United States Patent

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[54] VARIABLE PRESSURE SENSITIVE PUMP

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[21] Appl. No.: **20,875**

Related U.S. Application Data

[63] Continuation of Ser. No. 738,050, June 18, 1968, abandoned.

[52] **U.S. Cl.** **417/270,** 417/307

[51] **Int. Cl.** **F04b 49/00**

[58] **Field of Search** 417/269, 270, 286, 288, 307, 417/440, 502

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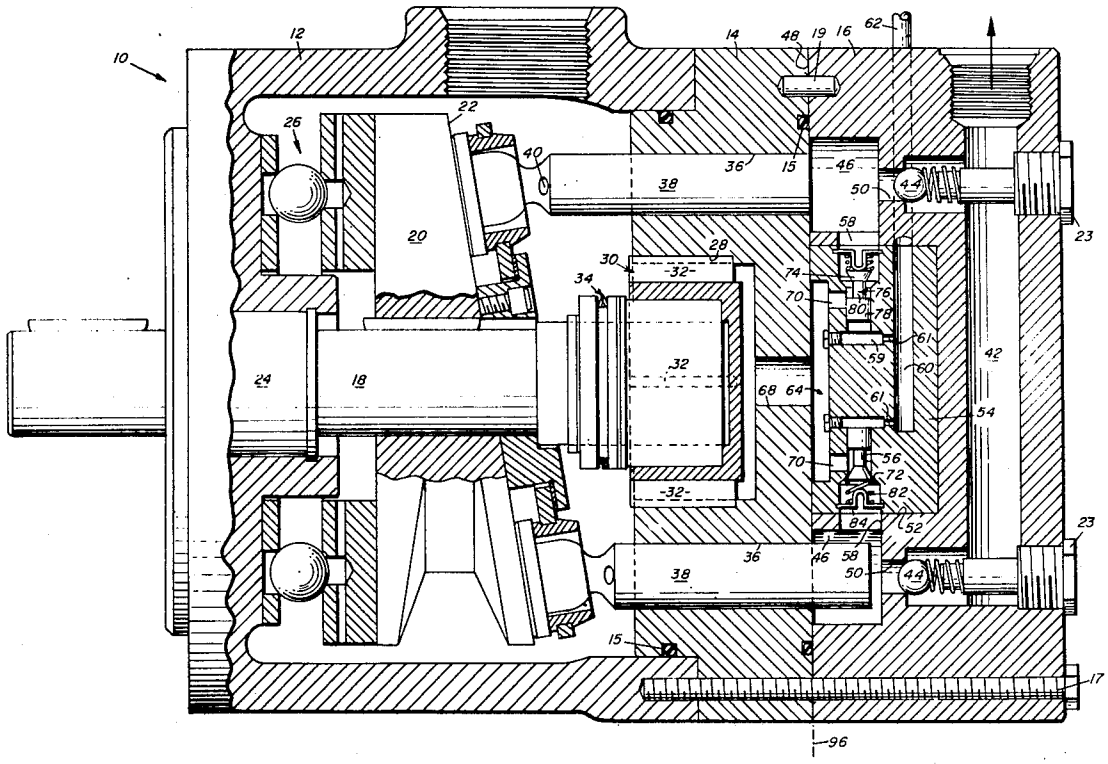
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[57] **ABSTRACT**

An axial pump having the capability of providing a plurality of independently adjustable fluid flows wherein there is an orifice network for returning adjustable amounts of pumped fluid from each piston to the inlet chamber depending on detected control pressures. A series of poppets are spring biased across orifices and the poppets adjust the open orifice period depending on the detected control pressures. The pump uses segmented bearings for its cam plate in combination with the aforesaid variable flow capacity. The pump further includes the use of a divided barrel wherein one portion houses reciprocating pistons and the other portion consists of a replaceable end-plate having passageways and valving means therein for determining the number of outputs and which of these outputs will be variable or fixed flow.

5 Claims, 8 Drawing Figures



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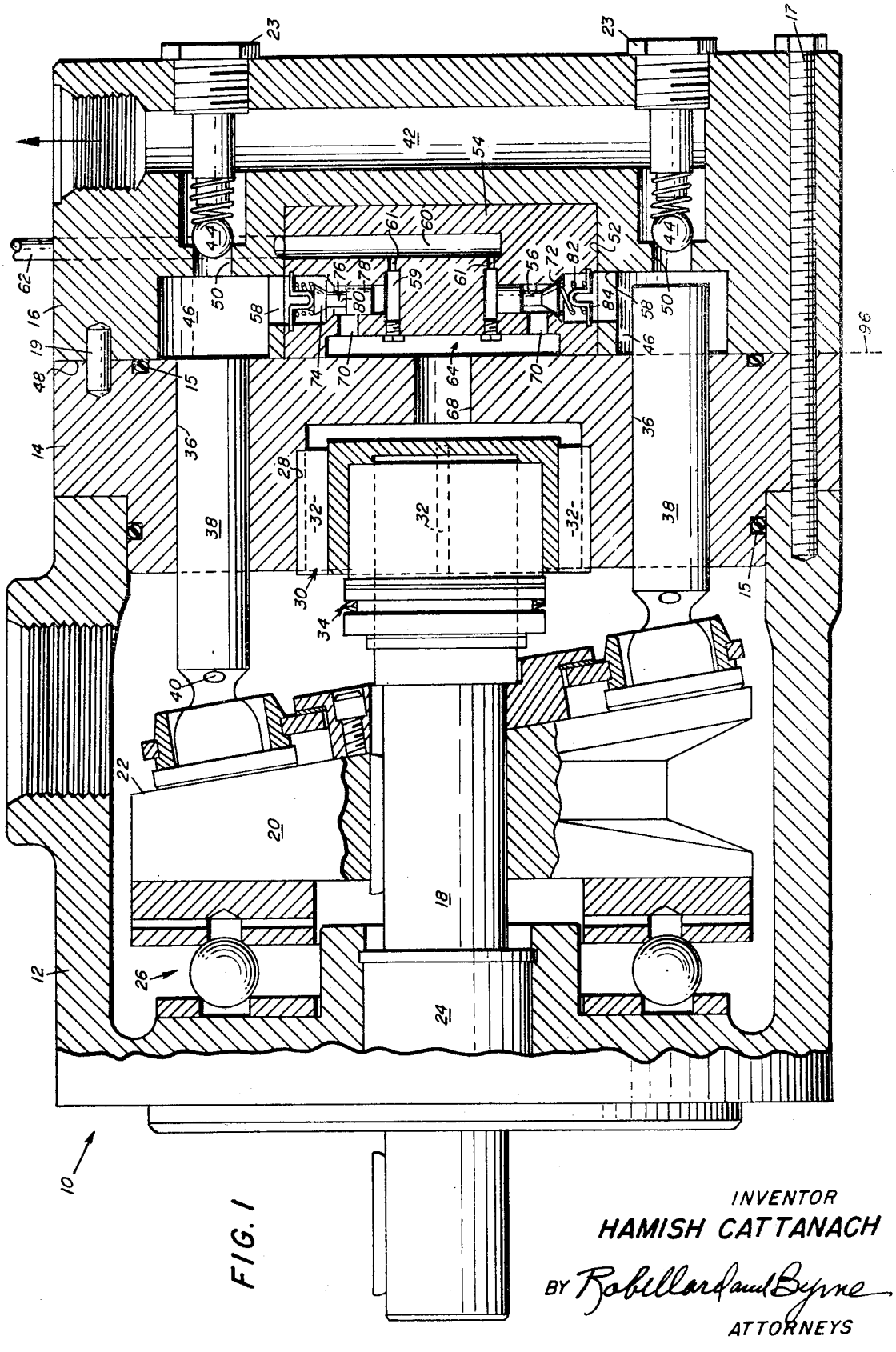
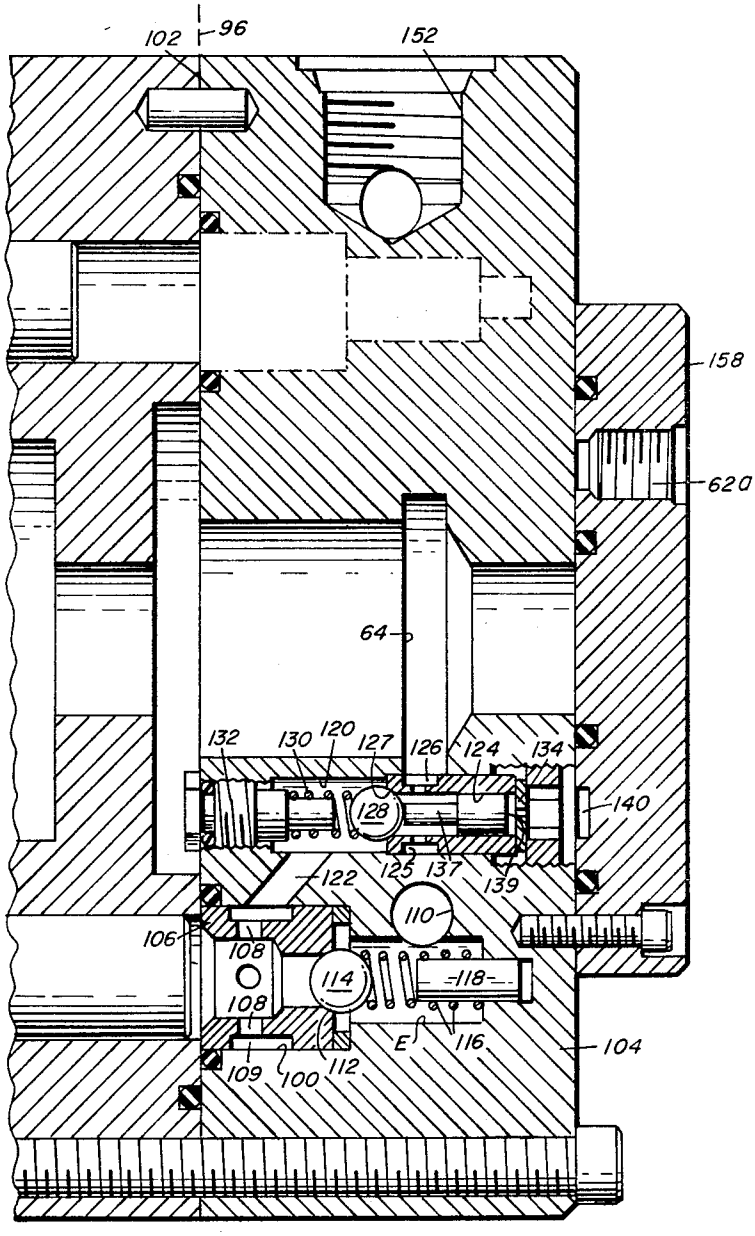


FIG. 1

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FIG. 5



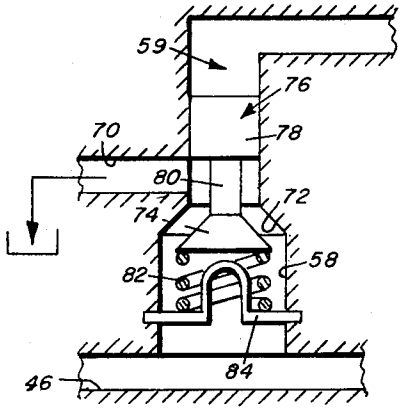
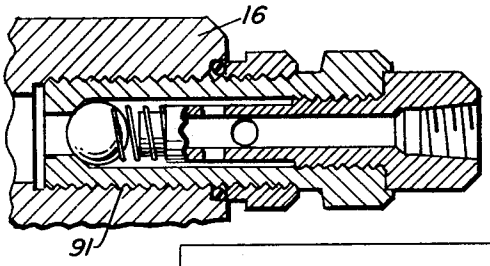


FIG. 1a

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FIG. 2



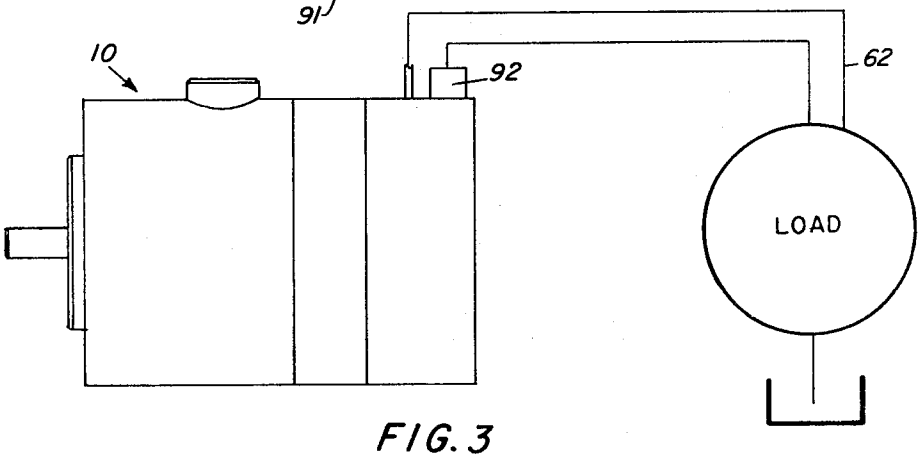


FIG. 3

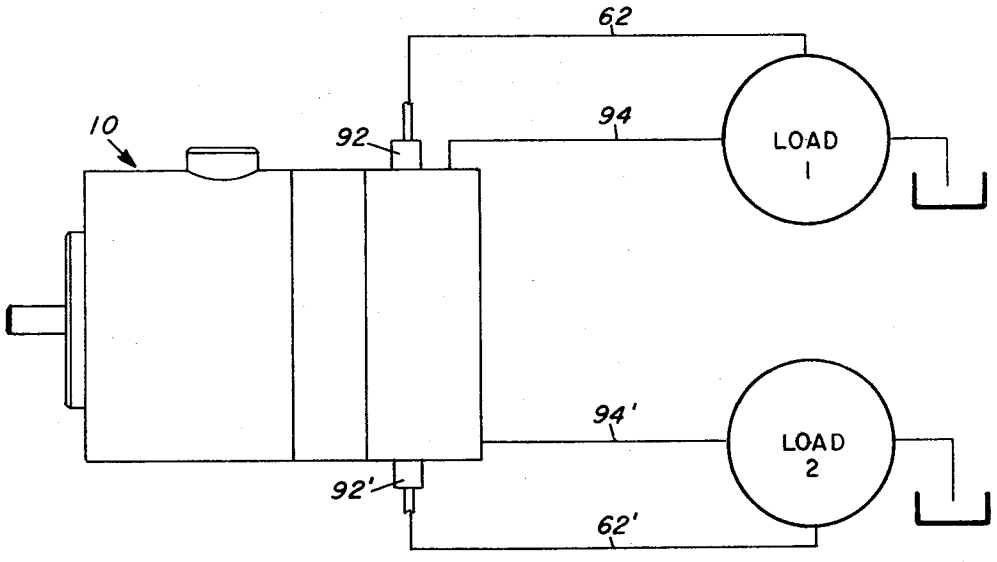
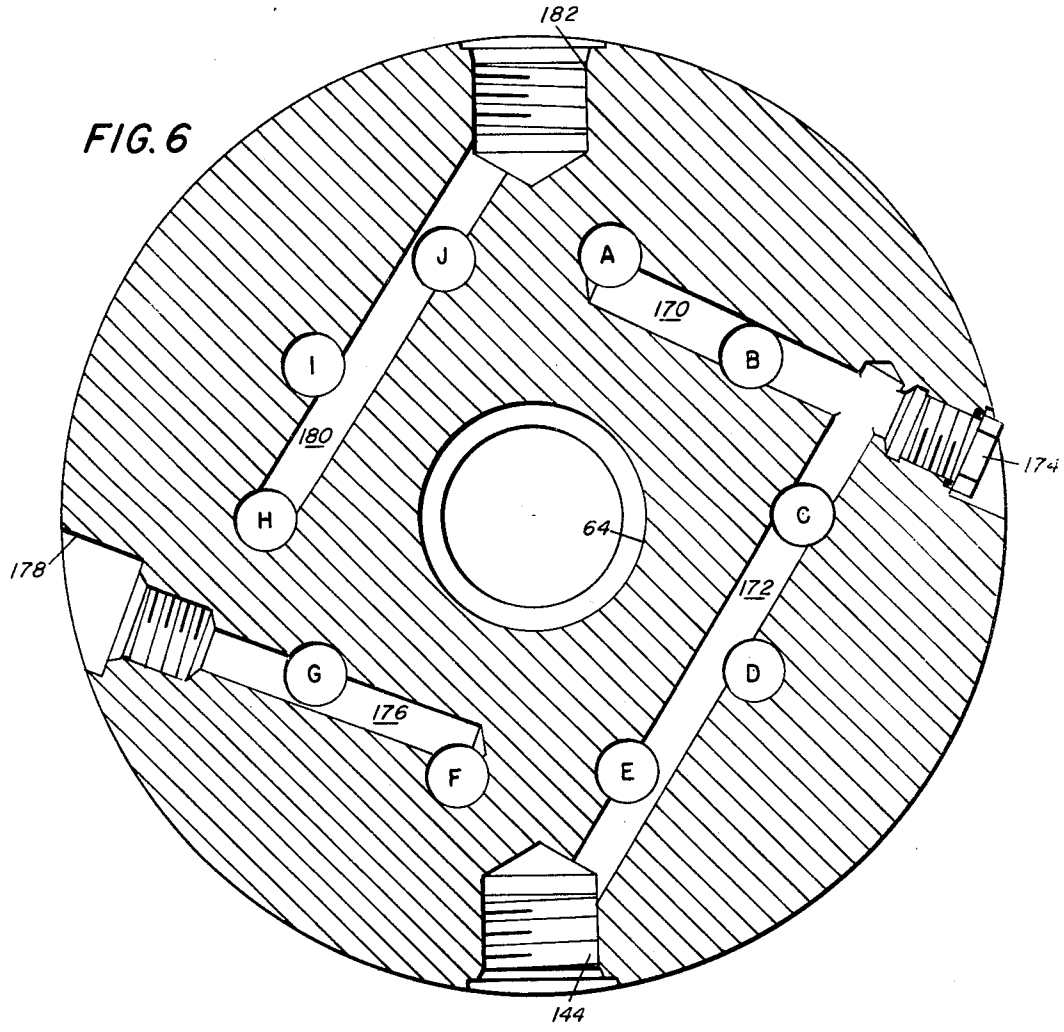


FIG. 4

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FIG. 6



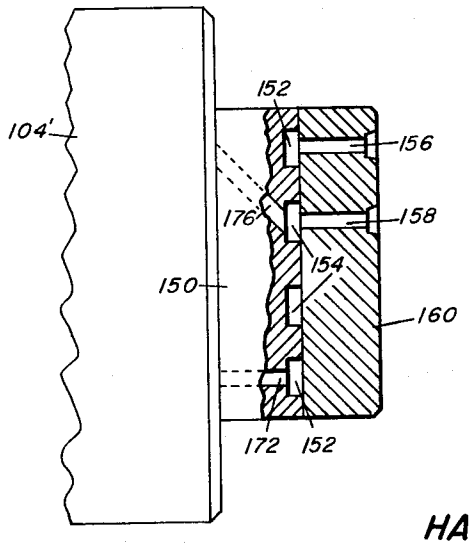


FIG. 7

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VARIABLE PRESSURE SENSITIVE PUMP

This application is a Continuation of Application 738,050 filed June 18, 1968, now abandoned.

Therefore, this invention relates generally to a hydraulic fluid pump and more particularly relates to a fluid pump wherein variable flow is obtained and adjusted in accordance with control requirements.

An objective of this invention is to provide a fluid pump wherein a by-pass system is provided between the pressurized end of the piston chambers and the intake chamber which by-pass system is closed during certain portions of the power stroke in accordance with control pressures.

Another objective of this invention is to provide a hydraulic pump which has the capability of providing two or more independently controlled variable flows from a unit driven by a common power source.

A further objective of this invention is to provide a multi-output fluid pump having a divided barrel housing having a first portion of standardized elements receiving the reciprocating pistons and a second end-plate, manifold portion for determining the number and character of the separate fluid outputs.

Another important objective of this invention is to provide a novel fluid translator wherein the axial forces are absorbed by a plurality of segmented bearings between the rotary cam plate and the pump housing together with means for automatically obtaining a plurality of automatically adjustable fluid outputs.

A still further objective of this invention is to provide a hydraulic pump with a spring-biased poppet across a by-pass passageway between the output end of the piston chambers and the intake chamber with means for determining the length of time the poppet remains open during the power stroke.

Another important objective of this invention is to provide a pump of the type described wherein the results in performance thereof are not materially affected by changes in operating pressures and temperatures.

Another important objective of this invention is to provide a fluid pump of the type described which has a plurality of outputs each of which is independently variably controlled while maintaining a construction of extreme durability, simplicity, and economy of design.

A further objective of this invention is to provide a fluid control device for each piston for determining in response to control pressures the amount of fluid which is by-passed to the intake side of pump during the pumping strokes.

Another objective of the invention is to provide a coverlet assembly for a fluid translator which increases the flexibility of the translator while maintaining a standardization of parts.

A still further objective of this invention is to provide a flow control by-pass valve dependent on a control pressure. More particularly, this objective is acquired through the use of a spring-biased poppet received in a T-network passageway having one end communicating with the flow line, a second end communicating with a return line passageway, and the third end thereof communicating with, or sensitive to the control pressure.

These and other objects of the invention will become more apparent to those skilled in the art by reference to the following detailed description when viewed in light of the accompanying drawings, wherein:

FIG. 1 is a longitudinal cross-section of the fluid translator of this invention;

FIG. 1*a* is a diagrammatic enlargement of the by-pass of FIG. 1;

FIG. 2 is a partial cross-section showing the ease with which variable multi-independent fluid flows are obtainable;

FIG. 3 and FIG. 4 are schematics showing typical systems in which the pump of this invention is used;

FIG. 5 is a vertical cross-section through the end-plate of a further embodiment of the invention;

FIG. 6 is a diagrammatic vertical section through FIG. 5 showing a manifold system; and

FIG. 7 is a partially diagrammatic view of a coverlet assembled for FIG. 5.

Referring now to the drawings wherein like numerals indicate like parts, the numeral **10** refers to the hydraulic pump of this invention. The pump housing is comprised of three basic units; namely, an inlet housing **12**, a piston carrier section **14**, and an end plate **16**. The three units **12**, **14** and **16** are fitted securely together by conventional sealing and bolting means such as seals **15** and a plurality of circumferentially arranged bolts **17**. A locating pin **19** is used to facilitate alignment.

A power driven shaft **18** extends into the housing **12**. Secured to the shaft is a rotating cam plate **20** having an inclined surface **22**. The shaft is rotatably secured within the unit **12** by a bearing assembly generally referred to as **24** and the axial forces thereof are absorbed by a segmented bearing assembly generally referred to by the numeral **26**. The bearings in their operation are more fully described in assignee's copending application Ser. No. 588,211, filed Dec. 5, 1966, entitled "Segmented Oil Film Bearing for Fluid Translator."

The carrier **14** is counterbored at **28**. Disposed within the counterbore **28** is an annular stabilizing sleeve **30** having a series of longitudinal passageways **32** therethrough. The inner end of shaft **18** is rotatably secured by a bearing assembly **33** which is located interiorly of the sleeve **30**. Spaced radially outwardly from counterbore **28** are a plurality of circumferentially arranged cylinder bores **36** each of which receives a reciprocating piston **38**. The pistons are hollow and are caused to travel through power and discharge strokes as more fully described in my above-identified copending application. The pistons **38** have interior check valve apparatus as disclosed in the assignee's Stewert U.S. patent Re. No. 25,850, issued Sept. 7, 1965.

As will be understood by those skilled in the art, the pistons receive fluid into their interior through apertures **40** during their intake stroke and discharge fluid into an exhaust manifold **42** through one-way checks **44** disposed between the piston chambers and the discharge chamber.

As seen best in FIG. **1**, each of the pistons **38** is partially received at the end of its discharge stroke by circular depressions **46** formed in the inner surface **48** of the end-plate **16** opposite each of the cylindrical bores **36**. Pressurized fluid in these depressions is communicated to the exhaust manifold **42** by way of openings **50** which provide a valve seat for one-way checks **44**.

The end-plate **16** is counterbored as shown by the lines **52** in FIG. **1**. Within this counterbore, a by-pass unit **54** is received. For purposes of discussion, the by-pass unit **54** is considered a part of the end-plate **16**. The unit **54** is fitted into the depression **52** and it is a separate piece only because it simplifies the boring of certain passageways. The by-pass unit **54** is formed with a plurality of radial passageways **56**. The outer enlarged ends **58** of the passageways are in communication with their respective depressions **46**. As shown in FIG. **1**, two of the passageways **56** are shown interconnected by a passageway **60**, respectively, through control orifices **61**. The connecting passageway **60**, in turn, is connected to a pressure sensor by way of a conduit **62**.

The by-pass unit **54** is counterbored at **64** which together with center opening **68** in piston carrier **14**, the slots **32** in sleeve **30**, and the openings **70**, communicates the radial bores **56** to the intake chamber of housing **12**.

Intermediate the lengths of the radial passageways **56** are seats **72** which are adapted for closing by the conical surfaces **74** of poppet members **76**. The poppet members **76** further include inner pistons **78** slidably received in the inner portions of bores **56**. The pistons **78** are connected to the closures **74** by way of stems **80** of reduced diameter. The poppets can be spring biased radially inwardly against the seats **72** by way of springs **82**. The springs extend between the closures **74** and retaining spider-type washers **84**. The by-pass units are best understood by reference to the diagrammatic of FIG. **1***a*.

In operation, the pistons **38** pump pressurized fluid to the discharge port **42** through the depressions **46** and passageways **50** past the checks **44**. Return flow from the discharge port **42**

is, of course, not permitted by these one-way checks. If closures 74 are fully seated against the valve seats 72 during the pressure stroke, full flow is discharged into outlet 42. The poppets open in during their suction stroke because of the difference in pressure between the piston chambers and the intake chamber. This permits an additional avenue by which oil can be sucked into the piston chamber.

In the event there is a pressure rise sensed in control passage 62, this pressure is reflected in the passageway system 60. This retards the closing of poppets 76 on their seats 72 during a portion of the discharge stroke. This permits a certain by-pass flow through orifice 70 into the intake chamber. The amount of time closure 74 is spaced from seat 72 will depend in part on the pressure drop caused by flow across the poppet seat and the level of this control pressure. It will also depend on the rate of spring decay when a spring is utilized.

During the suction strokes of the pistons, fluid not only enters the pumping chambers through apertures 40 but fluid is also drawn from the chamber network associated with chamber 64. In other words, the poppets are open (as shown in the upper by-pass of FIG. 1) during the suction phase of a stroke. The length of time the poppet remains open during the discharge stroke will depend in part on the pressure drop resulting from the rate of oil flow through the poppet seat and this is influenced on the level of control pressure on poppet pistons 78.

The instant invention takes advantage of the multi-flow advantages of the invention described in the Blair patent issued on June 21, 1960, as U.S. Pat. No. 2,941,475. In the Blair patent there is disclosed a means by which the plugs 23 are removed and isolating sleeves are inserted therein as shown in FIG. 2. Thus, if a desired number of isolating sleeves are inserted, any number of plurality of outputs is obtainable by way of exterior manifolds. In order to obtain the multi-flow advantages by using the Blair sleeves, additional threading at 91 is provided.

Referring again to FIG. 1, it is seen that passageway 60 communicates with two of the passageways 59. Thus, a pump having ten pistons and all the pistons collected in pairs in a like manner provides a total of five controlled outputs. However, those skilled in the art will appreciate that a "sensing" passageway 60 could be extended to each output and each output provided with an isolating sleeve. Therefore, a 10 piston pump can theoretically have 10 independently variable outputs or any combination of fixed and variable outputs. For a fixed output, passageway 58 can be plugged which eliminates all by-pass flow.

The schematic of FIG. 4 discloses a second output 94' leading to a second load having an independent sensing line 62' leading to a separate group of piston outputs. It is seen that a plurality of adjustable variable flows is obtained from a single pump by using the teachings of this invention.

As previously mentioned, the decay in springs 82 resulting from a certain detected control pressure will partially determine the time period fluid is by-passed (returned) to the intake chamber during a pumping stroke. This period is quite accurately determined by selecting the strength characteristics in spring 82, the size of the control orifice 61 between passageways 59 and 60, and the control pressure. A pressure reducing valve 92 can be interposed along the length of the sensing conduit as shown in FIGS. 3 and 4 such that field adjustments of control pressure are possible. The utilization of springs 82 have the effect of increasing volumetric efficiency and control.

The elements 14 and 16 can be termed a barrel assembly. The barrel assembly is divided into two components on either side of the plane 96 of FIG. 1. With this arrangement, an economy of manufacture is obtained by standardizing the components to the left of plane 96. The number and character of the flows obtainable from the pump can then be determined by selecting an end-plate 16 of the desired construction. For instance, although components 12 and 14 are standardized, a manufacturer can offer a pump having as many outputs as there are pumping pistons and can provide a variable flow to as many of these flows as desired by the manifolding design and poppet placement of end-plate 16. The embodiment of FIGS. 5–7 is especially able to accomplish the objective of a large number of independently variable outputs. In FIG. 5, the elements to the left of plane 96 are the same as in FIG. 1 except the outer strokes of pistons 38 are designed to terminate just prior to reaching the plane 96.

The pistons 38 each exhaust into bores 100 formed in the face 102 of an end-plate 104. The bores 100 communicate the piston outputs to an output passageway such as that shown by the numeral 110. Press-fitted into the bores 100 are sleeves 106 having perforations 108 intermediate their lengths leading to annular groove 109. Valve seats 112 are found at the ends of sleeves 106 which receive one-way check balls 114. The balls are biased against the valve seats by springs 116 which circumscribe locating pins 118.

In FIG. 5, the by-pass units are received in axial bores 120 rather than in radial bores as disclosed in FIGS. 1 and 1a. The bores 120 are communicated to the outputs of the pistons 38 through passageways 122. The by-pass units each include a sleeve 124 having perforations 125 leading to a peripheral groove 126 intermediate the sleeve length. A valve seat 127 is found at the inner end of the sleeve for reception of a ball valve 128. The ball valve 128 is spring-biased against the valve seat by a spring 130 that surrounds a positioning pin 132. Reciprocally received within the interior 134 of the sleeve 124 is a poppet piston 136. The piston has a stem 137 for unseating ball 128 and at its other end a surface 139 facing the control pressure. An orifice ring 140 is disposed between the surface 139 and the control pressure.

In order to obtain a desired number of independent outputs, the end-plate 104 is provided with a coverlet 158. If the entire pump output is varied by a single control pressure, the chambers 134 are communicated with the detected pressure passageway 62a by an annular groove 140. The pumping piston outputs are collected by output passageway 110 and delivered to the load via output 142.

When more than one output is desired, and these outputs are to be adjusted by different control pressures, a multiple coverlet assembly is used. For instance, if two independently variable outputs are desired, an intermediate coverlet 150 (FIG. 7) is provided. The intermediate cover on its side remote from the end-plate is annularly grooved at 152 and 154. These grooves are each respectively in communication with control pressure ports 156 and 158 formed in an outer coverlet 160. The particular set of piston outputs grouped for control by the control pressure sensed in port 156 have their by-pass sensing units communicated with groove 152 by bores 172 formed in coverlet 150. The other group of outputs have their by-pass sensing units communicated with the groove 154 by slant bores 176. If three variable outputs are required, a third independent groove is formed in the coverlet 150.

Presuming for a ten piston pump it is desired to have three outputs; namely, a first variable output of three pistons, a second variable output of two pistons and a fixed output of five pistons. In order to accomplish this, the end-plate is formed with a first manifold collecting three piston outputs each having a by-pass unit, a second manifold collecting two other piston outputs each having a by-pass unit, and a third manifold collecting the five remaining outputs.

As seen in the diagrammatic of FIG. 6, piston outputs A, B, C, D and E are joined by a pair of manifold passageways 170 and 172. The outer end of passageway 170 is plugged at 174 while the outer end of 172 leads to an outlet port 144. The by-pass passageways associated with outputs A—E, inclusive, are plugged since these five outputs are for fixed displacement. Piston outputs F and G are joined by a separate manifold passageway 176 which leads to outlet port 178 while piston outputs H, I and J are communicated by a manifold passageway 180 leading to an outlet 182. As seen in FIG. 7, the by-pass units associated with grouping F and G are conveniently communicated with the control pressure 156 and

the grouping H—I—J are conveniently communicated with the control pressure **158**.

In actual practice, improved efficiency is gained by not connecting adjacent outputs to the same outlet. The actual borings in the embodiment of FIGS. **5—7** can be located at various places. Here, adjacent manifold bores are grouped for purposes of clarity, but those skilled in the art will recognize that the location of actual borings can depend on several manufacturing considerations such as spacing and the strength of material. Normally, it is best to have several pistons of a particular group traversing their exhaust strokes while others of the same group are traversing their power strokes. It should be noted, however, that the provision of a coverlet system for communicating the by-pass sensors to their control pressures is equally efficient as a fluid collection device regardless of which piston outputs are grouped together. In the coverlet system, a concentric collection groove is formed for each variable output group and bores are drilled to communicate these grooves to their respective by-pass sensors.

In a general manner, while there has been disclosed effective and efficient embodiments of the invention, it should be well understood that the invention is not limited to such embodiments, as there might be changes made in the arrangement, disposition, and form of the parts without departing from the principle of the present invention as comprehended within the scope of the accompanying claims.

I claim:

1. A hydraulic pump of a type having a housing and having an inlet end and an outlet end, a barrel within said housing having a central, longitudinally extending axis, a plurality of cylinders within said barrel forming pumping chambers, said chambers being annularly arranged with the longitudinal axes thereof being parallel to and equally spaced from the axis of said barrel, a piston reciprocably received in each of said chambers, rotatable cam means axially spaced from said barrel and engaging and reciprocating said pistons in suction and discharge strokes, a fluid reservoir, each of said pumping chambers having an outlet passageway through which fluid is dischargeable through the outlet end of the housing during a pressure stroke, a second passageway for each chamber having a first end terminating intermediate said outlet passageway and a second end terminating at said reservoir through which fluid in said reservoir flows in a first direction to the outlet passageway during a suction stroke of said pistons and through which fluid in said outlet passageway can return to said reservoir in a second direction during the pressure stroke of said pistons, means for each of said chambers for obtaining a variable output from said chambers by varying the amount of fluid returned to said reservoir during the pressure strokes of said pistons, said means comprising a third passageway having a first end leading to a control pressure and a second end communicating with said second passageway intermediate the length thereof, controller means disposed in said third passageway between said control pressure and said second passageway and moveable responsive to said control pressure, closure means in said second passageway operably connected to said controller means for opening and closing said second passageway between said outlet passageway and said reservoir, removable plate means over the output end of said housing containing first and second manifold means, said first manifold means combining the outputs of selected pumping chambers into plural groups and communicating said groups respectively with separate outlets leading to separate loads, said second manifold means directing separate control pressures respectively to the third passageways of said groups of selected pumping chambers.

2. The hydraulic pump of claim **1** wherein said removable plate means comprises first and second plates removably attached to each other and containing said first and second manifold means respectively.

3. The hydraulic pump of claim **1** wherein said controller means is a piston slidably received in said third passageway and said second passageway is formed with a seat for receiving said closure means.

4. The hydraulic pump of claim **3** wherein a stem means connects said closure means to said piston.

5. The hydraulic pump of claim **4** and including spring means biasing said closure means to the closed position.

* * * * *