

[54] **FLOW CONTROL ARRANGEMENT FOR A PISTON PUMP**

[75] Inventor: **Ulrich Aldinger**, Stuttgart, Germany

[73] Assignee: **Robert Bosch GmbH**, Stuttgart, Germany

[22] Filed: **Jan. 20, 1972**

[21] Appl. No.: **219,284**

[30] **Foreign Application Priority Data**

Jan. 27, 1971 Germany..... 2103645

[52] U.S. Cl..... **417/270, 91/472, 91/498, 417/273, 417/295**

[51] Int. Cl..... **F04b 1/08, F01b 13/06**

[58] Field of Search..... 91/489, 498, 472, 474, 491, 91/492, 493, 494, 495, , 6.5

[56] **References Cited**

UNITED STATES PATENTS

2,529,309	11/1950	Purcell.....	91/494
3,063,380	11/1962	Strickland.....	91/489 X
2,961,147	11/1960	Osterkamp.....	417/295 X

2,553,655	5/1951	Herman et al.....	417/270
2,675,764	4/1954	McGee	417/273

FOREIGN PATENTS OR APPLICATIONS

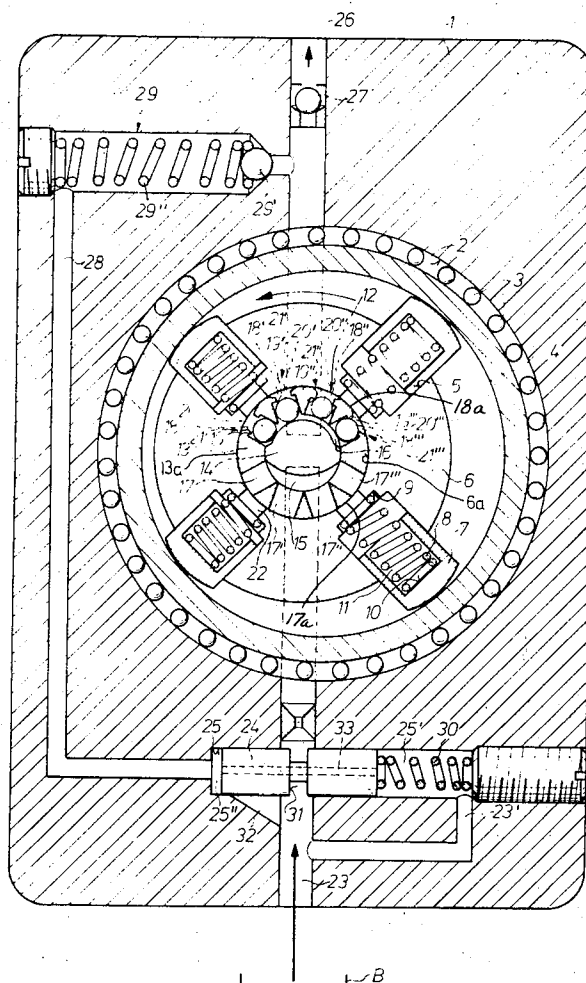
794,873	2/1936	France	91/498
---------	--------	--------------	--------

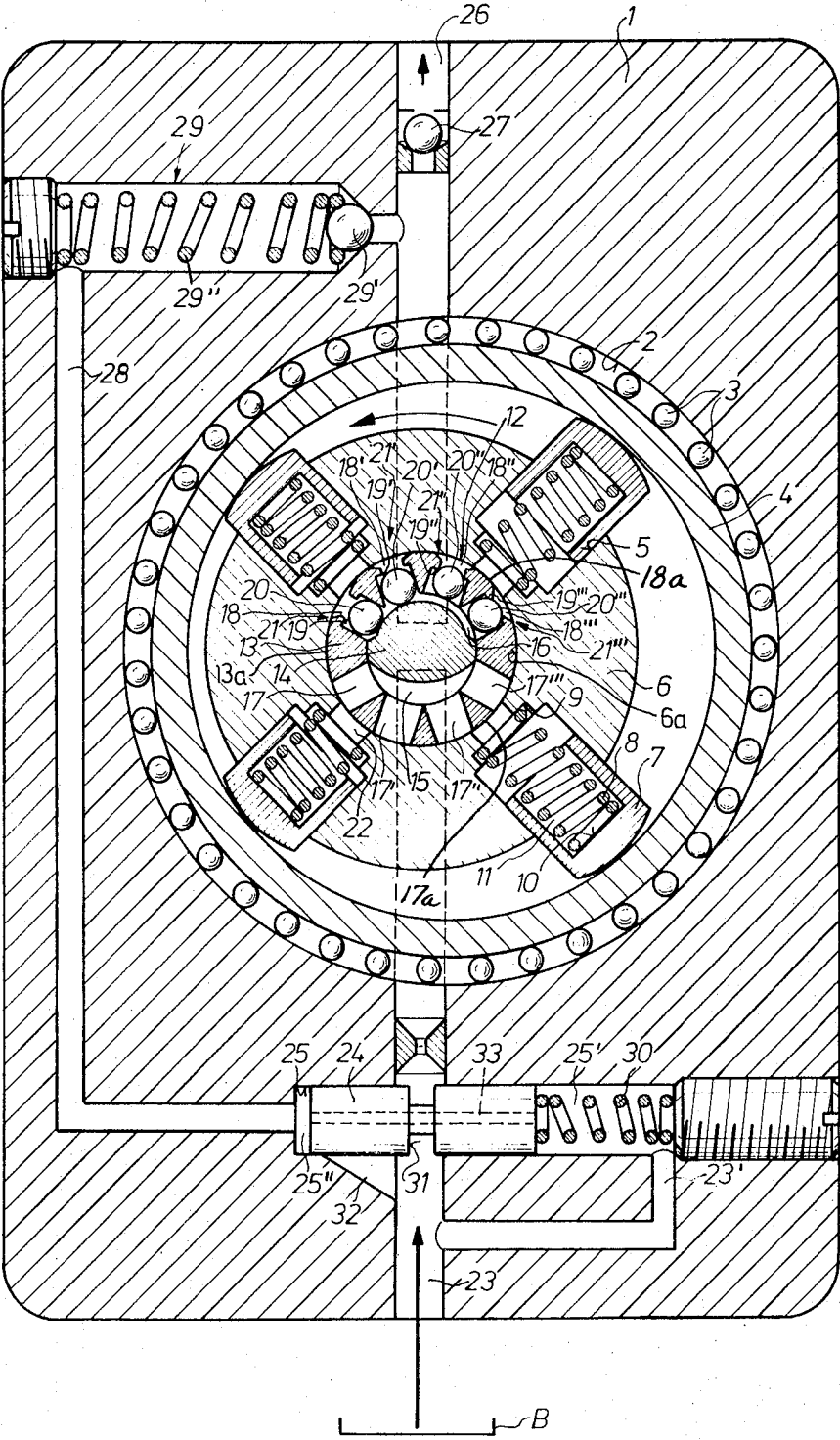
Primary Examiner—Carlton R. Croyle
Assistant Examiner—Richard Sher
Attorney, Agent, or Firm—Michael S. Striker

[57] **ABSTRACT**

A radial piston pump has a rotor with cylinder chambers in which pistons are reciprocated by an eccentric actuator ring. A stationary centrally located control means has low pressure inlet chambers and high pressure outlet chambers connected by radial channels with low pressure ports and high pressure ports which are swept by the cylinder ports of the pump rotor. Only in the radial channels in which high pressure prevails, check valves are provided so that no high pressure fluid can flow from a high pressure outlet chamber into a cylinder chamber still filled with low pressure fluid.

8 Claims, 1 Drawing Figure





FLOW CONTROL ARRANGEMENT FOR A PISTON PUMP

BACKGROUND OF THE INVENTION

The present invention relates to piston pumps, and more particularly to a radial piston pump in which the cylinder block rotates on a shaft-like stationary control means through which fluid is supplied and discharged through cylinder ports into the cylinders in which pistons are reciprocated by the eccentric actuator means. It is known to provide pumps of this type with a suction inlet provided with a throttle controlled by the outlet pressure.

The British Pat. No. 1,170,090 discloses a radial piston pump in which a throttle, controlled by the outlet pressure of the pump, regulates the flow of the pressure fluid to the cylinder chambers by varying the free cross section of the cylinder ports. Each cylinder chamber is closed by an outlet valve, which is spring biased and functions as a check valve, by which the pressure fluid is pushed by the outwardly moving pistons into the outlet conduit.

This construction requires a great number of outlet valves, since hydrostatic piston pumps usually have between seven and 11 cylinder chambers, so that the pumps of the prior art are complicated and expensive to manufacture. Furthermore, the great number of valves requires frequent service.

SUMMARY OF THE INVENTION

It is one object of the invention to provide a simple, inexpensive, and reliable pump of the above-described type.

Another object of the invention is to prevent flow from high pressure chambers into low pressure cylinder chambers.

With these objects in view, the low pressure inlet conduit and the high pressure outlet conduit of the pump communicate with two separate chambers in a control means which has radial channels leading to the rotary cylinder body and to the cylinder chambers. Only in the radial channels on the high pressure side of the pump, check valves are provided which cooperate with valve seats in the respective high pressure radial channels.

An embodiment of the present invention comprises a stator having inlet means and high pressure outlet means, and including actuator means, such as an eccentric actuator ring; a rotor including a rotary cylinder block having cylinder chambers, and pistons in the cylinder chambers operated by the actuator means, said cylinder block having a rotary first control surface formed with cylinder ports into which said cylinder chambers open, respectively; a stationary control means having a stationary second control surface in sliding contact with the first control surface.

In accordance with the invention, the control means has a low pressure inlet chamber and a high pressure outlet chamber communicating with the inlet means and the outlet means, respectively, and two sets of low pressure channels and high pressure channels communicating with the low pressure inlet chamber and the high pressure outlet chamber respectively, and opening in low pressure ports and high pressure ports on the second control surface successively cooperating with the cylinder ports on the first control surface.

Only the high pressure channels have valve seats, and check valves are provided in the high pressure channels, respectively, pressed by the high pressure in the high pressure outlet chamber against the respective valve seats so that no high pressure fluid from the outlet means can enter a cylinder chamber in which the low pressure prevails.

The construction of the present invention permits it to use fewer valves, while obtaining the same advantageous operation as the apparatus of the prior art. The advantage of the present invention is that upon the switching over of the cylinder chambers from the low pressure suction side to the high pressure outlet side of the pump, no pressure fluids from the outlet of the pump can enter into the cylinder chambers in which, directly after the flow reversal in the respective cylinder chamber, the pressure of the fluid is low. The same advantage is obtained when the pressure fluid inlet flow is throttled. The outwardly moving piston of a radial piston pump first enters the space in the cylinder chamber which is not filled with fluid due to the suction throttling, and pushes the fluid out when the pressure is sufficient to effect closing of the check valves.

The novel features which are considered as characteristic for the invention are set forth in particular in the appended claims. The invention itself, however, both as to its construction and its method of operation, together with additional objects and advantages thereof, will be best understood from the following description of specific embodiments when read in connection with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

The single FIGURE of the drawing is a cross-sectional view illustrating a radial piston pump in accordance with the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The pump illustrated in the drawing, has a stator housing 1 with a cavity 2 in which a ball bearing 3 is disposed whose inner ring 4 is eccentric to the axis of rotation of the cylinder block 6 which has angularly spaced cylinder chambers 5 in which pistons 7 are slidably mounted for reciprocating radial movement. The free ends of pistons 7 abut the inner surface of the actuator ring 4, and are cyclically reciprocated in radial direction. The pistons 7 are biased by springs 8 which abut a shoulder 9 at one end, and are located with the other end in a blind bore 11 in pistons 7 so that the pistons 7 are urged into engagement with the eccentric actuator ring 4. The cylinder block 6 is mounted for rotation on a control shaft means 12, and has a cylindrical inner rotary control surface 6a sliding on the outer stationary control surface 13a of the control shaft means 12.

Control shaft means 12 includes an outer cylindrical tubular body 13, and an inner cylindrical body 14 which is fixedly pressed into the outer tubular body 13. The inner body 14 has two diametrically opposite chambers, namely a low pressure inlet chamber 15 and a high pressure outlet chamber 16 respectively communicating with a low pressure inlet conduit 23 and a high pressure outlet conduit 26 provided in the stator housing 1. Four radial low pressure chambers 17, 17', 17'', and 17''' pass through the annular wall of the outer tubular body 13, and communicate at the inner ends with

the low pressure inlet chamber 15. The outer ends of the radial channels 17 to 17''' open in low pressure ports on the outer cylindrical control surface 13a.

On the high pressure side of the pump, four radial channels 18, 18', 18'', and 18''' communicate at the inner ends with the high pressure outlet chamber 16, and have high pressure outlet ports on the stationary cylindrical control surface 13a. The radially extending high pressure channels 18, 18', 18'', 18''' have annular shoulders 19, 19', 19'', 19''', respectively, and envelop spherical balls 20, 20', 20'', 20''', respectively, which together with the seats formed by shoulders 19 to 19''', constitute check valves 21, 21', 21'', 21'''. The wall thickness of the cylindrical tubular outer body 13 is selected so that the balls 20 to 20''' when abutting the shoulders 19 to 19''' of the radial channels 18 to 18''' are completely located in the radial channels 18 to 18''' without projecting beyond the inner cylindrical surface of the cylindrical tubular outer body 13. Consequently, the insertion of the inner body 14 in a press fit into the outer body 13 is not obstructed.

The cylinder chambers 5 in the cylinder block 6 have inner cylinder ports 22 cooperating with the outer ports of the radial channels 17 to 17''' and of the radial channels 18 to 18'''. The diameter of the cylinder ports 22 of the cylinder chambers 5, measured in circumferential direction on the inner cylindrical control surface 6a, is greater than the circumferential width of the face portions 17a between the radial channels 17, 17', 17'', 17''' or face portions 18a between the radial channels 18, 18', 18'', 18'''. In this manner, it is prevented that during rotation of the cylinder body 6, the cylinder bores 5 and cylinder ports 22 are completely closed by the respective face portions 17a, 18a of the cylindrical control stationary surface 13a so that no pressure fluid is compressed and then again relieved, which would create noise during operation of the pump.

The inlet duct 23 in the stator housing 1, communicates with an open container B for the fluid pumped by the pump. The inlet duct 23 is intersected by a valve cylinder 25 in which a throttle valve slide 24 is guided. Throttle valve slide 24 divides the duct 25 into two chambers 25', 25''. The outlet duct 26, in which a check valve 27 is provided, communicates through another check valve 29 with a connecting duct 28 which opens in the chamber 25''. Check valve 29 includes a ball 29' biased by a spring 29'' so that valve cylinder chamber 25'' receives pressure fluid when check valve 29 is opened. A spring 30 in chamber 25' opposes movement of the throttling valve slide 24 due to the action of pressure fluid in chamber 25'' when the pressure in the outlet duct 26 is high enough to open check valve 29. A branch duct 23' connects the inlet duct 23 with the valve chamber 25', and a groove 32 in the stator housing 1 opens a connection between chamber 25'' and inlet duct 23 when the throttle valve slide 24 is far enough displaced against the action of spring 30.

The throttle valve slide 24 has an annular groove 31 which, in a neutral position of throttle valve slide 24 obtained by spring 30, permits the flow of fluid from container B through inlet duct 23 toward the low pressure chamber 15 in the control shaft means 12. A central axially extending bore 33 passes through the throttling valve slide 24 which includes two piston portions and a connecting portion of smaller diameter. The axial central bore 33 connects chambers 25' and 25''.

During rotation of the cylinder body 6 in counter-clockwise direction, the eccentric actuator ring 4 causes reciprocating movements of pistons 17 during which fluid is sucked from inlet duct 23, inlet chamber 15, and radial channels 17 to 17'', and then pushed out through radial channels 18 to 18''', high pressure outlet chamber 16, and outlet duct 26. Outlet duct 26 is connected with a high pressure conduit for operating consumer apparatus, such as an hydraulic motor.

When the pressure in high pressure outlet duct 26 exceeds the pressure at which the pressure limiting valve 29 opens, pressure fluid flows through connecting duct 28 to the valve chamber 25'' and from there through the throttle bore 33 in the throttling valve slide 24 into the valve chamber 25' where gradually a pressure is built up which is less than the high pressure in the outlet duct 26 and valve chamber 25'', but greater than the initial low suction pressure in valve chamber 25'. The pressure differential at opposite ends of the throttle valve slide 24 effects a displacement of the same against the action of spring 30 so that the annular groove 31 on the throttling valve slide 24 is partly closed, resulting in throttling of the flow of fluid in the inlet duct 23 to the low pressure chamber 15. Consequently, the cylinder chambers 5 are less filled, and the output volume of the pump is reduced.

If the pressure in duct 26 drops due to a decreased load, the pressure limiting valve 29 closes, and throttling valve slide 24 is shifted back to its neutral position by the spring 30. Fluid displaced out of valve chamber 25'' flows through the throttling bore 33 into chamber 25', and through the branch duct 23' into the duct 23. The cross-section of the narrow throttling bore 33 determines the speed at which the throttling valve slide 24 is returned to its neutral position.

If the pressure difference at the throttling valve slide 24 becomes too great, the same is displaced so that the groove 32 is opened, and pressure fluid from connecting duct 28 can flow directly into the inlet duct 23. This causes a rapid drop of the pressure in the outlet duct 26, so that the pressure limiting valve 29 closes. Consequently, the throttling valve slide 24 also performs the function of a bypass valve.

During the passage of a cylinder chamber 5 from the suction side to the pressure side of the pump, the pressure fluid in high pressure chamber 16 and radial channels 18 to 18''' tends to flow through a cylinder port 22 into the cylinder chambers 5 in which still the low inlet pressure prevails. However, the flow presses the ball 20 against the seat formed by the annular shoulder 19 of the radial channel 18, so that pressure fluid cannot flow from the high pressure side of the pump into a cylinder chamber 5 still filled with low pressure fluid. During further rotation of the cylinder body 6, the strokes of pistons 5 first take up the space which is not filled with pressure fluid, and only when pressure fluid is displaced, the pressure in the cylinder chamber 5 is increased. When the pressure acts on balls 20 to open the radial channels 18 to 18'', discharge of the pressure fluid takes place. In other words, inertia and the outlet pressure cause a closing of the check valves 20, 19, and the pressure generated by pistons 7 in the cylinder chambers 5, open the check valves 19, 20, when the pressure is sufficiently high.

The small difference between the surface of balls 20 on which the outlet pressure acts, and the surface of balls 20 on which the inner pressure of the cylinder

chambers act, has the effect that the inner pressure of the cylinder chambers 5 is only slightly higher than the outlet pressure in the outlet chamber 16 at the beginning of the pumping operation.

The present invention is not limited to radial piston pumps whose control means is a control shaft provided with radial channels for check valves on the high pressure side of the pump. The invention can also be applied to axial piston pumps with a planar of spherical control surface on a valve plate. In such an apparatus, a number of check valves may be provided which all open into the outlet conduit.

It will be understood that each of the elements described above, or two or more together, may also find a useful application in other types of flow control arrangement for piston pump differing from the types described above.

While the invention has been illustrated and described as embodied in a radial piston pump provided with check valves in high pressure channels which connect the cylinder chambers with the outlet conduits of the pump, it is not intended to be limited to the details shown, since various modifications and structural changes may be made without departing in any way from the spirit of the present invention.

Without further analysis, the foregoing will so fully reveal the gist of the present invention that others can by applying current knowledge readily adapt it for various applications without omitting features that, from the standpoint of prior art, fairly constitute essential characteristics of the generic or specific aspects of this invention and, therefore, such adaptations should and are intended to be comprehended within the meaning and range of equivalence of the following claims.

What is claimed as new and desired to be protected by Letters Patent is set forth in the appended claims.

I claim:

1. Flow control arrangement for a piston pump, comprising a stator having inlet means and high pressure outlet means, and including actuator means, said inlet means including an inlet duct in said stator, and a biased throttle valve in said inlet duct, and said outlet means including an outlet duct in said stator, said stator being formed with a connecting duct connecting said outlet duct with said throttle valve for operating the same to reduce the inlet flow of fluid; a biased outlet check valve in said connecting duct in the region of said outlet duct, and opening when the pressure in said outlet duct is too high so that pressure fluid flows through said outlet check valve and connecting duct to said throttle valve for reducing the flow cross section of said inlet duct; a rotor including a rotary cylinder block having cylinder chambers, and pistons in said cylinder chambers operated by said actuator means, said cylinder block having a rotary first control surface formed with cylinder ports into which said cylinder chambers open, respectively; and a stationary control means having a stationary second control surface, said control means having a low pressure inlet chamber and a high pressure outlet chamber communicating with said inlet means and said outlet means, respectively, and a set of low pressure channels and a set of high pressure channels communicating with said low pressure inlet chamber and said high pressure outlet chamber, respectively, and opening in low pressure ports and high pressure ports on said second control surface successively cooperating with said cylinder ports on said

first control surface, only said high pressure channels having valve seats, respectively, and check valves in said high pressure channels, respectively, pressed by the high pressure in said high pressure outlet chamber against said valve seats, respectively, so that no high pressure fluid from said outlet means can enter a cylinder chamber in which low pressure prevails.

2. Flow control arrangement as claimed in claim 1 wherein said pump is a radial piston pump; wherein said actuator means is an eccentric ring; wherein said cylinder block has an inner cylindrical first control surface formed with angularly spaced cylinder ports; wherein said control means rotatably supports said first control surface of said cylinder block on said second control surface; wherein said low pressure inlet chamber and said high pressure outlet chamber are diametrically spaced on said control means; and wherein said low pressure channels and said high pressure channels are radial angularly spaced channels opening in circumferentially spaced low pressure ports and high pressure ports on said second cylindrical control surface for cooperation with said angularly spaced cylinder ports.

3. Flow control arrangement as claimed in claim 1 wherein said check valves are unbiassed and are freely movable balls located in said high pressure channels.

4. Flow control arrangement as claimed in claim 1 wherein said stationary control means includes an outer cylindrical tubular body having said second control surface on the outer periphery thereof, and being formed with radial angularly spaced low pressure channels and high pressure channels passing therethrough, and a cylindrical inner body located in said outer cylindrical tubular body and having said low pressure inlet chamber and high pressure outlet chamber diametrically disposed at the periphery thereof and surrounded by said outer cylindrical tubular body so that said radial channels connect said low pressure inlet and high pressure outlet chambers with said low pressure and high pressure ports, respectively, on said second control surface.

5. Flow control arrangement as claimed in claim 1 wherein said pump is a radial piston pump; wherein said actuator means is an eccentric ring; wherein said cylinder block has an inner cylindrical first control surface formed with angularly spaced cylinder ports; wherein said control means rotatably supports said first control surface of said cylinder block on said second control surface; wherein said low pressure inlet chamber and said high pressure outlet chamber are diametrically spaced in said control means; wherein said low pressure channels and said high pressure channels are radial angularly spaced channels opening in circumferentially spaced low pressure ports and high pressure ports on said second cylindrical control surface for cooperation with said angularly spaced cylinder ports; wherein said stationary control means includes an outer cylindrical tubular body having said second control surface on the outer periphery thereof, and being formed with radial angularly spaced low pressure channels and high pressure channels passing therethrough, and a cylindrical inner body located in said outer cylindrical tubular body and having said low pressure inlet chamber and high pressure outlet chamber diametrically disposed at the periphery thereof and surrounded by said outer cylindrical tubular body so that said radial channels connect said low pressure inlet and high pres-

sure outlet chambers with said low pressure and high pressure ports, respectively, on said second control surface.

6. Flow control arrangement as claimed in claim 5 wherein said check valves are spherical balls located in said radial high pressure outlet channels radially inward of said valve seats, respectively, and having a diameter smaller than the radial distance between the respective valve seat and the inner surface of said cylindrical tubular body so that said balls can be spaced from the outer periphery of said cylindrical inner body.

7. Flow control arrangement for a piston pump, comprising a stator having inlet means and high pressure outlet means, and including actuator means, said inlet means including an inlet duct in said stator, and a biased throttle valve in said inlet duct, and said outlet means including an outlet duct in said stator, said stator being formed with a connecting duct connecting said outlet duct with said throttle valve for operating the same to reduce the inlet flow of fluid; a biased outlet check valve in said connecting duct in the region of said outlet duct, and opening when the pressure in said outlet duct is too high so that pressure fluid flows through said outlet check valve and connecting duct to said throttle valve for reducing the flow cross section of said inlet duct; a rotor including a rotary cylinder block having cylinder chambers and pistons in said cylinder chambers operated by said actuator means, said cylinder block having a rotary first control surface formed with cylinder ports into which said cylinder chambers open, respectively; and a stationary control means having a stationary second control surface in sliding contact with said first control surface, said control means having a low pressure inlet chamber and a high pressure outlet chamber communicating with said inlet means and said outlet means, respectively, and a set of low pressure channels and a set of high pressure channels communicating with said low pressure inlet chamber and said high pressure outlet chamber, respectively, and opening in low pressure ports and high pressure ports on said second control surface successively cooperating with said cylinder ports on said first control surface, only said high pressure channels having valve seats, respectively, and check valves in said high pressure channels, respectively, pressed by the high pressure in said high pressure outlet chamber against said valve seats, respectively, so that no high pressure fluid from said outlet means can enter a cylinder chamber in which low pressure prevails, said stationary control means including an outer cylindrical tubular body having said second control surface on the outer periphery thereof, and being formed with radial angularly spaced low pressure channels and high pressure channels passing therethrough, and a cylindrical inner body located in said outer cylindrical tubular body and having said low pressure inlet chamber and said high pressure outlet chamber diametrically disposed at the periphery thereof and surrounded by said outer cylindrical tubular body so that said radial chan-

nels connect said low pressure inlet and high pressure outlet chambers with said low pressure and high pressure ports, respectively, on said second control surface, said check valve being spherical balls located in said radial high pressure outlet channels radially inward of said valve seats, respectively, and having a diameter smaller than the radial distance between the respective valve seat and the inner surface of said cylindrical tubular body so that said balls can be spaced from the outer periphery of said cylindrical inner body.

8. Flow control arrangement for a piston pump, comprising a stator having inlet means and high pressure outlet means, and including actuator means, said inlet means including an inlet duct in said stator, and a biased throttle valve in said inlet duct, and said outlet means including an outlet duct in said stator, said stator being formed with a connecting duct connecting said outlet duct with said throttle valve for operating the same to reduce the inlet flow of fluid; a biased outlet check valve in said connecting duct in the region of said outlet duct, and opening when the pressure in said outlet duct is too high so that pressure fluid flows through said outlet check valve and connecting duct to said throttle valve for reducing the flow cross section of said inlet duct; a rotor including a rotary cylinder block having cylinder chambers, and pistons in said cylinder chambers operated by said actuator means, said cylinder block having a rotary first cylindrical control surface formed with cylinder ports into which said cylinder chambers open, respectively; and a stationary control means having a cylindrical stationary second control surface in sliding contact with said first control surface, said control means having a low pressure inlet chamber and a high pressure outlet chamber communicating with said inlet means and said outlet means, respectively, and a set of radial low pressure channels and a set of radially high pressure channels communicating with said low pressure inlet chamber and said high pressure outlet chamber, respectively, and opening in low pressure ports and high pressure ports on said second control surface successively cooperating with said cylinder ports on said first control surface, only said high pressure channels having valve seats, respectively, and check valves in said high pressure channels, respectively, pressed by the high pressure in said high pressure outlet chamber against said valve seats, respectively, so that no high pressure fluid from said outlet means can enter a cylinder chamber in which low pressure prevails, said sets being diametrically arranged on said second stationary cylindrical control surface, individual low pressure ports and high pressure ports being separated from each other by circumferential face portions of said second stationary cylindrical control surface, the circumferential extension of said face portions of said second stationary cylindrical control surface being smaller than the diameter and the circumferential extension of said cylinder ports along said first rotary cylindrical control surface.

* * * * *