

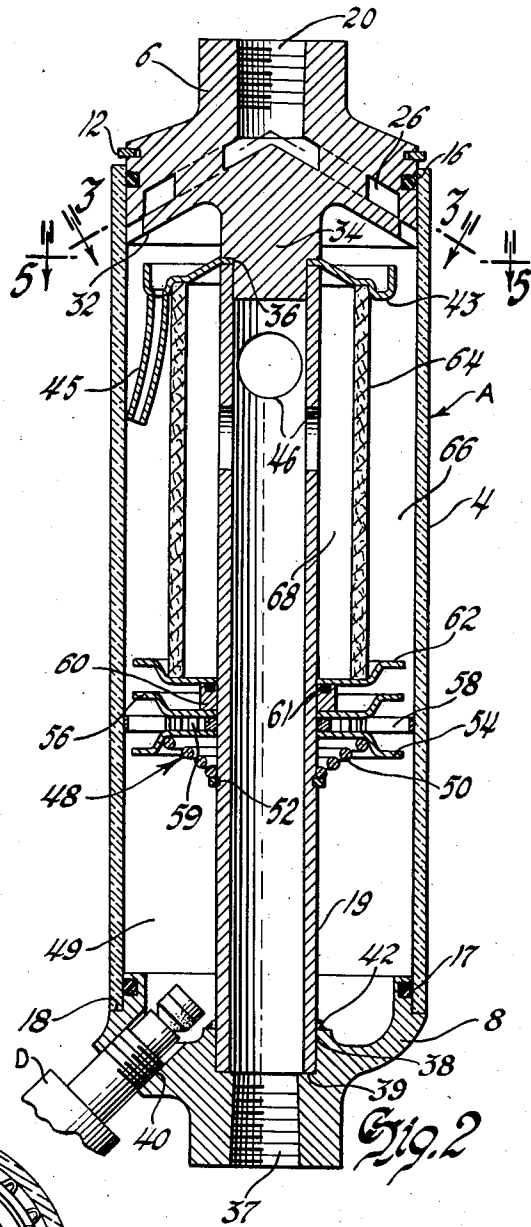
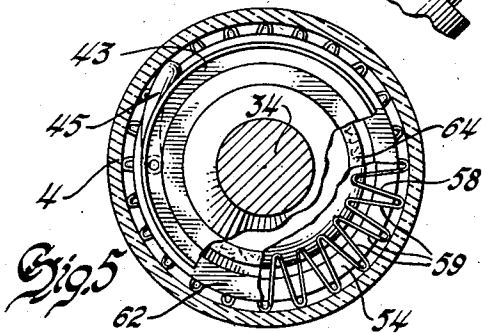
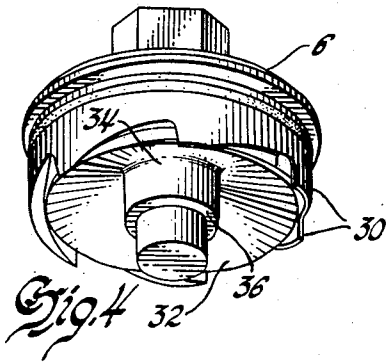
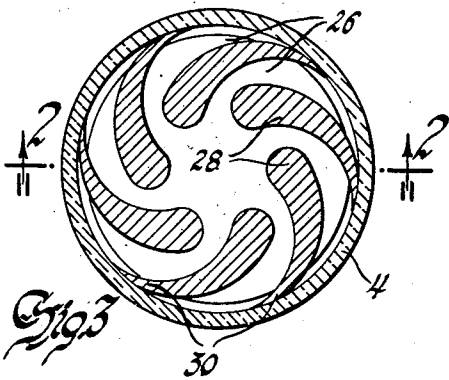
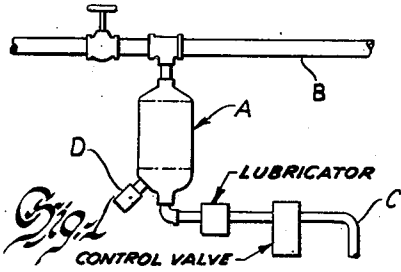
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FLUID CLEANER

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2,828,831

FLUID CLEANER

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This invention relates generally to a fluid cleaner and more particularly to a fluid cleaner having a centrifugal separating device or purger in combination with a fluid filter unit.

Fluid cleaning and separating devices are now known in the art which depend upon centrifugal force for effecting separation of suspended particles such as liquid and solid matter from fluids such as vapors or gases. In certain of such devices the particles separated from the fluid are discharged into the atmosphere through restricted openings in the walls of the device or through baffling into a sump chamber, while purged gaseous fluid is directed through a filter unit to the fluid discharge outlet of the device. The effectiveness of the centrifugal action in such cleaning and separating devices has been limited in the past to the particular range of fluid flow rates for which the unit has been designed. It has also been found that the effectiveness of the centrifugal action of such known cleaners has been dependent to a considerable extent upon whether the fluid flow is of a steady or a pulsating character. Filter elements associated with the purged discharge outlets of such known devices have produced a limited increase in the range of fluid flow rates at which such a unit might be safely and effectively used, but the use of such filter elements has been accompanied by an attendant undesirable pressure loss across the filter. This pressure loss requires a compensating increase in the pressure of the fluid before it enters the device. This necessitates the use of larger compressors or pumps and heavier pressure fluid mains, and results in higher operating expenses.

Further objection to the use of filter units in such devices has resulted from their tendency to complicate the assembly process with a corresponding increase in the cost of manufacture; when the device is in its operational location the filter elements have tended to be inaccessible and difficult to clean; and their associated supporting structures have also tended to make other elements of such a device inaccessible and difficult to clean.

Further objection has been found to known cleaning and separating devices of this type in that they are generally unsuitable for closed high pressure fluid systems. Operating in such a system, the incoming fluid is subjected to excessive turbulence and pressure loss within the unit. Such turbulence results in the re-entrainment of the previously separated particles within the purged fluid moving toward the filter and the outlet. Also, on account of the high rate of rotation imparted to the incoming fluid, finely suspended particles are carried radially inwardly by the resulting vortex action of the fluid and deposited on the surfaces of the unit adjacent to and radially inwardly of the discharge openings of the fluid inlet passages. Particles collected at this point tend to contaminate or block the filter unit or, in the absence of a filter unit, tend to become re-entrained in the outlet fluid.

The primary object of this invention is to provide an improved purger of the general type described above

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having a filter element therein, which will have effective centrifugal separation at all rates of fluid flow, whether steady or pulsating, and which will be effective at relatively high pressures and under abnormal operating conditions. This object is attained by providing such a device which has a receiving chamber, defined between the inner surface of a casing member and a filter element, into which an improved centrifuging inlet nozzle directs the incoming fluid smoothly and tangentially against the inner surface of the casing member, imparting both radial and axial velocity components to the fluid with a minimum of turbulence and pressure loss whereby the suspended particles are directed toward the inner surface of the casing member and pass axially into a sump chamber through a baffle assembly having surfaces for controlling both the rotational and axial components of fluid motion within the sump chamber while the purged fluid flows through the filter to the outlet of the device.

Another object of this invention is to provide a fluid cleaner of the general type described above which is relatively simple to assemble and disassemble and which has a removable outer casing member arranged in telescopic relation to the other elements of the unit whereby such other elements are readily accessible for cleaning purposes.

A further object of this invention is to provide a fluid cleaner and separating device in which the aforesaid baffle comprises axially extending openings located at a point spaced axially from the inlet nozzle and a series of blade members arranged in spaced parallel relation to each other and perpendicular to the axially extending openings.

Another object of this invention is to provide a fluid cleaner and separating device in which a baffling and collecting member is located within the casing intermediate the inlet and the aforesaid receiving chamber for the collection of suspended particles which are drawn upward from the nozzle by the vortex action of the whirling mass of fluid.

Other objects and advantages of this invention will become apparent from the following description of a preferred embodiment, having reference to the drawing, in which:

Figure 1 shows a typical application of the device of this invention in the fluid pressure delivery line for a device such as a pressure tool.

Figure 2 is a longitudinal cross sectional view of the device, the plane of the section being represented by the line 2—2 of Figure 3.

Figure 3 is a transverse cross sectional view taken substantially on the line 3—3 of Figure 2.

Figure 4 is a perspective view of the inlet nozzle shown removed from the device.

Figure 5 is a cross sectional view taken substantially on the line 5—5 of Figure 2, with parts broken away to show details of the baffle assembly.

Referring now more particularly to the drawing, Figures 2 to 5 show a fluid cleaner and separating device constructed in accordance with this invention comprising a generally cylindrical casing composed of a tubular sleeve member 4; a head or end member 6 telescopically fitting within the upper end of the sleeve and a lower head or end member 8 similarly fitting within the lower end of said sleeve. The upper end member is in the form of an integral casting having a circumferential groove for a retaining ring 12 and a second circumferential groove for a sealing ring 16 which constitutes a pressure seal between the sleeve 4 and the head 6. A similar pressure sealing ring 17 is interposed between the lower end of the sleeve 4 and the lower end member 8. The sleeve 4 at its lower end abuts against a shoulder 18 formed on the outer periphery of the lower end member 8 and is retained in position thereon by the action of retaining

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ring 12 in conjunction with a longitudinally extending internal tube 19 which interconnects and secures the two end members in spaced relation.

The upper head or end member 6 constitutes an inlet nozzle for the device and has an inlet passage 20 adapted to be attached to a fluid pressure conduit at its outer end and connecting within the head to a plurality of helical nozzle passages 26. The helical passages 26 are formed integrally with the head or end member 6 between cast-in vanes or blades 28. The outer tips 30 of these blades are in contact with the inner surface of the sleeve 4 and are tapered as best shown by Figures 3 and 4 to provide a smooth and uninterrupted surface for the tangential and axial flow of the entering fluid from the blades directly to the inner surface of the sleeve. Such a design imparts a high rate of rotation to the incoming fluid with a minimum of turbulence and pressure loss, and is unique in that the solids and water separated from the incoming fluid by the changes in fluid direction occurring within the nozzle are transferred directly to the inner surfaces of the sleeve. By this design effective centrifugal action is achieved at all fluid flow rates and is equally effective whether the fluid flow is of a steady or pulsating character.

The under surface of the upper end member 6 is in the form of a frusto-conical depression 32 from which a center boss 34 protrudes. The center boss 34 is formed with an annular shoulder 36 thereon. The upper end member 6 is secured to the upper end of the tube 19 by a telescopic press fit between the tube and boss 34. A baffle and collecting tray 43 having a center perforation in concentric relation with the boss 34 is interposed between the shoulder 36 of the boss and the end of the tube. The outer periphery of the tray 43 is in the form of an upwardly extending annular lip which is adjacent to but slightly spaced axially and radially inwardly of discharge openings of helical passages 26. The tray 43 serves to collect solid and liquid particles carried radially inwardly from the nozzle openings by the vortex action of the swirling fluid and deposited on the under surface of the head member 6. One or more spirally depending outlet tubes 45 (only one shown) serves to drain the solid and liquid particles collected on the tray to the inner surface of the sleeve 4 in the tangential and axial direction of the rotating fluid mass.

The lower end member 8 has a center outlet opening 37 which is adapted to be connected to the discharge conduit leading from the device and may have a second opening 40 located to one side thereof adapted for the mounting of sediment discharge valve D. Tube 19 abuts at its lower end against a shoulder 39 formed by an enlargement 38 of the center opening 37 and is secured to the lower end member 8 as by welding as shown at 42.

One or more openings 46 in the upper end of the tube 19 immediately adjacent to the center boss 34 form a passage for fluid from the interior of the casing 2 to the center discharge outlet 37 on the lower member.

As shown in Figure 2, a baffle assembly 48 is mounted on the tube 19 intermediate its ends by a spiral spring 50 interposed between a snap ring 52 engaging a peripheral groove on the tube and a lower downwardly-presenting dish-shaped horizontal baffle plate 54. Interposed between this lower baffle plate and an upwardly-presenting similarly dished intermediate baffle plate 56 is a vertical baffle which, as best shown in Figure 5, may consist of an annular corrugated member 58 forming a series of vertical deflector blades 59. However, this vertical baffle 58 may alternatively be formed as a plate with wide slots in its outer edge having a gear-like appearance or a disk with vertical fins on its outer edge having the appearance of a paddle-wheel or the like. In the design of the vertical baffle, the correct number of blades, for a particular axial depth of blade is more significant than the specific form in which blades are constructed. An annular spacer element 60 is mounted

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concentrically with the tube 19 and is interposed between the intermediate horizontal baffle plate 56 and a third upwardly-presenting dished horizontal baffle plate 62. The spacer member 60 may be provided with a seal 61 facing the latter baffle plate 62. While the vertical baffle member 58 serves as a vertical spacer element between the intermediate and lower horizontal baffle plates, an additional spacer element similar to 60, as shown in Figure 2, may alternatively be used for this purpose thereby facilitating removal of the vertical baffle 58, when necessary, without disturbing the horizontal baffle plates. The baffle assembly 48 divides the casing into an upper centrifuging and filtering chamber and a lower sump chamber 49 which is concentric about the tube 19.

It will be noted that the outer tips of the vertical deflector blades 59 are in contact with the inner surface of the sleeve 4. The outer peripheries of the horizontal baffle plates 54, 56 and 62 are in spaced relation to the inner surfaces of the sleeve 4, defining a restricted passage into the sump chamber and direct the rotating fluid and separated solid and liquid particles to the outer tips of the vertical deflector blades 59.

The upper horizontal baffle plate 62 serves as the lower mounting for an annular filter element 64 which is mounted in concentric relation with the sleeve 4 and the tube 19. The filter element is supported at its upper end by the upper tray 43. The filter 64, in conjunction with the inner surface of the sleeve 4, defines a fluid receiving chamber 66 for the rapidly rotating fluid entering the device. In conjunction with the tube 19, the tray 43 and the baffle plate 62, the filter element 64 defines a filter fluid chamber 68 which is in communication through the openings 46 in the tube 19 to the outlet 37 of the device.

As shown by Figure 1, in a typical application, the fluid cleaner and separating device of this invention represented by the letter A is connected to a pressure fluid main B and discharges purged fluid into a pressure fluid delivery line C leading to a pressure-operated device (not shown) such as a pressure tool. Figure 1 also shows a lubricator and control valve for the pressure device located in the delivery line C and in series with the fluid cleaner and separating device. A sediment discharge valve D, which may be automatically controlled by some condition such as the operation of the pressure device, is shown connected to the sump chamber of the device but does not constitute a part of this invention. Since such valves are generally old in the art, a detailed description explaining the construction and operation of such a valve is not given.

In operation, a pressurized fluid such as compressed air enters the device A through the inlet 20 and in passing through the helical nozzle passages 26 is caused to rotate against the inner surface of the sleeve 4. The nozzle passages are so designed as to produce a high rate of rotation in the fluid mass with a minimum of turbulence and pressure loss. The rotation imparts both radial and axial components to the fluid whereby suspended particles are transferred directly to the inner surface of the casing member and pass axially into the sump chamber 49 through the baffle assembly 48. The purged fluid passes through the filter 64, which filters out the fines (dust) that are not removed from the fluid by centrifugal action, and thence to the outlet 37 through the openings 46 and the tube 19.

In addition to its function of collecting fine suspended solids not removed by the centrifugal action, the filter unit 64 in defining a receiving chamber 66 for the incoming rotating air mass has been found to reduce the pressure drop across the air filter approximately 50% by inducing a more laminar air flow throughout the rotating fluid mass. The filter 64 also serves as a protective device under abnormal operating conditions, particularly in the event separated liquids flood the sump. The element will then strain out all suspended solids and permit only

the passage of clean gases and liquids to the filtered fluid chamber 68. The height of the openings 46 will generally prevent the separated liquids from being drawn into the outlet passage.

Under certain operating conditions a small amount of separated liquid and solid particles will flow across the frusto-conical bottom surface 32 of the upper head 6, down the center boss 34, and into the baffle and collecting tray 43. This phenomenon is caused by the vortex action of the swirling fluid. The matter collecting in the tray will then be drained from the tray through the tubes 45 by gravity and aspirating action to the inner surface of the sleeve 4. The outlet end of the tube 45 is positioned in the fluid stream at a point where maximum aspirating suction will be obtained. Under such operating conditions the baffling and collecting tray 43, in addition to its function as an upper support for the filter unit, prevents the deposit of particles separated by the vortex action of the rotating fluid mass on the filter element. The design of the tray 43 also serves to restrict the initial rotation of the fluid mass to a space immediately adjacent the inner surface of the sleeve.

The baffle assembly 48 protects the liquid and solids accumulated in the sump chamber 49 from agitation by fluid circulating about the filter element 64 and their consequent re-entrainment with the purged fluid in the receiving chamber 66 which would result from such agitation. The vertical baffle 58 provides the bulk of the protection by controlling the rotational fluid currents within the sump. Fluid spiralling downward through the baffle assembly is reflected off the vertical deflector blades 59. Only vertical circulation of fluid should be permitted through the deflector blades and these fluid currents assist in moving collected liquid and solid impurities through the baffle assembly and into the sump chamber.

The spaces between the vertical deflector blades 59 and the axial depth of these blades will determine the nature of fluid flow in the sump; the fluid flow in the sump can be made to circulate in the same direction or in the opposite direction to that above the sump by varying the depth of the blades providing the number and shape of the blades are not changed. The correct depth is obtained when fluid does not circulate in either direction within the sump chamber. It has been found that this ratio of blade spacing to axial depth should be about 1:1 for the illustrated embodiment.

The horizontal baffle plates 54, 56 and 62 control the magnitude of the vertical movement of fluid into and within the sump chamber 49. Generally the less the baffling the greater the air circulation within the sump. The baffles and deflector as shown in the drawing protect the liquids and solids in the sump to the extent that the surface of the liquids or solids is scarcely disturbed during normal operations.

Control of the fluid currents within the sump permits this entire space to be used efficiently for the storage of separated liquids and solids. Generally the sump can be allowed to fill completely with separated liquids before splashing over the top baffle. However, due to the design of the nozzle head 6 and the arrangement of the upper baffle and collecting tray 44, the filter 64 and the receiving chamber 66, as defined by the filter and the sleeve 4, the ability to operate with the sump completely filled with separated liquid is not noticeably affected by high fluid demand on the device.

It will be noted that due to the design of the device the various elements within the casing are readily accessible without removal of the device from its inline position. Removal of the retaining ring 12 from its groove in the upper head 6 permits the sleeve 4 to be slid upwardly exposing these elements for the purpose of inspection and cleansing.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and

materials, as well as in the details of the illustrated construction may be made within the scope of the appended claims, without departing from the spirit of the invention.

We claim:

1. A fluid filter and separating device including a cylindrical casing, means at one end of said casing for introducing fluid smoothly against the inner surface of said casing in an axial and tangential direction thereby producing a laminar swirling motion in said fluid, a sump within said casing for the collection of free water and other impurities centrifuged from the unfiltered fluid, a baffle and collecting means adjacent to and spaced axially of said first means, said baffle and collecting means being spacedly embraced by the inner surface of said casing and adapted to collect particles of water and other impurities carried inwardly of the casing from said first means due to the vortex action of the swirling motion of said fluid, a discharge conduit extending coaxially of said casing and having an outlet for filtered fluid in spaced axial relation to said first means and said collecting means, a filter element interposed between said first means and said discharged outlet, said filter element being in spaced concentric relation to the inner surface of said casing and said conduit and defining fluid receiving chambers therebetween, means for conducting said impurities from said collecting means into a portion of said chamber adjacent the inner surface of said casing, and a baffle means separating said chamber and said sump, said baffle means having components tending to eliminate both rotative and axial fluid flow within the sump.

2. A fluid filtering and separating device including an upright tubular casing, inlet passages at the upper end of said casing for introducing unfiltered fluid tangentially and downwardly against the inner surface of said casing thereby imparting axial and rotative motion to the fluid, baffle means mounted intermediate the ends of said casing for arresting the axial and rotative motion of the fluid, said baffle means dividing said casing into an upper chamber and a lower sump chamber for centrifuged impurities and undesired fluids, discharge means for filtered fluid located axially within said upper chamber, a tubular filter element in said upper chamber interposed between the inner tubular surface of said casing and said discharge means, and a baffle and collecting means located above said filter and adjacent the inlet passages for the collection of impurities carried radially inwardly and upwardly by the vortex action of the rotating fluid in entering the casing.

3. A fluid cleaner comprising an upright cylindrical casing, a head telescopically and slidably supporting the upper end of said casing and sealed with respect thereto, said head having a central inlet passage opening into a plurality of downwardly and outwardly directed helical passages formed integrally within said head and opening within said casing adjacent the inner surface of said casing, said passages being adapted to introduce unfiltered fluid directly and smoothly to the inner surface of said casing and for imparting an axially laminar centrifuging motion said fluid, a second head telescopically and slidably supporting the lower end of said casing and sealed with respect thereto, said second head having a discharge outlet for filtered fluid and a discharge opening for the discharge of impurities centrifuged from the inlet fluid, a tubular member extending concentrically within the casing, said tubular member forming an interconnecting support for said heads and providing a discharge passage to said outlet for the filtered fluid, said tubular member having an opening adjacent the upper end of the casing for the inlet of filtered fluid, baffle means mounted on said tubular member intermediate its ends and dividing the casing into an upper chamber and a lower sump chamber, and a filter element mounted within the upper chamber intermediate said tubular member and the casing and supported by the baffle means and said first named head.

4. A fluid cleaner comprising an upright cylindrical casing having a plurality of downwardly and outwardly directed helical inlet passages formed in the upper end of said casing for introducing unfiltered fluid directly and smoothly to the inner surface of said casing and for imparting laminar centrifuging motion to said fluid axially of said casing, the lower end of said casing having a discharge opening for filtered fluid and a second discharge opening for the discharge of impurities purged from the inlet fluid, a tubular member concentric with the casing and projecting into the filtered fluid discharge opening in sealed relation thereto at its lower end, said tubular member having an opening adjacent the upper end of the casing for the entry of filtered fluid into the tubular member, baffle means mounted intermediate the ends of the casing dividing the casing into an upper centrifuging and filtering chamber and a lower sump chamber, said baffle means comprising at least two horizontal dish-shaped baffle plates in spaced relation to each other and to the inner surface of the casing and a plurality of radially extending vertical blades in contact with the inner surface of the casing and in spaced relation to the peripheries of said plates, a baffle and collecting tray mounted centrally of and adjacent to said plurality of inlet passages, and a filter element mounted within the upper centrifuging chamber intermediate the tubular member and the casing through which fluid leaving the casing by way of said tubular member and outlet must pass, said filter element being supported by the uppermost dish-shaped baffle plate at its lower end and being supported by said collecting tray at its upper end.

5. A fluid cleaner and separating device including a cylindrical casing, a closure member telescopically and slidably mounted in each end of said casing and sealed with respect thereto, one of said closure members having an inlet passage formed therein and having a plurality of branch passages connected to said inlet passage, said branch passages terminating adjacent the inner surface of said casing and forming nozzles therewith for introducing fluid smoothly against the inner surface of said casing in an axial and tangential direction thereby producing laminar swirling of the fluid within said casing tending to centrifuge impurities against the inner surface of the casing, a first baffle means within said casing defining a sump chamber remote from the inlet end of said casing for the collection of impurities centrifuged from the swirling fluid, secondary baffle means mounted in spaced axial relation to said nozzles and defining a chamber adjacent the inlet end of said casing for the collection of impurities carried by the vortex action of the swirling fluid, and a discharge conduit extending coaxially within said casing and having a discharge opening for purged fluid intermediate said baffle means.

6. A fluid cleaner and separating device adapted to be mounted in a supply line of a fluid pressure system, said device including a cylindrical casing, a closure member telescopically and slidably mounted in each end of said casing and sealed with respect thereto, one of said closure members having a plurality of passages therein adapted to introduce fluid smoothly against the inner surface of said casing in an axial and tangential direction thereby producing a laminar swirling of the fluid within said casing tending to centrifuge impurities against the inner surface of the casing, means defining a sump chamber in the end of said casing remote from said one member for the collection of impurities centrifuged from the fluid, and a discharge conduit extending coaxially within said casing between said closure members and connectable to the discharge line of said system, said discharge conduit having an opening for purged fluid intermediate said one closure member and said sump chamber defining means, and said discharge conduit serving as a rigid support member between said closure members whereby said cylindrical casing may be slidably removed for in-

spection of the interior of said device without disturbing the remainder of said system.

7. A fluid cleaner and separating device including a cylindrical casing closed at each end to define a fluid receiving chamber, means at one end of said casing for introducing fluid into said chamber, said means including a plurality of passages opening circumferentially of said chamber immediately adjacent the inner cylindrical surface of said casing, the opening of each of said passages defining a smooth and uninterrupted surface with the inner cylindrical surface of said casing and being adapted to introduce fluid smoothly against the inner surface of said casing in an axial and tangential direction thereby producing a laminar swirling of the fluid within said chamber, sump means within said casing for the collection of free water and other impurities centrifuged from the fluid, baffle and collecting means adjacent said one end and spaced axially and radially inwardly of said passage openings for the collection of free water and other impurities carried inwardly of the casing from said passage means due to the vortex action of the swirling motion of said fluid, and a discharge conduit extending coaxially of said casing and having a discharge opening for purged fluid in axially spaced relation to said passage means and said collecting means.

8. A fluid cleaner comprising a cylindrical casing closed at each end to define a fluid receiving chamber, means at one end of said casing for introducing fluid into said casing so as to impart an axial and laminar swirling of the entering fluid against the inner surface of the casing, said means including a plurality of axially and outwardly directed helical inlet passages opening circumferentially of said chamber immediately adjacent the inner surface of said casing, said passages being separated and partially defined by a plurality of circumferentially spaced blades, the outer tip of each of said blades being in contact with the inner surface of said casing and providing a smooth and uninterrupted surface therewith for the laminar flow of entering fluid from the blade to the inner surface of said casing, sump means within said casing for collecting impurities purged from the entering fluid by the centrifugal action of the swirling fluid, and a conduit extending coaxially of said casing and having a discharge opening for purged fluid located in spaced relation to and intermediate said means.

9. A fluid cleaner comprising a cylindrical casing, means at one end of said casing for introducing fluid into said casing so as to impart an axial and laminar swirling movement of the fluid against the inner surface of the casing, said means including a plurality of axially and outwardly directed helical inlet passages opening circumferentially of and immediately adjacent the inner surface of said casing, said passages being partially defined by a plurality of circumferentially spaced blades therebetween, the outer tips of each of said blades being in contact with the inner surface of said casing and providing a smooth and uninterrupted surface therewith for the laminar flow of entering fluid from the blade to the inner surface of said casing, sump means within said casing for collecting impurities purged from the entering fluid by the centrifugal action of the swirling fluid, a conduit extending coaxially of said casing and having a discharge outlet for fluid located in intermediate spaced relation to said means, and a filter element within the casing through which fluid leaving the casing by the discharge outlet must pass, said filter element and said cylindrical casing defining a receiving chamber therebetween for the swirling entering fluid within which the heavier impurities are centrifuged to said sump without passing through the filter element.

10. A fluid cleaner comprising a cylindrical casing, means at one end of said casing for introducing fluid into said casing so as to impart an axial and laminar swirling movement of the fluid against the inner surface of the casing, said means including a plurality of axially and outwardly directed helical inlet passages opening circum-

ferentially of said chamber immediately adjacent the inner surface of said casing, said passages being partially defined by a plurality of circumferentially spaced blades therebetween, the outer tip of each of said blades being in contact with the inner surface of said casing and providing a smooth and uninterrupted surface therewith for the laminar flow of entering fluid from the blade to the inner surface of said casing, sump means within said casing for collecting impurities purged from the entering fluid by the centrifugal action of the swirling fluid, baffle means associated with said sump, said baffle means having vertical deflector blades restricting horizontal motion of fluid flowing into the sump, and a horizontal plate, the outer portion of said plate being in axially spaced relation to said vertical blades and restricting vertical motion of fluid flowing through said vertical blades into the sump, and a conduit extending coaxially within said casing and having a discharge opening for purged fluid located above said baffle means and spaced axially of said plurality of helical passages.

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