

June 10, 1952

W. R. EAMES
PUMPING SYSTEM

2,599,701

Filed Oct. 25, 1945

4 Sheets-Sheet 1

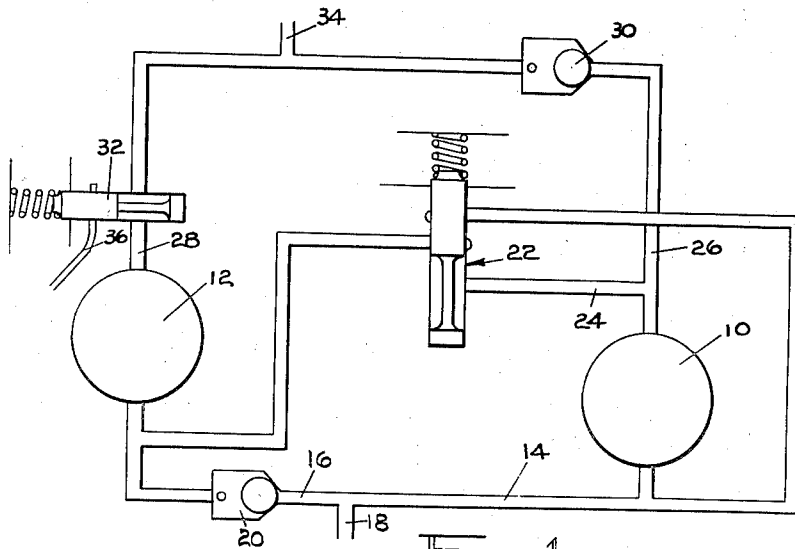


Fig 1

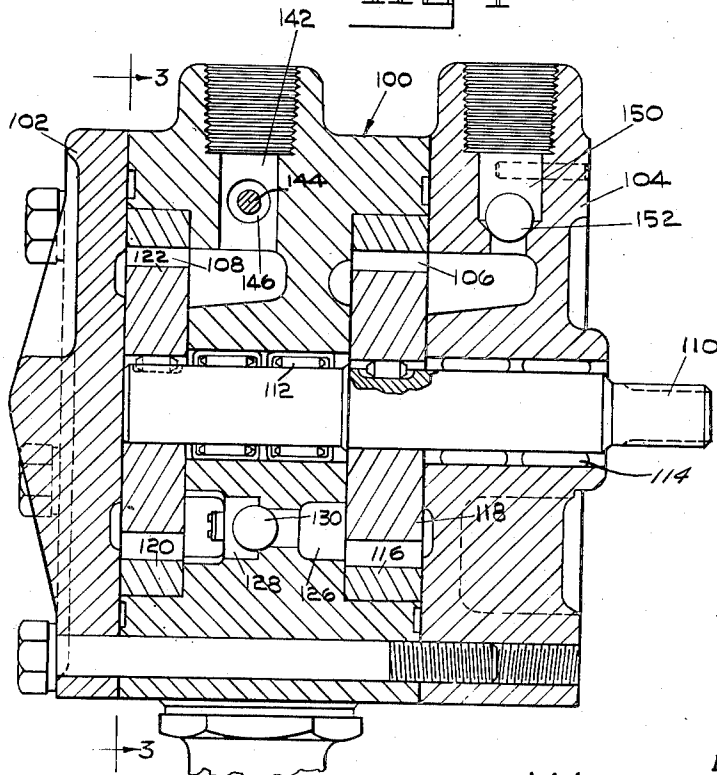


Fig 2

INVENTOR.
WALTER R. EAMES
BY
McDonald and Teagno
ATTORNEYS

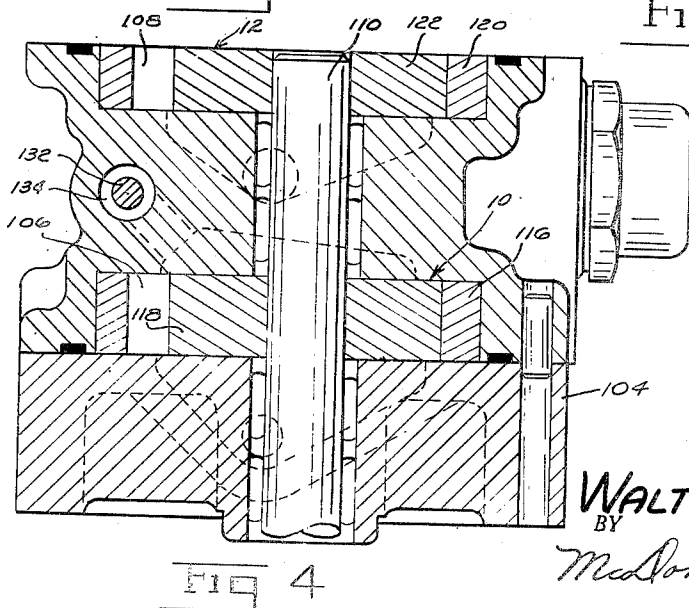
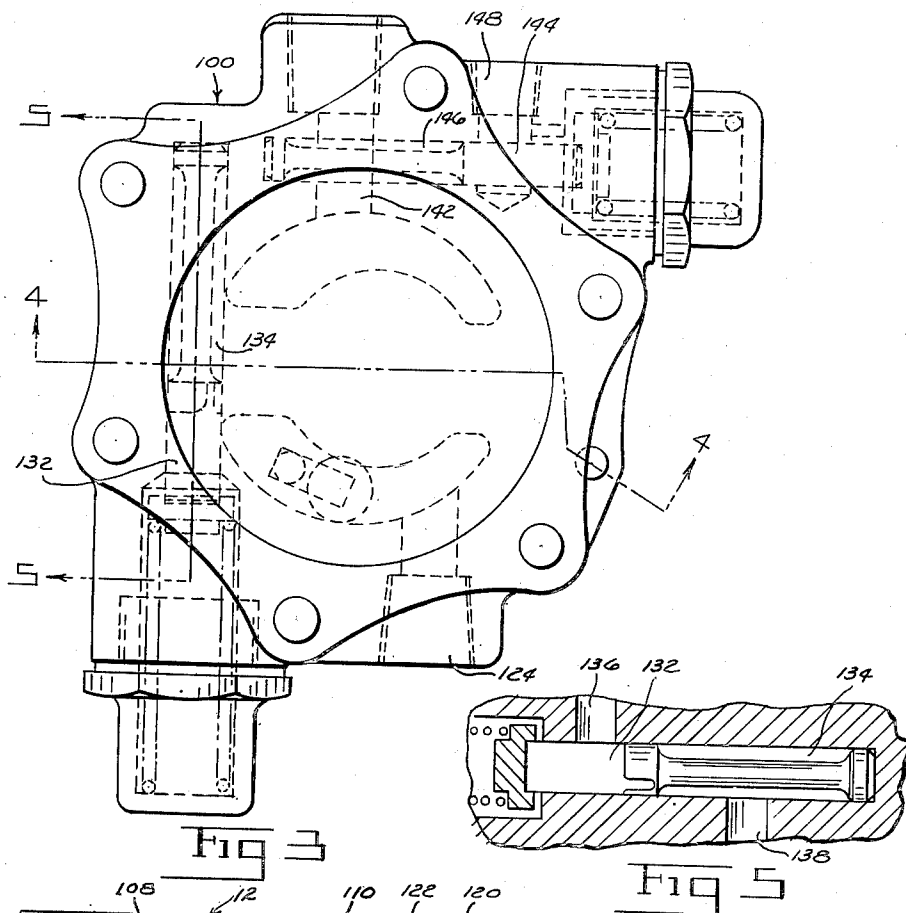
June 10, 1952

W. R. EAMES
PUMPING SYSTEM

2,599,701

Filed Oct. 25, 1945

4 Sheets-Sheet 2



INVENTOR.
WALTER R. EAMES
BY
McDonald and Tigno
ATTORNEYS

June 10, 1952

W. R. EAMES
PUMPING SYSTEM

2,599,701

Filed Oct. 25, 1945

4 Sheets-Sheet 3

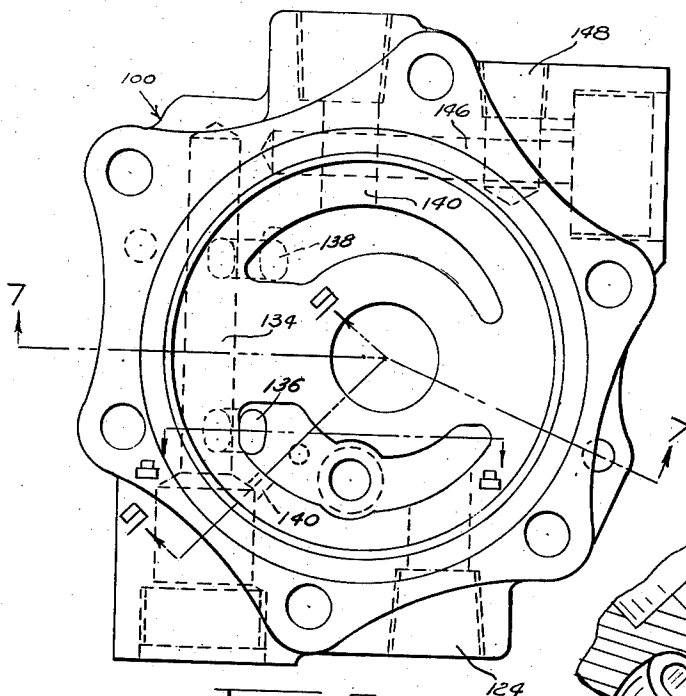


Fig 6

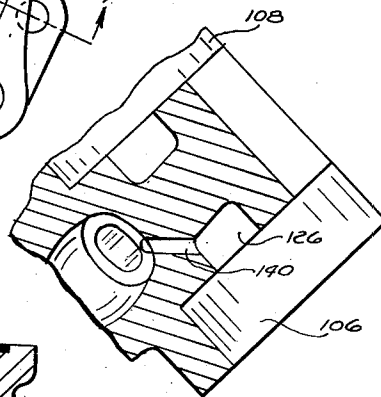


Fig 9

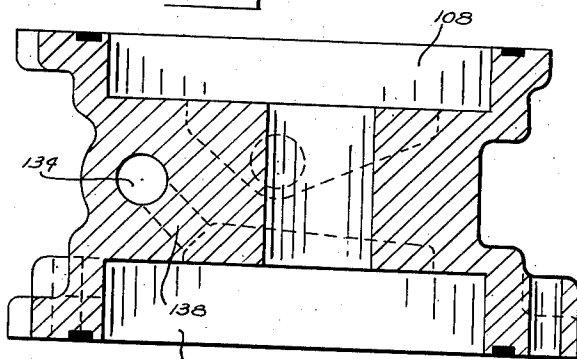


Fig 7

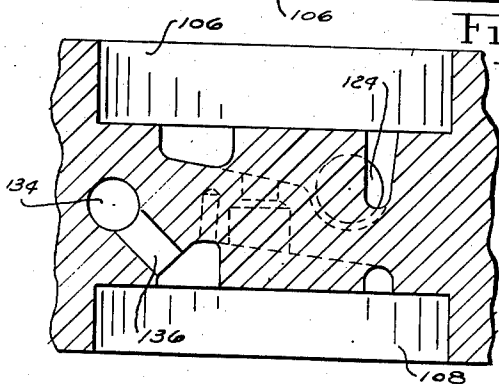


Fig 8

INVENTOR.
WALTER R. EAMES
BY
McDonald and Teague
ATTORNEYS

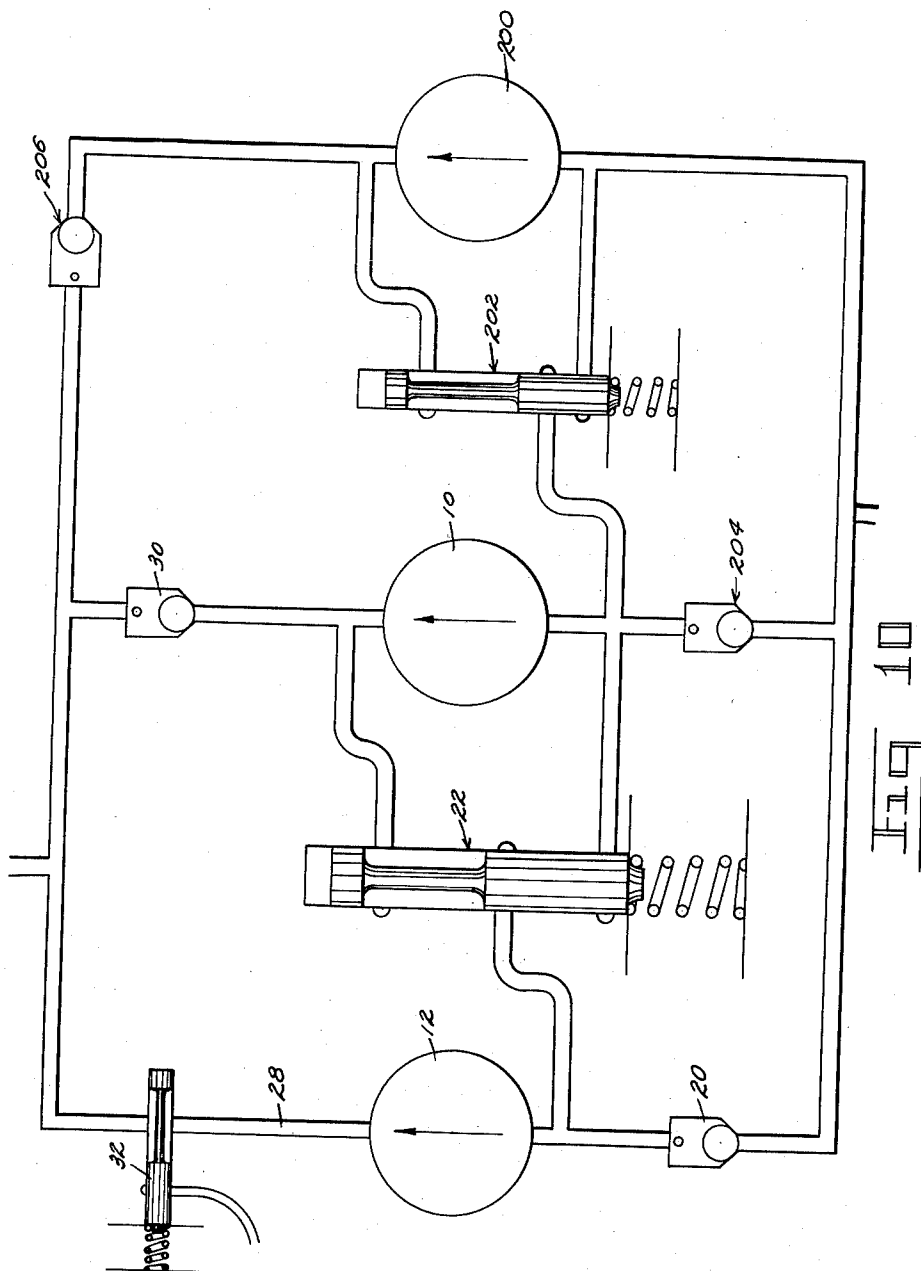
June 10, 1952

W. R. EAMES
PUMPING SYSTEM

2,599,701

Filed Oct. 25, 1945

4 Sheets-Sheet 4



INVENTOR.
WALTER R. EAMES
BY
McDonald and Teague
ATTORNEYS

UNITED STATES PATENT OFFICE

2,599,701

PUMPING SYSTEM

Walter R. Eames, Warren Township, Macomb County, Mich., assignor to Eaton Manufacturing Company, Cleveland, Ohio, a corporation of Ohio

Application October 25, 1945, Serial No. 624,471

8 Claims. (Cl. 103—11)

1

This invention relates to pumping systems and more particularly to multiple stage compound pumping systems.

Broadly the invention comprehends a pumping system embodying a multiple pump arranged in circuit having suitable valve control means therefor adaptable to provide for multiple stage pressure operation of the pumping system.

An object of the invention is the provision of a simple, efficient multiple stage pumping system.

Another object of the invention is the provision of a pumping circuit embodying a plurality of pumps and appropriate controls therefor to provide for varying stages of pressure compounding.

Another object of the invention is the provision of a pumping system adapted to pump at high capacity-low pressure during one phase of operation and low capacity-high pressure during another phase of operation.

Another object of the invention is the provision of a two-stage compound pumping system operable initially in parallel at high capacity-low pressure and after a predetermined pressure attainment operable at series in low capacity-high pressure.

A further object of the invention is the provision of a two-stage compound pumping circuit embodying a pair of different capacity pumps suitably controlled by automatic pressure responsive valves so as to be operable initially in parallel at high capacity-low pressure and subsequently upon attainment of a predetermined pressure in series at low capacity-high pressure.

Other objects and advantages of the invention will appear from the following description taken in connection with the drawings, forming a part of the specification; and in which:

Fig. 1 is a schematic diagram of the pumping circuit;

Fig. 2 is a vertical, cross-sectional view of a two-stage pumping system embodying the invention.

Fig. 3 is a vertical view taken along line 3—3 of Fig. 2;

Fig. 4 is a cross sectional view taken along line 4—4 of Fig. 3;

Fig. 5 is a cross sectional view taken along line 5—5 of Fig. 3;

Fig. 6 is a sectional view similar to Fig. 3 but in less detail;

Fig. 7 is a cross sectional view taken along line 7—7 of Fig. 6;

Fig. 8 is a fragmentary sectional view taken along line 8—8 of Fig. 6;

2

Fig. 9 is a fragmentary cross sectional view taken along line 9—9 of Fig. 6; and

Fig. 10 is a schematic diagram of the modified form of the pumping circuit shown by Fig. 1.

The instant invention is directed at a multiple stage compound pumping circuit wherein pressures developed are beyond the range of a single stage pumping circuit such that the use of several stages cuts the effective loads of one pump while at the same time providing for increased pump life. Circuits of this type are adaptable for use where initial capacity is of utmost importance and secondly high pressure such as in the case of automatic transmissions to provide holding pressure for the clutches employed therein. When shifting from one set of clutches to another it is desirable to have the particular clutch system selected filled rapidly so as to effect quick engagement and thence to be engaged at high pressure as the pumping system advances from its initial high capacity-low pressure stage to subsequent lower capacity-higher pressure stages.

The circuit herein specifically devised comprises a pair of rotor type pumps of slightly different capacities arranged in circuit with appropriate check and relief valves for automatically controlling the compound parallel and series operation of the pumps as they pass through the initial high capacity-low pressure stage to the low capacity-high pressure stage.

Referring to the drawings for more specific details of the invention, Fig. 1 represents a diagrammatic showing of a pump circuit herein devised wherein 10 and 12 represent respectively a pair of rotor pumps, 10 operating as the first stage pump and 12 the second stage pump of a two-stage compound pumping circuit. Intake lines 14 and 16 connected respectively to pumps 10 and 12 communicate with a reservoir, not shown, by way of inlet line 18 with a one-way check valve 20 interposed in the intake line 16 of the second stage pump. A relief and control valve 22 interposed intermediate to the discharge line 24 of the pump 10 and intake to the pump 12, said valve 22 also controlling communication between the fluid intake and discharge of pump 10. The pumps 10 and 12 have respectively in their direct discharge line 26 and 28 a one-way check valve 30 for pump 10 and pressure relief valve 32 for pump 12. The discharge lines 26 and 28 communicate beyond the valves 30 and 32 with a fluid line 34 adapted to be associated with the mechanism to be operated by the pump action. A relief port 36 is associated with the

relief valve 32 providing the return of pressure fluid to the reservoir upon cracking of valve 32.

With reference to Figs. 2 through 9 of the drawings, illustration is made of the specific embodiment of the aforementioned pumping circuit in a simple, compact arrangement of pumps and controls therefor in a single housing.

A housing 100 having suitable end plates 102 and 104 suitably secured on opposite ends thereof is provided with appropriate chambers 106 and 108 for the receipt and support of pumps 10 and 12 driven by a single shaft 110 suitably journaled in the housing 100 on bearings 112 and in the end plate 104 on bearings 114. The pumps 10 and 12 are of the type including respectively a pair of toothed rotors 116 and 118, and 120 and 122, one within and eccentric to the other and having a least one less tooth division than the other, the teeth having diagrammatic opposed full mesh and open mesh positions and preferably remaining in substantially contacting relationship with respect to each other between such positions. The rotors 116 and 122 are keyed to the shaft 110 and are driven thereby, said rotors driving their mating rotors through the inter-engagement of their respective teeth, and as the teeth move away from the full mesh position in the direction of rotation, they open between them pumping chambers which continue to increase in volume to open mesh position and which chambers decrease in volume from open mesh position to full mesh position in the direction of rotation. The first stage pump 10 is as shown made of slightly greater capacity than second stage pump 12.

The type of pumps here employed is not to be taken as any limitation of the invention but merely as an example of compact efficient pumps suitable for a pumping circuit of this nature.

The pump housing 100 is provided with inlet passage 124 (18, Fig. 1) which communicates respectively with chambers 106 and 108 by way of passages 126 and 128 (14 and 16, Fig. 1), said passage 128 being controlled by a one-way check valve 130 (20, Fig. 1) secured upon housing 100. A spring pressed control and relief valve 132 (22, Fig. 1) mounted for reciprocation in a bore 134 in the housing controls communication between a passage 136 on the inlet side of pump 12 and passage 138 (24, Fig. 1) connected to the discharge side of pump 10, said valve 132 also adapted to control passage 140 providing communication between the inlet and discharge passages of pump 10 by way of bore 134.

The pump 12 is provided with an outlet passage 142 (28, Fig. 1) communicating with a spring pressed relief by-pass valve 144 (32, Fig. 1) reciprocable in a bore 146 in housing 100 controlling the outlet pressure of pump 12 by way of pressure relief port 148 adapted to be connected with the reservoir for the pumping circuit. The pump 10 discharges through a passage 150 (26, Fig. 1) in the end plate 104 controlled as by a one-way check valve 152 (30, Fig. 1) interposed in the passage. The discharge passages 142 and 150 of the respective pumps 10 and 12 are adapted to be suitably connected at a point adjacent to or remote from the pump housing such as shown by fluid line 34 of Fig. 1 depending on the design requirements.

Fig. 10 illustrates a modified form of pump circuit shown by Fig. 1 wherein the difference resides in the addition of a pump 200, relief and control valve 202, and check valves 204 and 206. By the addition hereof another pump stage of

operation is provided and accordingly the stages of operation of circuits of this type are solely to be limited by the number of pumps provided. Inasmuch as the operation of this system follows the teachings of the pump circuit shown by Fig. 1 and hereinbefore described it is not deemed necessary that the precise operation hereof be recited other than to indicate that a proper selection of pump capacities and valve pressures is vitally important to the successful operation of the system.

For the purpose of illustrating a typical pumping circuit utilizing the instant scheme of two-stage compound pumping, the following pump capacities and control valve operating pressures are used, the first stage pump 10—5 gallons, second stage pump 12—4 gallons, control and relief valve 132 acting as a control valve to provide communication between the inlet side of pump 12 and outlet or discharge port of pump 10 at 150 #/sq. in. of pump 10 and as a relief valve at 250 #/sq. in. discharge pressure of pump 10 to provide communication between the discharge and intake of pump 10 so as to limit the maximum operating pressure of pump 10 to 250 #/sq. in., and relief valve 144 is set at 500 #/sq. in. to so control the combined discharge pressure of the pumps 10 and 12 by way of passage 142 when operating in series after the attainment of the maximum allowable operating pressure of pump 10 as controlled by valve 132.

With the aforesaid pump capacities and valve control pressures, in a normal operation of the pumping circuit upon rotation of the shaft 26 and consequent operation of the pumps 10 and 12, fluid is drawn from the reservoir of the pump circuit into the pumps providing for the development of pump pressure and discharge thereof from the respective pumps 10 and 12. In the initial stages of pressure development fluid under pressure is delivered to the pump circuit discharge passages 142 and 150 for supply to the mechanism to be operated thereby. This is the parallel stage of operation of the pumps wherein a large volume of fluid is delivered at a low pressure as a combined pumping action of both pumps by way of fluid delivery line or conduit 34 shown by Fig. 1. The complete parallel operation of the pumps continues until such time as the pressure developed by pump 10 attains 150 #/sq. in. wherein valve 132 is actuated to a point to permit of fluid pressure flow from pump 10 to and through the pump 12 to thus provide for the initial stage of compounding pressure to be discharged by pump 12. A transient stage of operation of the pumps between parallel and series will exist between 150 # to 250 #/sq. in. During this phase of operation, one-way check valve 130 is moved to close off the inlet of the pump 12 from the reservoir, whereas one-way check valve 152 is moved to closed position by the pressure discharged from pump 12 as opposed to the pressure of pump 10.

As the pressure in pump 10 increases and feeds to pump 12, valve 132 is further moved in bore 134 until such time as the discharge pressure of pump 10 reaches 250 #/sq. in. wherein the valve uncovers the passage 140 so as to provide communication between the intake and discharge sides of the pump 10 and thus limit the development of pressure on the fluid in pump 10 to 250 #/sq. in. With the control and relief valve 132 actuated to its limit at 250 #/sq. in. operating pressure of pump 10 and check valves 130 and 152 seated, the pressure developed by pump 10 is applied to pump

5

12 in the complete series operation of the pumps and the discharge of fluid under pressure is delivered from pump 12 of outlet 142 to the mechanism to be actuated thereby. As a means of controlling the maximum pressure at which the compound pumping circuit is desired to be operated, relief valve 144 is set to crack at 500 #/sq. in. to thus provide for relief of pressure fluid from the system through pressure relief port 148 which although not shown as such, is preferably adapted to be communicated back to the reservoir of the pumping circuit. After utilization of the pressure is developed for its intended purpose, the recession of pressure in the system causes the actuation or return of the valves to their normal positions and thus provides the reversal of operation of the pumping circuit, that is, from series pump operation at high pressure-low volume to low pressure-high volume. This completes a cycle of operation of the pumping circuit.

The pump capacities or control valve pressures hereinbefore recited are not to be taken as limitations upon the pumping circuit herein devised or its nature of operation except to the extent that it presents a practical arrangement that can be employed.

While this invention has been described in connection with certain specific embodiments, the principle involved is susceptible of numerous other applications that will readily occur to persons skilled in the art. The invention, therefore, is limited only as indicated by the scope of the appended claims.

What I claim is:

1. In a compound pump circuit, a pair of pumps and a combination pressure staging control and relief valve interposed between the outlet of one pump and the inlet of the other pump and the outlet and inlet of the pump whose pressure it controls, one of said pumps having a one-way check valve in its intake and said other pump having a one-way check valve in its discharge line said pressure staging and relief valve being subject to the pressure output of the pump having a one-way check valve in its discharge line.

2. In a compound pump circuit, a pair of interconnected, unlike capacity pumps, a combination pressure staging control and relief valve in the interconnection between the outlet of one pump and the inlet of the other pump and the outlet and inlet of the pump whose pressure it controls, fluid supply means for the pumps, a check valve in the intake side of one of the pumps, a check valve in the discharge of the other pump, and a pressure relief valve in the discharge of the pump having the check valve in its intake said pressure staging and relief valve being subject to the pressure output of the pump having a one-way check valve in its discharge line.

3. In a compound pump circuit, a pair of interconnected, unlike capacity pumps, a combination pressure control and relief valve in the interconnection between the outlet of one pump and the inlet of the other pump and the outlet and inlet of the pump whose pressure it controls for controlling the pressure at which the pumps change from a parallel to series operation and for limiting the maximum output pressure of the larger capacity pump, operable under the influence of pressure fluid discharged from the larger capacity pump, fluid supply means for the pumps, a check valve in the intake side of the smaller capacity pumps, a check valve in the discharge of the other pump, and a pressure relief valve in the discharge of the smaller capacity pump, said control and

6

relief valve controlling the output capacity of the larger capacity pump and also the communication between the discharge and intake thereof.

4. A compound pump circuit, a pair of interconnected unlike capacity pumps driven from the same shaft, valve means interposed in the communication between the outlet of the larger capacity pump and the inlet of the lesser capacity pump and the inlet and outlet of the larger capacity pump for respectively controlling the pressure at which the pumps are to change from parallel to series operation and for limiting the output pressure of the larger capacity pump in the series operation thereof operable under the influence of pressure fluid discharged from the larger capacity pump, and check valve means in the discharge and inlet of the respective second and first pumps for assisting in the control of the pump circuit during the parallel and series operation thereof.

5. A compound pumping circuit comprising a plurality of unlike capacity pumps having intercommunication with one another between the outlets of the larger capacity pumps and the inlets of the adjacent lesser capacity pumps normally arranged for initial parallel pump operation and combination pressure relief and control staging valves in the discharge of all of the pumps but the pump with the least capacity operable under the influence of pressure fluid from the pump in whose discharge it is located for controlling the pressure at which each pump will operate in series with the pump of next lesser capacity, said valves being also arranged in a conduit communication between the inlet and outlet ports of all the pumps but the pump of least capacity for limiting the maximum output pressure of its associated pump.

6. A compound pumping circuit comprising two unlike capacity pumps communicating with one another, valve means interposed between the outlet of the larger capacity pump and the inlet of the lesser capacity pump and between the outlet and inlet ports of the larger capacity pumps for controlling either the parallel or series operation of the pumps, said valve means being pressure actuated to initially control the parallel operation of the pumps intermediate the series operation of the pumps and finally to control the maximum output pressure of the larger pump, said valve means being operable under the influence of the pressure fluid being delivered from the first stage pump of the series stage of operation, a check valve in the discharge from the larger capacity pump, and a check valve in the intake to the smaller capacity pump for assisting in the control of the pumping circuit during the operations of the pump through both stages of parallel and series operation.

7. A multiple pump unit comprising a unitary body having a plurality of unlike capacity pumps mounted thereon and having interconnected passages between their respective intake and discharge and between the discharge of the larger capacity pump and intake of the smaller capacity pump, a drive shaft journaled in the body common to both pumps, a pressure responsive valve controlling communication between the discharge of the larger capacity pump and intake of the smaller capacity pump and communication between the discharge and intake of the larger capacity pump, said valve operable upon a predetermined pressure discharge from the larger capacity pump to change the pumps from a series

7

to parallel stage of operation and further operable at a higher predetermined pressure to limit the maximum output pressure of the larger capacity pump, a one way check valve in the discharge from the larger capacity pump, a one way check valve in the intake to the smaller capacity pump, and a pressure responsive valve for controlling communication between the discharge and intake of the smaller capacity pump, said latter pressure responsive valve operable upon predetermined pressure discharge of the smaller capacity pump to limit the maximum output pressure thereof.

8. A compound pumping circuit comprising a plurality of unlike capacity pumps having interconnected passages between their respective intake and discharge and between the discharge of the larger capacity pump and the smaller capacity pump, means for driving the pumps simultaneously, a pressure responsive valve controlling communication between the discharge of the larger capacity pump and the intake of the smaller capacity pump and communication between the discharge and intake of the larger capacity pump, said valve operable upon a predetermined pressure discharge from the larger capacity pump to change the pump from a series to parallel stage of operation and further operable at a higher

8

predetermined pressure to limit the maximum output pressure of the larger capacity pump, a one way check valve in the discharge from the larger capacity pump, a one way check valve in the intake to the smaller capacity pump and a pressure responsive valve for controlling communication between the discharge and intake of the smaller capacity pump, said latter pressure responsive valve operable upon predetermined pressure discharge of the smaller capacity pump to limit the maximum output pressure thereof.

WALTER R. EAMES.

REFERENCES CITED

15. The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
1,477,850	Pool	Dec. 18, 1923
1,825,661	Gull	Oct. 6, 1931
2,132,130	Sallot	Oct. 4, 1938
2,218,565	Vickers	Oct. 22, 1940
2,255,560	Fieber et al.	Sept. 9, 1941
2,280,392	Herman et al.	Apr. 21, 1942
2,366,388	Crosby	Jan. 2, 1945
2,377,556	Jeannin	June 5, 1945