AIR-OIL TANK

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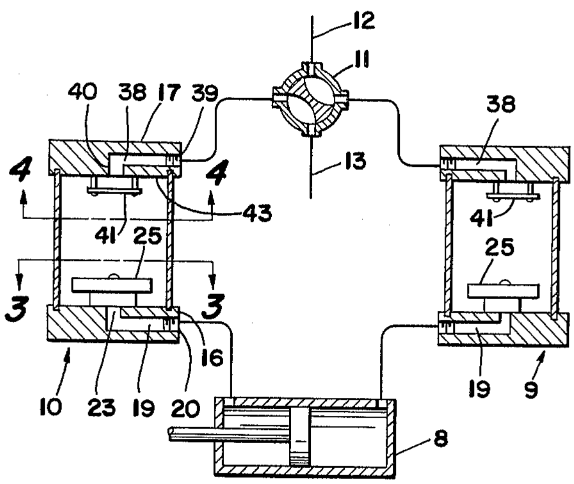

Fig. 1

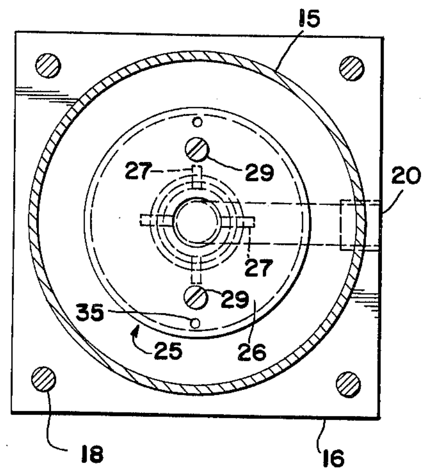

Fig. 3

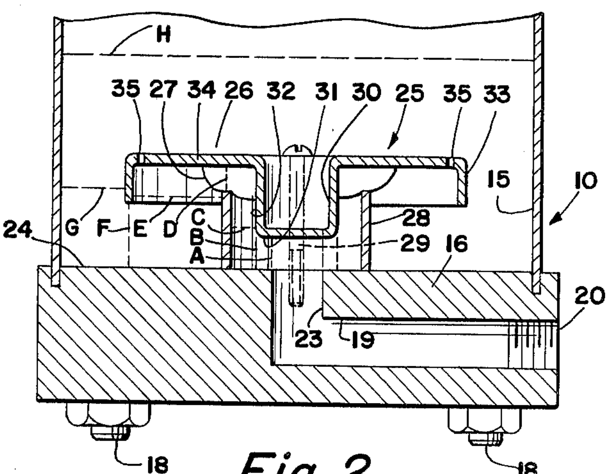

Fig. 2

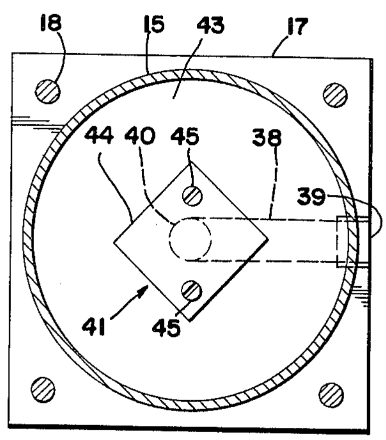

Fig. 4

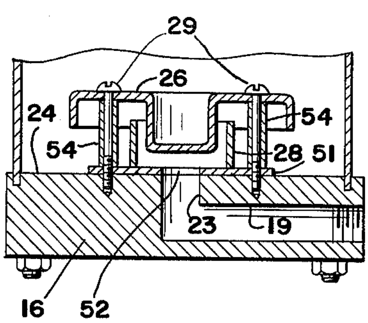

Fig. 5

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AIR-OIL TANK

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This invention relates to tanks for receiving both air and hydraulic oil under pressure, and more particularly to baffle means for controlling the entry of oil into the tank so as to prevent foaming of the oil.

Air-oil tanks are used for operating fluid motors in systems where a supply of air under pressure is economically available but it is desired to use a liquid as the power fluid for the motor because of the more positive action and closer control of the motor afforded by the liquid. Such air-oil systems are economical when a suitable supply of compressed air is available since it dispenses with the use of pumps, accumulators and other units required in an all hydraulic system.

One of the problems presented by use of an air-oil system is to keep the fluids separated. Entry of air into the hydraulic oil is undesirable because it then renders the fluid in the hydraulic portion of the system compressible with a corresponding reduction in positive action and control. On the other hand, entry of the hydraulic oil into the air side of the system causes loss of oil from the hydraulic side with ultimate failure of hydraulic operation and also causes contamination of the atmosphere into which the exhaust air is discharged. It is possible to separate the air from the oil by a movable piston or diaphragm but this results in much more costly and complicated arrangements than when the fluids are permitted to contact each other.

It has been found that in arrangements which permit the fluids to contact each other, separation of the fluids can be adequately maintained if the turbulence and the impingement of one fluid upon the other is substantially eliminated during operation of the system. This may be accomplished by providing entry patterns into the tank for both the air and the oil so that the velocity of the fluids as they enter the tank is reduced and by distributing the flow over a large area where it enters the main tank chamber for contacting the opposite fluid. Such entry patterns may be provided by properly designed baffles.

Accordingly, it is an object of this invention to provide a baffle arrangement for greatly reducing the velocity of each fluid before it contacts the other fluid within the air-oil tank.

It is another object to provide a tank of the type described in which the baffle for the oil influences the direction and manner of the oil flow so that the flow is substantially uniformly distributed throughout the flow path area at the point of entry into the tank chamber beyond the baffle.

It is another object to provide a tank of the type described in which the flow of oil into the tank chamber beyond the baffle is substantially in one direction, as opposed to turbulent or swirling flow, and which direction is the same as the rising level of oil in the tank.

It is another object to provide a baffle for the oil side of an air-oil tank in which the direction of flow is altered several times for uniformly smoothing out turbulent and unevenly distributed flow and the flow paths vary in a prescribed manner for reducing the velocity of the oil as it enters the tank.

Other objects of the invention will be apparent from the following description and from the drawings in which:

FIG. 1 is a cross section view of an air-oil system utilizing tanks with baffles in accordance with the present invention,

FIG. 2 is an enlarged cross section view of the oil side of the tank,

FIG. 3 is a cross section view along the lines 3—3 of FIG. 1 but of smaller scale than FIG. 2,

FIG. 4 is a cross section view along the lines 4—4 of FIG. 1, and

FIG. 5 is a cross section view of an alternate arrangement for the baffle in the oil side of the tank.

As shown in FIGURE 1, the system may include a fluid motor **8** operated by hydraulic oil from air-oil tanks **9**, **10**. A fourway control valve **11** may be utilized for alternately admitting air under pressure into and exhaust it from each of the tanks via air supply line **12** and exhaust line **13**.

Tank **10**, which is identical to tank **9**, includes a cylindrical tube **15** closed at its ends by end caps **16**, **17** attached thereto by tie rods **18**. End cap **16** is on the oil side of the tank and has a circular passage **19** with a threaded port **20** at the outer end thereof for connection to hydraulic motor **8**. At the other end of passage **19** is another circular passage **23** extending at right angles to passage **19** and opening into the interior flat face **24** of end cap **16**.

Attached to face **24** is an oil baffle generally designated **25**. This baffle includes a body member **26** supported by means of a plurality of equally spaced webs **27** upon a tubular center ring **28** which is concentrically disposed relative to passage **23**. Center ring **28** is concentrically spaced from cup **30** by webs **27** which are notched where they engage ring **28**. The webs also fix the axial spacing between ring **28** and body member **26**. Webs **27** may be welded to either ring **28** or body member **26**. Screws **29** clamp the parts together and in a fixed position on end cap **16**.

Body member **26** has a central cup **30** with a flat bottom surface **31** and with a cylindrical outer surface **32** which telescopes within and is concentric with center ring **28**, and it also has a transverse portion **34** connecting cup **30** with flange **33** which is concentric with tube **15** and cup **30** and which extends in an axial direction relative to tube **15**. Passage **23** is central relative to tube **15** and also extends axially with respect thereto. Body member **26** has several small openings **35** therethrough closely adjacent circular flange **33** for venting air from inside flange **33** when putting a supply of oil into the tank or in case the oil level drops below the flange during operation.

On the air side of the tank, end cap **17** has a passage **38** and a port **39** through which air under pressure may be introduced into the tank and also has a circular passage **40** connected to passage **38** and at right angles thereto. Passage **40** opens into interior face **43** of end cap **17** and is concentric with tube **15** and extends axially with respect thereto. A baffle assembly, generally designated **41**, includes a square baffle plate **44** attached to end cap **17** by screws **45** and spaced from the end cap by tubular spacers surrounding the screws. Plate **44** is located centrally within tube **15**.

During normal operation, tanks **9** and **10** are mounted in a vertical position, as shown in FIGURE 1. The capacity of each tank is such that during normal operation the level of oil within the tanks will at all times be above baffles **25** and below baffles **41**. With valve **11** in the position shown, air under pressure from supply line **12** enters the top of tank **9** to force oil from this tank into motor **8** for moving the piston therein to the left. At the same time, valve **11** connects the top of tank **10** to exhaust line **13**, permitting oil from motor **8** to return to tank **10**.

As the oil enters port **20** and passage **19** of tank **10**, it may have high velocity, depending upon the system and the work being performed by the motor. From passage 19 the oil flows axially through passage 23, radially between the lower end of cup 30 and the opposed end cap face 24, axially between center ring 28 and cup 30, then radially between the end of center ring 28 and the opposed upper end of member 26, then between the transverse portion 34 and end cap face 24, between the lower end of flange 33 and face 24, and axially again between flange 33 and tube 15 past baffle body member 26 into the interior of the tank. Flange 33, being parallel and concentric with tube 15, and of substantial length, causes substantially all of the fluid passing into the tank above plate 26 to be moving in an axial direction parallel with the wall of tube 15.

As the oil passes through the annular passage defined by flange 33 and tube 15, it completely fills this passage so as to be uniformly distributed therein. Moreover, the oil is traveling smoothly in laminar fashion and at greatly reduced velocity, as compared with the volocity in passage 19, as it enters the body of fluid above baffle 25.

In the illustrated embodiment of the invention, the area of passage 19 is the same as the area of boundary circle A at the periphery of passage 23 and between cup 30 and end cap face 24. However, the area of boundary circle B at the outer periphery of cup 30 and between the cup and surface 24 is about 1.5 times the area of boundary circle A and there is a corresponding reduction in the velocity of the oil as it passes from A to B.

The area of annular flow path C between cup 30 and center ring 28 is 1.13 to 1.2 times the area of boundary ring B, area D between the upper end of center ring 28 and the upper part of body 26 is 1.70 to 1.80 times area C. Beyond D, the areas of annular flow paths E, F and G are not critical except that none should be smaller than D and should preferably be greater. Also, G should have an area larger than that of any preceding section of the flow path and the lower end of flange 33 should axially overlap a portion of ring 28, as shown in FIGURE 2.

With the baffle arrangement described, it has been found that best results as far as turbulence and foaming of the oil is concerned are obtained when the area of flow path G is from .47 to .53 the diametral area H of tube 15.

As the air under pressure enters passages 38, 39 of tank 9, it impinges against the center portion of baffle plate 44 and then flows radially to the edges of plate 44 where it turns to flow into the tank. Since the density of air is much less than that of the oil, it will readily distribute itself to evenly "fill" the flow areas and there is less tendency for the air to penetrate the surface of the oil within the tank. Consequently, the simpler baffle arrangement shown at 41 is adequate.

In the optional form of the oil baffle shown in FIGURE 5, center ring 28 is welded to a plate 51 having an opening 52 therethrough in register with opening 23, opening 52 being slightly larger than opening 23 so that no part of plate 51 will project across opening 23 if the plate is not centered perfectly. Tubular spacers 54 surround screws 29 and have their opposite ends butted against plate 51 and member 26 to locate member 26 axially with respect to plate 51. If desired, plate 51 may be omitted and center ring 28 welded directly onto face 24 of end cap 16, in which case the lower ends of spacers 54 contact face 24. In both of these arrangements just described, webs 27 shown in FIGURE 2 are omitted.

Various other modifications may also be made within the scope of the invention as defined by the claims.

I claim:

1. An air-oil reservoir comprising a tank having an inlet for fluid, a baffle between the inlet and the interior of the tank, said baffle having surfaces for causing a plurality of changes in direction of flow of fluid entering the tank interior from said inlet, the flow path having generally concentric sections all of progressively greater area from the inlet to the interior of the tank, and last

baffle surface traversed by the fluid when entering the tank parallel to an opposed tank surface for a substantial distance whereby substantially all of the fluid flowing therebetween enters the tank in a direction parallel to said last mentioned surfaces.

2. An air-oil reservoir comprising a tank having an inlet for fluid, a baffle between the inlet and the interior of the tank, said baffle having surfaces for causing a plurality of changes in direction of flow of fluid entering the tank interior from said inlet, the flow path having generally concentric sections all of progressively greater area from the inlet to the interior of the tank, and said tank has a cylindrical side wall and the last baffle surface traversed by the fluid as it enters the tank is cylindrical and concentric with the tank side wall.

3. An air-oil reservoir comprising a tank having an inlet for fluid, a baffle between the inlet and the interior of the tank, said baffle having surfaces for causing a plurality of changes in directional flow of fluid entering the tank interior from said inlet, the flow path having generally concentric sections all of progressively greater area from the inlet to the interior of the tank, and a last section of said flow path having a cross section area approximately one half the cross section area of the tank in a plane perpendicular to said last flow path section and adjacent thereto.

4. An air-oil reservoir comprising a tank having an inlet for oil, an oil baffle between the oil inlet and the interior of the tank, said baffle having surfaces for directing oil entering the tank through said inlet through a series of changes in flow direction with the last of said directions being in a generally upward vertical direction corresponding to the direction of the rising oil level within the tank, the surface of the baffle traversed by the oil flowing in said last direction being parallel to an opposed tank surface, said last mentioned surfaces being parallel for a distance sufficient to cause substantially all the oil flowing therebetween to enter the tank beyond the baffle in a direction parallel to said last mentioned surfaces.

5. A reservoir for fluid comprising a tank having a cylindrical side wall and a transverse end wall, an inlet opening for fluid in said end wall, a baffle opposite said opening, said baffle having a first circular transverse surface spaced from said end wall, a first cylindrical surface adjacent said first transverse surface, a second cylindrical surface spaced radially outward of the first cylindrical surface and in partially telescoped relation thereto, a second transverse surface overlying the space between the first and second cylindrical surfaces and axially spaced from the second cylindrical surface, and a flange on said baffle adjacent the second transverse surface radially outwardly thereof and extending therefrom axially toward said transverse end wall, said flange being in spaced concentric relation with said cylindrical side wall of the tank, said wall, surfaces and flanges defining a flow path between the inlet opening and the tank interior beyond the baffle with sections of said flow path being of progressively greater area from the inlet toward the interior of the tank.

6. The reservoir of claim 5 in which said inlet opening comprises connected first and second circular passages in said end wall extending in directions respectively perpendicular and parallel to said cylindrical side wall, and in which the first transverse surface is spaced from the end wall a fixed distance so that the peripheral area of a cylinder having a diameter equal to that of the second circular passage and a length equal to the fixed distance is equal to the cross sectional area of said first passage.

7. The reservoir of claim 5 in which said inlet opening comprises connected first and second circular passages in said end wall extending in directions respectively perpendicular and parallel to said cylindrical side wall, and in which the first circular transverse surface has a diameter such that the peripheral area of a cylinder having a diameter equal to that of the first circular transverse surface

and a length equal to the axial distance of said first circular transverse surface from said end wall is substantially 1.5 times the area of the cross sectional area of said first passage.

8. The reservoir of claim 5 in which said inlet opening comprises connected first and second circular passages in said end wall extending in directions respectively perpendicular and parallel to said cylindrical side wall, and in which the cross section area of the annular space between the first and second cylindrical surfaces is between 1.7 and 1.8 times the cross sectional area of said first passage.

9. The reservoir of claim 5 in which said inlet opening comprises connected first and second circular passages in said end wall extending in directions respectively perpendicular and parallel with said cylindrical side wall, and in which the second transverse surface is axially spaced from second cylindrical surface a fixed distance such that the peripheral area of a cylinder having a diameter equal to the diameter of the second cylindrical surface and a length equal to that of said fixed distance is between 1.7 and 1.8 times the cross sectional area of the annular space between the first and second cylindrical surfaces.

10. The reservoir of claim 5 in which said flange and said cylindrical side wall are parallel for a distance sufficient to cause substantially all the fluid flowing therebetween to enter the tank beyond the baffle in a direction parallel to said cylindrical side wall.

11. The reservoir of claim 5 in which the flange axially overlaps said second cylindrical surfaces.

12. The reservoir of claim 5 in which the first and second transverse surfaces, the first cylindrical surface and the flange are provided by a member rigidly attached to said transverse end wall, and said second cylindrical surface is provided by a tubular member clamped against said transverse end wall by said member.

13. The reservoir of claim 12 in which there are radially extending webs axially spacing the tubular member and said second transverse surface to provide a flow path therebetween.

14. The reservoir of claim 12 in which there are radially extending webs axially spacing the tubular member from the second transverse surface and radially spacing the first cylindrical surface from the second cylindrical surface.

15. A reservoir for fluid comprising a tank having a cylindrical side wall and a transverse end wall with a flat interior surface, a central opening in said surface, baffle means between said opening and the interior of the tank beyond said baffle means, said baffle means including a member having a circular flat face opposite said opening and extending radially beyond the same, said member having a first cylindrical surface with a lower end at the outer margin of said circular flat face and extending axially therefrom away from said flat interior surface, a second transverse surface extending radially outward from the upper end of said first cylindrical surface and terminating at a downwardly extending circular flange whose outer surface is spaced from and concentric with said cylindrical side wall, said baffle means including a tubular member supported at its lower end by said flat interior surface and whose upper end is spaced from said second transverse surface, said tubular member being radially spaced from said first cylindrical surface and said flange, said walls, surfaces and flange cooperating to provide a flow path between said opening and said tank interior with sections of said flow path having progressively larger areas toward said tank interior.

16. The reservoir of claim 15 in which said baffle includes a member attached to said end wall by screws, and there are spacers associated with the screws for determining the axial location of said member relative to said end wall.

17. The reservoir of claim 15 in which said baffle includes a member attached to said end wall by screws, and there are spacers surrounding the screws between the member and the end wall for determining the axial location of said member relative to said end wall.

18. The reservoir of claim 15 in which the baffle includes a first member and a tubular member, the tubular member being attached to a plate which is against said end wall, said first member being attached to the end wall by screws, and spacers surrounding the screws between the first member and said plate for locating the axial position of said first member relative to said end wall and said tubular member.

19. An air-oil reservoir comprising a tank having an inlet for oil in the bottom wall thereof, an oil baffle between the oil inlet and the interior of the tank, said baffle having surfaces for directing oil entering the tank through said inlet through a series of changes in flow direction with the last of said directions being the same as the direction of the rising oil level within the tank, said surfaces including a transverse surface spaced from said bottom wall and a cylindrical surface extending from the transverse surface toward said bottom wall, and a vent opening in said transverse surface to permit bleeding of air therethrough when the level of oil in said tank approaches said transverse surface.

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