Nov. 17, 1964 W. M. EDWARDS 3,157,478

HYDRAULIC FLUID RETURN LINE AIR ELIMINATOR

Filed Dec. 28, 1960

FIG. 2

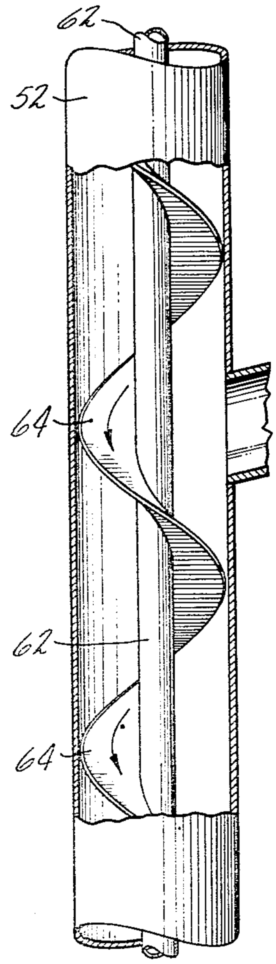


FIG. 1

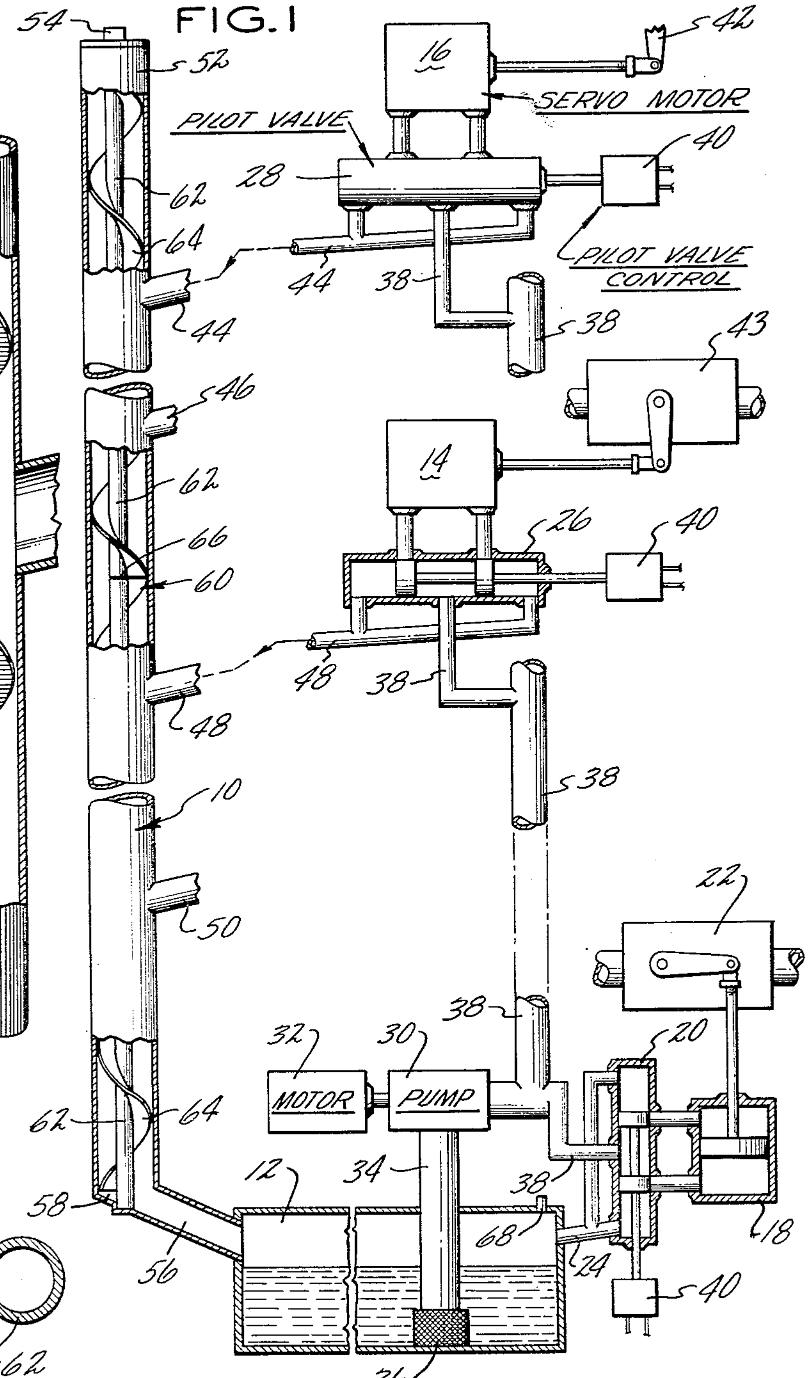
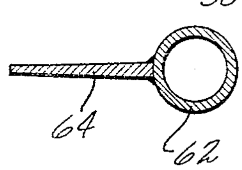


FIG. 3



INVENTOR
WILLIAM M. EDWARDS

BY Harris G. Luther
ATTORNEY

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HYDRAULIC FLUID RETURN LINE AIR ELIMINATOR

William M. Edwards, West Simsbury, Conn., assignor to Combustion Engineering, Inc., Windsor, Conn., a corporation of Delaware

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This invention relates to an hydraulic control system and particularly to mechanism preventing the entrainment or retention of air or gases in the hydraulic fluid and more particularly to preventing of such entrainment or retention incident to the free passage of return oil through a long vertical pipe.

This invention finds particular utility in the hydraulic control system for modern steam generators which may be several stories high and have controls at several different levels. Hence while a water return valve may be in the basement at approximately the level of the hydraulic fluid sump, another valve such as a feed water valve may be located, say, fifty feet higher and another valve such as the main steam or bypass valve may be located as much as 100 feet above the hydraulic fluid sump. Each of the above valves and many others are hydraulically and usually automatically controlled to maintain an operating condition and maximum efficiency of the steam generator. Some of these valves are ponderous and require large amounts of hydraulic fluid or oil to operate them, but may at times require very accurate positioning in the nature of a few thousandths of an inch. Such a hydraulic control system must be able to handle large volumes of hydraulic fluid but in order to accurately position the valve the fluid must at all times be free of air, or gases, and not form a mixture similar to an emulsion or foam.

In systems of this type it is usual to return the oil, discharged from the hydraulic pilot valves or servomotors of the control system, by gravity from the control stations to a common vertical return or stand pipe. The return lines are pitched at a normal pitch, say 1 inch to the foot, and discharge into the vertical return pipe at whatever level the drain line intersects the stand pipe.

It has been found that with some of the servos returning slugs of as much as five gallons of oil at a time that the slug in its drop through the vertical pipe, not only held air that might have been previously entrained but also tended to entrain additional air in its free drop and upon arriving at the sump so agitated the oil in the sump as to cause it to entrain additional air and foam and eventually cause the entire hydraulic fluid to be a mixture of air and oil similar to an emulsion with the oil in a continuous phase and the air in a dispersed phase. The air thus entrained in the hydraulic fluid would actually prevent operation of the steam generating system because of the inability of the servos to function accurately.

An object of my invention is mechanism which will prevent the entrainment of air in the hydraulic fluid in its passage through the vertical return pipe.

A further object is a simple, inexpensive mechanism which may be added to existing installations, structures, or designs without material alteration.

A still further object is a structure which may be prefabricated in sections and may be assembled, in the field, with the vertical return line.

An additional object is structure having a center core with a ribbon of rigid material secured to this core and extending radially outward from, and arranged in a spiral around, the core and sized to fit in a standard vertical return pipe.

Other objects and advantages will be apparent from the specification and claims, and from the accompanying drawing which illustrates a presently preferred embodiment of the invention.

FIG. 1 is a schematic view partly in section of the invention incorporated in a steam generating control system with the major portion of the system not shown.

FIG. 2 is an enlarged view of the spiral guide encased in the vertical return pipe.

FIG. 3 is a cross section of the spiral guide.

In the embodiment chosen to illustrate this invention, 10 indicates a vertical oil return line emptying return oil discharged from servo motors 14 and 16 into a sump 12. It should be understood that the servo motors 14 and 16 are shown only by way of example, as there may be many more discharging at various levels into the vertical standpipe 10. This invention finds particular usefulness in the controls for a steam generator known as the Sulzer Monotube boiler which is a well-known commercial boiler, and it is believed that only an exemplary showing is necessary for a complete understanding of the environment in which this invention finds particular usefulness. A servo motor 18 controlled by a pilot valve 20 and in turn controlling a valve which may be a water return valve 22 for the boiler system is shown at a level so related to the sump 12 that the return oil may flow through a normal pitched gravity drain 24 directly to the sump without any problem of air entrainment. Hydraulic fluid under pressure is supplied to the pilot valve 20 for the servo motor 18 and each of the pilot valves for these several servo motors in the control system such as pilot valve 26 for the servo 14 and pilot valve 28 for the servo 16, by means of a pump 30 driven by a motor 32 and drawing oil from the sump 12 through a line 34 and strainer 36, and discharging into pressure line 38 which is connected with each of the several pilot valves to supply oil under pressure to the pilot valves and their associated servo motors. Each pilot valve is provided with a suitable control 40 which may be manually actuated or automatically operated responsive to a condition or a function to be controlled such as temperature, pressure, mass flow, water level, and so forth. The discharge from the servo motors such as motor 16 which may control through linkage 42, a valve located near the top of the boiler which may be 50 to 100 feet above the sump 12 is directed by the pilot valve 28, controlling the motor 16, into a gravity drain line 44 which is suitably pitched to lead the discharge oil into the side of the vertical discharge pipe 10. Upon sudden changes in the operating conditions of the boiler, or for other reasons a servo motor may discharge as much as five gallons of hydraulic fluid at one time, substantially filling a drain line such as 44 for a considerable distance, such as two or three feet. Other discharge lines such as 46 leading from valve 26, controlling servo 14 for valve 43, and lines 48 and 50 may be arranged at different levels along the vertical pipe 10. These pipes 46, 48, and 50 are only exemplary showings of the several gravity drain lines that may feed into the vertical common return line 10.

The vertical return line 10 comprises a pipe 52 vented as its top 54 and, because it is not generally located directly over the sump 12, provided with a pitched gravity drain line 56 leading from the bottom 58 the sump 12.

Inserted in the pipe 52 is a spiral guide indicated generally at 60. The spiral guide comprises a core formed of a pipe 62, with a smooth imperforate ribbon of rigid material 64, extending radially outward from the core 62 wound in a spiral around the core 62 with the inner edge of the ribbon secured to the core, usually by spot welding, to form a helix throughout substantially the length of the core 62. The core 62 and its surrounding helix 64 are usually made up in lengths, say 20 feet, convenient to handle, and are slipped into the pipe 52 with a slight clearance between the outer edge of the helix and the inner surface of the pipe to permit ready insertion of the helix into the pipe, two adjacent cores 61 being welded together at 66 at the time they are assembled with the pipe 52 so that a substantially continuous helix is provided throughout the length of the vertical pipe 10 from a point above the discharge of the highest drain line 44 to the bottom 58 of the tube 10. The sump 12 is vented at 68 and the entire drain system operates at atmospheric pressure.

In operation, the several servo motors including motors 14, 16 and 18 discharge drain oil incident to their operation into their respective drain lines. The oil, which may come out as a slug of oil substantially filling the drain line, is urged by gravity, due to the pitch of the line, along the line, and into the vertical stack or drain 10. The oil which may still be in the form of a slug attempts to fill the drain 10 and drops by gravity to the nearest top surface of the ramp formed by the ribbon. Upon contacting this spiral ramp surface the free drop of the oil is interrupted and the oil is directed along the ramp. Friction between the lower surface of the slug of oil and the ramp tends to permit the upper surface of the oil to overrun the lower surface and spread out into a layer, of less height than the pitch of the spiral or helix, so that a layer of air is present over the layer of liquid permitting the escape of air previously entrained in the oil. Some of the oil may be forced by centrifugal action into contact with the interior surface of pipe 10 as it is traveling down the spiral and thus form an additional layer around the inside of the pipe. This smooth flow along the ramp and along the inside of the pipe prevents entrainment of any additional air and tends to release any air that nay have been previously entrained. Any additional oil that may be added from other drains will merge with the already formed layer and continue on as a layer of oil with an air space above it. It has been found that a core formed of a pipe of about ⅞" in diameter having a spiral or helix of about a 6" pitch and an outside diameter that will be received by a 3" pipe provides a very satisfactory air eliminating spiral. This will give an average angle of approximately 50 off of the horizontal for the oil flow. At the lower end of the pipe the layer of oil sliding down the spiral and along the inner surface of the vertical pipe 10 is received smoothly by the drain pipe 56 and led into the sump 12 without any material foaming or air entrainment.

The new fire resistant hydraulic fluids tend to retain entrained air to a greater extent than the older oils, and thus materially increase the importance of preventing the entrainment of air in the hydraulic fluids. It is of course well known that entrained air or air pockets render the hydraulic fluid squashy and the controls inaccurate, and in the steam generating system referred to above, render the controls so inaccurate and unreliable as to make the entire system inoperative.

From the above description it will be apparent that I have invented mechanism preventing the entrainment of air in the return oil of a hydraulic system, which mechanism is simple, efficient, inexpensive, occupies but little space in the crowded boiler room, and in fact may be incorporated in present designs without material alteration of those designs and occupy no additional space in the boiler house. It is a meritorious advance in the boiler control field and renders an otherwise inoperative structure operative.

It is to be understood that the invention is not limited to the specific embodiment herein illustrated and described, but may be used in other ways without departure from its spirit, and that various changes can be made which would come within the scope of the invention which is limited only by the appended claims.

I claim:

1. In a hydraulic control system having a vented sump and a vented gravity return line including a vertical vented pipe, pitched return lines leading to said pipe, an insert adapted to be slid into said pipe comprising a core, a ribbon arranged in a spiral along the length of the core, and having one edge secured to said core with the other edge spaced from said core, said other edge located adjacent the inside of said pipe when the insert is assembled with said pipe, and acting to locate said insert in said pipe.

2. The method of preventing air pumping and air entrainment in oil in a vented vertical oil gravity return pipe receiving oil slugs comprising feeding the oil in slugs into said pipe, interrupting the free gravity drop of one side of said slug and converting the free drop along and around the inside of said pipe to a spiral path, interrupting the free drop of other side of said slug at the next succeeding turn of the spiral path, limiting the thickness of the oil layer in the spiral path by spilling oil over one edge of said path to the next succeeding turn of the spiral path until the oil layer guided in the spiral path and confined by the pipe inner surface flows in a smooth stream with a vented air layer above the stream.

3. The method as defined in claim 2 in which the oil layer thickness is limited by spilling oil over the inner edge of said spiral path.

4. In a vertical oil return pipe, a guide surface for oil in said pipe, comprising a spiral ramp having a single oil guiding surface terminating at one edge adjacent the pipe interior surface and at the other edge adjacent the axis of said pipe, whereby the thickness of the flowing oil layer on said ramp surface is limited in part by oil spilling off one edge onto the interior surface of said pipe and in part by oil spilling off the other edge to the next succeeding turn of said spiral ramp.

5. In a vertical gravity feed oil return means preventing air pumping and entrainment comprising a vertical pipe, a single helical oil passage in said pipe including a single helical guide surface for said oil in said pipe for guiding said oil in a helical path along the inside of said pipe and having a radial extent between the helix axis and the inside surface of said pipe sufficient to present a slanting surface to interrupt free vertical drop of the oil inside of said pipe but insufficient to prevent radial inward flow across said surface and around the surface inner edge adjacent the helix axis and a free gravity drop to the next succeeding helix turn upon radial passage of the oil past the axis of said helix.

6. An oil return as claimed in claim 5 in which the helix angle with the vertical at the helix outer edge is between 30 and 50 degrees.

7. In a hydraulically actuated control system having a vented vertical hydraulic fluid gravity return line discharging into a vented sump, pitched discharge lines leading slugs of said fluid from hydraulic control members of said system into the side of said vertical return line at spaced points along said line, said return line comprising a circular cross-section pipe, a spiral ramp located inside said pipe and comprising a central core member connected with an outwardly extending helical guide surface extending substantially the entire length of said core and pipe and substantially from said core to said pipe but providing a clearance producing a fluid leak passage between the outer edge of said guide surface and the inner wall of said pipe.

8. A control system as claimed in claim 7 in a steam generator several stories high, with the sump at a level near the bottom of the generator, and a hydraulic control member near the top level of the generator discharging into said line near said top level.

References Cited in the file of this patent

UNITED STATES PATENTS

1,752,215	Waters	Mar. 25, 1930
1,917,171	Warner et al.	July 4, 1933

2,235,541	Warren	Mar. 18, 1941
2,316,729	Tryon	Apr. 13, 1943
2,570,171	Von Kohorn et al.	Oct. 2, 1951
2,705,053	Morris	Mar. 29, 1955
2,751,894	Clarkson et al.	June 26, 1956
2,852,003	Simmons	Sept. 16, 1958

FOREIGN PATENTS

289,813	Germany	Jan. 20, 1916