Aug. 9, 1927. 1,638,786

G. E. SMITH

CONTROL MECHANISM

Filed Feb. 28, 1924 4 Sheets-Sheet 1

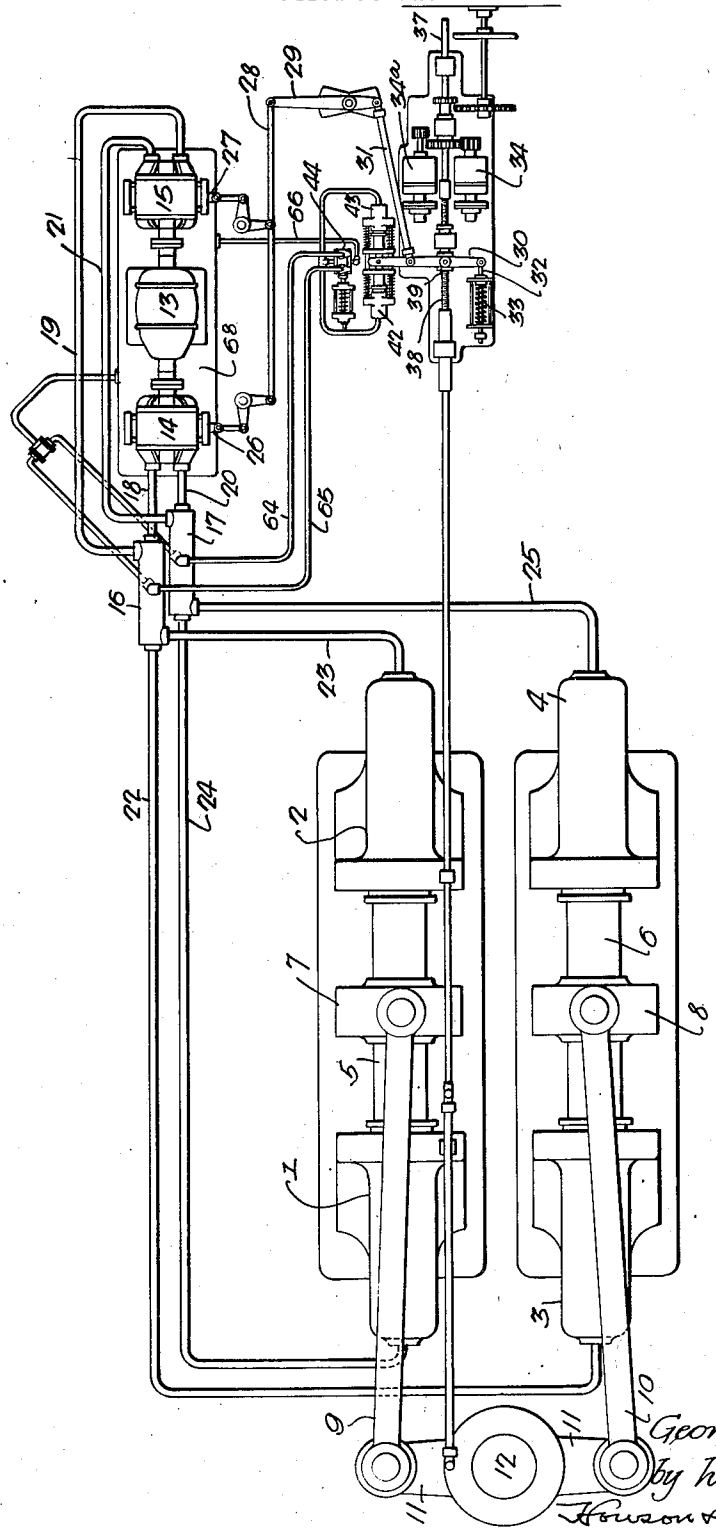


Fig. 1.

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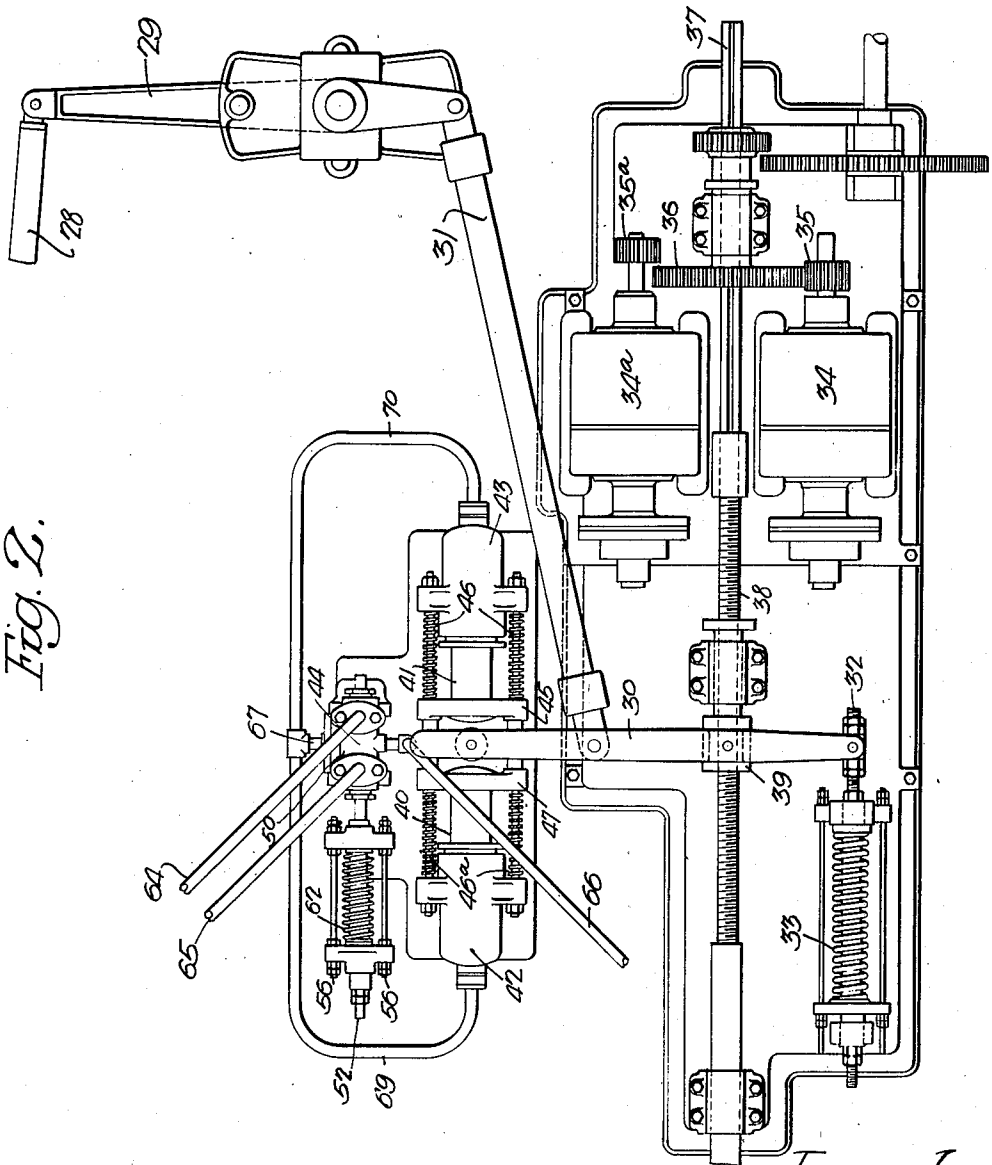


Fig. 2.

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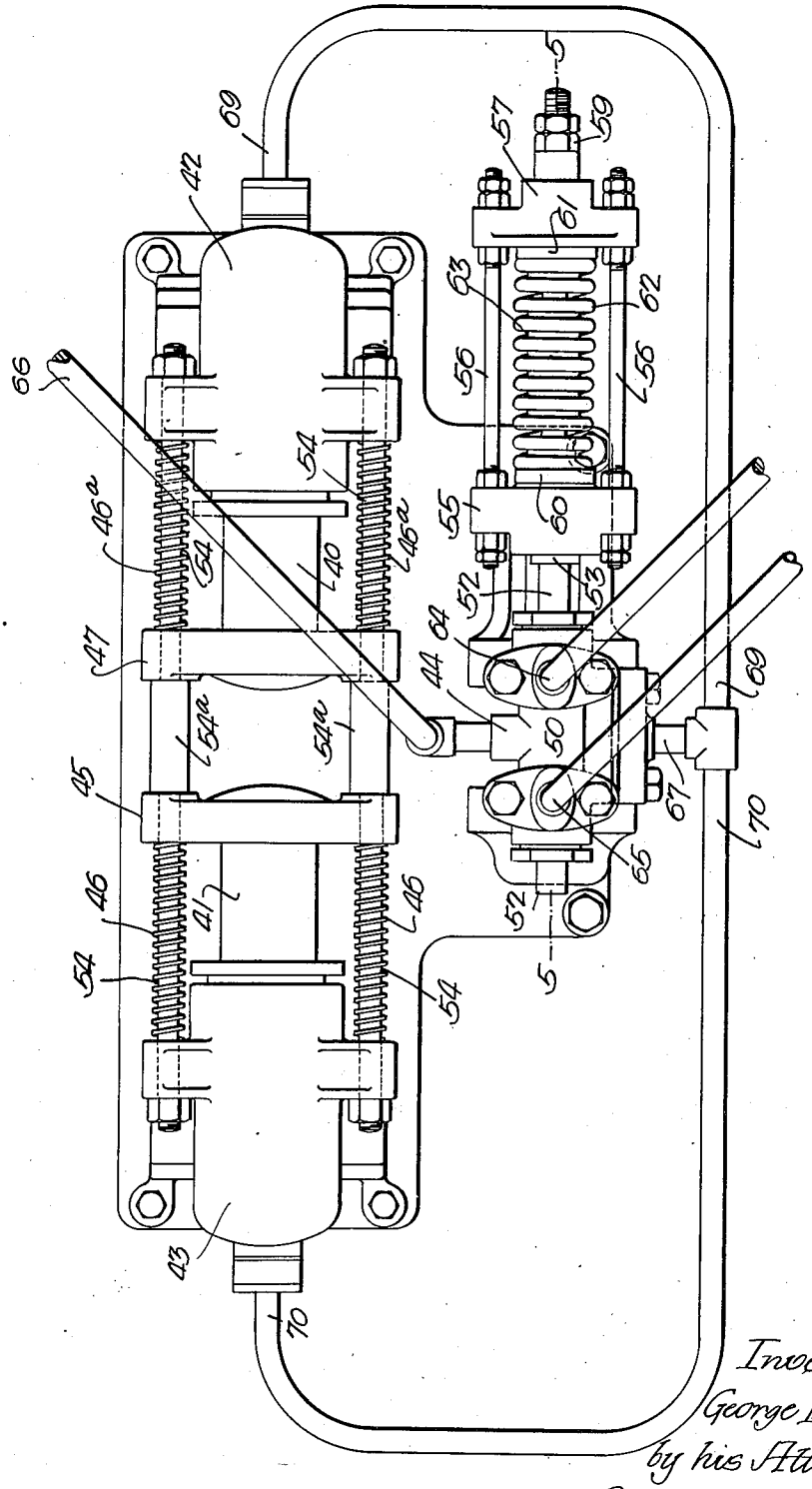


Fig 3.

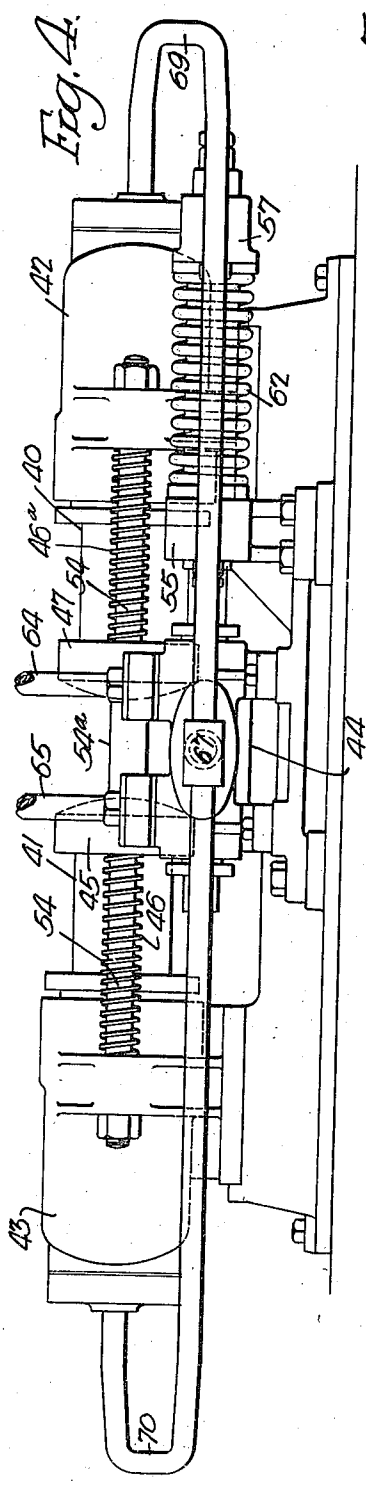
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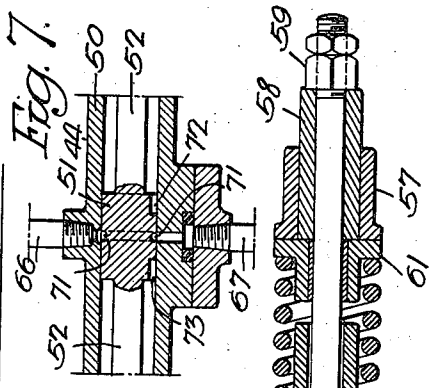
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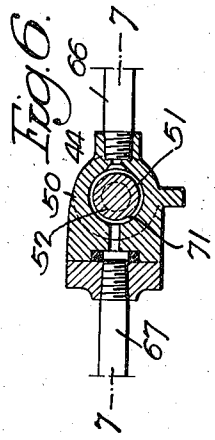
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CONTROL MECHANISM

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Patented Aug. 9, 1927. 1,638,786

UNITED STATES PATENT OFFICE.

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CONTROL MECHANISM.

Application filed February 28, 1924. Serial No. 695,841.

This invention relates to hydraulic apparatus and more particularly to certain improvements especially useful in hydraulic steering gear systems,—one object of said invention being to provide a relatively simple, substantial and reliable combination of elements for automatically reducing the amount of liquid delivered by a continuously driven, variable capacity pump or pumps when the pressure in the system increases above a predetermined point, with a view to protecting the pump motor or motors from injury or objectionable overload.

Another object of the invention is to provide a hydraulic steering gear including a pump for propelling the liquid required for operating the system, with novel means for automatically reducing the capacity of the pump whenever the pressure of liquid reaches a predetermined high point, and the invention more especially contemplates a relatively simple form of pressure responsive device for changing the stroke of a continuously driven, variable capacity pump when predetermined conditions exist in the system.

These objects and other advantageous ends I attain as hereinafter set forth, reference being had to the accompanying drawings, in which,

Fig. 1 is a plan, to some extent diagrammatic, illustrating one form of the apparatus constituting my invention;

Fig. 2 is a plan on a larger scale than Fig. 1, illustrating the detail construction of certain of the mechanism of the system;

Fig. 3 is a plan on a larger scale than Fig. 2, further illustrating the detail construction of certain parts of my invention;

Fig. 4 is a side elevation of the apparatus shown in Fig. 3;

Fig. 5 is a vertical section on the line 5—5, Fig 3;

Fig. 6 is a transverse section on the line 6—6, Fig. 5; and,

Fig. 7 is a horizontal section on the line 7—7, Fig. 6.

In the above drawings, 1—2 and 3—4 represent the two pairs of opposed single acting cylinders of a hydraulic steering gear including rams 5 and 6 which are fixed to cross heads 7 and 8, respectively. Through links 9 and 10, these cross heads, respectively, are connected to the arms 11—11 of a head fixed to a rudder post 12.

For supplying the above cylinders with fluid under pressure, I provide a continuously operating electric motor 13 shown in the present instance, as connected to two variable capacity fluid pumps 14 and 15. Obviously, either or both of these may be used at will without departing from my invention. These pumps, in the present instance, are of the variable stroke type and they may obviously be of any desired or suitable construction permitting of the reversal of the direction of the liquid circulated by them while the driving motor always operates in the same direction. In the present instance, I provide a pair of manifolds, 16 and 17 of which the first is connected to the two pumps by conduits 18 and 19 respectively, while the second is similarly connected to said pumps by conduits 20 and 21 respectively. The manifold 16 through the conduits 22 and 23 is connected to the two cylinders 3 and 2 while the manifold 17 through the conduits 24 and 25 is similarly connected to the two cylinders 1 and 4, respectively.

For altering the stroke of the pumps and hence the amount and direction of flow of liquid delivered from them, I connect the stroke adjusting elements indicated at 26 and 27, through links and bell crank levers, to an operating rod 28, one end of which is connected to one end of a lever 29. The opposite end of said lever is connected to a floating lever 30 by a link 31 and said floating lever is fulcrumed on one end of a yieldingly mounted rod 32. Said rod is so mounted as to be free to move longitudinally in either direction from a neutral or central position in which it is normally held by the spring 33. For actuating the floating lever 30 to cause operation of the steering gear, I provide two electric motors 34 and 34ª

respectively, provided with pinions 35 and 35ª either of which may be engaged by a gear 36 splined to and slidable upon a shaft 37 having a threaded portion 38. This shaft is connected to the rudder arms 11 so as to be moved longitudinally by movement of the rudder post 12 and has on its threaded portion a nut 39 to which the floating lever 30 is pivoted. It will be understood that either of said electric motors may be adjusted to operate the gear while the other is kept as a reserve;—it being merely necessary to adjust the pinions 35 and 35ª to put either motor into service while throwing out the other.

In accordance with my invention, said floating lever 30 extends between or is otherwise operatively connected to a pair of rams 40 and 41, respectively operative in a pair of opposed single acting cylinders 42 and 43 suitably mounted upon a supporting base and supplied with fluid under pressure under predetermined conditions from a pilot valve 44. Said rams 40 and 41 are respectively connected to cross heads 45 and 47 normally maintained in and at all times tending to return to definite positions on guide rods 54 under the action of two pairs of centering springs 46—46ª so that the adjacent end of the floating lever 30 likewise is held in or moved to a definite position by one or the other of said rams which, however, are held from moving toward each other from the positions shown in Fig. 3 by enlarged portions 54ª of the guide rods 54.

The pilot valve 44 is preferably constructed as shown in Figs. 4 to 7 inclusive, and comprises a cylinder 50 in which is slidably mounted a piston valve 51 having attached to it a rod 52.

One end of this rod, which projects outside of the cylinder 50 has a shouldered enlargement 53 slidably guided in a bearing 55 connected by tension rods 56 Fig. 2 with a second bearing 57. A sleeve 58 is slidable in this latter bearing and has one end engaged by a head 59 in the form of a pair of fixed or adjustable nuts on the end of the rod 52. Two flanged collars 60 and 61 are mounted on said rod so as to lie respectively adjacent the bearings 55 and 57 and between these collars coaxial with said rod is a coil spring 62. The shouldered enlargement 53 normally engages the collar 60 while the sleeve 58 likewise engages the collar 61, and the whole is so adjusted that the spring 62 tends to hold the valve 51 in and return it to a neutral position preferably in the middle of the cylinder 50. Within the spring 62 upon the rod 52 is a loose sleeve or equivalent device 63 of such a length as to limit the longitudinal movement of said rod within predetermined bounds.

The opposite ends of the cylinder 50 are connected through two conduits 64 and 65 with the two manifolds 17 and 16 respectively, so that fluid flowing between the pumps and the main cylinders 1, 2, 3 and 4 is operative in said cylinder 50 and tends to move the piston 51 in one direction or the other from its mid position. Also connected to the cylinder 50, in the case shown in its central transverse plane, are two other conduits 66 and 67 of which the first leads to a replenishing or over-flow tank 68 shown in the present instance as constituting the base or supporting frame for the driving motor 13 and pumps 14 and 15. The pipe 67 has two branches 69 and 70 respectively, connected to the two single acting cylinders 42 and 43 and as shown in Figs. 5, 6 and 7, the piston valve 51 has an annular port 71 which when said valve is in its mid position in the cylinder 50 establishes communication between the pipes 66 and 67 and hence connects the two cylinders 42 and 43 with the replenishing tank 68. In addition to the port 71, the piston valve 51 has at its opposite ends two other ports 72 and 73 in the form of elongated slots which when said valve occupies certain positions on opposite sides of its mid position, permits communication between the interior of the cylinder 50 and the pipe or port 67. Thus when said piston valve 51 has moved to the left against the action of the spring 62 from the position shown in Fig. 5 that side of the system including manifold 17 is connected through the pipes 67, 69 and 70 to the opposite ends of the cylinders 42 and 43. Similarly, the manifold 16 is connected to said cylinders through the port 73 when the piston valve 51 has been moved a predetermined distance to the right from its mid position.

In the above described arrangement of parts, if by means of suitable electrical apparatus well known to the art, the motor 34 is supplied with electric current, the threaded portion 38 of the shaft 37 is turned so that the position of the nut 39 is shifted, for example, toward the right. As a result, the floating lever 30 fulcrums on the rod 32 and its opposite end acting on the ram 41 forces it into the cylinder 43 against the action of the springs 46. This action is possible by reason of the fact that pilot valve 51 is normally in its mid position and the fluid which customarily fills both cylinders 42 and 43 is forced out of said cylinder 42 through pipes 69 and 67 through the annular port 71 of the pilot valve and the conduit 66 into the replenishing tank. This displacement of the floating lever through the link 31, lever 29 and link 28 so moves the shiftable elements 26 and 27 and the pumps 14 and 15 as to cause them to deliver fluid under pressure through the pipes 18 and 19 into the manifold 16, from whence

it flows through the pipes 22 and 23 through the cylinders 3 and 2. The rams 5 and 6 are thereupon moved in opposite directions so that the rudder post 12 and hence the rudder is turned in a counterclockwise direction. The resulting movement of the rudder head and arms 11 moves the shaft 37 toward the left thus likewise moving toward the left the nut 39 and shifting the floating lever 30 with its attached parts back to their normal positions. The shiftable elements 26 and 27 of the two pumps are thus returned to a position in which no liquid is delivered from the pumps so that the rudder is held in its displaced position.

If, however, some abnormal opposition is offered to the movement of the rudder or if it be brought to its hard-over position in either direction, it will be appreciated that the motor 13 would be subjected to an overload and abnormal fluid pressures would be present in the system. While the spring 62 and the pilot valve rod 52 is so designed that the ordinary working pressures of fluid in the system do not materially displace the pilot valve 51 from its mid position, under the abnormal pressure conditions above indicated, said spring 62 will yield in one direction or the other depending upon which end of the cylinder 50 received the high pressure fluid and the piston valve 51 will thereupon be displaced, for example, toward the left, thereupon bringing the port 72 into communication with the pipe 67. As a result, the high pressure fluid supplied to the cylinder 50 through the pipe 64 passes through said port 72 into the pipe 67 and thence into both of the pipes 69 and 70, so that whichever ram 40 or 41 has been moved by the floating lever 30 into its cylinder 42 or 43 will shortly be returned toward the position shown in Figs 2 and 3. Since the force applied to the floating lever 30 cannot move the shaft 37, said lever will fulcrum on said shaft and compress the spring 33 thus through the link 31, lever 29 and link 28 returning the shiftable pump elements 26 and 27 to their neutral positions in which the pumps 14 and 15 become inoperative. The over-loading of the motor 13 and the excessive pressure in the system thus will be effectually prevented, although the parts occupy the positions ready for further operation whenever the abnormal force opposing the movement of the rudder is lessened or when it is operated away from its hard-over position. When current is again supplied to the motor 34 to operate the rudder in the reverse position, the rotation of the screw 38 allows the spring 33 to return to its normal position and thereafter permits the floating lever 30 to actuate the link and vary the capacity of the pumps, at the same time forcing one of the rams 40 and 41 into its cylinder, if the fluid pressure of the system is below the objectionable high point at which the pilot valve spring 62 is designed to yield.

From the above description, it will be appreciated that the device will function as above described regardless of which side of the system has produced in it the abnormal pressure, since the spring 62 and hence the pilot valve 51 is free to move in either direction from the mid or normal position, and the fulcrum spring 33 and the floating lever is likewise designed to yield in either direction.

I claim:

1. The combination of an hydraulic system of a pump; an hydraulic motor actuated by fluid propelled by said pump; floating gear connected between the motor and the pump; and means operative on said floating gear to prevent over-load on the pump when the fluid pressure in the system exceeds a predetermined maximum.

2. The combination in an hydraulic system; of a variable stroke pump; an hydraulic motor; a bodily movable floating lever connected to said motor; and means operative on said lever to reduce automatically the quantity of liquid delivered by the pump when the pressure in the system exceeds a predetermined maximum.

3. The combination in an hydraulic system; of a pump; an hydraulic motor; a device for controlling said pump; an auxiliary motor operative on said device; and a pressure responsive pilot valve for controlling the device to automatically reduce the pressure in the system when it exceeds a predetermined amount.

4. The combination in an hydraulic system; of a pump; an hydraulic motor, means for controlling said pump including floating gear; an auxiliary motor for independently actuating said floating gear; and a pressure responsive pilot valve for causing operation of said auxiliary motor when the pressure in the system exceeds a predetermined maximum.

5. The combination in an hydraulic system; of a continuously operative variable stroke pump having a stroke adjusting element; an hydraulic motor actuated by fluid from said pump; floating gear connected between the motor and the stroke adjusting element; an auxiliary motor operatively connected to said floating gear; and a pressure responsive pilot valve for controlling said auxiliary motor.

6. An apparatus for preventing over-load in an hydraulic system comprising an hydraulic motor for controlling the pump of said system; and a pressure responsive pilot valve for controlling said motor.

7. Means for preventing over-load of an

hydraulic system comprising a normally centered hydraulic motor; and a pressure responsive pilot valve governing operation of said motor.

8. Means for preventing over-load of an hydraulic system comprising an hydraulic motor operative to cause reduction of pressure in said system; and a pilot valve for controlling said motor, responsive to abnormal fluid pressure in the system for delivering fluid under pressure to said motor when pressure of said fluid exceeds a predetermined maximum.

9. A device for preventing over-load in an hydraulic system comprising an hydraulic motor; a replenishing tank; and a pilot valve normally connecting said motor to a replenishing tank but responsive to abnormal pressures in the system to supply said motor with fluid under pressure when the pressure in the system exceeds a predetermined maximum.

10. The combination of an hydraulic motor; a continuously operating variable capacity pump for supplying fluid under pressure to said motor; floating gear for controlling the pump; an independent motor for actuating said floating gear; and an automatic pilot valve for supplying fluid under pressure to said latter motor to operate the floating gear to reduce the capacity of the pump when the pressure in the system rises abnormally.

11. The combination in an hydraulic system; of a floating lever; a bodily movable hand-controlled operating member for said lever; a connection from the lever to a device to be controlled thereby; a yieldably mounted fulcrum member connected to the lever; and an hydraulic motor for actuating the lever independently of the hand controlled member.

12. The combination in an hydraulic system; of a floating lever; a bodily movable hand-controlled operating member for said lever; a connection from the lever to a device to be controlled thereby; a yieldably mounted fulcrum member connected to the lever; an hydraulic motor for actuating the lever with a pressure responsive pilot valve for said hydraulic motor.

13. The combination in an hydraulic system, of a floating lever; a bodily movable hand controlled operating element for said lever; a connection from the lever to a device to be controlled thereby; a yieldably mounted fulcrum member connected to the lever; two opposed rams positioned to co-act with said lever; cylinders for said rams; and a pilot valve connected to admit fluid under pressure to said cylinders under predetermined conditions.

14. The combination in an hydraulic system; of a floating lever; a yieldably mounted fulcrum member for said lever; a hand controlled element connected to said lever; a member to be controlled also connected to the lever; an hydraulic motor connected to the lever including a plunger normally moved by the lever under operative conditions; and a pressure responsive pilot valve for admitting fluid under pressure to said motor to positively operate said lever when predetermined pressure conditions exist in an hydraulic system.

15. The combination in an hydraulic system; of a floating lever; a yieldably mounted fulcrum member for said lever; a hand controlled element connected to said lever; a member to be controlled also connected to the lever; two opposed spring actuated rams operative on the lever; cylinders for said rams; a replenishing tank; and a pilot valve normally connecting said cylinders with the replenishing tank but responsive to abnormal pressures in the system to connect said cylinders to the latter to positively operate the lever.

16. An hydraulic system comprising a floating lever; a bodily movable operating member therefor; means constituting a fulcrum for one end of said lever; and an hydraulic motor operative on the other end of said lever.

17. An hydraulic system comprising a floating lever; a bodily movable operating member therefor; means constituting a fulcrum for one end of said lever; an hydraulic motor operative on the other end of said lever; and a pressure responsive pilot valve for governing said motor.

18. An hydraulic system comprising a pump; an hydraulic motor actuated by fluid from said pump; a member actuated by said motor provided with a relatively movable section; a lever so mounted as to be actuated upon a movement of said member or the section thereof; and means operative on said floating lever to prevent overload on the pump when the fluid pressure in the system exceeds a predetermined maximum.

19. An hydraulic system comprising a pump; an hydraulic motor actuated by fluid from said pump; a member actuated by said motor provided with a relatively movable section; a lever so mounted as to be actuated upon a movement of said member or the section thereof; means constituting a fulcrum for one end of said lever; and means operative on the other end of said lever to prevent overload on the pump when the fluid pressure in the system exceeds a predetermined maximum.

20. An hydraulic system comprising a pump; an hydraulic motor actuated by fluid from said pump; a member actuated by said motor provided with a relatively movable section; a lever so mounted as to be actuated upon a movement of said member or the section thereof; an hydraulic motor operatively

associated with said lever; and a pressure responsive pilot valve for controlling said last-mentioned motor.

21. In an hydraulic system; a pump; an hydraulic motor actuated by fluid from said pump; a rod having a rotary section actuated bodily by said motor; a lever so fulcrumed on said rod as to be actuated upon a movement of said rotary section as well as the rod as a whole; a yieldable fulcrum for one end of said lever; an hydraulic motor operative on the other end of said lever; and a pressure responsive pilot valve for governing the operation of said last-mentioned motor.

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