April 12, 1932. H. S. PARDEE 1,853,925

PRESSURE SYSTEM

Filed Feb. 9, 1931

Fig. 1.

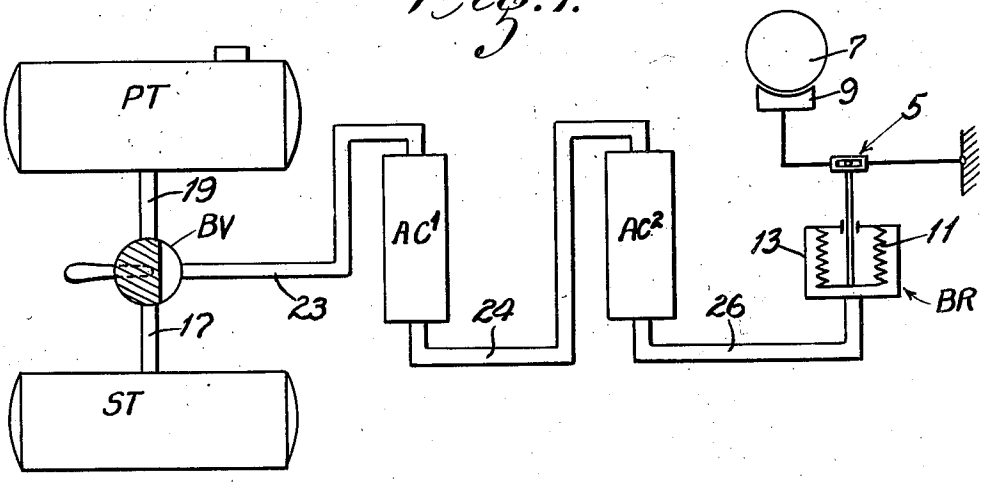
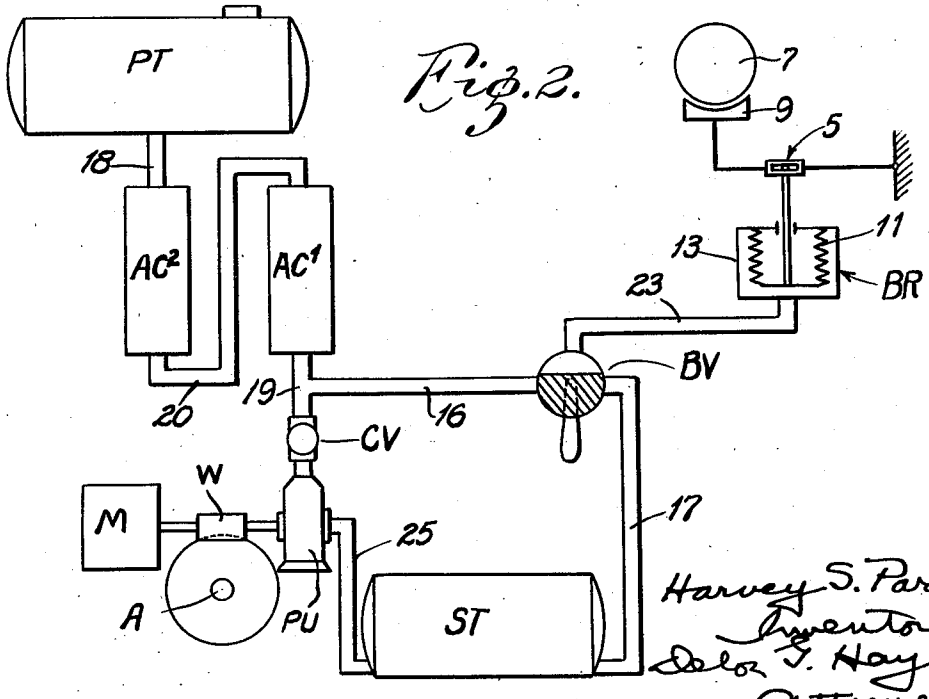


Fig. 2.



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UNITED STATES PATENT OFFICE

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PRESSURE SYSTEM

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This invention relates to fluid pressure systems, and with regard to certain more specific features, to fluid pressure systems utilizing a mixture of gaseous and liquid fluids.

Among the several objects of the invention may be noted the provision of apparatus in a liquid fluid pressure line for separating foreign gaseous fluids therefrom; the provision of apparatus of the class described located in a liquid pressure line adapted to provide an over all uni-directional flow of gas therein; the provision of apparatus of the class described comprising at least one trap in a liquid pressure line adapted to perform said separation; and the provision of apparatus of the class described adapted to prevent intermixing of saturated and unsaturated fluids contained in said line. Other objects will be in part obvious and in part pointed out hereinafter.

The invention accordingly comprises the elements and combinations of elements, features of construction, and arrangements of parts which will be exemplified in the structure hereinafter described, and the scope of the application of which will be indicated in the following claims.

In the accompanying drawings, in which are illustrated two of various possible embodiments of the invention,

Fig. 1 is a diagrammatic, hydraulic circuit showing one arrangement of the invention; and,

Fig. 2 is a diagrammatic, hydraulic circuit showing an alternative arrangement of the invention.

Similar reference characters indicate corresponding parts throughout the several views of the drawings.

In operating expansive work chambers or the like by means of a liquid pressure, using compressed gas as an energy storage medium, the liquid used normally contains a certain amount of the gas in solution. The amount of gas in solution varies among other things, with the pressure. Thus when the liquid is under a comparatively high pressure, a certain amount of gas is dissolved in the liquid, a part of which will come out of solution when the pressure is relieved, as when the work chamber or the like is exhausted. When the gas comes out of solution under such conditions of decreased pressure, bubbles of gas form in the liquid and rise and accumulate in the work chamber. This gas remains in the chamber or in other pockets in the system and must be compressed each time that liquid pressure is transmitted. This results in not only unnecessarily increasing the amount of liquid which must be used in each operation, but also in introducing a larger degree of time lag in operation. In short, a hydraulic system using a compressible gas as an energy storage medium is thus rendered slow and wasteful in operation.

The present invention as illustrated in Figs. 1 and 2, may be adapted for use, for example, in connection with the fluid pressure systems set forth in my United States Patent 1,784,310, issued December 9, 1920 and reissued as No. 18,033 of April 7, 1931.

Referring now more particularly to Fig. 1, the diagrammatic, hydraulic circuit shown includes an expansive chamber, or working cylinder BR connected, through a three-way valve BV, to a pressure tank PT and a sump tank ST. The working cylinder BR is provided with a piston, comprising an internal, compressible bellows 11, which is positively leak-proof and which is exposed to fluid pressure from the tank PT. The bellows 11 is connected to a linkage 5, which operates a brake 9, adapted to press against a vehicle or like wheel 7. The movement of the linkage 5, as shown in Figs. 1 and 2, is sufficient to operate the brake 9. It will be understood that other apparatus may be operated by the pressure system and that the working cylinder BR may be replaced by any other suitable engine or other means for obtaining work from a liquid under pressure, the braking arrangement being shown by way of example only.

The brake valve BV comprises a three-way, valve of the tapered plug, or other suitable type. It is adapted to connect either the tank PT or the tank ST with the working cylinder BR.

The tank PT comprises a pressure tank designed to withstand the pressure used, and to be air, oil, and water tight. For example, the

tank pressure may be constructed to hold safely a pressure of one hundred pounds per square inch. The sump tank ST is usually under atmospheric pressure, and is positioned to receive the drainage from the working cylinder BR.

Interposed in series between the valve BV and the working cylinder BR, are traps AC comprising upright cylindrical tanks as shown in Fig. 1, or other suitable regions of increased capacity in the connecting lines. The top of the first trap AC^1 is connected to the valve BV and then to the tanks PT and ST by line 23 and lines 19 and 17 respectively. The bottom of the trap AC^1 is connected to the expansive chamber or working cylinder BR by a line 26.

Each trap AC preferably has a capacity larger than the displacement of the engines BR. The traps AC may be formed as a plurality of smaller traps in which case the sum of the capacities of the plurality of traps is preferably larger than the displacement of the engines BR.

It is to be understood that apparatus not shown in the drawings, but described in detail in my said United States Patent 1,784,310 (reissued as No. 18,033 of April 7, 1931) is adapted to transfer fluid from tank ST into the pressure tank PT, as shown diagrammatically in Fig. 2.

The operation of the invention as shown in Fig. 1 is as follows:

The lines 24 and 26, joining the trap AC, the working cylinder BR, and the valve BV, as well as the cylinder and the traps themselves are filled with an unsaturated liquid. This hydraulic liquid preferably comprises a liquid relatively non-expansive and non-compressible as compared with gases. The same fluid is supplied to the pressure tank PT, but in the tank it is subjected to pressure with entrapped gas some of which incidentally dissolves in the liquid, under said pressure. The tank ST is under atmospheric pressure, hence the liquid contained therein does not contain an appreciable amount of dissolved gas as compared to the saturated liquid in the pressure tank. It is relatively unsaturated.

The requirement that the capacity of the chambers or traps AC be preferably somewhat greater than the displacement of the work cylinder BR (or cylinders, as the case may be) is desirable because the entering saturated liquid should never completely fill the traps AC as would be the case if the displacement of the working cylinder BR were greater than that of the traps.

On the working stroke the first chamber or trap AC^1 is partly filled at the top with saturated liquid from the tank PT which forces ahead of it the unsaturated liquid out of the bottom of the first trap AC^1 through line 24 into the next trap AC^2 then through line 26 and to the work cylinder BR. As soon as the pressure in the work cylinder BR is released, by changing the position of the valve BV to connect the work cylinder and the traps AC with the sump tank ST, which is at atmospheric pressure, the air in the saturated liquid, which entered the first trap AC^1 is released and this released air rises to the top of the trap and is pushed through lines 23 and 17 into the sump tank ST by the action of the return stroke of the work cylinder.

One such trap AC in the line is efficient but greater security is afforded if several traps AC^1 and AC^2 are located in the line at such intervals that the capacity of the pipe such as 24 connecting them is less than the displacement of the working chambers. Thus if at the start of the operation of the traps AC, the connecting lines 24 and 26 and the working chamber BR are filled with unsaturated liquid it is practically impossible for any gas entering with the saturated liquid to pass forward as far as the working cylinder BR. Each succeeding trap has only to take care of a possible increment of the expelled dissolved gas passed up by the trap immediately ahead.

Referring now more particularly to Fig. 2 which shows a modification of the arrangement of the traps AC in the system, the indicia PT, ST and BR represent respectively the pressure tank, sump tank and working cylinder which are identical to those shown in Fig. 1. The sump tank ST contains relatively unsaturated liquid and is under atmospheric pressure whereas the pressure tank contains liquid under a higher pressure. The engine BR or engines, as the case may be, are connected with the valve BV by line 23. Other connections to the valve BV will be pointed out hereinafter.

There is shown at PU a hydraulic pump for transferring unsaturated liquid from the tank ST to the tank PT. The pump PU is driven by the motor M which may also be the prime mover for a vehicle, to which this system is applied. The pump PU is connected with tanks ST and PT by means of lines 25, 19, 20 and 18, respectively. A check valve CV is inserted in the line 19 to controllably prevent flow of liquid from the tank PT to the pump when the pump is not working.

The traps AC instead of being positioned between the valve BV and the engines BR are in this embodiment positioned between the tanks PT and valve BV. The bottom of the first trap AC^1, is connected with the pump PU by line 19. The top of the trap AC^1 is connected with the bottom of the second trap AC^2 by line 20, and the top of trap AC^2 is connected with the bottom of the pressure tank PT by line 18. Thus the liquid or fluid from the pump PU enters the bottom

of AC^1, goes to the bottom of AC^2 and thence to the pressure tank PT.

The traps AC have a considerable capacity, preferably larger than the sum total of the displacements of the working cylinders or engines BR which may be in the system.

The valve BV as shown in Fig. 2, is connected to the tank PT by the lines 16 and 19, the trap AC^1, the line 20, the trap AC^2 and the line 18. Line 17 connects the valve BV with the tank ST. The line 16 taps the line 19 between the valve CV and the trap AC^1.

The operation of this alternative system is as follows:

With the valve BV closed, as is shown in Fig. 2, and the pump PU being operated by the motor M, unsaturated liquid from the tank ST is pumped to the bottom of the first trap AC^1. As the pumping continues, the liquid rises in the trap AC^1 forcing any air therein through line 20 to the bottom of the second trap AC^2 and this continues until the trap AC^1 is full. The liquid then overflows to the bottom of the second trap AC^2 which may eventually fill and overflow to the pressure tank PT and partially fill the same. The liquid in the tank PT becomes saturated with the gas, with which it is in contact in the tank PT. It is to be noted that the liquid which finally fills the trap AC^1, although under pressure, is not saturated with gas, inasmuch as it does not come in contact with such gas while under pressure.

When the working chamber BR is connected with both the pump PU and the pressure tank PT and the traps AC by way of the lines 23, valve BV, lines 16 and 19, unsaturated liquid from pump PU and/or from the bottom of the first trap AC^1 is forced into lines 16 and 23 to the working cylinder BR, thereby causing the bellows 11 to compress. Thus it is seen that although the liquid in the tank PT may be saturated with gas, only unsaturated liquid reaches the cylinder BR, since the lines 19 and 16 at the valve BV, contain only relatively unsaturated liquid, pumped directly from the tank ST into the first trap AC^1.

If the valve BV is now operated to cut off the connection between the lines 16 and 23, and to open the connection between the lines 23 and 17, thereby connecting the cylinder BR with the sump tank ST, the bellows 11 expands, forcing a proportional amount of unsaturated liquid from the lines 23 and 17 into the tank ST, sufficient unsaturated liquid remaining in the working cylinder BR and the line 23, nevertheless, to completely fill the volume enclosed therein.

While the pump PU is operating, unsaturated liquid may be used directly from the pump, up to the limit of its capacity, to supply the working cylinders BR. At other times, when the pump PU is stopped, the first trap AC^1, which also contains unsaturated liquid, supplies the cylinders BR.

Since saturated liquid is not used in the cylinder BR there results but little or no diminution of the entrained air in the pressure tank. Moreover, if the pump PU pumps both gas and liquid, the gas entering the first trap AC^1 immediately rises to the top, and is forced along to the next trap AC^2, in which it rises to the top and discharges into the pressure tank PT.

An advantage of this modification is the assurance that, even though liquid is withdrawn by the line 23 faster than it is pumped by the pump PU, air in the traps AC will remain at the top. The arrangement makes the flow of air uni-directional, in the direction of the tank PT, while the flow of liquid is bi-directional. Another advantage of the arrangement of the traps AC as shown in Fig. 2 is that a pump may be used which is adapted to pump certain quantities of gas as well as of liquid.

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

As many changes could be made in carrying out the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

I claim:

1. In combination in a closed gas and liquid pressure system, a pressure tank, a pump supplying said pressure tank and joined to said pressure tank by means of a connecting line, and at least two chambers interposed in series in said line, each having a large capacity in relation to the connecting lines in said system, one of said chambers being adapted to receive fluid from said pump at the bottom thereof and deliver said fluid from the top thereof to the bottom of said second chamber, said second chamber being adapted to deliver said fluid from the top thereof to the pressure tank.

2. In combination in a closed gas and liquid pressure system, a pressure tank, a pump supplying said pressure tank and joined to said pressure tank by means of a connecting line, and at least two chambers interposed in series in said line, each having a large capacity in relation to the connecting lines in said system, one of said chambers being adapted to receive fluid at the bottom thereof, from said pump and deliver said fluid from the top thereof to the bottom of said second chamber, said second chamber being adapted to deliver said fluid from the top thereof to the pressure tank, whereby uni-directional flow only of gas is permitted between said pump and pressure tank, but whereby bi-directional flow of liquid is permitted.

3. In combination with a gas and liquid pressure system having gas-saturated and unsaturated liquid, an engine and a pressure tank, said engine being connected with said pressure tank by a connecting line, said pressure tank having saturated liquid therein, said engine and at least part of said connecting line having unsaturated liquid therein, and at least one chamber interposed in said connecting line, the bottom of said chamber being connected with said engine, and the top of said chamber being connected with said pressure tank.

4. In combination with a gas and liquid pressure system having gas-saturated and unsaturated liquid, an engine and a pressure tank, said engine being connected with said pressure tank by a connecting line, said pressure tank having saturated liquid therein, said engine and at least part of said connecting line having unsaturated liquid therein, and at least two chambers interposed in series in said connecting line, said engine being connected to the bottom of one of said chambers, the top thereof being connected with the bottom of the other of said chambers, the top of said other chamber being connected with said pressure tank, whereby gas escaping from said saturated liquid is prevented from reaching said engine.

In testimony whereof I have signed my name to this specification this sixth day of February, 1931.

HARVEY S. PARDEE.