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HYDRAULIC CYLINDER ACTUATOR BAFFLES

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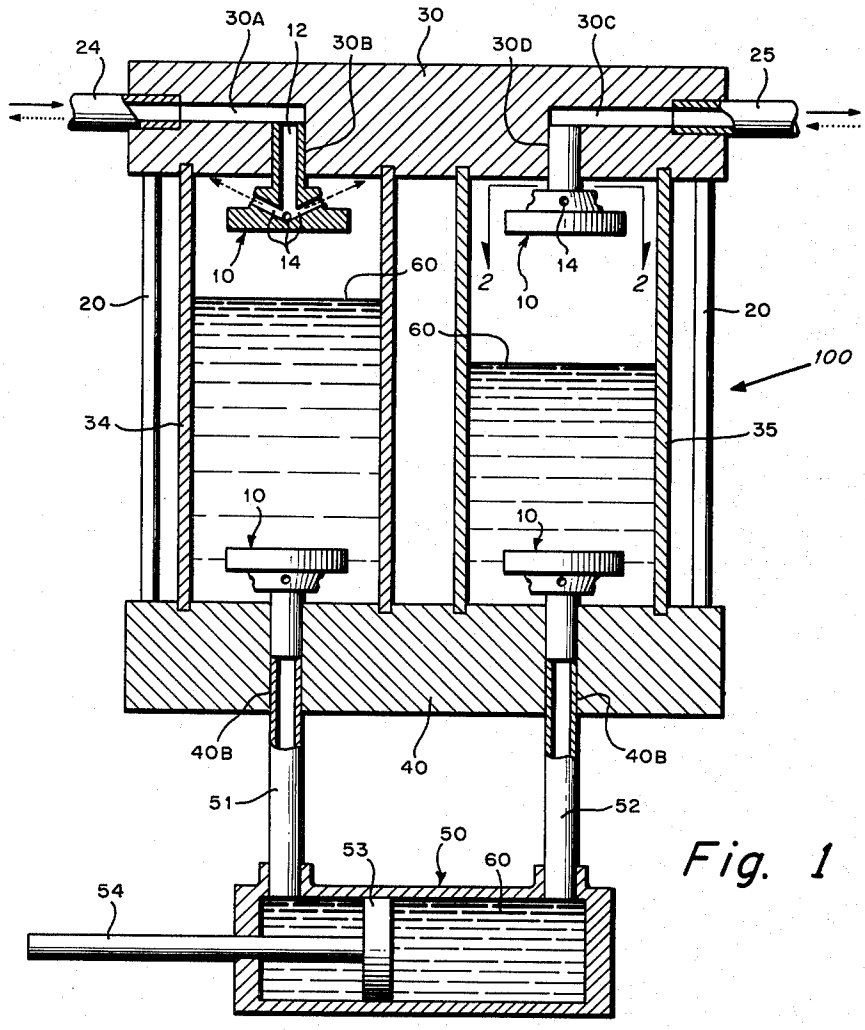


Fig. 1

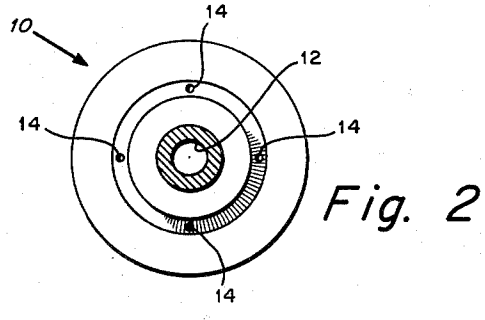


Fig. 2

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HYDRAULIC CYLINDER ACTUATOR BAFFLES

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This application is a continuation-in-part of application 317,164, filed October 18, 1963, for Hydraulic Cylinder Actuator.

This invention relates to an actuator for a hydraulic cylinder. More particularly, it relates to the baffles in actuating means for a hydraulic cylinder in which gas pressure is used in combination with hydraulic fluid.

In certain types of hydraulically actuated cylinders, a reservoir of hydraulic fluid is provided with access to the cylinder on each side of the piston within the cylinder. A differential in the gas pressure applied to the surfaces of the fluid in the cylinders results in an unbalanced force on the opposing faces of the piston and the cylinder is thus actuated. Accurate positioning of the piston, and carefully controlled movement of it are desirable in certain applications. In many applications, it is important that the position and movement of the piston be held to close tolerances, and that its movement be highly responsive to applied control.

Typically, the hydraulic fluid is oil and the gas is air: the terms oil and air are used throughout this specification as terms of convenience, but it is understood that all gases and hydraulic fluids known or suitable for the use in such hydraulic systems are contemplated within the scope of the invention.

A seemingly straightforward system in practice presents some complications that adversely affect its desirable characteristics. Sudden high pressure bursts of air impinge on the exposed surface of the oil in a reservoir and it has been found that there is a tendency to entrap air bubbles in the oil, in a manner explained below. This condition reduces the sensitivity of the system. It has also been found that when it is desired to hold the piston at a stable position by admitting equal air pressures to each reservoir, there may still be a tendency for the piston to creep because of differentials in the effective pressure on the surface of the oil in the two reservoirs due to differences in the characteristics (such as length) of the lines through which the air is supplied. Expedients have been practiced toward the end of reducing or eliminating these problems, and the present invention is an improvement over other such expedients.

The present invention has several advantages over the baffle type structure disclosed in my co-pending application, of which this is a continuation-in-part. Briefly, these advantages include less criticality of centering, better distribution of fluids entering and leaving the actuator cylinder, lower terminal velocity of fluids entering the actuator cylinder, more prevention of aeration of the hydraulic liquid, less splashing, and in general better sensitivity.

Prior means to prevent the entrapment of air in the oil are shown, for example, in United States Patents 2,683,463 and 3,053,233.

It is an object of this invention to provide a hydraulic cylinder actuator.

It is another object of this invention to provide improved baffling means for actuating means for an air-oil hydraulic cylinder system.

It is yet another object of this invention to provide an air-oil reservoir system adapted for use with a hydraulic cylinder, in which means are provided to prevent churning of the air and oil, and to reduce unwanted pressure differentials.

It is yet another object of this invention to provide means in a hydraulic cylinder oil reservoir to distribute the flow of incoming gas so as to avoid mixing with the oil.

Other aims and objects of this invention are made apparent in the following specification and claims.

The invention is best understood in connection with the drawing. FIGURE 1 is a schematized cross-sectional elevational view of a hydraulic cylinder and its actuating system. FIGURE 2 is a cross section of the line 2—2 from FIGURE 1.

A conventional hydraulic cylinder generally designated **50** is shown. This cylinder **50** is provided with a piston **53** to which is affixed a piston rod **54**. The piston is free to move axially within the cylinder **50** in the ordinary way. Hydraulic fluid, generally oil, **60**, is provided inside the cylinder **50** on both sides of piston **53**. Oil lines **52** and **51** open into the cylinder on opposite sides of piston **53**.

The actuator is generally designated **100**. It comprises a base **40** and a top **30**. These elements are preferably made of machined metal stock, such as brass, and may typically be rectangular blocks of metal, machined or otherwise fashioned to provide recesses and passages therethrough as indicated in the drawing. It is understood that the actuating means, which constitutes the subject of this invention, is illustrated as much larger than the hydraulic cylinder, which is included in the drawing only to show a complete system. In actuality, the scale of the cylinder and actuating means might be reversed.

A pair of reservoir cylinders **34** and **35** are provided between top **30** and base **40**. As shown, these hollow cylinders may be mounted between the top and the base by being fitted into circular grooves milled or otherwise formed in the facing surfaces of the top and base, respectively. Thus, a reservoir cylinder together with its closed top and bottom formed by part of the top **30** and base **40**, respectively, may be described as a reservoir. It is understood that tight seals are provided at all joints and that the shape of the reservoir is not critical to the invention. The exact dimensions of the reservoirs are not critical to the invention, but the typical field of application of this invention normally lies in reservoirs whose reservoir cylinders have diameters of one-inch or more, with the other dimensions of the reservoir typically in somewhat the same proportions shown in the drawing, although not necessarily so. The reservoir cylinders **34** and **35** may be made of metal, or may be made of transparent plastic or glass. There is an advantage in providing the pair of cylinders of transparent material when they are mounted in the close side-by-side relationship on a common base as illustrated in the preferred embodiment shown. The advantage is that the differential in oil levels between the two cylinders is immediately and easily visible to the eye of the operator. It is then apparent that this differential is an index to the position of the cylinder. The reservoir cylinders **34** and **35** may be provided with etched, engraved or other markings to provide index marks so that levels may be read quantitatively. Alternatively, linear measuring means may be provided to quantitatively measure the difference between the levels. Such a means includes a simple ruler with provision for raising or lowering it between the two reservoirs. It is also apparent, if the level of the oil **60** in each cylinder is set so as to be the same when the piston **53** is in some central or standard position, that an immediate quantitative or qualitative visual indication is given as to what side of the standard position the piston **53** is at any moment, and how far it is displaced. Thus, in the drawing, the oil **60** in reservoir cylinder **34** stands

higher than in cylinder 35 and this corresponds to a displacement of piston 53 toward the left of hydraulic cylinder 50.

The oil lines 51 and 52 communicate respectively to reservoir cylinders 34 and 35 through the respective bores 40B through base 40.

Air lines 25 and 24 communicate through certain connecting means described below respectively to reservoir cylinders 34 and 35. A preferred form of the communicating means is illustrated. Air bores 30A and 30C are provided in top 30 to respectively receive air lines 25 and 24 as shown. These air bores may be horizontally drilled or otherwise formed in the top 30. Considering first the structure connected to air bore 30A in reservoir 34, a dispersing head 10 is provided. The head 10 has an extension tube 12. This tube 12 has an outside diameter such that it fits snugly into the vertical air bore 30B, which is drilled or otherwise formed in top 30, and which communicates with the interior end of horizontal air bore 30A. The vertical air bore 30B is centered within the milled or otherwise formed circle on the underside of top 30 that accommodates the walls of reservoir 34. The tube 12 may be positioned in bore 30B by any convenient known means, such as by matching threads, locking screws, force fit, or camming surfaces, for example.

The main body of dispersing head 10 is thus supported inside reservoir cylinder 34. In the same manner, a dispersing head 10 is supported within reservoir 35, by having its extension tube inserted into a vertical air bore 30D. The description in connection with air bore 30B is also applied to air bore 30D. The lower dispersing heads 10 in reservoirs 34 and 35 also have their extension tubes fitted into the appropriate bottom air bores 40B, as illustrated. In the case of the bottom or lower heads 10, which are affixed to base 40, there is, of course, in the illustrated embodiment, no horizontal air bore. Each bore adapted to receive a dispersing head is centered within the groove or other boundary of the walls of its respective reservoir cylinder.

The air valving and supply means are conventional in themselves and are not shown in detail in the drawing. The arrows pointing in and out of air lines 24 and 25 do show the direction of the air. When it is desired to move piston 53, compressed air is supplied to one reservoir, for example, to reservoir 34; the air moving in the direction of the solid arrow at air line 24. At the same time, air line 25 may be vented, or as is often the case, connected to a vacuum; the solid line in connection with air line 25 shows the direction of air movement. Under the condition just described, the level of oil 60 in reservoir 34 would fall; the oil level in reservoir 35 would rise, and piston 53 in hydraulic cylinder 50 moves to the right. The dotted line arrows in FIGURE 1 show the movement of air in the respective air lines when the piston movement is reversed.

In use in systems of the type herein described, where operating pressures are typically of the order of between 90 and 175 pounds per square inch, there is a sudden burst of air admitted to a reservoir. This sudden burst tends to impinge on the exposed surface of the oil 60 and tends to churn or mix. As has been explained above, this is undesirable when precision control is required.

The reservoir cylinders 34 and 35 are mounted close together on a single base and underneath a single top to form a single balanced unit. The oil lines 51 and 52 are of equal length and, in general, the structure is such that the total paths to the opposite sides of piston 53 are kept as short and as equal as possible. It has been found that differences in the pressure transmitted to the opposite sides of piston 53, due to differences in frictional line drops, can have a significant effect. By thus providing a unitary compact balanced and short line actuator 100, the possibility of imbalance in the pressure ultimately applied against the opposite faces of piston 53 is reduced. This balanced ultimate pressure is desirable where a stable

condition is desired. Thus, in addition to the visual check advantages of providing a unitary actuator 100, there is the advantage of a more easily produced stable condition.

The structure of dispersing head 10 is best shown by reference to the sectionalized view in FIGURE 1, and the view in FIGURE 2. The extension tube 12 flares into a major or head portion. The major portion is provided with a plurality of channels 14. Each of these channels 14 communicate with the hollow interior of extension tube 12. In the embodiment shown, four of the channels 14 are provided, spaced 90-degrees apart. As best shown in FIGURE 1, each channel 14 extends outwardly from the longitudinal axis of extension tube 12 so that each said channel forms an acute angle with extension tube 12.

The angle, of itself, is not critical, but this angle in relation to the other dimensions of the structure is critical to the preferred operation of the entire structure.

It has been found that if the angle between channel 14 and extension tube 12 is so great that the stream of air passing from an air line into tube 12 and hence out channel 14 strikes a wall of the reservoir in a direct line from channel 14, there is a thrusting effect down the wall and into the oil 60. It must be borne in mind that the applications to which this structure is particularly suited, the opening and closing of valves to admit high pressures, vacuums, vents to atmosphere and shut-offs, are sudden and there is a consequent tendency to a blast effect.

On the other hand, it has also been found that if the angle between channel 14 and extension tube 12 is too acute, the air being directed relatively sharply against the undersurface of top 30 tends to create turbulence. It has been found that this turbulent effect is not preferred from the point of view of minimizing any disturbance of the free surface of oil 60. Thus, it may be stated that as the angle between the channel and the tube gets larger, the desirable baffling effect improves until the point of which the direct blast of air from the channel impinges directly on the wall, at which point, the baffling effect relatively suddenly decreases in effectiveness. It is thus apparent that the optimum angle between the channel 14 and the tube 12 is that at which the longitudinal axis of channel 14, as extended, strikes the undersurface of top 30 near, but not at, the junction of the top with the wall of the reservoir. Another way of stating the angular disposition of channel 14 is to say that as installed in a reservoir, the angle of channel 14 is such that the major portion of a stream of fluid directed through said channel would strike the top of the reservoir near, but not at or beyond, the junction of said top with said wall. The same description can be applied to the dispersing heads at the bottom of the reservoirs except, that in this case, the major portion of a stream directed through the channel would strike the bottom of the reservoir, rather than the top.

The total cross-sectional area of the four channels 14 is preferably greater than the cross-sectional area of the interior of extension tube 12. The reason for this is explained below. While four channels 14 are shown, and it has been found that these are satisfactory, it is understood that a greater number of channels can be used. While a lesser number of channels might be operative, the desirable distribution and baffling affect is not as pronounced. For the purposes of this patent, the underside of the top 30 and the upper side of the base 40 may be described as the end surfaces of the reservoir.

The use of the term "turbulence" above should not be taken as an implied allegation that the flow is technically laminar when the preferred arrangement is used; the term is used to indicate that there is a more violent blast effect.

The use of the lower baffles, which may be described as oil baffles or oil dispersing heads, are important particularly where low viscosity oils or water are being used. In such conditions, when the oil or water is flowing back into the reservoir, it tends to splash up and even enter

the air port, thence into the valving mechanism. This effect is particularly pronounced when the sudden reversal of conditions involves the rapid change from a pressure applied to the surface of oil in the reservoir to a vacuum. It has been found that the provision of baffles, such as those described herein, prevent the water or oil from tending to leap up the sides of the reservoir.

Previously known baffles have directed the fluids directly outwardly or to the side, so that they impinge directly on the walls of the reservoir. This type of baffling does not eliminate the blasting or striking of either gas or liquid, along the sides of the reservoir, which has been found to be a critical problem. The J-tube, as described in the co-pending application, does improve over those baffles which direct the blast to the side, but the present invention is an improvement over the J-tube also. The present dispersing head requires less criticality of centering in the reservoir, as compared to the J-tube. A slight displacement from the center on the part of the J-tube tends to result in an unequal dispersion. The present dispersing head results in a more even dispersion of the fluid over the entire end surface than in other known baffles.

Another advantage of the present head is that the increased cross-sectional area of the channels as compared to the tube as described above, results in a decrease in the velocity of the fluid as it enters the reservoir due to well-known physical principles. This is desirable in reducing the kinetic energy of the fluid.

It is understood that the use of only the top baffles is advantageous and useful. In particular, where there are low viscosity oils or water, it has been found additionally useful to also provide the lower or oil baffles. It is understood that even where higher viscosity oils are used, the lower baffles may be employed with some advantage, at least as a safety factor, and without any disadvantage.

The scope of this invention is to be determined by the appended claim and is not to be limited by the foregoing description and drawings which are illustrative.

I claim:

A pneumatic-hydraulic actuator, comprising a reservoir cylinder having a bottom end and a top end, a closed wall connecting said bottom end and said top end, each of said bottom end and top end having an inner surface, an oil line communicating with said reservoir cylinder through the inner surface of said bottom end thereof, an air line communicating with said reservoir cylinder through the inner surface of the top end thereof, each of said lines communicating with said cylinder through a dispersing head, each said dispersing head having an extension tube communicating to and extending from one of said lines through one of said inner surfaces into said reservoir cylinder, a plurality of channels in each said head communicating with said extension tube, each of said channels having a longitudinal axis at an acute angle with said extension tube and pointing toward the said inner surface through which said extension tube extends, and an extension of the longitudinal axis of each of said channels in a direction away from said extension tube intersects said inner surface near the intersection of said inner surface with said wall.

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