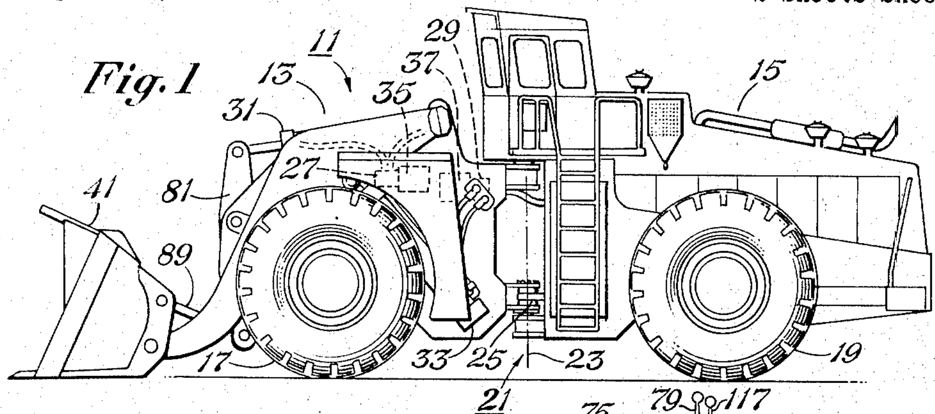
March 13, 1973 L. A. MOLBY 3,720,332

HYDRAULIC SYSTEMS

Filed April 27, 1971 2 Sheets-Sheet 1

Fig. 1



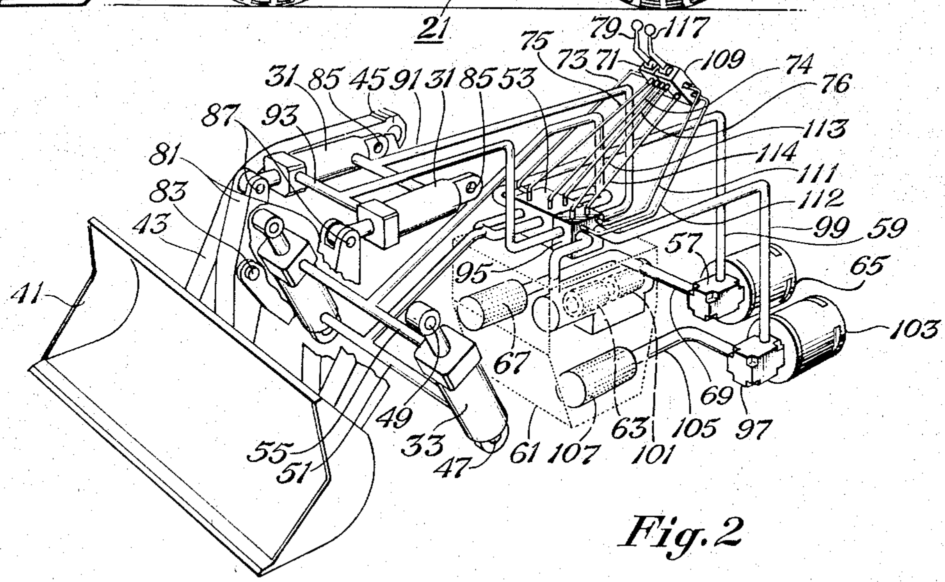


Fig. 2

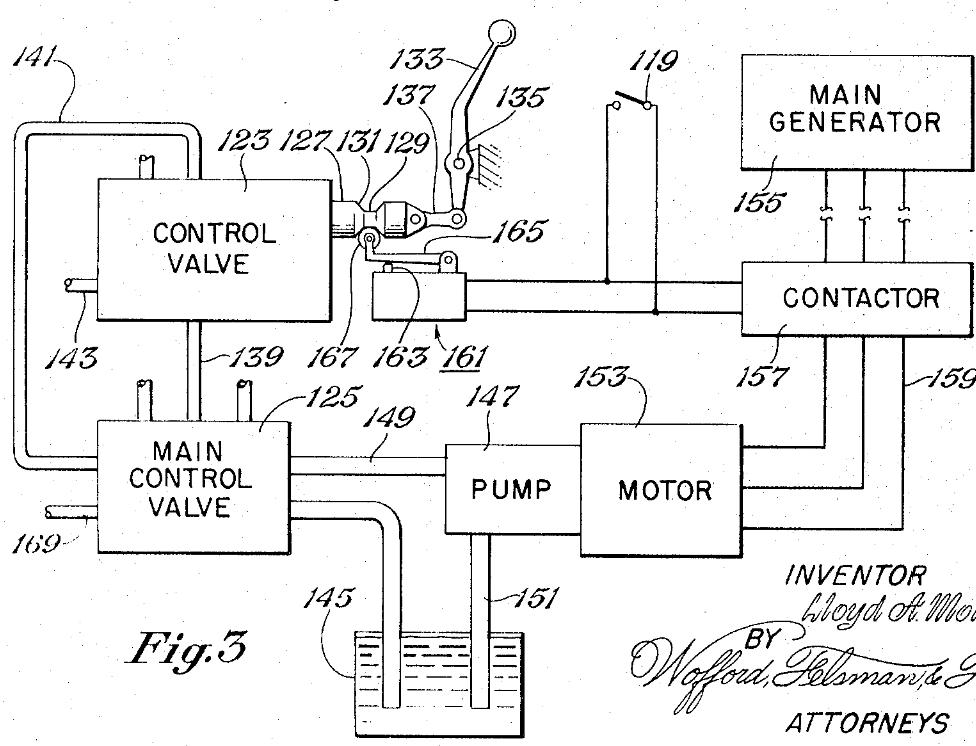


Fig. 3

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HYDRAULIC SYSTEMS

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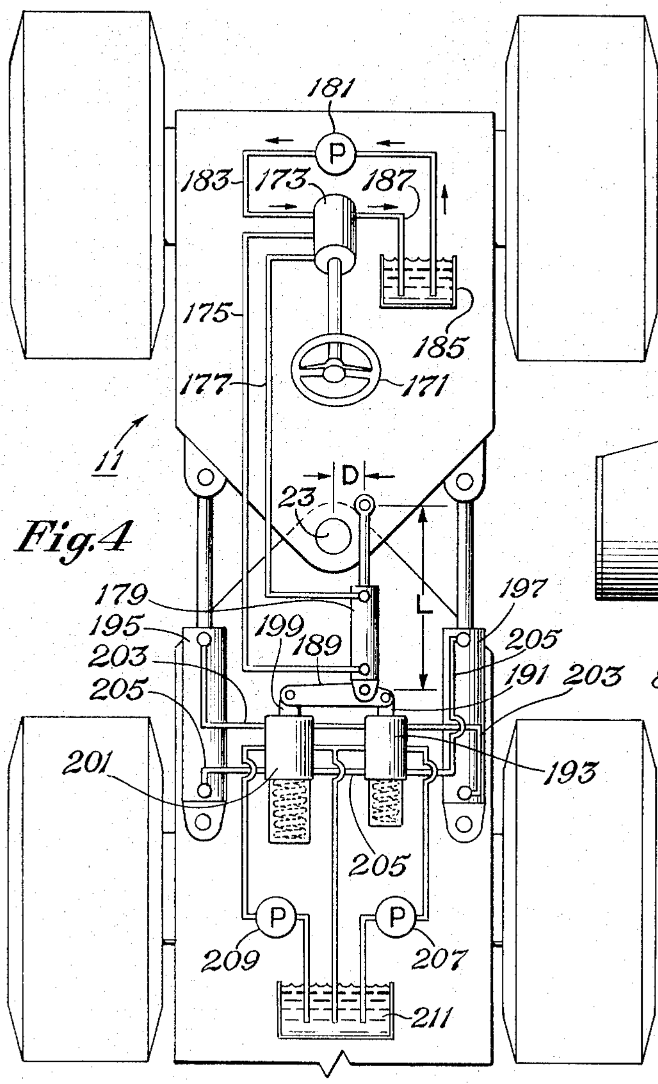

Fig. 4

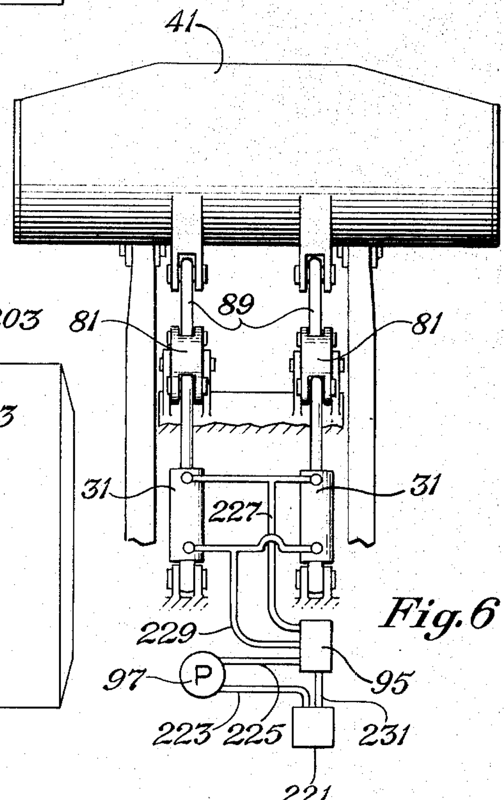

Fig. 6

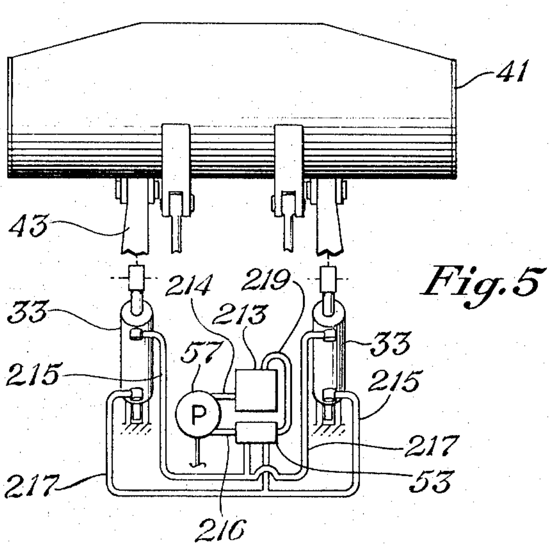

Fig. 5

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HYDRAULIC SYSTEMS

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Filed Apr. 27, 1971, Ser. No. 137,881
Int. Cl. B66f 9/00
U.S. Cl. 214—140 14 Claims

ABSTRACT OF THE DISCLOSURE

In a vehicle having a plurality of work performing means that are powered by hydraulic fluid the improvement characterized by a plurality of individual and separately operable hydraulic systems for operating the respective work performing means; the respective motors and pumps, preferably, being positioned relatively closely adjacent the work performing means for which they supply hydraulic fluid under pressure. Also disclosed are (1) a type of control valve that is operable to start a motor driving a respective pump simultaneously with directing the high pressure hydraulic fluid output of the pump to operate the work performing means; (2) other specific structural features; and (3) advantages.

BACKGROUND OF THE INVENTION

(1) Field of the invention

This invention relates to an improved hydraulic system for a vehicle having a plurality of work performing means that are powered by hydraulic fluid. More particularly, this invention relates to a plurality of separate and individual hydraulic systems for operating and powering respective ones of the plurality of work performing means on the vehicle.

(2) Description of the prior art

The prior art has seen a wide variety of machines wherein a work function is performed by a hydraulically powered device. For example, in front end loaders or road grader type equipment there are a large number of work functions that are performed by hydraulic means. Respective ones of the work functions may involve a hydraulic ram which is attached to a work piece. The hydraulic ram is used to raise and lower a bucket or grader blade, and to obtain the desired degree of tilt and the respective positions thereof. It is thus apparent that numerous hydraulic rams, or cylinder-piston units, are required for each vehicle. It is also apparent that these hydraulic rams are disbursed and disposed at various locations on the vehicle.

It is conventional practice in a machine of the type above-mentioned to have a single hydraulic fluid reservoir and a single hydraulic pump for the entire machine. The hydraulic pump is normally driven directly by a transmission means that is powered by the vehicle's internal combustion engine. The hydraulic pump is run continuously while the machine is running. Thus, hydraulic flow is constantly available to a manifold and selected valves on the manifold permit the hydraulic fluid to flow to selected hydraulic rams.

Vehicles such as those described hereinbefore are subject to several disadvantages. First, there are long runs of tubing, connections and pivot connections from the single pump location to the various hydraulic ram locations. This makes for a system that is expensive to install, difficult to maintain and that requires care in operation to prevent severing one or more of the high pressure hoses in the cumbersome setup. Second, the single hydraulic pump must be running all the time that the machine is travelling and is generating maximum hydraulic flow

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whether or not such flow is being used. Thus, even when the machine is merely travelling on roads to and from its destination, the maximum hydraulic fluid flow is still maintained. The excess horsepower that is employed in circulating the fluid is dissipated as waste heat and requires additional cooling. Third, in the event of failure of a hydraulic element such as the pump, the vehicle has had to be shut down to effect repairs in the field, instead of being able to drive the machine back to a central repaiar location where repair is facilitated and more satisfactorily carried out.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of an articulated front end loader vehicle employing one embodiment of this invention.

FIG. 2 is a schematic isometric view of an embodiment of this invention employing a plurality of separate hydraulic systems.

FIG. 3 is a schematic diagram of a control valve employed in one control means in a system in accordance with an embodiment of this invention.

FIG. 4 is a partial top plan view, partly schematic, illustrating an embodiment of this invention employing individual pumps and reservoirs in the hydraulic steering system.

FIG. 5 is a partial top plan view, partly schematic, illustrating an embodiment of this invention employing a separate hydraulic control system for the hydraulic rams raising the main beams.

FIG. 6 is a partial plan view, partly schematic, illustrating a hydraulic system for controlling the tilt of the bucket.

DESCRIPTION OF PREFERRED EMBODIMENTS

It is a primary object of this invention to provide an improvement in hydraulically operable power systems for vehicles wherein hydraulic power is employed to operate a plurality of work performing means; the improved hydraulic system obviating the disadvantages of the prior art type vehicles.

Other objects of this invention will be apparent to those familiar with the art when the following description is read in conjunction with the drawings.

Referring to FIG. 1, the present invention is shown incorporated in an articulated front end loader type vehicle **11** having a front section **13** and a rear section **15.** The front section **13** has a pair of front wheels **17.** The rear section **15** has a pair of rear wheels **19.** The front and rear sections **13** and **15** are pivotally connected via pivot connection **21** for horizontal steering movement relative to one another about a substantially vertical steering axis **23.** Specifically, a hydraulic ram, comprising a cylinder, piston and shaft arrangement, is connected to the front and rear sections on one or both sides of the pivot connection and effects the desired degree of steering via a steering connection **25** in response to the steering means in the operator's console. The steering connection **25** is disposed laterally from the pivot connection **21** for a desired moment arm over which the steering force can be applied. A steering system such as described in my copending application Ser. No. 137,936, entitled "Two Speed Steering System," filed Apr. 27, 1971, provides an improved steering system for the articulated vehicle **11.** The hydraulic system, with its plurality of pumps for supplying hydraulic fluid under pressure will be described in more detail with regard to FIG. 4 hereinafter. It should be borne in mind, however, that the hydraulic steering system is one of the plurality of work performing means on the vehicle **11** that are powered by hydraulic fluid.

The vehicle **11** also carries hydraulic pumps **27** and **29** disposed closely adjacent to the hydraulic rams **31** and **33** for which they supply hydraulic fluid at an elevated pressure. Disposed closely adjacent and connected with the respective pumps **27** and **29** are motors **35** and **37**, as well as the control valves and the reservoir (not shown in FIG. 1).

For clarity in explanation and understanding, a simple schematic isometric is illustrated in FIG. 2 showing the operation of the hydraulic rams raising and lowering the arms carrying the bucket and the hydraulic rams controlling the angle of tilt by way of the bell crank linkage arrangement. Referring to FIG. 2, the bucket **41** is carried on main beams, or arms, **43** that are pivotally mounted by way of a suitable pivot shaft **45** on the vehicle (not shown in FIG. 2). The main beams **43** are cutaway to show the hydraulic rams **33** for raising and lowering the main beams in response to high pressure hydraulic fluid suitably directed to either the piston end or the shaft end, respectively. Specifically, the hydraulic rams **33** are pivotally mounted by stub shaft **47** connecting one end with the vehicle and a second stub shaft **49** connecting the other end with the main beam **43**. The hydraulic cylinder portion of the hydraulic ram **33** is connected at its piston end via conduit **51** with a main control valve **53**. Similarly, the shaft end of the cylinder portion of the hydraulic ram **33** is connected via conduit **55** with the other side of the main control valve **53**. The main control valve **53** may be operably positioned to route hydraulic fluid at elevated pressure into either conduit **51** for raising the main beam **43** or into conduit **55** for power lowering of the main beam **43**. If desired, of course, the hydraulic fluid from the piston end may be routed back to a hydraulic reservoir and allow gravity to effect lowering of the bucket. Power lowering is advantageous, however, where tamping or the like is desired. The main control valve **53** is connected with a first pump **57** by way of conduit **59** and with a reservoir, or sump, **61** by way of suitable filter **63**. The pump **57** is driven by a motor **65**. The pump **57** is also connected with the sump **61** via a filter **67** and conduit **69**. The pump **57** may be the same as pump **27**.

The main control valve is hydraulically connected with a control valve **71** by way of conduit such as conduits **73–76**. The control valve **71** is operably positioned by a suitable lever **79** and effects fluid positioning of the main control valve so as to direct the main stream of high pressure hydraulic fluid to the respective conduit **51** or **55**.

The bucket **41** is tilted by movement of the bell crank **81** about its fulcrum shaft **83**. Specifically, the hydraulic rams **31** are pivotally connected at their one end with the vehicle via suitable shafts **85** and at their other end with the bell crank via shafts **87**. The bottom end of the bell crank is connected with the bucket via link **89**, FIG. 1, so as to effect tilting of the bucket in response to lengthening or shortening of the hydraulic ram **31**. The cylinder portion of the hydraulic rams **31** has their piston ends connected with the main control valve **95** via conduit **91**. Similarly, the cylinder portion of the hydraulic rams **31** have their shaft ends connected with the main control valve **95** via conduit **93**.

The main control valve **95** is connected with a second hydraulic pump **97** via conduit **99** and with the sump **61** via suitable conduit and filter means such as filters **63** and **101**. The pump **97** is powered by a motor **103** and is connected to the sump **61** via conduit **105**, and filter **107**. The main control valve **95** is fluidly connected with control valve **109** via conduits **111–114**.

As illustrated, the main control valves **53** and **95** have a common housing and a common return conduit, as well as a common sump **61**. Similarly, the pumps **57** and **97** have a common sump **61**. The common sump may be employed, since the low pressure suction conduits **69** and **105** are not as easily damaged as the high pressure conduits and can run from the common sump to the pumps. Advantages, however, individual sumps, or reservoirs, are employed and are disposed closely adjacent the pumps, as will become apparent from FIGS. 4–6, which are described later hereinafter.

As illustrated in FIG. 2, the control levers **79** and **117** are positioned closely adjacent each other to facilitate control of the height and the angle of tilt of the bucket by the operator. Such closely adjacent positioning is not so much a requisite when a linkage arrangement such as described in my co-pending patent application Ser. No. 835,464, entitled "Front End Loader Type Vehicle," filed June 23, 1969 now Pat. No. 3,606,061, granted Sept. 20, 1971; since, as described therein, the front end loader has a self levelling feature in which the bucket is emplaced at its surface position with its bottom edge substantially horizontal from its top position with the bottom edge being at the full dump angle.

In operation, hydraulic fluid is supplied under pressure to the main control valves **53** and **95** via respective conduits **59** and **99**. For example, the pumps **57** and **97** may have an output of about 190 gallons per minute, respectively. The main control valves **53** and **95** divert a small portion thereof; for example, about 2–6 gallons per minute; to the control valves **71** and **109**. The respective control valves **71** and **109**, responsive to the position of the control levers **79** and **117**, route a required amount of high pressure fluid back to the main control valves **53** and **95** to suitably position them, diverting the remainder of the hydraulic fluid back through the return position of the main control valves into sump **61**. For example, initially the bucket **41** may have its bottom edge levelled by extension of the hydraulic ram **31**. In such an event, the main control valve **95** is positioned to route high pressure hydraulic fluid via conduit **91** to the piston ends of the hydraulic rams **31**, extending the respective shafts and effecting the desired levelling of the bottom of the bucket **41**. Low pressure fluid from the shaft ends of the hydraulic rams **31** is returned through conduit **93** and through the low pressure fluid passageway of the main control valve **95** to the sump **61**. Once a desired load is obtained in the bucket **41**, the lever **117** is operated in the reverse direction to effect retraction of the hydraulic rams **31** and the desired tilt back of the bucket **41** to carry the load to its top position with minimal spilling. The lever **79** is operated to raise the bucket to its top position for dumping the load into a suitable receptacle such as a dump truck or the like. A portion of the diverted high pressure fluid is sent to position the main control valve **53** to direct high pressure hydraulic fluid into conduit **51** and thence into the piston ends of the hydraulic rams **33**. Consequently, the bucket ends of the main beams **43** are raised about their pivot shafts **45** to effect the desired height of the bucket **41**. At this point, the control lever **117** is operated to dump the bucket **41**. Specifically, the lever **117** positions the control valve and ultimately effects a positioning of the main control valve **95** to direct high pressure hydraulic fluid into conduit **93** to retract the shaft and move the bucket **41** into its dump position. Thereafter, the control lever **79** is positioned in the direction opposite to which it was initially positioned to route high pressure hydraulic fluid into the conduit **55** and effect controlled, powered lowering of the bucket **41**. As indicated hereinbefore, the low pressure hydraulic fluid from the hydraulic rams is vented through the respective return conduits to the sump **61**.

Advantageously, the motors **65** and **103** are not operating during the road travel of the vehicle **11** when the bucket **41** is moved to its road travel position, such as its upper position where there is a minimum of obstruction to visibility. Obviously, the motors **65** and **103** may be controlled by a manual switch such as switch **119**, FIG. 3. Such a manual switch may be preferred for long periods of use and nonuse. It is frequently advantageous to employ a switch means that is operatively associated with the control valve and its control lever to effect starting and stopping of the motor synchronously with direction of the hydraulic fluid through the control valve via the main control valve to its desired operation of the work performing means. Referring to FIG. 3, the control valve **123** and the main control valve **125** serve as a control means for controlling the work performing means such as one of the sets of hydraulic rams. The control valve **123** includes a plunger **127** that has a groove means **129** disposed peripherally therearound. On each side of the groove means **129** are disposed cam means **131**. The plunger **127** is connected with a control lever **133**. Any of the levers, linear or non-linear, that are available on the market may be employed as the control lever **133**. Specifically, the control lever **133** is pivotally mounted for movement about a fulcrum shaft **135** and has its lower end connected with the plunger **127** via link **137**. Accordingly, the plunger **127** is moved inwardly or outwardly in response to the appropriate direction of movement of the control lever **133**. The control valve **123** is connected via conduit **139** with the main control valve **125**, as a source of high pressure hydraulic fluid diverted by the main control valve. The control valve **123** is also connected with the main control valve via suitable conduit such as conduit **141** for effecting a respective position of the main control valve and thereby effecting the desired flow of high pressure hydraulic fluid to the work performing means. The main control valve may be biased toward neutral, but moved in a given direction against the biasing means by balanced hydraulic pressure or flow. The main control valve is conventional and need not be described in detail herein.

The control valve **123** also has a bypass conduit **143** for bypassing any unused high pressure fluid supplied by conduit **139**. The bypass conduit **143** may be returned to the main control valve **125** through appropriate conduit or directly to a reservoir **145**.

The main control valve **125** is connected with the discharge of pump **147** via conduit **149**. The suction side of the pump **147** is connected with the reservoir **145** via conduit **151**.

The pump **147** is powered by motor **153**. As illustrated, the motor **153** is a three-phase motor that is connected with the main generator **155** via contactor **157** and associated conductors such as conductor **159**. The contactor **157** is operable to effect series connection of the motor **153** with the main generator **155** to energize the motor and start the pump **147** in response to closure of a control switch associated with the contactor **157**. The control switch may be a manual switch **119**, referenced hereinbefore, or it may be a switch such as switch **161** that is closed by movement of the plunger **127**. As illustrated, the switch **161** has a switch plunger **163** that is depressed by a pivotally mounted lever **165** to effect a closed switch. The lever **165** has a roller **167** carried at its free end and engaging the recess means **129**. Consequently, as the plunger **127** is moved inwardly or outwardly, the roller **167** cams up the cam means **131** contiguous the recess means **129** to close the switch and energize the motor **153** via the contactor **157**. The switches **161** and **119** are connected in parallel and one or both may be employed as desired.

In operation, the operator of the vehicle will move control lever **133** in a predetermined direction to move the plunger **127** inwardly or outwardly. This movement closes the switch **161** and energizes the motor **153**, starting pump **147**. Hydraulic fluid is supplied to the main control valve **125** which diverts a small portion to the control valve **123**. A portion of the high pressure hydraulic fluid is returned, the amount being proportional to movement of the plunger **127**, through conduit **141** to effect positioning of the main control valve **125**. The remainder is bypassed to the reservoir, directly or indirectly, through conduit **143**. The main control valve **125** effects the requisite flow of high pressure hydraulic fluid to the work performing means until the desired work is done; for example, the main beam **43** is elevated to the desired height. Thereafter, the control lever **133** is released and is returned via a spring (not shown) to its shut-off position, opening switch **161** through movement of the roller **167** into the recess means **129**, and stopping pump **147**. A liquid block is held on the work performing means through the appropriate positioning of the main control valve **125**.

Movement of the control lever **133** in the opposite direction again cams the roller **167** up the opposite face of the cam means **131** contiguous the recess means **129** and starts the pump **147** as described hereinbefore. The control valve **123**, however, positions the main control valve in the opposite direction; for example, by way of another conduit **169**. In any event, the main control valve is positioned to effect a lowering of the main beam **43** and return of hydraulic fluid to the reservoir **145**. Once the desired position, such as the surface position, of the bucket has been achieved, the control lever **133** is released and automatically returned to the shut-off position, stopping the pump and repositioning the control valve and the main control valve, as described hereinbefore. While additional reference numerals have been given the elements in FIG. 3, it is apparent that many of the elements are equivalent to recited elements in FIG. 2. For example, the pump **147** may be the same as pump **57**, the control valve **123** may be employed as control valve **71** and the main control valve **125** may be employed as the main control valve **53**.

In FIGS. 4–6, discrete hydraulic systems are illustrated schematically with other systems cutaway for clarity of illustration.

Referring to FIG. 4, the steering system illustrated therein is described in detail in my co-pending application Ser. No. 137,936, referenced hereinbefore. The steering system need not be described in detail since the hereinbefore referenced application Ser. No. 137,936 can be referred to for such detailed explanation. A schematic operational description will serve to illustrate the use of a plurality of independently and separately operable hydraulic pumps to supply power for the respective elements. Specifically, steering wheel **171** operatively turns gerotor **173** to direct high pressure hydraulic fluid through one of the conduits **175** or **177** for effecting a predetermined length L of hydraulic ram interconnection means **179**. The gerotor **173** is supplied hydraulic fluid at elevated pressure from pump **181** via conduit **183**. The pump **181** obtains its hydraulic fluid from reservoir **185**. The gerotor **173** routes low pressure hydraulic fluid back to the reservoir **185** via conduit **187**. Ordinarily, the pump **181** will run continuously to maintain a supply of hydraulic fluid under elevated pressure for use in steering the vehicle **11**. The length L effects movement of the double bar link means **189**. The double bar link means **189** then moves, first, a first member **191** inwardly or outwardly to correspondingly effect a fluid flow via primary control valve **193** to the hydraulic ram power steering servos **195** and **197**. As the limit of travel of the first member **191** is reached, further movement of the double bar link means **189** effects movement of the second member **199** of the secondary control valve **201** for effecting a much greater flow of hydraulic fluid to the hydraulic ram power steering servos **195** and **197**. The primary and secondary control valves **193** and **201** are connected in parallel to supply hydraulic fluid under pressure to the respective high pressure ends of the parallel connected hydraulic ram power steering servos **195** and **197** for effecting the desired steer of the vehicle **11**. Specifically, the primary and secondary control valves have their discharge aperture connected in parallel with conduit **203** for routing high pressure hydraulic fluid to the shaft end of the hydraulic ram power steering servo **195** and to the piston end of hydraulic ram power steering servo **197** for effecting a steer to the left. Conversely, the primary and secondary control valves **193** and **201** have another discharge aperture connected in parallel with conduit **205** for routing high pressure hydraulic fluid to the shaft end of hydraulic ram power steering servo **197** and to the piston end of hydraulic ram power steering servo **195** for effecting a steer to the right.

Separate and independently operable pumps **207** and **209** take suction from a reservoir **211** and supply high pressure hydraulic fluid to the respective primary control valve **193** and the secondary control valve **201**. Either, or preferably both, pumps may be operated continuously if it is desired to have high pressure hydraulic fluid immediately available for the steering operation. On the other hand, either or both of the first and second members **191** and **199** may have the same configuration as the plunger **127** of FIG. 3 and employed with a switch such as switch **161** to start the respective pump when a demand for slow and fast power steering is made, as by movement of a respective member in a predetermined direction. The pumps need not be operated in the same manner. For example, it is possible to operate only the primary pump **207** continuously and leave the secondary pump **209** idle until demand is made upon the secondary control valve **201**. That is, the second member **199** will have a configuration and operative switch like plunger **127** of FIG. 3 so as to start the secondary pump **209** only upon demand for high speed steering.

In any event, the hydraulic fluid at elevated pressure is routed by either the primary control valve **193** alone or both the primary and secondary control valves **193** and **201** to effect the desired rate of steering via the hydraulic power steering servos **195** and **197**. As a degree of steer is effected, feedback from the steered section is effected. Specifically, the hydraulic ram interconnection member **179** is displaced a distance D from the substantially vertical steering axis **23** defined by the pivot connection, so that it returns the first and second members **191** and **199** to the shut-off position to stop the flow of hydraulic fluid at the moment the signalled degree of steer has been effected. The transistion to the shut-off point is effected smoothly, since the second member **199** and the secondary control valve **201** are returned to the shut-off position, first, to stop the large rate of flow of hydraulic fluid; and subsequently, the first member **191** and the primary control valve **193** are returned to the shut-off position to stop the precisely controlled, low speed flow of hydraulic fluid to the power steering servos **195** and **197**.

As can be seen in FIG. 4, the reservoirs **185** and **211** are advantageously positioned close to their respective pumps **181**, and **207** and **209**.

FIG. 5 illustrates another embodiment of the invention in which the reservoir, as well as the control valve and pump, is emplaced closely adjacent the hydraulic ram for which hydraulic power is to be supplied. Therein, the main beams **43** carrying the bucket **41** are cut away to illustrate more clearly the hydraulic rams **33** employed to raise and lower the bucket. The vehicle frame (not shown) of the vehicle carries the motor driven pump **57**. The pump **57** has its suction side connected with reservoir **213** via conduit **214** and has its discharge side connected with main control valve **53** via conduit **216**. The main control valve **53** has one discharge aperture connected with the shaft end of the hydraulic rams **33** via conduit **215**. The main control valve **53** has another discharge aperture connected with the piston end of the hydraulic rams **33** via conduit **217**. The main control valve **53** has its return aperture connected with the reservoir **213** via conduit **219**. The main control valve **53** may be positioned hydraulically by a control valve, as illustrated in FIG. 2, or it may be positioned by a suitable lineal member from a control console. Suitable lineal members comprise flexible members reciprocally encased within an armored housing, or linear rods extending from a control lever. In any event, the main control valve **53** is suitably positioned to direct the high pressure hydraulic fluid from pump **57** to the piston end of the hydraulic rams **33** for raising the main beams **43**; or to the shaft end of the hydraulic rams **33** for lowering the main beams **43**, as described hereinbefore. As illustrated, the pump, reservoir, and main control valve are located closely adjacent to the hydraulic rams they power so as to keep the high pressure fluid lines short for economical initial installation, easy maintainence and less care in operating the vehicle. The motor driving the pump may be controlled by manual switches or by switches that are closed or opened in response to movement of the control levers, or the like.

The operation of the system of FIG. 5 is the same as described with respect to FIG. 2 hereinbefore.

FIG. 6 illustrates schematically the hydraulic rams **31** effecting tilting of the bucket **41** via bell cranks **81**, with the hydraulic pump and reservoir emplaced closely adjacent the hydraulic rams for which they supply hydraulic fluid at elevated pressure. Specifically, the vehicle frame (not shown) carries the motor driven hydraulic pump **97**. Pump **97** has its suction side connected with the reservoir **221** via conduit **223**. The pump **97** has its discharge side connected with the main control valve **95** via conduit **225**. The main control valve **95** has one of its discharge apertures connected with the shaft side of the hydraulic rams **31** via conduit **227**. The main control valve **95** has its other discharge port connected with the piston side of the hydraulic rams **31** via conduit **229**. The main control valve **95** has its return port connected with reservoir **221** via conduit **231**. The main control valve **95** may be hydraulically positionable by a control valve such as control valve **109**, FIG. 2, or it may be positionable by any one of the other conventional positioning means enumerated with respect to the main control valve **53**, FIG. 5. In any event, the main control valve **95** is operative to direct high pressure hydraulic fluid into either conduit **227** or **229** to effect the desired tilting of the bucket **41** via either retraction or extension of the hydraulic rams **31** and appropriate movement of the bell cranks **81** and links **89**.

Operation of the hydraulic system of FIG. 6 is the same as described hereinbefore with respect to the components of FIG. 2.

The materials of construction ordinarily employed with the type of vehicle on which the systems are mounted will be employed in this invention.

This invention has been described with respect to having a single sump with which the respective pumps are connected via low pressure conduit; and the more advantageous structure in which separate reservoirs are disposed closely adjacent the pumps which are, in turn, disposed closely adjacent the respective hydraulically powered work performing means for which they supply hydraulic fluid at an elevated pressure.

Thus, it can be seen that the invention provides an improved vehicle having a plurality of discrete hydraulic systems that are separately and independently operable to provide the following advantages:

(1) There are no long runs of high pressure tubing, high pressure connections, and pivot connections to worry about in initial installation, in operation of the vehicle and in maintenance of the vehicle; consequently, there is less unsightly leakage;

(2) By having separately controllable pumps, the vehicle can travel great distances without pumping large quantities of hydraulic fluid, as was formerly required when a single pump, or multiple pumps, having the total capacity needed, was connected to the prime mover, or internal combustion engine;

(3) By employing separate switch means, only the amount of oil that is necessary to do the job being signaled is employed instead of pumping enough to do a plurality of jobs; and

(4) In the event of failure of a hydraulic system, it is possible to turn off that particular hydraulic system and steer the vehicle back to a maintenance area to effect repairs in such a favorable environment, instead of having to shut down the vehicle and effect repairs in the field before being able to drive it.

Although the invention has been described with a certain degree of particularity, it is understood that the present disclosure has been made only by way of example and that numerous changes in the details of construction and the combination and arrangement of parts may be resorted to without departing from the spirit and the scope of the invention.

What is claimed is:

1. In a vehicle having a plurality of work performing means that are powered by hydraulic fluid, the improvement comprising;
   - a plurality of independently and separately actuatable hydraulic fluid pumps;
   - a plurality of independently and separately actuatable motors each connected with its respective one of said hydraulic fluid pumps;
   - a plurality of independently and separately actuatable switch means for actuating said motors and pumps; and
   - a plurality of independently and separately operable control means connected by conduit means with the discharge side of respective of said pumps for controlling flow of fluid to and from said work performing means,
   - said control means including a control valve means having a plunger that is moved inwardly and outwardly to effect direction and quantity of flow of fluid, said plunger having groove means with contiguous cam means, a respective switch means being disposed adjacent said plunger, said switch means having actuation means by which said switch means is responsively actuated into the on and off positions, said actuation means having roller means disposed in said groove means in the shut-off position and adjacent said respective cam means contiguous with said groove means whereby said switch means is turned on upon movement of said plunger in either direction to effect actuation of said motor and start its associated pump supplying fluid to said control valve means.

2. The vehicle of claim 1 wherein said control means are operably connected with a lever means which also effects operation of a respective said switch means to both initiate pumping by a respective pump and control the distribution of the pumped hydraulic fluid to the respective work performing means.

3. The vehicle of claim 1 wherein a respective manually operable switch means is provided for controlling said respective motor independently of said respective control means.

4. The vehicle of claim 1 wherein said respective pumps and motors are positioned on said vehicle adjacent said respective work performing means for keeping the high pressure hydraulic fluid flow conduit means short.

5. The vehicle of claim 4 wherein each said pump has its individual reservoir that is also positioned adjacent said work performing means.

6. The vehicle of claim 1 wherein said control valve means includes a control valve and a main control valve; said control valve having said plunger, and being connected with said main control valve such that said main control valve is positioned in response to the output of said control valve with which it is connected.

7. The vehicle of claim 1 wherein said switch means is employed to operate a large current carrying contactor means intermediate a main generator and said motor, whereby said switch means and its associated conductors can be relatively small.

8. A vehicle adapted to perform a plurality of work performing functions comprising
   - a frame,
   - means for supporting said frame for movement,
   - means for driving said vehicle connected to said supporting means,
   - a plurality of work performing means on said frame adapted to be hydraulically actuated,
   - a plurality of hydraulic pumps,
   - a plurality of independent and separately actuatable motors,
   - each of said pumps being connected for actuation by its respective one of said motors,
   - means connecting pumps to their respective work performing means to supply hydraulic fluid to said work performing means,
   - a generator connected to and driven by said vehicle driving means,
   - switch means for connecting said generator to said motors whereby said driving means may be operated without the motor load on said generator, and
   - a plurality of control means connected to control the flow of hydraulic fluid from said motors to their respective work performing means.

9. A vehicle according to claim 8 including
   - means responsive to said control means for actuation of said switch means whereby when said control means is actuated said switch means starts its associated motor and pump responsive to said control means actuation to supply fluid thereto.

10. A vehicle according to claim 8 wherein
   - said vehicle is a front end loader having a bucket supported by arms, and
   - said work performing means includes actuators connected to said bucket and said arms to raise and lower and tilt said bucket.

11. The vehicle of claim 8 wherein
   - said control means are operably connected with a lever means which also effects operation of a respective said switch means to both initiate pumping by a respective pump and control the distribution of the pumped hydraulic fluid to the respective work performing means.

12. The vehicle of claim 8 wherein
   - a respective manually operable switch means is provided for controlling said respective motor independently of said respective control means.

13. The vehicle of claim 8 wherein
   - said respective pumps and motors are positioned on said vehicle adjacent said respective work performing means for keeping the high pressure hydraulic fluid flow conduit means short.

14. The vehicle of claim 8 wherein
   - each said pump has its individual reservoir that is also positioned adjacent said work performing means.

References Cited

UNITED STATES PATENTS

2,240,322	4/1941	Webster	60—97 E
2,282,194	5/1942	Lamond	60—52 S X
2,309,944	2/1943	Flowers	60—97 E U X
2,323,519	7/1943	Dean	60—DIGEST 2
3,528,244	9/1970	Weisenbach	60—97 E X

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60—52 HE, DIGEST 2, 52 S