

Dec. 7, 1971

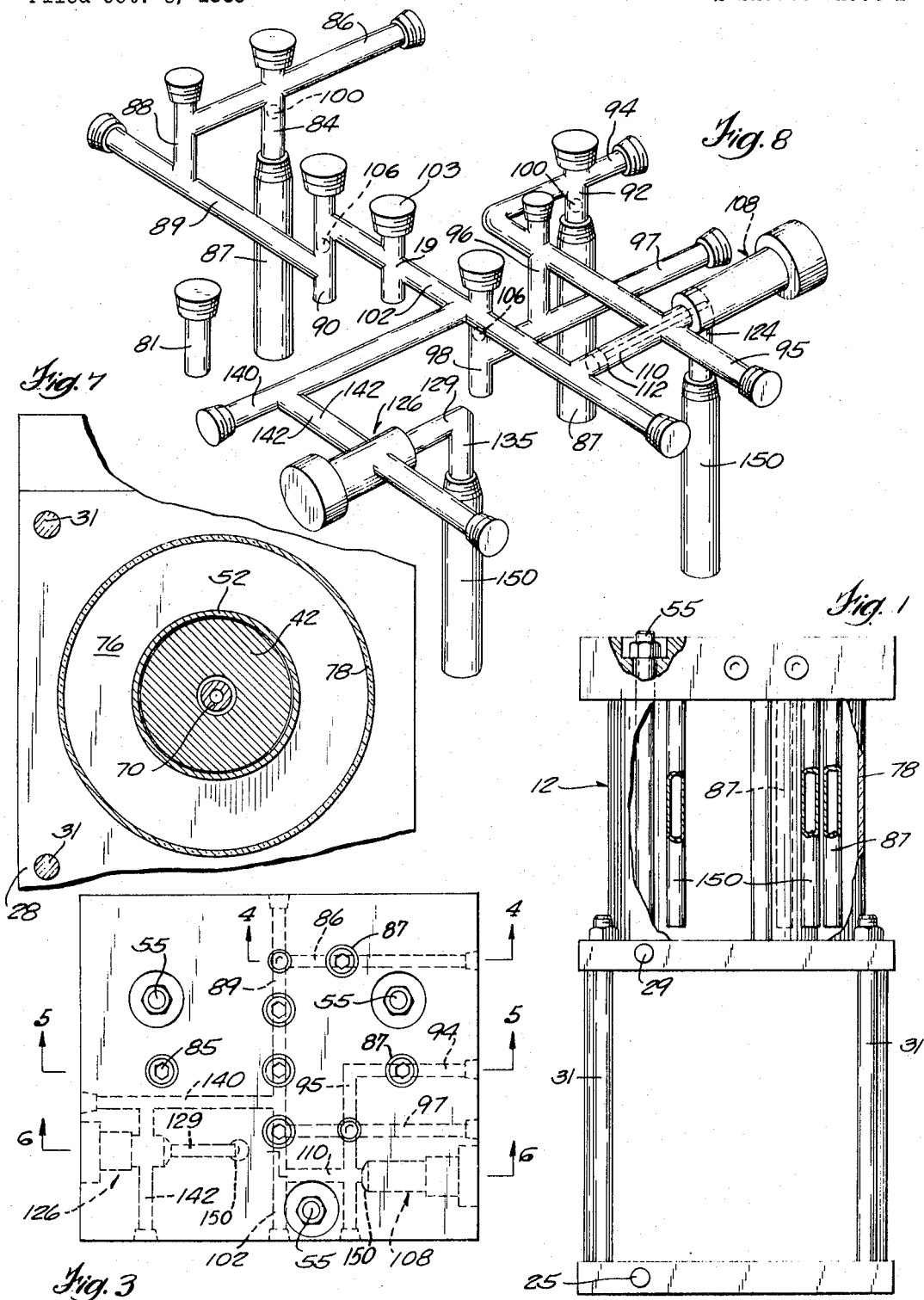
T. J. SCHOENLEBEN

3,625,006

TWO-STAGE HYDRAULIC BOOSTER

Filed Oct. 8, 1969

2 Sheets-Sheet 1



Inventor

Thomas J. Schoenleben

By

Whulb, Whulb, House & Clements
Attorneys

Dec. 7, 1971

T. J. SCHOENLEBEN

3,625,006

TWO-STAGE HYDRAULIC BOOSTER

Filed Oct. 8, 1969

2 Sheets-Sheet 2

Fig. 6

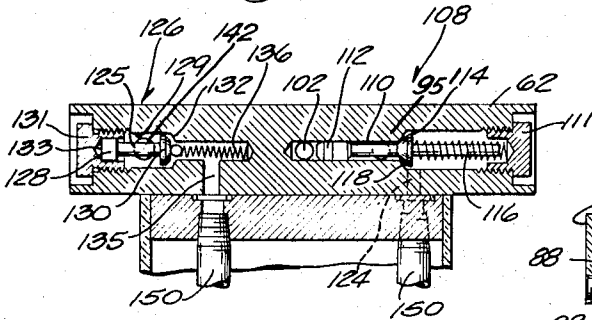


Fig. 2

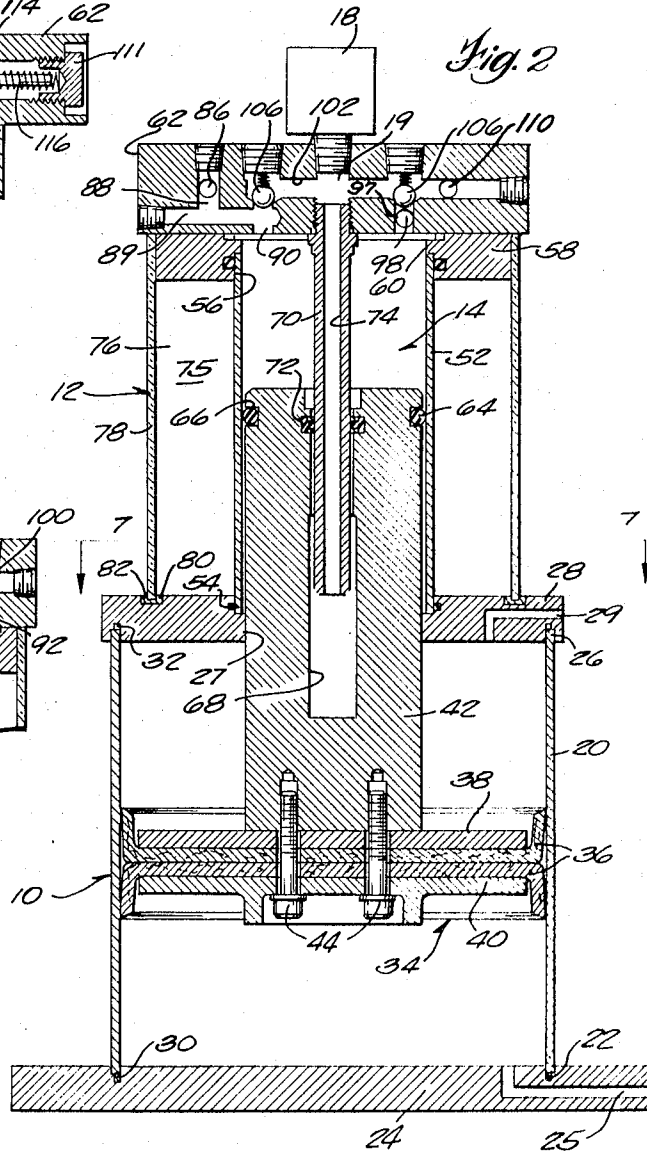
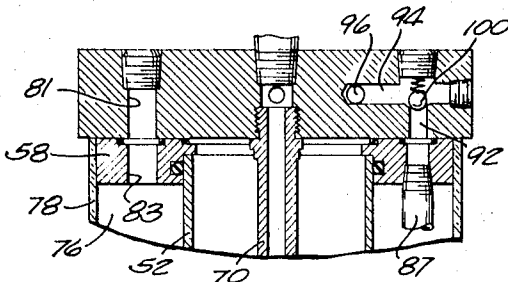


Fig. 5

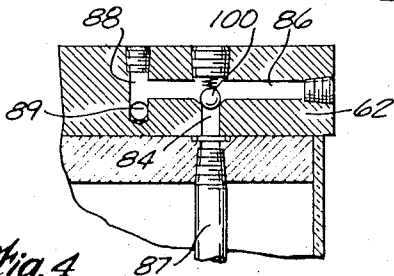


Fig. 4

Inventor
Thomas J. Schoenleben
Whelan, Whelan, House & Clemmens
Attorneys

1

3,625,006

TWO-STAGE HYDRAULIC BOOSTER
Thomas J. Schoenleben, Racine, Wis., assignor to
Tomco, Inc., Racine, Wis.

Filed Oct. 8, 1969, Ser. No. 864,682

Int. Cl. F15b 7/00

U.S. Cl. 60—54.6

6 Claims

ABSTRACT OF THE DISCLOSURE

An air actuated two-stage hydraulic booster including an air actuated piston and cylinder assembly and a low pressure hydraulic piston and cylinder assembly actuated by the air actuated assembly, a high pressure piston and cylinder assembly incorporated within the low pressure hydraulic assembly and a pressure responsive relief valve to release the pressure in the low pressure assembly to provide a single shot of high pressure fluid from the high pressure assembly.

BACKGROUND OF THE INVENTION

Hydraulically actuated devices, such as hydraulic presses, work holding clamps, and the like, generally require a large volume of hydraulic fluid in order to move the moveable parts of the hydraulic devices into position prior to actual operation of the device. These devices can then be actuated by a low volume of high pressure fluid. Most of these hydraulic devices use a single piston to provide a high volume of fluid first at low pressure and subsequently at high pressure.

SUMMARY OF THE INVENTION

The hydraulic booster disclosed herein provides both a high volume of hydraulic fluid at low pressure and a low volume of hydraulic fluid at high pressure in a single stroke of a piston. A low pressure piston and cylinder assembly is used to provide the high volume of low pressure fluid in the first stage. A high pressure piston and cylinder assembly incorporated in the low pressure assembly is used to provide the low volume high pressure fluid in the second stage. One of the advantages of this booster is that it can be operated from a standard compressed air system at 80 to 90 p.s.i. commonly found in a machine shop. The full force of the compressed air is initially used to bring the low pressure assembly up to 500 p.s.i. The entire force of the compressed air is then shifted to the high pressure assembly by releasing the pressure of the low pressure assembly. The high pressure assembly can be readily adapted to provide pressures between 1,400 p.s.i. to 10,000 p.s.i.

Other advantages of this system will be readily apparent from the following detailed description when read in connection with the accompanying drawings in which:

FIG. 1 is a side view in elevation of the booster partly broken away to show the return tubes to the reservoir.

FIG. 2 is a section view in elevation showing the booster.

FIG. 3 is a top view of the circuit plate.

FIG. 4 is a view taken on line 4—4 of FIG. 3 showing a fluid filler passageway.

FIG. 5 is a view taken on line 5—5 of FIG. 3 showing a second fluid filler passageway.

FIG. 6 is a view taken on line 6—6 of FIG. 3 showing the high pressure discharge valve and low pressure discharge valve.

FIG. 7 is taken on line 7—7 of FIG. 2 showing the high pressure piston and cylinder assembly.

FIG. 8 is a perspective view of the flow paths in the circuit plate.

2

DESCRIPTION OF THE INVENTION

Although the disclosure hereof is detailed and exact to enable those skilled in the art to practice the invention, the physical embodiments herein disclosed merely exemplify the invention which may be embodied in other specific structure.

The hydraulic booster of this invention generally includes a pneumatic piston and cylinder assembly 10 and a low pressure hydraulic piston and cylinder assembly 12. A high pressure hydraulic piston and cylinder assembly 14 is incorporated within the hydraulic assembly 12. The pneumatic piston and cylinder assembly 10 is actuated by compressed air to pressurize fluid in the hydraulic piston and cylinder assemblies 12 and 14. Pressurized fluid discharged from the hydraulic assemblies 12 and 14 is supplied to a hydraulic manifold 18 through an outlet passage 19 for distribution to the devices to be actuated.

More particularly, the pneumatic piston and cylinder assembly 10 includes a cylinder 20 which is seated in a groove 22 provided in a base plate 24 and in a groove 26 provided in a center plate 28. The cylinder 20 is sealed to the base plate 24 by means of an O-ring seal 30 and to the center plate 28 by means of an O-ring 32. Compressed air is admitted to the lower portion of the cylinder 20 through an air passage 25 provided in base plate 24. Compressed air can be admitted or discharged from the upper portion of the cylinder 20 through an air passage 29 provided in the center plate 28 which also includes a central opening 27. The base plate 24 is secured to the center plate by bolts 31.

A piston 34 is positioned in the cylinder 20 and includes a pair of cup seals 36 positioned between an upper plate 38 and a lower plate 40. The piston 34 is supported for reciprocal movement in the cylinder 20 by means of the low pressure piston 42 which extends upwardly through the opening 27 provided in the center plate 28. The air piston 34 is secured to the piston 42 by bolts 44.

The pneumatic assembly 10 is actuated by admitting compressed air through passage 25 provided in the base plate 24. Air in the upper portion of the cylinder 20 will be discharged through passage 29 provided in the center plate 28. The piston in the pneumatic assembly 10 can be returned by admitting compressed air into the upper portion of the cylinder through passage 29 or by using a compression spring.

The low pressure hydraulic piston and cylinder assembly 12 includes a cylinder 52 which is seated in a recess 54 provided around opening 27 in the center plate 28 and in a recess 56 provided in a subplate 58 having a central aperture 60. The upper end of the cylinder 52 is closed by means of a circuit plate 62 which is secured to the center plate 28 by bolts 55. The piston 42 includes an axially extending chamber 68 and extends into the cylinder 52 to form the piston for the hydraulic assembly 12. The piston 42 is sealed in the cylinder 52 by means of an O-ring 64 provided in a groove 66 around the upper end of the piston 42.

The high pressure piston and cylinder assembly 14 includes a tubular piston 70 and the chamber 68 in the piston rod 42. The piston 70 is secured to the circuit plate 62 and extends downwardly into the chamber 68 and is sealed in the chamber 68 by means of a seal 72. Means are provided for connecting the chamber 68 to the outlet passage 19 in the form of an axially extending passage 74 in the piston 70.

Hydraulic fluid 75 is stored within a reservoir 76 formed around the cylinder 52 by means of a translucent cylinder 78 which is seated in a groove 80 provided in the center plate 28 and closed at the upper end by the

subplate 58. The reservoir is sealed by means of a seal 82 provided in the groove 80. The reservoir 76 is filled with fluid through a passage 81 provided in the circuit plate 62 and a passage 83 provided in the plate 58. Passage 81 is closed by means of a cap 85.

Fluid from the reservoir is supplied to the low pressure cylinder 52 on the return stroke of piston 42 by means of filler tubes or nipples 87 secured to the subplate 58. One of the filler tubes 87 is connected to the cylinder by means of passages 84, 86, 88, 89 and 90. The other filler tube 87 is connected to the cylinder 52 by means of passages 92, 94, 95, 96, 97 and 98. Ball type check valves 100 are provided in the passages 84 and 92 to prevent the flow of hydraulic fluid back to the reservoir 76 when the fluid in cylinder 52 is being pressurized.

Fluid is discharged from the low pressure cylinder 52 to the manifold 18 on the pressure stroke of the piston 42 through passages 90, 98, 102 and 19. Ball type check valves 106 are provided in the passages 90 and 98 to prevent the reverse flow of fluid from the manifold 18 into cylinder 52.

High pressure fluid from chamber 68 is discharged to the manifold 18 through passage 74 in piston 70 and passages 102 and 19 in the circuit plate 62. The check valves 106 prevent the flow of high pressure fluid from chamber 68 into the low pressure cylinder 52.

Means are provided to release the pressure in low pressure cylinder 52 when the pressure reaches a predetermined limit. Such means is in the form of a pilot operated poppet valve 108 positioned in a passage 110 which intersects passages 95 and 102 in the circuit plate 62 and is connected to the reservoir 76 by a passage 124. The passage 110 is closed by means of a cap 111. The poppet valve includes a piston head 112 positioned for reciprocal motion within passage 110 and a valve 114 which is biased by means of a spring 116 into engagement with a valve seat 118. Hydraulic fluid in passage 102 acts on the face of the piston 112 against the bias of spring 116. When the pressure in passage 102 exceeds the bias of the spring 116, the poppet valve will move to the right moving valve 114 off of valve seat 118. Low pressure fluid in cylinder 52 will flow through passages 98, 97, 96 and 95 into passage 110 and then through passage 124 back to the reservoir 76. Once the pressure from the hydraulic fluid in the low pressure cylinder 52 is released, the full force of the compressed air in the pneumatic piston and cylinder assembly 10 will be applied to the high pressure piston and cylinder assembly 14. A small volume of high pressure fluid will be discharged through passage 74 in piston 70 to the manifold 18 for distribution to the devices to be actuated.

On the return stroke, the piston 42 will create a vacuum in cylinder 52 drawing fluid from the reservoir 76 into the low pressure cylinder 52. Fluid in the manifold 18 is prevented from flowing into the low pressure cylinder 52 by the check valves 106. Means are therefore provided to allow the fluid in the manifold 18 to flow back to the reservoir. Such means is in the form of a release valve 126 provided in a passage 129 in the circuit plate 62 which is closed by means of a cap 131 having an inner recess 133. The release valve 126 includes a stem 125 having a piston 128 at one end seated in recess 133 and a valve 130 at the other end positioned to engage the valve seat 132 provided in passage 129 in the circuit plate. The valve is biased to an open position by means of a spring 136. The spring 136 provides a maximum bias equivalent to a hydraulic force of 100 p.s.i. The passage 129 is connected to the passage 102 in the circuit plate by means of passages 140 and 142 and to the reservoir by means of a passage 135. As soon as the pressure in passage 102 exceeds 100 p.s.i., the pressure of the fluid will move valve 130 to the right against the valve seat 132 closing the passage 134. Whenever the pressure in passage 102 drops below 100 p.s.i., the release valve will open and any fluid in the manifold 18 will flow back

through passages 140, 142 and 135 into the reservoir 76.

Means are provided to prevent foam from forming in the reservoir 76 on the return flow of fluid through the poppet valve 108 and release valve 126. Such means is in the form of return tubes 150 connected to passages 124 and 135 in the circuit plate 62. The return tubes depend from the circuit plate downwardly to a point spaced from the center plate 28.

The pressure difference between the low pressure and high pressure assemblies 12 and 14 can be easily varied by merely replacing the piston 42 with a different diameter piston 42 having a different diameter chamber 68 and replacing piston 70 with a new piston 70 having the same diameter as the new chamber 68. In the embodiment shown, compressed air at 80 to 90 p.s.i. will provide low pressure hydraulic fluid at 500 p.s.i. and high pressure fluid at 10,000 p.s.i. The high pressure fluid can be decreased to 1,000 p.s.i. by increasing the diameter of chamber 68.

Various of the features of the invention are set forth in the following claims.

What is claimed is:

1. A two-stage hydraulic booster for operating a hydraulically actuated device, said booster comprising:

a cylinder having an outlet passage connected to the device,

a fluid in said cylinder,

a piston including a chamber, said piston being mounted for reciprocal motion in said cylinder,

means including a fixed piston extending into said chamber for connecting said chamber to said outlet passage,

an air actuated piston and cylinder assembly for moving said first piston to pressurize said fluid in said cylinder and said fluid in said chamber to actuate the device,

a fluid reservoir surrounding said cylinder,

means for connecting said reservoir to said cylinder, means responsive to a predetermined pressure for discharging the fluid from said cylinder into said reservoir,

means for preventing the flow of high pressure fluid from said outlet passage into said cylinder whereby the pressure of the fluid in said chamber acts solely on the device, and

normally open valve means responsive to a predetermined pressure in said outlet passage for preventing flow of fluid from said chamber to said reservoir and for releasing high pressure fluid from said chamber into said reservoir when the pressure in said outlet passage drops back to the predetermined pressure.

2. A booster according to claim 1 wherein said discharging means includes a pilot operated poppet valve having a piston head connected to respond to the pressure of the fluid in said outlet passage.

3. A two-stage hydraulic booster for actuating a hydraulic device, said booster comprising:

an air piston and cylinder assembly including an air piston,

a low pressure hydraulic piston and cylinder assembly including a low pressure piston connected to respond to the movement of said air piston to build up fluid pressure in said low pressure assembly,

said low pressure piston including a chamber,

a circuit plate having an outlet passage connecting said device to said low pressure assembly,

a high pressure piston connected to said outlet passage in said circuit plate and extending into said chamber to build up fluid pressure in said chamber on movement of said low pressure piston,

a fluid reservoir surrounding said low pressure assembly,

means connected to said outlet passage responsive to a predetermined pressure for discharging the fluid from said low pressure assembly into said reservoir

5

and a normally open valve means connecting said chamber to said reservoir and closing in response to a predetermined pressure in said outlet passage to prevent flow of fluid from said chamber to said reservoir.

4. A unitary two-stage hydraulic booster for operating a hydraulically actuated device, said booster comprising:

- a base plate,
- a first cylinder mounted on said base plate,
- an intermediate plate mounted on said first cylinder to define an air chamber in said first cylinder,
- a second cylinder mounted on said intermediate plate,
- a circuit plate mounted on said second cylinder and having an outlet passage connecting the second cylinder to the hydraulically actuated device,
- a first piston mounted for reciprocal motion in said first cylinder in response to changes in air pressure in said first cylinder,
- a second piston connected to said first piston and projecting through said intermediate plate into said second cylinder, a fluid chamber in said second piston,
- a fixed tubular piston mounted in said circuit plate and extending into said fluid chamber, said fixed piston connecting said fluid chamber to said outlet passage,
- means in said outlet passage in said circuit plate for

6

preventing flow of fluid from said fluid chamber into said second cylinder, and means in said circuit plate for releasing the pressure of the fluid in said second cylinder whereby the pressure of the fluid in said chamber acts solely on the device.

5. The booster according to claim 4 including a third cylinder mounted on said intermediate plate coaxial with said second cylinder, said releasing means being connected to discharge fluid from said second cylinder into said third cylinder.

6. The booster according to claim 5 includes means for connecting said third cylinder to said second cylinder.

References Cited

UNITED STATES PATENTS

3,407,601	10/1968	Beck	60—54.5 HA
3,412,554	11/1968	Voitsekhovski et al.	60—54.5 HA

MARTIN P. SCHWADRON, Primary Examiner

A. M. ZUPCIC, Assistant Examiner

U.S. Cl. X.R.

60—54.6 HA, 62.6