June 4, 1963 S. J. RHODES 3,092,037

HYDRAULIC PUMP MECHANISM

Original Filed Sept. 10, 1958 5 Sheets-Sheet 1

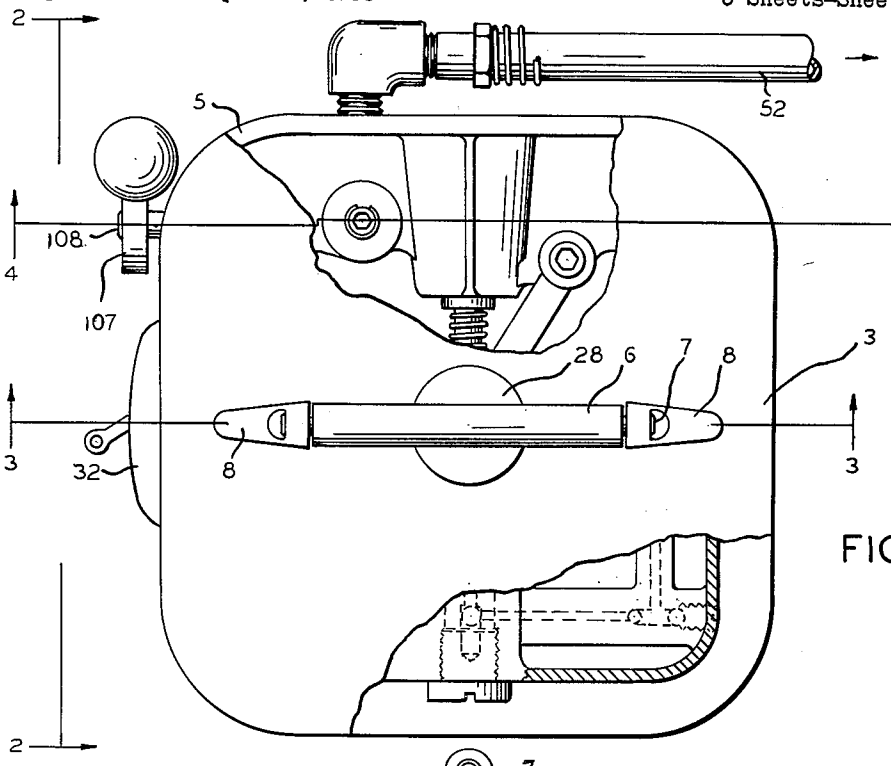


FIG. 1

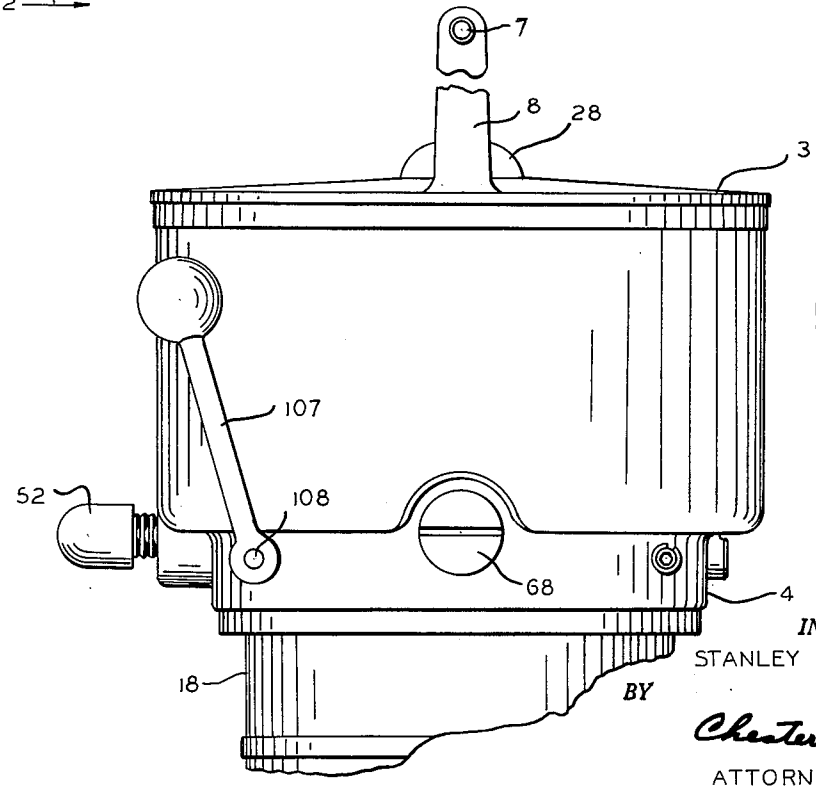


FIG. 2

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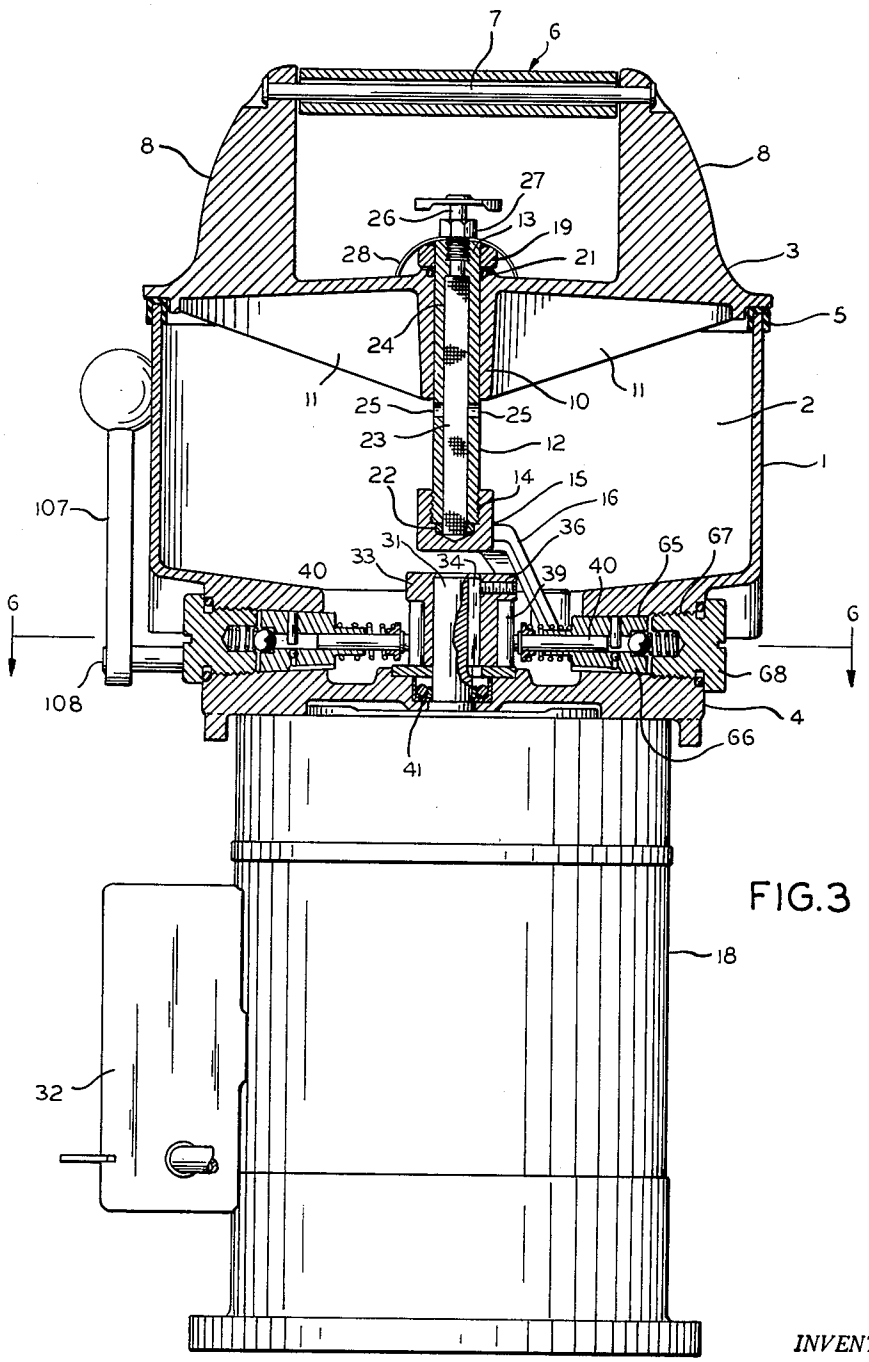


FIG.3

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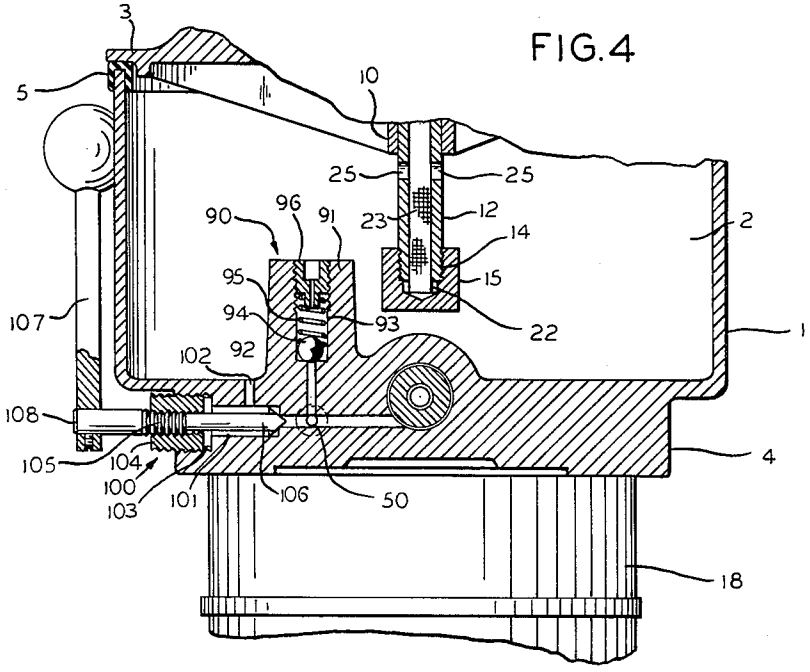
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FIG. 4



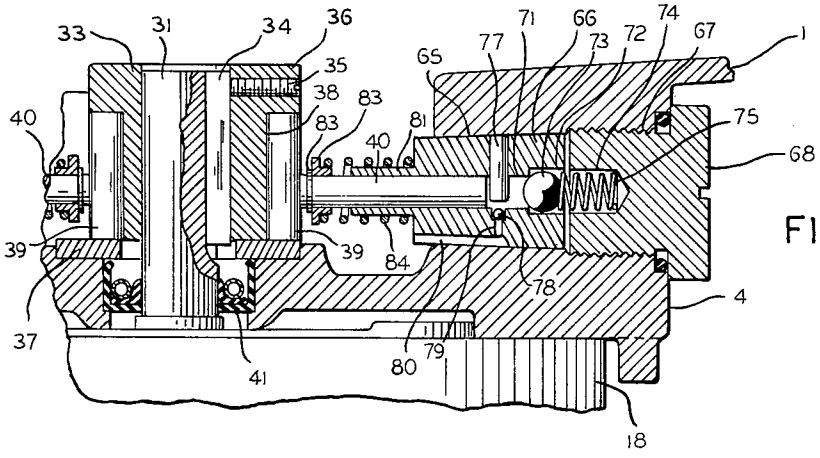


FIG. 5

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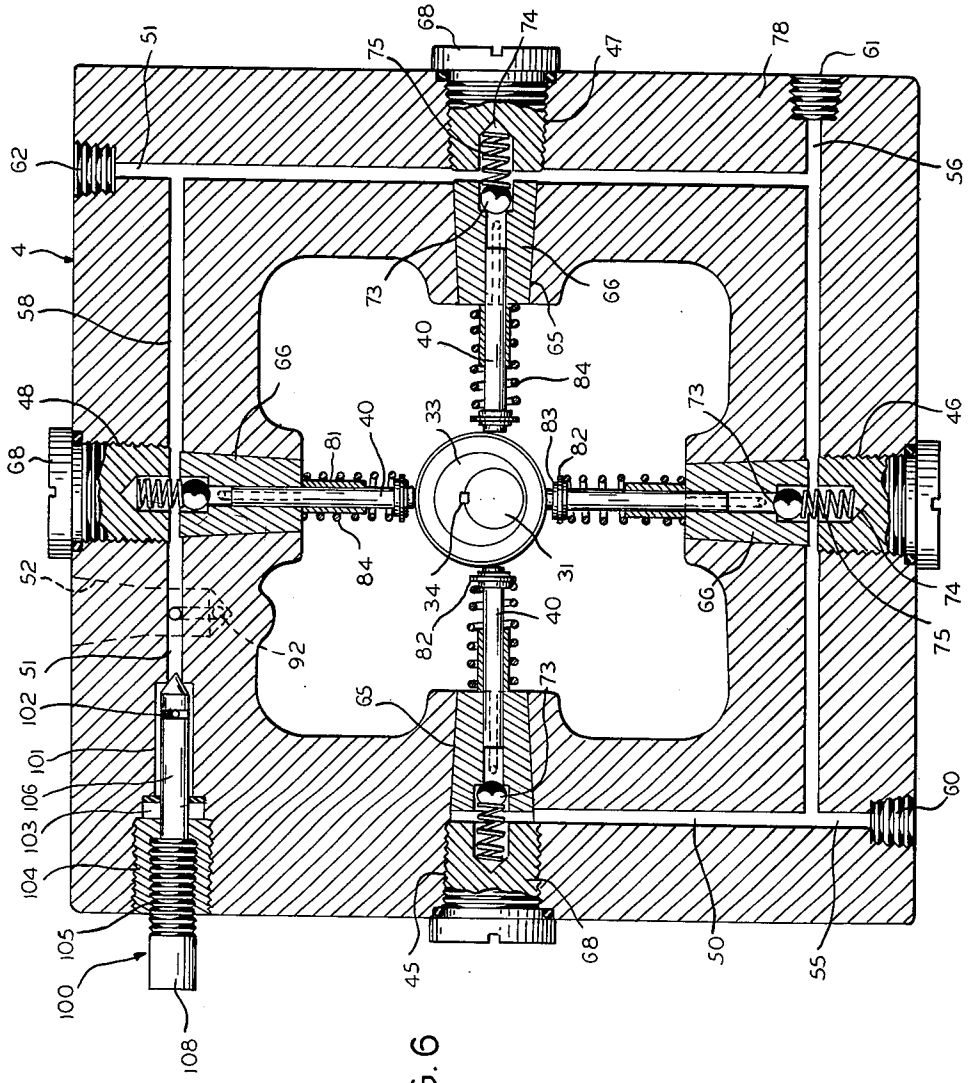


FIG. 6

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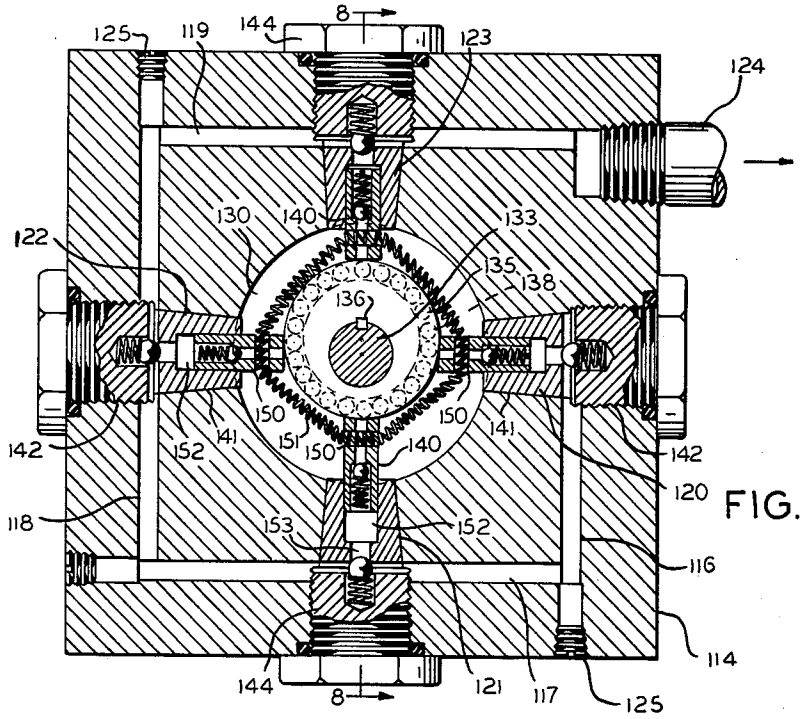


FIG. 7

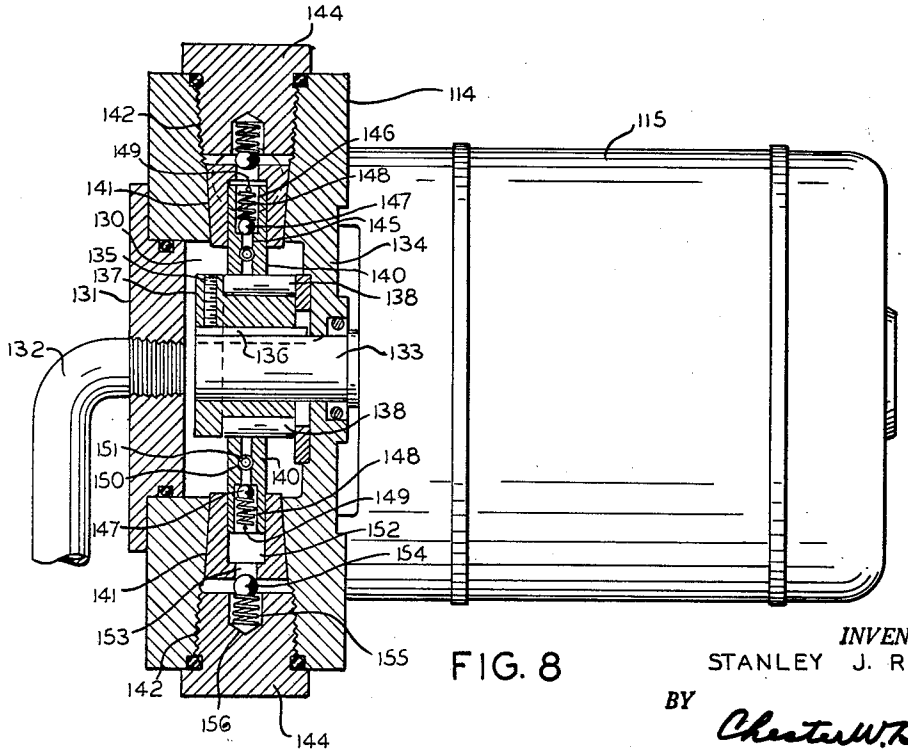


FIG. 8

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United States Patent Office

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3,092,037

HYDRAULIC PUMP MECHANISM

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Continuation of abandoned application Ser. No. 760,184, Sept. 10, 1958. This application Mar. 13, 1962, Ser. No. 180,934

11 Claims. (Cl. 103—174)

This invention relates to hydraulic pump mechanism.

This application is a continuation of my application Serial No. 760,184, filed September 10, 1958, now abandoned, for Hydraulic Pump Mechanism.

The primary object of this invention is to provide an efficient high pressure pumping mechanism which may be manufactured at a relatively low cost and at the same time be of a durable quality, which is simple in construction, and economical in operation.

More specifically, it is an object to provide pumping mechanism having a fluid displacement per unit weight of the pump greater than heretofore obtained and a fluid delivery at substantially higher pressures and lower power consumption than is currently available in similar devices known to me.

A further object is to provide pump mechanism which reduces power losses through friction, embodies a minimum of operating parts and thus requires less precision artistry in fitting the operating parts, and which is operable from a power source of much less rating than that required in similar devices heretofore known to me.

Another object is to provide pump mechanism which is inherently positively primed, thus eliminating a head of priming fluid and which assures positive fluid pressure on the suction side, thus assuring a maximum efficiency of volumetric displacement for any given power input and avoiding the limitations of volumetric displacement imposed by suction.

An object is to provide pump mechanism which efficiently utilizes forces heretofore dissipated in creating high pressures by applying such forces in a manner augmenting each other to obtain a total application thereof effecting the pumping operation advantageously rather than dissipating them disadvantageously.

Further objects and advantages will be apparent from the following description and accompanying drawing, in which like parts are designated by similar reference characters.

FIG. 1 is a top plan view with parts broken away to expose internal portions.

FIG. 2 is a fragmentary view in side elevation as seen from the left hand relative to FIG. 1.

FIG. 3 is a view in side elevation of the device shown in FIG. 1, the upper portion being shown in section taken on the line 3—3 of FIG. 1.

FIG. 4 is a fragmentary sectional view taken on the line 4—4 of FIG. 1.

FIG. 5 is an enlarged sectional view of a portion of that shown in FIG. 3.

FIG. 6 is a sectional view taken on the line 6—6 of FIG. 3, the view being enlarged for clarity.

FIG. 7 is a sectional view illustrating a modification of the pumping mechanism.

FIG. 8 is a view partly in section taken on the line 7—7 of FIG. 6.

The hydraulic pump mechanism disclosed herein embodies a casing 1 providing a fluid chamber 2 closed at the top by a cover 3 and having a pumping cylinder block section 4 beneath the chamber 2. As indicated in FIG. 3 a channeled resilient sealing ring 5 embraces the upper edge of the casing 1, the cover 3 resting thereon and being clamped in compressive relation thereto in the manner hereafter set forth. A handle comprising a tube

6 and rod 7 for manually conveying the cover 3 is secured to the relatively spaced uprights 8 integral with the cover. The cover 3 is provided with a centrally located tubular portion 10 on its inner face extending into the chamber 2 and braced by radial ribs 11. Extending through the tubular portion 10 is an elongated pipe 12 which is threaded at its upper end 13 and lower end 14. The lower end 14 is threaded into and closed by socketed end 15 of the bracket 16 which extends downwardly at an angle and is anchored to the cylinder block section 4 within the chamber 2 by means of an allen head bolt 17. Three additional equi-distantly placed similar bolts serve to anchor the casing to the upper end of the motor housing 18. The upper end 13 of the pipe 12 is engaged by a nut 19 which serves to clamp the cover 3 on the casing 1. Sealing rings 21 and 22 are placed respectively at the upper and lower ends of the pipe 12. A filter 23 is positioned in the pipe 12 and egress holes 24 and 25 are provided for permitting fluid to flow from the pipe 12 into the chamber 2 after passing through the filter. The upper end of the tube is closed by a manually operable plug 26 threaded therein and locked by a nut 27 which also retains the inverted dished cap 28 in place.

The cylinder block section 4 is provided with a centrally located aperture which receives the projecting end of the motor shaft 31 operated by a motor (not shown) within the housing 18. FIG. 3 shows a motor control switch box 32 on the motor housing 18. A cam 33 is mounted on the shaft 31 and is fixed thereto by means of a key 34 and set screw 35 extending through the flanged end 36 of the cam and engaging the key 34. A plate 37 is positioned at the lower end of the cam and with the flanged end 36 forms a channel 38 concentric with the cam. Within the channel a plurality of needle bearings 39 are positioned in adjacent relation for sequential engagement with the pistons or plungers 40. The specific manner of retaining the needle bearings in position between the plate 37 and flanged end 36 is not illustrated, since this is well known by those skilled in the art and is not claimed as the invention of applicant herein. Sealing means 41 disposed about the shaft 31 and adjacent the plate 37 prevents fluid in the chamber 2 from entering the motor housing 18.

As indicated in FIG. 6, the cylinder block section 4 is provided with four equi-distantly placed bores 45, 46, 47 and 48 extending radially relative to the cam 33. The bores are connected successively by a passage 50 beginning with the bore 45 and terminating at 51 where it is in communication with the lead-off pipe 52. In the embodiment shown in FIGS. 1 through 6, the passage 50 is formed by drilling four holes 55, 56, 57 and 58 in the cylinder block section 4 and then closing three of the holes by means of plugs 60, 61 and 62 to complete the passage 50.

Each of the bores 45 through 48 is tapered inwardly at 65 toward the cam and receives a tapered cylinder 66 complementary thereto. Each bore is threaded at its outer end and receives a screw bolt 68 which seals the bore against the passage of fluid to the exterior of the block section 4. The adjacent ends of the cylinder 66 and bolt 68 are relatively spaced to afford uninterrupted flow of fluid in the passage 50 and fluid pressure in the area between the cylinders and bolts maintains the cylinders firmly seated in the tapered portions 65.

Each of the cylinders 66 has a bore 71 which receives the piston 40 and is enlarged at 72 to receive the ball check valve 73. The screw bolt 68 is recessed at 74 to receive a compression spring 75 which biases the ball 73 into contact with the annular edge of the cylinder adjacent the enlarged recess 72. A pin 77 extends through the wall of the cylinder 66 and into the bore 71 to a point adjacent the check valve ball 78 in the inlet opening

79 which communicates with the inlet passage 80 in the outer wall of the cylinder 66. The pin 77 serves to retain the ball 78 in operative relationship to the opening 79. As shown, the cylinder 66 has a reduced extension 81 surrounding the piston 40. Adjacent the inner end of the piston a collar 82 is retained by means of a split ring 83. A compression spring 84, engaging the cylinder and collar 82, biases the piston 66 outwardly of the cylinder and into contact with the needle bearings 39 on the cam 33.

Two pressure relief valves are provided, one of which is automatic and set to operate at a predetermined value and the other of which is manually controlled. The automatic control valve 90 is located in a boss 91 apertured to provide an opening 92 communicating with the passage 50 and a larger bore 93 for the relief ball valve 94, compression spring 94 and apertured screw plug 95. When the ball valve is raised at the predetermined pressure, the fluid flows from the passage 50 through the opening 92, bore 93 and apertured screw plug 95 into the chamber 2.

The manually controlled valve 100 is normally closed and comprises a bore 101 and aperture 102 normal thereto providing a by-pass around the automatic valve 90 from the passage 50 to the chamber 2. The bore 101 has an enlarged portion 103 threaded to receive the tubular plug 104 which is threaded interiorly to receive the threaded portion 105 of the needle valve 106. An operating handle 107 is secured to the stem 108 of the needle valve and extends at right angle or laterally thereof. Normally the needle valve 101 seats firmly on the annular valve edge of the bore 101 as clearly illustrated in FIGS. 4 and 6.

The pumping mechanism disclosed in FIGS. 1 through 6 is adapted for use in transmitting power at high pressures to machines which do not require recirculation of the fluid, such as presses, etc. In operation, the fluid is drawn into each of the cylinders 66 through the passages 80 and openings 79 as the respective pistons 40 move outwardly under the bias of coil springs 84 and is then forced out of the cylinders into the passage 50 and outwardly through the lead-off pipe 52 to the machine (not shown). Fluid drawn into the cylinders from the chamber 2 is prevented from returning thereto by means of the ball valves 78 and fluid forced into the passage 50 from the cylinders is prevented from returning to the cylinders by beans of the ball valves 72. Thus the fluid is advanced to the pipe 52 and when the pressure in the pipe exceeds a predetermined value the automatic relief valve 90 operates to prevent the pressure from materially exceeding the predetermined value.

Upon completion of the work by the machine (not shown), the manually controlled valve 100 is opened to by-pass the fluid and return it to the chamber without stopping the pumping mechanism. To compensate for fluid loss, added fluid may be supplied by removing the plug 26 and introducing the fluid through the filter 23.

The modified form illustrated in FIGS. 7 and 8 is basically the same as that illustrated in FIGS. 1 through 6, but is adapted for a continuous flow of fluid in a fluid recirculating circuit and does not require the fluid storage chamber.

The cylinder block 114 is mounted on a motor housing 115 and secured thereto in any suitable manner (not shown). Four bores 116, 117, 118 and 119 are drilled, as shown, to constitute a fluid passage leading from the cylinder 120 past each cylinder 121, 122 and 123 successively, to the outlet pipe 124. Bores 116, 117 and 118 are each plugged by a screw bolt 125. The cylinder block is recessed centrally at 130 which is capped by a plate 131 into which is threaded a fluid return pipe 132. A motor shaft 133 projects from a motor (not shown) in the housing and through the bottom 134 of the recess 130. A cam 135 similar to that previously described is mounted on the shaft 133 and is secured thereto by means of a key 136 and set-screw 137. Needle bearings 138 are carried by the cam and are engaged by the pumping pistons 140.

The cylinder block 114 is provided with a plurality of bores radially of the shaft 133, each having inwardly tapered portion 141 and a threaded portion 142. In each bore is inserted a cylinder 120, 121, 122 and 123, respectively, and tapered complementary to the tapered portion 141 of the bore. A plug 144 is threaded into the portion 142 of each bore and its inner end is spaced from the adjacent cylinder to permit free movement of fluid from the cylinder to the passage.

As indicated each piston is provided with an axial opening 145 for the ingress of fluid and is enlarged at 146 to receive a fluid ball check valve 147 and a compression spring 148 held therein by means of a pin 149. Each of the pistons 140 is provided with transverse aperture 150 through which a toridal spring 151 extends and maintains the pistons in engagement with the needle bearings 138. As indicated each cylinder is provided with a bore 152 which slidably receives the piston 140. The bore terminates in an outlet 153 which is controlled by a ball valve 154, biased to close the outlet by a coil spring 155 seated in the recess 156 in the plug 144.

In the modified pumping mechanism shown in FIGS. 7 and 8, fluid in the fluid return pipe 132 and the recessed area 130 is drawn into the cylinder bores 152 through the openings 145 when the pistons are withdrawn from the bores by the toroidal spring 151 and is forced from the bores into the passages 116–119 and from there into the outlet pipe 124 when the pistons are moved by the cam 135 into the cylinder bores 152. Ball valves 154 prevent fluid from returning to the cylinder bores when the pistons 140 are receding and ball valves 147 prevent fluid from returning to the recess 130 when the pistons are moving into the bores.

When the fluid leaves the pumping mechanism it is transmitted to a device (not shown) to be operated thereby and is returned to the pumping mechanism from the device by means of the return pipe 132. Obviously the return pipe 132 may be connected to a reverse supply tank (not shown) which will maintain a supply of fluid.

Preferably, all of the elements of the pumping mechanism may be made of a comparatively light metal, such as aluminum, except those working parts which are movable and subject to constant wear and tear, for instance the cylinders, pistons, needle bearings, ball valves and springs, which may be of ferrous metals appropriate for their use.

From the foregoing it is apparent that I have provided pumping mechanism which is of light construction, sturdy and efficient, which reduces power losses to a minimum, utilizes power input effectively and requires a minimum power input for a maximum output.

Although I have disclosed specific embodiments of my invention, it will be understood that I do not limit the scope of the appended claims, unless the terms thereof justify such limitations.

I claim:

1. In a hydraulic pump including a rotatable cam, an annular cylinder block disposed radially about said cam to provide a centrally located supply chamber, said block having a plurality of bores with their respective axes coincident with a plane of rotation of said cam, said block having an outlet port lying in a plane coincident with said first mentioned plane, an outlet conduit extending from one of said bores across the remaining bores and terminating in an outlet between said one bore and the last of the successive ones of said remaining bores, and a plug in each of said bores terminating adjacent said outlet conduit and having a recess interiorly of said bore; the combination with a cylinder in each of said bores disposed between said outlet conduit and said supply chamber, said cylinder having an outlet valve seat adjacent said outlet conduit normally engaged by an outlet ball valve biased by a spring in the recess, said cylinder hav-

ing diametrically opposed apertures, of a pin secured in one of said apertures and extending to a point adjacent the other of said apertures, said other of said apertures having an inlet valve seat therein, an inlet ball valve disposed between said inlet valve seat and said pin, an inlet groove in the outer periphery of said cylinder extending from said other aperture to said supply chamber, a piston in said cylinder engaging said cam, and a coil spring on said piston reacting between said cylinder and piston to bias said piston into engagement with said cam.

2. In a hydraulic pump including a rotatable cam, an annular cylinder block disposed radially about said cam to provide a supply chamber, said block having a plurality of bores with their respective axes coinciding with a plane of rotation of said cam, said block having an outlet port lying in a plane coincident with said first mentioned plane, an outlet conduit extending from one of said bores across the remaining bores and terminating in an outlet between said one bore and the last of the successive ones of said remaining bores, each of said bores being tapered inwardly toward said supply chamber from a point adjacent said outlet conduit, the remaining portion of said bore being threaded on the side of said outlet conduit opposite said tapered portion, and a plug threaded into said bore and recessed adjacent said outlet conduit; the combination with a cylinder in each of said bores complementary to the tapered portion thereof and disposed between said outlet conduit and said supply chamber, said cylinders each having an outlet valve seat adjacent said outlet conduit normally engaged by an outlet ball valve biased by a spring in said recess, each of said cylinders having diametrically opposed apertures, of a pin secured in one of said apertures and extending to a point adjacent the other of said apertures, said other of said apertures having an inlet valve seat therein, an inlet ball valve disposed between said inlet valve seat and said pin, an inlet groove in the outer periphery of each of said cylinders extending from said other aperture to said supply chamber, a piston in each of said cylinders engaging said cam, and a coil spring on each of said pistons reacting between said cylinder and piston to bias said pistons into engagement with said cam.

3. In a hydraulic pump including a rotatable cam, a cylinder block disposed radially of said cam, said block having a plurality of bores with their axes coinciding with a plane of rotation of said cam, said block having an outlet port and an outlet conduit extending from one of said bores across the remaining bores and terminating in said outlet port, said bores being each tapered inwardly toward said cam from a point adjacent said outlet conduit, the remaining portion of each of said bores being threaded on the side of said outlet conduit opposite said tapered portion, and a plug threaded into each of said threaded portions of said bores, in combination with a cylinder in each of said bores complementary to the tapered portion of each of said bores respectively and disposed between said outlet conduit and said cam and each having an outlet valve seat adjacent said outlet conduit, a tubular piston in each of said cylinders and having an inlet valve seat therein and biased into engagement with said cam and having inlet ports adjacent said cam, and biased valving means controlling said outlet and inlet ports and responsive to reciprocation of said pistons.

4. In a hydraulic pump including a rotatable cam, a cylinder block disposed radially of said cam, said block having a plurality of bores with their axes coinciding with a plane of rotation of said cam, said block having an outlet port and an outlet conduit extending from one of said bores across the remaining bores and terminating in said outlet port, said bores being each tapered inwardly toward said cam from a point adjacent said outlet conduit, the remaining portion of each of said bores being threaded on the side of said outlet conduit opposite said tapered portion, and a plug threaded into each of said threaded portions of said bores; in combination with a cylinder

in each of said bores complementary to the tapered portion of each of said bores respectively and disposed between said outlet conduit and said cam and each having an outlet valve seat adjacent said outlet conduit, a piston in each of said cylinders and biased into engagement with said cam, and inlet and outlet valve means responsive to reciprocation of said pistons.

5. In a hydraulic pump including a rotatable cam, a cylinder block disposed radially of said cam, said block having a bore with its axis coinciding with a plane of rotation of said cam, said block having an outlet port and an outlet conduit extending from said bore and terminating in said outlet port, said bore being tapered inwardly toward said cam from a point adjacent said outlet conduit, the remaining portion of said bore being threaded on the side of said outlet conduit opposite said tapered portion, and a plug threaded into said threaded portion of said bore, in combination with a cylinder complementary to the tapered portion of said bore and disposed between said outlet conduit and said cam and having an outlet valve seat adjacent said outlet conduit, a tubular piston in said cylinder and having and inlet valve seat therein and biased into engagement with said cam and having inlet ports adjacent said cam, and biased valving means controlling said outlet and inlet ports and responsive to reciprocation of said piston.

6. In a hydraulic pump including a rotatable cam, a cylinder block disposed radially of said cam, said block having a bore with its axis coinciding with a plane of rotation of said cam, said block having an outlet port and an outlet conduit extending from said bore and terminating in said outlet port, said bore being tapered inwardly toward said cam from a point adjacent said outlet conduit, the remaining portion of said bore being threaded on the side of said outlet conduit opposite said tapered portion, and a plug threaded into said threaded portion of said bore; in combination with a cylinder complementary to the tapered portion of said bore and disposed between said outlet conduit and said cam and having an outlet valve seat adjacent said outlet conduit, a piston in said cylinder and biased into engagement with said cam, and inlet and outlet valve means responsive to reciprocation of said piston.

7. In a hydraulic pump including a rotatable cam, an annular cylinder block disposed radially about said cam to provide a centrally located supply chamber, said block having a plurality of bores with their respective axes coincident with a plane of rotation of said cam, said block having an outlet port lying in a plane coincident with said first mentioned plane, an outlet conduit extending from one of said bores across the remaining bores and terminating in an outlet between said one bore and the last of the successive ones of said remaining bores, and a plug in each of said bores terminating adjacent said outlet conduit and having a recess interiorly of said bore; the combination with a cylinder in each of said bores disposed between said outlet conduit and said supply chamber, said cylinder having an outlet valve seat adjacent said outlet conduit normally engaged by an outlet ball valve biased by a spring in the recess, of a tubular piston in said cylinder and having an inlet valve seat therein, an inlet ball valve in said piston, a spring in said piston biasing said inlet ball valve into engagement with said inlet valve seat, said piston having diametrically opposed inlet ports communicating with the interior of said piston, and spring means on said piston biasing said piston into engagement with said cam.

8. In a hydraulic pump including a rotatable cam, an annular cylinder block disposed radially about said cam to provide a centrally located supply chamber, said block having a plurality of bores with their respective axes coincident with a plan of rotation of said cam, said block having an outlet port lying in a plane coincident with said first mentioned plane, an outlet conduit extending from one of said bores across the remaining bores and

terminating in said outlet between said one bore and the last of the successive ones of said remaining bores, and a plug in each of said bores terminating adjacent said outlet conduit and having a recess interiorly of said bore; the combination with a cylinder in each of said bores disposed between said outlet conduit and said supply chamber, said cylinder having an outlet valve seat adjacent said outlet conduit normally engaged by an outlet ball valve biased by a spring in the recess, of a piston in said cylinder, spring means biasing said piston into engagement with said cam, and inlet conduit and valving means between the bore of said cylinder and said supply chamber, said inlet valving means normally biased closed and responsive to movement of said piston.

9. In a hydraulic pump including a rotatable cam, a cylinder block disposed about and radially of said cam, said block having a plurality of bores with their respective axes coinciding with a plane of rotation of said cam, said block having an outlet port lying in a plane coincident with said first mentioned plane an outlet conduit extending from one of said bores across the remaining bores and terminating in said outlet between said one bore and the last of the successive ones of said remaining bores, each of said bores being tapered inwardly toward said cam from a point adjacent said outlet conduit, the remaining portion of each of said bores being threaded on the side of said outlet conduit opposite said tapered portion, and a plug threaded into said bore and recessed adjacent said outlet conduit; the combination with a cylinder in each of said bores complementary to the tapered portion thereof and disposed between said outlet conduit and said cam, said cylinder having an outlet valve seat adjacent said outlet conduit normally engaged by an outlet ball valve biased by a spring in said recess, of a tubular piston in each of said cyclinders and having an inlet valve seat therein, an inlet ball valve in each of said pistons, a spring in each of said pistons biasing said inlet ball valve into engagement with said inlet valve seat, said pistons having diametrically opposed inlet ports communicating with the interior of said pistons, and spring means on said piston biasing said piston into engagement with said cam.

10. In a hydraulic pump including a rotatable cam, an annular cylinder block disposed radially about said cam to provide a supply chamber, said block having a plurality of bores with their respective axes coinciding with a plane of rotation of said cam, said block having an outlet port lying in a plane coincident with said first mentioned plane, an outlet conduit extending from one of said bores across the remaining bores and terminating in an outlet between said one bore and the last of the successive ones of said remaining bores, each of said bores being tapered inwardly toward said supply chamber from a point adjacent said outlet conduit, the remaining portion of said bore being threaded on the side of said outlet conduit opposite said tapered portion, and a plug threaded into said bore and recessed adjacent said outlet conduit; the combination with a cylinder in each of said bores complementary to the tapered portion thereof and disposed between said outlet conduit and said supply chamber, said cylinder having an outlet valve seat adjacent said outlet conduit normally engaged by an outlet ball valve biased by a spring in said recess, of a piston in each of said cylinders, spring means biasing said pistons into engagement with said cam, and inlet conduit and valving means between the bores of the cylinders and said supply chamber, said inlet valving means normally biased closed and responsive to movement of said pistons.

11. In a hydraulic pump including a rotatable cam, an annular cylinder block disposed radially about said cam to provide a supply chamber, said block having a plurality of bores with their respective axes coinciding with a plane of rotation of said cam, said block having an outlet port lying in a plane coincident with said first mentioned plane, an outlet conduit extending from one of said bores across the remaining bores and terminating in an outlet between said one bore and the last of the successive ones of said remaining bores, each of said bores being tapered inwardly toward said supply chamber from a point adjacent said outlet conduit, the remaining portion of said bore being threaded on the side of said outlet conduit opposite said tapered portion, and a plug threaded into said bore and recessed adjacent said outlet conduit; the combination with a cylinder in each of said bores complementary to the tapered portion of said bore and disposed between said outlet conduit and said supply chamber, said cylinder having an outlet valve seat adjacent said outlet conduit normally engaged by an outlet ball valve biased by a spring in said recess, a piston in each of said cylinder engaging said cam, a spring on said piston interposed between said cylinder and piston and biasing said piston into engagement with said cam, inlet conduit and valving means between the bore of said cylinder and said supply chamber responsive to movement of said pistons.

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