

Nov. 23, 1965

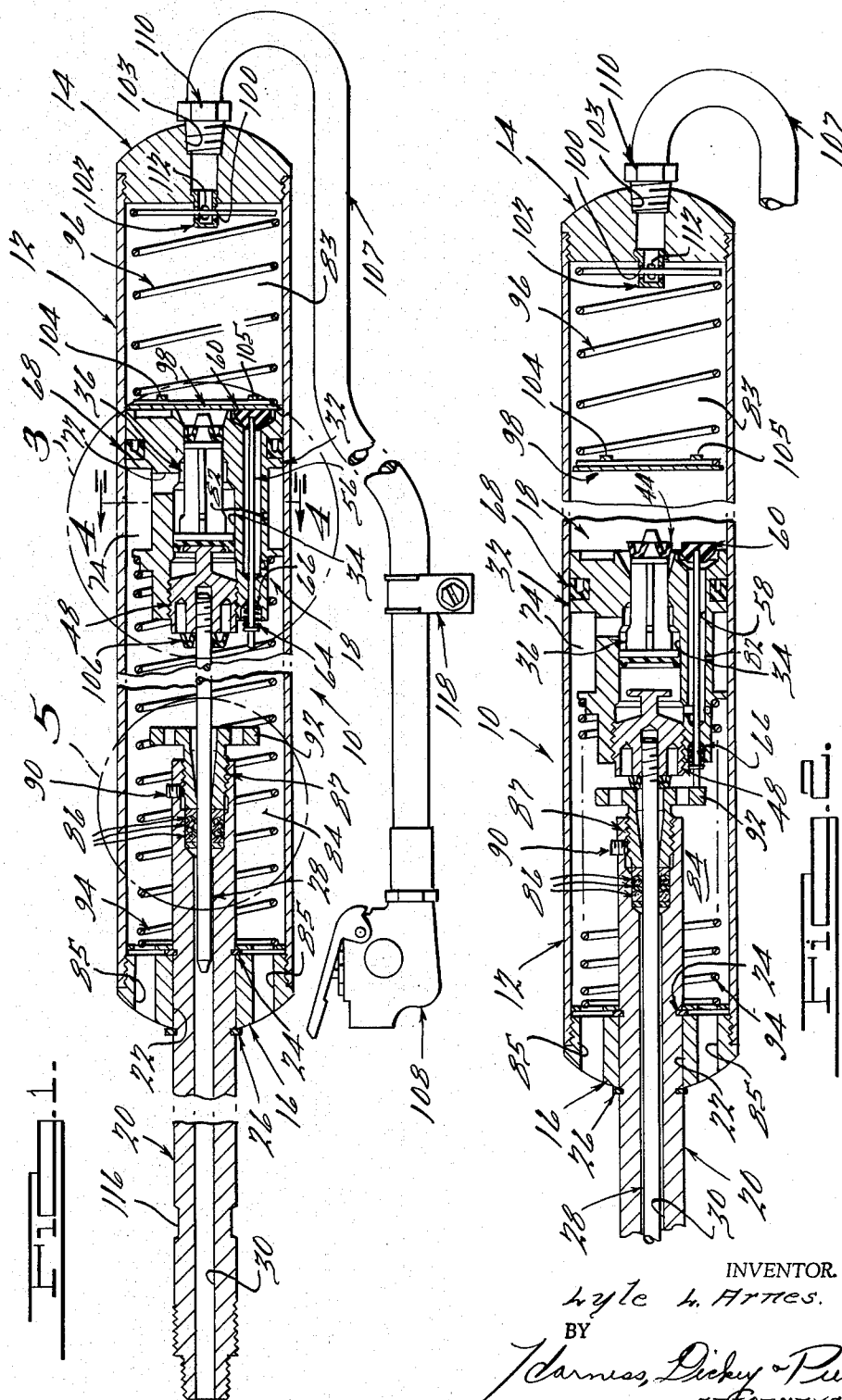
L. L. ARNES

3,218,980

PUMP

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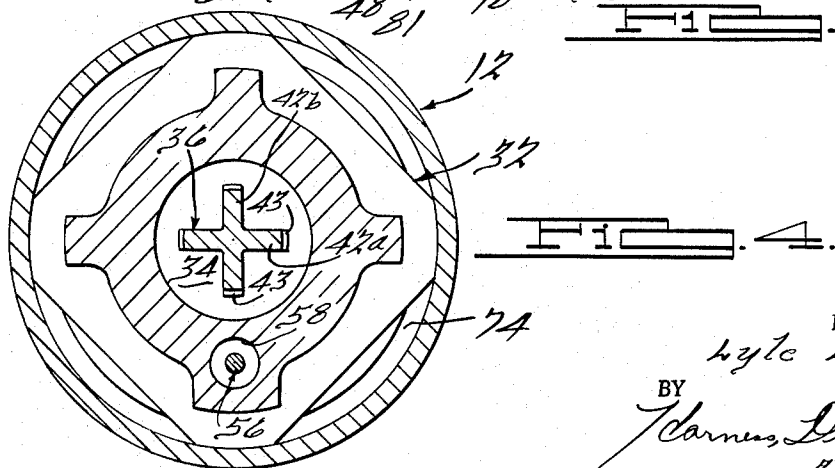
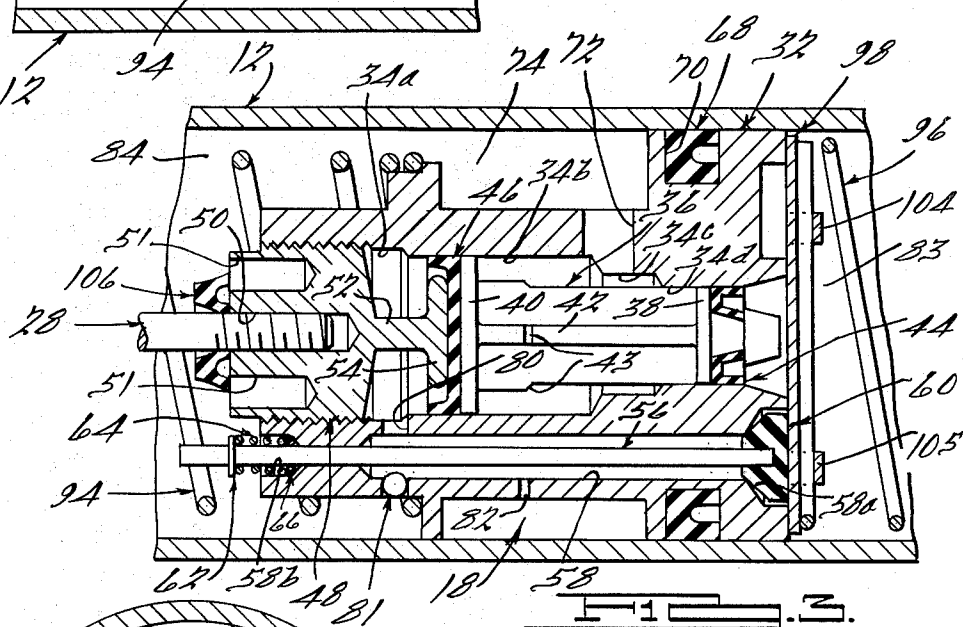
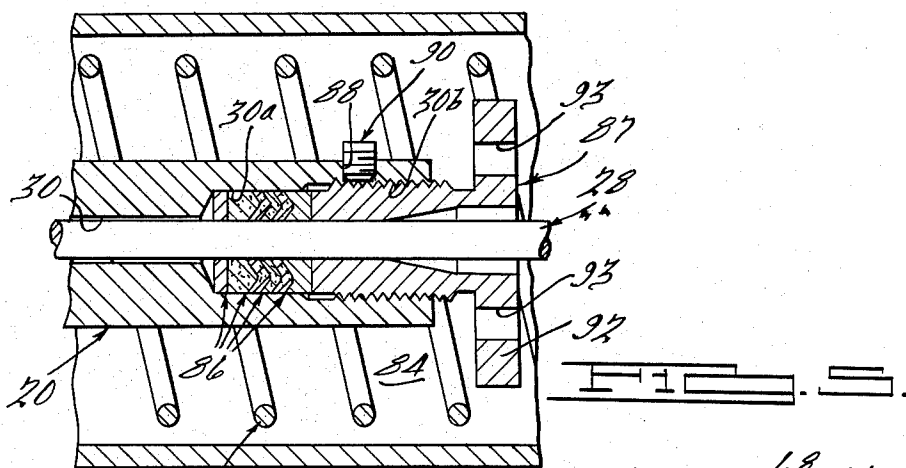
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2 Sheets-Sheet 2



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3,218,980 PUMP

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This invention relates generally to liquid pumping devices, and more particularly, to a combination pneumatic-hydraulic pumping device which is adapted to use air compressed at a relatively low pressure to pump hydraulic fluid under a relatively high pressure.

The pumping device of the present invention is particularly directed towards use with hydraulic jacks of the type used in automotive vehicle repair shops and which include a hydraulic pressure-operated load lifting lever that is elevated upon oscillation of a manipulating or pumping handle. The pumping device is adapted to be mounted on the jack handle or frame and use pressurized air as is commonly available in such repair shops to rapidly pump hydraulic fluid from the jack's fluid reservoir to its ram assembly, thereby effecting elevation of the jack's lifting lever without requiring oscillation or pumping of the manipulating handle. By virtue of the fact that the pumping device of the present invention is designed to use the existing or available valving of the jack's hydraulic power unit, both the construction of the pumping device and the operation thereof are extremely simple.

It is an object of the present invention to provide a combined pneumatic-hydraulic pumping device of the above character that is of an extremely compact construction.

It is another object of the present invention to provide a pumping device of the above character which is operable to convert the pumping energy of air under relatively low pressure to the pumping energy of hydraulic fluid under a relatively high pressure.

It is still another object of the present invention to provide a pumping assembly of the above character whose piston assembly reciprocates automatically while compressed air is communicated thereto.

It is yet another object of the present invention to provide a combined pneumatic-hydraulic pump of a simple design that can be easily assembled and economically manufactured.

Other objects and advantages of the present invention will become apparent from the following detailed description taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a longitudinal cross-sectional view of the pumping device of the present invention;

FIGURE 2 is a view similar to FIGURE 1 and illustrates the position of the piston assembly shown in FIGURE 1 at the completion of its compression stroke;

FIGURE 3 is an enlarged fragmentary cross-sectional view taken within the circle 3 of FIGURE 1;

FIGURE 4 is an enlarged transverse cross-sectional view taken along the line 4—4 of FIGURE 1; and

FIGURE 5 is an enlarged fragmentary cross-sectional view taken within the circle 5 of FIGURE 1.

Referring now to FIGURE 1 of the drawings, a pneumatic-hydraulic pump assembly 10, in accordance with a preferred embodiment of the present invention, includes a pump housing which consists of an elongated cylindrical hollow shell 12 with end plugs 14 and 16 threadably mounted within and closing the opposite ends thereof. A piston assembly, generally designated 18, is mounted within the shell 12 and is responsive to pressurized air being introduced into the shell 12 through the end cap 14 to reciprocate axially therewithin. An elongated hydraulic pumping cylinder 20 extends axially outward from the

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pump housing's end plug 16. The inner end of the cylinder 20 extends longitudinally within the shell 12 and is rotatably supported within an axially extending bore 22 in the end plug 16 by retaining rings 24 and 26 which are mounted within suitable grooves in the cylinder 20 on the inner and outer sides of the end plug 16. A piston rod 28, which extends axially within the shell 12, is threadably mounted to the inner end of the piston assembly 18 and is reciprocal within a central bore 30 of the hydraulic cylinder 20.

As best seen in FIGURE 3, the piston assembly 18 includes a piston 32 in which is formed an axially extending valve bore 34. The bore 34 is formed with an enlarged end section 34a, a slightly smaller diameter intermediate section 34b, a yet smaller diameter section 34c and still a smaller diameter end section 34d. An axially extending valve 36 is reciprocally mounted within the bore 34 and comprises end sections 38 and 40, and a medial section 42 which consists of perpendicular ribs 42a and 42b (as seen in FIGURE 4). It will be noted that the ribs 42a and 42b are each formed with a radially outwardly extending shoulder portion, generally designated 43, which is engageable with the end of the valve bore section 34c to limit the axial movement of the valve 36 within the bore 34. Packing means in the form of a U cross-sectioned packing ring 44 and a cup-shaped packing element 46 are respectively provided on the valve's end sections 38 and 40. An end plug 48 is threadably mounted within the valve bore section 34a and is formed with a central bore 50 in which the inner end of the hydraulic piston rod 28 is threadably mounted. A suitable sealant material (not shown) is interposed between the end plug 48 and the bore section 34a to provide an air-tight seal therebetween. A pair of diametrically opposed bores, generally designated 51, are formed in the outer end of the plug 48 and are adapted to removably receive a suitable tool for screwing the plug into the bore section 34a. Formed on the inner end of the end plug 48 is a central neck section 52 which terminates in an enlarged annular disc section 54. It will be seen in FIGURE 3 that the valve 36 is normally seated with the end plug's disc section 54 nested within the cup-shaped packing element 46.

The piston assembly 18 further includes a longitudinally extending cylindrical probe 56 which is slidably mounted within a longitudinal bore 58 formed in the piston 32 radially outwardly from the valve bore 34. The outer end of the bore 58 is formed with a conical section 58a in which is normally seated a frusto-conical shaped packing element 60 provided on the outer end of the probe 56. It will be seen that the probe 56 extends longitudinally inward from the piston 32 and that there is provided an annular retaining ring or shoulder 62 on the end portion thereof. The inner end of the bore 58 is formed with an enlarged section 58b and a coil spring 64 extends circumferentially between the shoulder 62 and inner end of the bore section 58b to resiliently maintain the probe's packing element 60 seated within the conical bore section 58a. An O-ring 66 is disposed intermediately between the spring 64 and the bottom of the bore section 58b to prevent pressurized air in the bore 58 from passing into the bore section 58b.

An annular U cross-sectioned packing ring 68 is mounted within an annular groove 70 formed around the periphery of the piston 32 and is adapted to provide an air-tight seal between the piston 32 and the inner periphery of the shell 12.

A radially outwardly extending passage 72 communicates the central valve bore 34 with an annular recess or chamber 74 formed around the outer periphery of the piston 32. Another radially extending passage 80 is formed in the piston 32 and communicates the bores

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34 and 58. A spherical closure plug 81 is press-fitted in the radially outer end of the passage 80 to prevent the leakage of air between the bore 58 and the interior of the shell 12. Still another small diameter radially extending bleed hole 82 communicates the bore 58 and chamber 74 and is adapted to control the rate of air flow out of cavity 34 during the return stroke of piston 32.

From the structure thus described, it will be seen that when the probe 56 is biased longitudinally outward with respect to the piston 32, the packing element 60 will become unseated from the bore 58, thereby permitting pressurized air within an air inlet chamber, generally designated 83 and defined by the shell 12, the piston 32 and the end cap 14, to pass through the bore 58 and the passage 80, and into the valve bore 34. Also, it will be seen that when the pressure within the valve bore sections 34a and 34b becomes sufficiently great, the valve 36 will be forced axially outward with respect to the piston 32 and from the position it assumes in FIGURE 3. As the valve 36 is thus biased, the packing ring 44 will become unseated from the valve bore section 34d, thereby communicating the shell's air inlet chamber 83 with the interior of the valve bore 34. By virtue of the valve's "x" configured medial section 42, pressurized air in the bore 34 may flow around the valve 36, through the radial passage 72, and into the annular chamber 74. Air within the chamber 74 then passes into an air outlet chamber which is generally designated 84 and is defined by the shell 12, the piston 32 and the end cap 16. As seen in FIGURES 1 and 2, the end plug 16 is provided with a plurality of axially extending, circumferentially spaced air exhaust ports, generally designated 85, out of which air in the outlet chamber 84 flows during the pumping operation.

Referring now to FIGURE 5, it will be seen that the inner end of the hydraulic pumping cylinder's central bore 30 is formed with enlarged diameter bore sections 30a and 30b. A plurality of axially aligned packing rings, generally designated 86, are disposed within the bore section 30a and are adapted to provide an oil-tight seal between the outer periphery of the piston rod 28 and the interior of the hydraulic cylinder 20. A hollow end plug 87 is threadably mounted within the bore section 30b and, as illustrated, the cylinder 20 is provided with a radially extending bore 88 in which is disposed a set screw 90 that is adapted to lock the plug 87 within the end of the cylinder 20. The inner end of the plug 87 is formed with a radially outwardly extending annular collar section 92 which the inner end of the probe 56 engages during the operation of the pumping assembly 10, as will be described. A pair of diametrically opposed bores, generally designated 93, are formed in the section 92 and, like the aforementioned bores 51, are adapted to removably receive a suitable tool for screwing the plug 87 into the bore section 30b.

It will be seen in FIGURES 1 and 2, that the piston assembly 18 is resiliently mounted interjacent two axially compressible coil springs 94 and 96. The spring 94, which is herein designated as a compression spring, extends around the inner end of the hydraulic cylinder 20 and abuts at one end against the inner side of the end plug 16 and at the opposite end against the annular shoulder section 78 formed on the piston 32. The spring 96 is designated as a cushion spring and extends longitudinally between the end plug 14 and a transversely extending cushion plate 98 which is adapted to operatively engage the outer (right) end of valve 36. The cushion spring 96 is supported in the above position by having its outer end bent diametrically and extending through a pair of diametrically aligned openings, generally designated 100, which are formed in a spring anchor 102 supported within an axially extending air inlet passage 103 that is formed in the end cap 14. The opposite end of the cushion spring 96 extends through suitable openings in a pair of axially outwardly extending bosses 104 and 105

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formed on the outer side of the cushion plate 98. It may be noted that the plate 98 is somewhat smaller in diameter than the interior of the shell 12 thereby allowing air which is introduced into the interior of the shell 12 through the passage 103 to flow around the plate 98. An annular bumper ring 106 is provided on the outer end of the end plug 48 and acts as a cushion means between the piston assembly 18 and the end plug 87.

Pressurized air is communicated to the pump assembly 10 through a suitable air conduit 107 and may be controlled by a manually operated air valve 108. The air conduit 107 is secured to the end cap 14 by a suitable fitting 110 which is threadably mounted within the air inlet passage 103. Together with the aforementioned compression spring support openings 100, the air deflector cap 102 is provided with a plurality of circumferentially arranged air inlet ports 112 through which air is communicated into the interior of the air inlet chamber 83 without impinging directly upon the outer surface of the cushion plate 98.

In operation, the pumping device 10 is preferably mounted on the frame or manipulating handle of its associated jack assembly. As seen in FIGURE 1, the outer end of the hydraulic pumping cylinder 20 is threaded and is thereby adapted to be screwed directly into an appropriate bore or passageway of the jack's hydraulic power unit. A wrench-engaging surface 116 is provided on the cylinder 20, and by virtue of the cylinder's rotatable mounting in the end plug 16, it may be conveniently screwed into the jack without necessitating rotation of the entire pumping device 10. A hose clamp 118 is provided on the air conduit 107 for detachably securing the conduit 107 to the jack handle.

Upon appropriate actuation of the air valve 108, pressurized air is communicated through the air conduit 107 and the air inlet passage 103 into the air inlet chamber 83. When the air pressure within the chamber 83 reaches a level sufficient to overcome resistant force exerted by the spring 94, the entire piston assembly 18 moves longitudinally inward until the inner end of the probe 56 engages the collar section 92 of the hydraulic cylinder's end plug 87. Upon engaging the collar section 92, the probe 56 is biased longitudinally within the piston 32, thereby unseating the packing element 60 and permitting pressurized air within the air inlet chamber 83 to flow into the bore 58, through the transverse passageway 80, and into the valve bore 34 interjacent the end plug 48 and the packing element 46. When the air pressure within the valve bore 34 becomes sufficiently great, and by virtue of the fact that the area of the valve's end section 40 is larger than that of the opposite end section 38, the valve 36 moves longitudinally outward within the piston 32, thereby unseating the packing ring 44 from the bore section 34d. The respective positions of the probe 56 and the valve 36 in their above described unseated condition may be best seen in FIGURE 2.

When the valve 36 is unseated, the pressurized air within the air inlet chamber 83 passes into the valve bore 34, around the valve 36, and into the radial passage 72. The air then passes through the annular chamber 74 and the shell's air outlet chamber 84, and thereafter out of the shell 12 through the air exhaust ports 85. As the pressurized air within the shell's inlet chamber 83 passes through the route thus described, the axial force of the compression spring 94 will become greater than the force of the pressurized air within the chamber 83 and the spring 94 will bias the entire piston assembly 18 longitudinally away from the inner end of the hydraulic cylinder 20.

Upon moving away or out of engagement with the collar section 92 of the end plug 87, the probe 56 is resiliently urged longitudinally within the piston 32 by the spring 64, thereby seating the packing element 60 within the bore section 58, preventing further flow of air through bore 58 and preventing the free flow of air out of cavity 34. The air entrapped in cavity 34 holds valve 36 in the

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open position (i.e., packing 44 unseated), resisting the tendency of the air rushing out of the chamber 83 to close the valve 36, during the return stroke of piston 32. This entrapped air is allowed to pass through the bleed hole 82 joining bore 58 and chamber 74.

As piston 32 nears the end of its return stroke, the small (right) end of valve 36 strikes cushion plate 98, which is backed up by the relatively light cushion spring 96. The cushion spring 96 and plate 98 work together to gently push valve 36 into bore 34, seating packing 44. Since all holes in the face of piston 32 are now sealed, the air remaining in the chamber 83 becomes the cushion which brings the piston 32 to a gentle but rapid stop and starts it on its next power stroke.

It will be apparent that as the piston assembly 18 reciprocates within the shell 12, the piston rod 28 will likewise reciprocate within the hydraulic pumping cylinder 20. Since the cylinder 20 is designed to communicate directly with the jack's hydraulic power unit, reciprocation of the piston rod 28 will effect a pumping of the hydraulic fluid from the jack's fluid reservoir to its power ram assembly. By appropriately introducing or communicating the pumping action of hydraulic cylinder 20 and piston rod 28 with the hydraulic circuitry of the jack's power unit, it is possible to use the existing or available valving provided in the power unit to effect the above fluid pumping, thereby enhancing the economies of size, weight and cost of the assembly 10.

It may be noted that a particular feature of the pumping assembly 10 of the present invention resides in the fact that no springs, detents or secondary control valves are required to hold the valve 36 in the open position against the inertia of air passing therethrough during the return stroke of the piston 32. This feature is critical in view of the fact that the closing forces tending to reseal the valve 36 within the piston 32 are substantially proportional to the pressure of the air being vented from the chamber 83, which pressure varies from approximately 10 p.s.i. to approximately 130 p.s.i. In the present invention, the force maintaining the valve 36 in the open position during the return stroke of the piston 32 varies in accordance with the pressure of the air being vented from the chamber 83, thereby making the valve 36 "self-adjusting."

While it will be apparent that the preferred embodiment herein illustrated is well calculated to fulfill the objects stated, it will be appreciated that the pumping device of the present invention is susceptible to modification, variation and change without departing from the proper scope or fair meaning of the subjoined claims.

What is claimed is:

1. In a pumping device,
a cylindrical pump housing,
piston means reciprocable in said housing,
a pumping cylinder in one end of said housing,
a piston rod connected to said piston means and being
reciprocal in said cylinder,
spring means interjacent the opposite ends of said housing
and said piston means,
an air inlet section in one end of said housing and an
air outlet section in the opposite end of said housing,
first valve means in said piston means operable to selectively
communicate air from said inlet section of said
housing to said outlet section in response to the fluid
pressure in said air inlet section, and second valve
means responsive to preselected movement of said
piston means to communicate the pressure conditions
in said inlet section to said first valve means.
2. A pumping device as set forth in claim 1 wherein
said first valve means is reciprocable within said piston
means to and from a position opening and closing fluid
passage means extending through said piston means.
3. A pumping device as set forth in claim 1 wherein
said piston means is provided with fluid passage means
adapted to communicate said air inlet and outlet sections

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of said housing and wherein said first valve means is movable to and from a position opening and closing said fluid passage means when said second valve means moves a preselected distance relative to said housing.

4. A pumping device as set forth in claim 1 wherein
said first valve means is adapted to relieve the air pressure
in said air inlet section of said housing when said
piston moves a preselected distance in said housing.

5. In a power device for a hydraulic jack,
a cylindrical pump housing,
piston means reciprocable in said housing,
a pumping cylinder in one end of said housing,
a piston rod connected to said piston means and being
reciprocal in said cylinder,
a fluid inlet section in said housing,
a fluid outlet section in said housing,
fluid passage means in said piston means communicating
said inlet section with said outlet section,
first valve means in said piston means movable to and
from a position opening and closing said fluid passage
means in response to fluid pressure conditions in said
fluid sections, and
second valve means in said piston means responsive to
the movement of said piston in said housing for
communicating the fluid pressure conditions of one
of said fluid sections to said first valve means to effect
actuation of the same.

6. A power device as set forth in claim 5 wherein said
second valve means comprises means on said piston which
is engageable with a stationary portion of said housing.

7. A power device as set forth in claim 5 wherein said
second valve means comprises a cylindrical probe slidably
mounted in said piston and engageable with a stationary
portion of said housing to effect air to enter said fluid
passage means thereby unseating said first valve means.

8. In a combined pneumatic-hydraulic pumping device,
the combination which includes,
an elongated hollow cylindrical housing,
end covers closing the opposite ends of said housing,
a reciprocal piston in said housing,
an air inlet chamber at one end of said housing and an
air outlet chamber at the other end of said housing,
an air inlet passage in the end cover of said housing adjacent
said air inlet chamber,
an air outlet passage in the end cover of said housing adjacent
said air inlet chamber,
a hollow hydraulic pumping cylinder coaxial with said
housing and being operatively supported by one of
said end covers with its inner end portion extending
longitudinally within said air outlet chamber,
said piston being formed with an axially extending valve
bore one end of which is closed by a valve plug,
a cylindrical piston rod reciprocable in said hydraulic
pumping cylinder and being attached at its inner end
to said valve plug,
an annular recess formed around the periphery of said
piston,
a radially outwardly extending fluid passage communicating
said valve bore with said annular recess,
a plurality of circumferentially spaced flow passages
formed around the periphery of said piston communicating
said annular recess with said air outlet chamber,
a valve in said valve bore reciprocable to and from a
position permitting air in said air inlet section to
pass through said valve bore into said radially extending
fluid passage,
a longitudinally extending bore formed in said piston
radially offset from said valve bore,
a cylindrical probe slidably mounted within said bore,
one end of said probe being engageable with stationary
means in said housing and the opposite end of said
probe having packing means thereon adapted to pro-

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vide an air-tight seal between said longitudinally extending bore and said air inlet chamber,
a fluid passage between said longitudinally extending bore and said valve bore, and
spring means in said housing extending longitudinally 5
between said piston and each of said end covers.

9. A pumping device as set forth in claim 8 wherein said valve is generally X-shaped in cross section.

10. A pumping device as set forth in claim 8 wherein said valve plug is formed with an end stop against which one end of said valve is seated and which partially defines a chamber in said valve bore that is communicable through said radially outwardly extending fluid passage with said longitudinally extending bore. 10

11. A pumping device as set forth in claim 8 which includes spring means for resiliently seating said packing means on said probe and wherein said probe is engageable with the inner end of said pumping cylinder. 15

12. A pumping device as set forth in claim 8 wherein the opposite ends of said valve are of a substantially different area in cross section. 20

13. In a pumping device,
a pumping housing,
a fluid inlet section in said housing,
a fluid outlet section in said housing, 25
piston means reciprocable in said housing between said inlet and outlet sections,
fluid passage means in said piston means communicating said inlet section with said outlet section,
first valve means in said piston means movable to and from a position opening and closing said fluid passage means, 30
second valve means movable to and from a position communicating said fluid inlet section with said first valve means, first spring means normally urging said piston means toward said fluid outlet section, and 35
second spring means normally urging one of said valve means to a closed position.

14. In a pumping device, 40
a pumping housing,
a fluid inlet section in said housing,
a fluid outlet section in said housing,
piston means reciprocable in said housing between said inlet and outlet sections, 45
fluid passage means in said piston means communicating said inlet section with said outlet section,
valve means in said piston means movable to and from a position opening and closing said fluid passage means, 50
said valve means being movable to said position opening said fluid passage means and being maintained in said open position by force which is proportional to the pressurized fluid being communicated through said fluid passage means, means responsive to preselected movement of said piston means within said housing for selectively communicating one end of said valve means with said fluid inlet section, first spring means normally urging said piston means toward said fluid outlet section, and second spring means normally urging said means responsive to preselected movement of said piston means from a position selectively communicating one end of said valve means with said fluid inlet section. 55

15. In a pumping device,
a pumping housing,
an air inlet section in said housing,

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an air outlet section in said housing,
piston means in said housing being movable on its forward stroke from said air inlet section to said air outlet section and being movable on its return stroke from said air outlet section to said air inlet section, 5

fluid passage means in said piston means communicating said air inlet section with said air outlet section, 10

valve means in said piston means movable to and from a position opening and closing said fluid passage means, 15

said valve means being maintained in said open position during said return stroke solely by the force of pressurized fluid being communicated through said fluid passage means, means responsive to preselected movement of said piston means within said housing for selectively communicating said valve means with said fluid inlet section, first spring means normally urging said piston means toward said air inlet section of said housing, and second spring means normally urging said last mentioned means from said position selectively communicating said valve means with said fluid inlet section. 20

16. In a pumping device,
a pumping housing,
an air inlet section in said housing,
an air outlet section in said housing, 25
piston means in said housing being movable on its forward stroke from said air inlet section to said air outlet section and being movable on its return stroke from said air outlet section to said air inlet section, 30

fluid passage means in said piston means communicating said air inlet section with said air outlet section, valve means in said piston means movable to and from a position opening and closing said fluid passage means, 35

said valve means being movable to said open position when the differential pressure across said valve means reaches a preselected level, 40

said valve means being maintained in said open position during said return stroke of said piston means solely by a force of pressurized fluid being communicated from said air inlet section to said air outlet section through said fluid passage means, means responsive to preselected movement of said piston means within said housing for selectively communicating said valve means with said fluid inlet section, first spring means normally urging said piston means toward said air inlet section of said housing, and second spring means normally urging said last mentioned means from said position selectively communicating said valve means with said fluid inlet section. 45

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