Oct. 3, 1967 R. C. DARNELL 3,344,927

PURIFIER

Filed Aug. 19, 1965 2 Sheets-Sheet 1

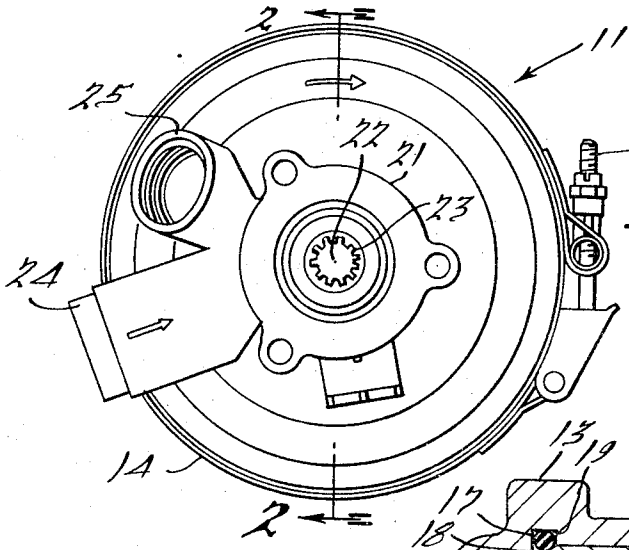


FIG. 1.

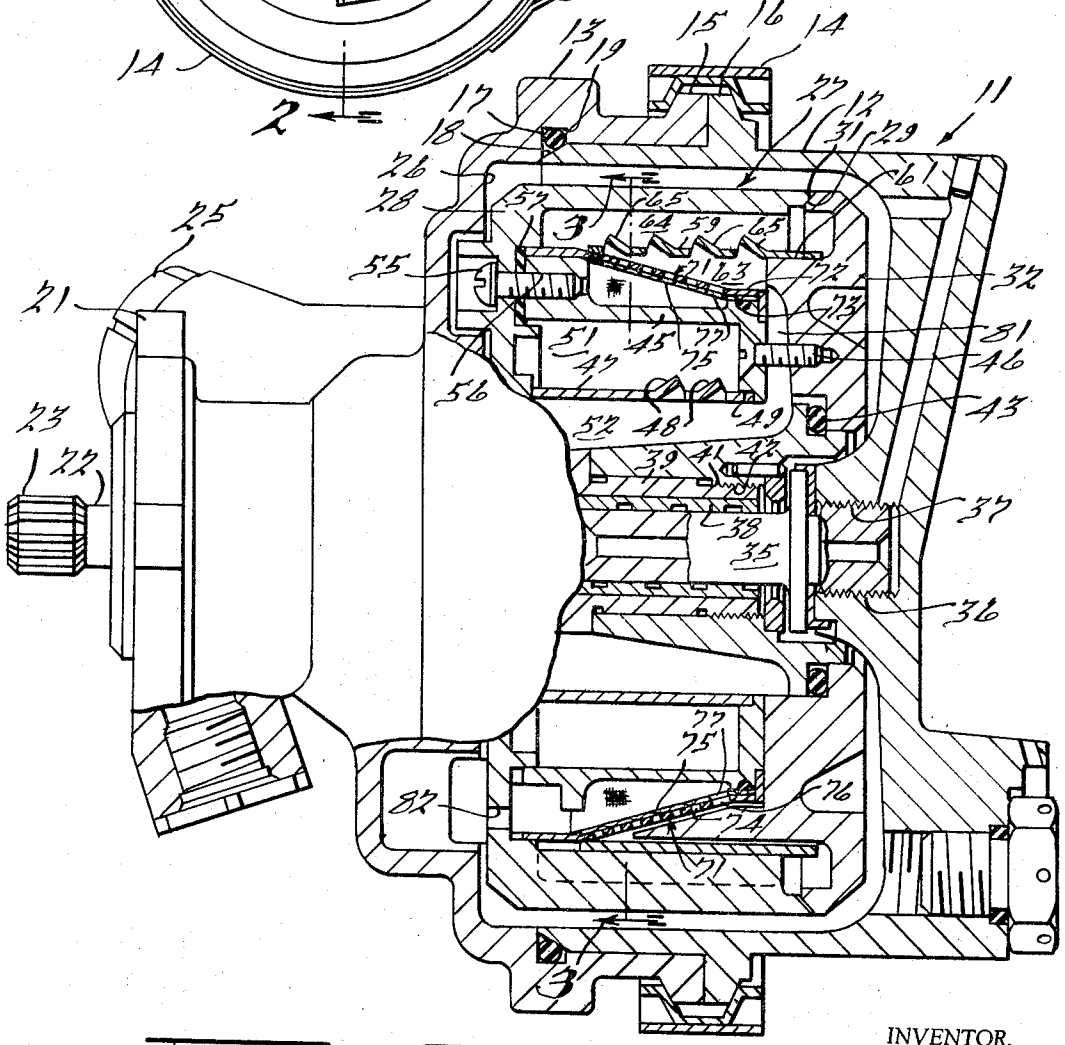


FIG. 2.

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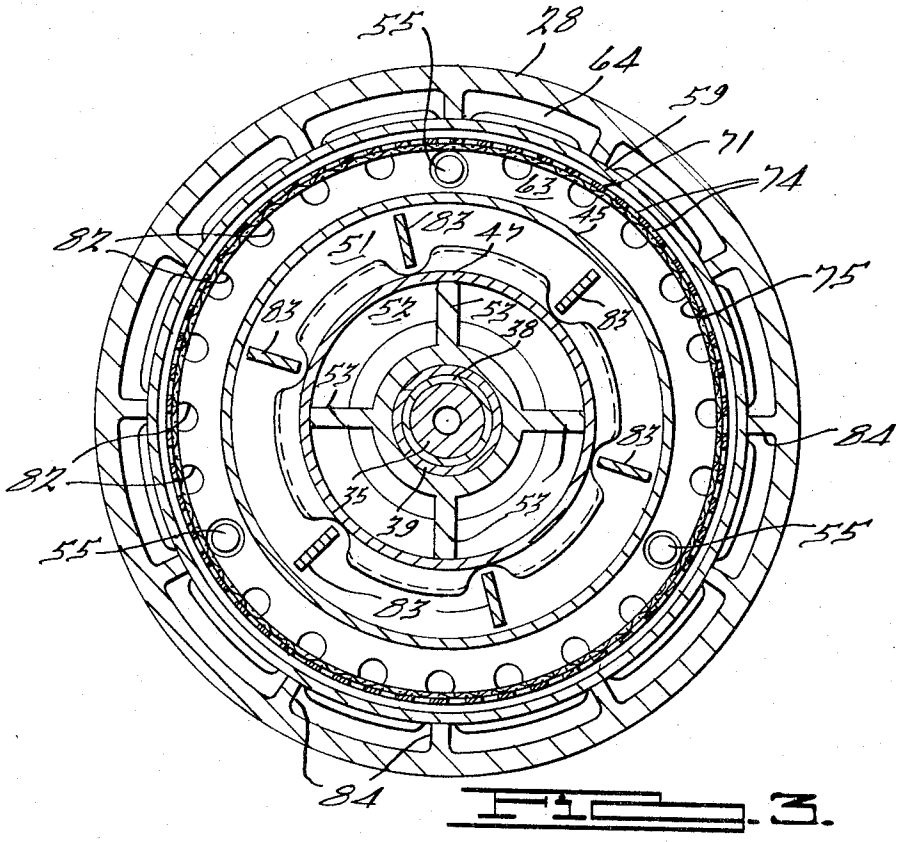


FIG. 3.

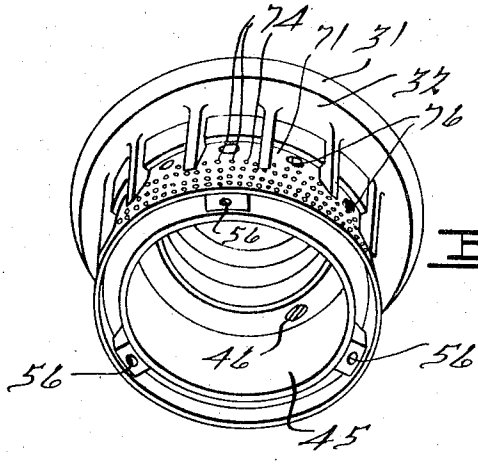


FIG. 4.

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3,344,927

PURIFIER

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8 Claims. (Cl. 210—360)

ABSTRACT OF THE DISCLOSURE

This application discloses a purifier for centrifugally extracting particles larger than a predetermined size from a fluid. The purifier includes a housing that defines a fluid inlet passage and a fluid outlet passage with a fluid cavity therebetween. An impeller is supported for rotation within the cavity for driving the heavier particles radially outwardly into a contaminant repository that encircles the cavity. The particles are driven into the contaminant repository through relatively large holes in a perforate member that defines the inner periphery of the repository. To preclude re-entry of the particles into the fluid stream upon the cessation of rotation of the impeller, a perforate screen is positioned adjacent the openings in the perforate member of the contaminant repository. This screen extends across the fluid inlet and outlet and is rotated when the impeller rotates to provide a self-cleaning action.

This invention relates to a purifier for extracting particles larger than a given size from a fluid and more particularly to a centrifugal purifier that removes particles of a given size from a fluid.

In my United States Patent No. 3,050,240, issued Aug. 21, 1962, entitled, "Centrifugal Contaminant Extractor," and assigned to the assignee of this invention, there is illustrated a centrifugal purifier wherein contaminants are separated from a fluid by means of a centrifugal force. The fluid and entrained contaminants are centrifuged by a rotating impeller contained within an impeller cavity. The centrifugal force drives the contaminants into a contaminant repository that is positioned around the impeller cavity. An inner shell that defines the inner surface of the contaminant repository has specially formed louvers for permitting the contaminants to enter the repository and which aid in precluding the re-entry of the contaminants to the fluid system when the impeller is not rotating. In certain applications, however, it is desirable to provide a more positive means of assuring that the contaminants will not re-enter the fluid system.

It is, therefore, an object of this invention to provide a centrifugal purifier for removing contaminants from a fluid that provides means for positively assuring that the separated contaminants will not re-enter the fluid.

In certain types of fluid systems, it is necessary to insure that all particles in excess of a given size will be removed from the circulated fluid. The size of particles extracted by a centrifugal purifier of the type shown in my aforementioned patent depends upon such variables as the speed of rotation of the impeller, the diameters of the various components, the mass of the particles, the viscosity of the fluid and other factors. Since it is frequently difficult, if not impossible, to accurately control these factors and maintain them all constant, a centrifugal purifier of the type described in my aforementioned patent cannot be used in all applications wherein it is essential that particles in excess of a certain size are extracted from the fluid circulated. Although conventional depth or surface type of filters are capable of extracting particles in excess of a given size, these types of filters require frequent servicing which a centrifugal purifier does not require.

It is, therefore, a further object of this invention to provide a centrifugal purifier that is capable of extracting contaminants in excess of a predetermined size from a fluid.

It is a still further object of this invention to provide a self-cleaning type of filter that will extract particles in excess of a given size from a fluid.

A centrifugal purifier embodying this invention comprises a fluid cavity in which a rotating impeller is supported to impart a centrifugal force to the fluid and entrained contaminants in the cavity. A contaminant repository is provided in fluid communication with the cavity to receive the entrained contaminants that are driven from the cavity under the influence of centrifugal force. A fallout device having a plurality of finely spaced openings is positioned across the mouth of the contaminant repository to preclude re-entry of the contaminants to the fluid system upon the cessation of rotation of the impeller.

As a further feature of the invention, the fallout device may be in the form of an annular perforate member and the fluid is routed radially inwardly through the fallout device. The fallout device is rotated so that particles which are excluded from the circulated fluid by the fallout device will be thrown away from it by the centrifugal force of rotation.

Other objects and advantages of this invention will become more apparent as this description proceeds, particularly when considered in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a front elevational view of a centrifugal purifier embodying this invention;

FIGURE 2 is an enlarged partial cross-sectional view taken generally along the line 2—2 of FIGURE 1;

FIGURE 3 is a cross-sectional view taken along the line 3—3 of FIGURE 2; and

FIGURE 4 is a perspective view of a portion of the centrifuge assembly shown in FIGURES 1 through 3.

Referring now in detail to the drawings, a centrifugal purifier embodying this invention is identified generally by the reference numeral **11**. The centrifugal purifier **11** has many features in common with that disclosed in my aforementioned patent and reference may be had to that patent for specific details that are not disclosed herein because they form no part of this invention. The centrifugal purifier **11** includes an outer shell made up of a housing **12** and cover plate **13** that are affixed together by a clamp assembly **14** that engages upstanding adjacent ribs **15** and **16** of the cover **13** and housing **12**, respectively (FIGURE 2). An O-ring seal **17** is compressed between a chamfered annular shoulder **18** of the housing **12** and an annular groove **19** formed in the cover **13** to preclude fluid leakage from the purifier **11**.

The cover **13** is provided with a flanged mounting portion **21** that is adapted to be affixed to an engine or other prime mover. A drive shaft **22** is journaled within the cover **13** and has a splined end **23** that is adapted to be fixed in driving engagement with the prime mover. The internal supporting mechanism for the drive shaft **22** and seals which preclude leakage from the purifier **11** around the drive shaft **22** form no part of this invention and reference may be had to my aforementioned patent for details of the construction of these components. A fluid inlet fitting **24** and fluid outlet fitting **25** are formed in the cover **13** which communicate by means of suitable fluid passages with a hollow annular cavity **26** defined by the housing **12** and cover **13** and with the centrifuge assembly, indicated generally by the reference numeral **27**, contained therein.

The centrifuge assembly **27** is comprised of a first generally cup-shaped housing **28** having a beveled outer end **29** that engages a similar beveled end **31** of a cover member **32**. The cup-shaped housing **28** and cover member **32**

define annular fluid cavity means in which entrained contaminants are centrifuged from a fluid as will become more apparent as this description proceeds.

A pilot shaft **35** has a male threaded end **36** that is threaded into a tapped hole **37** formed centrally in the housing **12**. A bearing member **38** is positioned coaxially upon the pilot shaft **35** and a driving sleeve **39** is formed integrally with the housing **28** and journaled upon the bearing member **38**. The drive sleeve **39** is splined or connected in any other suitable manner (not shown) to the drive shaft **22** so that the centrifuge assembly **27** will rotate with the drive shaft **22**. The drive sleeve **39** has a male threaded end **41** that is received in a tapped hole **42** formed in a hub member. An O-ring seal **43** is compressed between the outer end of the hub member and the adjacent surface of the centrifuge cover member **32** to effect a fluid-tight seal in this area.

A generally cup-shaped inner shell **45** is affixed, by means of a plurality of screws **46**, to the centrifuge assembly cover member **32**. A perforate first inner shell **47** having louvered openings **48** is press fitted into an annular recess **49** formed at the inner periphery of the inner shell **45**. The first perforate inner shell **47** and cup-shaped member **45** define a first annular contaminant repository **51** and the perforate inner shell **47** defines the outer periphery of a first annular fluid cavity **52**. A plurality of impellers **53** are formed integrally with the hub portion of the cup-shaped member **28** and extend within the annular cavity **52** (FIGURE 3).

The cup-shaped housing **28** is affixed to the cover member **32** through the inner shell **45** by means of a plurality of screws **55** that are threaded through apertures in the base of the cup-shaped housing **28** and engage tapped holes **56** formed in the outer periphery of the inner shell **45**. An annular gasket **57** is positioned between the adjacent surfaces of the inner shell **45** and cup-shaped housing **28** to insure against fluid leakage.

A second perforate inner shell **59** is press fitted onto an annular hub portion **61** of the centrifuge cover member **32** and defines a second fluid cavity **63** with the inner shell **45** and a second annular contaminant repository **64** with the cup-shaped housing **28**. A plurality of louvered openings **65** are formed in the second inner shell **59** to permit fluid communication between the second cavity **63** and the second contaminant repository **64**, for a purpose which will become more apparent as this description proceeds.

A fallout device for limiting the size of particles that may pass through the centrifugal purifier **11** and for precluding the re-entry of the separated contaminants into the fluid system when the impellers **53** are not rotating is positioned within the second annular fluid cavity **63**. The fallout device comprises a generally conical shaped perforate shell **71** having an annular hub portion **72** that is press fitted onto an annular shoulder of the inner shell **45**. A gasket **73** is positioned between the hub portion **72** and the inner shell **45**. The conical shaped portion of the perforate shell **71** is provided with a plurality of apertures **74** that are of sufficient size and sufficiently closely spaced so as to not significantly restrict the flow through the shell **71**.

Positioned radially inwardly of the shell **71** and supported by it is a conical screen **75** having a plurality of finely spaced, equally sized openings. The openings in the screen **75** are considerably smaller than the openings **74** and smaller than the openings provided by the louvers **65**. The size of the openings in the screen **75** is selected to be the same as the smallest size of particle which may pass through the purifier assembly **11**. Larger particles will thus be excluded from passage through the device, as will become more apparent as this description proceeds.

A plurality of circumferentially spaced by-pass openings **76** are formed in the shell **71** adjacent the hub portion **72**. Similarily sized and spaced by-pass openings **77** are formed in the conical screen **75** adjacent the openings **76**. The by-pass openings **76** and **77** serve a function that will become more apparent as this description proceeds.

Operation

The purifier assembly **11** is adapted to be used in any type of fluid system, but is particularly useful in separating contaminants from the fuel of aircraft engines. In such a use it is adapted to be interposed in the fuel line and is supplied with fuel under pressure by a fuel pump (not shown). Fuel enters the purifier assembly **11** through the inlet fitting **24** wherein it is directed by suitable passages (not shown) to the first annular cavity **52**.

When the engine is operating, the drive shaft **22** is rotated and thus the centrifuge assembly **27** is also rotated due to its connection with the drive shaft **22**, which has heretofore been described. The rotation, assisted by the action of the impellers **53** imparts a centrifugal force to the fluid and entrained contaminants. A portion of the contaminants will be driven into the first contaminant repository **51** through the louvered openings **48**. The louvered openings **48** may be constructed in such a way so that they will assist in precluding escape of the contaiminants back into the fluid system, as is described in my aforementioned patent application, when rotation of the centrifuge assembly **27** ceases.

The fluid exits from the first annular cavity **52** through a plurality of radially extending fluid passages **81** that open into the rear of the second annular cavity **63** radially outwardly of the smaller diameter portion of the screen **75** (FIGURE 2). The centrifugal force will drive the entrained contaminants into the second contaminant repository **64** through the louvered opening **65**. The louvered opening **65** also may be constructed to assist in precluding re-entry of the contaminants to the fluid system when rotation of the centrifuge assembly **27** ceases.

Any particles that are larger in size than the openings in the screen **75** and which have not previously been centrifuged from the fluid into one of the contaminant repositories **51** or **64**, will not be free to pass radially through the screen **75** to fluid outlet openings **82** formed in the cup-shaped housing **28** due to the size of the openings in the screen **75**. These larger particles will engage the outer periphery of the screen **75** and as it rotates with the remainder of the centrifuge assembly **27** the larger particles will eventually be centrifuged away from the screen **75** into the contaminant repository **64**.

A very small percentage of the larger particles can pass through the centrifuge assembly through the by-pass openings **76** and **77**. The quantity of such particles by-passing the screen **75** will be relatively small, however. If for some reason the screen **75** should become clogged due to an excess accumulation of particles, the flow of fluid to the engine will not be seriously restricted since by-pass flow can occur through the by-pass openings **76** and **77**. If this by-pass condition occurs, the centrifuge assembly should be disassembled and cleaned as soon as possible.

It should be noted that when rotation of the centrifuge assembly **27** and particularly the impellers **53** has ceased, particles might tend to escape from the contaminant repositories **51** and **64** into the fluid contained within the cavities **52** and **63**. This escaping contaminant would be free to re-enter the fluid system when the centrifugal purifier **11** were again caused to operate. The particles will, however, be precluded from re-entering the fluid system by the fallout screen **75**. Immediately upon rotation of the screen **75** these particles will again be centrifuged back into the contaminant repository **64** and thus cannot pass from the centrifugal purifying assembly **11**. If additional means for precluding the fallout of particles is desired, the contaminant repositories **51** and **64** may be filled with a foraminous entrapment media, as disclosed in the copending patent application of Richard L. Carmon, entitled "Centrifugal Purifier," filed Oct. 23, 1965, Ser. No. 503,924 and assigned to the assignee of this invention.

The centrifugal action generated by the purifier **11** provides some boost in the pressure of the fluid circulated through the purifier assembly **11**. If additional boost is desired, a boost-type purifier assembly, as shown in my Patent No. 3,178,105 issued Apr. 13, 1965, entitled "Contaminant Extracting Boost Pump," and assigned to the assignee of this invention, may be utilized. The fallout screen **75** may be used in conjunction with a contaminant extracting boost pump of the type disclosed in that patent.

A plurality of circumferentially spaced separators **83** extend within the first contaminant repository **51** to preclude an unequal buildup of contaminant therein particularly when the centrifuge assembly **27** is at rest. Without the separators **83** the contaminant would collect at the lowest portion of the contaminant repository **51** and create an imbalance when rotation was again initiated. Similar separators **84** extends into the contaminant repository **64** to prevent an unequal buildup of contaminant in this repository.

Various other changes and modifications may be made without departing from the spirit and scope of the invention, as defined by the appended claims.

What is claimed is:

1. A centrifugal purifier for removing entrained contaminants larger than a predetermined size from a fluid in a fluid system comprising means defining a fluid cavity, fluid inlet means and fluid outlet means in communication with said fluid cavity, a rotating impeller supported within said cavity for imparting a centrifugal force to the fluid and entrained contaminants therein, a contaminant repository, said contaminant repository being defined at least in part by a member having enlarged openings for providing for fluid communication between said cavity and said contaminant repository for passage of entrained contaminants from said cavity to said contaminant repository under the influence of the centrifugal force generated by said impeller, and a perforate member having a plurality of finely spaced openings extending adjacent and across the openings in said first mentioned member and within said cavity for precluding the re-entry of the contaminants to the fluid system upon the cessation of rotation of said impeller, said openings in said perforate member being sized to exclude particles greater than said predetermined size, said perforate member being positioned between said fluid inlet means and said fluid outlet means whereby at least a portion of the fluid flowing through said cavity passes through said perforate member.

2. A centrifugal purifier for separating contaminants having a size larger than a predetermined size from a fluid comprising housing means defining fluid cavity means, a rotating impeller for imparting a centrifugal force to the fluid and entrained contaminants in said cavity means, an annular perforate member supported for rotation within said cavity means, said perforate member having finely spaced openings sized to exclude particles greater than a predetermined size from fluid flowing through said perforate member, fluid inlet means opening into said cavity means radially outwardly of said perforate member, fluid outlet means opening into said cavity means radially inwardly of said perforate member whereby at least a portion of the fluid flowing from said fluid inlet means to said fluid outlet means passes radially inwardly through said perforate member, means for rotating said perforate member for driving the particles separated from the fluid by said perforate member away from said perforate member to prevent plugging thereof, and an annular contaminant repository encircling said perforate member, said contaminant repository being defined in part by an annular member having enlarged openings for fluid communication of said contaminant repository with said fluid cavity means for receiving and retaining the particles separated from the fluid by said impeller and by said perforate member, the openings in said annular member being substantially larger in area than the respective openings in said perforate member.

3. A centrifugal purifier for removing entrained contaminants from a fluid in a fluid system comprising means defining an annular fluid cavity, a rotating impeller supported within said cavity for imparting a centrifugal force to the fluid and entrained contaminants, an annular contaminant repository defined in part by a perforate inner shell, the perforations in said inner shell providing for fluid communication between said annular cavity and said annular contaminant repository for passage of entrained contaminants from said cavity to said contaminant repository under the influence of the centrifugal force generated by said impeller, and an annular perforate member having a plurality of finely spaced openings positioned radially inwardly of said inner shell within said cavity for precluding re-entry of the separated contaminants to the fluid system upon the cessation of rotation of said impeller, the openings in said perforate member being substantially smaller than the openings in said perforate inner shell.

4. A centrifugal purifier for separating contaminants having a size larger than a predetermined size from a fluid comprising means defining an annular fluid cavity, a rotating impeller supported within said cavity for imparting a centrifugal force to the fluid and entrained contaminants, an annular contaminant repository surrounding said cavity and being defined in part by a perforate inner shell, the perforations in said inner shell providing for fluid communication between said cavity and said contaminant repository for passage of entrained contaminants from said cavity to said contaminant repository under the influence of the centrifugal force generated by said impeller, an annular perforate member supported for rotation within said cavity radially inwardly of said perforate inner shell, said perforate member having finely spaced openings sized to exclude particles greater than a predetermined size from fluid flowing through said perforate member, fluid inlet means opening into said cavity radially outwardly of said perforate member, fluid outlet means opening into said cavity radially inwardly of said perforate member whereby at least a portion of the fluid flowing from said fluid inlet means to said fluid outlet means passes radially inwardly through said perforate member, the openings in said perforate member being substantially smaller in size than the openings in said perforate inner shell, and means for rotating said perforate member for driving the particles separated from the fluid by said perforate member away from said perforate member into said contaminant repository to prevent plugging of said perforate member.

5. A centrifugal purifier for separating contaminants having a size larger than a predetermined size from a fluid comprising means defining an annular fluid cavity, a rotating impeller supported within said cavity for imparting a centrifugal force to the fluid and entrained contaminants, an annular contaminant repository surrounding said cavity and being defined in part by a perforate inner shell, the perforations in said inner shell providing for fluid communication between said cavity and said contaminant repository for passaeg of entrained contaminants from said cavity to said contaminant repository under the influence of the centrifugal force generated by said impeller, an annular perforate member supported for rotation within said cavity radially inwardly of said perforate inner shell, said perforate member having finely spaced openings sized to exclude particles greater than a predetermined size from fluid flowing through said perforate member, fluid inlet means opening into said cavity radially outwardly of said perforate member, fluid outlet means opening into said cavity radially inwardly of said perforate member whereby at least a portion of the fluid flowing from said fluid inlet means to said fluid outlet means passes radially inwardly through said perforate member, the openings in said perforate member being substantially smaller in size than the opening in said perforate inner shell, means for rotating said perforate member for driving the particles separated from the fluid by said perforate member away from said

perforate member into said contaminant repository to prevent plugging of said perforate member, and means affixing said impeller to said perforate member for simultaneous rotation of said impeller and said perforate member.

6. A centrifugal purifier for separating contaminants having a size larger than a predetermined size from a fluid comprising means defining an annular fluid cavity, a rotating impeller supported within said cavity for imparting a centrifugal force to the fluid and entrained contaminants, an annular contaminant repository surrounding said cavity and being defined in part by a perforate inner shell, the perforations in said inner shell providing for fluid communication between said cavity and said contaminant repository for passage of entrained contaminants from said cavity to said contaminant repository under the influence of the centrifugal force generated by said impeller, a conical perforate member supported for rotation within said cavity radially inwardly of said perforate inner shell, said conical perforate member having finely spaced openings sized to exclude particles greater than a predetermined size from fluid flowing through said perforate member, fluid inlet means opening into said cavity radially outwardly of said conical perforate member, fluid outlet means opening into said cavity radially inwardly of said conical perforate member whereby at least a portion of the fluid flowing from said fluid inlet means to said fluid outlet means passes radially inwardly through said perforate member, the openings in said perforate member being substantially smaller in size than the openings in said conical perforate inner shell, means for rotating said conical perforate member for driving the particles separated from the fluid by said conical perforate member away from said conical perforate member into said contaminant repository to prevent plugging of said conical perforate member, and means affixing said impeller to said conical perforate member for simultaneous rotation of said impeller and said conical perforate member.

7. A centrifugal purifier for removing entrained contaminants having a size larger than a predetermined size from a fluid comprising means defining fluid cavity means, a rotating impeller in said cavity means for imparting a centrifugal force to the fluid and entrained contaminants, an annular contaminant repository defined in part by a perforate inner shell extending around said cavity means, the perforations in said inner shell providing for fluid communication between said cavity means and said contaminant repository for passage of entrained contaminants from said cavity means to said contaminant repository under the influence of the centrifugal force generated by said impeller, a conical perforate member having finely spaced openings sized to exclude particles greater than a predetermined size from fluid flowing through said perforate member, fluid inlet means opening into said cavity means radially outwardly of the smaller diameter portion of said conical perforate member, fluid outlet means opening into said cavity radially inwardly of the larger diameter portion of said conical perforate member whereby at least a portion of the fluid flowing from said fluid inlet means to said fluid outlet means passes in a substantially radially inward direction through said conical perforate member, and means for rotating said conical perforate member for driving the particles separated from the fluid by said conical perforate member outwardly from said perforate member into said contaminant repository to prevent plugging of said perforate member.

8. A centrifugal purifier as set forth in claim 2 wherein the means for rotating the perforate member includes means for affixing the impeller against rotation relative to said perforate member.

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