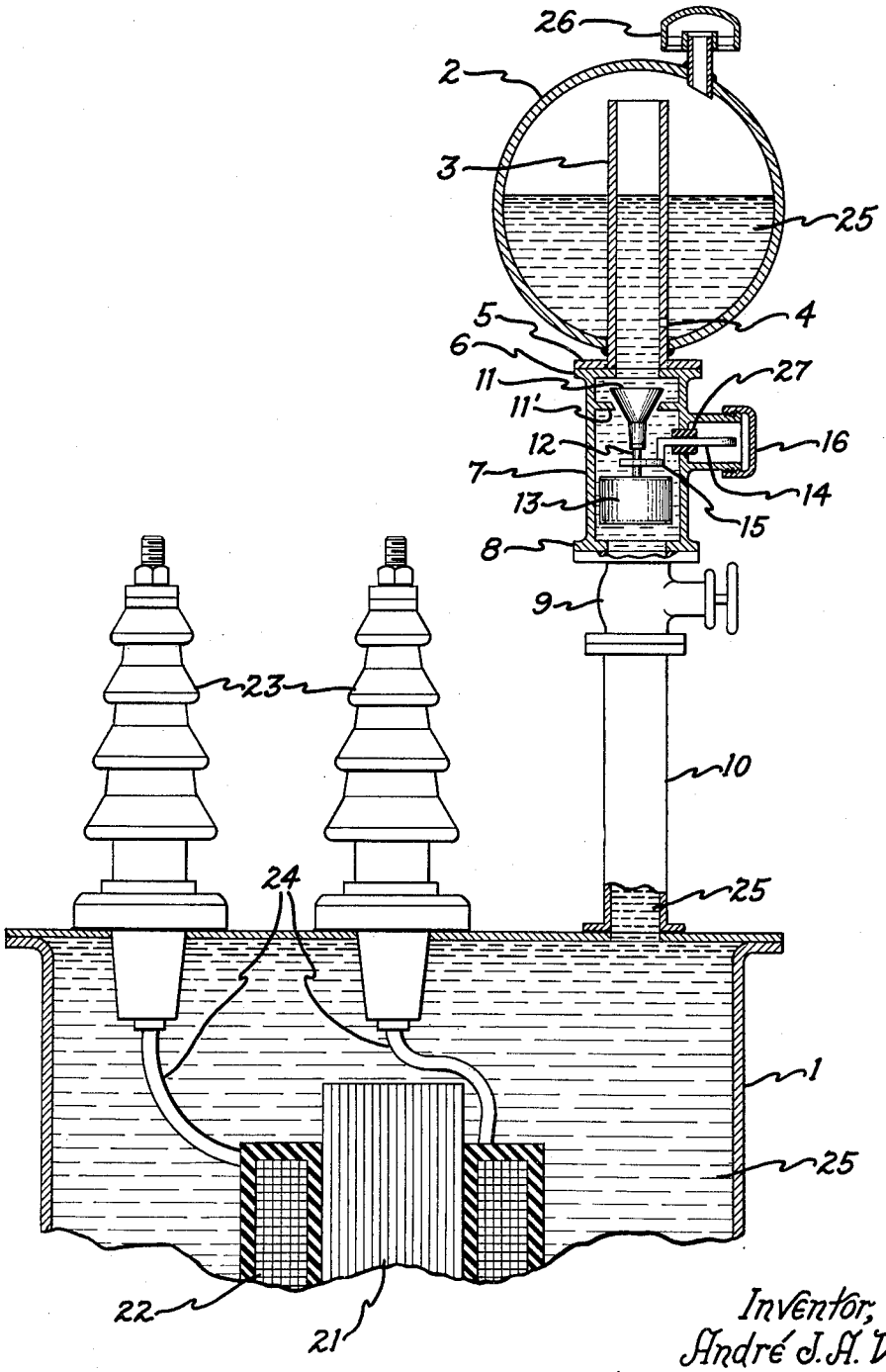
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FLUID SYSTEM

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FLUID SYSTEM

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This invention relates to fluid systems, and in particular to an improved arrangement for limiting the rate of flow between components of a fluid system.

In many types of fluid systems it is necessary that the fluid be allowed to flow freely from one component of the system to another, and yet it is often desirable that means be provided for limiting the rate of flow of the fluid in one direction. For example, in a power transformer which is immersed in a dielectric liquid, it is necessary to provide for free expansion of the dielectric liquid which is in the transformer tank when the apparatus temperature rises to its operating level, and also to provide for return flow of the liquid to the transformer tank when the operating temperature falls. Also, the dielectric liquid must be free to expand and contract with variations in ambient temperature and pressure. To achieve this, it is well known to make use of an auxiliary storage tank or reservoir which is connected directly to the main transformer tank, and which permits both the expansion of the dielectric liquid out of the main tank and the return of the dielectric liquid to the main tank as the apparatus temperature falls to the lowest value permissible under operating conditions. The auxiliary storage tank may be of the conservator type which is vented to the atmosphere by means of breathers supplied with filters or drains. The auxiliary storage tank may be connected to the transformer tank by a tube containing a separate valve.

Since it is necessary to bring out the ends of the high voltage windings of the transformer, the apparatus is generally supplied with insulated porcelain bushings. Some types of bushings are filled with dielectric liquid, and when the liquid is the same type that is in the transformer, the liquid in the bushings is usually in direct communication with that which surrounds the core and windings of the transformer inside the main tank. In fluid systems of this type, it is necessary that the pressure in the main tank and bushing always be kept positive (i.e., greater than atmospheric) so that if a leak occurs in the system, the fluid will flow out of the main tank and bushing and reveal the leak. Also, with a positive pressure on the system, no air or moisture will leak into the main tank or bushings and decrease the dielectric strength of the insulating fluid. This consideration makes it necessary to place the auxiliary tank above the other components of the system in such a way that the lowest portion of the tank is always slightly above the highest point on the other parts of the apparatus. In this way a fluid head is established, and the pressure in the main tank and bushings is always greater than atmospheric pressure. Under these conditions, should a leak occur as for example by the porcelain in one of the bushings breaking, the dielectric liquid which is in the auxiliary tank would escape to the outside of the system because of the leak. Since under normal operating conditions the dielectric liquid generally fills about ½ of the auxiliary tank, which holds about

10% as much liquid as the main tank, then about 5% of the liquid present in the system would be the minimum lost from such a leak. For a transformer which, for example, contains 40 tons of liquid dielectric, the loss would be at least about 2 tons. Another disadvantage of the loss of liquid dielectric is the risk of fire when the liquid is inflammable.

In the past, several procedures have been recommended to remedy the above mentioned shortcomings in this type of system. One previously employed procedure was to use fast closing valves which operate when such a leak occurs. This solution resulted in a very complex control system that was extremely expensive, or else required the use of personnel to constantly observe the apparatus and manually close the valves. Consequently, efforts have been made towards finding a system whose operation does not require manual intervention or special surveillance. Moreover, such a system must respond to the following conditions:

(1) The auxiliary tank must be isolated in case of a significant leak of the dielectric in the transformer tank.

(2) Free exchange of the dielectric liquid between the tank and the auxiliary reservoir must be assured when normal changes occur in the operating temperature of the apparatus.

A solution to this problem was presented in French Patent 931,617, of October 9, 1943 (corresponding to U.S. 2,481,984) that included an improved syphon. Although the solution presented in the above mentioned patent required little maintenance and was relatively simple in basic operation, a practical embodiment of apparatus in accordance with that invention that functions satisfactorily is extremely costly and thus is not practical for transformer tanks of average size.

Accordingly, an object of this invention is to provide an arrangement for solving the problem expressed above, that is simple in design, reliable in operation, and reduced in cost.

Another object of this invention is to provide an improved arrangement for limiting the loss of liquid from an auxiliary tank connected to a main tank when a leak occurs in the main tank.

A further object of my invention is to provide an improved fluid system for electrical apparatus.

Another object of this invention is to provide an improved arrangement for limiting the rate of fluid flow between components of a fluid system.

Briefly stated, according to one aspect of my invention, liquid may be evacuated from an auxiliary storage tank through an orifice of pre-determined size until a float valve is lowered in an evacuation pipe so that the valve seats itself and closes the evacuation pipe when the flow of the liquid is greater than that which can pass through the orifice; during normal operation of the system, the float valve is raised above its seat by liquid in the evacuation pipe.

While the specification concludes with claims particularly pointing out and distinctly claiming the subject matter which I regard as my invention, it is believed that the invention will be better understood from that following description taken in connection with the accompanying drawing.

In the drawing:

The single figure is a somewhat schematic partially

cross-sectional view of an embodiment of apparatus in accordance with my invention.

Referring now to the drawing, a conventional transformer assembly comprising a magnetic core **21** and current carrying winding **22** is shown enclosed in a main tank **1**. High voltage bushings **23** applied to the top of the tank **1** may be connected to the transformer winding by leads **24** in the conventional manner. The main tank **1** is filled with a dielectric liquid **25**, such as transformer oil, and the bushings **23** may be filled with the same liquid **25** in such a manner that the liquid in the bushings communicates with that in the tank **1**.

In order to provide for expansion and contraction of the liquid in the bushings and main tank, an auxiliary reservoir tank **2** is connected to the main tank by a fluid flow control system that will be described more in detail hereafter. It should be noted that the lowest point on the reservoir **2** is elevated above the highest point on the transformer bushings and tank. A fluid flow path between the auxiliary reservoir **2** and the main tank **1** may be established by a tubular channel comprising a tube **3** which extends into the auxiliary reservoir and terminates in an open end located above the highest level that the dielectric liquid **25** will reach. The reservoir **2** may be vented to the atmosphere by suitable means such as a conventional breather **26**. Damage resulting from faults or other phenomena which cause rapid expansion of the liquid **25** will be minimized because of the escape path provided through the relatively large diametered tube **3** to the air space in the reservoir **2**. A calibrated orifice **4** of predetermined size is provided in the lower part of the tube **3**, the orifice **4** being located in the reservoir **2** below the lowest level that the dielectric liquid **25** will reach. The tube **3** extends outside of the reservoir **2** and may end in a flanged coupling **5**, which may be connected to a flange **6** on a cylindrical body **7**, which forms a portion of the tubular channel. The body **7** may be made, for example, of steel. The lower part of the cylindrical body **7** also may end in a flange **8** which may be connected to the transformer tank **1** by means of a conventional shut off valve **9** and a tube **10**, thus completing the above mentioned fluid flow path. Systems already in operation may be inexpensively converted to a system in accordance with my invention merely by interposing a tube **3**, cylindrical body **7**, and the flow regulating device described hereafter between the main tank and reservoir.

A flow regulating device in accordance with my invention may be located on the inside of the cylindrical body **7**. Such a device may comprise a valve element **11** which closes by resting in a conventional valve seat **11'**. The valve element **11** may be connected to a guiding rod **12** which has a buoyant body or float **13** on its lower end. The buoyancy of the float **13** is such that it will lift the valve when submerged in the dielectric liquid. When there is no dielectric liquid on the inside of the cylindrical body **7**, the weight of the valve and float is such that the valve will be closed in the conventional manner in the seat **11'**.

Means for elevating and controlling the position of the float valve assembly may also be provided. For example, a lever **14** having a forked end **15** may be provided extending through an opening in the cylindrical body **7**. The prongs of the forked end **15** are spaced on opposite sides of the rod **12**. The location of the forked end **15** between the valve **11** and float **13** is such that when the cylindrical body **7** is filled with dielectric liquid, the end **15** limits the height at which the valve **11** floats to a level spaced above the seat **11'**. When the cylindrical body **7** does not contain dielectric liquid, the fork is located such that the valve **11** can firmly rest in its seat **11'**. When it is desired to raise the valve **11** from the seat **11'**, pivoting of the end of the lever **14** extending beyond the cylindrical body **7** causes the forked end **15** to move upwardly and engage the lower end of the valve **11** raising same from the seat **11'**. A removable cover **16** may be provided for protecting the end of the lever. The opening through which the lever **14** passes may be sealed by resilient gasket means **27** according to conventional practice.

The operation of the above described arrangement for limiting the rate of flow between the components of a fluid system in accordance with my invention is essentially as follows. The main transformer tank **1** may be initially filled with dielectric liquid **25** by means of a conventional intake opening (not illustrated) in the auxiliary reservoir **2**. A fluid connection between the auxiliary tank **2** and the transformer tank **1** may be established by moving the lever **14** downwardly thus raising the valve **11**. When the dielectric liquid **25** has reached its desired equilibrium position between the auxiliary tank **2** and the transformer tank **1**, the valve **11** is at rest and held above the seat **11** by the float **13**, and restrained from movement out of the cylindrical body **7** by the forked end **15**. This can be readily ascertained from the outside of the system because the upward force of the float **13** on the forked end **15** will cause the outside end of the shaft **14** to be pushed downwardly. Until the liquid reaches this level, the weight of the valve **11** on the forked end **15** will pivot the end of the shaft **14** upwardly. Once the equilibrium in the tank **1** has been established and verified by the procedure described immediately above, the protecting cover **16** may be put back in place. The automatic valve **11** is then ready to regulate the flow of dielectric liquid from the auxiliary tank to the transformer tank **1**.

It will be readily apparent that the valve **11** does not interfere with the flow of the dielectric liquid **25** from the tank **1** to the reservoir **2** as the apparatus heats up. So long as the rate of flow between the reservoir **2** and tank **1** is such that the dielectric liquid **25** passes through the orifice **4** in the tube **3** slowly enough to maintain the cylindrical body **7** filled at all times, the valve **11** will float above the seat **11'**. Thus, the valve **11** does not interfere with the flow of dielectric liquid **25** from the auxiliary reservoir **2** to the main transformer tank **1** when the rate of flow is less than that which is permitted by the calibrated orifice **4**.

In case of an accidental leak in the remainder of the system, caused, for example, by the breaking of one of the busings **23**, if the oil flow becomes greater than that which can pass freely through the calibrated orifice **4**, the cylindrical body **7** below the valve **11** will empty itself, and the float **13** will no longer be buoyed upwardly by the liquid. This will cause the valve **11** to rest in the seat **11'**, thus blocking the flow path between the auxiliary reservoir **2** and the main tank **1**. Thus, the remaining liquid in the reservoir **2** will stay there and not be lost through the leak in the other part of the system. The weight of this liquid above the valve **11** will exert a downward pressure on the valve and secure it tightly in place. After correction of the defect which caused the leak, communication between the tank **2** and tank **1** can be reestablished merely by pivoting the lever **14** downwardly and thus lifting the valve **11**.

Next to a great simplicity of operation, the automatic control system in accordance with my invention described above has the advantage that it can be mounted with great ease on systems already in existence merely by inserting the cylindrical body **7** and its associated valve assembly and tube **3** between an auxiliary reservoir and a main tank. In addition to allowing free expansion of the dielectric liquid in the main tank and the return flow of the liquid from the auxiliary reservoir to the main tank, my system also limits the loss of liquid in the case of a leak in the main tank or associated elements. Although my invention has been described with reference to an embodiment of an electrical transformer, it will be readily apparent to those skilled in the art that a system for controlling the rate of fluid flow in accordance with my invention has general application and can be employed in other combinations and systems. In any system where

it is necessary to limit the flow of fluid from one component of a system to another to a pre-determined rate, this may be accomplished by calibrating the diameter of the orifice **4** in the tube **3** until the rate of flow is as desired.

It will be understood, of course, that while the form of the invention herein shown and described constitutes the preferred embodiment thereof, it is not intended herein to illustrate all of the possible equivalent forms or ramifications thereof. It will also be understood that the words used are words of description rather than of limitation, and that various changes may be made without departing from the spirit and scope of the invention herein disclosed, and it is aimed in the appended claims to cover all such changes that fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A fluid system comprising a sealed main tank having an internal pressure greater than atmospheric pressure, an auxiliary reservoir, a fluid occupying said main tank and reservoir, means including a device for regulating the rate of flow of said fluid between said main tank and reservoir connecting said tank to said reservoir, said means comprising a tubular channel hydraulically connecting said main tank and reservoir so that said fluid can flow back and forth from said tank to said reservoir and from said reservoir to said tank, said tubular channel having an orifice of pre-determined size therein, said orifice being located on the interior of said reservoir, said tubular channel having an upper end vented to atmospheric pressure, a float valve in a portion of said tubular channel between said orifice and said main tank, the predetermined size of said orifice being calibrated so that escape of said fluid from said main tank at a rate greater than the flow rate allowable through said orifice will empty said portion of said tubular channel and cause said float valve to close, whereby escape of the fluid remaining in said reservoir will be prevented.

2. A fluid system comprising a sealed main tank having an internal pressure greater than atmospheric pressure, a fluid expansion reservoir connected to said tank, a liquid filling said main tank and occupying a portion of said reservoir, the lowest point on said reservoir being located above the highest point on said tank, said reservoir being vented to the atmosphere, a tube extending upwardly into said reservoir and terminating in an open end above the highest level reached by the liquid in said reservoir, there being an orifice of pre-determined size in the lower end of said tube adjacent the bottom of said reservoir, said tube being connected to a cylindrical housing containing a float valve, said cylindrical housing being connected to said main tank, thus providing a flow path between said main tank and reservoir that allows said liquid to flow back and forth from said tank to said reservoir and from said reservoir to said tank, said float valve being located between said orifice and said main tank in order to control flow of said liquid to and from said reservoir, the pre-determined size of said orifice being calibrated so that escape of said liquid from said main tank at a rate greater than the flow rate allowable through said orifice will empty said cylindrical housing and cause said float valve to rest in its seat, whereby the flow path between said main tank and reservoir will be closed and escape of the liquid remaining in said reservoir will be prevented, and means operable from the exterior of said housing for raising said float valve from its seat.

3. A system as recited in claim 2 in which said means for raising said float valve comprises a pivotably mounted lever extending through said cylindrical housing, said lever having a forked end located on the interior of said housing for engaging said float valve and raising same from its seat.

4. Electrical apparatus comprising a current carrying device enclosed in a sealed main tank having an internal pressure greater than atmospheric pressure, a fluid expansion reservoir connected to said main tank, a dielectric liquid filling said main tank and occupying a portion of said reservoir, the lowest point on said reservoir being located above the highest point on said tank, said reservoir being vented to the atmosphere, a tube extending upwardly into said reservoir and terminating in an open end above the highest level reached by the dielectric liquid in said reservoir, there being an orifice of pre-determined size in the lower end of said tube adjacent the bottom of said reservoir, said tube being connected to a cylindrical housing containing a float valve, said cylindrical housing being connected to said main tank, thus providing a flow path between said main tank and reservoir, said float valve being located between said orifice and said main tank in order to control flow of said dielectric liquid to and from said reservoir, the pre-determined size of said orifice being calibrated so that escape of said dielectric liquid from said main tank at a rate greater than the flow rate allowable through said orifice will empty said cylindrical housing and cause said float valve to rest in its seat, whereby the flow path between said main tank and reservoir will be closed and escape of the dielectric liquid remaining in said reservoir will be prevented, and means operable from the exterior of said housing for raising said float valve from its seat.

5. An electrical transformer comprising a core and winding enclosed in a sealed main tank having a pressure greater than atmospheric pressure, said winding being connected to bushings extending through said tank, a fluid expansion reservoir connected to said tank, a dielectric liquid filling said main tank and bushings and occupying a portion of said reservoir, the lowest point on said reservoir being located above the highest point on said bushings and main tank, said reservoir being vented to the atmosphere, a tube extending upwardly into said reservoir and terminating in an open end above the highest level reached by the liquid in said reservoir, there being an orifice of pre-determined size in the lower end of said tube adjacent the bottom of said reservoir, said tube being connected to a cylindrical housing containing a float valve, said cylindrical housing being connected to said main tank, thus providing a flow path between said main tank and reservoir, said float valve being located between said orifice and said main tank in order to control flow of said liquid to and from said reservoir, the pre-determined size of said orifice being calibrated so that escape of said liquid from said main tank at a rate greater than the flow rate allowable through said orifice will empty said cylindrical housing and cause said float valve to rest in its seat, whereby the flow path between said main tank and reservoir will be closed and escape of the liquid remaining in said reservoir will be prevented, and means operable from the exterior of said housing for raising said float valve from its seat.

6. A transformer as recited in claim 5 in which said float valve comprises a valve element connected to a buoyant body by a rod, and said means for raising said float valve comprises a pivotably mounted lever extending through said cylindrical housing, said lever having a forked end whose prongs are located on the interior of said housing on opposite sides of said rod for engaging said float element and raising same from its seat.

7. In combination, a main tank, an auxiliary reservoir mounted above said main tank and being vented to the atmosphere, a conduit interconnecting said tank and reservoir, a liquid normally filling said tank and conduit and partially filling said reservoir, said conduit extending into said reservoir above the liquid level therein and having an open top end, a restricted orifice associated with said conduit in the vicinity of said auxiliary reservoir for limiting downward flow of liquid through said conduit from said auxiliary reservoir to said main tank, a valve in said conduit between said orifice and said main tank, and a float in said conduit between said valve and said

main tank for normally maintaining said valve open, said float acting to close said valve in response to the partial emptying of said conduit by liquid flow therefrom into said main tank at a rate greater than said orifice will permit liquid to flow from said auxiliary reservoir into said conduit.

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