

[54] **PRESSURE-COMPENSATED HAND PUMP**
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[51] Int. Cl. **B62d 27/06**
[58] Field of Search **180/89 A; 417/214, 218; 296/28 C, 35 R**

[56] **References Cited**
UNITED STATES PATENTS
2,472,104 6/1949 Grant et al. 417/218
2,947,376 8/1960 Norrie 180/89 A

2,423,162 7/1947 Summers 417/218 X
3,472,547 10/1969 London 180/89 A X
FOREIGN PATENTS OR APPLICATIONS
650,782 3/1951 Great Britain 417/218

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[57] **ABSTRACT**
A hand pump having compensating means thereon for optimizing displacement per stroke while the force required to operate the pump is maintained at a relatively constant level over a widely variable load pressure range.

2 Claims, 7 Drawing Figures

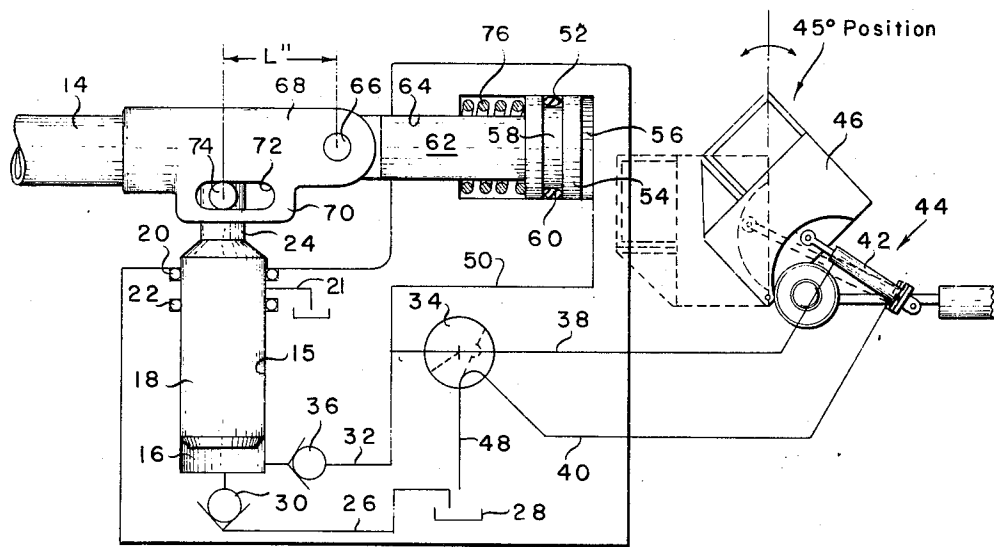


Fig. 1

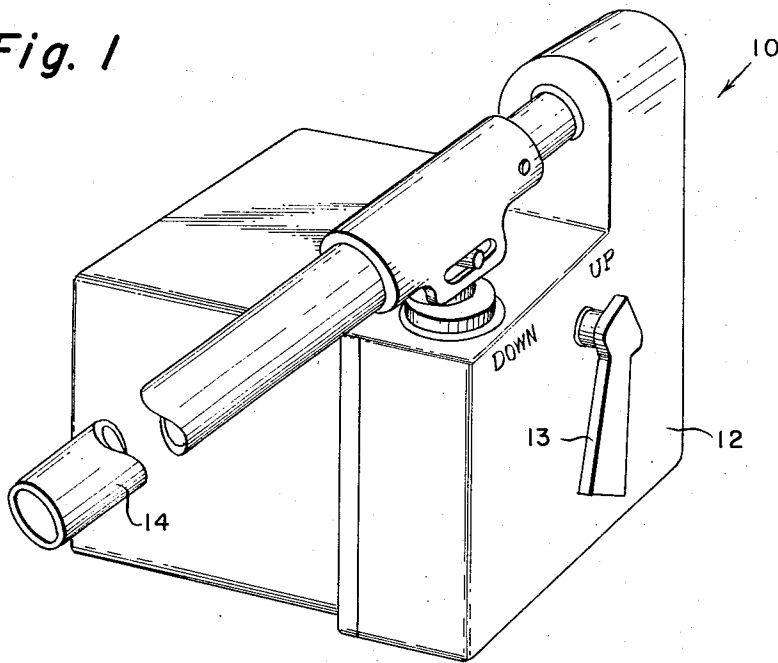


Fig. 2

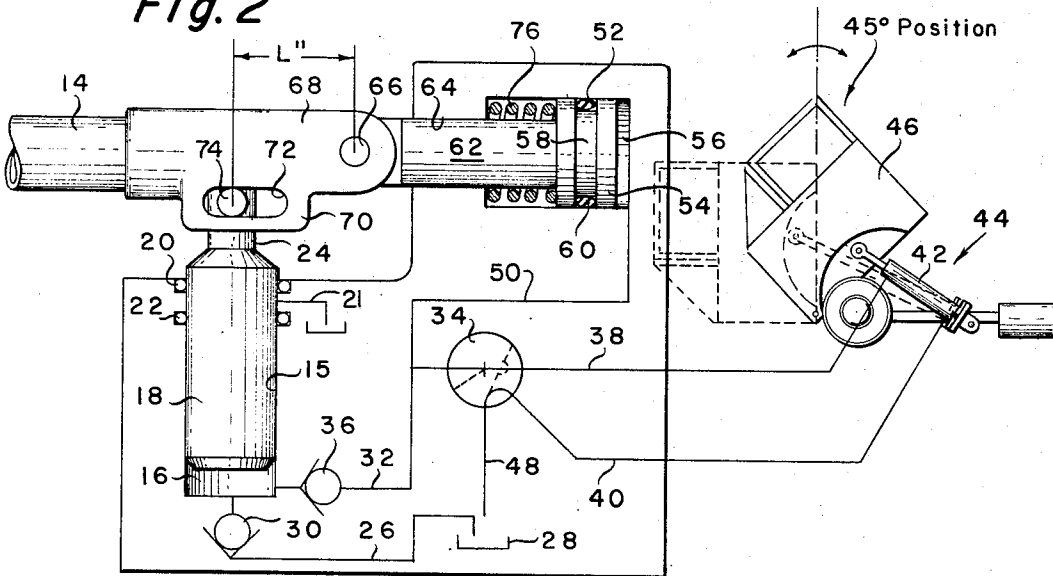
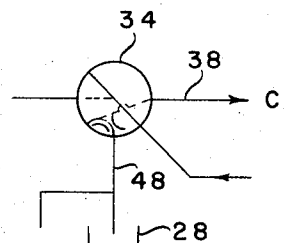


Fig. 3



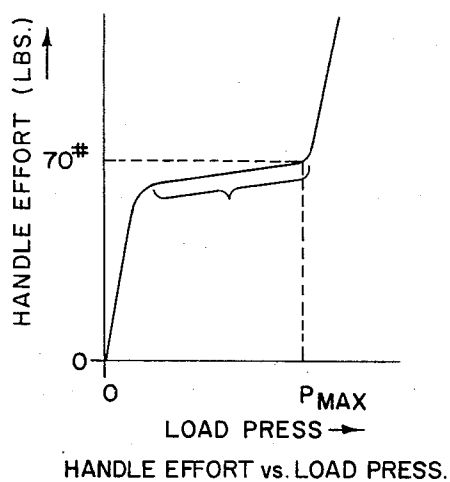


Fig. 4

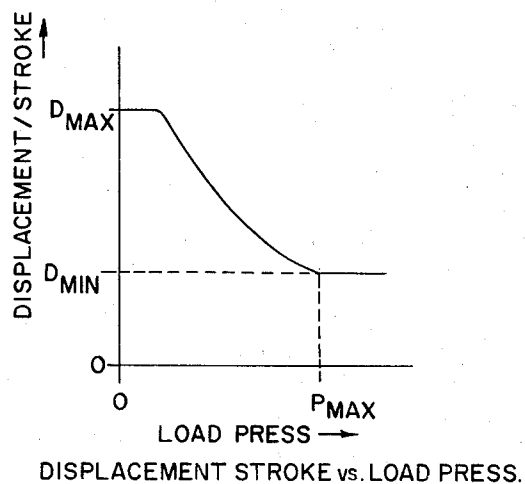


Fig. 5

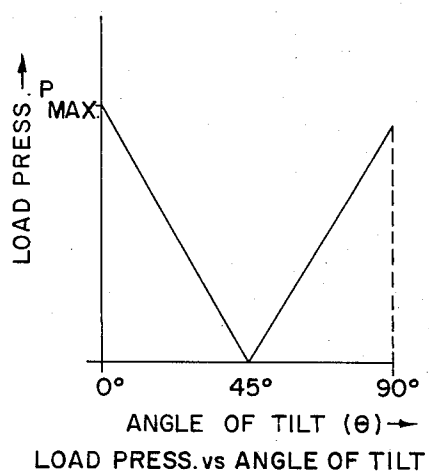


Fig. 6

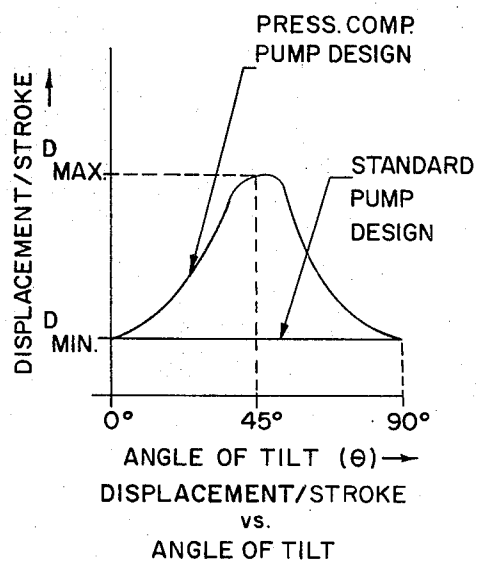


Fig. 7

PRESSURE-COMPENSATED HAND PUMP

This invention relates generally to hand pumps and more particularly to hand pumps for use over a widely variable load range.

As a practical matter in hand pumps with a fixed displacement, the amount of force required to actuate the pump handle increases proportionately for a given displacement as the load pressure on the pump rises. The increase is particularly pronounced in a pump where the load pressures vary greatly over a wide range. An illustrative example of such variable loads is in a reciprocating hydraulic piston and cylinder assembly used in tilting the cabs of tiltable cab vehicles, wherein the load pressure on the hydraulic cylinder varies greatly during the travel of the tiltable cab from the normal position, and past the over-the-center position to the fully tilted position.

It is an objective of this invention to provide a hand pump having means to maximize displacement per stroke over a range of widely variable load pressures, while maintaining the force required to actuate the pump at a relatively constant level.

It is a further objective of this invention to provide a means responsive to the load pressure on the pump to vary the effective pump-handle length in proportion to the rise in load pressure thereby giving greater leverage to the pump operator. As the effective length of the pump handle is increased, the stroke length of the pumping piston is decreased. In handle-operated pumps of the prior art, the effective handle length and piston-stroke length remain constant despite wide variations in load pressures. In this invention, the piston-stroke and thereby displacement, vary from the maximum at lower load pressures to the minimum at maximum load pressures.

More particularly, it is an objective of this invention to provide maximum displacement per stroke consistent with a handle force maintained at a constant pressure level of, for example, 70 lbs. throughout a variable load-pressure range, the ultimate goal being to lower the number of strokes required to completely raise a load, such as a tilting cab.

The objectives of this invention are realized by providing a hand-operated pump which, in a preferred application, is used for raising and lowering tilting cabs on tractor-trailers. Generally, the pump comprises a housing having inlet and outlet means, and a chamber therein communicating with the inlet and outlet means. A piston is slidably received in the chamber. A handle is pivotally attached at one end thereof to said housing. Means are provided for connecting the top end of the piston to the handle at a point spaced from said one end of the handle. Compensating means are provided responsive to load pressures for varying the effective length of the handle whereby greater leverage is provided to the pump operator as the load pressure on the pump increases. The compensating means includes a second chamber in the housing having a second piston slidably received therein in a direction transverse to the first piston. A passageway communicates the second chamber to the outlet passageway and is sensitive to load pressures. The handle is pivotally attached to one end of the second piston whereby as load pressures are increased, the piston is caused to reciprocate outwardly of the housing shifting the lever relative to the first-mentioned piston and increasing the effective lever length from the free end thereof to its connection with

said first piston. Simultaneously, the effective length of the handle between its connections with said first and second pistons decreases thereby shortening the stroke length of the first piston.

These and other objects of the invention will become more apparent to those skilled in the art by reference to the following detailed description when viewed in light of the accompanying drawings wherein:

FIG. 1 is a perspective view of the pump of this invention;

FIG. 2 is a schematic illustration of the pump of this invention as used with a tilting cab vehicle;

FIG. 3 is a schematic illustration showing the rotary valve of FIG. 2 in the reverse position;

FIG. 4 is a diagram showing the relationship between handle force and load pressures;

FIG. 5 is a diagram showing the relationship between the displacement per piston stroke and load pressures;

FIG. 6 is a diagram showing the relationship between load pressures and the angle of tilt of the cab of a tilting cab vehicle; and

FIG. 7 is a diagram showing the relationship of displacement per piston stroke versus the angle of tilt of the cab of a tilting cab vehicle.

Referring now to FIGS. 1 and 2, the pump of this invention is generally indicated by the numeral 10 and comprises a housing 12, having a pumping lever 14, pivotally attached thereto. The housing includes a pumping chamber 16 which slidably receives a pumping piston 18. Suitable seals 20 and 22 are provided at the upper end of the cylinder 15, and a leakage path 21 to the reservoir leads from the area between the seals. The pumping piston emerges from the housing and has a piston rod 24 attached to the outer end thereof. An inlet passageway 26 communicates the chamber 16 with the reservoir 28 via check valve 30 and an outlet passageway 32 communicates chamber 16 with a reversing valve 34 via check valve 36. On the suction stroke of the piston 18, hydraulic fluid is drawn from reservoir 28 past check valve 30 into chamber 16. On the power stroke of the piston, the fluid in cylinder 16 is forced past check valve 36 and through outlet passageway 32 to reversing valve 34. The reversing valve 34 selectively communicates the outlet passageway 32 and the reservoir with inlet-outlet lines 38 and 40 which lead to double-acting cylinder 42 on a tilting cab vehicle generally indicated by the numeral 44. The cylinder 42 tilts the cab 46 past the over-the-center position or 45° position, to the fully tilted position shown in broken line.

In FIG. 2, the valve 34 is shown in a position whereby inlet-outlet conduit 38 is communicated with the outlet or pressure passageway 32, and inlet-outlet conduit 40 is communicated with the reservoir 28 via reservoir passageway 48. This is the so-called "down" position. The valve is rotated by handle 13 to the so-called "up" position, shown in FIG. 3 wherein inlet-outlet conduit 40 is communicated to the outlet or pressure passageway 32. Relating this to the diagrammatic illustration of the tiltable cab vehicle in FIG. 2, when the valve is in the "down" position and the cab is in the fully tilted position, the upper chamber of cylinder 42 receives fluid under pressure, while the lower chamber is exhausted to reservoir. When the valve is in the position shown in FIG. 3, the lower chamber is communicated to fluid under pressure and the upper chamber is exhausted to reservoir.

The compensator mechanism of this invention includes a cylinder 52 having a piston 54 slidably received therein, defining a compensator chamber 56. The chamber 56 is communicated with the outlet passageway 32 via line 50. The piston 54 includes an annular groove 58, which receives a resilient seal 60, and a piston rod 62 which is attached to the piston and extends outwardly of the housing through opening 64. A pump handle 14 is pivotally connected to the piston rod 62 by means of beam 68 and pin 66. The beam is provided with two downwardly extending flanges 70 each having elongated slots 72 therein. Only one of the flanges can be seen in the drawing. The flanges straddle the piston rod 24 and the slots 72 slidably receive the free ends of the pin 74 which extends transversely through the piston rod 24.

In operation, when the pressure load sensed in the outlet passageway 32 is at a predetermined minimum level, the piston 54 is at the far end of the cylinder 52. In this position, the distance "L" between pin 66 and pin 74 is at the maximum meaning that the stroke length of the piston 18 at its maximum. If during the pumping operation, the load pressure increases past the predetermined minimum, the increase is sensed in line 50 and transmitted to chamber 56 whereby piston 54 is caused to shift to the left. The spring 76 which normally tends to urge the piston 54 to the far right-hand side of cylinder 52 determines the above-referred to minimum level. As the piston 54 moves to the left, the distance "L" decreases, thereby shortening the handle radius between pin 66 and pin 74. This effectively shortens the stroke of the piston 18 and thereby lowers the displacement thereof. Accordingly, the effective length of the handle between the pin 74 and the outer end of the handle is increased providing greater leverage to the operator of the pump. The effect of the compensator mechanism is to maximize displacement of the piston 18 while maintaining the force required to operate the handle 14 at a substantially constant level, for example, 70 lbs., over a range of widely variable pressures. This handle force level may be varied by adjusting spring 76.

As mentioned earlier, the pump of this invention has particular application with load pressures which vary widely over a given range. Indicative of loads of this type is a tilting cab wherein the cab is tilted $\pm 45^\circ$ past the over-the-center position. The relationship of angle of tilt through 90° to load pressures is given in the diagram of FIG. 6. In the normal operational position of the cab, the load pressure is at maximum but decreases, as shown, as the cab reaches its over-the-center position at approximately 45° ; but then, it again increases as the cab travels to the fully tilted position at approximately 90° . It is to be understood that as the cab moves past the over-the-center position, it is then in a free-fall condition. Accordingly, the valve 34 is provided with an appropriate metering exhaust orifice to restrict the flow from the piston 42 to reservoir, thereby retarding the descent of the cab.

The displacement per stroke of the pump of this invention varies inversely to the increase in load pressure as shown in the diagram of FIG. 5. The relationship of the displacement per stroke of the pump of this invention and the angle of tilt of a tilting cab is shown in FIG. 7. As the cab goes from 0° to 45° , the load pressure goes from maximum to minimum while displacement goes from minimum to maximum. From 45° to 90° , the

pressure goes from minimum to maximum while the displacement goes from maximum to minimum. The displacement in a standard pump of the prior art is indicated by the straight line, so designated, in the diagram of FIG. 8. The diagram of FIG. 5 shows the relationship of handle effort or force to an increase in load pressures in the pump of this invention. It can be seen that over substantially the entire range of pressure increase from zero to maximum, the force required to operate the handle is maintained at a relatively constant level of approximately 70 lbs.

In a general manner, while there has been disclosed an effective and efficient embodiment of the invention, it should be well understood that the invention is not limited to such an embodiment as there might be changes made in the arrangement, disposition, and form of the parts without departing from the principle of the present invention as comprehended within the scope of the accompanying claims.

I claim:

1. In a vehicle comprising a frame, a cab tiltably mounted on said frame, a hydraulic cylinder assembly attached at one end to said frame and at the other end to said cab, said cylinder being double acting and having first and second chambers, a hand pump, said pump comprising a housing having inlet and outlet means, conduit means communicating said inlet and outlet means to said first and second chambers, a reservoir in communication with said inlet means, a pumping chamber in said housing in communication with said outlet means, a pumping piston slidably received in said pumping chamber, a handle attached to said pumping piston at a point spaced from one end of said handle, said housing having a compensating chamber disposed transversely relative to said first chamber, a second piston slidably received in said compensating chamber, said handle being pivotally attached at said one end to said second piston, a load pressure sensing passageway communicating said compensating chamber to said outlet means whereby said second piston is shifted in response to pressure changes in said outlet means to vary the effective length of said handle between said connection point with said pumping piston and said pivotal connection with said second piston, valve means in said housing for selectively communicating said first and second chambers with said pumping chamber and said reservoir through said conduit means, and metering means in said valve means for metering the outflow from that chamber of said cylinder assembly communicated to said reservoir.

2. A hand pump for actuating a double-acting cylinder having first and second chambers comprising a housing having inlet and outlet means, conduit means communicating said inlet and outlet means to said first and second chambers, a reservoir in communication with said inlet means, a pumping chamber in said housing in communication with said outlet means, a pumping piston slidably received in said pumping chamber, a handle attached to said pumping piston at a point spaced from one end of said handle, said housing having a compensating chamber disposed transversely relative to said first chamber, a second piston slidably received in said compensating chamber, said handle being pivotally attached at said one end to said second piston, a load pressure sensing passageway communicating said compensating chamber to said outlet means whereby said second piston is shifted in response to

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pressure changes in said outlet means to vary the effective length of said handle between said connection point with said pumping piston and said pivotal connection with said second piston, valve means in said housing for selectively communicating said first and second chambers with said pumping chamber and said reser-

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voir through said conduit means, and metering means in said valve means for metering the outflow from that chamber of said cylinder assembly communicated to said reservoir.

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