FLUID PRESSURE ENERGY TRANSLATING DEVICE

Filed April 22, 1958

2 Sheets-Sheet 1

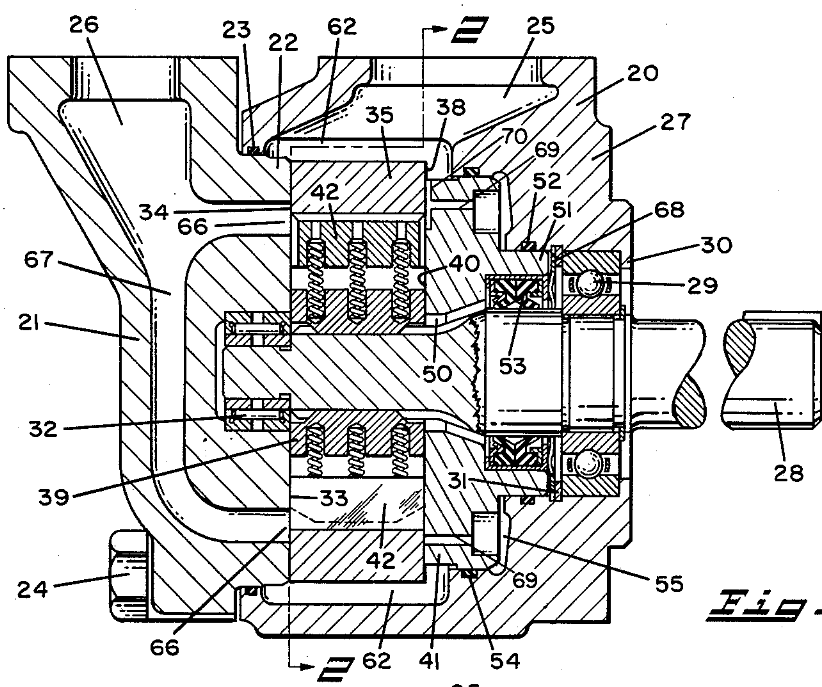

Fig. 1

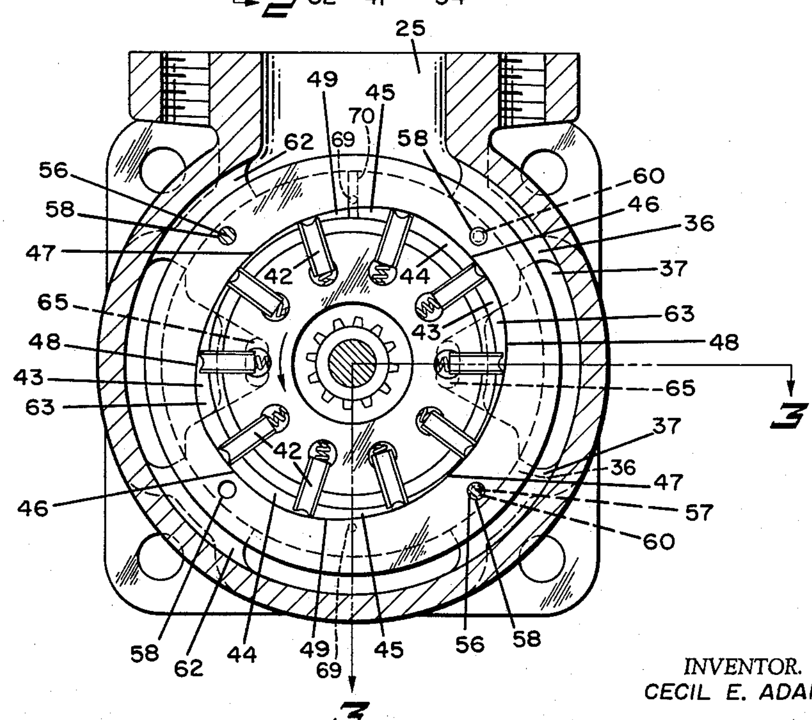

Fig. 2

INVENTOR.
CECIL E. ADAMS
BY Donald J. Dietrich,
AGENT.

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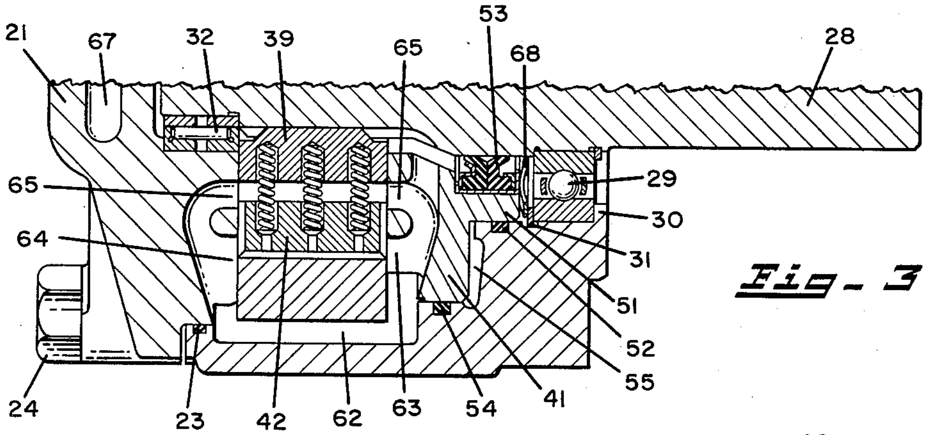

Fig. 3

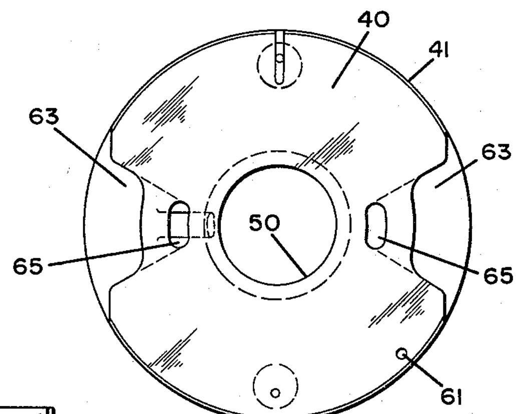

Fig. 5

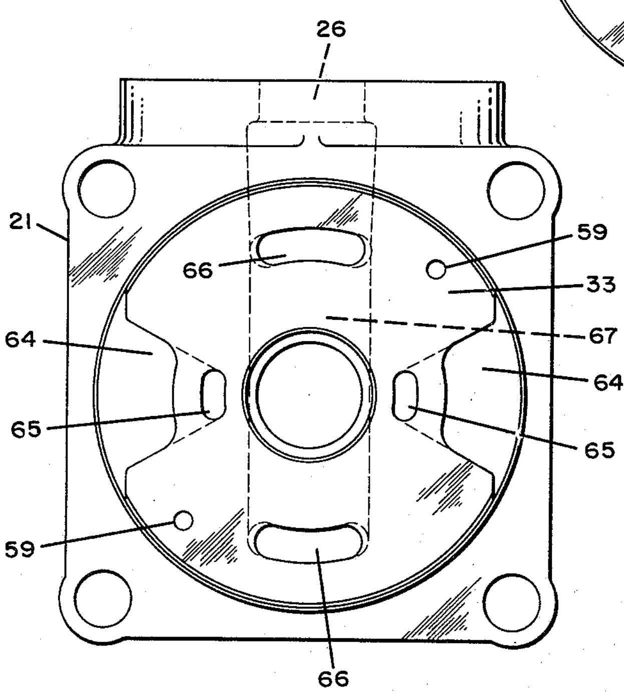

Fig. 4

INVENTOR.
CECIL E. ADAMS

BY Donald J. Detrich,

AGENT.

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3,012,511
FLUID PRESSURE ENERGY TRANSLATING DEVICE

Cecil E. Adams, 488 E. Dunedin Road, Columbus, Ohio
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3 Claims. (Cl. 103—42)

This invention relates to fluid pressure energy translating devices such as fluid pumps and motors, and more particularly it relates to improvements in that kind of such devices which includes a stator encompassing or surrounding rotary elements and all of which are encased or enclosed within a housing.

The main object of the invention is to provide improved structure in devices of the kind set forth whereby the stator of the device is mounted within the housing in an improved manner.

In carrying out the foregoing object, it is another object of the invention to provide an improved device in which the peripheral surface of the stator cooperates with the housing of the device in providing fluid passageway means which encompasses or surrounds the stator.

Another object of the invention is to provide improved structure in devices of the kind set forth wherein the stator cooperates with the housing in providing a fluid passageway which encompasses or surrounds the stator and whereby the housing, at one end of the stator, forms a pressure chamber in which there is a cheek plate that functions in the nature of a piston and pressure in the chamber urges the cheek plate toward the stator to isolate its interior from said passageway.

Further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred form of embodiment of the invention is clearly shown.

In the accompanying drawings:

FIG. 1 is a view in section of a fluid energy translating device of the kind set forth in the objects which includes the invention, the particular device shown being a hydraulic pump;

FIG. 2 is a view in section, the section being taken on line 2—2 of FIG. 1;

FIG. 3 is a view in section, the section being taken on line 3—3 of FIG. 2 and showing particularly the arrangement of suction or inlet ports in the pump;

FIG. 4 is a view in elevation of the end head or cap of the pump seen in FIG. 1, the view illustrating particularly the fluid ports and passages therein, and

FIG. 5 is a view in elevation of the movable head or cheek plate of the pump seen in FIG. 1, the view illustrating particularly the fluid ports and passages therein.

The invention herein described and claimed is applicable to gear and vane type fluid energy translating devices and in fact may be employed with advantage in any fluid energy translating device which includes a casing or housing containing a stator and/or a bushing, port plate, cheek plate or head the position of which may be determined by fluid and/or spring pressures. While the invention is described and illustrated herein in connection with a vane type hydraulic pump, it is to be understood that it is not to be interpreted as being limited to a device of this type.

Fluid energy translating devices such as pumps and motors have long been known which are of a type that include a housing in which there is a stator that encompasses or surrounds a rotor and in which there may or may not be an end bushing, cheek plate or head which forms a wall at one side of the stator and rotor and is urged toward them by a spring and fluid pressure means. It will be noted from the following description that this

invention provides a fluid energy translating device in which the stator is spaced from the interior of the housing in such manner that the space between the housing and peripheral surface of the stator may be employed as a fluid passage means in the device. It will also be seen that the invention provides a device the overall size of which, in respect to its fluid pumping capacity, may be relatively small.

The pump shown in the drawings includes a body, casing or housing formed in part by a hollow casting 20 and an end cap or block 21 having a cylindrical boss portion 22 which telescopes into the open end of the body member 20 and is sealed therewith by an O-ring 23 received in a groove in the body member 20. The end cap or block 21 is secured to the housing member 20 by four cap screws, one of which is indicated by the numeral 24 in FIG. 1 of the drawings, and it may be rotated to and secured in any one of four positions with respect to the housing member 20. By this arrangement, the relative radial or rotated positions of the inlet, low pressure or suction port 25 in the housing member 20 and the high pressure, exhaust or outlet port 26 in the end cap 21 may be changed with respect to one another.

The end wall 27 of the housing member 20 opposite the cap or block 21 includes a bore through which the pump shaft 28 extends. Shaft 28 is supported for rotation in the bore by a ball bearing 29 which is secured against axial movement in the bore by a flange 30 on the housing member and a snap ring 31 which is received in a groove in the bore. The end of shaft 28 which is within the housing is carried for rotation in a needle type roller bearing 32 mounted in a central bore or recess in the end cap or block 21.

The end of the boss portion 22 of the end cap or block 21 is finished to form a flat cheek plate surface 33 which abuts a flat end surface 34 of a cam ring or stator 35 and the end cap or block 21 clamps the cam ring or stator 35 axially rigidly against four abutment surfaces 36 formed by four lugs 37 (see FIG. 2) on the interior of the housing member 20. The lugs 37 are shown in the drawings as integral parts of the housing member 20 and their abutment surfaces 36 engage only the adjacent flat end surface 38 of the cam ring or stator 35.

The cam ring or stator 35 encircles or encompasses a rotor 39 which is mounted upon the shaft 28 for relative axial movement with respect thereto through a spline joint connection. The width of the rotor 39 is no greater than and is preferably of the order of one and one-half thousandths of an inch less than the axial thickness of the cam ring or stator 35 in order that it may rotate when the pump is pumping fluid without undue friction between itself and the pump end heads or cheek plate surfaces 33 of the end cap or block 21 and a cheek plate surface 40 of a floating cheek plate member 41 which will be described in detail hereinafter. The rotor 39 is provided with a plurality of radially extending vane slots in each of which there is a vane 42 that is urged radially outwardly by springs against the inner surface of the cam ring or stator 35.

The cam ring or stator 35 has a cylindrical external surface and its interior surface is generally elliptical to provide a balanced type pump in which there are diametrically opposite low pressure or suction zones 43, fluid transfer zones 44 and high pressure or exhaust zones 45 (see FIG. 2). In order to provide these zones, the interior or cam surface of the cam ring 35 is formed in part upon two arcs 46 of equal radii struck from the axis of the shaft 28 which arcs extend across the transfer zones 44 between the suction and pressure zones 43 and 45, respectively, and two arcs 47 of equal radii, but of less length than the first-mentioned radii, struck from the axis of shaft 28 and which arcs 47 are substantially tangent to the peripheral surface of the rotor 39 and extend one between each of the adjacent suction and pressure zones 43 and 45, respectively. The arcs 46 and 47 are connected by cam portions or surfaces 48 and 49.

The cheek plate 41 is a disk finished on one side to form the smooth flat cheek plate surface 40 which abuts the adjacent flat end surface 38 of the cam ring or stator 35 and it is provided with a central bore 50 surrounded by a cylindrical boss 51 which extends into the bore in the end wall 27 of the casing or housing member 20 and is sealed thereto by an O-ring 52 contained in an annular groove in the housing member. The central bore in the cheek plate 41 receives an oil seal 53 which engages the shaft 28 and prevents the loss of fluid therearound from within the casing or housing member 20 as well as the entrance of air to the interior of the casing. The cylindrical peripheral surface of the cheek plate 41 is sealed to the housing member 20 by means of an O-ring 54 and the cheek plate 41 cooperates with the housing member 20 to provide an annular pressure chamber 55 at one end of the cam ring or stator 35 in which the cheek plate 41 functions as an axially movable, non-rotatable piston.

From the foregoing description, it will be apparent that the flat cheek plate surface 33 of the end cap or block 21 abuts and seals with one end 34 of the cam ring or stator 35, that the opposite end 38 of the cam ring or stator 35 abuts the abutment surfaces 36 of the lugs 37 and that the end cap or block 21 clamps the cam ring or stator 35 against the abutment surfaces of the lugs. In other words, the cam ring or stator 35 is sandwiched between the abutment surfaces 36 of the lugs 37 and the end cap or block 21 and it is unsupported through its peripheral surface against radial movement with respect to either of these elements.

Dowel pins 56 and 57 are provided which extend into bores formed in the ends of the cam ring or stator 35, the end cap or block 21 and the floating cheek plate 41. These pins 56 and 57 and their respective bores retain the end cap 21, the cam ring 35 and the floating cheek plate 41 in their proper axially aligned and rotated positions with respect to one another during the assembly of the pump and the pin 57 prevents rotation of the cheek plate 41 during operation of the pump. The pins 56 and 57 and their bores are so arranged that the cam ring 35 may be carried in either of two positions, one providing for clockwise rotation of the shaft 28 and the other providing for its counter-clockwise rotation.

In the specific arrangement of the pins and bores in the pump illustrated, four bores 58 are formed in end 34 of the cam ring or stator 35 which abuts the end cap 21 and these bores are formed on axes spaced equal distances from the axial center of the cam ring and spaced ninety degrees apart (see FIG. 2) and two bores 59 (see FIG. 4) are drilled into the end cap or block 21 through its cheek plate surface 33. The axis of the bores 59 are at such distance from the axial center of the cheek plate surface 33 that their axes coincide with the axes of the bores 58 and they are arranged in the end cap 21 at one hundred and eighty degrees with respect to each other, that is, they are diametrically opposite each other whereby the pins 56 may be fited into the two of bores 59 and either of the diametrically opposite pair of bores 58 in the end cap 21 thereby to interengage or interlock the end cap 21 and the cam ring or stator 35. The opposite end 38 of the cam ring 35 is provided with two bores 60 which are spaced ninety degrees apart and at equal distances from the axial center of the cam ring 35 (see FIG. 2) and the cheek plate 41 is provided with one bore 61 (see FIG. 5) which may be aligned axially with either of the bores 60 to receive the pin 57.

When the position of the cam ring 35 is to be changed from the position seen in FIG. 2 of the drawings to provide for reverse rotation of the shaft 28, the end cap 21 and bearing 32 are removed as a unit from the housing member 20 after which the cam ring 35 and rotor 39 are removed as a unit from the body member 20 and shaft 28. The cam ring and rotor unit is then rotated ninety degrees whereby the pins 57, which may have a press fit in the bore 61, can be inserted into the other bore 60 in the cam ring. The two pins 56 are then shifted to the previously unused bores 58 in the stator and the cap 21 is replaced so that these pins 56 will extend into its bores 59. Pin 57 preferably has a smaller diameter than the pins 56 in order that the cam ring can not be inadvertently turned end for end during the operation required to adapt the pump for reverse rotation of its shaft. It will be seen that whenever the above described steps are followed that the result thereof is that the major axis of cam ring will be rotated through an angle of ninety degrees, either in a clockwise or a counter-clockwise direction.

The suction or inlet passageway through which fluid flows into the pump from the port 25 includes an annular recess or groove 62 formed within the housing member 20 and surrounding the cam ring 35. This recess or groove 62 cooperates with the cylindrical exterior surface of the boss portion 22 of the end cap 21, the cylindrical exterior or peripheral surface of the cam ring 35 and the cylindrical peripheral surface of the cheek plate 41 to form a passageway which encompasses the pumping apparatus of the pumping unit. When the pump is operating, fluid flows from the main inlet or suction port 25 to the passageway or groove 62 and circumferentially around the cam ring 35 to two points spaced one hundred and eighty degrees apart at which points the fluid flows axially around the cam ring 35 and enters an inlet or suction port 63 formed in the cheek plate 41 and an inlet or suction port 64 formed in the end cap or block 21 (see FIG. 3). The ports 63 in the cheek plate 41 are axially aligned with the ports 64 in the end cap or block 21 and these ports are identical in shape. Each pair of the ports 63 and 64 opens into a suction zone 43 adjacent a cam portion 48 of the cam ring 35 when the cam ring 35 is in the position shown in FIG. 2 of the drawings. When the cam ring 35 is rotated ninety degrees in the manner previously described to provide for reverse rotation of the shaft 28, the pressure zones 45 become suction zones and the ports 63 and 64 open into them. Each of the ports 63 and 64 also includes a radial extension which terminates in a port 65 by which fluid is admitted to the bottoms of the vane slots in the rotor 39 as the slots pass the ports 54.

The end cap or block 21 also includes two high pressure or exhaust ports 66 which are spaced one hundred eighty degrees apart and at ninety degrees with respect to each of the inlet or suction ports 64 (see FIG. 4) and these ports 66 are connected with the main exhaust or high pressure outlet port 26 of the pump by a passageway 67 formed in the end cap 21.

From the foregoing description, it will be seen that the fluid being pumped enters the pump at the main inlet or suction port 25, flows circumferentially around the cam ring 35 in the groove 62 in two directions and then divides over the ends of the cam ring 35 to enter the ports 63 and 64 and flows through these ports to enter the opposite ends of the suction zones 43. It will also be seen that the vanes of the pump move the fluid from the suction zones 43 across the transfer zones 44 and cause it to be displaced from the pressure zones 45 into the exhaust ports 66 and from the pump through the passageway 67 and main exhaust port 26.

In the pump illustrated, the cheek plate 41 is held, when the pump is operating, against the cam ring with a light force which is exerted thereon in part by a spring 68 which abuts the end of the boss portion 51 of the cheek plate and the snap ring 31 and in part by pressure in the pressure chamber 55. Actually the position which the cheek plate 35 will occupy with respect to the cam ring or the force by which it will be urged against the cam ring 35 will be determined by the difference in the pressures on the opposite ends thereof and in this pump the area on the end thereof which is exposed to the pressure in the high pressure zones 45 is approximately two-thirds that of the area of the end surface thereof which is exposed to pressure in the pressure chamber 55. This ratio may, of course, be varied and variations therein may be determined in part by the pressure differential which it is desired to maintain between the pressure zones 45 and the pressure chamber 55, in part by the strength of the spring 68, and in part by the arrangement and sizes of passageways in the cheek plate 41 which are now to be described.

In order that fluid and pressure may be admitted from the pressure zones 45 into the pressure chamber 55, the cheek plate 41 is provided with two bores 69 which extend axially through the cheek plate 41 from the end 40 thereof to that end thereof which is in the pressure chamber 55. These passageways 69 are spaced one hundred eighty degrees apart and are at such radial distances from the axial center of the cheek plate 41 that their mouths or ends in the cheek plate surface 40 will be covered by the adjacent flat end surface 38 of the cam ring 35 adjacent the pressure zones 45 when the cheek plate is urged against the latter. They are also so located that when the cam ring is rotated ninety degrees to reverse the direction of rotation of the shaft 28 they will engage the cam ring adjacent the zones 43 which then become pressure zones.

It will be seen that the mouths or ends of the bores or passageways 69 cooperate with the end surface 38 of the cam ring to form a pair of valves or variable orifices. The mouth or entrance to one of the bores 69 terminates at a radial cut, scratch or groove 70 which is preferably formed in the cheek plate 41 as shown and which extends radially from one of the pressure zones 45 to the suction passageway 62.

When the pump is operating to pump fluid and the cheek plate is held in its normal "kissing contact" with the cam ring 35 there will be a small flow of fluid from the pressure zone 45 through the cut, scratch or groove 70 past the mouth of the bore 69 to the suction or inlet passageway 62. In function, the cut, scratch or groove 70 and the bore 69 associated therewith may be compared with that of an electric potentiometer in that the greater the distance the mouth or entryway of the bore 69 is spaced from the entrance of the cut, scratch or groove 70 the less the pressure in the pressure chamber 55 will be. Certain features herein described relating to the pressure balancing of the cheek plate 41 are more fully described and claimed in my copending application Serial No. 729,777, filed April 21, 1958, for "Fluid Pressure Energy Translating Devices" to which reference should be made for a more complete description of the operation of the device herein described and modifications thereof.

It is obvious from the foregoing description that by this invention there has been provided a fluid energy translating device the casing or housing of which is formed by two elements, namely, a hollow housing member and an end cap or plug therefor and between which there is carried a cam ring or stator that is mounted only through means positioned at its opposite ends. It should be obvious to those skilled in the art that this construction includes numerous features which yield the advantages of low cost construction accompanied by reduced overall size for any unit having a given volumetric capacity, as well as the advantage of reduced weight.

While the form of embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

I claim:

1. In a fluid pump, means forming a housing, pumping mechanism within said housing including a stator and rotary pumping means within said stator, shaft means for driving said rotary pumping means, and low and high pressure inlet and outlet ports for said pumping mechanism, said stator having an end and a peripheral surface area, means supporting said stator in said housing whereby said peripheral surface and said end are spaced from wall means within said housing, means forming a pressure chamber within said housing adjacent said stator end, a movable cheek plate within said pressure chamber normally closing the end of said stator and cooperating with its said peripheral surface and said wall means to form an annular low pressure inlet passageway leading to said inlet port means, means in said pressure chamber resiliently urging said movable cheek plate toward the end of said stator, and passageway means for conducting pressure to said pressure chamber, said cheek plate means forming a movable valve element between the interior of said pumping means and said annular low pressure inlet passageway adapted to be moved to its open position by surges in pressure within said pumping mechanism thereby permitting fluid to flow from a high pressure area within said pumping means directly to said low pressure inlet passageway.

2. In a fluid pump, means forming a housing, a pumping mechanism within said housing including a stator and rotary pumping means within said stator, shaft means for driving said rotary pumping means, and low and high pressure inlet and outlet ports for said pumping mechanism, said stator having an end and a peripheral surface area, means supporting said stator in said housing whereby said peripheral surface area and said end are spaced from wall means within said housing, a movable cheek plate normally closing the end of said stator and cooperatting with it, said peripheral surface area and said wall means to form an annular low pressure inlet passageway leading to said inlet port means, means resiliently urging said movable cheek plate toward the end of said stator, said cheek plate means forming a movable valve element between the interior of said pumping means and said annular low pressure inlet passageway adapted to be moved to its open position by surges in pressure within said pumping mechanism thereby permitting fluid to flow from a high pressure area within said pumping means directly to said low pressure inlet passageway.

3. In a fluid pump, means forming a housing, a pumping mechanism within said housing including means forming a pumping chamber having an open end, means supporting said pumping chamber forming means in said housing such that a fluid passage encompassing said chamber forming means is defined between said chamber forming means and said housing, movable cheek plate means normally closing the open end of said pumping chamber, low and high pressure inlet and outlet ports for said pumping chamber, said passage communicating with said inlet port, rotary pumping means in said pumping chamber for transferring fluid from a low pressure zone in said pumping chamber adjacent said low pressure inlet port means to a high pressure zone in said pumping chamber adjacent said high pressure outlet port means, shaft means for driving said rotary pumping means, means resiliently holding said movable cheek plate means in its pumping chamber closing position, and passageway means adjacent said open end of said pumping chamber normally sealed from the interior thereof by said movable cheek plate means, said passageway extending from adjacent said high pressure zone to said passage whereby surges in pressure in said high pressure zones may move said cheek plate means to open said end of said pumping chamber and permit the fluid in said high pressure zone to flow directly into said passage.

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UNITED STATES PATENT OFFICE

CERTIFICATION OF CORRECTION

Patent No. 3,012,511

December 12, 1961

Cecil E. Adams

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

In the grant, lines 1 to 3, for "Cecil E. Adams, of Columbus, Ohio," read -- Cecil E. Adams, of Columbus, Ohio, assignor to American Brake Shoe Company, of New York, N. Y., a corporation of Delaware, --; line 12, for "Cecil E. Adams, his heirs" read -- American Brake Shoe Company, its successors --; in the heading to the printed specification, line 4, for "Cecil E. Adams, 488 E. Dunedin Road, Columbus, Ohio" read -- Cecil E. Adams, Columbus, Ohio, assignor to American Brake S Company, New York, N. Y., a corporation of Delaware --.

Signed and sealed this 24th day of April 1962.

(SEAL)
Attest:

ESTON G. JOHNSON
Attesting Officer

DAVID L. LADD
Commissioner of Patents