

May 27, 1952

E. J. RINGER
POWER-OPERATED HYDRAULIC PRESSURE DEVICE, INCLUDING
YIELDABLE PISTON STOP
Filed Oct. 8, 1945

2,598,604

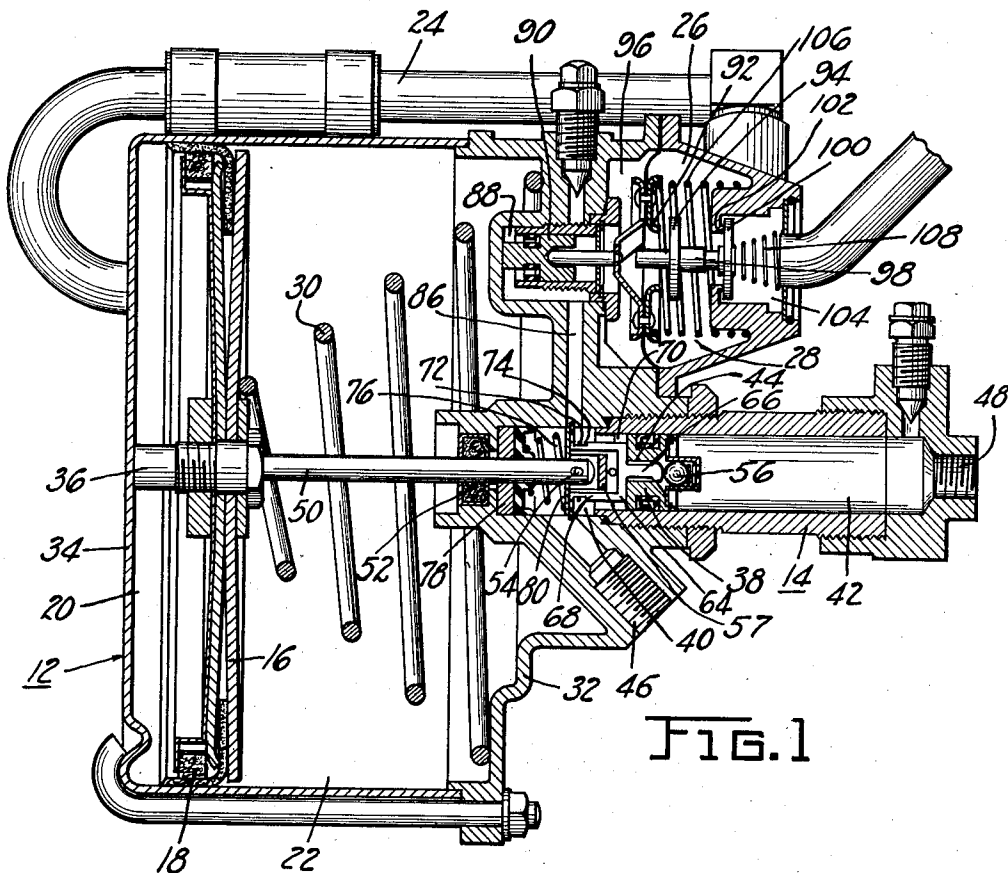


FIG. 1

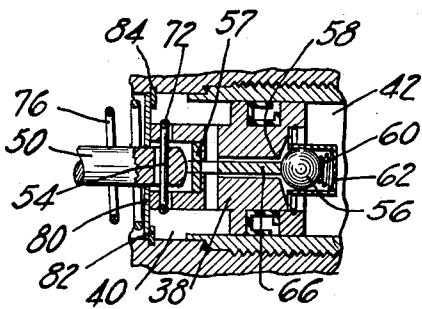


FIG. 3

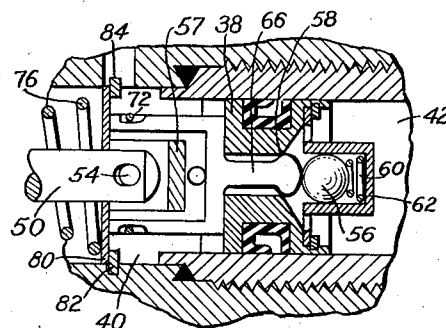


FIG. 2

INVENTOR.
EVUE J. RINGER
BY

T. J. Plante
ATTORNEY

UNITED STATES PATENT OFFICE

2,598,604

POWER-OPERATED HYDRAULIC PRESSURE
DEVICE, INCLUDING YIELDABLE PISTON
STOPEvue J. Ringer, South Bend, Ind., assignor to
Bendix Aviation Corporation, South Bend, Ind.,
a corporation of Delaware

Application October 8, 1945, Serial No. 620,905

8 Claims. (Cl. 60—54.6)

1

The present invention relates to a power operated hydraulic device including yieldable piston stop which functions similarly to the device shown in Price Patent No. 2,353,755.

The primary object of the present invention is to provide a unit of the type disclosed in said patent which will be an improvement thereover (1) in reducing the cost of making the unit, and (2) in increasing the reliability of operation of the unit.

A more specific object of the present invention is to provide improved means for retracting the piston in the power operated hydraulic cylinder, and to provide means associated therewith for insuring that the passage through said piston is properly controlled at all times, and is sufficiently unencumbered when the unit is in released position to permit adequate flow of fluid therethrough, regardless of manufacturing tolerances.

Other objects and advantages of the present invention will become apparent during the course of the following description, wherein reference is had to the accompanying drawing, in which:

Figure 1 is a vertical cross-sectional view taken through a device which incorporates my invention, said device being the combination of a power unit with a hydraulic actuator operated thereby.

Figure 2 is an enlarged cross-sectional view showing the rear portion of the hydraulic cylinder of Figure 1.

Figure 3 is a cross-section taken through the hydraulic piston of Figures 1 and 2 at right angles to the section shown in Figures 1 and 2.

In the drawing, a differential air pressure power cylinder or power unit 12 is arranged to operate the piston in a hydraulic actuator 14, preferably with the assistance of pressure derived from the conventional manually operated master cylinder. The hydraulic actuator is carried by the power cylinder casing to provide a unitary assembly. Reciprocable within the power cylinder 12 is a power piston or pressure responsive movable wall 16 which is provided with the usual annular seal 18, and which divides the power cylinder into a control chamber 20 and a constant pressure chamber 22.

Although the present inventive concept is equally applicable regardless of the particular operating principles of the power unit, the illustrated embodiment of the invention is intended to use manifold vacuum as the source of power, and furthermore it is constructed as a vacuum-suspended rather than an atmosphere-suspended unit. Therefore, the constant pressure chamber

2

22 is connected by suitable means (not shown) to a vacuum source, such as the usual intake manifold of an automotive vehicle. Control chamber 20 is connected by means of conduit 24 with chamber 26 of a control valve 28, which regulates operation of the power cylinder.

Power piston 16 is biased to retracted position by means of a relatively heavy return spring 30, which is compressed between the forward end 32 of the power cylinder and the piston 16. The released or retracted position of the power piston is determined by contact thereof with the rear wall 34 of the power cylinder casing, a projection 36 preferably being provided at the rear of piston 16 adapted to contact the rear wall of the power cylinder casing for this purpose.

Reciprocable in hydraulic cylinder 14 is a piston 38, which divides said cylinder into a rear chamber 40 and a forward chamber 42. When piston 38 is in released position, as shown, communication between chambers 40 and 42 is permitted by a passage 44 which extends longitudinally through the center of said piston. An inlet opening 46 is intended to permit communication of chamber 40 with the conventional manually operable master cylinder, suitable conduit means being provided. An outlet opening 48 is arranged to permit communication of chamber 42, through suitable conduit means, with the motor or motors which are to be operated, such as the conventional wheel cylinders of a hydraulic brake system.

A pressure transmitting rod 50 is secured to power piston 16 and extends through an opening 52 in the forward end of the power cylinder into the bore of hydraulic cylinder 14. The forward end of rod 50 is secured to hydraulic piston 38 by means of a positive connection, such as the cross-pin 54. There should be a slight clearance between the pin and the pin slot in order that the end of the rod can act directly against the hardened thrust plate 57, which is pressed into piston 38. With this arrangement, the power piston 16 controls both the pressure stroke and the retraction stroke of hydraulic piston 38, and the single return spring 30 serves the dual function of retracting both the power piston and the hydraulic piston. Heretofore, it has been considered necessary to provide separate return springs for the power and hydraulic pistons, but the present invention makes it possible to utilize a single spring to return both pistons.

When the combination power and hydraulic device is in released position, it is necessary that chambers 40 and 42 be in communication with

one another, in order that chamber 42 and the wheel cylinders may compensate for variations in the volume of the fluid by communication with the manually operated master cylinder, which in turn is adapted to compensate for volume variations in the fluid because of its direct connection with the usual integral reservoir. On the other hand, during the pressure stroke of hydraulic piston 38 it is necessary that communication between chambers 40 and 42 be prevented, otherwise the entire force developed by the power cylinder will react against the manually operated master cylinder, and the full brake applying pressure will have to be developed by the operator.

In order to control the flow of fluid through passage 44, a valve element 56 is provided. When the valve element 56 seats at 58, flow of fluid from chamber 42 to chamber 40 is prevented, although flow in the reverse direction can still occur. A light spring 60, mounted in a retaining case or cage member, 62, urges the valve element 56 toward seated position.

Means must be provided to hold valve element 56 away from its seat when piston 38 is in released position. This means may take the form of the valve unseating element 64 which has a forward projection 66 extending through passage 44 to contact valve element 56, and which has offset rearwardly extending projections 68 which are located in slot 70 provided in piston 38 and which are adapted to contact a stop member slightly before piston 38 has returned to released position, in order that said stop member will cause relative movement between member 64 and piston 38 to force valve element 56 from its seat. Member 64 is loosely assembled in piston 38 by means of a snap ring 72 which is fixed in place on the piston, and which extends into an elongated groove 74 in each rear extension 68 of member 64. Snap ring 72 also serves to retain the loose cross pin 54 in position.

Because of the accumulated tolerances in the power cylinder and hydraulic cylinder, it is impossible to have more than one definite stop for the power and hydraulic piston combination to determine the released position of said pistons. In arrangements of the type heretofore provided, in which the power piston and hydraulic piston were not positively connected, it was possible to provide a separate stop for each of them, and it was of course necessary to provide a separate spring urging each piston toward the respective stop.

When the power and hydraulic pistons are positively connected, as in the present case, if separate fixed stops are provided for each of said pistons, then the presence of tolerances in the combination unit means that it is almost certain that one of the pistons will reach its released position ahead of the other, and that the latter will therefore be held away from fully retracted position. Such a situation has certain very troublesome disadvantages. For example, if the hydraulic piston reaches its retracted position ahead of the power piston, then the entire force of the large return spring 30 will have to be taken as a shear load on the small connecting pin 54. On the other hand, if the power piston returns to its released position ahead of the hydraulic piston, there is no guarantee that said hydraulic piston will have moved sufficiently far toward its released position to insure unseating of ball valve 56 by member 64. If the ball valve is not held away from its seat when the parts are in released position, there is the danger that a varia-

tion in volume of fluid in chamber 42 of the wheel cylinder will cause the brakes to lock.

To obtain the advantages of a direct connection between the power piston and the hydraulic piston, and at the same time entirely overcome the difficulty heretofore discussed, I have provided novel means for causing member 64 to unseat valve element 56, regardless of the exact position which piston 38 assumes when fully retracted. This means is a yieldable stop member arranged to contact valve unseating element 64 to cause a predetermined amount of relative movement between said member 64 and piston 38, while yet limiting the shear load on pin 54 to a relatively low amount. For this purpose, I provide a compression spring 76 located in the rear of chamber 40 and compressed between the closure member 78 and a washer or stop element 80. The washer 80 is prevented from moving toward the right by means of a movement limiting member 82 which snapped into a groove 84 provided in the inner wall of the hydraulic cylinder. I prefer to use a non-circular resilient member for this purpose, such as a member having a hexagonal or octagonal shape, in order to avoid any danger that the washer 80 might slip through the limiting member 82.

The spring 76 must be sufficiently strong to overcome the force of spring 60 plus any pressure differential in the hydraulic system tending to hold valve 56 seated.

When the rearwardly extending forks of member 64 contact washer 80, further rearward movement of member 64 is prevented, and subsequent movement of piston 38 towards the left will cause the valve seat 58 to move away from valve element 56, thereby opening communication between chambers 40 and 42. However, if the rear surface of piston 38 contacts washer 80 before projection 36 of power piston 16 has engaged the rear wall of the power cylinder casing, spring 76, which is much lighter than spring 30, will compress, permitting the hydraulic piston assembly to continue moving toward the left until the power piston has come to its resting position. The full shearing load on pin 54 is therefore the force exerted by spring 76, rather than that exerted by spring 30. Also, loads on the other ports of the hydraulic piston are limited to the force of spring 76.

In making the combined power unit and hydraulic actuator, the tolerances should be so arranged that hydraulic piston 38 will never remain too far to the right when the power piston has reached fully retracted position. In other words, any tolerances allowed should be in the direction of causing compression of spring 76, thereby insuring that the return movement of piston 38 will always be sufficient to cause valve element 56 to be moved away from its seat.

The general operation of the device is as follows. When the operator wishes to apply the brakes, he develops pressure in the manually operated master cylinder by means of the usual pedal. The fluid under pressure moves from the manually operated master cylinder through the connecting conduits and through opening 46 into chamber 40. Because, in the released position of the unit, valve element 56 is away from its seat, a certain amount of the fluid may flow through passage 44 into chamber 42 and thence to the wheel cylinders to initiate application of the brakes. At the same time fluid under pressure from the manually operated master cylinder moves from chamber 40 through passage 86 into

5

chamber 88 to act on piston 90, driving the same toward the right to cause valve seat 92 to engage valve element 94, thereby cutting off communication between chamber 26 and chamber 96, which is connected to vacuum. Further movement of piston 90 and valve seat 92 pushes thrust connection 98 to move valve element 100 away from valve seat 102, thereby admitting air at atmospheric pressure from chamber 104 to chamber 26, whence the air is conducted to control chamber 20 of the power cylinder, developing a pressure differential over power piston 16 which moves the same towards the right against the resistance of return spring 30. The force developed by the power piston acts through rod 50 to drive piston 38 toward the right, the force being exerted directly against thrust plate 57. Since member 64 is only loosely assembled in piston 38, a slight movement of said piston toward the right will permit spring 60 to move ball valve element 56 to seated position, after which fluid in high pressure chamber 42 can no longer flow into chamber 40, although it is still possible for fluid to flow in the reverse direction in case of power failure or power run-out. The manually developed pressure which is transmitted from the operator operated master cylinder to chamber 40 continues to assist in applying the brakes by exerting a pressure against the rear of piston 38. Therefore, the work output at the brake is a total of the work done by the power cylinder and the work done by the operator.

When the operator wishes to release the brakes, he releases pressure in the manually operated master cylinder. This reduces the pressure in chamber 40, and also in chamber 88, permitting valve return spring 106 to move member 92 toward the left, first causing valve element 100 to seat under the influence of spring 108, and subsequently causing valve seat 92 to move away from valve element 94, again evacuating control chamber 20 of the power cylinder, and destroying the differential over power piston 16. This permits return spring 30 to force power piston 16 toward the left, drawing with it hydraulic piston 30. Just before the power and hydraulic pistons have reached released position, member 64 contacts washer 80 and forces ball valve element 56 away from its seat. As explained above, should it be necessary for piston 38 to move farther to the left, after it has contacted washer 80, this is permitted by spring 16.

With the present arrangement, no initial adjustment is necessary to compensate for manufacturing tolerances, because the proper control of the passage through the hydraulic piston is insured. Furthermore, large parts of the unit, such as the power cylinder parts, can be bottomed or rested against a rugged structural element, i. e., the power cylinder casing.

Although a particular embodiment of my invention has been described, it will be understood by those skilled in the art that the object of the invention may be attained by the use of constructions different in certain respects from that disclosed without departing from the underlying principles of the invention. I therefore desire by the following claims to include within the scope of my invention all such variations and modifications by which substantially the results of my invention may be obtained through the use of substantially the same or equivalent means.

I claim:

1. A combined differential air pressure power unit and hydraulic actuator operated thereby

6

comprising a casing for the power unit, a power piston reciprocable therein, a hydraulic cylinder secured to the power cylinder casing and having a bore concentric with the power cylinder piston, a hydraulic piston reciprocable in said bore, said hydraulic cylinder having an inlet opening behind said piston and an outlet opening ahead of said piston, said piston having a passage extending longitudinally through the center thereof constituting the only means of direct communication between the inlet and outlet openings, a valve element at the forward end of said passage which when seated permits flow of fluid only from the inlet side toward the outlet side and not in the reverse direction, a spring urging said valve element toward seated position, a rod secured to the power cylinder piston and extending into the hydraulic bore to contact the hydraulic piston, a cross-pin providing a lost motion return connection between the forward end of the rod and the hydraulic piston, a relatively heavy spring in the power unit acting against the power piston to retract both the power piston and the hydraulic piston, said power piston having a rearwardly extending projection which contacts the power unit casing when the piston is in retracted position, a washer in the hydraulic cylinder which is contacted by the rear of the hydraulic piston when the latter is in retracted position, a spring compressed between the forward end of the power unit casing and said washer to oppose yieldably further return movement of the hydraulic piston after said piston has come into contact with the washer, said spring being sufficiently strong to overcome the spring which urges the valve element to seated position plus any hydraulic pressure acting on said valve element, but being relatively weak in comparison to the spring which returns the power piston to released position, a movement limiting member secured in a groove in the hydraulic cylinder and arranged to limit forward movement of the washer under the influence of the spring acting thereon, and a valve unseating member carried by said piston but capable of movement relative thereto and arranged to contact the washer on the return stroke before the piston contacts said washer, thereby forcing the valve element from its seat to permit compensation for changes in the volume of the liquid on the forward side of the hydraulic piston.

2. A combined differential air pressure power unit and hydraulic actuator operated thereby comprising a casing for the power unit, a pressure responsive movable wall reciprocable therein, a hydraulic cylinder supported on the power cylinder casing and having a bore concentric with the power cylinder movable wall, a hydraulic piston reciprocable in said bore, said hydraulic cylinder having an inlet opening behind said piston and an outlet opening ahead of said piston, said piston having a passage extending longitudinally through the center thereof constituting the only means of direct communication between the inlet and outlet openings, a valve element associated with said passage which when seated permits flow of fluid only from the inlet side toward the outlet side and not in the reverse direction, a spring urging said valve element toward seated position, a rod secured to the power cylinder movable wall and extending into the hydraulic bore to act on the hydraulic piston, lost-motion return connection between the forward end of the rod and the hydraulic piston, a relatively heavy spring in the power unit acting

against the movable wall to retract both said movable wall and the hydraulic piston, the released position of said movable wall being determined by the power unit casing, a floating stop member in the hydraulic cylinder which is contacted by the rear of the hydraulic piston when the latter is in retracted position, a spring compressed between the forward end of the power unit casing and said stop member to oppose yieldably further return movement of the hydraulic piston after said piston has come into contact with the stop member, said spring being sufficiently strong to overcome the spring which urges the valve element to seated position plus any hydraulic pressure acting on said valve element, but being relatively weak in comparison to the spring which returns the movable wall to released position, a movement limiting member secured inside the hydraulic cylinder and arranged to limit forward movement of the stop member under the influence of the spring acting thereon, and a valve unseating member carried by said piston but capable of movement relative thereto and arranged to contact the stop member on the return stroke before the piston contacts said stop member, thereby forcing the valve element from its seat.

3. A combined differential air pressure power unit and hydraulic actuator operated thereby comprising a casing for the power unit, a pressure responsive movable wall reciprocable therein, a hydraulic cylinder having a bore concentric with the power cylinder movable wall, a hydraulic piston reciprocable in said bore, said hydraulic cylinder having an inlet opening behind said piston and an outlet opening ahead of said piston, said piston having a passage therethrough constituting the only means of direct communication between the inlet and outlet openings, a valve element associated with said passage which when seated permits flow of fluid only from the inlet side toward the outlet side and not in the reverse direction, a spring urging said valve element toward seated position, a thrust transmitting member secured to the power cylinder movable wall and extending into the hydraulic bore to act on the hydraulic piston, a lost-motion return connection between the thrust transmitting member and the hydraulic piston, a relatively heavy spring in the power unit acting against the movable wall to retract both said movable wall and the hydraulic piston, the released position of said movable wall being determined by the power unit casing, a floating stop member in the hydraulic cylinder which is contacted by the rear of the hydraulic piston when the latter is in retracted position, a spring compressed between the rear wall of the hydraulic bore and said stop member to oppose yieldably further return movement of the hydraulic piston after said piston has come into contact with the stop member, said spring being sufficiently strong to overcome the spring which urges the valve element to seated position plus any hydraulic pressure acting on said valve element, but being relatively weak in comparison to the spring which returns the movable wall to released position, a movement limiting member secured inside the hydraulic cylinder and arranged to limit forward movement of the stop member under the influence of the spring acting thereon, and a valve unseating member carried by said piston but capable of movement relative thereto and arranged to contact the stop member on the return stroke before

the piston contacts said stop member, thereby forcing the valve element from its seat.

4. In a power-operated hydraulic cylinder, a piston in the cylinder dividing it into two chambers, a conduit adapted to connect said chambers, a valve controlling said conduit, a resilient member urging said valve to close said conduit, a floating member associated with said valve capable of displacing the same to open the conduit, a stop member which is engaged first by the floating member and then by the piston when the latter approaches retracted position, and a spring which acts on said stop member to urge it toward the piston and which is yieldable to permit movement of the piston and stop member as a unit to reach fully retracted position.

5. In a power-operated hydraulic cylinder, a piston in the cylinder dividing it into two chambers, a conduit adapted to connect said chambers, a valve controlling said conduit, a floating member associated with said valve capable of displacing the same to open the conduit, a stop member which is engaged first by the floating member and then by the piston when the latter approaches retracted position, and a spring which acts on said stop member to urge it toward the piston and which is yieldable to permit movement of the piston and stop member as a unit to reach fully retracted position.

6. A combined power unit and hydraulic actuator operated thereby comprising a casing for the power unit, a pressure responsive movable wall reciprocable therein, a hydraulic cylinder associated with the power unit, a piston in the cylinder dividing it into two chambers, a mechanical connection between the movable wall and the piston, a return spring acting on the movable wall to return it and the piston to retracted position, a conduit adapted to connect the two chambers of the cylinder, a valve arranged to control said conduit, a member associated with said valve capable of displacing the same to open the conduit, and a yieldable stop which first causes the aforesaid member to move the valve away from closed position as the piston returns to retracted position and thereafter yields to permit further retractile movement of said piston.

7. A combined power unit and hydraulic actuator operated thereby comprising a casing for the power unit, a pressure responsive movable wall reciprocable therein, a hydraulic cylinder associated with the power unit, a piston in the cylinder dividing it into two chambers, a mechanical connection between the movable wall and the piston, a return spring acting on the movable wall to return it and the piston to retracted position, a conduit adapted to connect the two chambers of the cylinder, a valve arranged to control said conduit, a member associated with said valve capable of displacing the same to open the conduit, and a yieldable stop which causes the aforesaid member to move the valve away from closed position as the piston returns to retracted position.

8. A combined power unit and hydraulic actuator operated thereby comprising a casing for the power unit, a pressure responsive movable wall reciprocable therein, a hydraulic cylinder associated with the power unit, a piston in the cylinder dividing it into two chambers, a mechanical connection between the movable wall and the piston, a return spring acting on the movable wall to return it and the piston to retracted position, a rigid stop which determines

the retracted position of the movable wall, a conduit adapted to connect the two chambers of the cylinder, a valve arranged to control said conduit, a member associated with said valve capable of displacing the same to open the conduit, a stop member which is engaged by the piston when the latter approaches retracted position, and a spring which acts on said stop member to urge it toward the piston and which is yieldable to permit movement of the piston and stop member as a unit to reach fully retracted position.

EVUE J. RINGER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,246,140	Main -----	June 17, 1941
2,260,490	Stelzer -----	Oct. 28, 1941
2,455,985	Elliott -----	Dec. 14, 1948