A combination accumulator and hydraulic fluid pressure actuated power unit has a pair of pistons, one of which is extensible and is adapted for connection to an object to be controlled, and the other of which is free-floating within the cylinder of the unit to define an extra gas subchamber between the floating piston and the extensible piston. Thus, when a fixed volume of hydraulic fluid is supplied to the side of the floating piston opposite the gas subchamber, the gas is firmly supported by the noncompressible hydraulic fluid and the load is floatingly supported by the gas. By varying the volume of hydraulic fluid, the floating piston can be reciprocated within the cylinder with the compressed gas functioning substantially as a noncompressible fluid to thus reciprocate the extensible piston. The unit can be readily adapted for single or double acting use.

7 Claims, 3 Drawing Figures
This invention relates to the field of fluid pressure control for various shiftable structures and articles requiring power for support or operation, and has as an important object to provide a special fluid pressure actuated power unit that doubles as a source of “floating” support.

Another important object of the invention is to provide a combination accumulator and power unit wherein floating or shock-absorbing action is obtained by a compressible fluid in the unit while positive, power supplying action is obtained by noncompressible fluid in the unit.

In carrying out the preceding objects an important aim of the present invention is the provision of a special free-floating piston within the unit that is displaced by noncompressible fluid on one side thereof while acting against compressible fluid on the opposite side.

A further important object is to provide such a unit wherein its ability to cushion loads in no way interferes with or impairs its ability to positively shift the loads.

An additional important object of this invention is to provide a special unit as aforesaid which can be easily rendered single or double acting.

In the drawing:

FIG. 1 is a schematic side elevation view of a farm implement showing one representative manner in which the combination accumulator and pressure-actuated power unit of the present invention may be utilized;

FIG. 2 is an enlarged, vertical cross-sectional view of the unit when the latter is in condition to floatingly support an object such as the header of the implement in FIG. 1; and

FIG. 3 is a view of the unit similar to FIG. 2, but showing the condition of the unit when the supported object is raised to the fullest limit of the unit.

The implement 10 has a frame structure 12 and a header structure 14 swingably supported thereon for vertical shifting movement between a fully lowered and a fully raised position. As illustrated, the unit 16 of the present invention may be interposed between the frame 12 and the header 14 in order to control such swinging of header 14, and also to floatingly support the latter during advancement of the implement 10 over a field. It will be readily recognized from the description which follows, however, that the principles of the present invention are not limited to the specific use of unit 16 illustrated in FIG. 1, and that such representative illustration is made only for the purpose of rendering the manner of use of unit 16 fully and clearly understandable.

It is also important to point out at this juncture that the frequent reference herein made to “compressible” and “noncompressible” fluids is done with a view to contrasting the relative compressive abilities of the fluids selected for use in unit 16. Although liquids are capable of being compressed to a degree, such compression is so slight as to be negligible for practically all applications, including those contemplated by the present invention. Therefore, it is to be understood that, in the interest of conciseness and expediency, noncompressible as herein used includes not capable of being compressed within all practical limits of load application.

The unit 16 has a hollow cylinder 18 provided with a chamber 20 extending from one end 22 of cylinder 18 to the opposite end 24 thereof. A piston 26 having an elongated stem 28 is reciprocable longitudinally of chamber 20 in sealing engagement with the interior thereof for extension and retraction of the stem 28 through end 24. A passage 30 through stem 28 longitudinally thereof is open at one end to the chamber 20 and is closed at the opposite end thereof by a suitable component such as a plug 32.

A special free-floating piston 34 is also located within chamber 20 between the piston 26 and end 22 of cylinder 18. Piston 34 thus subdivides chamber 20 into a pair of subchambers 36 and 38 on opposite sides of piston 34, and the piston 26 also operates to effectively subdivide chamber 20 into yet a third subchamber 40 between piston 26 and end 24.

A port 42 in end 22 communicates subchamber 38 with a line 44 through a fitting 46 for supplying subchamber 38 with a noncompressible hydraulic fluid denoted by the numeral 48. On the other hand, the passage 30, upon removal of plug 32, may be used to charge the subchamber 36 with a suitable compressible fluid denoted by the numeral 50, such fluid 50 preferably taking the form of nitrogen gas. A second port 52 in end 24 communicates subchamber 40 with the atmosphere and may be used to vent subchamber 40 when unit 16 is placed in a situation requiring only single-acting operation, or port 52 may be provided with a suitable fitting such as 54 to enable hydraulic fluid to be supplied to subchamber 40 for double-acting applications.

In use, the unit 16 may be installed as illustrated in FIG. 1 wherein the outermost apertured end 56 of piston stem 28 is secured to the header 14 while the remote end 22 of cylinder 18 is secured to frame 12 through aperture 58. Height control and floating support of header 14 is thereby provided through controlled extension and retraction of the piston 26 while the cylinder 18 remains stationary. It is within the scope of the present invention, however, to reverse this procedure so that the piston 26 remains stationary and cylinder 18 is reciprocated relative thereto. Such an arrangement requires only that the unit 16 be inverted from its orientation illustrated in FIG. 1 and hydraulic fluid 48 supplied to subchamber 36 while compressible gas 50 is supplied to subchamber 38. Passage 30 could be used to carry hydraulic fluid 48 to subchamber 36, and port 42 could be used to charge subchamber 38 with gas 48.

It is also within the scope of the present invention to maintain the orientation of unit 16 as illustrated and simply supply subchamber 36 with hydraulic fluid 48 while charging subchamber 38 with gas 50. Once again, a convenient manner of carrying out this arrangement is simply to use passage 30 for hydraulic fluid 48 and port 42 for gas 50.

Assuming for purposes of illustration that the unit 16 is to be utilized as illustrated in FIG. 1 wherein piston 26 is reciprocated and only a single-acting arrangement is required because of the fact that header 14 can return to its lowermost position by gravity, charging of the subchamber 36 with the gas 50 causes the subchamber 36 in cooperation with the topside 34a of piston 34 to function as an accumulator in floatingly supporting header 14. Introduction of hydraulic fluid 48 into subchamber 38 through port 42 and against the lower side 34b of piston 34, causes the latter to move upwardly against gas 50, compressing the later until the
header 14 just begins to lift from the ground. This condition is illustrated in FIG. 2 and thus represents the situation wherein header 14 only lightly engages the ground, its load being borne by the gas 50 backed up by the "solid" fluid 48 within subchamber 38.

Therefore, as the implement 10 is advanced over a field, the unit 16 operates to effectively float header 14 so that abrupt rises in the terrain be encountered, for example, header 14 can immediately respond and easily ride up and over such rises because of the assistance imparted thereto by the compressed gas 50. On the other hand, should an abrupt depression be encountered, the header 14 does not slam downwardly against the bottom of the depression, but instead, very gently settles therewithin to accommodate such deviation in surface contour.

When it is necessary to raise the header 14 to an above-ground position, it is only necessary to pump an additional volume of hydraulic fluid 48 into subchamber 38 which causes the piston 34 to be shifted upwardly, such as shown in FIG. 3, to extend piston stem 28. Inasmuch as the header 14 has previously compressed gas 50 almost to the fullest extent possible for the particular weight of header 14 in order to floatingly support the same, very little further compression of gas 50 is experienced during the positive lifting process. Because the header 14 has already expended its compressive force, gas 50 in effect acts as a noncompressible fluid at this time to push piston 26 upwardly in response to the similar displacement of piston 34.

Lowering of header 14 may be carried out simply by allowing an appropriate portion of the hydraulic fluid 48 to escape from subchamber 38 through port 42, whereupon the floating piston 34 gradually drops toward end 22 to allow the weight of header 14 to push stem 28 back into chamber 26.

During such single-acting operation of unit 16 the port 52 serves only as a vent for the subchamber 40 behind piston 26, allowing air to escape therefrom when piston 26 is moved toward end 24 and allowing ambient air to be drawn into subchamber 40 when piston 26 is moved in the opposite direction toward end 22. Of course, unit 16 can be easily made double-acting by simply attaching the fitting 54 to port 52 and coupling a suitable hydraulic line (not shown) therewith for introducing hydraulic fluid into subchamber 50. Thus, instead of allowing piston 26 to retract on its own accord, hydraulic fluid may be supplied to subchamber 40 through port 52 in order to forcibly move piston 26 toward end 22 to retract stem 28. Thus, the piston 26 is rendered positively replaceable in opposite directions, making it suitable for application requiring such double-acting capability.

It should now be apparent from the foregoing that the unit 16 fills a need heretofore wanting in this field and does so in a non-complex, highly efficient manner. In order to provide floating support in combination with the ability to positively raise and lower an object such as an implement header, it has heretofore been the common practice to use a relatively complex hydraulic system requiring a multitude of hydraulic flow lines and valves, not to mention the separate accumulators and fluid-actuated piston and cylinder assemblies necessary. By virtue of the present invention, such complex systems are no longer required inasmuch as the role of the cushioning and shock-absorbing accumulator has now been combined with the function of a fluid pressure actuated power device, all within the same unit. The key to such highly desirable combination is, of course, the floating piston 34 which enables noncompressible hydraulic fluid to be supplied to one side thereof while compressible cushioning gas is supplied to the opposite side thereof within the same major chamber. By virtue of the floating piston 34, the ability of unit 16 to function as a floating support device does not impair its ability to function as a device for supplying positive shifting or lifting power. Moreover, when the unit 16 is used in single-acting arrangements, the hydraulic pressure in the system can be dropped to zero without the accumulator pressure dropping to zero. This permits hydraulic lines of the system to be connected and disconnected while maintaining shock-absorbing capabilities.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A combination accumulator and pressure-actuated power unit comprising: a hollow cylinder having a working chamber therewithin and adapted for connection to one of two relatively shiftable structures; a first piston within said chamber and dividing the latter into a pair of subchambers on opposite sides of said piston; a compressible fluid in one of said subchambers filling the same; means for introducing a noncompressible fluid into the other of said subchambers; and a second imperforate piston reciprocable within said chamber and adapted for connection to the other of said relatively shiftable structures, said first piston being free-floating within said chamber whereby to permit cushioning of said structures against said compressible fluid when a fixed volume of said noncompressible fluid is maintained, yet to permit powered relative shifting of the structures when the volume of said noncompressible fluid is varied, said second piston being reciprocable within said one subchamber against said compressible fluid.

2. A combination accumulator and pressure-actuated power unit as claimed in claim 1, wherein said means for introducing noncompressible fluid is disposed on the side of said first piston remote from said second piston.

3. A combination accumulator and pressure-actuated power unit as claimed in claim 1, wherein said second piston has a sealable passage therethrough for initially charging said one subchamber with said compressible fluid.

4. A combination accumulator and pressure-actuated power unit comprising: a hollow cylinder having a working chamber therewithin and adapted for connection to one of two relatively shiftable structures; a first piston within said chamber and dividing the latter into a pair of subchambers on opposite sides of said piston; a compressible fluid in one of said subchambers filling the same; means for introducing a noncompressible fluid into the other of said subchambers; and a second imperforate piston reciprocable within said chamber and adapted for connection to the other of said relatively shiftable structures,
said first piston being free-floating within said chamber whereby to permit cushioning of said structures against said compressible fluid when a fixed volume of said non-compressible fluid is maintained, yet to permit powered relative shifting of the structure when the volume of said non-compressible fluid is varied,

said second piston being operable to define a third subchamber on a side thereof opposite the remaining subchambers, said third subchamber having a port therein for venting the same during powered relative displacement of the cylinder and second piston in a single direction.

5. A combination accumulator and pressure-actuated power unit as claimed in claim 4, wherein said one subchamber is disposed between said other and said third subchambers.

6. A combination accumulator and pressure-actuated power unit comprising:

a hollow cylinder having a working chamber therein and adapted for connection to one of two relatively shiftable structures;
a first piston within said chamber and dividing the latter into a pair of subchambers on opposite sides of said piston;
a compressible fluid in one of said subchambers filling the same;
means for introducing a noncompressible fluid into the other of said subchambers; and
a second imperforate piston reciprocable within said chamber and adapted for connection to the other of said relatively shiftable structures,
said first piston being free-floating within said chamber whereby to permit cushioning of said structures against said compressible fluid when a fixed volume of said noncompressible fluid is maintained, yet to permit powered relative shifting of the structures when the volume of said noncompressible fluid is varied,
said second piston being operable to define a third subchamber on a side thereof opposite the remaining subchambers, said third subchamber having a port therein and means coupled with said port for introducing noncompressible fluid to said third subchamber for powered relative displacement of the cylinder and second piston in double directions.

7. A combination accumulator and pressure-actuated power unit as claimed in claim 6, wherein said one subchamber is disposed between said other and said third subchambers.