

Oct. 9, 1956

G. L. OMON

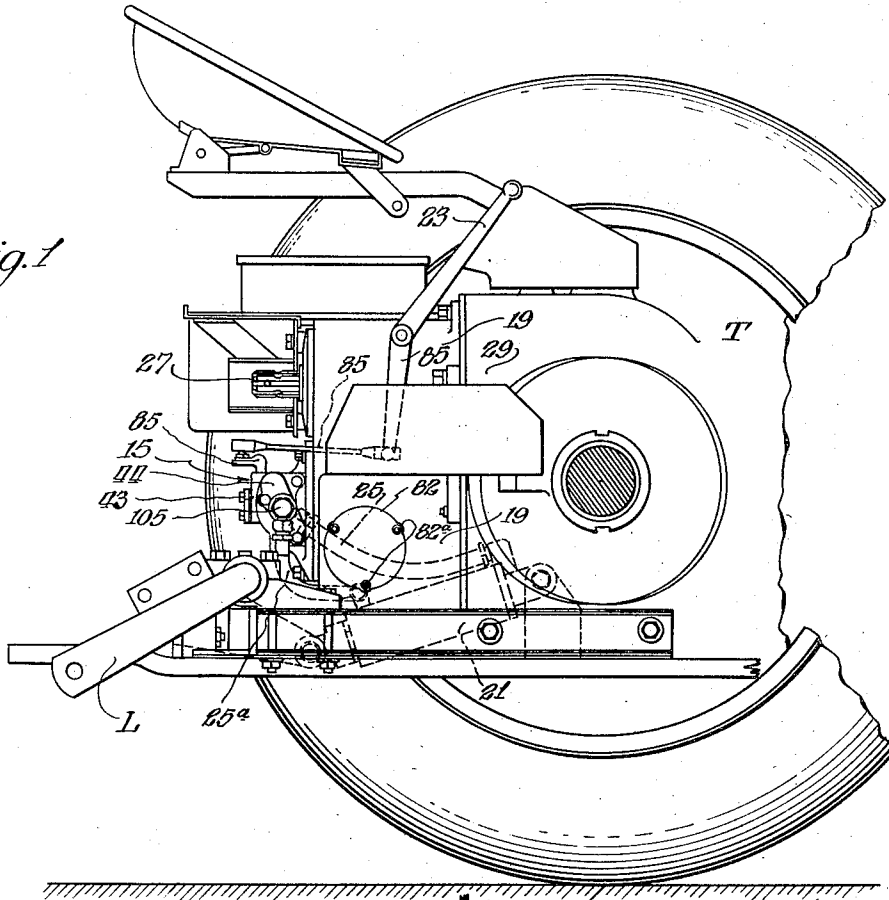
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HYDRAULIC SYSTEM

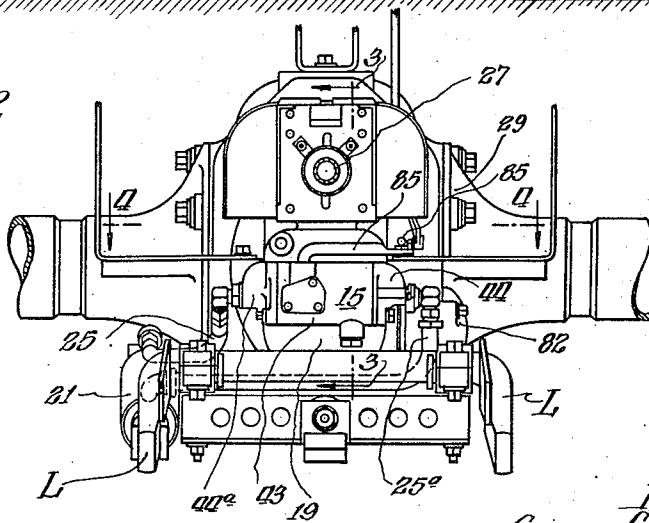
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6 Sheets-Sheet 1

*Fig. 1*



*Fig. 2*



Inventor:  
Gene L. Omon  
By: Seams, Pond & Anderson  
Attys.

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G. L. OMON

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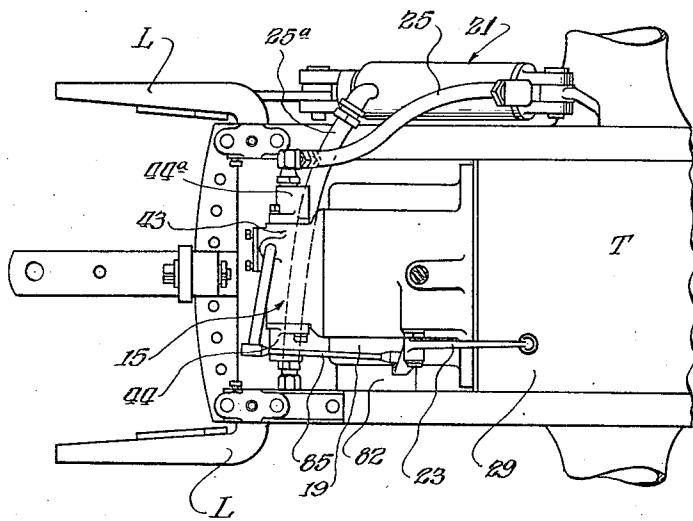


Fig. 1

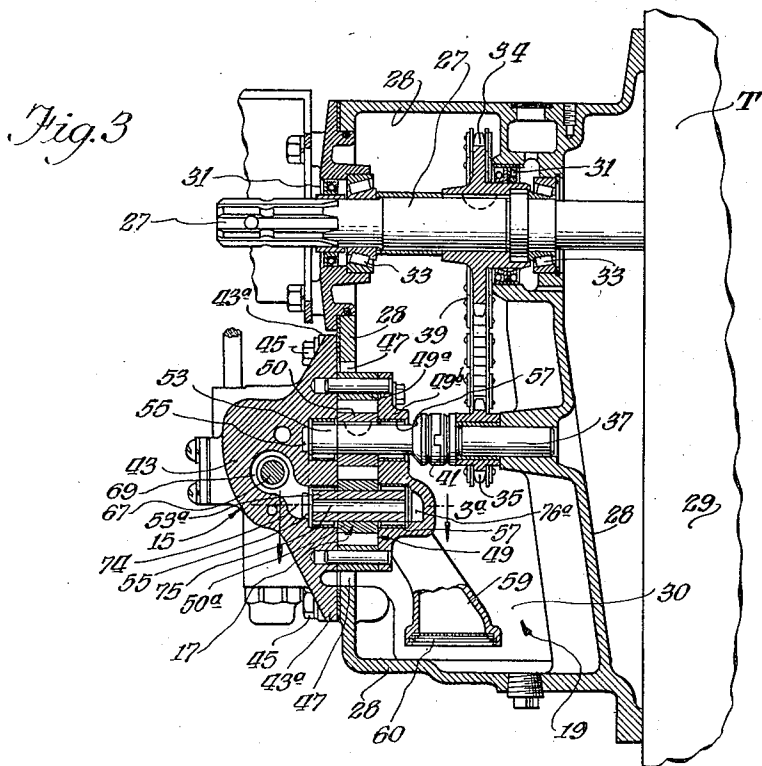


Fig. 3

Inventor:  
Gene L. Omon  
By: Soans, Pond & Anderson  
Attys.

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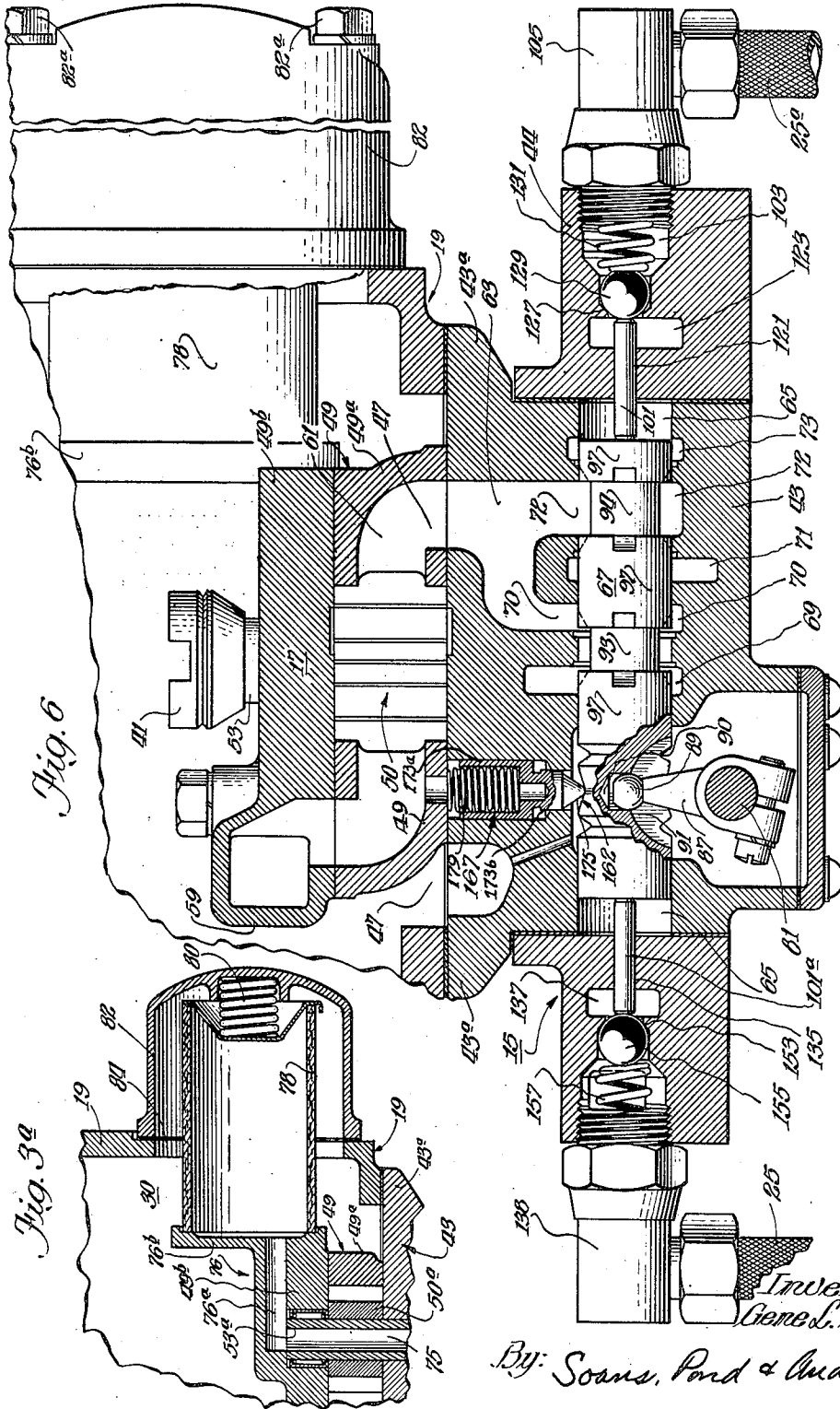
G. L. OMON

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HYDRAULIC SYSTEM

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6 Sheets-Sheet 3



Inventor:  
Gene S. Omon

By: Soans, Pond & Anderson  
Attys.

Oct. 9, 1956

G. L. OMON

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HYDRAULIC SYSTEM

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6 Sheets-Sheet 4

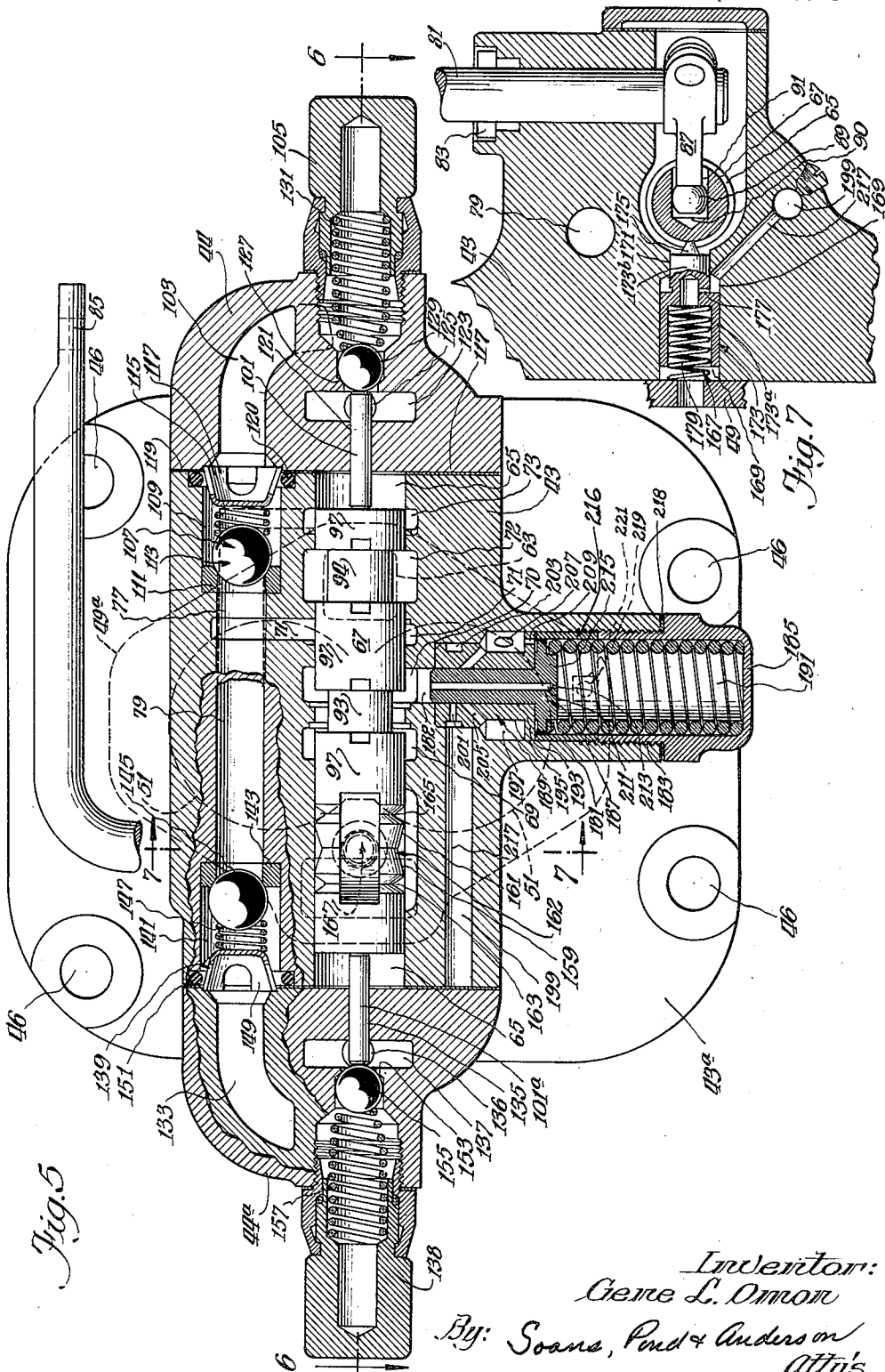


Fig. 5

Fig. 7

Inventor:  
Gene L. Omon  
By: Soane, Pond & Anderson  
Attys.

Oct. 9, 1956

G. L. OMON

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Fig. 9

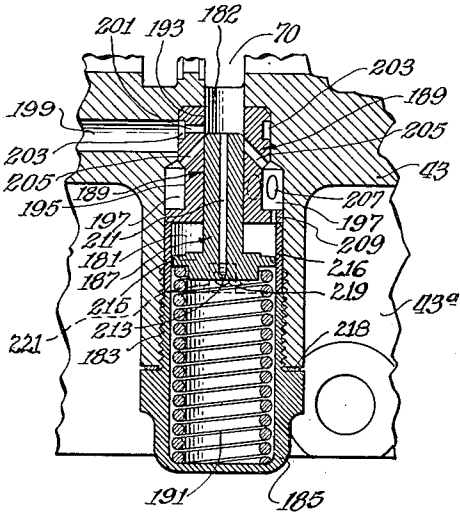


Fig. 10

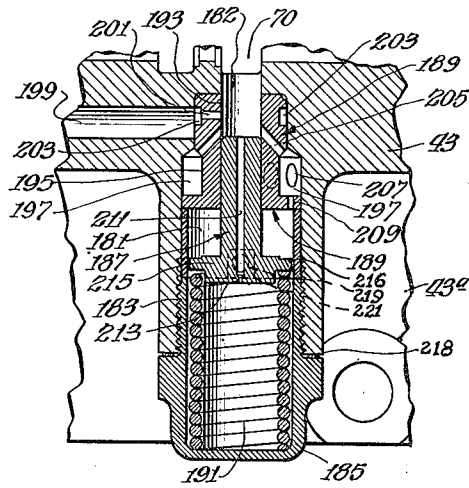


Fig. 12

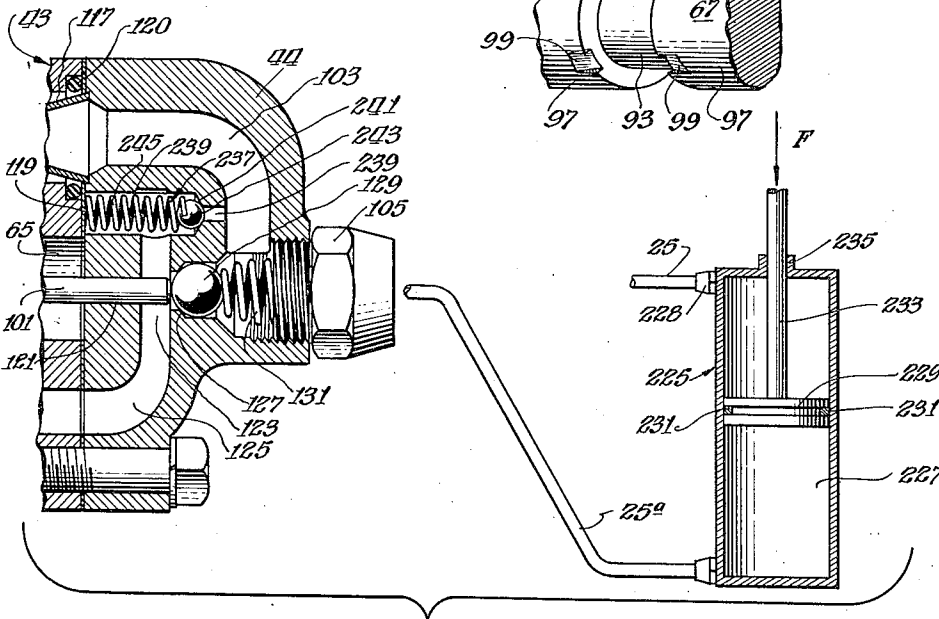
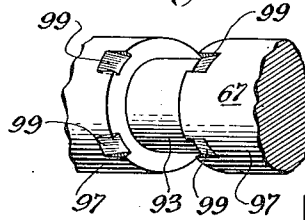


Fig. 8

Inventor:  
Gene L. Omon

By: Soans, Pond & Anderson  
Attys.

Oct. 9, 1956

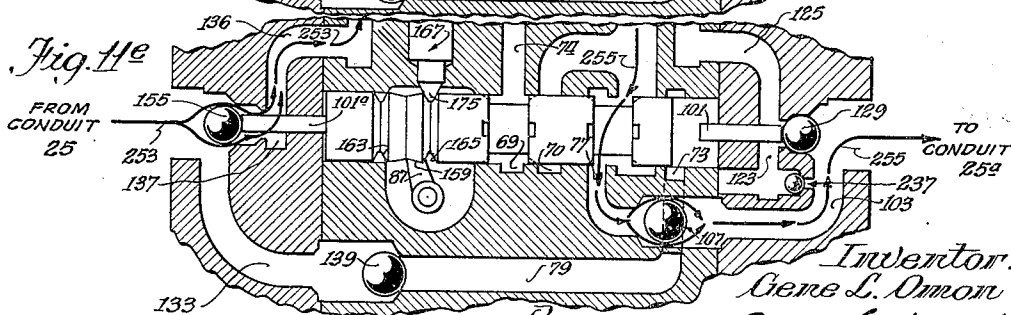
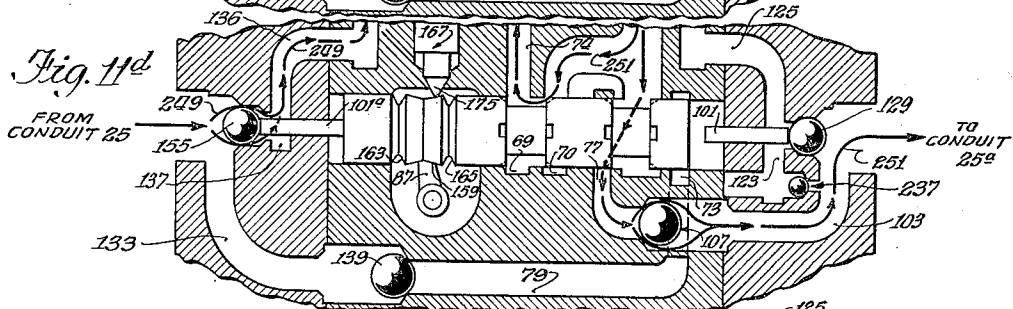
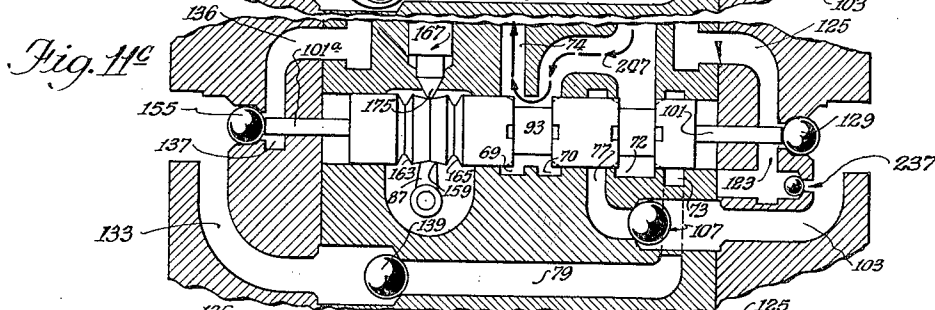
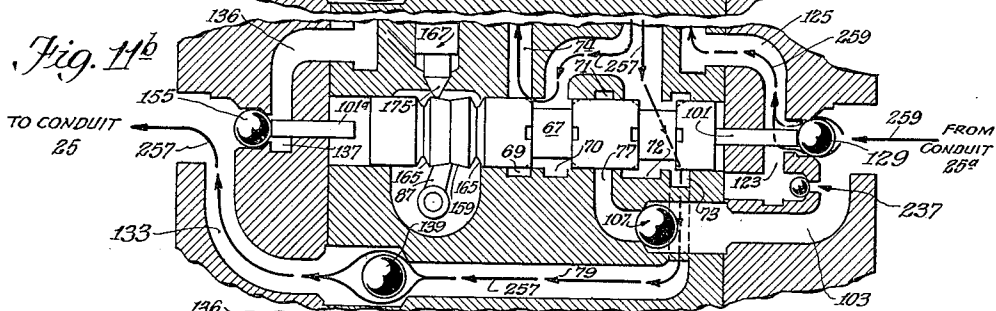
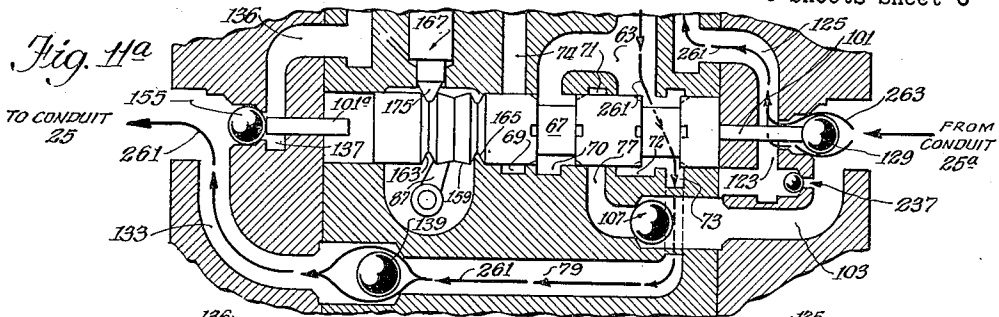
G. L. OMON

2,765,746

HYDRAULIC SYSTEM

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6 Sheets-Sheet 6



Inventor:  
Gene L. Omon  
By: Soans, Pind & Anderson  
Attys.

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## HYDRAULIC SYSTEM

Gene L. Omon, Milwaukee, Wis., assignor to J. I. Case Company, Racine, Wis., a corporation of Wisconsin

Application March 11, 1950, Serial No. 149,059

10 Claims. (Cl. 103—42)

The present invention relates to an improved hydraulic system and in particular relates to an improved hydraulic system for operating and controlling hydraulically actuated power translating devices.

A large proportion of heavy apparatus, such as agricultural type tractors, farm implements, earth moving machinery, etc., is provided with a hydraulic system for accomplishing mechanical adjustments, such as moving or lifting some element which is attached to, or which is associated with, the apparatus. For example, in one widely used hydraulic system for this purpose, hydraulic fluid under pressure is supplied from a continuously operating pump which circulates the fluid from a reservoir or sump maintained at normal or atmospheric pressure. The flow of the pressure fluid is controlled by suitable valve means which is connected to the power translating device by a pair of conduits. The valve means is operable to selectively circulate pressure fluid to the translating device through either one of the conduits and to simultaneously bleed a corresponding amount of pressure fluid from the other of the conduits, thereby providing for the positive operation of the apparatus in a selected direction. Further, the valve means is operable to seal both of the conduits in order to positively lock the controlled apparatus in any desired position. In addition to satisfactorily operating the controlled apparatus, it is desirable that the control means be automatically operable to disengage the source of hydraulic pressure from the system in the event that the pressure becomes excessive in any part of that system or when the controlled apparatus reaches a predetermined position.

Heretofore, the control means for multiple-conduit systems have been large and unduly complicated and have required a multiplicity of expensive and delicate valves and a large number of exposed conduits and hoses for pressure fluid. Consequently, such control means frequently became damaged and, as a result, required expensive and time consuming repairs. Moreover, the operation of most of the prior art control valves required the movement of several levers by the operator if the rate of adjustment of the controlled apparatus and the direction of movement were to be accurately controlled. Hence, closely controlled operation required the undivided attention of the operator during the adjusting period, and thus hindered the attainment of integrated or simultaneous movement of the basic or parent equipment and the controlled apparatus.

Accordingly, the principal object of the present invention is to provide an improved hydraulic system of the multiple-conduit type including an improved control valve, the system being simple in construction, economical to manufacture, positive in action, and free from the operating difficulties which are inherent in the prior systems. A further object of the invention is the provision of an improved control valve of the class described which may be operated by a single control lever to effectively control the speed of operation and the direction of movement of the apparatus being adjusted.

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A more specific object of the invention is the provision of a unitary control valve and hydraulic pump for a system of the class described whereby external conduits between the pump and the valve are eliminated, thereby facilitating the repair and maintenance of the system.

Another object of the invention is the provision of a control valve of the class described which includes novel pressure responsive safety means for automatically disengaging the source of hydraulic pressure from the system in the event that the pressure becomes excessive within the valve itself or in the remainder of the hydraulic system. Other objects and advantages of the invention will become known by reference to the following description and the accompanying drawings of one preferred embodiment thereof.

In the drawings:

Fig. 1 is a side elevational view of the rearward end of an agricultural tractor which is provided with a hydraulic system in accordance with the invention, certain parts of the tractor being cut away to show various features of the system;

Fig. 2 is a fragmentary, elevational view of the rearward end of the tractor illustrated in Fig. 1;

Fig. 3 is a sectional view taken on line 3—3 in Fig. 2;

Fig. 3a is a sectional view taken on line 3a—3a in Fig. 3;

Fig. 4 is an elevational view taken on line 4—4 in Fig. 2;

Fig. 5 is a sectional view of the control valve assemblage which forms a part of the hydraulic system illustrated in the preceding figures. The view is taken along a vertical plane which extends generally transversely of the line of draft of the tractor with which the system is associated, certain parts of the valve assemblage being cut away to show various features of the valve construction;

Fig. 6 is a sectional view taken on line 6—6 in Fig. 5;

Fig. 7 is a sectional view taken on line 7—7 in Fig. 5;

Fig. 8 is a sectional view taken through the right hand end of the control valve as shown in Fig. 5. This view also shows a diagrammatic representation of one of the safety features of the illustrated valve;

Figs. 9 and 10 are enlarged, fragmentary views of another of the safety means incorporated in the control valve illustrated in the preceding figures. These figures show the safety means in successive controlling positions;

Figs. 11a to 11e, inclusive, are diagrammatic, sectional views of successive control positions of the valve illustrated in the preceding figures; and

Fig. 12 is a fragmentary, perspective view of the control member which is one of the operating elements of the valve illustrated in the preceding figures.

A hydraulic system having various features of the invention is illustrated in the drawings operatively associated with an agricultural tractor T. The various elements of the system are supported upon the tractor T, and the tractor engine (not shown) is employed as the source of power for pressurizing the hydraulic fluid. The illustrated system controls the operation of a pair of lifting arms L which are attached to the rearward end of the associated tractor through the medium of a power translating device which may be a hydraulic ram or jack. The lifting arms L are adapted to be connected by a suitable mechanical linkage (not shown) to the apparatus associated with the tractor T during operation.

The system shown in the drawings comprises, in general, a control valve means 15, a continuously operating pump 17 (Fig. 3), a reservoir 19 for hydraulic fluid, a power translating means such as the hydraulic ram 21 (Figs. 1, 2, and 4), illustrated, for accomplishing the movement of the lifting arms, and a control handle or lever 23 which is moved by the operator of the apparatus to effect the

energization of the hydraulic ram 21. The ram 21 is provided with a double acting piston (not shown) which operates in an elongated chamber, and in the illustrated structure, a pair of flexible, fluid conduits 25 and 25a interconnect the ram chamber, on opposite sides of the piston, with the control valve 15.

The tractor T, in addition to the usual chassis, engine, support wheels, steering mechanism, etc., includes a power-take-off shaft 27 at its rearward end which is connected with the tractor engine (not shown) through the usual clutch (also not shown). The control valve 15 and the hydraulic pump 17, illustrated in the drawings, are assembled as an integral unit which is adapted to be supported at the rearward end of the tractor T in a manner such that the pump 17 may be driven from the power-take-off shaft 27. The sump or reservoir 19, illustrated, is of cast construction and includes a plurality of walls 28 which define a hollow, box-like chamber. The reservoir 19 is attached to the tractor T, rearwardly of the rear axle housing (indicated as 29 in Figs. 3 and 4) to provide both a sump 30 for hydraulic fluid and a housing for the drive means for the pump 17. The reservoir casting may be a separate unit which is held in place on the tractor by suitable supporting brackets or it may be formed as an integral part of the rear axle and power take-off assemblage on the tractor T.

The illustrated reservoir 19 is an integral part of the associated tractor T, and the power take-off shaft 27 extends through the upper portion of the reservoir 19. A pair of oil seals 31 are provided in the walls 28 of the reservoir around the rotatable power take-off shaft 27 to prevent hydraulic fluid from being thrown from the sump 30. As is illustrated particularly in Fig. 3, a roller bearing 33 is disposed adjacent each of the oil seals 31 to insure that the power take-off shaft 27 is adequately supported. Drive means for the pump 17 (Fig. 3) is disposed within the reservoir 19, and this means includes a sprocket 34 which is keyed to the power take-off shaft 17 and a sprocket 35 which is rotatably journaled on a stub shaft 37, supported in the rearward wall 28 of the reservoir 19. The sprockets 34 and 35 are operatively connected by a roller chain 39 and one section of a suitable coupling 41 is attached to the sprocket 35. This section of the coupling 41 is adapted to be engaged by the power input connection for the pump 17.

In the illustrated unit, the pump 17 and the control valve 15 form an integrated assemblage. Accordingly, certain features of the valve construction will be described before proceeding with the description of the pump 17. The control valve 15 includes a body 43 of cast metal or the like which is cored and machined to provide various valve openings and passageways, as will be hereinafter described, and the ends of the body 43 comprise right-hand and left-hand end housings 44 and 44a, respectively (Figs. 5 and 6). A unitary supporting flange 43a is cast integrally with the body 43, and this flange 43a is provided with suitable holes 46 to permit attachment of the valve body 43 to the rearward wall of the reservoir 19 by means of a plurality of cap screws 45 or the like (Fig. 3). The lower portion of the rearward wall of the reservoir 19 is cut away to provide an opening 47 which is somewhat smaller than the overall dimensions of the flange 43a, and as shown particularly in Figs. 3 and 6, the pump 17 is inserted into the reservoir 19 through this opening in order that the pump 17 will be in close proximity to the supply of hydraulic fluid maintained in the sump 30. The positioning of the pump 17 within the reservoir eliminates the need for gaskets in the pump construction since any leakage will drain back into the fluid in the reservoir. As a result of the elimination of pump gaskets, the pump parts may be machined to close working tolerances without requiring allowances for the resiliency of gasket material.

As is also illustrated in Figs. 3 and 6, the rearward surface of the control valve body 43 is substantially plane,

and a casing 49 for the pump 17 is bolted to this plane face. The pump 17, illustrated, is of the gear-type, and accordingly the casing 49 includes a body section 49a and a cover section 49b which, in combination with the rearward surface of the valve body 43, define a pumping chamber for the gears 50 and 50a of the pump 17. The casing body 49a, in the illustrated structure, is generally diamond shaped (Fig. 5) and is provided with a pair of generally circular, interconnected openings 51 which are proportioned to receive the pumping gears 50 and 50a. The openings 51 are disposed one above the other so that the pumping gears 50 and 50a are vertically aligned when they are meshed together. The gears 50 and 50a are of the usual type and are attached to stub shafts 53 and 53a, respectively, whereby the gears 50 and 50a may be rotatably supported. One end of each of the stub shafts 53 and 53a is rotatably journaled in one of a pair of suitable apertures 55 in the rearward face of valve body 43 (Fig. 3), and the other or forward end of each of the shafts 53 and 53a is journaled into one of a pair of apertures 57 in the cover section 49b which constitutes one wall of the pump casing 49. The shaft 53 associated with the upper of the gears, gear 50, extends outwardly through the cover section 49b and is to connect with one end of the coupling 41; the other end of the coupling is attached to the sprocket 35. The valve body 43 and the reservoir 19 are proportioned so that the stub shaft 53 (associated with the upper gear 50 of the pump 17) and the stub shaft 37 (associated with the driving sprocket 35) are axially aligned when the valve body 43 is in place on the rearward end of the reservoir 19.

The pump 17 also includes an inlet fitting 59 which, in the illustrated structure, is a hollow, horn-shaped casting (Fig. 3). The inlet fitting 59 interconnects the lower portion of the sump 30 with one of the tips of the gears 50 and 50a (Fig. 6), and a screen 60 (Fig. 3) of relatively fine mesh is provided across the lower end of the inlet fitting 59 for removing small particles of grit and other foreign materials from the hydraulic fluid passing into the pump 17. The pump 17 delivers the pressurized hydraulic fluid through a passageway 61 (Fig. 6) into a passageway 63 in the valve body.

The control valve 15, particularly illustrated in Figs. 5, 6, and 7, is adapted to selectively deliver the pressurized fluid from the pump 17 to the pair of conduits 25 and 25a leading to the power translating means associated with the system. A horizontally disposed, transversely extending passageway 65 is provided centrally of the valve body 43 to form a guideway for a control member or control spool 67. The passageway 65 is conveniently cylindrical in shape and is machined to close tolerances so that a substantially liquid-tight seal will be formed between the control spool 67 and the walls of the passageway 65. In order that the pressurized fluid may be conducted through the control passageway in various pre-selected paths, a plurality of spaced-apart, enlarged openings or chambers 69, 70, 71, 72, 73, are disposed in longitudinally spaced relationship along the control passageway 65. These chambers are connected by suitable passageways and bores to various portions of the hydraulic system.

Specifically, the chamber 69 in the valve body 43 (Figs. 5 and 6), communicates with the sump 30 through a suitable passageway 74 (Figs. 3 and 3a) in the valve body 43 and through a passageway 75 in the supporting shaft 53a for the lower gear 50a of the pump 17. In this connection, the shaft 53a is conveniently fabricated from a hollow tubular member to provide the passageway 75. This arrangement reduces the number of passageways through the pump 17 and through the valve body 43, and thereby enables the production of a more compact unit by effecting close cooperative association of the pump 17 and the control valve 15.

In order to maintain the oil in the system in a clean, grit free condition, all of the oil passing from the valve

through the passageway 75 is filtered. In this connection, a member 76 having a passageway 76a therein is attached to the rearward side of the pump cover 49b, the passageway 76a being in communication with the passageway 75 as illustrated in Fig. 3a. The other end of the passageway 76a terminates in a plate-like section 76b of the member 76 which provides a base for a filter cartridge 78. The cartridge 78 comprises a cylindrical wall of porous material which is pressed against the plate-like section 76b by a coiled spring 80. The spring 80 acts upon a dome-like cover 82 which fits over an aperture 84 in the side of the reservoir housing 19 (Fig. 3a). The cover 82 desirably is detachably connected to the reservoir housing 19 by bolts or the like (82a) so that the filter cartridge 78 is accessible for cleaning the replacement. In operation, all of the oil returning to the sump through the passageway 75 is circulated through the cartridge 78 whereupon it is cleaned before it is returned to the sump. In the event that the operator permits the cartridge 78 to become clogged with foreign materials, a pressure will build up which will lift the cartridge 78 from the base 76b against the pressure of the spring 80, thereby permitting the oil to circulate around the filter. This filter arrangement does not comprise a part of the present invention and is the subject matter of a pending application Serial No. 186,418 by John F. Talak, filed September 23, 1950, assigned to the assignee of the present invention.

The passageway 63 (Fig. 6), which communicates at one end with the outlet passageway 61 from the pump 17, is branched and communicates with the chambers 70 and 72 which are located along the control passageway. The chamber 71, which, as illustrated in the drawings, is located between the chambers 70 and 72, is connected with the right-hand end of the unit (Figs. 5 and 6) by a bore 77, this bore communicating at one end with the chamber 71 and at the other end with the right-hand end of the valve body 43. The chamber 73, which is located adjacent the chamber 72 (which chamber communicates with one of the branches of the passageway 63) communicates with a bore 79 (Figs. 5 and 7) which connects the chamber 73 to a point in the left-hand end of the control valve 17.

The control spool 67 which fits within the control passageway 65 is adapted to be moved longitudinally of the passageway between determined limits into various control positions to interconnect the chambers 69 to 73, inclusive, in a predetermined sequence. In this connection, a vertically disposed control shaft 81 (Figs. 6 and 7) is journaled into a suitable bearing insert 83 in the valve body 43 and this control shaft 81 is operatively connected to the control lever 23 on the tractor by a mechanical linkage 85. The control shaft 81 is mechanically connected to the control spool 67 by an arm 87 which is rigidly attached at one end to the control shaft 81 and which is provided at its other end with a ball shaped fitting 89 (Figs. 6 and 7) adapted to fit within a socket 90 provided in a groove 91 in the control spool. Movement of the control lever 23 between predetermined limits effects movement of the control spool 67 longitudinally of the passageway 65 either from right to left or from left to right as viewed in Figs. 5 and 6.

As illustrated in Figs. 5 and 6, the control passageway 65 is defined between the chambers by annular bearing surfaces and each end of each of the annular surfaces is machined on a plane normal to the axis of the control passageway 65 to form a well defined, registering section for the control spool 67. The control spool 67 is fabricated from a piece of cylindrical stock and has two portions of reduced diameter (indicated as 93 and 94 in Figs. 5 and 6), disposed in spaced relation along its length. The portions of reduced diameter 93 and 94 are positioned to effect intercommunication between various of the enlarged openings or chambers 69 to 73, inclusive, in the valve body 43 as will be hereinafter described in

greater detail. As shown particularly in Fig. 12 and in Figs. 5 and 6, the shoulders which are formed between the portions of stock having a normal diameter, indicated as 97, and the portions of reduced diameter, 93 and 95, are provided with angularly disposed, wedge-shaped, cut out sections 99 which are adapted to cause a gradual change in the effective area of intercommunication between the various chambers during both the initial and final stages of establishing intercommunication therebetween. The provision of these angularly cut sections 99 eliminates the possibility of "fluid hammer" in the system and provides for smooth and even operation of the power translating device at even the slowest speeds. This makes possible the rapid and accurate adjustment of the power translating device under all operating conditions.

As before pointed out, the right-hand and the left-hand end housings 44 and 44a, respectively, are bolted or otherwise attached to the corresponding ends of the valve body 43. The housings 44 and 44a may be of cast construction and, as illustrated in Figs. 5 and 6, are cored and machined to provide fluid passageways, valve seats, and bearing surfaces for a pair of operating rods 101 and 101a for positioning the control spool 67 as will hereinafter be described. As is particularly shown in Fig. 5 the right-hand housing 44 includes a passageway 103 which communicates with the bore 77 in the valve body 43, and this passageway 103 is connected to the fluid conduit 25a by a conventional coupling 105. A unidirectional valve such as the spring pressed ball valve assemblage 107, illustrated particularly in Fig. 5 is disposed in the bore 77 to prevent the flow of hydraulic fluid from the conduit 25a into the chamber 71 and the control passageway 65.

In order to dispose the valve assemblage 107 in the bore 77, the bore 77 is counter-drilled to provide a valve chamber 109, and an annular valve seat 111 of suitable material is pressed in place to provide a seat for a ball sealing member 113. The ball 113 is biased against the seat 111 by a coiled compression spring 115 which acts against a spider support 117 held in position in the counter-drilled portion of the bore 77 by means of the pressure exerted by the registering face of the end housing 44. As is shown in the drawings (Fig. 5), a gasket 119 is disposed between the valve body 43 and the end housing 44 to seal the space between these members. In order to further insure that the hydraulic fluid will be maintained within the system, a section of O-ring-type packing 120 is disposed about the counter-drilled portion of the valve chamber 109 to provide an added resistance to the out flow of hydraulic fluid, since this connection is under extremely high pressure at all times during the operation of the unit.

The right-hand end housing 44 is also provided with a bore 121 which is axially aligned with the control spool 67 and which interconnects the control passageway 65 with the passageway 103. A chamber 123 is provided intermediate the ends of the bore 121 and this chamber is interconnected with the sump 30 by a passageway 125 (Fig. 8). The end of the bore 121 which communicates with the passageway 103 is provided with a counterbored portion which provides a seat 127 for a ball-type sealing member 129. The ball 129 is biased into the closed position against the seat 127 by a coiled, compression spring 131 which is held in place by the coupling 105 interconnecting the hydraulic conduit 25a to the passageway 103. The ball valve 129 in its normal, closed position prevents the flow of pressure fluid from the conduit 25a into the sump 30. Thus the passageway 103 constitutes a pressure passageway for the conduit 25a and this pressure passageway is connectable to the sump 30 through the valve 129 (and the chamber 123 and passageway 125).

Intercommunication between the control passageway 65 and the chamber 123 is effectively prevented by the positioning rod 101 which is proportioned to slidably fit within the bore 121. The length of the rod 101 is proportioned

so that one of its ends contacts the ball valve 129 and the other end engages the right-hand end of the control spool 67 when the spool is in the neutral position, that is the position shown in Figs. 5 and 6 and Fig. 11c.

The left-hand end housing 44a is similar in construction to the right-hand end-housing 44 which has been described. As shown in Figs. 5 and 6, the housing 44a is provided with a passageway 133 communicating with the bore 79, a bore 135 interconnecting the left-hand end of control rod passageway 65 and the passageway 133, and a chamber 137 intermediate the ends of the bore 135, which communicates with the sump 30 through a passageway 136 (Fig. 5). The passageway 133 is connected to the conduit 25 by a conventional coupling 138. A uni-directional valve 139 is disposed in a counter-drilled portion 141 of the bore 79 in order to prevent the flow of fluid from the external system into the bore 79, and this valve includes an annular valve seat 143, a valve ball 145, a biasing spring 147, and a spring support or spider 149. A section 151 of O-ring type packing is disposed between the bore 79 and the passageway 133 to seal the hydraulic fluid in that passageway and bore. Thus, the construction of the valve 139 is substantially the same as the construction of the valve 167.

The end of the bore 135 which communicates with the passageway 133 is provided with a counter-drilled portion to provide a valve seat 153, and a ball-sealing member 155 is disposed in this seat and is biased towards the closed position by a coiled, compression spring 157 which is held in place by the coupling 138. The second control-spool positioning rod 101a is disposed intermediate the left-hand end of the control spool 67 and the valve ball 155 as illustrated in Fig. 5, and this rod 101a effectively closes the bore 135 between the chamber 137 and the adjacent end of the control-spool passageway 65. The pressure passageway from the control passageway to the conduit 25 thus includes the bore 79 and the passageway 133 and the outer portion of this pressure passageway (the passageway 133) is connectable to the sump 30 through the valve 153.

As has been previously pointed out, in a valve means of this character, it is desirable that the control spool 67 be movable in a manner such that (a) movement of the controlled apparatus in one direction or in the other can be effected selectively, (b) the control member can be located in one or more predetermined positions to effect continuous travel of the controlled apparatus in one direction or the other without requiring attention to the control during a prolonged adjusting period, and (c) the control member will be automatically released from the locked position and automatically returned to its normal or neutral position when the controlled apparatus reaches a predetermined position during routine operation or in the event that the pressure in the system rises to an abnormally high value.

As may be seen from the drawings, the control spool 67 is resiliently held in the neutral position by means of the combined actions of the positioning rods 101 and 101a and the springs 131 and 157. This resilient positioning of the control spool 67, in combination with several features to be described, is operable to effect the above described operational requirements.

In the illustrated control valve the control spool 67, adjacent the left-hand end thereof, is provided with a pair of frustro-conical sections 159 and 161 (Figs. 5 and 6) which are machined or otherwise fabricated in the control spool 67 adjacent the point at which the control arm 87 is mechanically connected to the control spool 67. The frustro-conical sections 159 and 161 are oppositely disposed to form a rather shallow, annular, V-shaped groove 162, as illustrated. A pair of rather sharply defined, V-shaped, annular grooves 163 and 165 are also provided in the control spool 67, one at each side of the shallow groove 162. The groove 163 is located adjacent the conical section 159, and the groove 165 is located adjacent

the conical section 161. The sharply defined grooves 163 and 165 and the conical sections 159 and 161 provide a cam surface which is engaged by a spring biased detent mechanism 167 (Figs. 6 and 7).

The detent mechanism 167 (Figs. 6 and 7) is disposed in a passageway 169 which extends radially outwardly from the control passageway 65 and which interconnects the sump 30 and the control passageway 65. The passageway 169 includes a section of reduced diameter 171 which communicates with the control passageway 65, the enlarged section communicating with the sump 30, as illustrated.

The control detent mechanism 167 includes a detent plunger 173 having two piston-like sections 173a and 173b, one of which 173a, is adapted to slidably fit within the larger section of the passageway 169, the other of which, 173b, is adapted to slidably fit within the portion 171 of the passageway 169 which is of reduced diameter. The piston-like section 173b of the detent plunger 173 carries a conical shaped projection 175 which is adapted to be biased against cam surface formed by the V-shaped grooves 163 and 165, and the conical sections 159 and 161 of control spool 67. As may be seen in Fig. 7, the detent plunger 173 is of hollow construction and includes a passageway 177 of small diameter which interconnects the hollow central portion of the detent plunger 173 and the enlarged portion of the passageway 169 adjacent the inner or smaller end thereof. The detent plunger 173 is biased into a position engaging the control spool 67 by a coil spring 179 which bears against a portion of the pump casing 49 (Figs. 6 and 7).

The spring 179 is proportioned so that it exerts sufficient pressure to hold the conical point 175 of the detent plunger 173 in either the groove 163 or the groove 165 with sufficient force to lock the control spool 67 in either the extreme right-hand or left-hand position. Since the control spool 67 will effect the continuous operation of the hydraulically controlled power translating device in either of these positions, it is desirable to provide an automatic release for the detent plunger 173 in the event that the power translating device reaches its limit of travel during routine operation or in the event that the pressure in the controlled system rises to over a predetermined value. Accordingly, the illustrated apparatus is provided with a releasing mechanism which is responsive to the pressure within the hydraulic system and which is operable to retract the detent plunger 173 from the grooves 163 and 165.

This releasing mechanism, which is particularly illustrated in Figures 5, 7, 9, and 10, includes an elongated, cylindrical chamber 181 in the valve body 43, one end of the chamber being in communication with the chamber 70 around the control spool 67 through a short passageway 182 and the other end of the chamber 181 being open and provided with a threaded portion 183 for receiving a threaded closure member 185. The chamber 181 is adapted to contain a piston mechanism including a piston 187, a piston guide 189, and a biasing spring 191, this mechanism being adapted to control the operation of the detent plunger 173 as will be hereinafter described.

The piston guide 189 which is fabricated to close tolerances, is disposed in the end of the chamber 181 adjacent the passageway 182. The piston guide 189 includes a passageway 193 which extends axially of the chamber 181 for receiving the piston 187 and an annular depression or groove 195 which coacts with the walls of the chamber 181 to define an annular passageway 197. The axially extending passageway 193, adjacent the passageway 182, is connected with a horizontally disposed, transversely extending passageway 199 in the valve body 43 through a small opening 201 in the piston guide 189. The opening 201 communicates with an annular groove 203 in the upper end of the piston guide 189 thus making it unnecessary to align the opening 201 with the passageway 199 when assembling the valve 15. A series of circumferentially spaced, radially extending, passageways 205 are

provided in the piston guide 189 to connect the passageway 193 at a point below the opening 201 with the annular passageway 197. The passageway 197 is connected with the sump 30 through an overflow opening 207 and is connected with the hollow portion of the chamber 181, below the piston guide 189, by at least one small aperture 209.

The piston 187 is slidably disposed within the axially extending passageway 193 in the piston guide 189, and conveniently this piston may be cylindrical in shape. The piston 187 and the passageway 193 in the piston guide 189 are machined to close tolerances, as before pointed out, to provide a substantially liquidtight seal between the external surface of the piston 187 and the walls of the passageway 193. The piston 187 is provided with an axially extending passageway 211 terminating in a small aperture 213 which communicates with the interior of the chamber 181, and the lower end of the piston 187 is provided with an enlarged portion 215 which is adapted to provide a seat for the compression spring 191 which biases the piston 187 toward the chamber 70. The other end of the spring 191 is seated against the inner surface of the closure member 185 as illustrated in the drawings. The portion of the closure member 185, which is screwed into the threaded portion 183 of the chamber 181, is proportioned so that it engages an annular sleeve 216 in the upper portion of the chamber 181 and moves that sleeve into engagement with the lower end of the piston guide 189. The sleeve 216 holds the guide 189 in position in the upper portion of the chamber 181 and provides a cylinder wall for the enlarged portion 215 of the piston 187. The portion 215 is engaged by the sleeve 216 with a fairly good fit, e. g. a clearance of about .005 inch on each side. A washer 218 is disposed between the member 185 and the lower end of the walls defining the chamber 181 to prevent the leakage of hydraulic fluid.

In order to enable the piston 187 to open readily and to prevent a fluid lock in the event that the chamber 181 becomes filled with fluid below the enlarged portion 215, a bleed hole 219 is provided which communicates with the sump 30. In this connection, the sleeve 216 is provided with a cut out portion 221 so that the hole 219 will not be covered by the sleeve 216. A passageway 217 is provided intermediate the passageway 199 in the valve body 43 and the inner portion of the passageway 169 outwardly of the section of reduced diameter 171 as illustrated in Fig. 7 to hydraulically interconnect the detent plunger 173 with the release mechanism.

In the event that the pressure in the chamber 70 rises to over a predetermined value during the operation of the hydraulic system, the piston 187 will be forced downwardly by the fluid pressure against the biasing action of the spring 191 until the opening 201 is uncovered (Fig. 9). At this point the hydraulic fluid passes through the passageway 199 and the passageway 217 into the inner end of the passageway 169 whereupon the fluid forces the detent plunger 173 outwardly against the action of the spring 179 to release the control spool 67 which will move to the neutral position under the action of the springs 131 and 157.

In the event that the control spool 67 does not move to the neutral position when the detent plunger 173 is retracted, as for example when a foreign object becomes lodged in the control spool passageway 65 or when the operator does not release the control, the pressure will continue to build up until the piston 187 is forced downwardly a sufficient amount to open the radially extending passageways 205 (the position of the piston 187 illustrated in Fig. 10). The hydraulic fluid will then flow through the radially extending passageways 205 into the annular passageway 197 and thence to the sump 30 through the opening 207. At this time some of the fluid in the annular passageway will flow through the passageway 209 into the chamber 181 above the portion 215 of the piston 187. The flow of the hydraulic fluid to the sump

30 will lower the fluid pressure within the system to a safe value, and the spring 191 will then return piston 187 to a position partially covering passageways 205 so that the pressure will be maintained at a safe maximum value, this value being determined by the strength of the spring 191 and the area of the piston 187. The fluid trapped above the portion 215 of the piston 187 will be forced through the passageway 209 into the passageway 197. This flow of fluid through the passageway 209 will damp the closing movement of the piston 187 and will thereby prevent chattering of the piston 187.

During the operation of the system in extremely cold weather, the hydraulic fluid in the sump 30 may become so viscous as to cause excessive pressures to be developed in the system. These excessive pressures will also be relieved through the passageways 205 after the pressure builds up to a value where they are uncovered.

The various openings and apertures through which the hydraulic fluid flows during the operation of the releasing mechanism are proportioned to effect the desired operation. Specifically, the opening 201 and the passageways 199 and 217 have a larger cross sectional area than the opening 177 in the detent plunger 173 and the areas are proportioned to insure that the pressure produced in the inner end of the passageway 169 will be sufficient to overcome the force of the spring 179. In one commercial embodiment of the invention the piston 187 and the spring 191 were proportioned so that a pressure of 1100 pounds per square inch was operable to force the piston 187 downwardly to uncover the opening 201 while a pressure of 1500 pounds per square inch was required to depress the piston 187 sufficiently to uncover the openings 205. In this embodiment the normal operating pressure was 800 pounds per square inch. Further, the passageway 211 and the aperture 213 are just large enough to permit hydraulic fluid to seep into the chamber 181, and this fluid flows to the sump through the bleed hole 219. The fluid in the chamber 181 provides lubrication for the portion 215 of the piston 187 which engages the sleeve 216.

Another safety feature is incorporated in the hydraulic system to protect the valve 15 and the external hydraulic system from excessively high pressures which may be developed due to a failure in some part of the controlled system. In control systems which include a hydraulic ram for a power translating device these failures may cause the development of exceedingly high pressures. A diagrammatic view of a typical hydraulic ram 225 in combination with the control valve 15 embodying various features of the invention is illustrated in Fig. 8. The hydraulic ram 225 includes a cylindrical chamber or cylinder 227 which is provided at one end with a hydraulic connection 228 adapted to be connected to the hydraulic conduit 25 and at the other end with a connection 228a which is adapted to be connected to the conduit 25a. A piston 229 having a packing or sealing ring 231 is disposed within the cylinder 227 and is movable longitudinally of the cylinder 227 by the changes in hydraulic pressure effected by the control valve 15. The piston 229 is connected to the controlled apparatus (not shown) by a piston rod 233 which extends outwardly through a packing gland 235 in one end of the cylinder. In the event that the sealing ring 231 becomes worn or damaged, the reactive forces of the controlled apparatus or load upon the piston rod 233 may cause extremely high pressures to be developed within the system. The direction of the reactive force is shown by the arrow F in Fig. 8.

This reactive force ordinarily would be caused by the weight of the implement or portion thereof which was raised in the first instance by the pressure differential between the lower and the upper side (as shown in Fig. 8) of the piston 229. As hereinbefore indicated, this pressure differential would normally be only a few hundred pounds per square inch, and during normal operation of the device, assuming the packing ring 231 to be

fluid tight, this differential would not be exceeded and the implement would be supported thereby. However, for reasons which will be clear from the foregoing description, at such times as the implement is at rest, that is, not being actually raised or lowered, fluid at either conduit 25a or 25 is prevented from reaching either relief valve 167 or valve 219 by check valves 107 and 139. Thus, the controlled implement is being carried by the pressure differential across the piston 229 and even a slight leakage past packing ring 231 will tend to equalize the pressure below and above the piston 229. The pressure differential will then be insufficient to support the implement and the weight of the implement will cause downward movement of piston 229 with a corresponding movement of the piston rod 233 into the cylinder 225. The rod 233 will displace some of the fluid in the cylinder and will cause an increase of pressure in the space above piston 229. The implement will continue to drop until the pressure below the piston is again sufficiently in excess of the pressure above the piston to support the implement. In an extreme case, the implement will be supported by the pressure on a limited area of the underside of piston 229 equal to the cross sectional area of the piston rod 233. The pressure necessary to do this, of course, is very much greater than that for which the system is intended and as above stated it is not released by the relief valves 167 and 219.

For example, assuming that the piston rod 233 has a cross sectional area of .785 square inch (a rod 1 inch in diameter) and that the thrust resulting from the weight of the load is 3000 pounds, the pressure within the system, that portion of the system which is external of the valves 107 and 139 will rise to about 3820 pounds per square inch due to the hydraulic action in the cylinder. Since the usual hydraulic system of the type illustrated is designed to operate at a pressure of from about 600 to 800 pounds per square inch, it will be readily seen that the elevated pressures resulting from a failure in the ram may severely damage the equipment.

Relief of the excessive pressures which may develop in the external system is accomplished by providing means for venting the hydraulic fluid in the conduits 25 and 25a and in the power translating means to the sump 30. This means includes a valve mechanism 237 in one of the end housings 44 or 44a of the valve 15. In the illustrated valve, the valve mechanism 237 is located in the right-hand end housing 44 intermediate the passageways 103 and 125. The valve mechanism includes a passageway 239 which is provided with a valve seat 241 intermediate the passageways 103 and 125. A ball type, sealing member 243 is disposed in the seat 241 and is biased into the closed position, towards the passageway 103, by a spring 245. The other end of the spring 245 acts against the right-hand end face of the valve body as illustrated (Fig. 8). The spring 245 is proportioned to yield only upon pressures greatly in excess of those for which the equipment is intended but less than pressures which would be damaging to the equipment. Thus, in the event the pressure in that portion of the system which is external to the valves 107 and 139 increases to a dangerous value, because of mechanical failure or otherwise, that portion of the system will be connected to the sump 30 through the valve mechanism 237 and the passageway 125, and the pressure prevented from rising further.

As has been pointed out in the foregoing, the control spool 67 is movable longitudinally of the control passageway 65 into a plurality of control positions for interconnecting the various chambers in a predetermined sequence. During operation, movement of the hand lever 23 on the tractor by the operator rotates the control shaft 81 and the control arm 87 which in turn effects movement of the control spool 67 into the various positions. The control spool 67 is biased towards the neutral position by the action of the valve springs 131 and 157 acting through the positioning rods 101 and 101a, the rods 101

and 101a being proportioned to substantially eliminate slack movement in the elements disposed between the ball valves 155 and 129, i.e. the positioning rods 101 and 101a and the control spool 67. The rods 101 and 101a, in the illustrated apparatus, thereby serve the dual function of centering the control spool 67 in the central or neutral position and of lifting the ball valves 129 or 155 as the spool is moved from side to side under the action of the hand lever 23.

Operation of the hydraulic ram 21 in the illustrated system is accomplished by the continuously operating pressurizing pump 17 through the controlling action of the valve 15. The various control positions of the control spool 67 in the valve 15 are shown in the diagrammatic views Figs. 11a to 11e inclusive.

Fig. 11c illustrates the control spool 67 in the central or neutral position; when the spool 67 is in this position, the hydraulic fluid follows the paths shown by the arrows 247 in that figure. The hydraulic fluid circulates freely from the pump 17, through the passageway 63, around the portion of the reduced diameter 93 on the control spool 67, and into the chamber 69 and the passageway 74 which communicates with the sump 30 through the hollow, supporting shaft 53a for the lower gear 50a of the pump 17 and the filter cartridge 78. Thus no pressurized fluid can reach the controlled mechanism.

Movement of the control spool 67 to the left into the position shown in Fig. 11d, causes the rod 101a to open the ball valve 155 thereby permitting hydraulic fluid from the conduit 25 to pass into the sump 30 through the chamber 137 and the passageway 136 as indicated by the arrows 249 (Fig. 11d). Simultaneously, the spool 67 has moved to the left a sufficient amount to effect communication between the chambers 71 and 72 around the portion of reduced diameter 94 while at the same time restricting the communication between the chambers 69 and 70 around the portion of reduced diameter 93. The restriction of the flow between chambers 69 and 70 causes the development of pressure in the system. Hydraulic fluid from the pump then flows in two paths as shown by the arrows 251, one portion of the fluid being directed to the sump 30 through the passageway 74 and the other portion of the fluid flowing through the bore 77, around the valve 107, and through the passageway 103 to the conduit 25a. It may be seen that the amount of fluid flowing from the hydraulic ram 21 through the conduit 25 to the sump 30, indicated by the arrows 249, is compensated for by the amount of fluid flowing to the ram 21 through the conduit 25a. This transfer of hydraulic fluid in the cylinder of the hydraulic ram effectively moves the piston in the desired direction at a relatively slow speed.

Further movement of the control spool 67 to the left causes the detent plunger 173 to become engaged in the annular groove 165 in the spool 67 as illustrated in Fig. 11e. At this point, the detent 173 holds the spool in position and the operating member of the controlled ram is moved at a maximum rate of travel. In this position, the opening between the chambers 70 and 69 is closed by an enlarged portion of control spool as illustrated, and all of the hydraulic fluid from the pump 17 passes directly from the chamber 72, around the portion of reduced diameter 94 in the spool 67, and the fluid then flows through the bore 77, around the valve 107, and through the passageway 103 to the conduit 25a communicating with the hydraulic ram 21. The ball 155 is moved outwardly from the seat a maximum amount by the rod 101a so that the fluid in the hydraulic ram which is displaced by the fluid from the conduit 25a is permitted to flow through to the sump in the manner which has been described. The path of the fluid flowing from the ram to the sump 30 is shown by the arrows 253 (Fig. 11e), and the path of the fluid flowing to the ram from the pump is shown by the arrows 255 (Fig. 11e).

The control spool 67 may be moved in the opposite

direction to stop the operation of the controlled ram at any time. Manual movement of the control handle 23 will cause the conical point 175 of the detent plunger 173 to slip from the groove 165 and across the cam surface formed by the frustro conical sections 159 and 161. As soon as the detent plunger 173 is released from the groove 165, the springs 131 and 157 bias it towards the central or neutral position. In the event that the source of hydraulic fluid is not manually disconnected from the hydraulic ram before the piston of the ram has moved to its extreme position, as when the attention of the operator is required for some other purpose, the operator merely permits the ram to move to its extreme position whereupon the pressure within the system will increase to a value sufficient to move the piston 187 downwardly to uncover the opening 201 in the piston guide 189. At this point the hydraulic fluid flows through the passageways 199 and 217 to automatically retract the detent plunger 173 from the groove 165. The action of the valve springs 131 and 157 will then move the control rod to the neutral position and circulate all of the hydraulic fluid to the sump as shown in Fig. 11c.

In order to effect the movement of the controlled power translating device or ram in the opposite direction, the control spool 67 is moved to the right of the central position to the position illustrated in Fig. 11b. In this position, the ball valve 129 is opened by the positioning rod 101 and the hydraulic fluid flowing from the pump flows in two paths as shown by the arrows 257. In one path of flow the pressurized fluid from the pump 17 flows from the chamber 70 to the chamber 69 and thence to the sump 30, and in the other path the fluid flows from the chamber 72 to the chamber 73 and thence through the bore 79 and the passageway 133 to the conduit 25. The fluid in the ram is returned to the sump 30 through the conduit 25a and the passageway 125 as shown by the arrows 259 (Fig. 11b). Here again the ram is operated at a relatively slow rate.

Further movement of the spool to the right, to the position shown in Fig. 11a, causes the conical point 175 of the detent plunger 173 to become engaged in the groove 163. This movement also serves to open the valve 129 to a greater degree and to cause all of the fluid circulating from the pump 17 to flow from the chamber 72 to the chamber 73 and thence through the bore 79 and passageway 133 to the controlled ram as shown by the arrows 261, Fig. 11a. The hydraulic fluid flows from the ram to the sump in the path shown by the arrows 263 (Fig. 11a). Either manual or automatic release may be employed to move the control spool 67 back to the neutral position.

As may be seen from the foregoing description of the operation of the valve and of the hydraulic system, the hydraulic fluid flowing from the pump to the controlled power translating device is divided into two separate streams when the control spool is located in all positions except the extreme end positions. This feature enables the operator to exert a very close control upon the rate of movement of the controlled device. In addition to the ease of control effected by the division of flow of the hydraulic fluid, the cut away portions 99 on the control spool make possible an extremely accurate adjustment of the flow of hydraulic fluid into any one chamber in the control passageway 65. Moreover, as illustrated in the drawings, the seats for the ball valves 129 and 155 are proportioned to restrict the flow of hydraulic fluid around the ball sealing member in all but the extreme open position for each valve. Thus, when moving the controlled apparatus in either direction at slow speed, the valves 129 and 155 aid in effecting smooth operation and accurate control.

The various elements of the valve and of the associated pump are so interrelated that the number of parts in the units are reduced to a minimum and maintenance and repair costs are maintained at a low level. This is accom-

plished by providing two functions for many of the elements, and by incorporating various safety means into the valve and pump construction. For example, the automatic releasing mechanism, as has been pointed out, is operable to release the control spool and to cause it to move into the neutral position in the event that the pressure in the system exceeds a predetermined value, and if the spool does not move into that position, the automatic releasing mechanism is operable to interconnect the pressure system to the sump. Further, excessive pressures which may be caused by a failure in the external hydraulic system are guarded against by the provision of the valve 237 which automatically interconnects the external system with the sump in the event that the pressures in the external system rise above a predetermined value. The provision and construction of these means thus forms an important part of the invention.

Various features of the invention which are believed to be new are set forth in the appended claims.

I claim:

1. In a system of the class described which includes a sump for containing hydraulic fluid, a pumping unit comprising a fluid pump and a control valve, a body section for said control valve, said body section having one plane surface, a first outlet in said body section, an inlet in said body section which terminates at said plane surface, a second outlet in said body section which terminates at said plane surface, and means for selectively connecting said inlet to said outlets, a member which defines the outline of a pumping chamber, said member being attached to the plane surface of said body section, a pair of pumping gears, said gears being disposed in said chamber defining member, a cover plate having an inlet therein, said cover plate being attached to said chamber defining member to form a closure for said pumping gears, a supporting shaft for each of said gears, one of said shafts having a longitudinally extending passageway therein, means for carrying one end of each of said shafts in said body section, the shaft which includes the longitudinally extending passageway being in communication with said second outlet in said body section, and means for carrying the other end of each of said shafts in said cover plate, the shaft which includes the longitudinally extending passageway extending through said cover plate and having communication with the sump, said body section and said chamber defining member and said cover plate being arranged so that the pressurized fluid from said pumping chamber communicates with the inlet of said body section, and the inlet in said cover plate being arranged to communicate with the inlet side of said pumping gears, whereby fluid may flow in paths through said cover plate inlet, through said pumping gears, through the inlet of said valve body, and selectively through either the first outlet of said valve body, or through the second outlet in said valve body, through the longitudinally extending passageway in said gear supporting shaft, and thence through that passageway to the sump.

2. In a hydraulic system of the class described, means defining the walls of a sump for containing hydraulic fluid and having an opening in one side thereof, a pump and control valve for pressurizing fluid and for directing that fluid in predetermined paths, and opening in the wall of said sump for receiving said pump and control valve, said pump and control valve comprising a body section having one plane surface which includes a flanged portion which is proportioned and positioned to seal the opening in said sump, a first outlet in said body section, an inlet in said body section which terminates at said plane surface, a second outlet in said body section which terminates at said plane surface, and means for selectively connecting said inlet to said outlets, a member which defines the outline of a pumping chamber, said member being attached to the plane surface of said body section, a pair of pumping gears, said gears being disposed in said chamber defining member, a cover plate having an inlet therein,

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said cover being attached to said chamber defining member to form a closure for said pumping gears, a supporting shaft for each of said gears, one of said shafts having a longitudinally extending passageway therein, means for carrying one end of each of said shafts in said body section, the shaft which includes the longitudinally extending passageway being in communication with said second outlet in said body section, and means for carrying the other end of each of said shafts in said cover plate, the shaft which includes the longitudinally extending passageway extending through said cover plate, said body section and said intermediate member and said cover plate being arranged so that the pressurized fluid from said pumping chamber communicates with the inlet of said body section, and the inlet in said cover plate being arranged to communicate with the inlet side of said pumping gears, said body section being attached to the walls of said sump with said pump extending through said opening in said sump whereby said inlet in said cover plate is placed in communication with the hydraulic fluid contained in said sump and said passageway through said gear supporting shaft opens into said sump, whereby fluid may flow in paths through said cover plate inlet, through said pumping gears, through the inlet of said valve body, and selectively through either the first outlet of said valve body, or through the second outlet in said valve body through the longitudinally extending passageway in said gear supporting shaft and thence through that passageway to the sump.

3. In a hydraulic system having a source of fluid, a pump having an improved control valve comprising a housing defining an elongated chamber therein, said housing also including a pair of fluid outlets communicating with said chamber, a plurality of first passageways in said housing placing said chamber in communication with the pump, source of fluid, and said fluid outlets, a pair of additional passageways in said housing placing each of said fluid outlets in communication with the source, a pair of valve means controlling said additional passageways, a control member disposed in said chamber for axial movement to control said first passageways, operating means intermediate said control member and said pair of valve means for effecting opening of one of said valve means to place the associated fluid outlet in communication with the source in response to movement of said control member to a control position affording flow between the pump and the other of said fluid outlets, and a relief means comprising a by-pass passage connecting one of said additional passageways downstream of the associated one of said valve means with said source, a check valve controlling communication between said one additional passageway and said by-pass passage, said check valve being operable in response to a predetermined pressure in the downstream portion of said one additional passageway to permit the passage of the fluid to the sump and thereby relieve the pressure in the conduit.

4. In a hydraulic system having a source of fluid and a pump, an improved control valve comprising a housing defining a chamber therein, said housing also including a pair of fluid outlets communicating with said chamber, a plurality of first passageways in said housing placing said chamber in communication with the pump, source of fluid, and said fluid outlets, a unidirectional valve in each of the passageways which connect said chamber with said fluid outlets to prevent flow through said outlets to said chamber, a pair of additional passageways in said housing each placing a portion of one of the fluid outlet passageways downstream of said unidirectional valve in communication with said source of fluid, a biased check valve controlling the flow of fluid from each of the fluid outlet passageways to the associated one of said additional passageways, a control member in said chamber which is movable to a plurality of positions for controlling communication between said source, pump, and fluid outlets through said first passageways, said control member

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being biased toward a neutral position affording communication between said pump and said source, a mechanical connection between said control member and said check-valves, said mechanical connection being operable to open the check valve associated with one of said fluid outlets to connect the latter with said source of fluid in response to movement of said control member to a position affording the discharge of fluid through the other of said fluid outlets, and a relief means comprising a by-pass passage connecting one of said fluid outlet passageways downstream of its unidirectional valve with the associated one of said additional passageways, and a spring biased check valve controlling communication between said fluid outlet passageway and said by-pass passage and operable to open in response to a predetermined pressure in said one fluid outlet passageway.

5. In a hydraulic system having a source of fluid and a pump, an improved control valve comprising a housing defining an elongated chamber therein and having a pair of fluid outlets, a plurality of passageways in said housing placing said chamber in communication with said source, pump, and said fluid outlets, respectively, a control member disposed in said chamber for axial movement to control communication between said source, pump, and said fluid outlets, said control member being biased to a neutral position wherein pressure fluid from said pump is directed back to the source, a control lever operatively connected with said control member through means including detent means engageable with said control member to hold the latter in at least one of its control positions, and a release mechanism for said detent means which is in communication with said chamber and responsive to a predetermined pressure in said chamber to retract said detent means from engagement with said control member whereby the latter will return to said neutral position.

6. In a hydraulic system having a source of fluid and a pump, an improved control valve comprising a housing defining an elongated chamber therein and having a pair of fluid outlets, a plurality of passageways in said housing placing said chamber in communication with said source, pump, and said fluid outlets, respectively, a control member disposed in said chamber for axial movement to control communication between said source, pump, and said fluid outlets, said control member being biased to a neutral position wherein pressure fluid from said pump is directed back to the source, a control lever operatively connected with said control member through means including detent means engageable with said control member to hold the latter in at least one of its control positions, and a release mechanism for said detent means which is in communication with said chamber and responsive to a predetermined pressure in said chamber to retract said detent means from engagement with said control member, said release mechanism including a cylindrical chamber defined by a portion of said control valve housing, said cylindrical chamber having communication with said elongated chamber and with said detent means, a piston in said cylindrical chamber, means biasing said piston against the normal fluid pressure in said elongated chamber to a position preventing communication with said detent means, said piston being movable in response to a predetermined pressure in said elongated chamber to permit communication between said elongated chamber and said detent means, whereby the pressure fluid thereby directed to said detent means effects a retraction of the latter from its position engaging said control member to permit the control member to return to its neutral position.

7. In a hydraulic system having a source of fluid and a pump, an improved control valve comprising a housing defining an elongated chamber therein and having a pair of fluid outlets, a plurality of passageways in said housing placing said chamber in communication with said source, pump, and said fluid outlets, respectively, a control member disposed in said chamber for axial movement to control communication between said source, pump, and said

fluid outlets, said control member being biased to a neutral position wherein pressure fluid from said pump is directed back to the source, a control lever operatively connected with said control member through means including detent means engageable with said control member to hold the latter in at least one of its control positions, and a release mechanism for said detent means which is in communication with said chamber and responsive to a predetermined pressure in said chamber to retract said detent means from engagement with said control member whereby the latter will return to said neutral position, said release mechanism including a cylindrical chamber defined by said housing, a first passageway placing said cylindrical chamber in communication with one of the passageways communicating with said elongated valve chamber for the passage of pressurized fluid therethrough, a second passageway placing said cylindrical chamber in communication with said detent means, and an outlet in said cylindrical chamber which communicates with said source of fluid, a piston in said chamber, means biasing said piston into a position covering said second passageway and outlet, said piston being operable in response to an excessive pressure to move to a position opening said second passageway and direct pressure fluid therethrough to retract said detent means, and said piston being further movable against said biasing means in response to pressures of a second predetermined amount to open said outlet to the source of fluid.

8. Apparatus as set forth in claim 7, wherein said piston includes means affording communication between said first passageway and said cylindrical chamber past said piston, thereby providing means permitting the flow of fluid past said piston to damp the movement of said piston within said cylindrical chamber.

9. In a hydraulic system having a source of pressurized fluid, and a control valve for directing the flow of the pressurized fluid including a housing having a plurality of passageways and including a control member in the housing which is movable to positions controlling the flow of the pressurized fluid through the passageways, a releasable means for holding the control member in a predetermined position comprising, a detent plunger biased for engagement with the control member in said predetermined position, means defining a chamber and a first passageway for placing said chamber in communication with the control valve housing, means defining a second passageway affording communication between said detent plunger and said chamber, a piston in said chamber, means for biasing said piston against the

normal fluid pressure in said first passageway to maintain said piston in covering relation to said second passageway, said biasing means being yieldable in response to a predetermined pressure on said piston to permit movement of said piston to a position uncovering said second passageway, whereby pressurized fluid will flow through said second passageway to act upon said detent plunger and effect a retraction thereof from its position engaging said control member.

10. In a system of the class described which includes a sump for containing hydraulic fluid, an improved pumping unit comprising means defining a casing, an inlet in said casing in communication with the sump, an outlet in said casing, a pumping chamber in said casing which communicates with said inlet and said outlet, a pair of gears disposed in said pumping chamber in meshing engagement with each other, a supporting shaft for each of said gears, one of said gear supporting shafts having a longitudinally extending passageway therein, a control valve including a body which is attached to said pump casing, an outlet in said body, an inlet in said body which is in communication with the outlet in said pumping chamber, and a second outlet for said body which is in communication with one end of the passageway in said one supporting shaft, and means providing communication between the other end of the passageway and said sump.

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