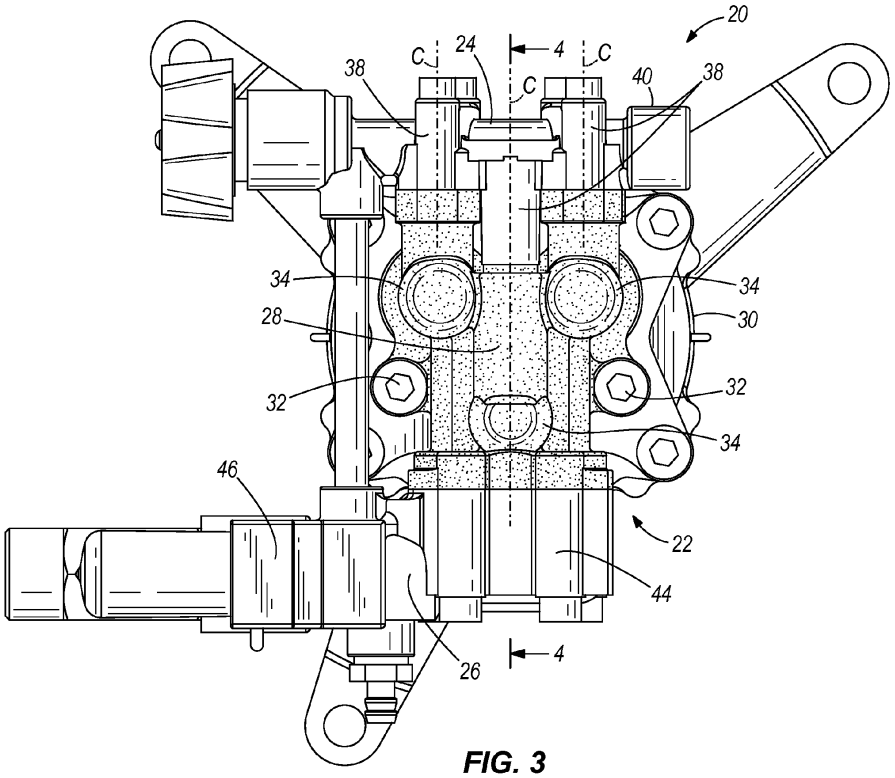

FIG. 3

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Description

FIELD OF THE INVENTION

[0001] The present invention relates to a cylinder head for a pump, such as a pressure washer pump.

BACKGROUND TO THE INVENTION

[0002] Cylinder heads generally include an inlet manifold for receiving a low pressure fluid and directing the low pressure fluid to the pump, an outlet manifold for receiving a pressurized fluid from the pump and directing the pressurized fluid to an outlet, and a pressure chamber between the inlet manifold and the outlet manifold. The pump includes pistons and cylinders for pressurizing the fluid and valves in line with the pistons and cylinders for selectively directing fluid from the inlet manifold to the cylinders. The inlet manifold and pressure chamber form passages in line with the cylinders for receiving the valves and are formed from a single piece of a single material, along with the outlet manifold.

SUMMARY OF THE INVENTION

[0003] According to a first aspect of the invention there is provided a cylinder head for a pump, the pump including a piston and a cylinder block at least partially defining a cylinder chamber receiving the piston, the cylinder chamber extending in a longitudinal direction, the cylinder head being couplable to the cylinder block, the cylinder head comprising:

an inlet manifold for receiving a low pressure fluid and for directing the low pressure fluid to the cylinder chamber, the inlet manifold being formed as a single piece;

an outlet manifold for receiving a pressurized fluid from the cylinder chamber and for directing the pressurized fluid to an outlet, the outlet manifold being formed as a single piece separate from the inlet manifold; and

a pressure chamber positioned fluidly between the inlet manifold and the outlet manifold for receiving the low pressure fluid from the inlet manifold and directing the low pressure fluid to the cylinder chamber, and for receiving the pressurized fluid from the cylinder chamber and directing the pressurized fluid to the outlet manifold, the pressure chamber being formed as a single piece separate from the inlet manifold and separate from the outlet manifold, the pressure chamber being formed of a first material;

wherein at least one of the inlet manifold and the outlet manifold is formed of a second material different than the first material.

[0004] Preferably the cylinder head further comprises an inlet valve positioned in the cylinder head for controlling flow of low pressure fluid from the inlet manifold to the pressure chamber, the inlet valve being oriented along an axis extending transverse to the longitudinal direction of the cylinder chamber such that the low pressure fluid flows through the inlet valve in a direction transverse to the longitudinal direction of the cylinder chamber.

[0005] Preferably the inlet valve is oriented along an axis extending substantially perpendicular to the longitudinal direction of the cylinder chamber such that the low pressure fluid flows through the inlet valve in a direction substantially perpendicular to the longitudinal direction of the cylinder chamber.

[0006] Preferably the cylinder head further comprises an outlet valve positioned in the cylinder head for controlling flow of pressurized fluid from the pressure chamber to the outlet, the outlet valve being oriented along an axis extending transverse to the longitudinal direction of the cylinder chamber such that the pressurized fluid flows through the outlet valve in a direction transverse to the longitudinal direction of the cylinder chamber.

[0007] Preferably the axis is a first axis, and wherein the cylinder head further comprises an inlet valve positioned in the cylinder head for controlling flow of low pressure fluid from the inlet manifold to the pressure chamber, the inlet valve being oriented along a second axis extending transverse to the longitudinal direction of the cylinder chamber such that the low pressure fluid flows through the inlet valve in a direction transverse to the longitudinal direction of the cylinder chamber.

[0008] Preferably the outlet valve is oriented along an axis extending substantially perpendicular to the longitudinal direction of the cylinder chamber such that the pressurized fluid flows through the outlet valve in a direction substantially perpendicular to the longitudinal direction of the cylinder chamber.

[0009] Preferably the axis is a first axis, wherein the cylinder head further comprises an inlet valve positioned in the cylinder head for controlling flow of low pressure fluid from the inlet manifold to the pressure chamber, the inlet valve being oriented along a second axis extending substantially perpendicular to the longitudinal direction of the cylinder chamber such that the low pressure fluid flows through the inlet valve in a direction substantially perpendicular to the longitudinal direction of the cylinder chamber.

[0010] Preferably the first material withstands higher pressures than the second material.

[0011] Preferably the first material includes brass.

[0012] Preferably the second material includes aluminum.

[0013] Preferably the first material includes brass and the second material includes aluminum.

[0014] Preferably the pressure chamber cooperates with the cylinder head to define the cylinder chamber for receiving the piston.

[0015] Preferably both of the inlet manifold and the outlet manifold are formed of the second material different

than the first material.

[0016] According to a second aspect of the invention there is provided a pump for pressurizing a fluid, the pump comprising:

a piston;
a cylinder block at least partially defining a cylinder chamber receiving the piston;
a cylinder head coupled to the cylinder block, the cylinder head including
an inlet manifold for receiving a low pressure fluid and directing the low pressure fluid to the cylinder chamber, the inlet manifold being formed as a single piece,
an outlet manifold for receiving a pressurized fluid from the cylinder chamber and directing the pressurized fluid to an outlet, the outlet manifold being formed as a single piece separate from the inlet manifold, and
a pressure chamber positioned fluidly between the inlet manifold and the outlet manifold and in fluid communication with the cylinder chamber for receiving the low pressure fluid from the inlet manifold and directing the low pressure fluid to the cylinder chamber and for receiving the pressurized fluid from the cylinder chamber and directing the pressurized fluid to the outlet manifold, the pressure chamber being formed as a single piece separate from the inlet manifold and from the outlet manifold, the pressure chamber being formed from a first material,

wherein at least one of the inlet manifold and the outlet manifold is formed from a second material different from the first material.

[0017] Preferably the cylinder head further includes an inlet valve positioned in the cylinder head for controlling flow of low pressure fluid from the inlet manifold to the pressure chamber, the inlet valve being oriented along an axis extending transverse to the longitudinal direction of the cylinder chamber such that the low pressure fluid flows through the inlet valve in a direction transverse to the longitudinal direction of the cylinder chamber.

[0018] Preferably the inlet valve is oriented along an axis extending substantially perpendicular to the longitudinal direction of the cylinder chamber such that the low pressure fluid flows through the inlet valve in a direction substantially perpendicular to the longitudinal direction of the cylinder chamber.

[0019] Preferably the cylinder head further includes an outlet valve positioned in the cylinder head for controlling flow of pressurized fluid from the pressure chamber to the outlet, the outlet valve being oriented along an axis extending transverse to the longitudinal direction of the cylinder chamber such that the pressurized fluid flows through the outlet valve in a direction transverse to the longitudinal direction of the cylinder chamber.

[0020] Preferably the axis is a first axis, and wherein the cylinder head further includes an inlet valve positioned in the cylinder head for controlling flow of low pressure fluid from the inlet manifold to the pressure chamber, the inlet valve being oriented along a second axis extending transverse to the longitudinal direction of the cylinder chamber such that the low pressure fluid flows through the inlet valve in a direction transverse to the longitudinal direction of the cylinder chamber.

[0021] Preferably the outlet valve is oriented along an axis extending substantially perpendicular to the longitudinal direction of the cylinder chamber such that the pressurized fluid flows through the outlet valve in a direction substantially perpendicular to the longitudinal direction of the cylinder chamber.

[0022] Preferably the axis is a first axis, wherein the cylinder head further includes an inlet valve positioned in the cylinder head for controlling flow of low pressure fluid from the inlet manifold to the pressure chamber, the inlet valve being oriented along a second axis extending substantially perpendicular to the longitudinal direction of the cylinder chamber such that the low pressure fluid flows through the inlet valve in a direction substantially perpendicular to the longitudinal direction of the cylinder chamber.

[0023] Preferably the first material withstands higher pressures than the second material.

[0024] Preferably the first material includes brass.

[0025] Preferably the second material includes aluminum.

[0026] Preferably the first material includes brass and the second material includes aluminum.

[0027] Preferably the pressure chamber cooperates with the cylinder head to define the cylinder chamber for receiving the piston.

[0028] Preferably both of the inlet manifold and the outlet manifold are formed of the second material different than the first material.

[0029] According to a third aspect of the invention there is provided a pump for pressurizing a fluid, the pump comprising:

a piston;
a cylinder block at least partially defining a cylinder chamber receiving the piston, the cylinder chamber extending in a longitudinal direction;
a cylinder head coupled to the cylinder block, the cylinder head including
an inlet manifold for receiving a low pressure fluid and directing the low pressure fluid to the cylinder chamber, the inlet manifold being formed as a single piece,
an outlet manifold for receiving a pressurized fluid from the cylinder chamber and directing the pressurized fluid to an outlet, the outlet manifold being formed as a single piece separate from the inlet manifold,
a pressure chamber positioned fluidly between the inlet manifold and the outlet manifold and in fluid communication with the cylinder chamber for receiv-

ing the low pressure fluid from the inlet manifold and directing the low pressure fluid to the cylinder chamber and for receiving the pressurized fluid from the cylinder chamber and directing the pressurized fluid to the outlet manifold, the pressure chamber being formed as a single piece separate from the inlet manifold and from the outlet manifold, the pressure chamber being formed from a first material including brass,

an inlet valve positioned in the cylinder head for controlling flow of low pressure fluid from the inlet manifold to the pressure chamber, the inlet valve being oriented along an axis extending substantially perpendicular to the longitudinal direction of the cylinder chamber such that the low pressure fluid flows through the inlet valve in a direction substantially perpendicular to the longitudinal direction of the cylinder chamber, and

an outlet valve positioned in the cylinder head for controlling flow of pressurized fluid from the pressure chamber to the outlet, the outlet valve being oriented along an axis extending substantially perpendicular to the longitudinal direction of the cylinder chamber such that the pressurized fluid flows through the outlet valve in a direction substantially perpendicular to the longitudinal direction of the cylinder chamber,

wherein the inlet manifold and the outlet manifold is formed from a second material including aluminum. Other independent aspects of the invention will become apparent by consideration of the detailed description, claims and accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0030] FIG. 1 is a perspective view of a prior art pump having a cylinder head.

[0031] FIG. 2 is a top view of the prior art pump shown in FIG. 1.

[0032] FIG. 3 is a top view of a pump having a cylinder head according to one embodiment of the invention.

[0033] FIG. 4 is a cross section of the pump taken along line 4--4 of FIG. 3.

[0034] FIG. 5 is a left side view of the pump shown in FIG. 3.

[0035] FIG. 6 is a front view of the pump shown in FIG. 3.

[0036] FIG. 7 is rear view of the pump shown in FIG. 3.

DETAILED DESCRIPTION OF THE PREFERRED EMBOPDIMENTS

[0037] Before any independent embodiments of the invention are explained in detail, it is to be understood that the invention is not limited in its application to the details of construction and the arrangement of components set forth in the following description or illustrated in the following drawings. The invention is capable of other independent embodiments and of being practiced or of being carried out in various ways.

[0038] FIGS. 1-2 illustrate a prior art cylinder head 10 for a pressure washer pump 12. As best illustrated in FIG. 2, the cylinder head 10 includes an inlet manifold 14, an outlet manifold 16 and a pressure chamber 18. The inlet manifold 14, the outlet manifold 16 and the pressure chamber 18 are formed as a single piece from brass, which is represented by stippled shading. Brass is selected to handle the pressure of the water in the pressure chamber 18. The pressure chamber 18 houses pistons and corresponding valves, which are oriented and arranged substantially in line with each other along an axis A parallel to a direction in which the pistons reciprocate. The inlet manifold 14 is positioned substantially on top of, i.e., in line with, the pistons and valves along the axis A to direct inlet water to the valves and pistons.

[0039] FIGS. 3-7 illustrate a pump 20 having a cylinder head 22 according to one embodiment of the invention. The cylinder head 22 includes an inlet manifold 24, an outlet manifold 26 and a pressure chamber 28 between the inlet manifold 24 and the outlet manifold 26. The inlet manifold 24 and the outlet manifold 26 are formed from a first material and the pressure chamber 28 is formed from a second material, which is different from the first material. The second material is represented with stippled shading. In particular, the second material is stronger (i.e., designed to withstand higher pressures) than the material used to form the inlet manifold 24 and the outlet manifold 26. In the illustrated construction, the inlet manifold 24 and the outlet manifold 26 are formed of aluminum and the pressure chamber 28 is formed from brass. In other embodiments, other materials suitable for the pressure to which each part is subjected may be employed.

[0040] The pump 20 also includes a cylinder block 30 to which the pressure chamber 28 is coupled by fasteners 32, such as bolts. In the illustrated embodiment, three fasteners 32 are employed (see the first and second fasteners 32 in FIG. 3 positioned near the outlet manifold 26 and the third fastener 32 in FIG. 4 positioned near the inlet manifold 24 and beneath a middle lateral outlet 38 of the inlet manifold 24). In other embodiments, other suitable fasteners may be employed, or the pressure chamber 28 and cylinder block 30 may be otherwise suitably coupled. The cylinder block 30 and pressure chamber 28 each at least partially define cylinders 34, which house respective pistons 36 (FIG. 4). In the illustrated embodiment, the pump 20 includes three pistons 36 and three respective cylinders 34. In other embodiments, one, two, four or more pistons and cylinders may be employed. Each piston 36 and cylinder 34 defines an axis B extending in a direction substantially parallel to a direction in which the pistons 36 reciprocate. The cylinder block 30 houses a piston actuator 48 for actuating the pistons 36.

[0041] The inlet manifold 24 includes a low pressure inlet 40 for receiving a low pressure fluid, such as water,

and low pressure outlets 38 for directing the low pressure fluid to the respective cylinders 34. The number of low pressure outlets 38 is equal to the number of cylinders 34. At least one of the low pressure outlets 38 is oriented to define a central axis C substantially perpendicular to the axis B of the respective piston 36 and cylinder 34. In the illustrated embodiment, each of the low pressure outlets 38 are oriented substantially perpendicular to the respective cylinder 34.

[0042] As best illustrated in FIG. 4, the pressure chamber 28 includes inlet valves 42 (one shown in FIG. 4) positioned therein and positioned adjacent and in fluid communication with respective low pressure outlets 38 for receiving the low pressure fluid from the inlet manifold 24. In some embodiments, the pressure chamber 28 may partially define the low pressure outlets 38. There is one inlet valve 42 for each low pressure outlet 38. Therefore, in the illustrated embodiment, there are three inlet valves 42. The inlet valves 42 are each positioned fluidly between the inlet manifold 24 and the respective cylinder 34, downstream of the inlet manifold 24 and upstream of the respective cylinder 34. Each inlet valve 42 is oriented along the axis C, in line with and in fluid communication with the respective low pressure inlet 38 and substantially perpendicular to the respective cylinder 34 and axis B. In other words, fluid flows through each inlet valve 42 in a direction substantially parallel to the axis C.

[0043] The inlet valves 42 are one-way check valves that open to enable the pistons 36 to draw the low pressure fluid into the pressure chamber 28 and close to enable the pistons 36 to pressurize the low pressure fluid to a high pressure fluid. The pistons 36 then force the high pressure fluid to respective high pressure inlets 44 to the outlet manifold 26, which in turn deliver the high pressure fluid to a high pressure outlet 46. The high pressure inlets 44 are aligned along a central axis D substantially parallel to the axis C of the respective low pressure outlet 38 and substantially perpendicular to the axis B of the respective piston 36 and cylinder 34. Outlet valves 50 (one is illustrated in FIG. 5) are positioned in the outlet manifold 26 in fluid communication with each respective high pressure inlet 44. The outlet valves 50 are aligned with the axis D in a direction substantially parallel to the axis C of the respective low pressure outlet 38 and substantially perpendicular to the axis B of the respective piston 36 and cylinder 34. The outlet valves 50 are one-way check valves that open to enable the pistons 36 to force the high pressure fluid towards the outlet 46 and close to prevent backflow.

[0044] Because the inlet and outlet valves 42, 50 and respective low pressure outlet 38 and high pressure inlet 44 are positioned transverse to the pistons 36 and cylinders 34 (in other words, not in line with the pistons 36 and cylinders 34), the height of the pressure chamber 28 is reduced and thus the amount of brass, or other suitable pressure-rated material, is reduced. Also, because the valves 42, 50 and the inlet and outlet manifolds 24, 26 are adjacent the pistons 36 and cylinders 34 in a transverse direction to the axis B, the inlet and outlet manifolds 24, 26 can be formed from a different material than the pressure chamber 28, such as aluminum, further reducing the amount of brass, or other suitable pressure-rated material, needed to form the pressure chamber 28.

[0045] Thus, the invention provides, among other things, a low cost cylinder head having a novel arrangement of parts allowing a portion of the cylinder head to be formed of aluminum.

[0046] One or more independent features and independent advantages of the invention may be set forth in the following claims:

Claims

1. A cylinder head for a pump, the pump including a piston and a cylinder block at least partially defining a cylinder chamber receiving the piston, the cylinder chamber extending in a longitudinal direction, the cylinder head being couplable to the cylinder block, the cylinder head comprising:

   an inlet manifold for receiving a low pressure fluid and for directing the low pressure fluid to the cylinder chamber, the inlet manifold being formed as a single piece;
   an outlet manifold for receiving a pressurized fluid from the cylinder chamber and for directing the pressurized fluid to an outlet, the outlet manifold being formed as a single piece separate from the inlet manifold; and
   a pressure chamber positioned fluidly between the inlet manifold and the outlet manifold for receiving the low pressure fluid from the inlet manifold and directing the low pressure fluid to the cylinder chamber, and for receiving the pressurized fluid from the cylinder chamber and directing the pressurized fluid to the outlet manifold, the pressure chamber being formed as a single piece separate from the inlet manifold and separate from the outlet manifold, the pressure chamber being formed of a first material;

   wherein at least one of the inlet manifold and the outlet manifold is formed of a second material different than the first material.

2. A pump for pressurizing a fluid, the pump comprising:

   a piston;
   a cylinder block at least partially defining a cylinder chamber receiving the piston;
   a cylinder head coupled to the cylinder block, the cylinder head including
   an inlet manifold for receiving a low pressure fluid and directing the low pressure fluid to the cylinder chamber, the inlet manifold being

formed as a single piece,
an outlet manifold for receiving a pressurized fluid from the cylinder chamber and directing the pressurized fluid to an outlet, the outlet manifold being formed as a single piece separate from the inlet manifold, and
a pressure chamber positioned fluidly between the inlet manifold and the outlet manifold and in fluid communication with the cylinder chamber for receiving the low pressure fluid from the inlet manifold and directing the low pressure fluid to the cylinder chamber and for receiving the pressurized fluid from the cylinder chamber and directing the pressurized fluid to the outlet manifold, the pressure chamber being formed as a single piece separate from the inlet manifold and from the outlet manifold, the pressure chamber being formed from a first material,
wherein at least one of the inlet manifold and the outlet manifold is formed from a second material different from the first material.

3. The device of claims 1 or 2, wherein the cylinder head further includes an inlet valve positioned in the cylinder head for controlling flow of low pressure fluid from the inlet manifold to the pressure chamber, the inlet valve being oriented along an axis extending transverse to the longitudinal direction of the cylinder chamber such that the low pressure fluid flows through the inlet valve in a direction transverse to the longitudinal direction of the cylinder chamber.

4. The devise of claim 3, wherein the inlet valve is oriented along an axis extending substantially perpendicular to the longitudinal direction of the cylinder chamber such that the low pressure fluid flows through the inlet valve in a direction substantially perpendicular to the longitudinal direction of the cylinder chamber.

5. The device of claims 1 or 2, wherein the cylinder head further includes an outlet valve positioned in the cylinder head for controlling flow of pressurized fluid from the pressure chamber to the outlet, the outlet valve being oriented along an axis extending transverse to the longitudinal direction of the cylinder chamber such that the pressurized fluid flows through the outlet valve in a direction transverse to the longitudinal direction of the cylinder chamber.

6. The device of claim 5, wherein the axis is a first axis, and wherein the cylinder head further includes an inlet valve positioned in the cylinder head for controlling flow of low pressure fluid from the inlet manifold to the pressure chamber, the inlet valve being oriented along a second axis extending transverse to the longitudinal direction of the cylinder chamber such that the low pressure fluid flows through the inlet valve in a direction transverse to the longitudinal direction of the cylinder chamber.

7. The device of claim 5, wherein the outlet valve is oriented along an axis extending substantially perpendicular to the longitudinal direction of the cylinder chamber such that the pressurized fluid flows through the outlet valve in a direction substantially perpendicular to the longitudinal direction of the cylinder chamber.

8. The device of claim 7, wherein the axis is a first axis, wherein the cylinder head further includes an inlet valve positioned in the cylinder head for controlling flow of low pressure fluid from the inlet manifold to the pressure chamber, the inlet valve being oriented along a second axis extending substantially perpendicular to the longitudinal direction of the cylinder chamber such that the low pressure fluid flows through the inlet valve in a direction substantially perpendicular to the longitudinal direction of the cylinder chamber.

9. The device of any preceding claim, wherein the first material withstands higher pressures than the second material.

10. The device of any preceding claim, wherein the first material includes brass.

11. The device of any preceding claim, wherein the second material includes aluminum.

12. The device of any preceding claim, wherein the first material includes brass and the second material includes aluminum.

13. The device of any preceding claim, wherein the pressure chamber cooperates with the cylinder head to define the cylinder chamber for receiving the piston.

14. The device of any preceding claim, wherein both of the inlet manifold and the outlet manifold are formed of the second material different than the first material.

15. A pump for pressurizing a fluid, the pump comprising:

a piston;
a cylinder block at least partially defining a cylinder chamber receiving the piston, the cylinder chamber extending in a longitudinal direction;
a cylinder head coupled to the cylinder block, the cylinder head including
an inlet manifold for receiving a low pressure fluid and directing the low pressure fluid to the cylinder chamber, the inlet manifold being formed as a single piece,
an outlet manifold for receiving a pressurized

fluid from the cylinder chamber and directing the pressurized fluid to an outlet, the outlet manifold being formed as a single piece separate from the inlet manifold,

a pressure chamber positioned fluidly between the inlet manifold and the outlet manifold and in fluid communication with the cylinder chamber for receiving the low pressure fluid from the inlet manifold and directing the low pressure fluid to the cylinder chamber and for receiving the pressurized fluid from the cylinder chamber and directing the pressurized fluid to the outlet manifold, the pressure chamber being formed as a single piece separate from the inlet manifold and from the outlet manifold, the pressure chamber being formed from a first material including brass,

an inlet valve positioned in the cylinder head for controlling flow of low pressure fluid from the inlet manifold to the pressure chamber, the inlet valve being oriented along an axis extending substantially perpendicular to the longitudinal direction of the cylinder chamber such that the low pressure fluid flows through the inlet valve in a direction substantially perpendicular to the longitudinal direction of the cylinder chamber, and

an outlet valve positioned in the cylinder head for controlling flow of pressurized fluid from the pressure chamber to the outlet, the outlet valve being oriented along an axis extending substantially perpendicular to the longitudinal direction of the cylinder chamber such that the pressurized fluid flows through the outlet valve in a direction substantially perpendicular to the longitudinal direction of the cylinder chamber,

wherein the inlet manifold and the outlet manifold is formed from a second material including aluminum.

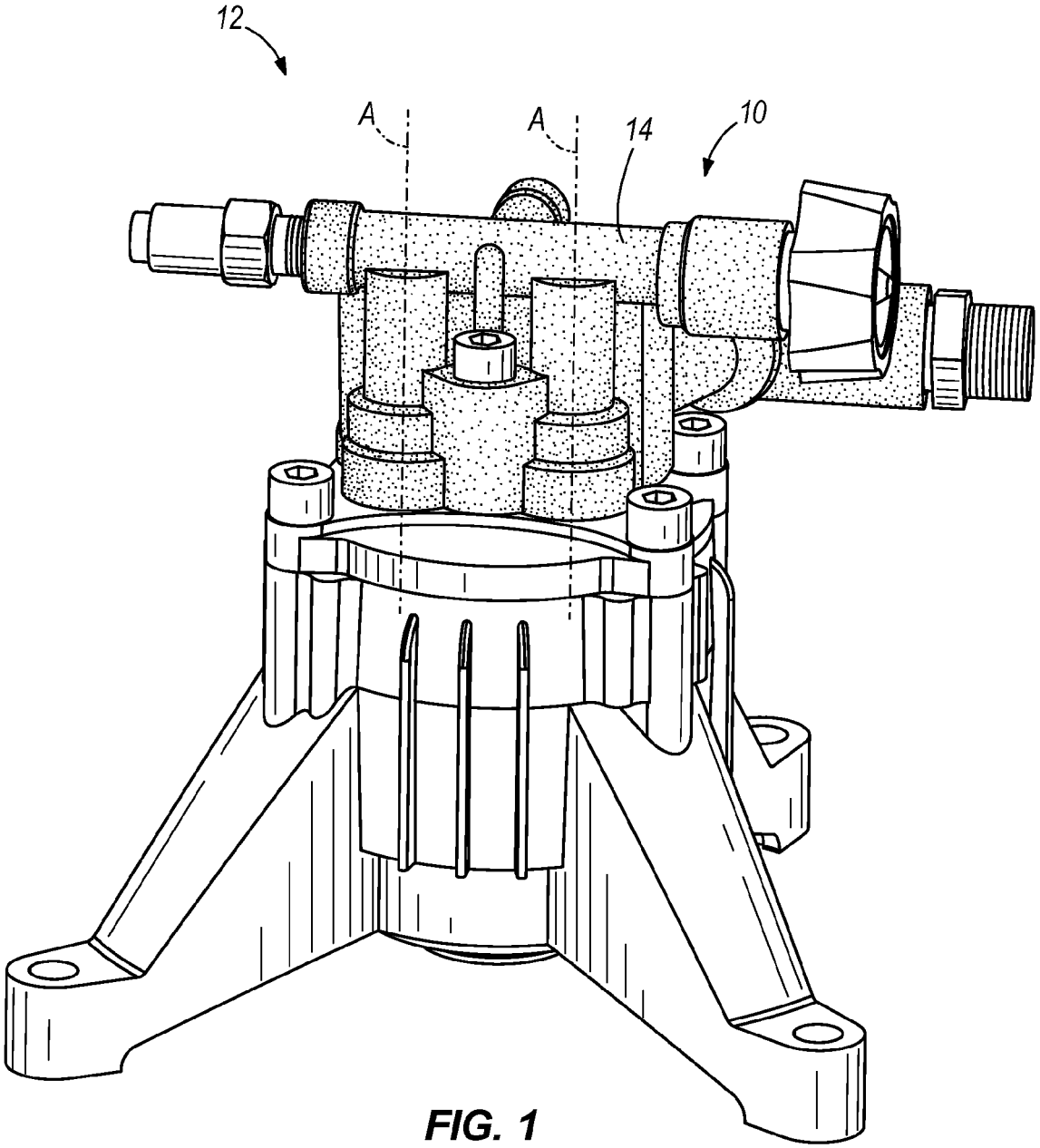

FIG. 1
PRIOR ART

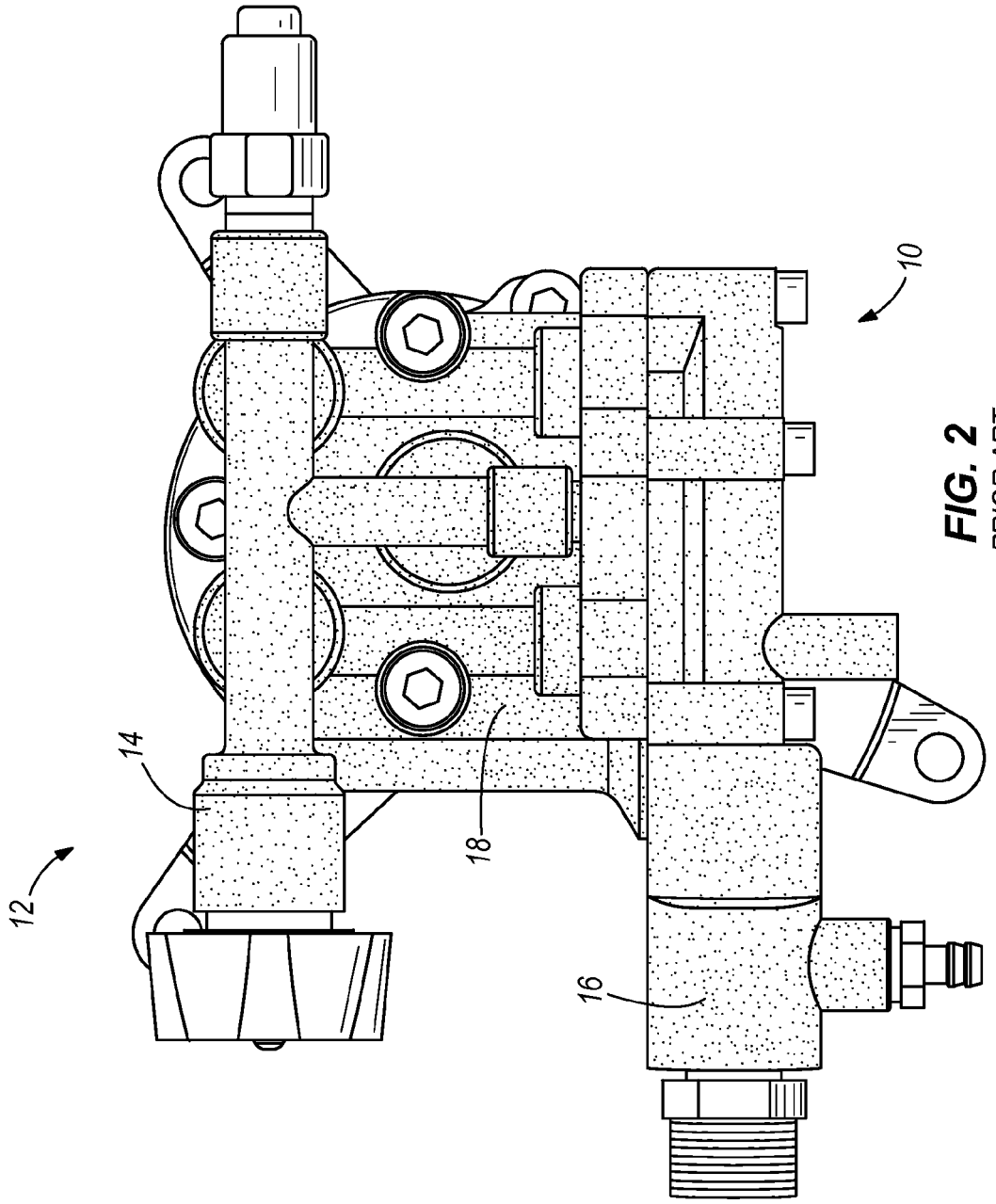

FIG. 2
PRIOR ART

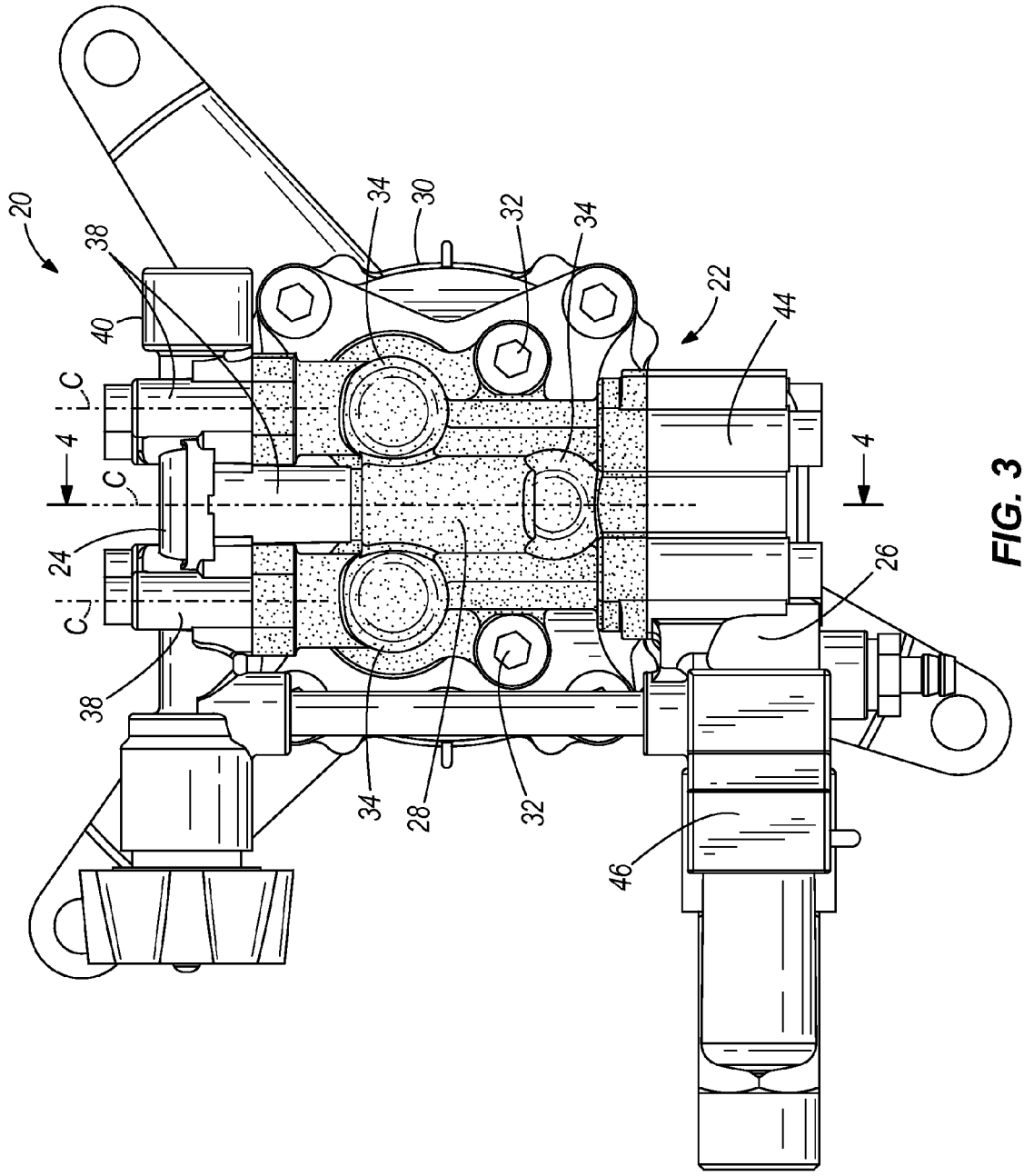

FIG. 3

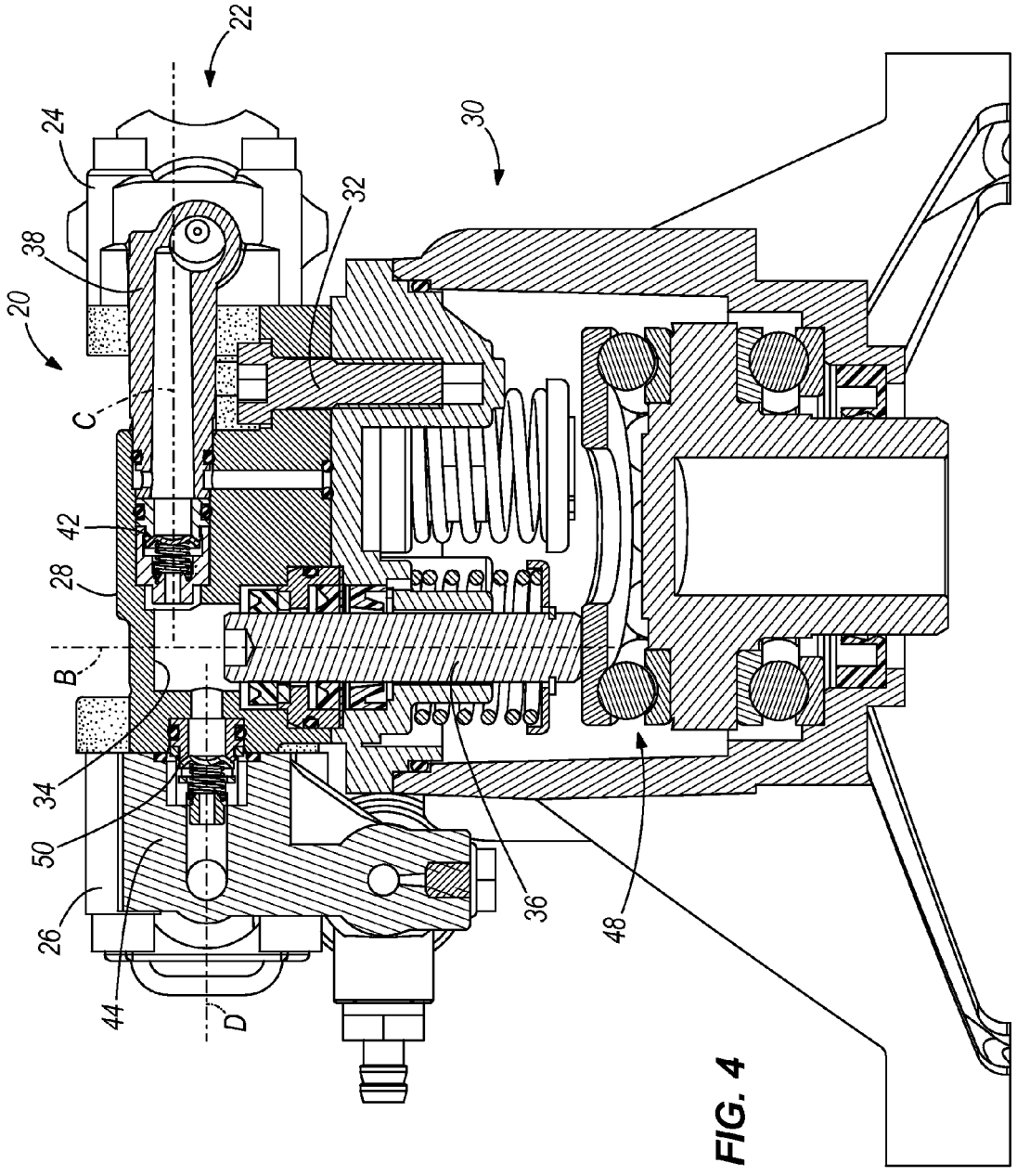

FIG. 4

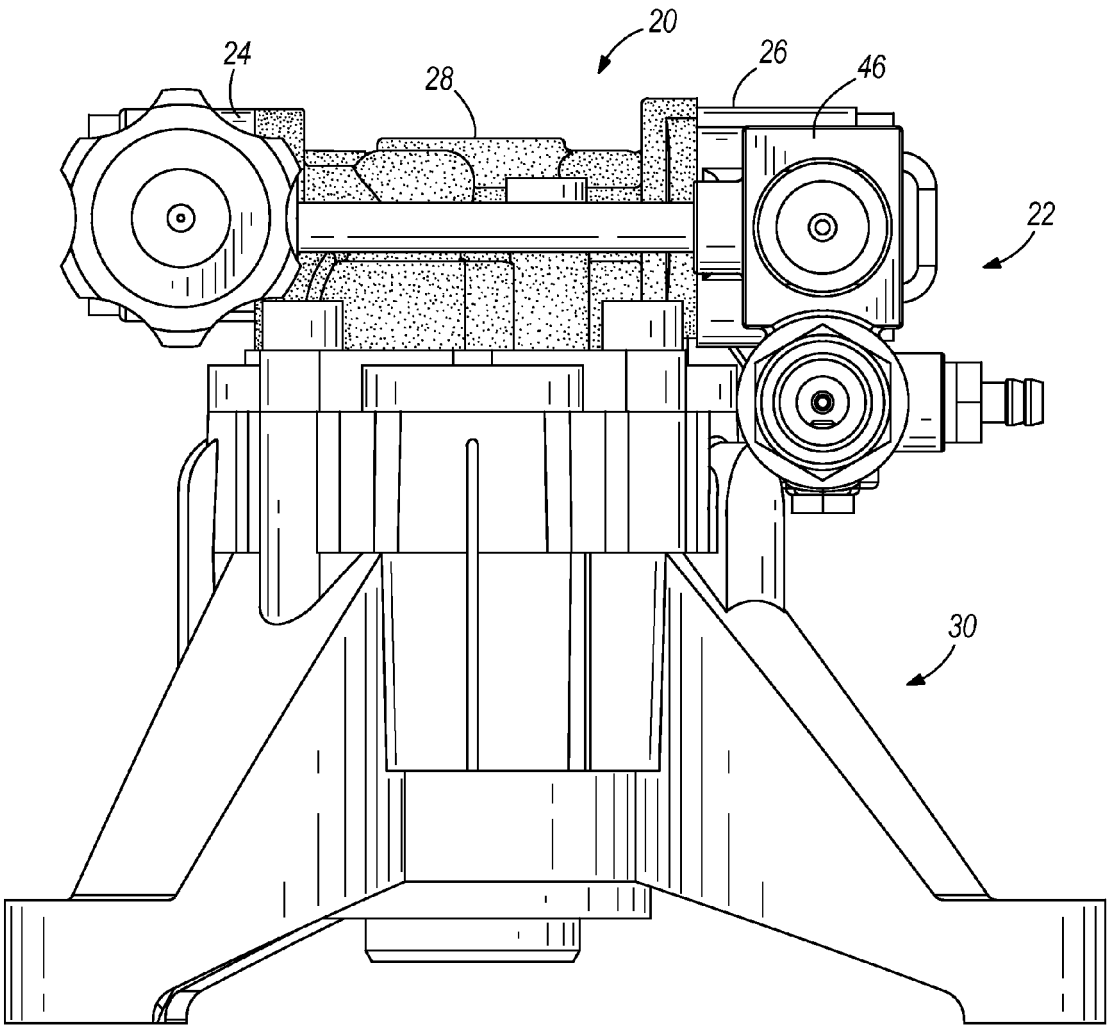

FIG. 5

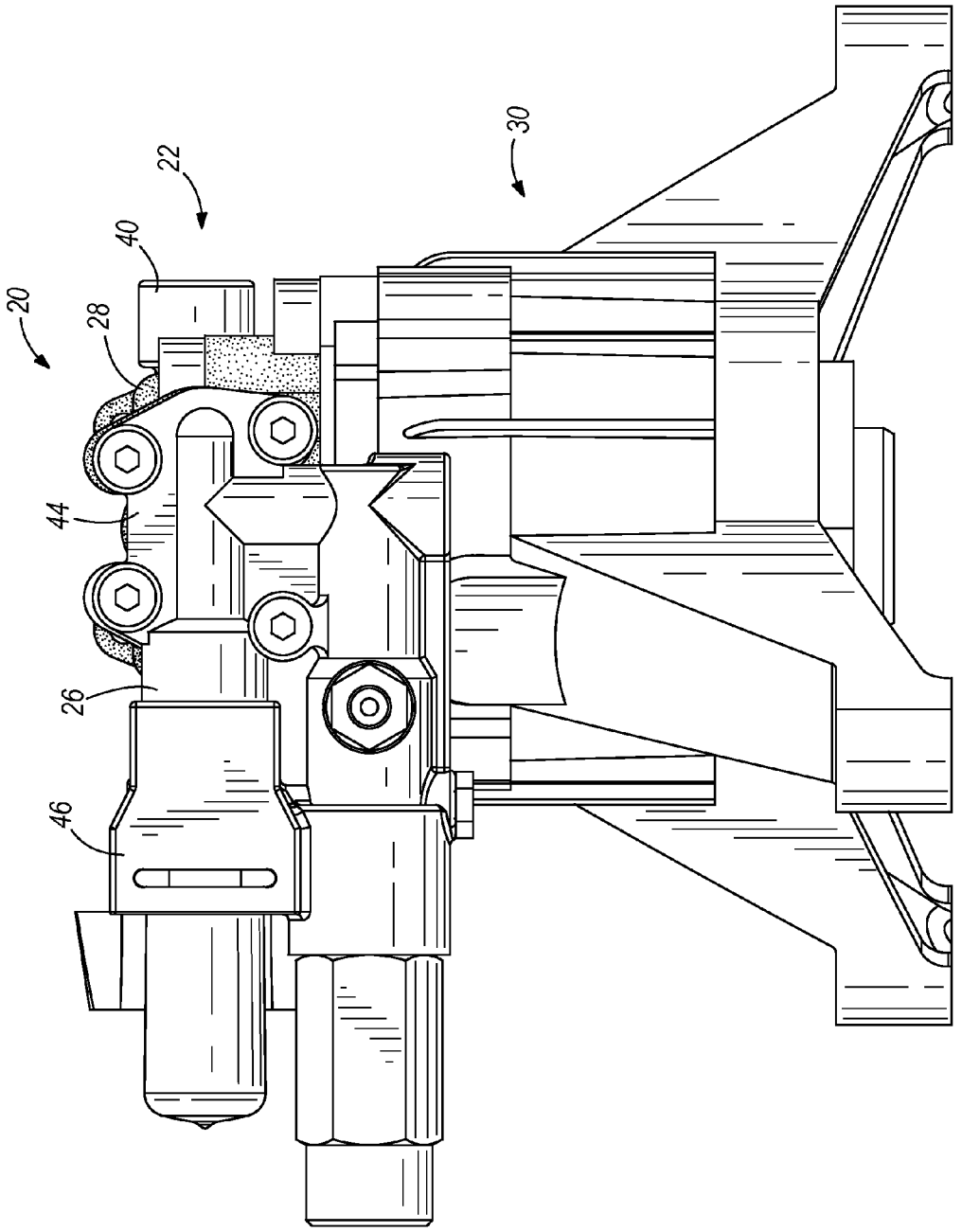

FIG. 6

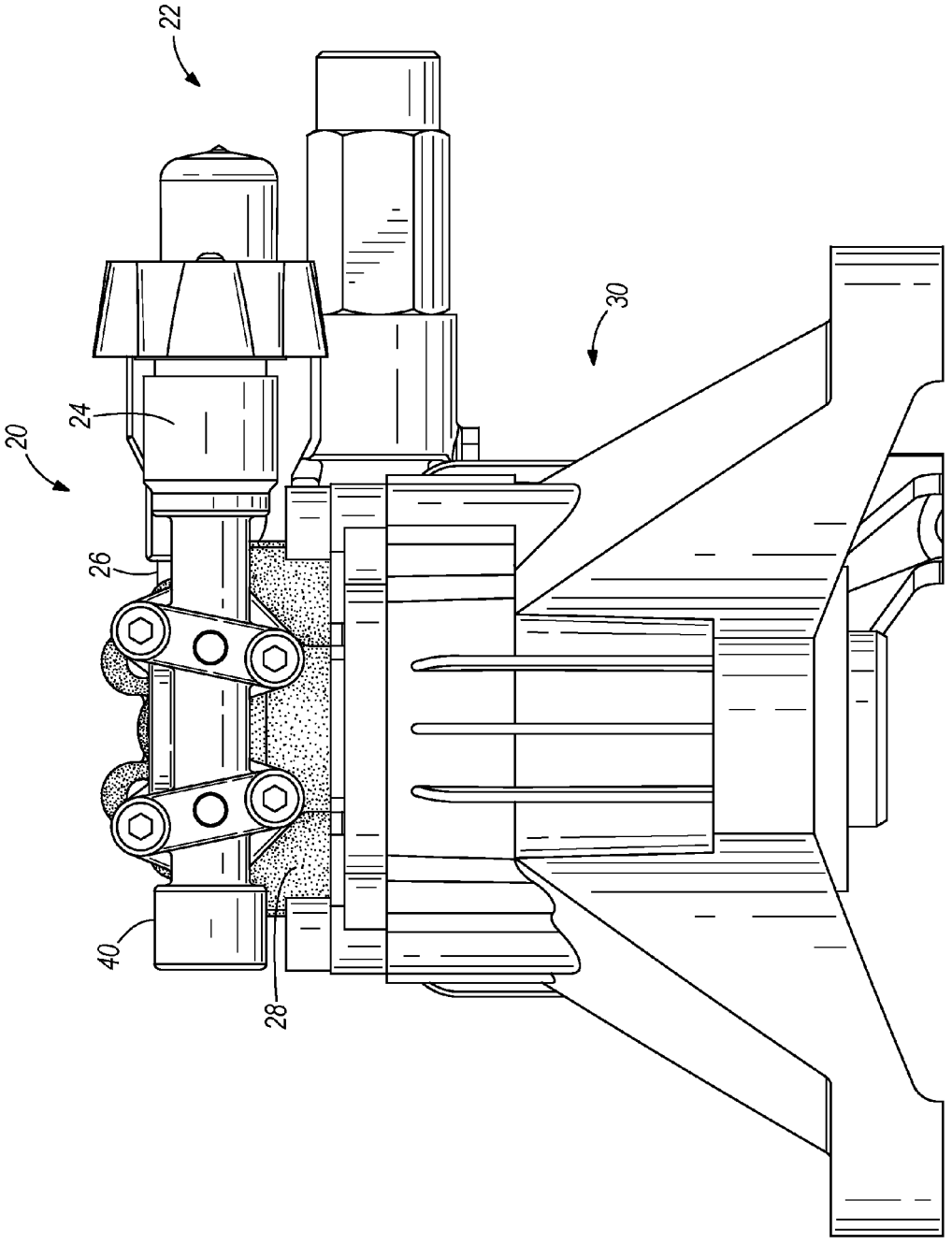

FIG. 7

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EUROPEAN SEARCH REPORT

Application Number
EP 12 16 8574

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	US 4 572 056 A (FUNKE HERBERT [DE]) 25 February 1986 (1986-02-25) * column 1, line 8 - page 5, line 32; figure 1 *	1-15	INV. F04B39/12 F04B53/00
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X	US 4 808 092 A (FUNKE HERBERT [DE]) 28 February 1989 (1989-02-28) * column 1, line 6 - column 16, line 26; figures 1-5 *	1-15	
X	US 4 573 886 A (MAASBERG WOLFGANG [DE] ET AL) 4 March 1986 (1986-03-04) * column 1, line 45 - column 4, line 47; figures 1,2 *	1-15	
X	US 4 116 364 A (CULBERTSON SAMUEL W ET AL) 26 September 1978 (1978-09-26) * column 3, line 69 - column 6, line 50; figures 1-4 *	1-15	TECHNICAL FIELDS SEARCHED (IPC) F04B
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-/--

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 September 2012	Jurado Orenes, A

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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EUROPEAN SEARCH REPORT

Application Number
EP 12 16 8574

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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TECHNICAL FIELDS SEARCHED (IPC)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	18 September 2012	Jurado Orenes, A

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T : theory or principle underlying the invention
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D : document cited in the application
L : document cited for other reasons

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1

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 12 16 8574

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