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Grider et al.

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[54] **HYDRAULIC SYSTEM FOR SINGLE ENGINE TRUCK CRANE OR THE LIKE**

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[51] **Int. Cl.**.....**F15b 11/16**

[58] **Field of Search** .....60/52 HE, 19; 91/414; 214/138 R

[56] **References Cited**

UNITED STATES PATENTS

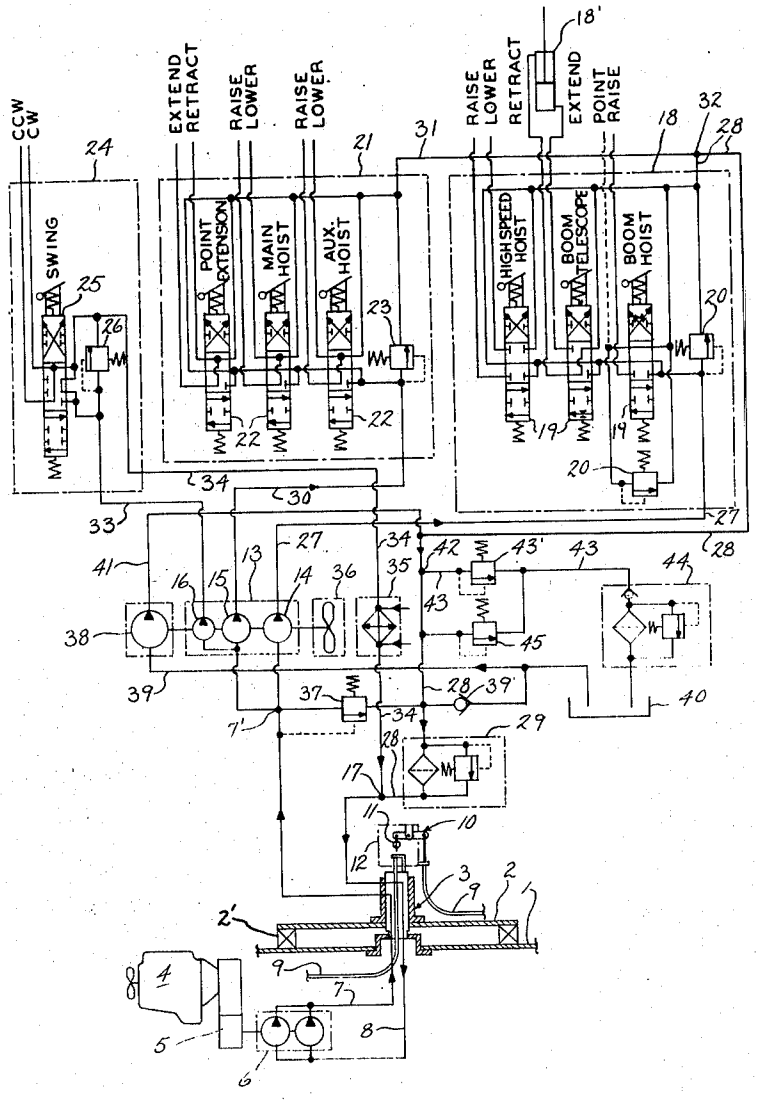
2,643,515	6/1953	Harsch	91/414 X
2,768,499	10/1956	Pilch	91/414 X
2,977,769	4/1961	Troche	60/52 HE X
3,550,506	12/1970	Gardenhour	91/414

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[57] **ABSTRACT**

A hydraulic system for a single engine truck crane includes a pump input section in the carrier that is driven by the carrier engine and an output section in the upper works. A closed loop connects the input and output sections and requires only two passages through the swivel joint. The working reservoir is in the upper works, and a supercharge pump in the upper works is driven by the output section and draws from the reservoir to feed the loop. In one embodiment the output section comprises a flow divider leading to valve units and working motors which are incorporated in the closed loop, and in another embodiment the output section includes a power motor which is driven by the pump in the carrier and which drives working pumps in the upper works that serve the working motors.

9 Claims, 2 Drawing Figures

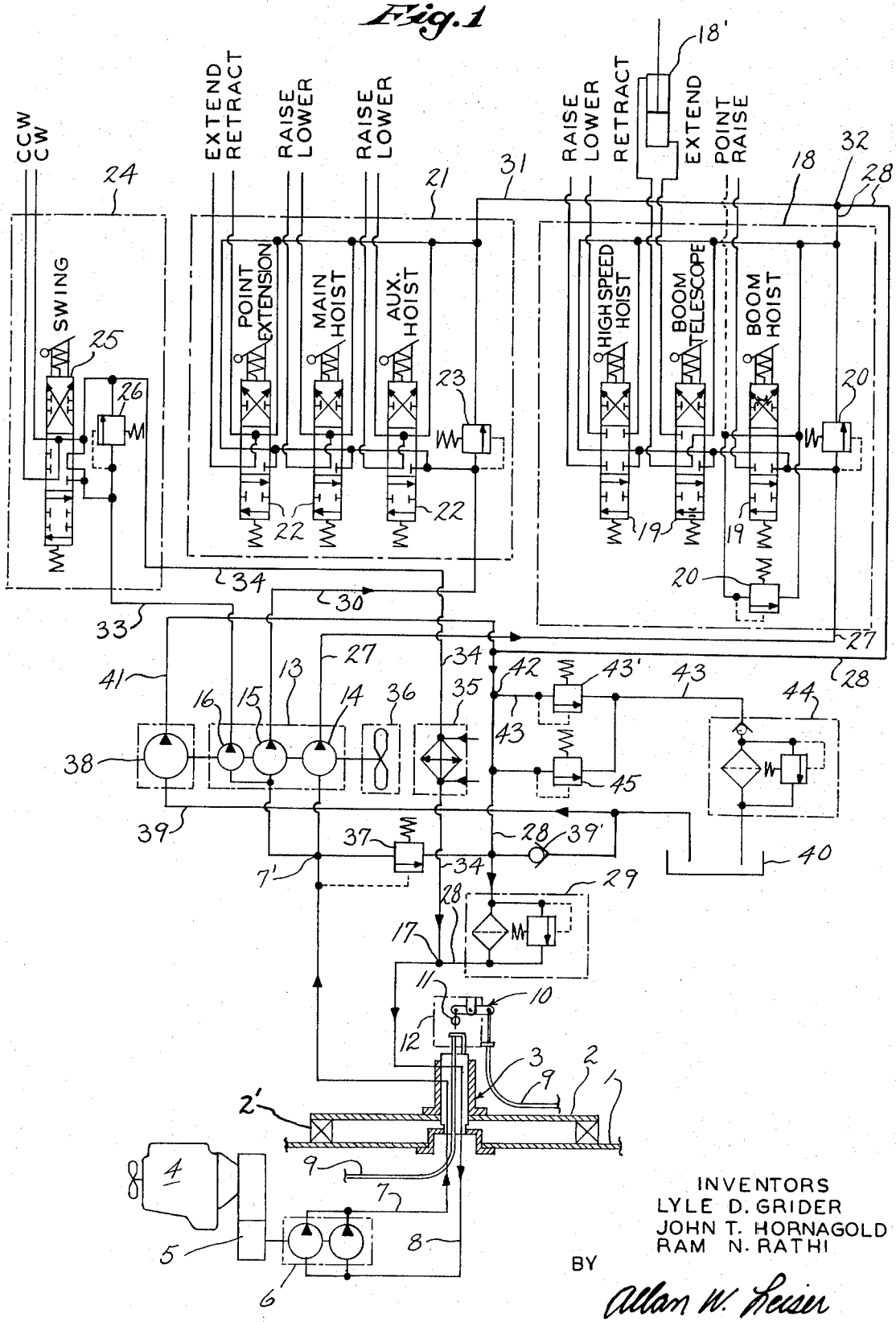


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Fig. 1



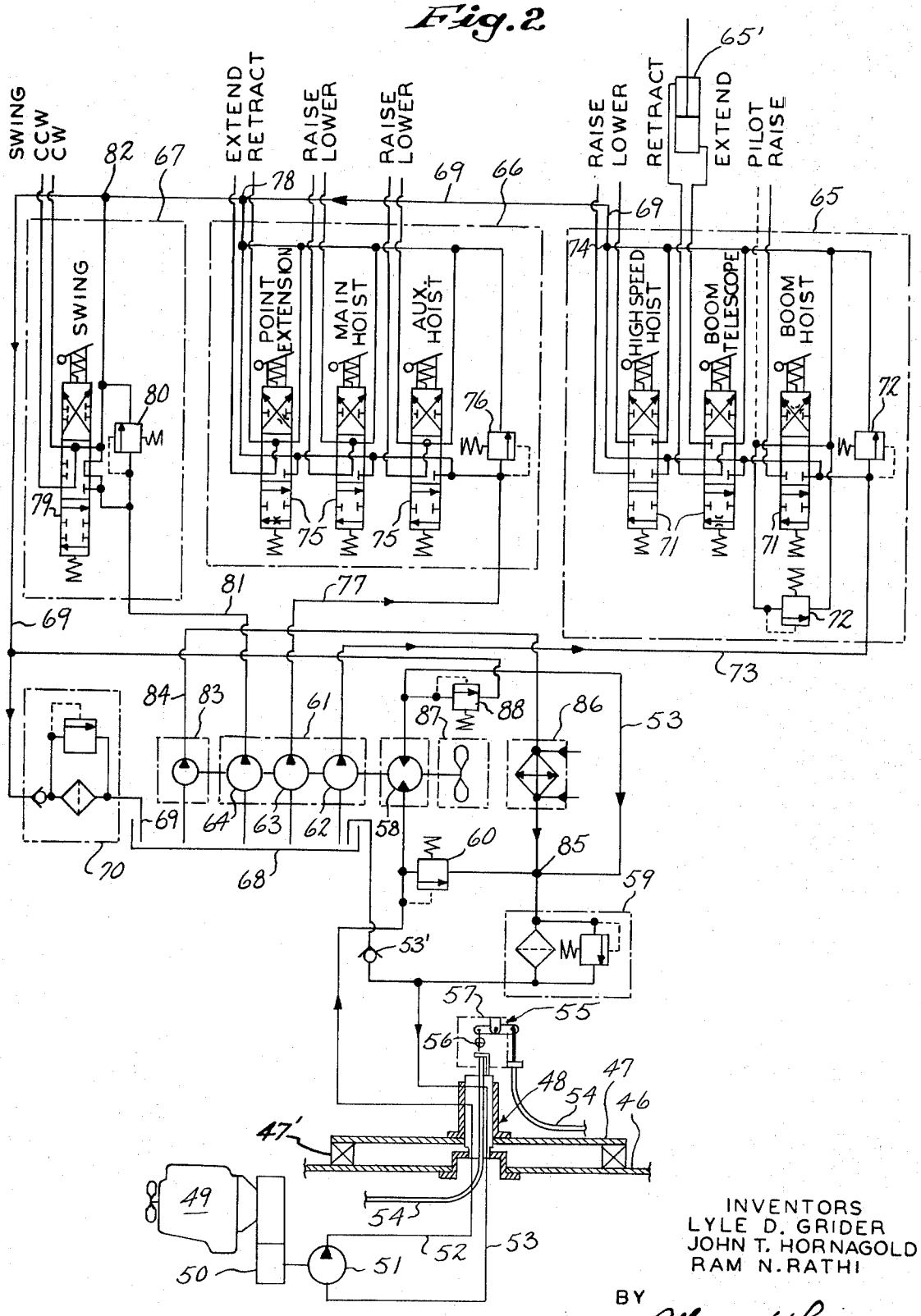
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Fig. 2



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HYDRAULIC SYSTEM FOR SINGLE ENGINE TRUCK CRANE OR THE LIKE

BACKGROUND OF THE INVENTION

This invention relates to truck cranes or similar machines of the type in which a single engine in a carrier serves also as a prime mover for operating elements in an upper works rotatably mounted on the carrier, and particularly to an improved hydraulic system for such a machine.

Conventionally, truck cranes and similar mobile machines have two engines, one in the carrier and one in the upper works. It is, however, advantageous at least in some cases to provide a single engine machine in which the carrier engine also serves as a prime mover for the upper works. Among other things, this eliminates the need for two separate engines and fuel systems, and the operator is more isolated from engine noise.

Heretofore, single engine machines have generally had working pumps for the upper works elements located in the carrier and driven directly by the carrier engine, and the multiple output lines from the pumps are fed upwardly through a multi-passage swivel joint between the carrier and upper works and thence to the operating elements. This sort of arrangement, however, has several serious disadvantages. First, the several pumps which are necessary in most machines take up considerable space in the carrier, and this presents a particular design problem where standard carriers are purchased and used. Second, since both pressure and return lines must lead through the swivel joint, the swivel joint becomes extremely long and expensive; and it is difficult to handle and repair and presents designs problems because of the vertical space required. Third, the working fluid reservoir must be located in the carrier where it presents additional space problems, and where the weight of fluid in the reservoir cannot be used advantageously as a counterweight for the upper works. These problems are of course particularly serious in large machines.

SUMMARY OF THE INVENTION

The general object of this invention is to provide a hydraulic includes for a single engine machine including a pump inlet section in the carrier, an output section in the upper works, and a closed loop connection between the two which requires only two passages through the swivel joint, the working fluid reservoir being disposed in the upper works for advantageous weight distribution. In the preferred embodiments, a supercharge pump in the upper works is driven by the output section in what amounts to a "feedback" action and draws fluid from the reservoir to supply losses in the closed loop. In one embodiment of the invention, the output section includes a flow divider and the operating valves and working motors are incorporated in the closed loop, and there are special provisions for compensating for the differences in fluid requirements as working cylinders extend or retract.

The system of the invention is extremely simple and relatively inexpensive while still being highly efficient, and it offers numerous design advantages. Since only a pump section need be in the carrier, standard carrier designs can easily be used, and it is also relatively easy to modify the upper works to substitute a separate engine, thus allowing the same basic design to be used for both single and dual engine machines.

Other objects and advantages will appear from the description to follow.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram illustrating a first embodiment of the invention incorporating a flow divider output section, and

FIG. 2 is a schematic diagram which is similar to FIG. 1 but which shows another embodiment in which the output section includes a power motor which drives working pumps.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to FIG. 1, the reference numeral 1 indicates the deck of a conventional carrier and the numeral 2 indicates the floor of a conventional revolving frame or upper works which is revolvably mounted on the carrier by means of a conventional bearing 2' and is hydraulically connected to the carrier through a standard swivel joint 3. As indicated, the carrier 1 can be of any conventional type, it being a particular advantage of this invention that any of a number of standard carrier designs can be used without extensive modification. The upper works 2 will of course mount suitable operating elements, which in the case of a truck crane will include a boom with raising and extending mechanisms, a swing mechanism to revolve the upper works 2, and a hoist mechanism, all powered by double or single acting cylinders or other hydraulic motors, one of which is shown schematically as 18'. While the particular embodiments shown are intended for truck cranes, however, it will be apparent that the invention is applicable to any machine with a carrier and a revolving upper works which mounts operating elements. Swivel joints which provide for hydraulic passages between a carrier and upper works are also well known, and the swivel joint 3 may be of any suitable type. Since the general construction and operation of truck cranes is well known to those skilled in the art, and since the invention has other equally obvious applications, a detailed showing and description of the elements thus far referred to is unnecessary and has been omitted for the sake of simplicity and clarity.

A standard engine 4 is located in the carrier and powers the carrier and the upper works as will be described. The engine 4 is fitted with any suitable type of power take-off unit 5, and thus serves to drive a pump input section, which in this embodiment is a set of two gear pumps 6 suitably placed in the carrier, although one or more pumps could be used depending on requirements. A pressure line 7 leads upwardly from the pumps 6 and a return line 8 leads downwardly to them, and these lines pass through the swivel joint 3. It is a particular advantage of the invention that only the two lines 7 and 8 need pass through the joint 3.

Since the engine 4 powers the upper works, it must be controllable by an operator seated therein. To this end, a throttle cable 9 leads from the upper works to the carrier through the swivel joint 3, this being accomplished by means of a pivoting linkage 10 and a ball swivel 11. There must also be electrical connections between the carrier and upper works, and this can be

accomplished through any suitable type of conventional electrical swivel joint, indicated schematically by the reference numeral **12**.

The reference numeral **13** designates a flow divider which constitutes the output section of the hydraulic system in this embodiment. Flow dividers are also well known to those skilled in the art, and can be considered essentially as a group of pumps with a common inlet, which is shown schematically as the terminus **7'** of the line **7**. In the present embodiment, there are three pumps **14**, **15** and **16** which serve separate valve units as will be described. Flow from all of these ultimately returns to a point **17** which can be considered to define the upper terminus of the return line **8** as a unitary element.

The pump **14** serves a valve unit **18** made up of a bank of three standard, interconnected, manually operated directional control valves **19**, and including two pressure relief valves **20**. The pump **15** serves a valve unit **21** made up of three more manually operated, interconnected directional control valves **22** and a pressure relief valve **23**. The pump **16** serves a valve unit **24** which includes a single manually operated directional control valve **25** and a pressure relief valve **26**. The valve units **18**, **21**, **24** serve of course to feed pressure fluid to and accept return fluid from the working motors for the operating elements (not shown). Again, the particular elements and functions are not relevant to the invention as such, and so the functions have simply been indicated on the drawings in a manner which makes them readily understandable to those skilled in the art. It should be noted, however, that the valve units have closed loop connections with their associated cylinders or other motors so that all fluid flowing from the valve units is ultimately returned to them and thence to a common return as will be described.

Fluid from the pump **14** moves to the valve unit **18** through a line **27**, and all of the return fluid leaves the valve unit **18** through a line **28** which leads through a filter unit **29** to the point **17**. The valve unit **21** is served through a line **30**, and all return fluid from the unit **21** leaves through a line **31** which joins the line **28** at point **32**. The valve unit **24** is served by a line **33**, and return fluid moves through an intermediate return line **34** which includes a heat exchanger **35** and which terminates at the point **17**. A fan **36**, which is suitably driven by the flow divider **13**, operates to cool oil passing through the heat exchanger **35**. While only a portion of the total oil flow is thus cooled, this is sufficient to maintain the total system temperature at desired levels.

A main pressure relief valve **37** is connected between the pressure line **7** and the return line **28**, to protect against excessive overall system pressures.

Since the valve units **18**, **21** and **24** all have closed loop connections with their working motors, they and their motors can be considered to be incorporated in a completely closed loop which, in essence, leads from the pumps **6** through the line **7** to the flow divider **13**, through the valve units and motors to the point **17** and thence through a common return line **8** to the pumps **6**. Since this is a closed loop system which does not draw directly from a reservoir, some provision must be made to replace unavoidable oil losses and maintain acceptable inlet pressures at the pump **6**, and this is accomplished by means of a supercharge pump **38** which is also suitably driven by the flow divider **13**. An inlet line **39** for the pump **38** leads from a working oil reservoir **40** which is located in the upper works. An output line **41** leads from the pump **38** and joins the line **28** at point **42**, which is on the return side of the loop. A supercharge relief line **43** leads from the line **28** to the reservoir **40** and includes a pressure relief valve **43'** which is set and serves to limit the output pressure of the pump **38**. Fluid passed through the relief valve **43'** moves through a filter unit **44** back to the reservoir **40**. A check valve **39'** is connected between the lines **39** and **28**, and this allows the pumps **6** to suck oil from the reservoir **40** during start-up to prevent cavitation; the valve **39'** being closed when supercharge pressure builds up.

Since the system will usually involve a number of double acting single rod hydraulic cylinders as working motors, such as the cylinder **18'**, there can be a significant difference in flow rates depending upon whether the cylinders are being extended or retracted. When the cylinders are being extended the input flow is significantly greater than the return flow because of the cylinder rods, and when they are being retracted the return flow is significantly greater. In one commercial design, for example, there is a net difference of approximately 95 gallons between the requirements for movement of all cylinders from full retraction to full extension and movement from full extension to full retraction, and some means must be provided to compensate for this differential. In the embodiment shown, this is accomplished by the pump **38** and a second relief valve **45** which is connected in parallel with the valve **43'** and is set to open at a somewhat higher pressure. The capacity of the pump **38** is such that, during extension when more fluid is moving out from the flow divider **13** than is being returned through the line **8**, it can supply the difference from the reservoir **40**. During retraction, when excess fluid is being returned, the valve **45** will open and pass the excess to the reservoir **40**. While the valve **43'** could theoretically serve both to limit the pump **38** and to dispose of excess fluid during retraction, it is difficult to provide a single relief valve which can accommodate such widely varying flow rates, and using the second valve **45** set to open at higher pressure is a highly advantageous method.

It is important to note that all working fluid for the system is supplied by the reservoir **40** which is in the upper works. Not only does this make it unnecessary to provide reservoir space in the carrier **1**, but the reservoir **40** can easily be located in the upper works in a position where the weight of the fluid serves as an additional counterweight.

Referring now to the embodiment of FIG. **2**, the carrier deck is designated by the reference numeral **46**, **47** designates the upper works, **47'** is the bearing, and **48** designates the swivel joint. An engine **49** operates through a power take-off **50** to drive a single pump **51** which constitutes the input section of the hydraulic system. A pressure line **52** leads from the pump **51** through the swivel joint **48**, and a return line **53** leads back through the joint **48** to the pump **51**. A throttle cable **54** controls the engine **49** through a linkage **55** and a ball swivel **56**. An electrical swivel connection is

indicated schematically at 57. The elements 46 through 57 correspond, respectively, to the elements 1 through 12 in the embodiment of FIG. 1, except that the terminal connections for the lines 52 and 53 are different and the input section is a single pump—although multiple pumps could be used.

The pressure line 52 in this embodiment leads directly to a power gear motor 58 in the upper works, and the return line 53 leads back from the power motor 58 through a filter unit 59 to the pump 51, there being as a result a simple closed loop connection between the pump 51 and power motor 58, the power motor 58 serving as an output section which supplies power to working pumps. A system relief valve 60 is connected across the lines 52 and 53 to limit overall system pressure. Again, it is important to note that the lines 52 and 53 represent the only hydraulic connections between the carrier and upper works, so that the swivel joint 48 need have only two hydraulic passages.

The power motor 58 drives a working pump section 61 made up in this case of three working pumps 62, 63, and 64. The pumps 62–64 correspond, respectively, to the pumps 14–16 in the embodiment of FIG. 1, and serve valve units 65, 66, and 67 which correspond, respectively, to the valve units 18, 21, and 24 of the embodiment of FIG. 1. In this embodiment, however, the working pumps and valve units are not incorporated in the closed loop, and the pumps 62–64 draw from a common working fluid reservoir 68 which is in the upper works. A common return line 69 returns all fluid to the reservoir 68 through a filter unit 70. A check valve 53' is connected between the reservoir 68 and line 53 to prevent cavitation during start-up, and is closed when supercharge pressure is built up.

The valve unit 65 includes three valves 71 and two pressure relief valves 72. It is supplied by a line 73 leading from the pump 62, and all return fluid is fed into the line 69 at point 74. The valve unit 66 includes three valves 75 and a pressure relief valve 76; and it is supplied by a line 77 leading from the pump 63 with return fluid moving into the line 69 at point 78. The valve unit 67 includes a valve 79 and pressure relief valve 80; it is supplied by a line 81 from the pump 64 and return fluid flows into the line 69 at point 82. Again, all of the valves are manually operated directional control valves which control double or single acting cylinders or other working motors, one of which is shown at 65', and the particular functions are indicated on the drawing.

A supercharge pump 83 is also driven by the power motor 58 and draws from the reservoir 68. An output line 84 leads from the pump 83 and connects to the return line 53 at point 85, the pump 83 thus serving to replenish losses in the closed loop. A heat exchanger 86 in the line 84 faces a fan 87 which is also driven by the power motor 58, this providing a cooling of a portion of the system oil to maintain the entire system temperature at a desired level. To compensate for extra oil introduced into the closed loop by the pump 83, there is a pressure relief valve 88 which is connected between the lines 53 and 69.

Other than the fact that the valve units and working motors are not included in the closed loop circuit, the embodiment of FIG. 2 offers the same advantages as the embodiment of FIG. 1. Only two passages through the swivel joint 48 are necessary, the supercharge pump 83 is driven by the output section of the system to have a feedback type of action, and all of the working fluid for the system is supplied by the single reservoir 68 which is located in the upper works and can be desirably located to provide an additional counterweight.

It is important to note that both embodiments only a power take-off unit and a pump section of one or a few pumps need be located in the carrier, and this makes it extremely easy to accommodate the system to standard carrier frames. In both cases, it would be relatively easy to replace the output section with a separate engine occupying the same space, so that the same basic design can be used for either single or dual engine machines. The systems are highly effective and yet relatively simple and inexpensive.

Although two preferred embodiments of the invention have been shown, it will be obvious that other embodiments and variations in application and structure are possible without departure from the spirit of the invention. The invention is not, therefore, to be limited by the showing herein or in any other manner except as may specifically be required.

We claim:

1. A hydraulic operating system for a truck crane or the like including a carrier with an engine, an upper works revolvably mounted on the carrier and a hydraulic swivel joint interposed between the carrier and upper works, said system comprising:

a pump input section mounted in the carrier and driven by the engine; an output section in the upper works; a closed hydraulic loop connecting the input and output sections, the loop including a single pressure line leading from the input section through the swivel joint into the upper works and a single return line leading from the upper works through the swivel joint to the input section; a fluid reservoir in the upper works that supplies substantially all of the working fluid for the system; and a super charge pump that draws from the reservoir and serves to pump fluid into the closed loop.

2. A hydraulic operating system according to claim 1 wherein the supercharge pump is in the upper works and is driven by the output section and pumps fluid into the closed loop at a point in the upper works.

3. A hydraulic operating system according to claim 2 wherein: the upper works includes a plurality of control valve units with each unit adapted to have a closed loop connection with at least one working motor and to supply all pressure fluid to and receive all return fluid from the working motor; and the output section comprises a flow divider connected to the pressure line; and there are a plurality of outputs from the flow divider which lead to respective valve units; and return fluid from all of the valve units enters the return line in the upper works; and an output line from the supercharge pump leads to the return line.

4. A hydraulic operating system according to claim 3 wherein: at least one valve unit serves at least one working motor which is a double acting cylinder that requires more fluid for extension than for retraction and returns more fluid during retraction than during extension; and the supercharge pump is adapted to supply the extra fluid required for extension; and there is a relief line leading from the return line to the reser-

voir which includes pressure relief valve means, the pressure relief valve means serving to limit the output pressure of the supercharge pump and to dispose of excess fluid entering the return line during retraction.

5. A hydraulic operating system according to claim 4 wherein the pressure relief valve means includes two pressure relief valves in parallel, one of which opens at a certain predetermined pressure to control the output pressure of the supercharge pump and the other of which opens at a higher predetermined pressure to dispose of excess return fluid.

6. A hydraulic operating system according to claim 3 wherein: there is a cooling fan in the upper works that is driven by the flow divider; and there is an intermediate return line leading from one of the valve units to a point on the return line which includes a heat exchanger facing the fan.

7. A hydraulic operating system according to claim 2 wherein: there is at least one working pump in the upper works which draws from the reservoir; and the output section comprises a hydraulic power motor which is driven by the input section and which drives the working pump and the super charge pump.

8. A hydraulic operating system according to claim 7 wherein: the upper works includes a plurality of valve units; and there are a corresponding number of working pumps all driven by the power motor, one working pump serving each valve unit.

9. A hydraulic operating system according to claim 8 wherein: an output line leads from the supercharge pump to the return line and includes a heat exchanger; and there is a fan in the upper works which is driven by the power motor and faces the heat exchanger.

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