

June 5, 1956

L. HORNOSTEL
SEPARATOR-PUMPING

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2 Sheets-Sheet 1

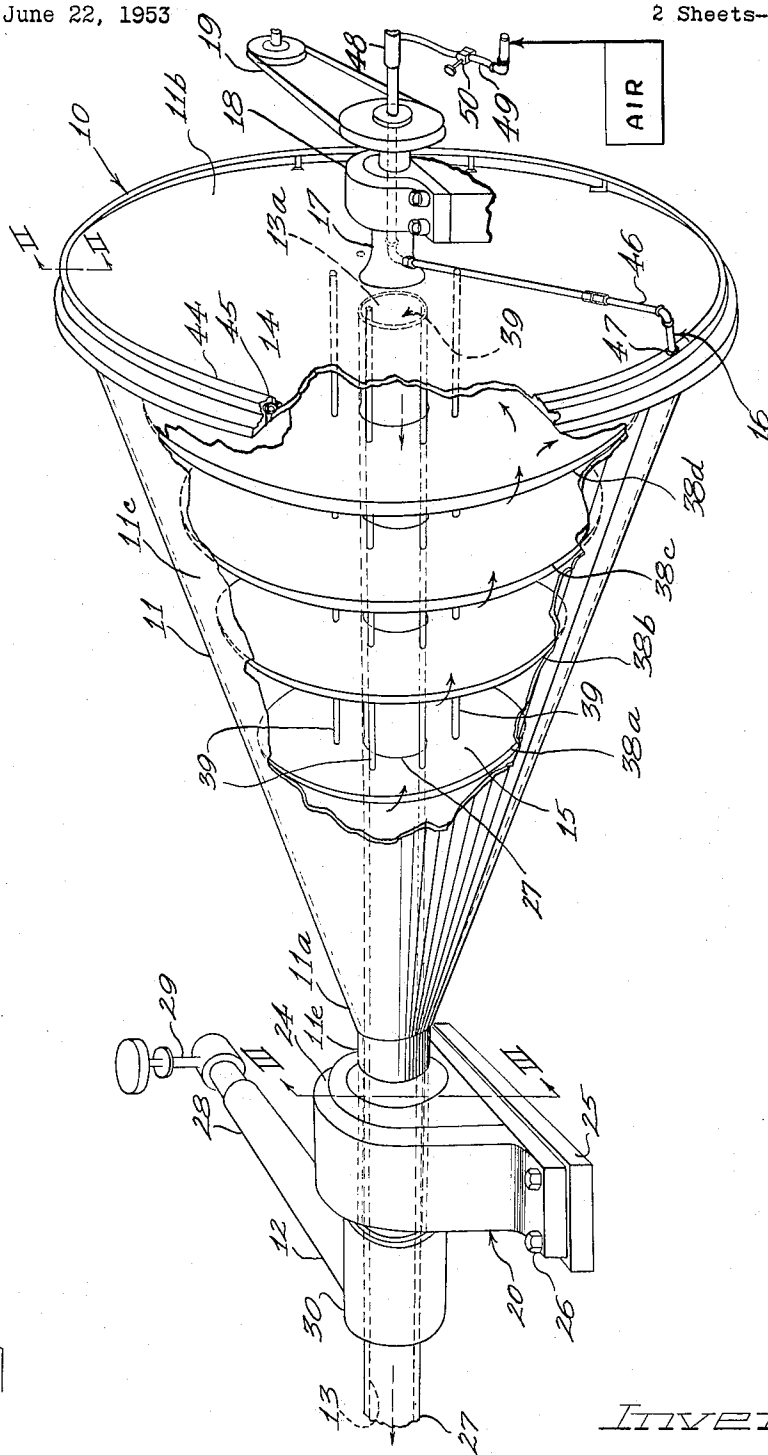


Fig. 1

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Fig. 1

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Fig 2

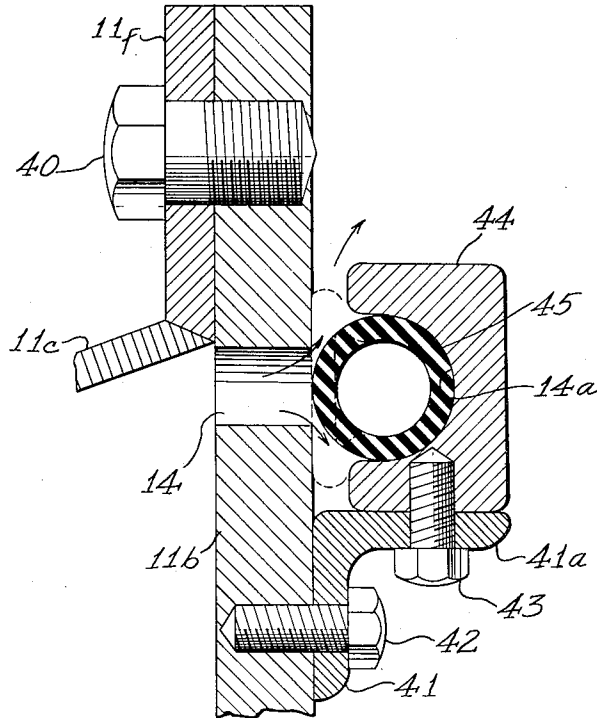
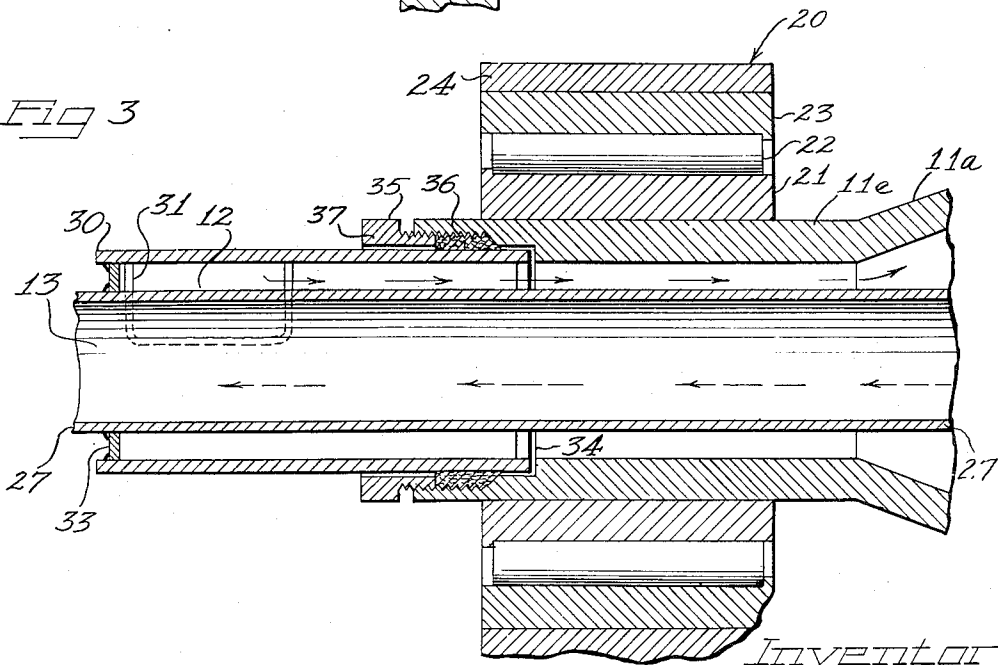


Fig 3



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SEPARATOR-PUMPING

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This invention relates to the pumping of fluids and the centrifugal separation of heavier impurities therefrom, and more particularly, to a method of and apparatus for pumping paper machine stock and centrifugally separating heavier impurities therefrom.

As is well known in the art, the presence of an appreciable amount of even very small particles of impurities in the paper stock may be harmful in the paper machine operation for a number of reasons, including interference with the pumps and the like used in transporting the stock from one point to another in a paper machine and the formation of defects in the web itself on the forming wire, or during subsequent dewatering operations. In view of the great variety of possible sources of impurities in the stock, these impurities include such materials as metal scrap and particles of inorganic materials such as sand. The present invention is concerned principally with the removal of those impurities which are heavier than the fluid medium in which they are borne. Such impurities in paper machine stock include the aforementioned metal particles and inorganic particles. It will appear from the following disclosure, however, that the instant apparatus and method might be used for the separation of impurities which are lighter than the fluid medium, and such an operation would require relatively minor alterations in view of the teachings here embodied.

In the operation of paper machines heretofore, two general methods of removing impurities were employed. In general, the devices used for removing such impurities were positioned at the discharge of the fan pump and prior to the stock inlet to the head box. One type of device used is a screen, which may be used to screen out particles larger than a predetermined minimum particle size which would pass through the screen. The screens, of course, ultimately accumulate a sufficient amount of impurities so that the screens resist the passage of stock therethrough and must be removed and cleaned before being reinstalled.

Another type of device used for removing impurities from paper stock is generally referred to as the "Vortrap" which employs the general principles of the centrifuge. In the "Vortrap" operation, the stock is pumped at a high rate of speed through a helically wound pipe in a downward direction so as to cause swirling or centrifugal motion in the stock, and the stock is released from the pipe into a chamber, wherein the impurities are urged against the wall and the impurity-free stock rises upwardly through the center of the chamber leaving the impurities behind. It will, of course, be appreciated that the rate of flow at which the stock is pumped into such a device must be very high, and the frictional losses are also very high, so that the rate of flow of stock departing from such a device is substantially reduced and additional pumping may be necessary. Also, by their very nature such devices can accommodate only a relatively small volume of stock flow and large batteries of these devices must be used in parallel in order to accommodate an

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appreciable amount of stock flow during the paper machine operation.

The instant invention provides a combination fluid pump and centrifuge, which not only separates heavier impurities from the stock or the like fluid by the use of centrifugal force, but also pumps the fluid by the use of centrifugal force, the necessary energy for imparting centrifugal force to the fluid for accomplishing both purposes being furnished by the rotation of a single rotating device.

It is, therefore, an important object of my invention to provide an improved apparatus for and method of pumping fluid and centrifugally separating heavier impurities therefrom.

It is another object of my invention to provide a fluid pump and centrifuge comprising a casing, means defining an axial fluid inlet at one end of said casing, means defining an axial fluid outlet for said casing separate and apart from said axial inlet, means defining a second fluid outlet at the end opposite the inlet end of the casing and radially outward from the axial outlet, rotating means within the casing imparting centrifugal force to fluid in the casing to urge the fluid toward the outlets, and draw-off means cooperating with said second outlet to selectively permit and prevent fluid flow therethrough.

It is a further object of my invention to provide an improved method of pumping fluid and centrifugally separating heavier impurities therefrom, which comprises swirling impurity-bearing fluid into a diverging annular stream having fast enough centrifugal speed to force the impurities outwardly and along the outer surface of the diverging stream, withdrawing impurity-free fluid from the inner side of the divergent annular stream and releasing centrifugally urged impurity-rich fluid from the outer side of the divergent annular stream intermittently to maintain a predetermined minimum amount of impurities in the outer portion of the stream.

Other objects, features and advantages of my invention will become apparent to those skilled in the art from the detailed description of a preferred embodiment thereof and the drawings illustrating such preferred embodiment.

On the drawings:

Figure 1 is a view in perspective of a separator-pump embodying my invention, with parts shown in section and parts broken away;

Figure 2 is a sectional elevational detail view of the periphery of the separator-pump base, taken substantially along the line II—II of Figure 1; and

Figure 3 is a sectional elevational detail view of the bearing assembly at the left hand side of Figure 1, taken substantially along the line III—III of Figure 1.

As shown on the drawings:

The reference numeral 10 indicates generally a fluid pump and centrifuge comprising a generally conically shaped casing 11, means 12 defining an axial fluid inlet near the casing apex 11a (Figure 3), means 13 defining an axial fluid outlet for the casing 11, means 14 defining a second fluid outlet at the end 11b opposite the inlet or apex end 11a of the casing 11 and radially outward from the axial outlet 13 (Figure 2), rotating means 15 within the casing 11 for imparting centrifugal force to fluid in the casing 11 to urge the fluid toward the outlets 13 and 14, and draw-off or valve means indicated generally at 16 cooperating with the second fluid outlet 14 to selectively permit and prevent fluid flow therethrough. Each of such means and/or elements will now be discussed in detail.

The casing 11 is a generally hollow conically shaped body that is rotatable about its conical axis, and this body comprises conical walls 11c which taper in one direction

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toward the conical apex approximately at 11a and diverge in the opposite direction to engage the conical base 11b. The conical base 11b has a central hub 17 suitably affixed to the outer surface of the base 11b, as by welding, and the hub 17 is suitably journaled in a bearing assembly 18 (shown in reduced size in Figure 1 for the purpose of simplifying the view) which suitably supports the base end of the casing 11 for rotation about its axis. Suitable drive means 19 (such as the belt and pulley means here shown) are connected to the hub member 17 and to a suitable driving source (not shown) to drivably rotate the hub 17 and the casing 11.

Referring now to Figure 3, it will be seen that the apex end 11a of the housing 11 has an axial sleeve or projection 11e extending outwardly therefrom and suitably journaled in the bearing assembly designated generally by the reference numeral 20. The bearing assembly 20 comprises an inner race 21 corotatably mounted of the sleeve portion 11e, rotating bearing members 22 which are interposed between the inner race 21 and an outer race 23, and the bearing housing 24 (shown only partially in Figure 3) which encloses the bearing members 21, 22 and 23 in the usual manner. The bearing housing 24 is, of course, mounted in the usual manner upon a suitable pedestal 25, for example, by means of bolts 26, and this bearing assembly 20 thereby supports the apex end of the casing 11 for rotation.

As shown best at Figure 3, a hollow shaft 27 extends axially through the sleeve member 11e and the apex end 11a into the casing 11, and this hollow shaft 27 extends substantially throughout the height of the conical casing 11 to close proximity with the base 11b of the casing 11. As previously indicated, the shaft 27 is provided with a hollow bore 13 which provides a fluid outlet 13a closely adjacent to the casing base 11b. The fluid flows into the outlet 13a and through the hollow bore 13 out the apex end 11a of the casing 11.

The fluid inlet means 12 provided for the casing 11 consist in an inlet pipe 28 having a suitable control valve 29 therein, which pipe 28 communicates with a T-fitting 30, at the opening 31 (Figure 3). As will be seen in Figure 3, the T-fitting 30 axially receives the hollow pipe 27 and is sealingly engaged thereto by means of the annulus 33 welded to the pipe members 27 and 30 at one end of the T 30. At the opposite end of the T-fitting 30 is a spider 34 which effectively supports and braces the pipe members 27 and 30 and permits fluid flow into the casing 11 surrounding of the hollow pipe 27 as indicated by the solid line arrows in Figure 3.

As will be appreciated, the pipe members 27 and 30 are mounted for relative rotation with respect to the casing 11, or in other words, the pipe members 27 and 30 are held against rotation while the casing 11 is rotated. In order to effect a suitable fluid seal between the T-fitting 30 and the casing sleeve 11e a packing gland assembly 35 is provided comprising the packing 36, and an annular packing ring 37 threadedly engaging casing sleeve 11e for suitably compressing the packing 36 to cause rotary and sealing engagement with the T-fitting 30.

The casing 11 has corotatably mounted therein a plurality of disc-shaped members 38a, 39b, 38c and 38d, which are actually annular members of increasing size to correspond with the increasing divergence of the conical casing walls 11c and which rotate in close running relation with the hollow shaft 27 which extends axially there-through. A plurality of mounting rods 39 extend from the casing base 11b in parallel alignment with the axis through the disc members 38, and these rods 39 are secured to the base 11b and the disc members 38, as by welding, so as to corotatably support the disc members 38 in the casing 11. The disc members 38 serve a dual function of urging the fluid entering the casing 11 outwardly against the inside of the casing walls 11c (since the disc members 38 are spaced from the casing wall 11c,

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although in close proximity to such casing wall 11c) and imparting centrifugal force to the fluid in the casing 11. The rods 39 and the inside of the casing walls 11c also cooperate with the discs 38 to impart centrifugal force to the fluid within the casing. It will thus be seen that by rotating the casing 11, containing fluid therein, the discs 38, rods 39 and the casing walls 11c (by frictional drag) all serve to impart centrifugal force to the fluid within the casing; and the discs 38 serve as baffles to prevent fluid flow along the axis of the casing, so that the fluid is forced outwardly against the casing walls 11c and by virtue of the divergence of the casing walls 11c the fluid is forced therealong in the direction of the casing base 11b. Any heavier materials or impurities in the fluid during this operation are, of course, constantly forced to the closest proximity to the casing walls 11c whereas the impurity-free fluid will serve to fill the remaining volume of the casing 11. Also such fluid, whether near the periphery of the casing base 11b or near the center thereof, is subjected to the pumping pressure generated by the centrifugal force which has been imparted to the fluid; and this pumping pressure urges the substantially impurity-free fluid near the central portion of the casing base 11b into the opening 13a in the hollow shaft 27. This opening 13a is thus an axial fluid outlet for the instant casing 11, and the fluid entering this outlet 13a is under the pumping pressure generated through the centrifugal pumping action of the instant device, so that this fluid flows through the hollow pipe 27 at substantially the flow rate imparted thereto by the centrifugal pumping action of the rotating casing 11. The fluid flowing through the hollow pipe 27 is, of course, substantially impurity-free, since the heavy impurities are urged by centrifugal force against the peripheral portion of the base 11b and the centrifugal force causes such heavy impurities to remain at this location while substantially impurity-free fluid is forced inwardly toward the center of the casing base 11b and then out through the hollow pipe 27.

In order to remove or otherwise dispose of the heavy impurities which are collected at the extreme peripheral portion of the base 11b, a plurality of openings 14 are provided in the base 11b at the extreme peripheral portion thereof (Figure 2). These openings 14 thus define a second fluid outlet at the base end of the casing 11 which outlet is radially outward from the axial outlet 13a. Referring to the details of Figure 2, it will be seen that the casing base 11b is suitably bolted to the conical casing walls 11c by means of a flange member 11f suitably affixed to the walls 11c (as by welding) and suitably bolted to the casing base 11b, as by the bolt 40 threadedly engaging the base 11b. Also affixed to the base 11b is a peripherally aligned bracket 41 suitably affixed to the base 11b by means of bolts 42 threadedly engaging the base 11b. The bracket 41 provides a peripheral shell or flange 41a which is radially inward but in close proximity to the outlet openings 14, and which has suitably mounted thereon by means of bolts 43 an annular member 44 presenting a groove 44a which faces the openings 14. Seated in the groove 44a is a resilient elastomer tube 45. The tube 45 is a pneumatic (or other type of fluid actuated tube) which assumes the position shown in Figure 2 at reduced pressure, so as to permit the flow of fluid thereby (as indicated by the arrows) for the purpose of purging the gathered impurities located at the peripheral openings 14. When the openings 14 are "unblocked" as by the contraction of the tube 45 to the position shown in Figure 2, the centrifugally urged fluid in the casing 11 rushes through the openings 14 and flushes the impurities collected therein out of the casing 11. When the tube 45 is subjected to high fluid pressure and caused to expand thereby, the tube 45 assumes the position shown in light dotted lines in Figure 2 and thereby blocks off completely the openings 14. By this arrangement it is possible to purge the impurities through

the openings 14 whenever desired, but it is not necessary to continuously cause the flow of fluid through the openings 14. In addition, the resilient nature of the tube 45 permits this tube to function effectively in blocking off the openings 14, even though small particles or impurities may not have completely been purged from the mouths of the openings 14.

In operating the pneumatic tube 45, a suitable air line 46 (Figure 1) is connected to the tube 45 at 47 and extends radially inwardly to the hub 17 and then outwardly through a central bore in the hub 17 to a universal joint 48, so that this section 46 of the air line may rotate continuously with the casing 11. A non-rotating portion 49 of the air line with a suitable control valve 50 communicates with the air line 46 through the universal joint 48 and also communicates with a source of air under pressure. By actuation of the control valve 50 it is possible to increase or decrease the air pressure within the tube 45 and correspondingly cause opening or blocking of the outlet openings 14, when such is desired.

It will thus be seen that with maximum air pressure on the tube 45 the peripheral outlet 14 is closed, and the rotating casing 11 effectively receives fluid through the axial inlet 12, over the peripheral edges of the discs 38 and down along the conical casing walls 11c to the casing base 11b, whereat impurity-rich fluid is centrifugally urged and retained at the extreme peripheral portion of the base 11b and impurity-free fluid being lighter is driven inwardly and into the axial outlet 13a, whereupon the impurity-free fluid is urged by the pumping force of the device out through the hollow pipe 27, as indicated by the dotted line arrows. Whenever it is desired to purge collected impurities at the extreme peripheral portion of the base 11b, the air pressure at the control valve 50 is reduced and the tube 45 collapses or contracts sufficiently to permit the flow of fluid through the peripheral openings 14, so that a predetermined minimum amount of impurities may be maintained in the extreme peripheral portion of the casing 11.

It will be understood that modifications and variations may be effected without departing from the scope of the novel concepts of the present invention.

I claim as my invention:

1. A fluid pump and centrifuge comprising a generally conically shaped casing, means defining a fluid inlet near the casing apex, a hollow shaft defining an axial fluid outlet near the casing base, means defining a second fluid outlet at the periphery of the casing base, means rotatable relative to said shaft within the casing imparting centrifugal force to fluid in the casing to urge the fluid toward the outlets, and baffle means in said casing interposed between the inlet and said outlets for causing fluid flow therein along the casing walls and substantially preventing axially aligned fluid flow toward the casing base.

2. A fluid pump and centrifuge for separating heavier impurities from the fluid, comprising a casing, a shaft extending axially into said casing, said casing and said shaft being mounted for relative rotation, rotating means mounted within said casing to impart centrifugal force to fluid within the casing, means defining an axial inlet at one end of said casing surrounding said shaft, means defining an axial outlet for said casing at the end opposite said inlet end, and means defining a second outlet for said casing at the end opposite the inlet end and radially outward from said axial outlet said rotating means being positioned substantially entirely between said inlet and said outlets.

3. A fluid pump and centrifuge for separating heavier impurities from the fluid, comprising a casing, a shaft extending axially into said casing, said casing and said shaft being mounted for relative rotation, rotating means mounted within said casing to impart centrifugal force to fluid within the casing, means defining an axial inlet at one end of said casing surrounding said shaft, said

shaft having an axial bore extending from adjacent the end opposite the inlet end of the casing through the shaft and outside of the casing to provide an axial outlet for said casing, and means defining a second outlet for said casing at the end opposite the inlet end and radially outward from said axial outlet said rotating means being positioned substantially entirely between said inlet and said outlets.

4. A fluid pump and centrifuge for separating heavier impurities from the fluid, comprising a hollow shaft, a casing axially receiving said shaft and rotatably mounted thereon, means defining an axial inlet at one end of the casing, said hollow shaft terminating adjacent the end opposite said casing inlet end to provide an axial outlet for the casing, centrifugal pumping means corotatably mounted in said casing for imparting centrifugal force to the fluid therein, and means defining a second outlet for said casing at the end opposite the inlet end and radially outward from said axial outlet.

5. A fluid pump and centrifuge comprising a conically shaped casing mounted for rotation about its conical axis, a plurality of axially spaced disk-shaped baffles corotatably mounted with said casing and extending radially to close proximity with the casing inside walls, means defining a fluid inlet near the casing apex, a hollow shaft extending axially into the apex and the casing to close proximity with the casing base to provide an axial outlet for the casing, and means defining a second fluid outlet at the periphery of the casing base.

6. A fluid pump and centrifuge comprising a conically shaped casing mounted for rotation about its conical axis, a hollow shaft extending axially into the apex end of the casing to close proximity with the casing base to provide an axial outlet for the casing, a plurality of axially spaced baffles corotatably mounted within said casing for close running relation to the shaft therein and extending radially to close proximity with the casing inside walls, means defining a fluid axial inlet surrounding the shaft at the casing apex, and means defining a second fluid outlet at the periphery of the casing base.

7. A fluid pump and centrifuge comprising a generally conically shaped casing, means defining a fluid inlet near the casing apex, means defining an axial fluid outlet near the casing base, means defining a second fluid outlet at the periphery of the casing base, rotating means within the casing imparting centrifugal force to fluid in the casing to urge the fluid toward the outlets, and a resilient elastomer tube seated adjacent said peripheral outlet and adapted to selectively open and block said outlet by respective contraction and expansion thereof.

8. A fluid pump and centrifuge comprising a generally conically shaped casing, means defining a fluid inlet near the casing apex, means defining an axial fluid outlet near the casing base, means defining a second fluid outlet at the periphery of the casing base, rotating means within the casing imparting centrifugal force to fluid in the casing to urge the fluid toward the outlets, an elastomeric pneumatic tube seated adjacent said peripheral outlet, and pneumatic pressure means connected to said tube for increasing and decreasing pressure therein selectively to block and open the peripheral outlet.

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