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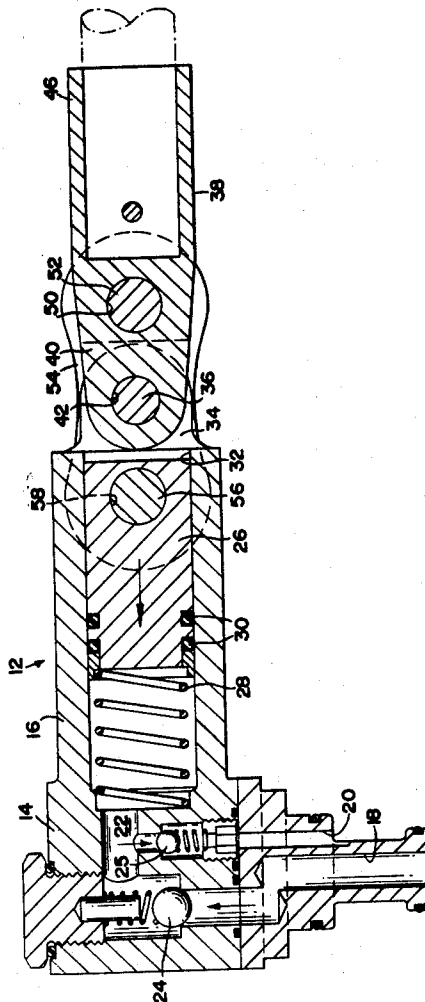
[54] **RECIPROCATING PUMP**
5 Claims, 4 Drawing Figs.

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 60/52, 74/105, 417/559

[51] Int. Cl..... **F04b 19/22,**
 F15b 15/18, F16b 21/44

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 60/52(HA); 74/105

ABSTRACT: A novel variable capacity pump particularly for hand operation comprising a pump housing wherein a piston reciprocates within the housing. A lever or pump handle actuates the piston through a rigid link means which is connected between the piston and the lever, the lever being pivotally connected to the pump housing at a pivot point which is aligned with the plane of movement of the piston. The pivot point also is between the points of connection of the link means to the piston and the lever when the piston is in the outermost position of its stroke in the housing.



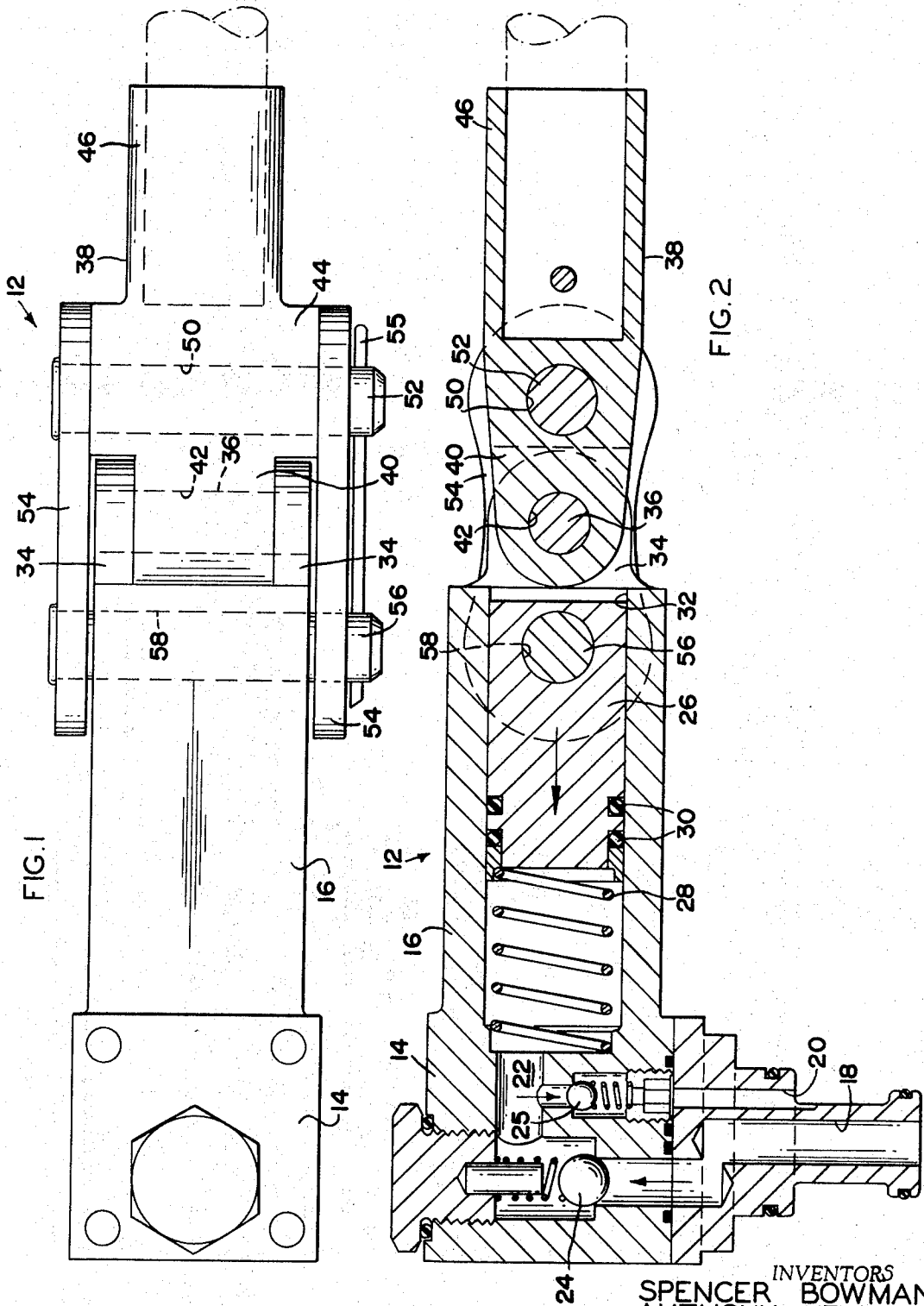
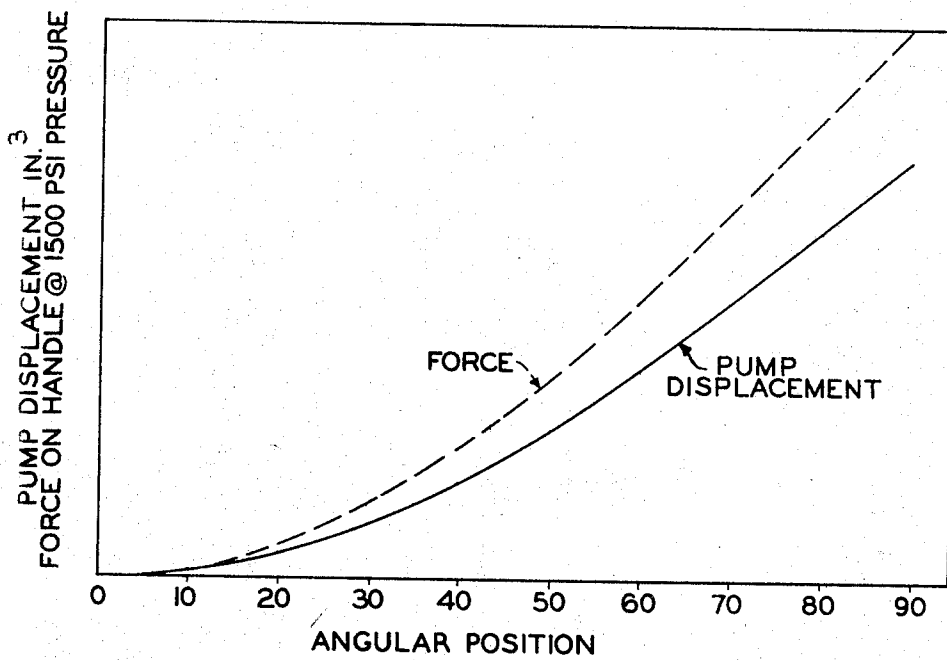
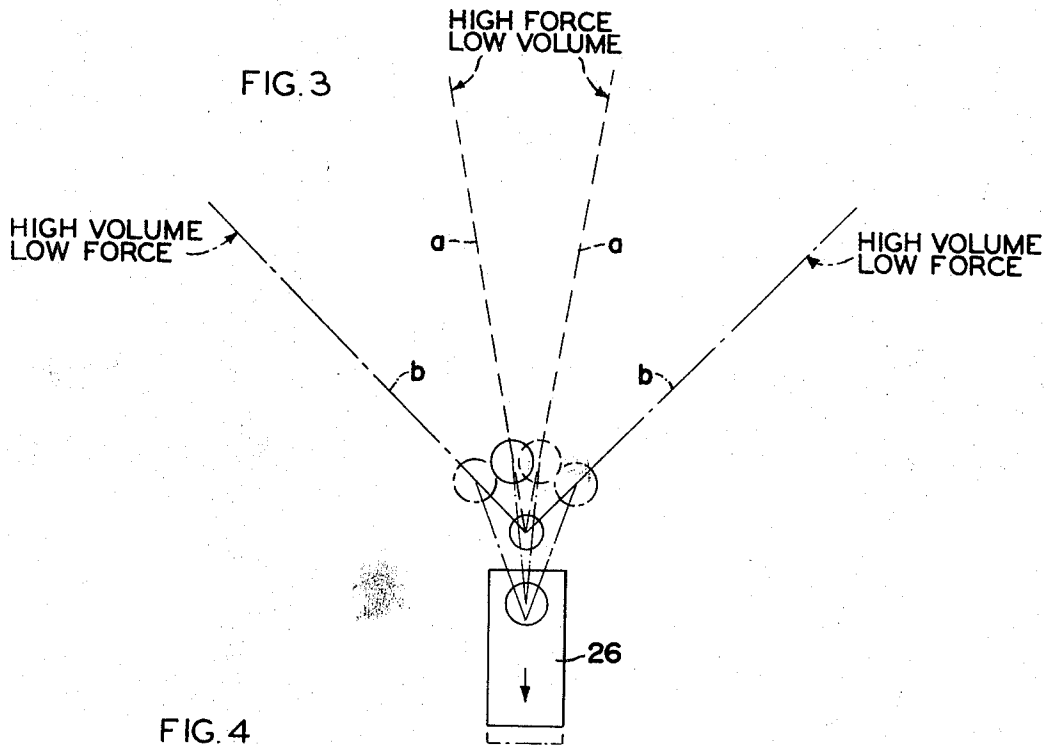


FIG. 1

FIG. 2

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RECIPROCATING PUMP

The present invention relates to a pump, and in particular to a novel pump of the piston type especially adapted to hand operation wherein the length of stroke of the piston or the pump output is easily varied to accommodate for changes in load.

A very conventional type of hand pump utilizes a reciprocating piston within a cylindrical housing. One end of a lever or pump handle is connected to the housing, and the piston is connected to the lever at a point intermediate its ends usually selected to provide a force advantage at the handle end or free end of the lever. Movement of the lever or handle back and forth or up and down causes the pump piston to reciprocate within the housing.

The problem with this type of pump actuating mechanism is that the leverage which can be exerted by the pump handle is usually not variable so that it can be adjusted with pump load. In addition, there is usually no provision for varying the length of travel or stroke of the piston and thus output of the pump. An operator usually must move the pump lever or handle to the full length of its stroke for efficient operation of the pump. This is satisfactory, as long as normal loads are encountered, but in frequent pump applications, it is desired initially to bring the system connected to the output end of the pump as quickly as possible up to a high pressure at which time the output or volume of flow from the pump is reduced. If the pump is sized for this initial high output it is usually a difficult task for the operator to actuate or adjust the pump to a lesser output with a smaller stroke of the lever or pump handle.

It is an object of the present invention to provide a variable volume constant force and constant work pump particularly adapted for hand operation.

In accordance with the present invention, there is provided a pump comprising a pump housing; a piston positioned within said housing for reciprocal movement therein, and a lever or pump handle to actuate the piston. A rigid link means is connected between the piston and the lever, the lever at one end being pivotally connected to the pump housing at a pivot point which is in line with the plane of movement of the piston. When the piston is at the outermost point of its stroke, the pivot point is between and preferably intermediate the points of connection of the link means to the lever and to the piston.

A spring biases the piston to its outermost point of its stroke, at which point the lever is held in line with the direction of movement of the piston, and is in an at-rest position. The lever is stroked in an arcuate path which extends to opposite sides of the at-rest position whereby the piston makes two strokes for every full stroke of the lever. In that the point of connection of the link means to the lever travels in the same arcuate path as the lever about the pivot point, its direction of movement begins to more closely parallel the movement of the piston at the opposite ends of the lever stroke. As a result, the ratio of movement of the piston to movement of the pump handle or lever arm is less in the part of the lever stroke near the at-rest position, and progressively greater as the ends of the lever stroke are approached, the increase following closely a geometric progression. This makes the pump very sensitive near the at-rest position in that movement of the lever effects a small movement of the piston.

An operator can operate the pump using full strokes until a load resistance or high pressure in the output system is encountered, and then can easily decrease the length of stroke to a narrow arc on opposite sides of the at-rest position and accurately compensate for the increased load or pressure and maintain a constant work input if desired.

By the same token it will be apparent that the leverage exerted through the link between the pump handle or lever and the piston varies depending upon the position of the handle or lever in its stroke, so that the operator can very accurately adjust the length of stroke with the output pressure and maintain a constant force on the pump handle or lever.

The invention and advantages thereof will become more apparent upon consideration of the following specification, with reference to the accompanying drawing, in which:

FIG. 1 is a side view of the pump housing in accordance with the invention;

FIG. 2 is a section view of the pump of FIG. 1 taken at right angles to the FIG. 1 view;

FIG. 3 is a schematic elevation view illustrating operation of the pump; and

FIG. 4 is a graph also illustrating operation of the pump.

Referring to the drawings, the pump 12 is provided with a housing 14 defining a pump cylinder 16 having inlet and outlet connections 18 and 20. Between the inlet and outlet connections 18 and 20, the housing defines a compression chamber 22 in communication with the pump cylinder 16. Sealing the chamber from the inlet and outlet connections are ball valves 24 and 25 which are spring loaded to maintain pressure in the compression chamber 22 and in the outlet connection 20.

Reciprocally positioned within the pump cylinder 16 is a piston 26 which is biased outwardly from the cylinder in the direction of the uppermost point of its travel by means of a coil spring 28 seated in the bottom of the pump cylinder. The piston is sealed within the chamber by means of spaced O-rings 30.

Welded at the open end 32 of the pump cylinder to the pump housing are spaced apart frame members or sockets 34 through which a pivot pin 36 is extended, the pivot pin being connected to and acting as the pivot point for lever 38. The lever is provided with a tongue portion 40 which extends between the sockets 34, the tongue portion defining an opening 42 which receives the pivot pin 36.

Referring to FIG. 1, the tongue leads to an enlarged shoulder 44 of the lever, which in turn leads to the lever arm 46, the latter having a free or handle end spaced from the pivot pin. The shoulder 44 is provided with an opening 50 which extends parallel to the opening 42, through which connection pin 52 extends, the pin holding on opposite sides of the shoulder area spaced rigid link members 54. One of the link members is retained by the head of the pin 52, the other by means of a cotter pin 55.

The opposite ends of the links, which extend downwardly towards the pump cylinder, are connected to a second connection pin 56, which is retained in opening 58 extending through the piston 26 parallel to the openings 42 and 50. The three openings and pins are parallel, and further are in alignment when the lever is in the shown at-rest position. Preferably the pivot pin 36 is intermediate or halfway between the pins 52 and 56 holding the link members 54.

The biasing by spring 28 forces the piston 26 to its outermost position in the pump cylinder, restrained in that position by links 54 through the outer connection pin 52 and attachment of the lever to the pump housing. It is this outward biasing of the piston which establishes the at-rest position or upright position shown in the drawings of the lever, aligned with the axis or direction of movement of the piston.

It is evident that an operator of the pump can actuate the pump handle 46 backwards and forwards about pivot pin 36, and to opposite sides of the upright or at-rest position.

For full capacity operation or maximum volume output, the operator will actuate the lever 46 backwards and forwards to the limits of its stroke, the connection pin 52 following an arcuate path. As the pump handle is moved towards the extreme ends of the stroke, the connection pin moves in a path which more closely parallels the direction of movement of the piston thereby speeding up or accelerating the movement of the piston and increasing the ratio of movement of the piston to movement of the lever. In this way, the operator can stroke at maximum volume output permitting high speed loading of the pump until a load resistance is met. As a load is encountered, depending upon its magnitude, the stroke of the lever is shortened. When the stroke is limited to short arc lengths on opposite sides of the at-rest vertical position of the arm, the ratio of movement of the piston to movement of the lever is very

small so that the operator can very easily adjust the length of travel or stroke of the piston to the proper magnitude necessary to keep the work expended by the operator at a substantially constant level.

In addition, it is apparent that the leverage exerted through the link between the pump handle or lever varies with the position of the pump lever in its stroke. At a point near the at-rest position, the lever exerts a very small component of force in a relatively horizontal direction and a very large component of force through the link. As the arc length is increased, the component of force exerted through the link becomes correspondingly less.

This is illustrated in FIG. 3, the short high force (with reference to the force exerted through link members 54 and piston 26) low volume stroke being defined by the dashed lines *a-a* and the longer, low force (low link force) high volume stroke being defined by the dot-dash lines *b-b*. With reference to the graph of FIG. 4, as the angular position of the handle increases, the pump displacement progressively increases, as shown by the solid line of the graph. With the short stroke, the ratio of handle movement to displacement is low, this ratio increasing as the stroke is increased. Similarly, for a constant pump output pressure, the force which must be exerted by the operator on the handle progressively increases with angular position of the handle, this force on the handle being low with a short stroke.

The invention can be linked to a variable slope wedge to raise a weight. When the "slope" of the pump handle is small, *i.e.* the leverage is substantial, near the at-rest position, the piston moves very little, but very high pressures by the piston can be attained.

Near the limits of the handle or lever stroke, the "slope" is substantial, but the leverage is small. Thus a very large output can be pumped, but only small pressures can be attained.

In that the change of leverage with stroke length is almost a geometric progression, as shown in FIG. 4, the operator can with remarkable sensitivity adjust the length of stroke to pump with a constant force, and thereby pump to greater pressures than heretofore attained.

It is possible to drive the pump of the present invention with a variable speed constant torque hydraulic or other motor,

wherein the pump handle or lever is rapidly oscillated with shortened strokes as a load is encountered with the force and/or torque remaining constant. Because of the sensitivity mentioned above, it is a simple matter to provide an automatic mechanism which automatically varies stroke length with load encountered.

Although the invention has been described with reference to specific embodiments, variations will be known to those skilled in the art.

We claim:

1. A variable volume constant force pump comprising:
a housing containing a cylinder bore with a pressure end and an open end;

piston means positioned within said bore for reciprocal movement therein adapted to compress fluid when moved toward said pressure end;

lever means pivotally mounted to said open end on a pivot axis; and

rigid linkage members pivotally connected at one end to said piston and at the other end to said lever, each said connection having an axis parallel to said pivot axis, said lever connection axis being on a side of said pivot axis remote from said piston connection axis and aligned therewith when said lever is in a position such that the piston is closest to said open end.

2. A pump according to claim 1 wherein said lever member connection axis travels in an arcuate path with movement of said lever means with the center of said path being said pivot axis.

3. The pump of claim 1 wherein said rigid linkage members comprise first and second members, said members being on opposite sides of said lever and said piston, said pivotal lever mounting being intermediate said members.

4. The pump of claim 1 wherein said piston is directed towards said pressure end in increasing increments from an initial increment of zero, with uniform increments of movement as said lever is moved from a position where said axes are aligned to a second position where said axes are not aligned.

5. The pump of claim 4 wherein said second position is arcuately spaced on either side of said aligned position.

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