Feb. 15, 1966 G. T. DOWNEY 3,235,174

CENTRIFUGAL LIQUID PURIFIER

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Fig 1.

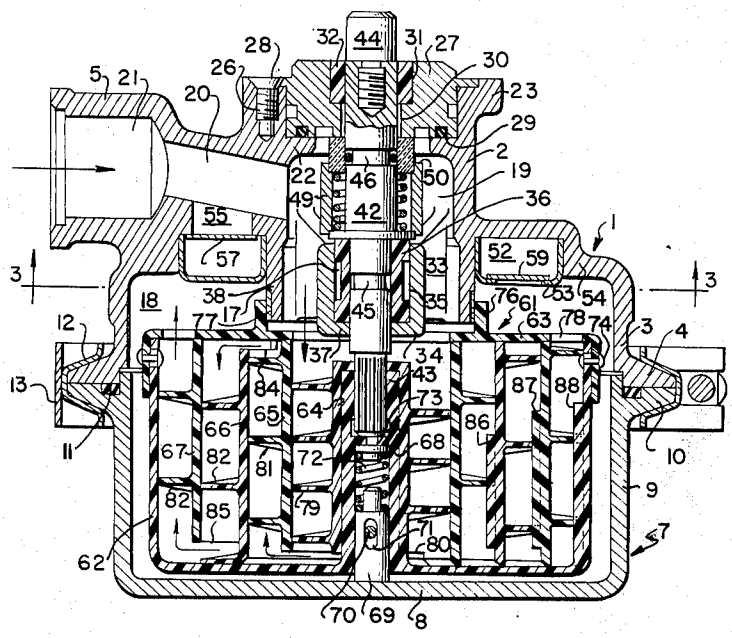
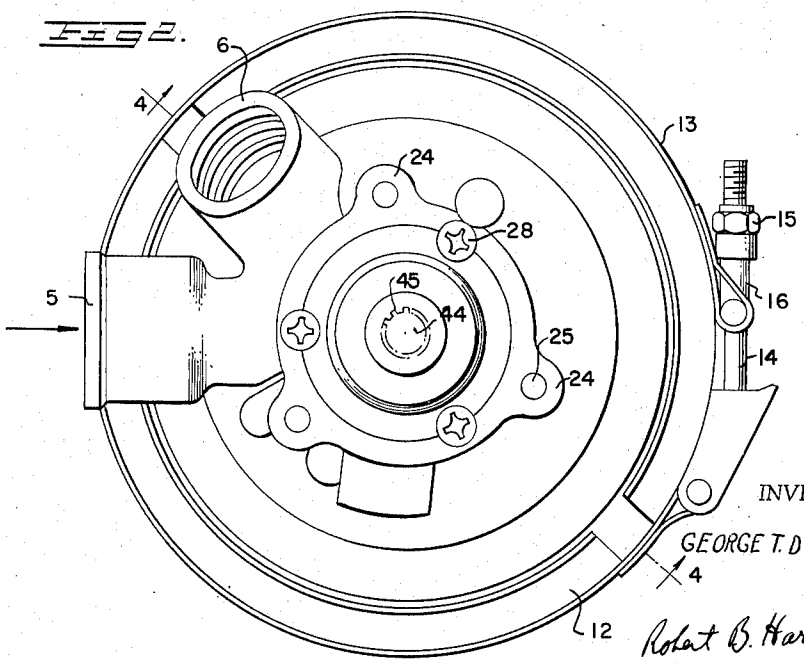


Fig 2.



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Fig 3.

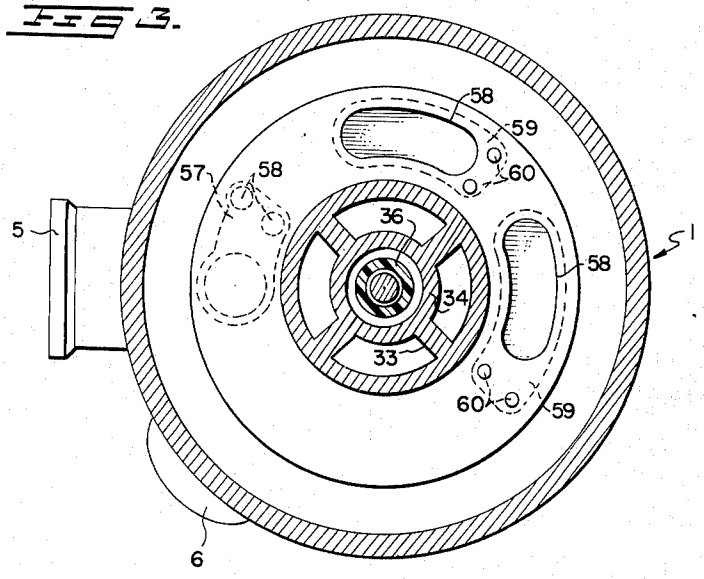


Fig 4.

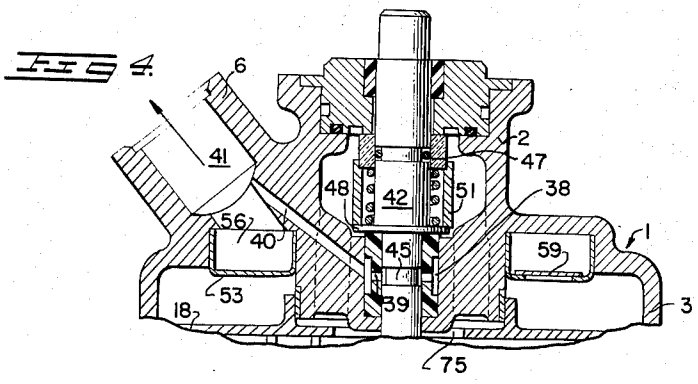


Fig 5

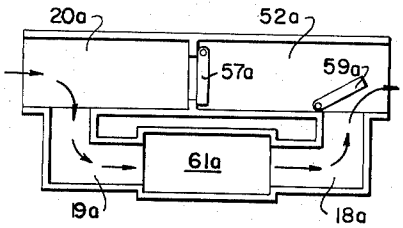
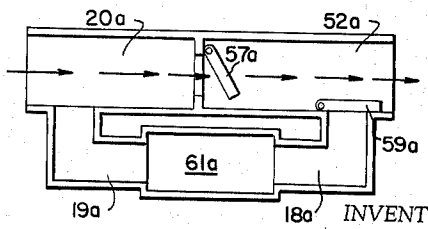


Fig 6.



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3,235,174

CENTRIFUGAL LIQUID PURIFIER

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8 Claims. (Cl. 233—19)

The present invention relates in general to devices for removing foreign particles from liquids by the use of centrifugal force to thereby purify or clarify the liquids to condition them for a desired use. Such devices are used, for example, in liquid fuel systems and the like wherein the liquid must be freed from particles of foreign matter which would have a damaging effect to the apparatus within the system. The use of the present device, however, is not limited to incorporation within any specific system, but also finds utility in operations in which purification of the liquid alone is the desired end result.

The present device is more especially adapted for use in series with a fluid pressure or pumping means and acts as a fluid pressure booster and a liquid purifier or, in the alternative, by-pass passage when it is desired to eliminate the purification step. The present device is also adapted to more effectively remove foreign particles from the liquid regardless of their density and specific gravity.

In the prior art, much difficulty has been encountered in removing foreign particles such as cotton lint or other fibers having a relatively low density and thus not adapted to centrifugal separation. Other problems such as providing a by-pass means to completely remove the centrifugal apparatus from the stream of flow to prevent the dumping of collected contaminate in the fluid stream are also obviated by the present invention. The present invention further contemplates increased storage capacity within the centrifuge element for particles of contamination and the retention of the particles of fluid within the centrifugal field for a maximum period of time.

This invention thus has for its primary object the presentation of novel and useful improvements in the efficiency and effectiveness of centrifugal liquid purifying devices.

Another object of the present invention is to provide a centrifugal liquid purifier which acts also as a pump and which, when de-activated, is automatically by-passed in the fluid passage so as not to cause an impedance to flow and which will not be washed out by the regular flow.

A further object of this invention is to provide a by-pass valve arrangement for a centrifugal liquid purifier which is operated solely by the hydraulic pressure differentials within the system to direct the fluid through the centrifugal element when it is in operation but to completely by-pass the centrifugal element when it is not operating.

A further object of this invention is to provide a centrifugal liquid purifier unit in which the pressure at the inlet is less than the pressure at the outlet when the centrifugal unit is operating and in which the pressure at the inlet is greater than the pressure at the outlet when the centrifugal unit is not operating.

A further object of the present invention is to provide a liquid separator which will remove low density particles from the liquid by means of electro-static forces which supplement the centrifugal force to which the particles are subjected.

A further object of the present invention is to provide a centrifuge element composed of a dielectric material to create an electro-static charge by the friction of the centrifuge element moving through the liquid.

A further object of the present invention is to provide a centrifuge element composed of a dielectric material to create an electro-static charge by the friction of the centrifuge moving through the liquid which will remove low density particles found particularly in liquid fuels such as cotton lint, road dust and iron oxide particles.

A further object of the present invention is to provide a centrifugal fuel purifier which is light in construction, and provides for self-cleaning bearing surfaces resulting in an increased bearing life.

A further object of this invention is to provide a centrifugal liquid separator in which the rotary member comprises a helical screw and a tortuous path.

A still further object of this invention is to provide a centrifugal fuel purifier having an increased storage volume for collected contamination and which subjects the particles of liquid to a maximum centrifugal loading for an extended period of time.

The means by which the foregoing objects and other advantages, which will be apparent to those skilled in the art, are accomplished are set forth in the following specification and claims and are illustrated in the accompanying drawings dealing with a preferred embodiment. Reference is now made to the accompanying drawings in which:

FIG. 1 represents a vertical cross section of a centrifugal apparatus embodying the present invention.

FIG. 2 is a top plan view of the apparatus shown in FIGURE 1.

FIG. 3 is a sectional view taken substantially along lines 3—3 of FIGURE 1.

FIG. 4 is a fragmentary cross sectional view of the device taken substantially along lines 4—4 of FIGURE 2.

FIG. 5 is a diagrammatic representation of the flow path of the liquid through the centrifuge element when the centrifuge is operating.

FIG. 6 is a diagrammatic representation of the flow path of the liquid through the device during the by-pass condition when the centrifuge element is not operating.

Referring now to the drawings, wherein like reference numerals are used to indicate identical parts in the various views, the preferred embodiment of the invention, shown in FIGS. 1 to 4, comprises a housing indicated generally at 1 which includes an upper cylindrical portion 2, a lower cylindrical portion 3 having an annular lip 4, an inlet fitting 5 and an outlet fitting 6 shown in FIGURES 2 to 4.

The lower half of the body of the centrifugal liquid purifier is formed by a cylindrical bowl 7 having a closed bottom 8, a vertical wall 9 and a mating lip portion 10 which engages and mates with the lip portion 4 of the housing 1. The lower lip 10 of the bowl also carries an annular sealing member 11 in its upper face which provides a liquid pressure seal between the housing 1 and bowl 7 when the members are clamped together in any well known manner. One well known manner of clamping the housing 1 and the bowl 7 together is illustrated in FIGS. 1 and 2 and comprises an annular V-band 12 which engages the lips 4 and 10 and which is pressured thereagainst by an adjustable pressure band 13. The pressure band 13 carries a screw clamp means on its terminal ends which includes a threaded bolt 14 and a nut 15.

The threaded bolt 14 is secured to one end of the band 13 and passes through a cylindrical sleeve 16 carried by the opposite end of the band. The nut 15 is threaded onto the end of the bolt 14 to provide an adjustable clamping action which will be obvious to those skilled in the art.

The upper cylindrical portion 2 of the housing 1 has an outside diameter which is less than the outside diameter of the lower cylindrical portion 3 of the housing and further includes a depending hollow cylindrical extension

17 which extends downwardly into the cylindrical cavity 18 formed by the lower cylindrical portion 3 and the bowl 7. The wall of the extension 17 is parallel to the wall of the lower portion 3 of the housing and terminates at a position above the annular lip 4 of the housing. The housing 1, including the upper portion 2, the lower portion 3, the annular lip 4, the inlet and outlet fittings 5 and 6 respectively and the depending cylindrical extension 17 are preferably formed of a unitary casting of a lightweight metal composition such as aluminum or aluminum alloy. The bowl 7 is also preferably formed of a unitary casting of aluminum or aluminum alloy.

The upper cylindrical portion 2 with its depending extension 17 forms a vertical passage 19 in the housing which is open at the upper and lower ends and which is connected by a passage 20 to the passage 21 which forms the opening for the inlet fitting 5. The upper portion 2 further includes an internal annular shoulder 22 which protrudes a short distance into the upper part of the passage 19 and also an external mounting flange 23 on its upper end. The mounting flange 23 is provided with ears 24 having holes 25, shown in FIGURE 2, which may be used to mount and support the entire unit. The mounting flange also includes screw threaded holes 26, the purpose of which will be presently described.

The top opening of the passage 19 is fitted with a cover 27 which fits snugly into the opening of the passage, rests on the top face of the shoulder 22 and is held against rotation with respect to the mounting flange 23 by screws 28 which extend therethrough and into the screw threaded holes 26 of the flange. An O-ring seal 29 provides a liquid seal between the lower face of cover 27 and upper face of the shoulder 22. The cover 27 has a central bore 30 with an upper portion 31 of increased diameter to provide an annular recess for the mounting of an outboard bearing 32 preferably made from a material such as filled Teflon.

The wall of the depending cylindrical extension 17 has, formed integrally therewith, inwardly extending webs 33 which support an inboard bearing retention sleeve 34 centered in the passage 19. The webs 33 are four in number and are shown clearly in FIGS. 1 and 3. The webs 33 and the bearing retention sleeve 34 are part of the overall housing 1 and may be cast integrally therewith. The bearing retention sleeve has an internal bore 35 which receives an inboard bearing 36 which is also preferably formed of filled Teflon. The bearing 36 is pressed into the bore of the sleeve 34 and is supported on its bottom face by a shoulder 37 extending a short distance into the bore of the sleeve 34.

The inboard bearing 36 is seen to be hollow and cylindrical in form with a centrally located annular channel 38 formed in its outer surface. Radial passages 39, shown in FIGURE 4, serve to connect the channel 38 with the bore of the bearing 36. A small diameter access passage 40 connects the channel 38 of the inboard bearing with passage 41 which forms the opening for the outlet fitting 6 and thus subjects the inner portion of the inboard bearing to the pressure existing in the outlet passage 41. As clearly shown in FIGURE 4, the access passage 40 extends through the body of one of the webs 33 which is nearest the outlet passage.

A drive shaft 42 is mounted in the housing 1 and is maintained in rotatable position by the outboard bearing 32 and the inboard bearing 36. The drive shaft 42 further includes a drive connection 44 which extends beyond the outboard bearings 32 and a lower extension 43 which may be provided with splines 45 as illustrated in FIGURE 2. The drive connection 44 preferably constitutes a separate element from the lower portion of the drive shaft and acts as a shear section in case of the jamming of the drive shaft for any reason. The drive shaft further includes an annular portion 39*a* of reduced diameter which registers with the passages 39 of the inboard bearing. A second annular portion 46 of reduced diameter provides for the mounting of an O-ring seal 47 on the drive shaft. Located about midway on the drive shaft 42 is an integral flat annular shoulder 48 which rides adjacent the top face of the inboard bearing 36 when the drive shaft is in assembled position and which provides a seat for a helical compression spring 49, the upper end of which seats against an annular ceramic sealing ring 50 which prevents leakage between the passage 19 and the bore of the cover 27 and which engages the O-ring seal 47 of the drive shaft to prevent leakage between the drive shaft and the ceramic seal. A protective sleeve 51 surrounds the spring 49 and may be composed of aluminum or aluminum alloy.

A continuous annular passage 52 is located in the housing 1 and is formed by the insertion of an annular inverted U-shaped sheet metal ring 53 between the wall of the depending extension 17 and an offset portion 54 of the housing 1. The wall of the housing 1 provides the top covering for the channel 52. The annular sheet metal ring 53 may be held in position by means of a forced fit or by any suitable screw or detent fastening means not shown. Passages 55 and 56 connect the inlet and the outlet passages 20 and 41 respectively to the annular passage 52. A flat stainless steel reed valve 57, within the annular passage 52, is attached to the underside of the top covering wall of the housing 1 and covers the passage 55 to prevent fluid flow from the passage 52 into the inlet passage but will flex to allow fluid flow from the inlet passage 20 into the passage 52 when the fluid pressure within the passage 20 is greater than that within the passage 52. The valve 57 may be secured to the housing by any suitable means such as the screw means 58 shown in FIGURE 3. The annular ring 53 has two identical elongated ports 58 formed in its bottom wall which are fitted with flat stainless steel reed valves 59 secured at one end to the top face of the bottom wall of the ring 53 by rivet means 60 and which prevent fluid flow from the passage 52 into the cavity 18 but flex to permit flow from the cavity 18 into the passage 52 when the fluid pressure in the cavity is greater than that in the passage 52.

Looking now at the lower half of the device, a centrifuge element indicated generally at 61 is mounted for free rotation within the cavity 18 and is supported for driving engagement with the drive shaft 42. The principal structure of the centrifuge element 61 includes a cup shaped member 62, a cover plate 63 secured thereto and a series of concentric cylinders 64, 65, 66 and 67 which are keyed to the member 62 and rotate therewith when the member 62 is driven by the shaft 42. The entire centrifuge element including the cup shaped member, the cover plate and the concentric cylinders are preferably formed of nylon but may be formed from any suitable light weight dielectric material and still be within the spirit of the present invention. The cup shaped member 62 is further characterized by a centrally located hollow upstanding core 68 the upper end of which is provided with a splined driving connection with the splined portion 43 of the drive shaft. The lower end of the hollow core 68 is provided with a slidable plunger 69 which is indexed to the core by means of a pin 70 carried by the core and extending through a slot 71 in the plunger. The plunger 69 seats against the bottom 8 of the bowl 7 and is urged thereagainst by the action of a helical compression spring 72 the opposite end of which seats against a shoulder 73 of the core. Through the action of the spring 72 and the sliding plunger 69, the centrifuge element is biased upwardly against the bottom of the drive shaft 42, but is allowed a certain amount of axial movement.

The cover plate 63 of the centrifuge element is fixedly secured to the cup shaped member 62 by means of rivets or the like 74 and further includes a central opening 75 which allows for the flow of fluid from the passage 19 into the body of the centrifuge element. The cover

plate 63 is also provided with an upstanding annular bearing member 76 which surrounds the lower terminal portion of the extension 17 and engages the face of the bearing sleeve 77 fitted onto the lower end of the extension 17. The upstanding cylindrical bearing portion 76 provides the centering means for the rotating centrifuge element and forms a self-cleaning bearing seal with the sleeve 77 due to the fluid pressure differential between the cavity 18 and inner portion of the centrifuge element which will presently be explained. An arcuate outlet opening 78 is located in the cover plate 63 adjacent its outer peripheral edge and extends as far around the circumference thereof as possible to allow for low fluid velocity for the liquid leaving the centrifuge element. The extent of this opening, however, may be varied depending upon the fluid velocity desired at the outlet of the centrifuge.

Turning now to the internal construction of the centrifuge element, the innermost of the concentric cylinders 64 is designed to fit snugly over the core member 68 and is keyed to the core for rotation therewith as illustrated in FIG. 1. The top portion of the inner cylinder 64 closely surrounds the splined end of the shaft 42 and is permitted only a slight amount of upward movement by reason of the enlarged portion of the shaft 42 above its spline 43. The inner cylinder 64 has a helical screw blade 79 on its outer periphery which is designed to impel the fluid downwardly from the passage 19 in the direction of the arrow in FIGURE 1 when the drive shaft 42 is rotated in a clock-wise direction as viewed in FIGURE 2. A second concentric cylinder 65 extends about the outer peripheral edge of the screw blade 79 and has its vertical wall flush with the opening 75 of the cover 63. The cylinder 65 extends the entire distance from the cover 63 to the bottom of the cup shaped member 62 except for an elongated cut away portion 80 on its lower end which allows the downwardly directed fluid from the screw 79 to pass therethrough and to be directed upwardly in the direction of the arrow in FIGURE 1 by the action of a second helical screw blade 81 which is oppositely directed from the screw blade 79. Third and fourth concentric cylinders 66 and 67, having oppositely directed helical screw blades 82 and 83 respectively, are similarly placed to provide progressive cylindrical chambers through which the fluid is impelled in a tortuous path by the action of the screw blade. The cylinders 66 and 67 have elongated openings 84 and 85 respectively which are similar to the opening 80 in the cylinder 65 and allow the fluid to flow from one successive cylindrical chamber to the next. The length and size of these openings may be varied, depending upon the fluid velocity desired in any specific embodiment of the present invention. The wall of the outermost cylinder 67 is located substantially flush with the inner side of the outlet opening 78 so that the outlet opening registers only with the outermost cylindrical chamber. The cylinders 65, 66, and 67 are all keyed to each other and to the rotating member 62 by means of keys 86, 87, and 88. It will be further noted that the lead of the individual concentric screw blades, progressing from the center of the centrifuge outwardly, is increased to provide increased contaminate storage volume since the particles of contamination are collected on the inner walls of the concentric rotating cylinders.

Operation

The operation of the prefered embodiment of the present invention will now be described in detail with reference to the drawings. The operation of the centrifugal liquid purifier will be described with relation to its incorporation into a fluid pressure system with the fluid entering the inlet 21 of the purifier under pressure created by any desirable type of pump means located upstream from the purifier. This condition of operation will more clearly illustrate the novel operation of the unit either as a purifying means and pressure booster or as an automatic by-pass passage when it is desired to temporarily eliminate the purifying step. It will be expressly understood, however, that the centrifugal purifier unit of the present invention need not be used in series with a fluid pressure means but may be connected directly to a source of liquid since, when operating, it provides its own pumping action.

Under the conditions just stated, any suitable power means such as an electrical motor or the like will be drivingly connected to the end 44 of the drive shaft 42 to rotate the shaft 42 in a clock-wise direction, as viewed in FIGURE 2, when the operation of the centrifuge is desired. With suitable conduits attached to the inlet fitting 5 and to the outlet fitting 6 of the element and considering, for the moment, that the power shaft 42 is not yet operating, the fluid under pressure will enter the element through the inlet passages 21 and 20 and may follow either the path through the passage 19 or the path through the passage 55. With the centrifuge element being stationary as yet, the tortuous path provided by the screw blades and the concentric cylinders will provide an impedance to normal flow of fluid and hence the fluid will pass directly through the passage 55 and bias the reed valve 57 to an open position allowing the fluid to pass directly into the annular passage 52. From the passage 52 the fluid will flow through the passages 56 and 41 to the outlet conduit. Under these conditions the fluid pressure at the inlet 21 is normally greater than the fluid pressure at the outlet 41 and also the fluid pressure within the conduit 52 will be greater than that within the chamber 18 thus maintaining the reed valves 59 in a closed position to prevent the flow of fluid from the chamber 18 into the outlet passages. As soon as the centrifuge element is energized, the fluid within the chamber 19 will be impelled downwardly and through the successive chambers of the centrifuge and into the cavity 18. This flow path is indicated clearly by the arrows in FIGURE 1. The energy imparted to the liquid by the initial action of the centrifuge element will thus cause a rise in pressure within the cavity 18 and create a pressure differential between the passage 52 and the cavity 18 since the fluid pressure in the passage 52 is at this time equal to that at the inlet passage 21.

With the fluid pressure in cavity 18 exceeding that in the passage 52, the reed valves 59 are biased to an open position to allow the fluid to flow from cavity 18 into the passage 52 and from thence to the outlet passages 56 and 41. At the same time the rising pressure within the passage 52 will cause the reed valve 57 to close and to remain closed, since the pressure on the outlet side of the element and in the passage 52 is now greater than that of the fluid entering through the inlet 21 and passage 55. A diagrammatic illustration of the fluid flow within the device when the centrifuge element is rotating is clearly shown in FIGURE 5 with the essential elements shown corresponding to the essential elements illustrated in FIGURES 1 to 4. In FIGURE 5 the inlet passage corresponding to the inlet passage 20 of the device is shown as 20*a*, the vertical passage is represented at 19*a*, the centrifuge element at 61*a*, the outlet cavity at 18*a*, the outlet reed valves at 59*a*, the annular passage at 52*a* and the inlet reed valve at 57*a*. As shown in FIGURE 5, with the centrifuge element operating to cause a pressure rise from that of the fluid at the inlet 20*a*, the pressure in the outlet is greater than that at the inlet resulting in the closing of the by-pass reed valve 57*a* and the opening of the outlet check valves 59*a* with the fluid being prevented from taking a direct by-pass flow path.

If at any time it becomes desirable to eliminate the purifying step, the rotation of the power shaft 42 is ceased with a resultant drop in fluid pressure in the outlet cavity 18. As soon as this happens the fluid pressure at the inlet is again greater than that of the outlet 41 and the reed valve 57 is again biased to an open condi-

tion to allow the fluid to pass from the passages 21, 20 and 55 directly into the outlet passages 52, 56 and 41. With the drop in pressure in the cavity 18, the reed valves 59 are again seated and remain seated by the difference in pressure between the passage 52 and the chamber 18. This condition is diagrammatically illustrated in FIGURE 6 with the pressure at the inlet 20*a* being greater than the pressure at the outlet 52*a*, the reed valve 57*a* being biased open and the reed valves 59*a* being held in a closed position and the fluid passing directly from the inlet to the outlet in a direct bypass flow path indicated by the arrows.

It will be also readily apparent that during the operation of the centrifuge the internal portion of the inboard bearing 36 will be subjected to the fluid pressure at the outlet by way of the passage 40, channel 38, radial passages 39 and the reduced portion 45 of the drive shaft. The pressure of the fluid in the passage 19, however, is the same as that at the inlet which is considerably lower than the pressure at the outlet and thus allows for a slow flow of clean liquid between the drive shaft and the bearing to provide the self-cleaning feature of the inboard bearing mounting. The bearing surface between the sleeve 77 and the upstanding cylindrical member 76 of the cover plate is also seen to be self-cleaning since, during relative rotation of these parts, the fluid pressure in the cavity 18 is greater than the fluid pressure in the passage 19 and a back flow of clean liquid between the members 76 and 77 occurs. The novel structural relationship provided by applicant's device wherein the constant washing of the bearing surfaces occurs during operation thus results in a longer bearing life and improved bearing efficiency.

Having fully described the mechanical operation of the present device and the alternate flow paths, attention is now directed to the improved purifying action obtained from the novel internal structure of the centrifuge element 61 itself. First of all, it will be noted that the tortuous path to which the particles of liquid are subjected as they move in reversed directions through the series of cylindrical chambers from the inlet 75 to the outlet 78 serves to maintain the particles within the centrifugal field for an extended period of time and under a maximum loading. The solid particles of contamination within the liquid will be deposited and retained against the inner walls of each of the concentric cylinders 65, 66 and 67 as well as the wall of the cup shaped member 62, with the available area for such deposition being greatly increased by the plurality of cylindrical walls made available by the plurality of concentric cylinders. The available area for deposition is also enhanced by the increased lead of the screw blades on the outer cylindrical members. This feature alone constitutes a vast improvement over the efficiency of the prior art devices of a comparable size and weight. Still further advantages are obtained by the present construction wherein the rotating concentric cylinders, cup shaped member 62 and cover plate 63 are made of nylon or any similar light weight dielectric material. The friction created by the walls of these cylindrical members as they move through the liquid will induce an electro-static charge on the surface of the dielectric material and provide a further attraction for the particles of the contamination in addition to the centrifugal force. The electro-static force will be particularly efficient in removing particles of light weight contaminate such as cotton lint, road dust and iron oxide particles commonly found in motor fuels. It will also be obvious that the particles of contamination which are stored on the inner walls of the concentric cylinders will not be washed into the normal stream of flow when the centrifuge is deenergized by reason of the automatic and direct by-pass path previously described. When it is desired to clean the centrifugal liquid purifier element of the present invention, it is only necessary to remove the centrifuge element from the housing by removing the clamping means and the bowl 8 at which time the centrifuge element may be conveniently removed and washed.

It will be readily apparent to those skilled in the art that the present invention provides novel and useful improvements in centrifugal liquid purifier devices of the character described. The arrangement in types of structural components utilized within the invention may be subjected to numerous modifications well within the purview of this invention and applicant intends only to be limited to liberal interpretation of the specification and appended claims.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. A liquid purifier comprising: a hollow body including an inlet port adapted to receive pressure fluid, an outlet port in said body, a first chamber in said body defining an inlet chamber and connected to said inlet port, a second chamber in said body positioned to receive fluid flow from said first chamber, an annular closed channel in said body registering with said outlet port, a passage connecting said annular channel with said inlet chamber, a first fluid pressure responsive valve means in said passage for permitting fluid flow from said inlet port directly to said annular channel when the fluid pressure in said inlet port is greater than the fluid pressure in said channel, second fluid pressure responsive valve means mounted in said channel for permitting fluid flow from said second chamber to said channel when the fluid pressure in said second chamber is greater than the fluid pressure in said channel, and selectively rotatable centrifugal liquid purifying means mounted in said second chamber in rotatable sealing engagement with said inlet chamber.

2. The combination according to claim 1 further including means to selectively rotate said centrifugal liquid purifying means comprising, a rotatable drive shaft mounted in said first chamber, bearing means surrounding said shaft, an annular passage located in said bearing structure and means connecting said annular passage with said outlet whereby the external portion of said bearing is subjected to the pressure at the inlet and the internal portion of said bearing is subjected to the pressure at the outlet.

3. The combination according to claim 1 wherein, the rotatable centrifugal liquid purifying means comprises; a rotatable outer cylindrical shell, said shell including a cup-shaped portion and a circular top cover, said cover having a centrally located inlet opening and an arcuate outlet opening adjacent its outer peripheral edge, a plurality of spaced concentric cylinders mounted in said shell to form a plurality of spaced cylindrical chambers, the innermost chamber registering solely with said inlet opening and the outermost chamber registering solely with said outlet opening, passage means in said concentric cylinders to provide a tortuous path for fluid flow first downwardly to the opposite end of the innermost chamber and terminating in upward flow through said outermost chamber and to said outlet, and alternately reversed helical screw flights mounted on the walls of said cylinders to force fluid within said element along said tortuous path.

4. The combination according to claim 3 wherein, the entire centrifuge element is composed of a dielectric material.

5. The combination according to claim 1 wherein, the centrifugal purifying means includes means to provide a tortuous path for fluid passing from said inlet chamber to said annular closed channel and helical screw means to impel the fluid and to increase the fluid pressure passing from said inlet chamber to said second chamber when said purifying means is rotated.

6. The combination according to claim 5 wherein, said rotatable centrifugal liquid purifying means is composed entirely of a dielectric material whereby the friction created by said material moving through the liquid will

induce an electrostatic charge on the surface of said material.

7. The combination according to claim 5 wherein, the tortuous path is formed by a plurality of spaced concentric cylinders and said screw means are carried by the walls of said cylinders.

8. In a liquid purifier unit including a hollow body portion having an inlet adapted to be connected to a source of liquid under pressure and an outlet, the combination comprising a selectively operable rotatable centrifuge to remove particles of contamination from the liquid and to boost the pressure of the liquid passing from said inlet to said outlet above the pressure level of the liquid at the inlet, means to direct fluid from said inlet to the centrifuge, means to direct fluid from the centrifuge to the outlet, by-pass passage means to direct flow of liquid through the body portion from the inlet to the outlet, a first valve in said by-pass passage means, said valve being opened in response to fluid flow between the inlet and outlet when the centrifuge is not operating and said valve being closed in response to pressure at said outlet when said centrifuge is operating, and a second valve located between the centrifuge and said outlet, said second valve being opened when said centrifuge is operating and being closed when said centrifuge is not operating.

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