

Sept. 4, 1951

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2,566,633

FILTER SYSTEM

Filed June 21, 1948

2 Sheets-Sheet 1

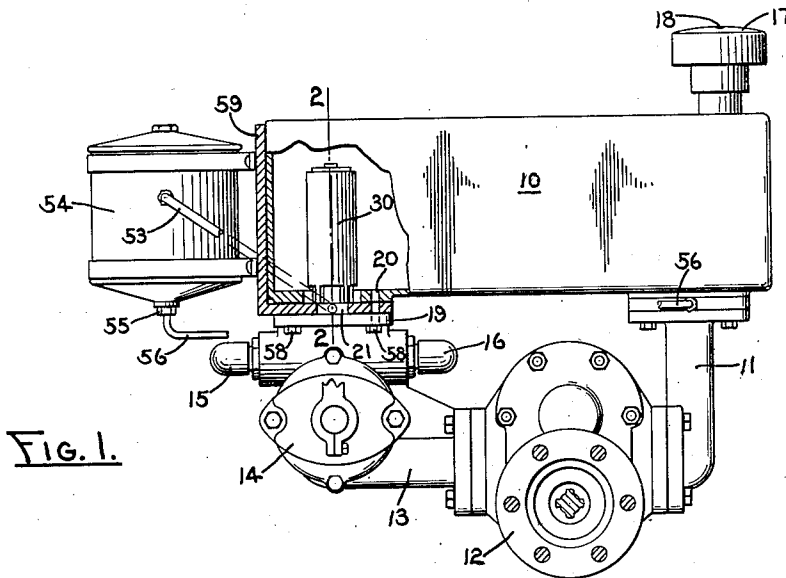


FIG. 1.

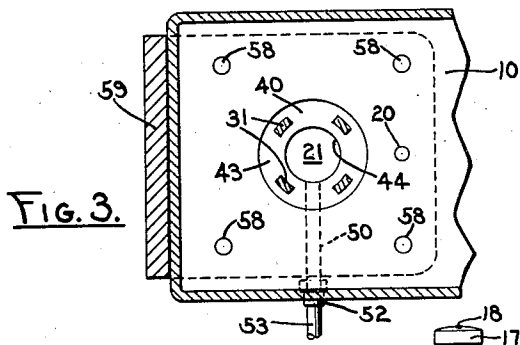


FIG. 3.

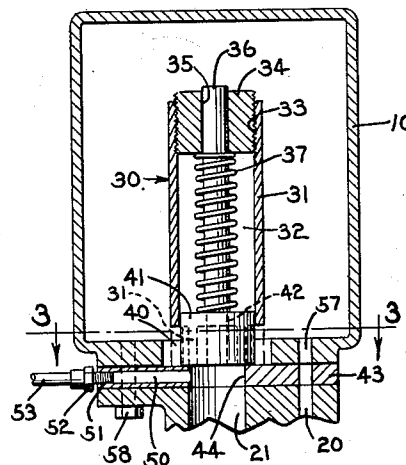


FIG. 2.

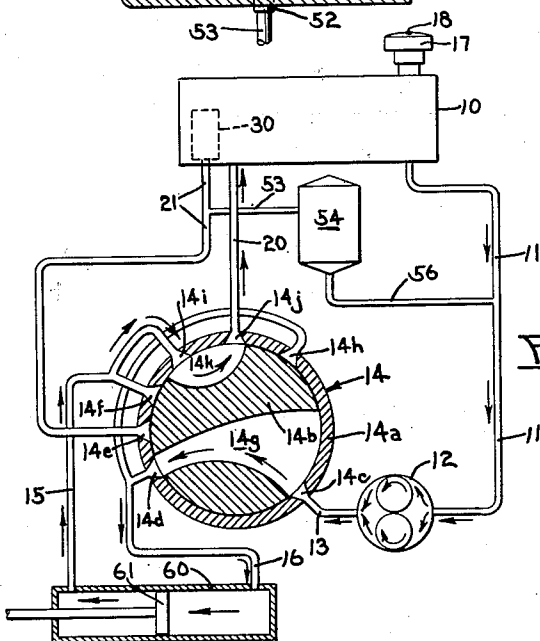


FIG. 4.

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2 Sheets-Sheet 2

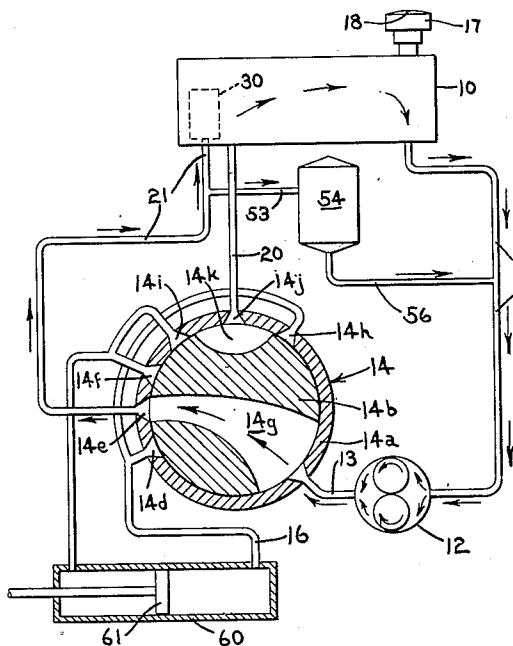


FIG. 5.

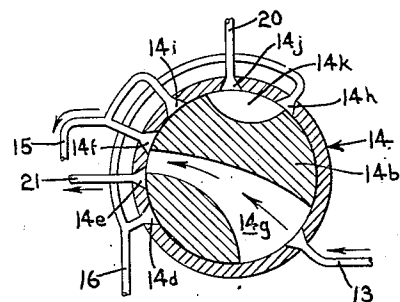


FIG. 6

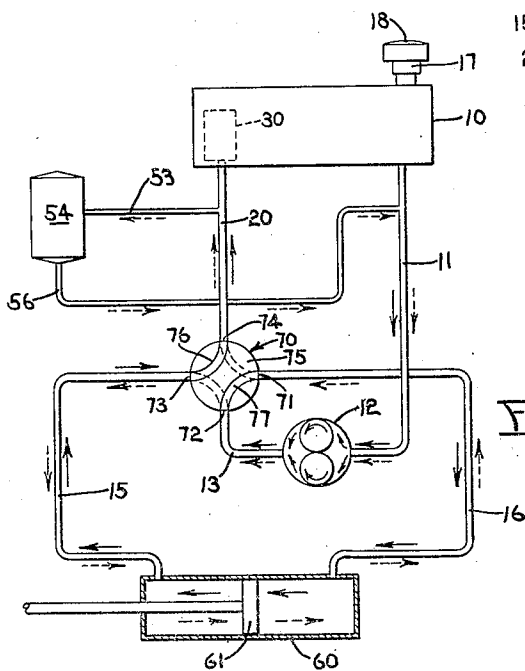


FIG. 7.

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FILTER SYSTEM

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3 Claims. (Cl. 60—52)

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My invention relates to an oil filter system for hydraulic apparatus and is more specifically concerned with an attachment to be added to standard or well-known oil circulating systems for controlling heavy equipment, which makes possible the addition of a standard oil filter.

In many heavy road building equipment, earth moving devices, and agricultural implements, earth engaging means thereof are manipulated by hydraulic control systems employing hydraulic cylinders or rams extended or contracted in response to hydraulic pressures imposed thereon. Such control systems are inherently expensive in initial cost and have been found to deteriorate rapidly because of dust, dirt, and other abrasive material that accumulate in the hydraulic system and are circulated with the fluid. Much of the abrasive material has been found to come from elements of the control systems themselves, such as metal chips from the ram, valve, pump or other structure. The extent of the wear in conventional systems in normal operation necessitate a complete overhaul annually. The repetitious nature of the overhauling and repairing operations is so great that in many instances the expense of maintenance of such hydraulic control systems far overshadows the even considerable expense of its initial purchase.

It is conventional in hydraulic control systems to employ a fluid reservoir, a pump, and a valve in association with one or more rams whereby fluid pressure generated by the pump may be selectively imposed on opposite ends of the ram or rams. When a ram is manipulated, fluid is bled, from the end of said ram opposite the end to which fluid pressure is applied, back through the valve and from the valve to the reservoir. In order that the system may at all times be ready to operate, the pump is run constantly. When a ram is maintained in predetermined position, the valve seals the ram from the rest of the control system and fluid from the pump is by-passed through the valve back to the reservoir, the pump merely serving to circulate the fluid to the reservoir and to remain ready for immediate effect on the ram in response to valve manipulation. At such times, the pump is said to be in stand-by condition. When in stand-by condition, the valve effectively isolates both ends of the ram from the control system and maintains the ram in predetermined position. It is significant that during normal operations hydraulic control systems are maintained in stand-by condition approximately 95% of the time.

An obvious solution to the problem of main-

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tenance previously discussed is that of filtering the fluid to remove all abrasive material therefrom. For many years efforts have been expended by manufacturers of hydraulic control systems and others to this end but without success. It has been found impractical to build filters to withstand the excessive pressures in hydraulic control systems and still capable of effective operation in screening abrasive material from the hydraulic fluid. The experimentation in this direction has been so extensive and the lack of success so universal, that the manufacturers of hydraulic control systems have generally reached the conclusion that there is no possible solution to the problem and that periodic repair and replacement is unavoidably a concomitant defect of such systems. The filtering system of the present invention has succeeded in solving the problem and has proved itself by extensive use capable of reducing maintenance expenses almost to the point of elimination.

It is an object of the present invention to minimize wear and maintenance expenses incident to operation of hydraulic control systems.

Another object of my invention is to provide a fluid filtering system whereby standard oil filters can be employed in hydraulic control systems without danger of rupture because of excessive pressures.

It is another object of my invention to provide a means for by-passing excessive pressures around a filter so that it will be impossible for excessive pressure to be built-up in the filter.

Another object is to provide a filtering system for hydraulic control systems in which a pressure pump, while in stand-by condition, is employed to circulate fluid in the control system through the filtering system.

Another object is to provide, in an hydraulic control system in which a constantly running pump imparts circulatory movement to fluid in the system and a valve is manipulated periodically to impress part or all of fluid pressure generated by the pump upon a ram and to by-pass the fluid not directed to the ram back to the intake of the pump under substantially no pressure, a filtering system receiving said by-passed fluid and screening dirt, abrasive material, and other foreign matter therefrom.

Another object is to provide in an hydraulic control system having a fluid reservoir and a fluid pump which when in stand-by condition circulates fluid from the reservoir, through the pump, and back to the reservoir, a valve interposed the pump and the reservoir adapted to resist flow of

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fluid from the pump to the reservoir sufficiently to divert such flow through a filter, and adapted to open for passage of fluid directly from the pump to the reservoir upon the exerting thereon of a pressure in excess of a predetermined magnitude.

It is also among the objects of my invention to provide a simple attachment which can be applied to standard oil pressure systems for operating heavy equipment which will permit the use of a filter, thereby prolonging the effective life of the equipment and reducing the cost of expensive repairs.

Other and further objects and advantages of my invention will become apparent from the drawings and the specifications relative thereto.

In the drawings:

Fig. 1 shows a portion of a conventional hydraulic control system to which the system of the present invention has been added.

Fig. 2 is a cross-section taken on line 2—2 of Fig. 1 of means provided by the present invention against which fluid pumps employed in hydraulic control systems build up sufficient pressure for filtering purposes when the pump is operating in a stand-by condition.

Fig. 3 is a fragmentary sectional view taken on line 3—3 of Fig. 2.

Fig. 4 is a schematic diagram illustrating the operation of the system of the present invention in combination with a conventional hydraulic control system.

Fig. 5 is a schematic diagram similar to that shown in Fig. 4 and illustrating the positioning of the control valve in by-pass position and the resulting fluid flow through the filtering system of the present invention.

Fig. 6 is a fragmentary view of the system shown in Figs. 4 and 5 illustrating the control valve in an intermediate position in which the partial flow of hydraulic fluid is directed through the filtering system.

Fig. 7 is a schematic diagram illustrating the fluid flow in a modified form of the present invention.

In the drawings, Fig. 1 illustrates a well-known hydraulic system which comprises a fluid reservoir tank 10, having an outlet conduit 11 communicating with a pump 12, and a pump discharge conduit 13 communicating with a directional valve 14. Conduits 15 and 16 communicate with the interior of the valve 14 and also with an hydraulic piston or ram, subsequently to be described, to be operated by the fluid pressure. Further details of the internal connections will become apparent in an explanation of Fig. 4. The tank is provided with a filling opening closed by a cap 17 having a breathing opening 18 there-through. The opening permits expansion and contraction of fluid in the tank incident to temperature variations and the like and precludes the subjecting of the tank to damaging pressure variations.

The directional valve 14 is also formed with a mounting flange 19 adapted to mount the valve to the tank 10. The flange 19 is formed with a ram bleeding bore 20 and a by-pass bore 21 adapted to communicate with the interior of the valve 14. The significance of bores 20 and 21 will also become apparent in the subsequent discussion of Fig. 4.

The parts described up to this point constitute standard equipment and are no part of the present invention. My invention resides in the addition of a filtering system and of a pressure build-

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up mechanism, designated generally 30, which comprises a cylindrical housing 31 defining a chamber 32, as seen in Fig. 2. The upper portion of the housing 31 is internally threaded, as at 33, and a plug or cap 34 is threadedly disposed therein. The plug 34 is formed with an axial bore 35 adapted to receive a valve stem 36. The purpose of the back pressure valve is to provide a closure against which the pump 12 may build up small pressures sufficient for filtering purposes and which opens at predetermined pressures to avoid all excessive pressures of damaging effect on a filter subsequently described.

Whereas, I have herein illustrated the means for closing the top of the housing 31 as a plug, such as 34, it will become apparent that the principal function of such member is to position the stem 36 and to act as a backing for a compression spring 37. Any member which will perform this function should be considered an equivalent. Other devices which could be substituted might include a plate welded to the top of the housing 31 and could be either solid or could assume the form of a spider bracket.

The lower extremity of the housing 31 is formed with a plurality of perforated sections 40, shown in Figs. 2 and 3, which, as will be seen, act as oil passages when the pressure build-up mechanism 30 functions to relieve pressure. A valve 41 is slideably disposed in the chamber 32 and is attached to the stem 36 by means of a threaded connection 42. The spring 37 is adapted to press against the top of the valve 41 urging it in a downward direction in fluid-tight engagement against a plate 43 interpositioned the housing 31 and the flange 19. The plate 43 is formed with a bore 44 adapted to register with the bore 21 for the passage of oil or other hydraulic fluid and is interposed the flange 19 and the tank 10 on which the plate 43 is also formed with a bore 50 adapted to communicate with the bore 44 and having an interiorly threaded section 51 adapted to receive a tubular fitting 52. A conduit 53 is secured in communication with the bore 50 by means of the fitting 52 and communicates with a filter 54. The filter 54 is of more or less standard construction and is provided with a discharge 55 which communicates with the discharge line 11 from the oil tank by means of a conduit 56. A bore 57 is formed through the plate 43 in fluid communication with the ram bleeding bore 20 and the interior of the tank 10. The plate is conveniently mounted on the tank by bolts 58 extended upwardly through the flange 19, passed through the plate and screw-threadedly engaged to the tank 10. By extending the plate upwardly, as at 59, along an end of the tank, a convenient mounting for the filter 54 is provided.

Reference to Figs. 4, 5 and 6 will clarify the system of the present invention. It is to be understood that the illustrations of the valves 14 in the above figures are purely schematic to indicate the operation thereof and are not intended to duplicate the exact structure employed. The valve includes a body 14a in which a core 14b is rotatably positioned. The body provides a high pressure inlet 14c connected by the conduit 13 to the high pressure side of the pump 12. The housing further provides a plurality of outlets 14d, 14e and 14f, respectively, connected to one end of a cylinder 60, to the by-pass bore 21 and to the opposite end of the cylinder 60, respectively. The core has formed therein a passageway 14g having an enlarged intake end in constant registration with the inlet 14c and se-

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lectively registering at the opposite end thereof with a control outlet 14d, 14e or 14f or with any adjacent two thereof. The housing further provides bleeding openings 14h and 14i in fluid communication with the control openings 14d and 14f, respectively, by way of conduits 16 and 15, respectively. An opening 14j is provided in the housing intermediate the bleeding openings 14i and 14h and is in fluid communication with the bleeding bore 20, previously described. A passage 14k is positioned so that as fluid is fed to one end of the cylinder 60 fluid is bled from the opposite end of the cylinder back through the passage 14k into the tank 10. A piston 61 is slidably mounted in the cylinder 60 and the piston and cylinder together constitute a two-way control ram of well-known form.

As shown in Fig. 4, when pressure is employed at the control opening 14d its respective bleeding opening 14h is closed. As shown in Fig. 5, when the hydraulic control is in stand-by condition, the pump urges fluid through the passage 14g which is maintained in registration with the opening 14e and fluid circulated through the by-pass bore 21. In such condition the core 14b blocks control openings 14d and 14f and bleeding openings 14i and 14h.

In Fig. 6 an intermediate condition is illustrated in which a portion of hydraulic fluid from the pump is directed through the passageway 14g out of the opening 14e and back to the by-pass bore 21 and the remainder of the fluid through the opening 14f to the cylinder 60 to control the piston 61. It will be noticed that in this condition the opening 14h is in partial registration with the passage 14k permitting the opposite end of the cylinder gradually to bleed. For purposes of convenience, the bleeding bore 20 and the by-pass bore 21 are schematically illustrated in tubular form in Figs. 4, 5 and 6.

As will be readily understood, the spring 37 (referring to Fig. 2) will determine the amount of pressure against the bottom of the valve 41, which will cause the valve 41 to lift from sealing engagement with the plate 43, thereby permitting fluid to escape from the passageway 44 through the apertures 40 and into the tank 10. Screw-threaded adjustment of the plug 34 in the housing 31 predetermines pressure exerted by the spring 37 downwardly and the pressure the pump 12 may build up against the bottom of the valve 41 for filtering purposes.

Operation

The operation of the device is clearly apparent and is briefly summarized at this point. The pump at 12 is motivated from a power take-off of a tractor or the like, not shown, in order to circulate hydraulic fluid from the tank 10 through the conduit 11, pump 12, discharge conduit 13, valve 14, and back to the tank through the bleeding bore 20 and/or the by-pass bore 21.

The valve core 14b of the valve 14 is most frequently positioned as shown in Fig. 5 for stand-by operation of the pump, in which position the total discharge of hydraulic fluid from the pump is directed through the outlet 14e and the by-pass bore 21 to the pressure build-up mechanism 30. When the valve is so positioned, the piston 61 of the cylinder 60 is locked in predetermined position by the effective sealing of the control outlets 14d and 14f and the bleeding openings 14i and 14h by the core 14b. In this stand-by condition, the pump builds up a sufficient pressure against the mechanism 30 to force

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fluid through the filter 54 and back through the conduits 56 and 11 to the intake side of the pump 12. This pressure is quite low being generally of the magnitude of five pounds to the square inch, or less. Under normal stand-by conditions the entire volume of hydraulic fluid pumped through the pump 12 is filtered at 54 and effectively cleaned of dirt, rust, scale and other abrasive material.

In the event excessive pressure is built up against the filter 54, incident to clogging or the like, the valve 41 is urged upwardly against the resistance of the spring 37 and the hydraulic fluid circulated through the tank as is normally done by pumps in stand-by condition in conventional hydraulic systems. It will be perfectly obvious that the tank 10 can be under no pressure because of the breather opening 18 and thus the pressure to which the filter 54 is subjected is accurately controlled by the pressure build-up mechanism 30. Attention is again directed to the fact that in hydraulic control systems the valve 14 and pump 12 are operated in stand-by condition for normally in excess of 95% of the time of operation of the control system.

When it is desired to move the piston 61 of the cylinder 60 to the left, as viewed in Fig. 4, the valve core 14b is rotated counter-clockwise from the stand-by position of Fig. 5 to direct hydraulic fluid from the pump to the right end of the cylinder by way of conduit 16. Simultaneously the bleeding opening 14i is connected in fluid communication with the bore 20 through the opening 14j and the left side of the cylinder permitted to bleed back to the tank 10 through the conduit 15. So positioned, the opening 14h is closed by the core as is the control opening 14f and the stand-by opening 14e. When the piston in the cylinder is moved, pressures many times that to which a normal filter may be exposed are required. For example, such filters are constructed to withstand and operate effectively under pressures of four or five pounds per square inch. The pressures required to manipulate the ram may approximate fifty times this pressure. Thus when the ram is manipulated, the sealing of the opening 14e by the core 14b protects the filter against all such pressures. These periods during which the filter is divorced from the control system seldom exceed from two to four percent of the operating time of the control system.

It will be evident that in the operation of the control system there will be times at which the passage 14g is directed to a pair of the adjacent openings 14d, 14e and 14f. This condition is shown in Fig. 6 and is employed when it is desired slowly to move the piston 61 in either direction. In Fig. 6 the passage 14g is in registration with both of the openings 14e and 14f. The partial registration constricts the fluid flow through both of the openings. Under such condition a partial flow of fluid through conduit 15 serves to position the piston and the remainder of the fluid is diverted through the bore 21 and the filter 54, the pressure build up mechanism 30 serving to resist fluid flow through the bore 21 sufficiently to divert the same through the filter. As before, the pressure build up mechanism 30 operates as a relief valve in the event that excessive pressures are imposed thereon and dissipates said pressure into the tank 10. Simultaneously the opening 14h is arranged in constricted fluid communication with the bore 20

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permitting the end of the cylinder toward which the piston 61 is moved to bleed back through the bore 20 to the tank 10. The total time during which the valve 14 is employed in the condition shown in Fig. 6 rarely exceeds from one to three percent of the total operating time of the system.

The filtering system of the present invention is convenient to install, easily accessible for repair, and is accurately adjustable by means of the nut 34 to impress predetermined pressures on the filter of small magnitude. This accurate control permits the employment of low pressure filters and makes available their effective operation and economy of construction. The filtering system is efficient in that hydraulic fluid is diverted through the filter after it has passed through the hydraulic control system and in that it is normally operative for approximately 95% of the time the control system is in operation. In actual operation the system and elements of the present invention have reduced repair and maintenance expenses for hydraulic control systems with which they have been employed almost to the point of elimination.

Modified form

The hydraulic system schematically shown in Fig. 7 employs elements already described and like parts are given like numbers. A valve 70, however, is employed differing from the valve 14 previously described. In the system shown in Fig. 7, the bore 20 is the only path for fluid from the valve to the tank 10 and thus returns all hydraulic fluid to the tank resulting from bleeding of the cylinder 60 or from the positioning of the valve in stand-by condition. The valve 70 employs a two-way structure having an inlet 71 and discharge ports 72, 73 and 74. A centrally disposed core 75 is formed with the passageways 76 and 77. As shown in the schematic illustration, the passageway 77 communicates between the ports 71 and 72 and the passageway 76 between the ports 73 and 74 so that the flow of fluid is as follows: Commencing with the pump 12, fluid is forced under pressure through the line 13, passageway 77, conduit 16 and into the cylinder 60 forcing the piston 61 to the left. Fluid which is held in the cylinder to the left of the piston 61, is forced through the line 15, passageway 76, and bore 20 to the tank 10. The bore 20 is provided with a pressure build-up mechanism 30 in the manner already described for bore 21. It will be readily understood that when the valve 70 is positioned in a stand-by condition there will be a flow of hydraulic fluid from the pump to the tank. The pressure build-up mechanism 30 resists such flow sufficiently to create a pressure sufficient to divert the hydraulic fluid through the conduit 53, filter 54 and conduit 56 back to the conduit 11 and thence to the pump 12. Under such condition, the total flow of hydraulic fluid is filtered.

When the valve 70 is positioned as shown in Fig. 7, controllably to position the piston 61 in the cylinder 60, it will be apparent that no greater pressure is imposed on the bore 20 than the weight of fluid standing thereabove and the resistance offered by the pressure build-up mechanism 30. Said mechanism diverts the hydraulic fluid through the filter 54 as previously described and opens whenever pressure due to clogging or periodic fluid surges exceeds the structural limits of the filter 54 and for dissipation of such excessive pressure in the tank. The system of the

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present invention operates similarly when the valve 70 is positioned to change the pattern of fluid flow to the cylinder or directly back to the tank for stand-by operation.

Thus, it will be seen that I have provided a pressure relief system or attachment to be used in connection with standard hydraulic systems, which permits the use of filtering devices which will substantially clean the hydraulic fluid used in the system, thereby preventing excessive wear on the pump and the hydraulic control pistons.

While I have herein shown and described my invention in what I have conceived to be the most practical and preferred embodiments, it is recognized that departures may be made therefrom within the scope of my invention, which is not to be limited to the details disclosed herein, but is to be accorded the full scope of the claims so as to embrace any and all equivalent devices.

This application is a continuation in part of my application having Serial Number 788,026, which was filed November 25, 1947, resulting in Patent Number 2,526,411 dated October 17, 1950.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:

1. In a hydraulic control system having a reservoir, a pump, and a two-way ram; the combination of a conduit interconnecting the reservoir and the pump; a valve in fluid communication with the pump; said valve having a by-pass port, a pair of pressure supply ports, a pair of bleeding ports, and an exhaust port in fluid communication with the reservoir; a conduit interconnecting one end of the two-way ram and a pressure supply port and a bleeding port; a conduit interconnecting the opposite end of the ram and the other supply port and bleeding port; a conduit interconnecting the by-pass port and the reservoir; a pressure build up valve connected to said last named conduit precluding fluid flow therefrom into the reservoir when pressure in said conduit is less than a predetermined magnitude and opening for discharge into the reservoir when the pressure exceeds the predetermined magnitude; and a filter in fluid communication between said last named conduit and the conduit interconnecting the reservoir and the pump; the valve having a controllably positioned core adapted to direct fluid therethrough from the pump to the by-pass port and to block the bypass port while directing fluid flow to an individual pressure supply port while simultaneously blocking the bleeding port to which the supply port is connected by the conduit and the opposite pressure supply port and directing return fluid flow therethrough from the opposite bleeding port to the exhaust port.

2. In a hydraulic control system including a two-way hydraulic control ram, and a pump having an intake and a discharge; a control valve having an inlet, a pair of pressure outlets, a pair of bleeding openings, a discharge opening, and a core positionable to connect the inlet to either of the pressure outlets while closing the remaining outlet and a bleeding opening and simultaneously connecting the remaining bleeding opening to the discharge opening, said core also having an intermediate position in which both pressure outlets and both bleeding openings are closed and the inlet connected to the discharge opening; bleeding conduit means connected between the intake of the pump and the discharge opening of the valve; by-pass conduit means connected between the intake of the pump and the discharge opening of the valve in parallel relation

to the bleeding conduit means; a pressure release valve in the by-pass conduit means; a filter in the bleeding conduit means; and conduits individually connecting the discharge openings of the valve and opposite ends of the ram and bleeding openings of the valve with opposite ends of the ram.

3. In a hydraulic control system including a double acting hydraulic control line, and a pump having an intake and a discharge; a control valve having an inlet connected to the discharge of the pump, a pair of alternately openable pressure outlets connected to opposite ends of the ram, a pair of alternately closeable bleeding openings connected to opposite ends of the ram and a discharge opening connected to the intake of the pump, said valve being operable selectively to direct hydraulic fluid under pressure from the pump to selected ends of the ram while bleeding the opposite end of the ram back through

the valve discharge opening and into the intake on the pump; a filter connected between the discharge opening of the valve and the intake of the pump; and a by-pass conduit having a pressure release valve therein connected between the discharge opening of the valve and the intake of the pump in parallel relation to the filter.

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