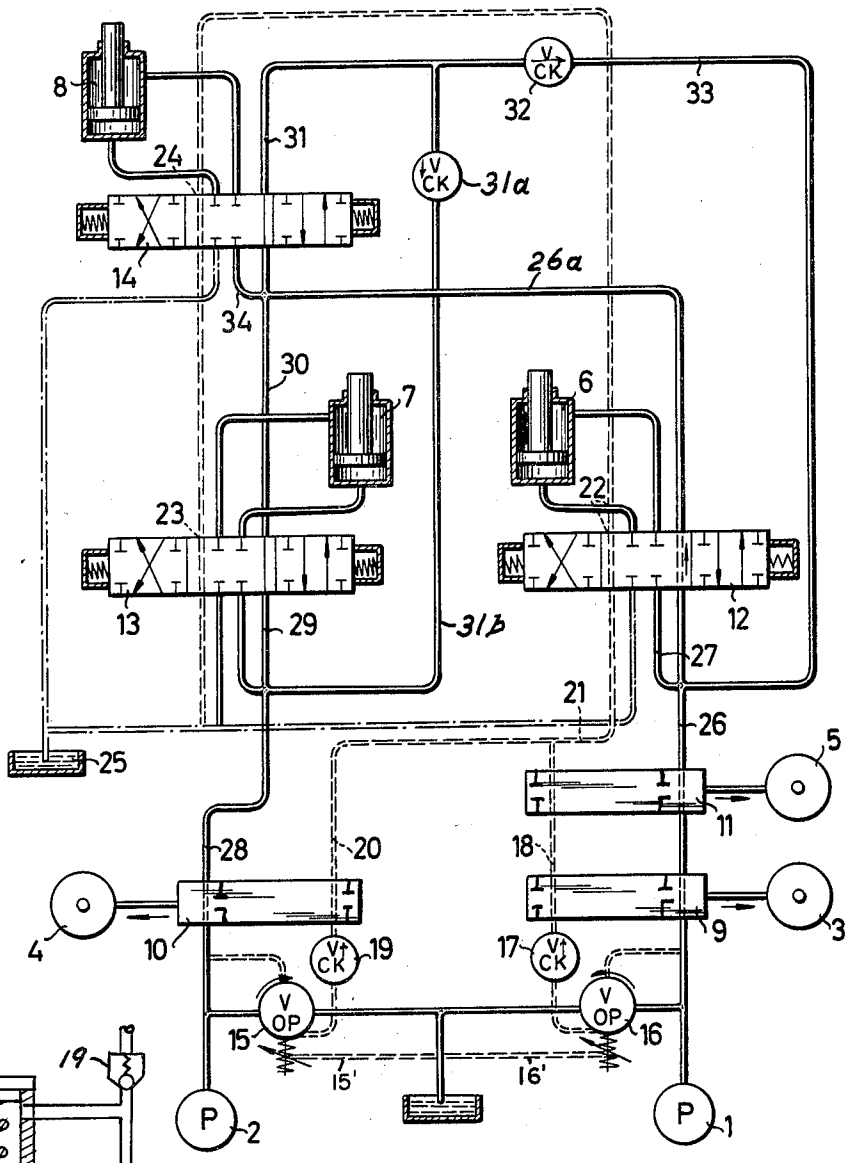
Nov. 18, 1969 J. GERBER ET AL 3,478,647

CIRCUIT FOR HYDRAULICALLY OPERABLE DEVICES, ESPECIALLY HYDRAULIC DREDGES

Filed March 11, 1968 3 Sheets-Sheet 1

FIG. 1



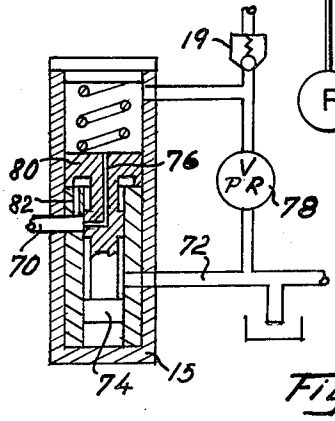


Fig. 4.

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FIG. 2

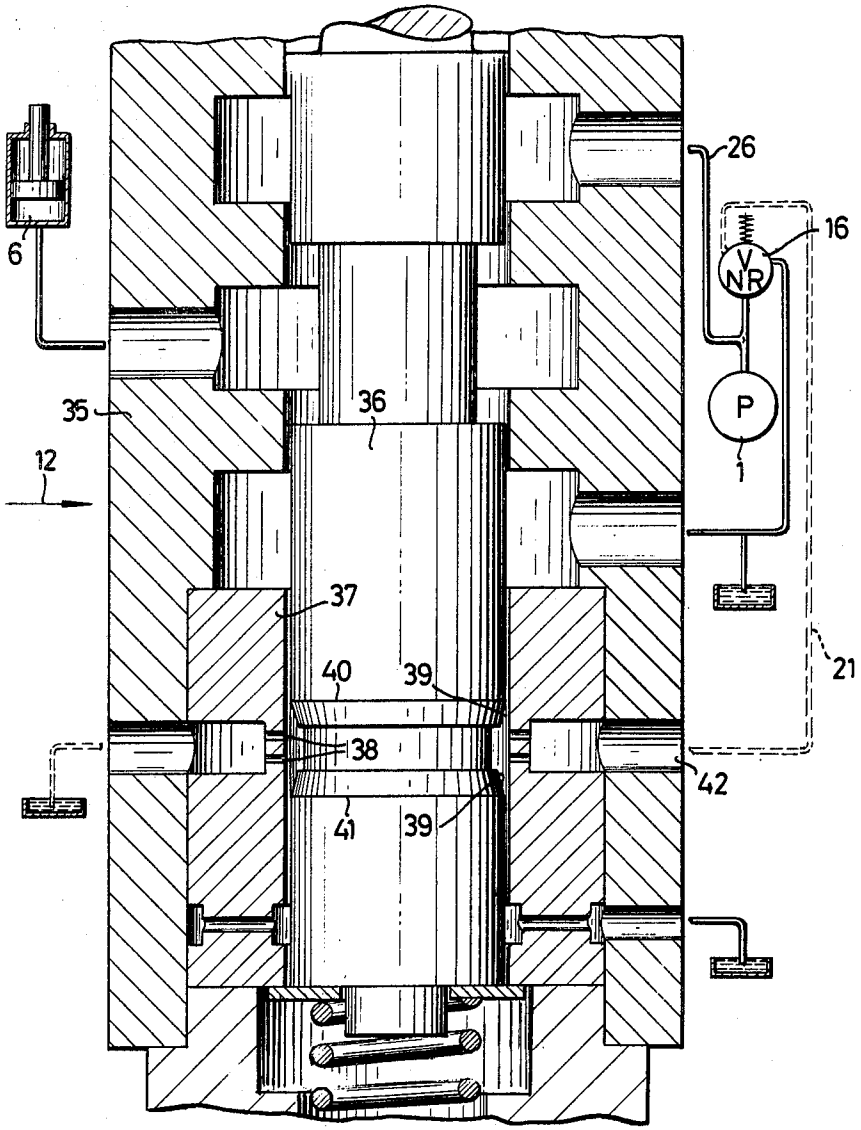

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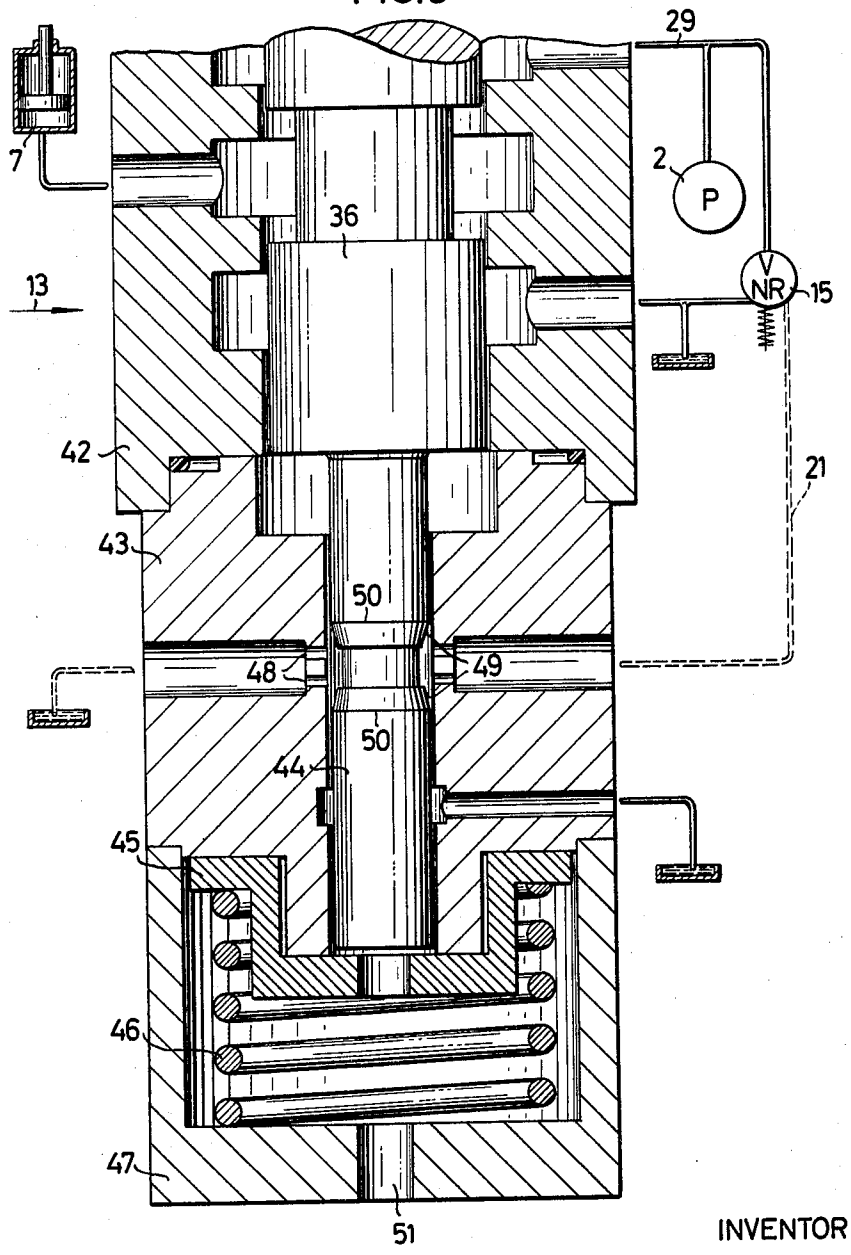
FIG.3



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CIRCUIT FOR HYDRAULICALLY OPERABLE DEVICES, ESPECIALLY HYDRAULIC DREDGES

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U.S. Cl. 91—411 9 Claims

ABSTRACT OF THE DISCLOSURE

Hydraulic circuit for implements such as a dredge in which a pair of pumps supply a plurality of motors via a control valve for each motor with a bypass channel leading from said pumps to exhaust via said valves and which bypass channel is interrupted when any valve is shifted from its neutral position. A second channel leads from each pump to the inlet of some of the control valves and is interrupted upon shifting of any of the control valves and on the downstream side of the shifted control valve.

The present invention relates to a control circuit for hydraulically operable devices, especially a hydraulic dredge, steam shovel, excavator, or the like, with at least two hydraulic pumps which are adapted simultaneously and selectively to operate the driving and swinging mechanism or at least two of a minimum of three working devices on the dredge, or the like as, for instance, the pump, the dipper arm and the bucket, while the pressureless circulation of both pumps is respectively passed through precontrolled pressure limiting valve whereas the control oil is passed through other valves. For each double-acting consumer, two 4-way valves are required. These 4-way valves have to be actuated individually in conformity with the desired oil supply to the individual consumers. Such an arrangement requires a considerable number of servicing elements.

It is, therefore, an object of the present invention to provide a control circuit for hydraulically operable devices, which will overcome the above-mentioned drawback.

It is another object of this invention to provide a simple control circuit requiring only a few actuating elements, in which for purposes of obtaining high working speeds when actuating one cylinder only, the said cylinder will receive the delivery of both pumps whereas when actuating an additional cylinder, each cylinder will automatically receive the delivery of one pump only while the control of the oil motors for the driving and swinging mechanism, in a manner known per se, will be effected independently of each other from one associated pump only.

These and other objects and advantages of the invention will appear more clearly from the following specification in connection with the accompanying drawing, in which:

FIGURE 1 represents a control circuit according to the present invention;

FIGURE 2 is a partial longitudinal section through a control valve with the particular guiding means for the control oil according to the present invention; and

FIGURE 3 is a partial section through a control valve preceded by an auxiliary control valve.

The problem underlying the present invention has been solved in conformity with the present invention by an arrangement according to which the control conduits which control the pressureless circulation of the pumps (**1**, **2**) and are provided with check valves are after the passage through the precontrolled pressure limiting valves combined with the control valves associated with the driving

mechanisms and the swinging mechanisms so as to form a common control conduit which latter after passing through the control valves which are associated with the working devices will in idling condition of the circuit return the control oil to an oil reservoir whereas when actuating one control valve or a plurality of control valves the delivery to the oil reservoir will be blocked.

Advantageously, according to a further development of the present invention, the control of the control oil is effected through the intervention of an auxiliary piston which is displaceably arranged in a control bushing which axially precedes the control housing of the control valve and simultaneously serves as housing. The advantage of this arrangement consists in that ordinary mass produced 6-way valves can be employed instead of expensive special valves so that it is also possible to equip already produced devices of the type involved with the circuit according to the present invention.

Referring now to the drawings in detail, the pumps **1** and **2** produce the pressure oil for actuating the right and left driving mechanisms **3**, **4** when the dredge is equipped with a track-laying drive. The pumps **1** and **2** furthermore produce the pressure oil for actuating the swinging mechanism **5** and the cylinders **6**, **7** and **8** for respectively actuating the boom, the dipper arm and the digging vessel or bucket of the dredge. The two driving mechanisms **3** and **4** and the swinging mechanism **5** receive the pressure oil through control valves **9**, **10** and **11**. The cylinders **6**, **7** and **8** receive the pressure oil for actuating the same through associated control valves **12**, **13** and **14**. Pump **1** has associated therewith a relief valve **16** from where the control oil, in case no consumers are to be actuated, passes through the check valve **17**, the valves **9** and **11**, and the control conduit **18** whereas the control oil from the relief valve **15** passes through the check valve **19**, control valve **10** and control conduit **20**. The two control conduits **18** and **20** unite so as to form the control conduit **21**. As long as the control valves **12**, **13** and **14** occupy their neutral position, the control oil will in a pressureless condition pass to the oil reservoir **25** through the passages **22**, **23** and **24** in said control valves **12**, **13** and **14**, respectively. The relief valves **15** and **16** each have a leakage return oil line or conduit **15'** and **16'**, respectively, associated therewith as represented by dotted lines in FIG. 1.

The combination or separation of the delivery of the said two pumps **1** and **2** for actuating either one or more of the three working cylinders **6**, **7** and **8** is effected in the following manner: When, for instance, the control valve **12** for the working cylinder **6**, or more specifically, the valve spool of control valve **12** is from its neutral position moved toward the right or the left, the two control conduits **18** and **20** which have been united to the control conduit **21** are blocked. As a result, the circulation of both pumps **1** and **2** is blocked by the relief valves **15** and **16**, and the delivery of the pump **1** passes through conduits **26** and **27** to the working cylinder **6**, whereas the delivery of the pump **2** passes through conduits **28**, **29**, **30**, **31**, the check valve **32** and the conduits **33** and **27** to the working cylinder **6**.

When now, for instance, the control valve **14** is additionally actuated by moving the same from its neutral position toward the right or toward the left, the passage of the oil under pressure delivered by the pump **2** from conduit **30** to conduit **31** is interrupted so that the delivery of pump **2** now passes through conduit **34** to the working cylinder **8**. This combination possibility also applies to the flow between control valves **13** and **14** and the flow between control valves **12** and **13**. In order to prevent a mutual pressure influence of the relief valves **15** and **16**, check valves **17** and **19** are respectively arranged in the control conduits **18** and **20**.

FIG. 2 shows in greater detail the passages in a control

valve, for instance the control valve **12**. As will be seen from FIG. 2, the valve spool **36** is reciprocable in the control valve housing **35**. The housing **35** has pressed thereinto a bushing **37** which comprises one or more nozzle bores **38**. When the valve spool **36** is actuated, in any convenient manner, for instance, hydraulically or mechanically, the nozzle bores **38** are first throttled by the inclined surfaces **39** and are subsequently shut off by control edge **40** or **41**, respectively. As a result, the control oil flow which enters the control valve **12** through bore **42** can be throttled in a fine sensitive manner in order to be able in the precontrolled relief valves **15** and **16** to effect the division of the delivered oil flow in conformity with the requirements for the fine control of the consumer.

According to another embodiment of the invention illustrated in FIG. 3, the control housing, for instance, of the control valve **13** has screwed thereonto an intermediate housing **43** in which an auxiliary valve spool **44** is displaceable mounted. Valve spool **44** rests by means of a spring dish **45** and spring **46** against the cover **47**. The nozzle bores **48**, the inclined surfaces **49**, and the edges **50** have the same function as that of the respective members **38**, **39** and **40** described above in connection with FIG. 2. The actuation of the main valve spool **36** in one direction is in the particular embodiment illustrated in the drawing effected by hydraulic control through the connection **51**.

As will be evident from the above, the arrangement according to the present invention affords the possibility, without resorting to electrical or mechanical coupling members, in a purely hydraulic manner to combine any desired number of pump circuits of a corresponding number of consumers in any desired manner. In this way, for instance, when employing three-pump circuits, two out of four consumers will obtain the oil of all pumps if only one of said pump circuits is actuated, whereas a third consumer may be delivered only with the oil from two pumps anl the oil of the third pump will be available to the fourth or other consumers.

Referring further to the operation of the hydraulic system shown, adjustment of valve **10** to cause a supply of fluid to the right-hand driving mechanism **4** will interrupt the connection of pump **2** to conduit **28** and will also interrupt the connection of check valve **19** with conduit **20**. Pump **2** will thus deliver fluid solely to driving mechanism **4** only. Pump **1**, at this time may continue to bypass to tank **25** via check valve **17** and conduits **18** and **21**.

Similarly, shifting of valve **9** will cause pump **1** to deliver solely to left-hand driving mechanism **3**, or shifting of valve **11** will cause pump **1** to deliver solely to swing mechanism **5**. Valve **11** is effective only if valve **9** is not shifted. It will be seen that driving mechanisms **3** and **4** can be operated either independently or simultaneously but when both thereof are driven no other device can be actuated. Mechanism **5** can be actuated only when mechanism **3** is not actuated.

If none of mechanisms **3**, **4** and **5** are actuated, any one or two of cylinders **6**, **7** and **8** can be actuated. If either one of pumps **1** or **2** is cut off from its conduit **26**, **28** by actuation of one of the valves **9**, **10**, **11**, then any one only of cylinders **6**, **7**, **8** can be actuated by pressure from the other of the pumps.

In the case where none of valves **9**, **10**, **11** are shifted to supply their respective components, shifting of valve **13** will cause actuation of cylinder **7**. Pump **2** will supply valve **13** directly through conduits **28** and **29**, whereas pump **1** will supply valve **13** via conduits **26**, **26***a*, **31**, check valve **31***a* and conduits **31***b* and **29** so that the supply of both pumps is delivered to piston **7**. If, while valve **13** is shifted, either one of valves **12** or **14** is shifted, the respective piston **6**, **8**, will be actuated by fluid from pump **1**. At this time, pump **2** supplies piston **7** only, while pump **1** supplies one only of pistons **6**, **8**.

If, on the other hand, valve **14** is shifted to actuate piston **8**, pump **2** will supply valve **14** via conduits **29** and **30** while pump **1** will also supply valve **14** via conduits **26** and **26***a*. It will be evident that a supply from one of pumps **1**, **2** to valve **14** will continue even if one or the other of valves **12**, **13** is shifted to divert the supply of the other pump.

In still another case, if valve **12** is shifted, pump **1** will supply valve **12** directly while pump **2** will also supply valve **12** via conduits **29**, **30**, **31**, check valve **32**, and conduits **33** and **27**. Shifting of either of valves **13** or **14** will cut off pump **2** from valve **12**, while leaving pump **1** connected thereto, and will direct the fluid from pump **2** to the device pertaining to the shifted valve.

From the foregoing it will be seen that, when none of valves **9**, **10**, **11** are shifted, any one or two of pistons **6**, **7**, **8** can be actuated. When only one piston is actuated, both pumps supply fluid thereto and when any two pistons are actuated, each is supplied by a respective pump.

FIGURE 4 illustrates schematically valve **15**. In FIGURE 4, the line from the pump is indicated at **70**, and the line back to the reservoir is indicated at **72**. A valve member **74** is moveable upwardly to connect lines **70** and **72** when pump pressure becomes excessive. When valve member **74** is in its FIGURE 4 position and all other valves are in neutral position, fluid passes from conduit **70** through restricted passage **76** to the lower side of valve **19** and therethrough. When a valve of the system is moved away from neutral position, fluid flow through valve **19** is interrupted.

Thereafter, if the pump pressure rises to an excessive amount, relief valve **78** will open and the pressure standing on the underside of piston **80** due to passage **82** will force the piston and valve member upwardly to connect lines **70** and **72**, while shutting off passage **66**. The restriction of passage **76** is greater than that of passage **82** so that after relief valve **78** opens, there will be an overpressure under piston **80** which will cause relief valve **15** to open.

It is, of course, to be understood, that the present invention is, by no means, limited to the particular arrangement shown in the drawings, but also comprises any modifictions within the scope of the appended claims.

What is claimed is:

1. A hydraulic control circuit, especially for hydraulically actuated implements such as dredges and the like, comprising: pump means, a plurality of motor means to be actuated by pressure fluid from said pump means, control valve means for said motor means each having service port means connected to the respective motor means and having pressure inlet port means and a movable valve member, each valve member having a first position wherein said service port means are disconnected from said inlet port means and at least a second position wherein at least one of the said service port means pertaining thereto is connected to said inlet port means, first bypass channel means leading from said pump means to exhaust and including a portion extending through each control valve means with said portions in series, second channel means leading from said pump means to the inlet port means of said control valve means and including a portion extending through each control valve means and interposed between the inlet port means of the respective control valve means and the inlet port means of the next following control valve means and with said portions in series, movement of any said valve members out of its said first position interrupting both of the said portions of said first and second channels extending therethrough

2. A hydraulic control circuit according to claim **1** in which said pump means comprises first and second pumps, said second channel means comprising a pertaining said second channel for each pump, said control valve means comprising three control valves with said first pump being connected to the inlet port means of a first one of said control valves and said second pump connected to the inlet port means of a second one of said control valves, the said portion of said second channel means extending through the third

one of said control valves being connected to both of said second channels, the portion of each said second channel leading from said third control valve to the inlet port means of the next following control valve having a check valve therein opening away from said third control valve.

3. A hydraulic control circuit according to claim 2 in which a further valve means is interposed between each said pump and the inlet of the pertaining control valve, each said second channel including a portion extending through said further valve means of the pertaining pump and each further valve means interrupting the said portion when shifted to cause the supply of fluid to a connected motor, said first channel means including a portion pertaining to each pump which extends through the pertaining further valve means and which portion is interrupted upon shifting of the valve means to supply fluid to a connected motor, said last mentioned portions of said first channel means being in parallel and each having a check valve therein opening away from the pertaining pump.

4. A hydraulic control circuit according to claim 1 in which each control valve means has a housing in which the respective valve member is reciprocably mounted, said housing comprising a section having ports therein forming the inlet and outlet ends of the portion of said first channel means which extends therethrough, and auxiliary valve member means in said section and movable together with said first mentioned valve member and

comprising an annular groove with inclined end portions, said groove registering with said ports in said section when said valve member is in its said first position and said inclined end portions throttling and then closing said ports as the valve member is shifted out of said first position thereof.

5. A hydraulic control circuit according to claim 4 in which each said port in said section is in the form of at least one nozzle bore.

6. A hydraulic control circuit according to claim 4 in which said section is in the form of a bushing inserted into said housing.

7. A hydraulic control circuit according to claim 4 in which said section is mounted on the end of said housing and includes means for receiving pilot fluid for shifting said valve member in one direction.

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