

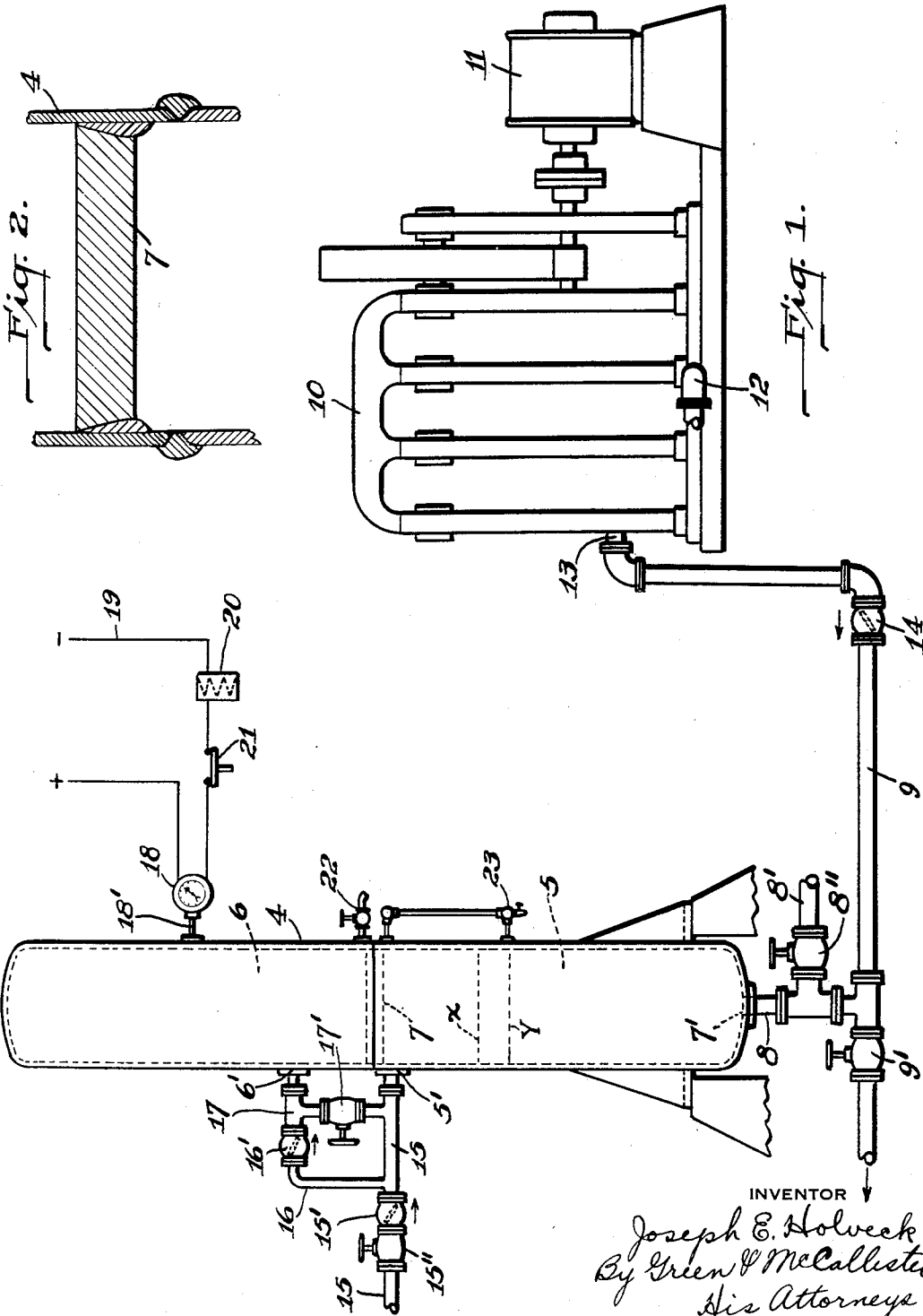
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HYDROPNEUMATIC ACCUMULATOR

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HYDROPNEUMATIC ACCUMULATOR

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This invention relates to hydro-pneumatic accumulators such as are employed with hydraulic pumps, and also to a method of establishing the desired pneumatic pressure within such an accumulator.

An object of the invention is to produce an improved hydro-pneumatic accumulator.

A further object is to produce an improved method of charging such an accumulator with the desired degree of pneumatic pressure.

These and other objects which will be made more apparent throughout the further description of the invention, are attained by means of the apparatus herein illustrated and described.

In the drawing Figure 1 is a diagrammatic view of a hydraulic pump associated with a two-compartment hydro-pneumatic accumulator embodying my invention; and Fig. 2 is a fragmental sectional view illustrating, more or less diagrammatically, a detail of construction of the tank shown in Fig. 1.

The accumulator illustrated consists essentially of a two-part accumulator so arranged that both parts may be employed as a single compartment accumulator, or so that one part may be employed in connection with a hydraulic pump in charging the other with the desired pneumatic pressure.

Hydro-pneumatic accumulators ordinarily consist of an air tight tank enclosing a single compartment and having a liquid inlet port at the lower end thereof, which is connected to a source of liquid under pressure, such as a hydraulic pump, and also to a delivery or distribution system for such liquid. The accumulator receives and stores what may be termed a reserve supply of liquid and the arrangement is ordinarily such that air is trapped within the upper portion of the tank and, by being compressed, exerts pressure on the liquid within the tank and thereby establishes what may be termed an artificial or a pneumatic head for the liquid. Accumulators, such as described, are included as a part of a liquid distribution system, where it is desired to maintain the liquid in the system under high pressure. A separate air compressor is ordinarily employed for initially, and thereafter periodically charging the accumulator with compressed air so as to maintain the desired quantity of compressed air and the desired volume of liquid stored within the accumulator. Such compressors, although adding materially to the cost of an accumulator installation, are of relatively low capacity and consequently considerable time is expended in charging the accumulator with pneu-

matic pressure, hereinafter termed "compressed air" or "air pressure."

Under normal operating conditions it is usually necessary to periodically recharge the accumulator with compressed air in order to re-establish the desired proportions between the quantity of compressed air and the quantity of liquid within the accumulator. This recharging must be resorted to every several days, depending, of course, upon the conditions encountered, but the function of the air compressor, although important, is not such as to merit the additional expense of a high capacity compressor.

The arrangement of accumulator illustrated is such as to eliminate the necessity of employing a separate air compressor during the operation of initially charging the accumulator with compressed air or in subsequent operations of re-establishing the desired proportion of air and liquid within the accumulator. This is accomplished by employing a two-part or two-compartment accumulator in which the arrangement is such that one compartment may, in effect, be employed as an air compressor for charging the other compartment with compressed air at a predetermined pressure, and may also be employed as the liquid supply chamber and a portion of the air chamber of the accumulator when the accumulator is used as a hydro-pneumatic accumulator.

As shown, the accumulator consists of a shell or tank 4, the interior of which is divided into what may be termed a primary compartment 5 and a secondary compartment 6 by an intermediate diaphragm or partition 7. The primary compartment is provided at its lower end with a liquid inlet port 7', which communicates through piping 8 with the delivery main 9 of the distribution system. As shown, the piping 8 is provided with a branch pipe 8', which leads to an atmospheric discharge and is provided with a valve 8''. The main 9 receives liquid, hereinafter termed water, from a pump 10. The pump may be of any type, but as diagrammatically illustrated, is a multiple cylinder, single acting pump and is operatively connected to a driving motor 11. Water from any source is delivered to the suction port 12 of the pump and is delivered through the discharge port 13 to the delivery main 9. As is usual, a check valve 14 is interposed in the main 9 between the pump and the accumulator. This valve is so arranged as to permit a substantially unrestricted flow of water from the pump toward the accumulator and the distribution system, but it prevents a flow in the

opposite direction. A valve 9' is so located in the main 9 as to establish and cut off communication between the accumulator and the distribution system.

5 The secondary compartment 6 is, in effect, the air chamber of the accumulator, although as will be shown the upper end of the primary compartment 5 is normally employed as an air chamber and, as such, augments the volumetric capacity provided by the chamber 6. As shown, 10 the compartment 6 is provided with an air inlet port 6', which communicates with a source of compressed air through piping 15 and 16, and the compartment 5 is also provided with an air 15 port 5', located near the top of the compartment or adjacent the diaphragm 7, and which communicates with the source of compressed air through the piping 15. The arrangement is, however, such that the two air ports 5' and 6' may be placed in direct communication by means of 20 piping 17. As shown, the piping 17 is provided with a valve 17', and, in effect, forms a by-pass between the pipes 15 and 16 and around, check valves 15' and 16' respectively located in those 25 pipes.

As shown, the compartment 6 communicates with a pressure gauge 18, through a suitable pipe 18'. This pressure gauge is diagrammatically 30 illustrated as a part of an automatic loading and unloading mechanism for the pump 10. This mechanism is diagrammatically and partially shown, since such mechanisms are well known; but, as illustrated, the pressure responsive mechanism of the gauge 18 is adapted to make and 35 break a circuit 19, which is shown as including a solenoid 20. The solenoid controls the operation of mechanical means (not shown) for loading and unloading the pump 10. The circuit 19 is also provided with a manually controlled switch 40 21. The compartment 6 may be provided with a drain valve 22 and I have shown the compartment 5 as provided with a water level gauge 23.

In Fig. 2 I have more or less diagrammatically 45 illustrated one way of installing the diaphragm 7 between the compartment 5. As there illustrated, it will be apparent that the structure, in effect, includes two tanks, both of which are substantially cylindrical, and that the partition 7 50 forms a common head for these tanks. The portions of the tank 4 which enclose the compartments 5 and 6 are separately formed, but are so formed as to be conveniently welded to the partition so that they, in effect, form a single tank divided at a point intermediate its ends by the 55 partition 7.

Accumulators, such as the accumulator illustrated, are adapted to be employed in connection with water distribution systems where there is a pulsatory supply of water to the system and, 60 as previously stated, they are also employed for the purpose of providing a reserve supply of water which may be employed in augmenting the delivery of the pump or even, under some conditions, in place of the pump. It is therefore 65 desirable to provide an air space within the accumulator which is of sufficient capacity to maintain a substantially uniform pressure within the accumulator even under the varying conditions of water level within the accumulator which may 70 be normally encountered. It is, of course, apparent that the air pressure within the accumulator will be determined by the pressure under which the water is delivered to the accumulator but, in order to maintain the desired volume of 75 air at the desired pressure, within the accumu-

lator, it is necessary to preliminarily charge the accumulator with a predetermined volume of air at a predetermined pressure. As has been said, separate air compressors are ordinarily employed for this purpose and also for the purpose of recharging the accumulator with air when the 80 quantity of air within the accumulator is reduced sufficiently to interfere with the proper normal or desired operation of the accumulator.

Where an accumulator is installed in connection with a system operating under a high water 85 pressure, for example, a water pressure of 1,000 pounds per square inch, the air charging mechanism is not only expensive from the standpoint of first cost, but also from the standpoint of operation and maintenance. 90

The apparatus illustrated as an embodiment of my invention makes it possible to initially charge and periodically recharge the accumulator with compressed air without the necessity of employing a separate air compressor. The apparatus is so arranged that the hydraulic pump 95 which is, of course, designed to deliver water at the desired pressure, is employed in the operation of charging and recharging the accumulator with compressed air. 100

In most factories where accumulators are employed it is usual to employ compressed air, at say 100 pounds per square inch, in some commercial operations. A source of compressed air is 105 therefore usually available. For this reason I assume, throughout the further description of my invention, that the piping 15 communicates with such a source of compressed air and delivers air at a pressure of 100 pounds per square inch. 110 It will, however, be apparent that the hydraulic pump may be employed in charging and recharging the accumulator with compressed air even though such a source of compressed air is not available. 115

In initially charging the accumulator with air at a high pressure (for example, 1000 pounds pressure) I close the valve 17', thus shutting off direct communication between the compartments 5 and 6 and I also close the valve 9'. I 120 then drain out all the water from the compartment 5 by opening the drain valve 8'. After this draining operation the valve 8' is closed and the valve 15' in the air line is opened. The check valves 15' and 16' are so arranged as to 125 permit a flow of air from the source of air pressure to the tank, consequently air under pressure will be delivered to both the compartments 5 and 6 and the flow of air will continue until the air pressure in those compartments equals 130 the pressure within the piping 15—that is to say, 100 pounds. The pump 10 is then started, or if it is running, it is loaded by manipulating the switch 21 so that it delivers water under pressure to the compartment 5. The operation of 135 the pump is continued until the compartment 5 is filled with water. The water level within the compartment is, of course, observed through the gauge glass 23 during this operation to prevent overfilling the compartment and forcing water into the air lines. It is, of course, apparent that the filling of the compartment 5 with water displaces the air contained within that compartment and forces it into the compartment 6 140 through the check valve 16', with the result that the pressure of the air within the compartment 6 is doubled, that is, raised to 200 pounds, the assumption being that the volumetric capacity of the two compartments 5 and 6 are equal. 145 The pump 10 is then unloaded so that it ceases 150

to deliver water to the compartment 5, the valve 17' is retained closed. The water is then drained from the compartment 5 by opening the valve 8''. During this draining operation the valve 15'' is left open, since under such conditions, the draining operation will be augmented by the air pressure delivered to the compartment 5 through the check valve 15'. It is, of course, apparent that the check valve 16' is held closed by the increased pressure of the air within the compartment 6. After the draining of the compartment 5 is completed, the valve 8'' is closed and air under pressure from pipe 15 is permitted to fill that compartment. The valve 9' is retained in the closed position. The pump 10 is then loaded or caused to deliver water under pressure to the compartment 5 with the result that the air in that compartment will be again displaced and forced into the compartment 6 through the one way, or check valve 16'. When the compartment 5 is completely filled with liquid the pumping operation is stopped, the valve 8'' is opened and the procedure above described is continued until the desired air pressure is obtained within the compartment 6.

At the end of the operation just described it will be apparent that three volumes of air, initially at 100 pounds pressure, have been forced into the compartment 6, and that therefore the pressure in that compartment at the end of the operation has been raised to 300 pounds.

At the end of the twelfth air displacing operation the pressure in the compartment 6 will equal 1300 pounds per square inch. In order to obtain the desired normal operating pressure within the combined compartments 5 and 6 I then operate the pump 10 to fill the compartment 5 to the normal water level, such as indicated in Fig. 1 by the dotted line X, it being understood that preceding this operation the compartment 5 was first filled with air at 100 pounds pressure. I then close the valve 15'' and by opening the valve 17' connect the two compartments 5 and 6, and with the volumetric capacities of a tank such as illustrated, the resulting pressure within the accumulator will equal 1000 pounds pressure. It is, of course, apparent that the predetermined pressure to which the air is raised within the compartment 6 will be established by the volumetric capacities of the two compartments and the volume of the compartment 5 which is to be employed as a part of the combined air chamber. This is merely a matter of mathematical computation.

After the accumulator is thus initially charged with air, the valve 9' is opened, the loading and unloading mechanism is rendered automatic and, in the example given, the pressure gauge 18' will record 1000 pounds pressure and will therefore unload the pump. The pump will remain unloaded until delivery conditions lower the level of the water within the compartment 6 to a level, such as indicated by the dotted line Y in Fig. 1, at which time the pressure within the accumulator will have dropped a sufficient amount to actuate the automatic mechanism to load the pump and to deliver water at the pumped pressure to the accumulator.

It will be apparent that to those skilled in the art that the passage 17 and valve 17' may be replaced by any means for establishing communication between the compartments 5 and 6 after the charging operation is completed. For example, the passage 17 and valve 17' may be omitted by providing means for opening the check valve

16' and maintaining it open, while it is desired to have the two compartments in direct communication. I, however, prefer to employ the separate passage 17 with the separate valve 17', since by so doing I may provide a more adequate passage between the two compartments than would be possible, or at least otherwise desirable.

If, during normal operation, the quantity of air in the accumulator is reduced the recharging operation is carried on in the same manner as above described, except under such circumstances that the initial pressure in the compartment 6 is materially above the pressure available in the air piping 15. A loss of air will be noted by the water level within the compartment 5 when the pressure in the accumulator is raised to the normal operating pressure (1000 pounds). That is to say, if the water level in the compartment 5 is above the normal level X when the air pressure within the accumulator is 1000 pounds, it will be apparent that the quantity of air in the accumulator has diminished. In recharging, the valve 9' is closed and the pump is operated to raise the level of the liquid to the top of the compartment 5, thus forcing the compressed air from compartment 5 into compartment 6. The valve 17' is then closed, thus trapping the high pressure air in compartment 6. The valve 15'' and the valve 8'' are then opened to drain compartment 5. After the draining operation the valve 8'' is closed and air at 100 pounds pressure fills the compartment 5. The pump is then operated to again fill compartment 5 with water. It will be apparent that as the compartment 5 is filled with water the pressure of the air above the water is increased, and at some water level the pressure of the air in compartment 5 will exceed the pressure trapped within the compartment 6, and consequently air from compartment 5 will be delivered through the one-way valve 16' to the compartment 6 as the water filling operation is continued. The recharging operation is thereafter similar to the charging operation and when the desired pressure is again obtained within the compartment 6, the valves 8'' and 15'' are permanently closed, the valves 9' and 17' are opened and the switch 21 is permanently closed, with the result that the apparatus is again in condition for normal operation and under the automatic control of the loading and unloading mechanism.

It will, of course, be apparent that the operation of initially charging the accumulator will be somewhat lengthened if a pressure lower than 100 pounds pressure is initially admitted to the compartments 5 and 6, but that the charging and the recharging operations may be accomplished even though air under pressure is not available. Under such conditions air at atmospheric pressure is trapped in the compartments 5 and 6 by the check valves 16' and 15' respectively, and the valve 17' is then closed. The further operation of charging or recharging will be as above described, except that the precautions taken to displace substantially all the air from the compartment 5 must be more carefully observed. That is to say, the water must be raised to the maximum level in the compartment 5 during each air displacing operation, since otherwise the operation of charging or recharging will be greatly lengthened.

While I have described what I now consider to be the preferred embodiment of my invention, it will be apparent that omissions, other than those mentioned, and other variations in the apparatus illustrated may be made without depart-

ing from the spirit and scope of the invention as defined by the appended claims.

What I claim is:

1. An accumulator comprising two isolated compartments, constituting primary and secondary compartments of the accumulator, a check valve communicating with the upper portion of the primary and with the secondary compartment for delivering fluid under pressure from the primary to the secondary compartment, means for establishing communication between said compartments to deliver fluid from the secondary to the primary compartment, means for delivering liquid under pressure to the primary compartment, means for draining the primary compartment, and means for connecting the lower portion of the primary compartment to a liquid distribution system.

2. A combined hydro-pneumatic accumulator and charging mechanism comprising a storage chamber for compressible fluids, a compressor chamber, a source of supply of compressible fluid under pressure, branch pipes connecting the source of supply of fluid with the storage and compressor chambers, respectively, a check valve between the supply source and the branch pipes and a check valve in the branch pipe communicating with the storage chamber permitting flow of fluid from the compressor chamber to the storage chamber, a drain for the compressor chamber, a source of pumped liquid means for alternately connecting the bottom of said compressor chamber to the source of pumped liquid and to the drain, whereby when the compressor chamber is connected to drain, fluid enters the same to replace the liquid and when the compressor chamber is connected to the supply of pumped liquid, the fluid is compressed and delivered to the storage chamber and retained therein by the check valve in the branch pipe connected thereto, and means for connecting the storage chamber with the branch pipe connecting the compressor chamber when the pressure in the storage chamber is of a desired predetermined value and the compressor chamber is charged with liquid to a predetermined level.

3. A combined hydro-pneumatic accumulator and charging mechanism comprising a storage chamber for compressible fluid, a compressor chamber, a source of supply of compressible fluid under pressure, branch pipes connecting the source of supply of fluid with the storage and compressor chambers, respectively, a check valve between the supply source and the branch pipes

and a check valve in the branch pipe connecting the source to the storage chamber permitting the flow of fluid from the compressor chamber to the storage chamber, a drain for the compressor chamber, a source of pumped liquid and a liquid distribution system, means adapted to alternately connect the bottom of said compressor chamber to the source of pumped liquid and to drain, whereby when the compressor chamber is connected to the drain, fluid enters the same to replace the liquid and when the compressor chamber is connected to the supply of pumped liquid, the fluid is compressed and delivered to the storage chamber and retained therein by the check valve in the branch pipe connected thereto, a pipe having a valve therein for interconnecting said chambers in fluid exchanging relation independently of the check valve in said branch pipe when the pressure in the storage chamber is of a desired predetermined value and the compressor chamber is charged with liquid to a predetermined level, and means for connecting the compressor chamber to the source of pumped liquid and to the distribution system so that both chambers function as an accumulator.

4. A combined hydro-pneumatic accumulator and self charging device comprising two independent compartments, a source of supply of compressed fluid, branch pipes connecting said compartments to the source, a check valve between the source and branch pipes, a check valve in one of said branch pipes connected to one of said compartments permitting the flow of fluid thereto from the other compartment, a drain, an hydraulic pump and a distribution line therefor means adapted to alternately connect the other of said compartments to the drain and to the distribution line of the hydraulic pump, whereby when the last mentioned compartment is connected to drain both compartments are initially filled with compressed fluid at the pressure of the source, and when said last mentioned compartment is connected to the distribution line liquid is delivered thereto to compress the fluid therein and deliver it to the other compartment wherein the fluid is retained by the check valve in said branch pipe, and means for connecting said compartments in free fluid exchanging relation when the level of the liquid in the second mentioned compartment is at a predetermined height and the pressure in the other compartment is at a predetermined value.

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