

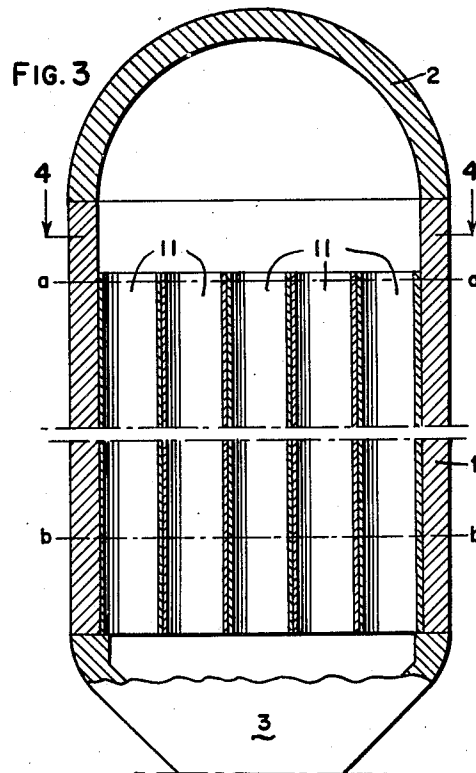
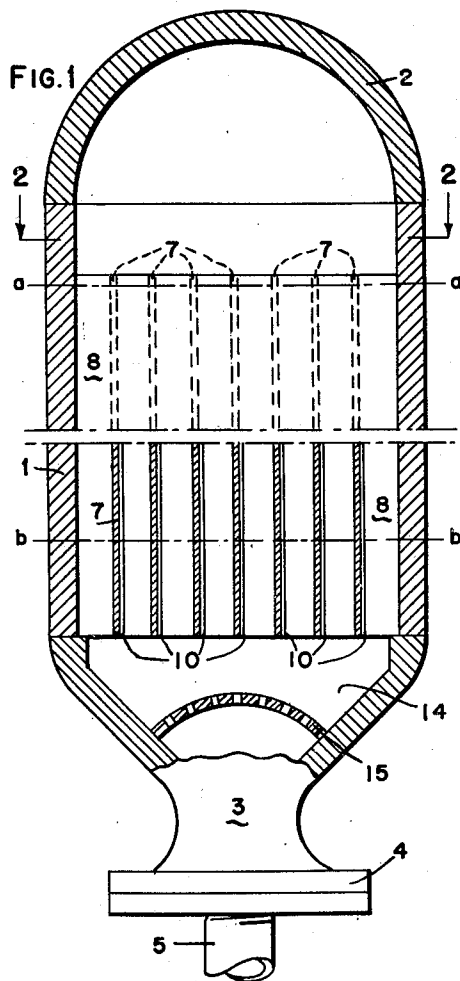
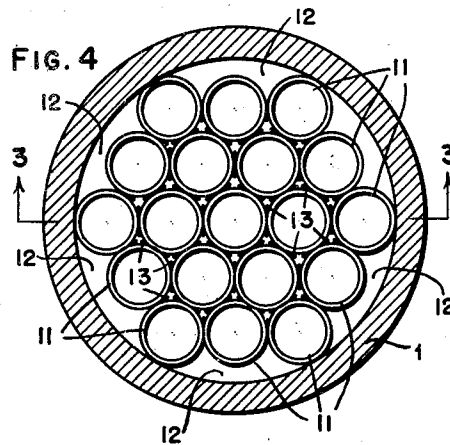
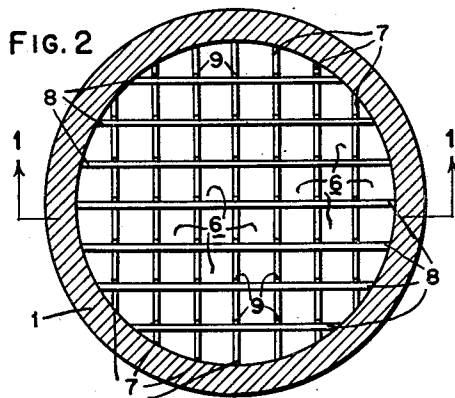
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ACCUMULATOR

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ACCUMULATOR

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This invention relates to accumulators of the type in which motive liquid is kept under pressure in a fluid tight vessel by gas compressed into the upper part of the vessel and in intimate contact with the surface of the liquid. The motive liquid is ordinarily oil, the gas is ordinarily compressed air and they will be referred to herein as such but it is to be understood that the invention is not limited to an accumulator in which oil is kept under pressure by compressed air.

The accumulator is charged by a pump which delivers oil thereto until the air therein is compressed to such an extent that the pressure in the accumulator reaches a predetermined maximum and then further delivery of oil is interrupted such as by means of a pressure responsive valve or by the pump automatically reducing its displacement until it is delivering just enough oil to maintain the maximum pressure substantially constant.

The oil stored in an accumulator is ordinarily employed to effect operation of a hydraulic motor or other device at speeds in excess of any speed that would be possible if the motor or other device were operated solely by oil delivered directly thereto from a pump of the same size as the pump which charges the accumulator. For example, oil stored in an accumulator is often employed to advance the piston of a hydraulic motor at high speed on a working stroke at the end of which the piston is retracted by the pump or by other means and the pump immediately starts to deliver oil to the accumulator to recharge it. The oil exhausted from the motor flows to a reservoir from which the pump is supplied with oil.

When compressed air is in intimate contact with the surface of oil, air will dissolve in the oil very quickly but it will penetrate only a short distance below the surface of the oil. Consequently, the upper stratum of oil in a fluid pressure type accumulator is a solution of oil and air and this solution will be referred to as "saturated oil" although the oil may not be completely saturated with air.

As long as the oil in the accumulator is static, the stratum of saturated oil insulates the oil therebelow against penetration by the air to any considerable extent but, when the accumulator is recharged after being partially discharged, the oil in the accumulator becomes turbulent which causes the saturated oil to be mixed with the other oil and unsaturated oil to continually rise to the surface where additional air is dissolved in it so that all of the oil in the accumulator is soon saturated.

When oil is thereafter delivered from the accumulator to the motor, it is incapable of effecting positive performance of the motor for the reason that the air in the oil makes the oil very

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elastic. For example, if a reciprocating hydraulic motor is operated at high speed through a given distance by saturated oil delivered thereto from an accumulator and then it is operated at a slower speed solely by oil delivered thereto at a uniform rate from a pump, the slower speed may not be uniform as the elasticity of the saturated oil in the motor will cause the motor speed to vary excessively in response to changes in motor load.

After the motor discharges the oil into an atmospheric reservoir, the air in the oil tends to form into bubbles which rise to the surface of the oil in the reservoir. That is, the oil foams. If the oil remained in the reservoir for a considerable period of time, all of the excess air in the oil would escape into the atmosphere but the pump is drawing oil from the reservoir and delivering it to the accumulator at the same time that the motor is discharging into the reservoir so that the oil supplied to the pump contains air and, hence, is very elastic.

As each pump cylinder opens to the pump discharge port, the elastic oil in the cylinder is suddenly compressed by the pressure in the accumulator with the result that pump delivery is reduced. Consequently, a longer time is required for the pump to charge the accumulator than would be necessary if the oil were free of excess air.

As each pump cylinder opens to the pump intake port, the compressed elastic oil in the cylinder suddenly expands. These sudden compressions and expansions of the oil in the pump cylinders causes violent vibrations and results in excessive noise. The vibrations damage the equipment and the noise is very annoying to the operator and to other persons in the vicinity.

The present invention has as an object to provide an accumulator which will overcome the above mentioned disadvantages of the prior accumulators.

According to the invention in its general aspect, an accumulator is provided with means for preventing the surface of the oil in the accumulator from being agitated to thereby prevent air from entering the greater part of the oil in the accumulator.

The invention is exemplified by the accumulators shown in the accompanying drawing in which the views are as follows:

Fig. 1 is a view partly in elevation and partly in section of an accumulator in which the invention is embodied, the section being taken approximately on the line 1—1 of Fig. 2 and a portion of the accumulator intermediate its ends has been omitted in order to show the accumulator on a larger scale.

Fig. 2 is a sectional plan view taken on a line 2—2 of Fig. 1.

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Fig. 3 is a view similar to Fig. 1 but showing a different form of interior construction.

Fig. 4 is a sectional plan view taken on the line 4—4 of Fig. 3.

Each of the accumulators chosen for illustration has a cylindrical body section 1, a dome shaped top section 2 and a bottom section 3 having a flange 4 upon its lower end for connection to a pipe 5 through which oil flows to and from the accumulator. Top section 2 and bottom section 3 are rigidly secured, as by welding, to opposite ends of body section 1 and form therewith a fluid tight vessel.

Large accumulators ordinarily have walls composed of several thicknesses of metal. That is, a large accumulator ordinarily consists of a plurality of fluid tight vessels arranged one within another with the walls thereof in intimate contact but in order to simplify the drawing each wall has been shown as a single thickness of metal. It is to be understood, however, that the invention is in no way limited to the construction shown.

The cross-sectional area of vessel 1—3 is divided into a plurality of vertical channels each of which has sufficient length and a sufficiently small cross-sectional area to prevent incoming oil from agitating the surface of the oil in the accumulator regardless of whether the accumulator is fully charged or has been discharged to its lower limit, it being understood that the accumulator is never fully discharged when it is in operation.

Various means may be employed to form the channels. As shown in Figs. 1 and 2, a plurality of channels 6 are formed by a set of separators 7 and a set of separators 8 arranged at right angles to each other.

One set of separators may extend across the vessel and the other set may consist of short sections welded or otherwise secured to the separators of the first set but, as shown, separators 7 extend across the vessel in one direction and have slots 9 extending downward from the upper edges thereof, separators 8 extend across the vessel at right angles to separators 7 and have slots 10 extending upward from the lower edges thereof, and the unslotted portion of each separator extends thru slots in the separators at right angles thereto so that the two sets are interlocked.

Channels may also be provided by a plurality of tubes 11 arranged within vessel 1—3 as indicated in Figs. 3 and 4, the spaces outside of tubes 11 providing a plurality of additional channels 12.

Tubes 11 have been shown arranged close together and as being connected into a unit by welding the walls of adjacent tubes to each other at the upper and lower ends thereof as indicated at 13 in Fig. 4 but the tubes may be spaced farther apart and connected to each other by fins welded to adjacent tubes at the upper and lower ends thereof.

The channel forming means, such as plates 7 and 8 or tubes 11, are arranged within body section 1 before one end or the other thereof is closed by connecting top section 2 or bottom section 3 thereto.

In order to prevent oil from flowing at high velocity directly into the channels immediately above pipe 5, a suitable baffle is preferably arranged below and spaced from the lower ends of the channels to provide a chamber 14 in which the oil is diffused before entering the channels. The baffle may be of any suitable construction but

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it has been shown as a spherical perforated plate 15 which is fixed in position in any suitable manner such as by welding it to the side wall of bottom section 3.

When oil is pumped into the accumulator through pipe 5, it flows through the perforations in baffle 15 and is diffused in the oil in chamber 14 so that oil enters all of the channels at nearly the same rate, thereby preventing excessive turbulence in any of the channels.

The accumulator should be large enough to hold considerably more oil than is required to operate the motor or other device. For example, assuming that the level of the oil is at a line *a—b* when the accumulator is charged to the desired pressure, the level of oil should be a considerable distance above the bottom of the accumulator, as indicated by the line *b—b*, when enough oil has been discharged from the accumulator to operate the motor or other device.

The upper ends of the channels should extend to or above line *a—b*. Each channel should have such a small cross-sectional area that the oil therein can be turbulent for only a very short distance and the lower ends of the channels should extend far enough below line *b—b* to prevent incoming oil from agitating the stratum of saturated oil which extends downward a short distance below line *b—b* when oil first starts to enter the accumulator to recharge it.

Since the stratum of saturated oil is never agitated, the oil discharged from the accumulator to the motor or other device is substantially free of excess air and the difficulties encountered by use of an ordinary accumulator are avoided.

The accumulator described herein is susceptible of various modifications and is adapted to various uses without departing from the scope of the invention which is hereby claimed as follows:

1. An accumulator, comprising a fluid tight vessel adapted to contain a quantity of liquid and a compressed gas above said liquid and having an opening at its lower end for the flow of liquid to and from the interior of said vessel, and a plurality of channels arranged within said vessel to divide the cross-sectional area thereof into a plurality of passages each of which has sufficient length and a sufficiently small cross-sectional area to prevent the upper portion of the liquid in said vessel from being agitated by liquid entering said vessel thru said opening.

2. An accumulator, comprising a fluid tight vessel adapted to contain a quantity of liquid and a compressed gas above said liquid and having an opening at its lower end for the flow of liquid to and from the interior of said vessel, a plurality of channels arranged within said vessel to divide the cross-sectional area thereof into a plurality of passages each of which has sufficient length and a sufficiently small cross-sectional area to prevent the upper portion of the liquid in said vessel from being agitated by liquid entering said vessel thru said opening, and a baffle arranged below and spaced from the lower ends of said channels to prevent high velocity flow of liquid into the channels in alinement with said opening.

3. An accumulator, comprising a fluid tight vessel adapted to contain a quantity of liquid and a compressed gas above said liquid and having an opening at its lower end for the flow of liquid to and from the interior of said vessel, a plurality of channels arranged within said vessel to divide the cross-sectional area thereof into a plurality of passages each of which has sufficient length and a sufficiently small cross-sectional area to

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prevent the upper portion of the liquid in said vessel from being agitated by liquid entering said vessel thru said opening, and a perforated plate arranged in a stationary position between and spaced from said opening and the lower ends of said channels to divide liquid entering said vessel into a plurality of small streams.

4. An accumulator, comprising a fluid tight vessel adapted to contain a quantity of liquid and a compressed gas above said liquid and having an opening at its lower end for the flow of liquid to and from the interior of said vessel, and channel forming means arranged within said vessel intermediate the ends thereof and dividing the cross-sectional area of said vessel into a plurality of channels small enough to prevent liquid entering through said opening from causing liquid in said channels to become turbulent for more than a very short distance.

5. An accumulator, comprising a fluid tight vessel adapted to contain a quantity of liquid and a compressed gas above said liquid and having an opening at its lower end for the flow of liquid to and from the interior of said vessel, channel forming means arranged within said vessel intermediate the ends thereof and dividing the cross-sectional area of said vessel into a plurality of channels small enough to prevent liquid entering through said opening from causing liquid in said channels to become turbulent for more than a very short distance, and a baffle arranged below and spaced from the lower ends of said channels to prevent high velocity flow of liquid into the channels in alinement with said opening.

6. An accumulator, comprising a fluid tight vessel adapted to contain a quantity of liquid and a compressed gas above said liquid and having an opening at its lower end for the flow of liquid to and from the interior of said vessel, a first plurality of spaced apart separators arranged within said vessel and extending across the interior thereof, and a second plurality of spaced apart separators arranged at right angles to said first separators and forming therewith and with the wall of said vessel a plurality of channels to prevent the upper portion of the liquid in said vessel from being agitated by liquid entering through said opening.

7. An accumulator, comprising a fluid tight vessel adapted to contain a quantity of liquid and a compressed gas above said liquid and having an opening at its lower end for the flow of liquid to and from the interior of said vessel, a first plurality of spaced apart separators arranged within said vessel and extending across the interior thereof, a second plurality of spaced apart separators arranged at right angles to said first separators and forming therewith and with the wall of said vessel a plurality of channels to prevent the upper portion of the liquid in said vessel from being agitated by liquid entering through said opening, and a baffle arranged below and spaced from the lower ends of said separators to prevent high velocity flow of liquid into the channels in alinement with said opening.

8. An accumulator, comprising a fluid tight

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vessel adapted to contain a quantity of liquid and a compressed gas above said liquid and having an opening at its lower end for the flow of liquid to and from the interior of said vessel, a first plurality of spaced apart separators arranged within said vessel and extending across the interior thereof, a second plurality of spaced apart separators arranged at right angles to said first separators and forming therewith and with the wall of said vessel a plurality of channels to prevent the upper portion of the liquid in said vessel from being agitated by liquid entering through said opening, and a perforated plate arranged in a stationary position between and spaced from said opening and the lower ends of said separators to divide liquid entering said vessel into a plurality of small streams.

9. An accumulator, comprising a fluid tight vessel adapted to contain a quantity of liquid and a compressed gas above said liquid and having an opening at its lower end for the flow of liquid to and from the interior of said vessel, and a plurality of tubes arranged within said vessel to provide a plurality of channels small enough to prevent the upper portion of the liquid in said vessel from being agitated by liquid entering through said opening.

10. An accumulator, comprising a fluid tight vessel adapted to contain a quantity of liquid and a compressed gas above said liquid and having an opening at its lower end for the flow of liquid to and from the interior of said vessel, and a plurality of channels arranged within said vessel to divide the cross-sectional area thereof into a plurality of passages each of which has sufficient length and a sufficiently small cross-sectional area to prevent the upper portion of the liquid in said vessel from being agitated by liquid entering said vessel thru said opening, said vessel being of such capacity that the liquid contained therein when said accumulator is fully charged is in excess of requirements and said channels being of such lengths that the upper ends thereof extend above the surface of the liquid after said accumulator has been fully charged and the lower ends thereof extend below the surface of the liquid after a normal volume of liquid has been discharged from said accumulator.

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