March 10, 1970 R. E. FEASEL 3,499,531

CYCLONIC SEPARATION DEVICES

Filed June 25, 1969 2 Sheets-Sheet 1

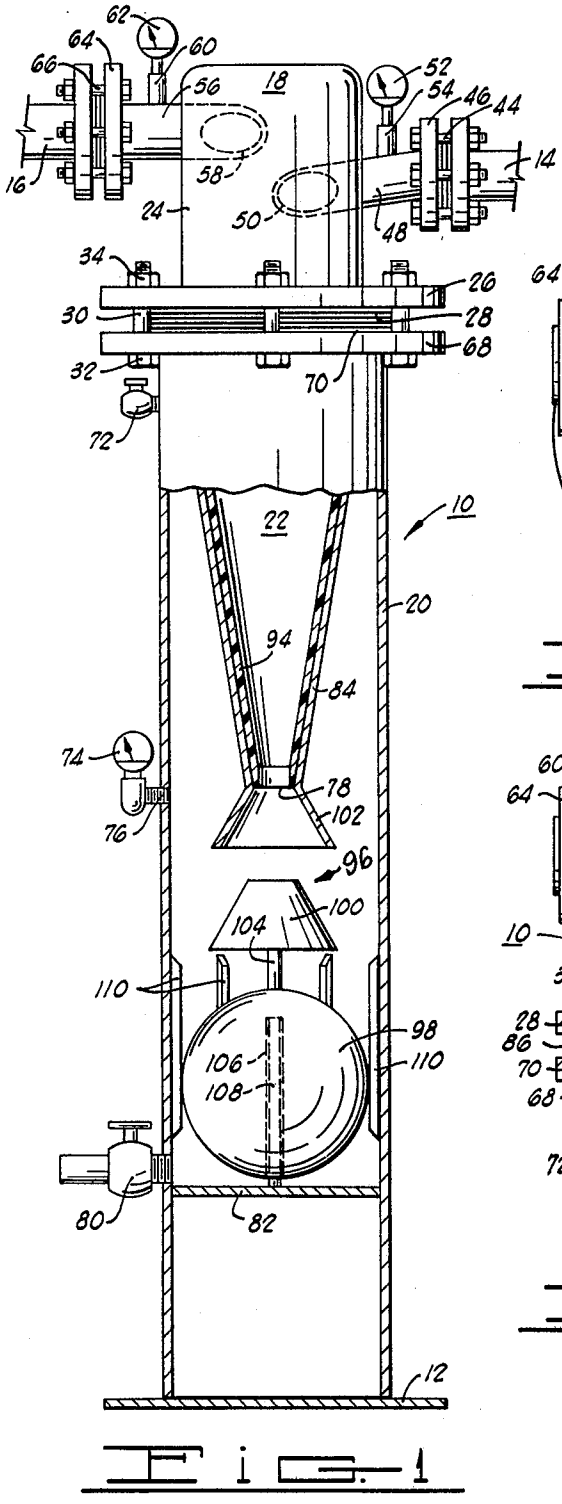

Fig. 1

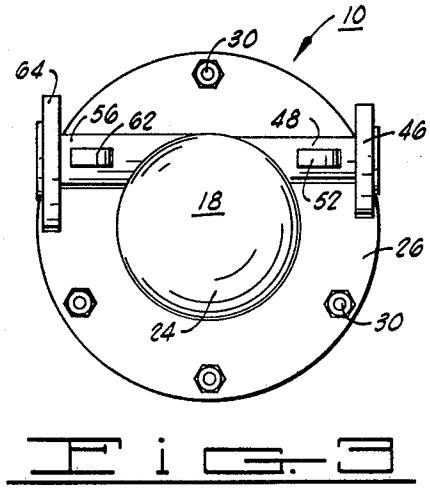

Fig. 3

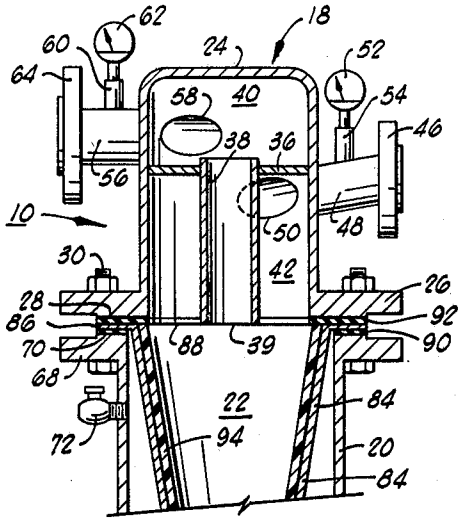

Fig. 2

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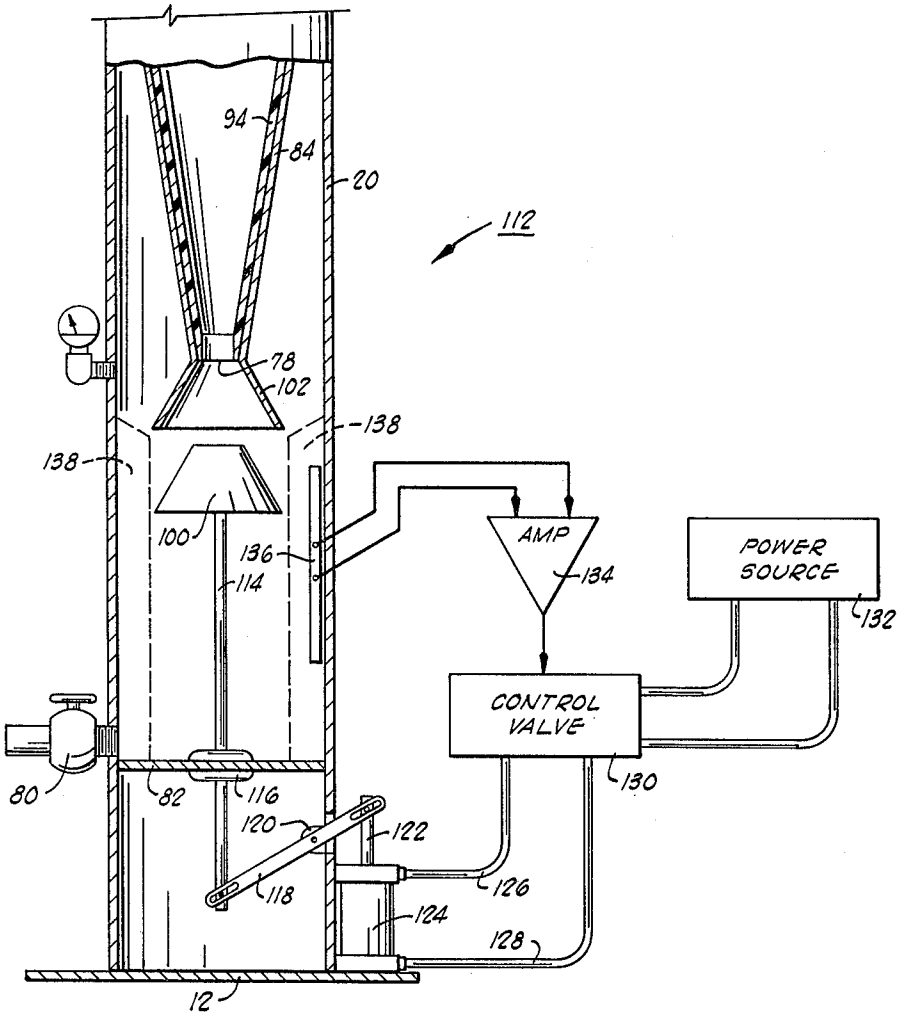

Fig. 4

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CYCLONIC SEPARATION DEVICES

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Continuation-in-part of application Ser. No. 762,071, Sept. 24, 1968. This application June 25, 1969, Ser. No. 836,540

Int. Cl. B04c *5/16, 5/085;* B01d *21/26*

U.S. Cl. 210—114 10 Claims

ABSTRACT OF THE DISCLOSURE

Improvements in apparatus for the separation of particulate matter from fluid under pressure, the apparatus consisting of a first chamber means for receiving tangential input flow of fluid under pressure for circulation therein and introduction into a low friction cone member disposed immediately thereblow, and conduit means leading from the upper portion of said cone member vertically through the center of said first chamber for communication into a second chamber isolated thereabove and providing a tangential flow output of the fluid. The apparatus includes still an additional chamber enveloping the cone means and in communication with the lower end thereof, and a continuously adjustable valve means to vary the degree of communication between the cone means and the additional chamber such that optimum pressure differential can be derived as between the first chamber interior, the interior of the cone member, and the interior of the second chamber leading to the outlet conduit.

CROSS REFERENCE TO A RELATED APPLICATION

The present invention is a continuation-in-part of the subject matter in U.S. patent application No. 762,071 entitled "Improvements in Cyclonic Separation Devices," and filed by the same inventor on Sept. 24, 1968.

BACKGROUND OF THE INVENTION

Field of the invention

The invention relates generally to improvements in cyclonic separator devices and, more particularly, but not by way of limitation, it relates to specific improvements in pressure regulating devices for cyclonic separator apparatus of the type employed for refining and cleaning fluids under pressure.

Description of the prior art

The prior art includes a great many types of cyclonic separation devices, which, in some aspects, are very similar to the present invention. The general theory of operation of cyclonic separators is indeed old and well-known and the basic structures required to carry out such processing of fluent material must, or necessity, be somewhat similar due to the geometrical considerations of the physical layouts. More recent improvements in cyclonic separation apparatus have been directed toward the more specific structural limitations which attend an apparatus for operation with particular fluent materials carrying impurities of generally known and anticipated type, size, and weight.

SUMMARY OF THE INVENTION

The present invention contemplates an improved cyclonic separation device wherein fluid under pressure is cleaned of particulate matter during a flow stage of operations. In a more limited aspect, the invention consists of a first chamber means for receiving fluid at a first pressure in a tangential input flow to set up a cyclonic or circular flow, the first chamber means communicating downward with a cone member which is lined with a low friction surface and which is tapered to produce an increase in pressure differential proceeding down the cone member. A clean fluid conduit then leads from the upper central portion of the cone member through the center of the first chamber into communication with a second chamber which provides a circular flow and pressure equalization of the fluid for tangential exit through an outlet conduit. An additional chamber envelopes the cone member, being sealingly connected about the top end thereof, and communication therebetween is optimally restricted by a variable valve structure to insure that non-circulating fluid and sediment material which has been separated from the fluid is contained in the additional chamber for discharge.

Therefore, it is an object of the present invention to provide a separator device which can be installed in a flow line to effect fluid cleansing at high rates of flow.

It is also an object of the invention to provide an apparatus for use in industrial or domestic water lines to reduce pipe fouling, corrosion, chemical treatment costs, and costs arising from maintenance of attendant equipment.

It is still further an object of the present invention to provide an apparatus which can be connected in series in flow lines and which employs no cartridges or other such filtration media which require cleaning or backwashing, and which operation may be continuous as contaminates can be withdrawn during operation.

Finally, it is an object of the invention to provide a flow line cleansing apparatus which operates continuously at constant efficiency while requiring essentially no maintenance.

Other objects and advantages of the invention will be evident from the following detailed description when read in conjunction with the accompanying drawings which illustrate the invention.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a vertical elevation partially cut away of a separator unit as connected in a flow line;

FIG. 2 is a vertical section of the upper portion of a separator unit;

FIG. 3 is a top view of a separator unit; and

FIG. 4 is a vertical section illustrating an alternative form of regulating valve which may be utilized.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to the drawings, a separator unit **10**, as secured to a suitable deck plate or such **12**, receives fluid input from an entry conduit **14** and it directs fluid output through an exit conduit **16**. The separator unit **10** consists of an upper head portion **18** which is sealingly secured on top of a cylindrical housing portion **20** which supports an inverted cone member **22** therein.

Referring also to FIGS. 2 and 3, the head portion **18**

may be formed from such as a shell or dome **24** formed from mild steel or other suitable heavy structural material. The dome **24** is formed with an annular flange **26** which includes a gasket facing **28** and a plurality of holes equally spaced therearound to receive fasteners **30** therethrough. The fasteners **30** may be such as bolts **32** and nuts **34**, or various other conventional fastening means may be utilized. An annular plate **36** is secured as by welding across approximately the vertical midpoint (as shown) of the dome **24** interior. An axial conduit **38** is then joined through the center of annular plate **36** to extend axially downward into an open-end termination **39** within the upper opening of cone member **22**. Thus, the annular plate **36** divides the head portion **18** into an upper chamber **40** and a lower, annular-shaped chamber **42** opening downward in communication with the cone member **22**.

Fluid input from entry conduit **14** is effected through sealed flange connections by means of fasteners **44** securing a flange **46** of input conduit **48**. The input conduit **48** is rigidly affixed to lead into lower chamber **42** of dome **24** through a tangential hole **50**. A pressure gauge **52** is affixed through a connector stub **54** to communicate with the interior of input conduit **48**. An output conduit **56** is rigidly affixed to lead tangentially from an exit hole **58** from upper chamber **40**. Output conduit **56** includes a connector stub **60** and a pressure gauge **62**, and the conduit **56** terminates in a flange **64** for affixure by means of fasteners **66** to the exit conduit **16**.

The upper end of housing unit **20** is formed with a flange **68** and gasket face **70** and it may be formed as a cylinder, as shown in FIG. 1, to extend downward into contact with a suitable supporting means such as a deck plate **12**. The housing **20** includes a suitable stopcock **72** disposed through its wall at an upper position to serve as an air vent. A pressure gauge **74** is secured through the wall of housing **20** by means of a connector stub **76** at approximately the level of the bottom narrow end **78** of cone member **22**. Still another stopcock **80** is disposed through the housing member **20** at a lowermost point for the purpose of removing trapped sediment such as sand, silt, rust and other materials which have been removed from the fluid. Thus, a bottom plate **82** is secured as by welding across the housing member **20** to form the bottom plate therein and stopcock **80** is positioned just above this level.

The cone member **22** consists of an outer cone **84**, fabricated from steel or such, which is formed to have an outward connecting flange **86** around its top or wider open end **88**. A suitable ring gasket **90** and an upper ring gasket **92** may be respectively positioned below and above the cone flange **86** for sealing abutment against the respective gasket facings **70** and **28** to provide a high pressure seal. The internal, conical surface of the cone member **22** is coated with a selected plastic lining **94**. In one form of the invention, a cured urethane polymer which exhibits a low friction surface property was cast on the conical section **84** which, in turn, was formed from steel.

Optimum pressure differential and return sediment blocking is effected by a flow regulating valve **96** as shown in FIG. 1. The valve **96** consists of a float ball **98** and stop plug **100** in coaction with a conically formed stop receptacle **102**. The stop receptacle **102** may be such as a cone-shaped metallic member which is secured as by welding around the narrow end **78** of cone member **22** to form an outwardly flaring opening therebeneath. The stop plug **100** is then formed from a suitable material in the same segmental cone-shaped as receptacle **102** so that it can be received upward therein to completely cutoff fluid flow.

The stop plug **100** is supported on a shaft **104** which is rigidly secured to the float ball **98**. Float ball **98** may be formed from a suitable plastic or metal to include a guide hole **106** in axial alignment with shaft **104** such that it coacts with a rod **108** to maintain float ball **98** and stop plug **100** in proper alignment with the stop

receptacle **102** at all times. A plurality of guide vanes **110** may be disposed in vertical alignment about the inner wall of cylindrical housing portion **20** to ensure proper guidance of float ball **98** along with adequate liquid and/or sediment passage therearound for communication to the outlet valve **80**.

OPERATION

The separator unit **10** may be used in either industrial or domestic fluid flow lines to effect removal of particular matter at high flow rates. For example, presently constructed types of separator unit **10** may be connected into a water flow line at flow rates up to 100 gallons per minute to effect removal of sand, silt, rust and other foreign materials. The separator units **10** are constructed to utilize a differential pressure of approximately 25 lbs. per square inch of gravity as between the input and exit conduits to effect separation, and the specified flow rate of 100 gallons per minute is only one rate as derived from a particularly constructed model. Thus, higher or lower flow rates may be accommodated by extrapolation with respect to the various design parameters.

When the separator unit **10** is installed, input fluid from entrance conduit **14** is applied through the input conduit **48** for tangential input through hole **50** into the lower chamber **42** of head portion **18**. The fluid is continually introduced into a circular flow which, due to the applied force, seeks a level down within cone member **22** so that a vortical flow is set up. The centrifugal force tends to move particulate matter outward against the plastic cone member **94** whereupon it can progress down through the lower opening **78** of cone member **22** for eventual deposition below regular valve **96** and periodic or continuous removal through stopcock **80**.

The cleansed fluid tends to concentrate within the center of the volume within conical member **22** at an increased pressure which forces it to flow upward through the lower opening **39** of axial conduit **38**; whereupon it is cyclically agitated around within upper chamber **40** for tangential removal through hole **58** and output conduit **56** to the exit conduit **16**.

Pressure meters **52** and **62** are placed in each of the respective input conduit **48** and output conduit **56** to indicate the differential pressure. Thus, in one form of operation, the input meter **52** may read approximately 25 p.s.i.g. whereupon the output meter **62** should read zero pounds pressure, or nearly so, if exit conduit **16** is free from blockage. The differential pressure of about 25 p.s.i.g. is usually sufficient to effect particle separation through centrifical force during the violent vortical flow within cone member **22**.

The regulator valve **96** may be adjusted to some degree which is consonant with the pressure, viscosity and other related considerations for a particular fluid application. The outlet valve **80** can be adjusted to set a predetermined level of liquid-solid filtrant within the lower part of cylindrical housing portion **20**, and this, in turn, will hold float ball **98** and stop plug **100** at the proper level to maintain the optimum flow of material down through narrow end **78** of cone member **22**. This flow amount through end **78** is normally to be adjusted (by outlet valve **80**) so that no filtered material can find its way back upward into cone member **22**. It is also contemplated that some applications may benefit from a bleeding-in of selected and/or regulated air pressure through stopcock **72**.

It is recognized that the force necessary to move stop plug **100** upward within stop receptacle **102** may some times be greater than can be obtained by such as float ball **98**. In such case, necessary additional force may be obtained through electrical, pneumatic, or hydraulic power application. FIG. 4 shows one form of alternative regulator valve structure **112** which regulates position of stop plug **100** within stop receptacle **102** by means of a non-flotation, powered movement.

The stop plug **100** is affixed on a rod **114** which is slidably disposed to extend downward through a sealing ring **116** into pivotal connection with a lever **118**. Lever **118** is secured for fulcral movement at a post **120** to extend the other end into pivotal affixure to a piston shaft **122** of a fluid-actuated cylinder **124**. The cylinder **124** receives fluid under pressure through conduits **126** and **128** from a control valve **130**, and control valve **130** as energized by a power source **132** is actuated in accordance with sensor input from a suitable conventional form of amplifier **134**.

The liquid level, i.e. liquid plus solid filtrant, within the lower part of housing portion **20** may be sensed by a suitable liquid level sensor element **136** which provides an output indicative of liquid level to the amplifier **134**. The sensor element **136** may be any of various types of liquid level sensor which is capable of providing an electrical output proportional to its immersion in liquid. For example, sensor element **136** may be a slide wire type of sensor having its resistive components shorted out in proportion to such immersion. Many other types of sensors may also find employ and its is fully contemplated that either electrical or fluid-powered mechanisms may be used in such valving applications. Also, it may be desirable to employ a plurality of baffles **138** to eliminate certain vortical turbulence which might arise.

It should be understood that the greatest efficiency is obtained by designing each individual separator unit **10** to have dimensions consonant with best operation for whatever the flow rate of the fluid line with which it is to be used. Thus, a separator unit for use with a higher flow rate would have enlarged conduit members, chambers, and cone member, these elements being enlarged by a parametric proportion which would be ascertained from consideration of the increase in flow rate to be handled. Similarly, separator units **10** may be designed to be physically smaller for use with lower flow rates. All parts of the separator units **10** may be fabricated from well-known materials utilizing conventional fastener techniques; for example, the unit may be constructed using commercially available, standard pipe, flanges and steel plating, such stock being assembled by means of electric welding.

The foregoing discloses a novel separator device which can be employed for cleaning particulate matter from flowing liquids continuously and in relatively maintenance free matter. Such a cyclonic separation device requires no changing of filtration media of any kind and, therefore, it requires no shutdown of flow as the various contaminates may be withdrawn from the unit while the particle separation continues unaffected. Such cyclonic separation units are particularly adapted for separating suspended particulate matter such as sand, rust, etc. from industrial or domestic waters while in flow.

What is claimed is:

1. Apparatus functioning to perform cyclonic separation of particulate matter from a fluid under pressure, comprising:

lower chamber means having a generally cylindrical shape with a first end closed and a second end open and being disposed in the downward direction;

input conduit means connected for tangential communication with said lower chamber means for introducing said fluid under pressure;

conduit means which is conically shaped with both ends open and having the larger end sealingly secured about the lower chamber means second end with the smaller end disposed vertically therebelow, said conduit means having the interior lined with resilient material having a low coefficient of friction relative to particulate matter;

housing means sealingly secured about said lower chamber means second end and extending a closed space below said conduit means smaller end;

upper chamber means having a generally cylindrical shape with a first upper end closed and a second lower end sealingly secured around the first end of said lower chamber means;

flow conduit means disposed through the center of said first end of said lower chamber means into communication with said upper chamber means, said flow conduit means extending axially through said lower chamber means to terminate immediately below said lower chamber means second end;

output conduit means connected for tangential communication with said upper chamber means to provide an outlet for said fluid under pressure;

stop means of approximately the same size as the open smaller end of said conduit means;

adjusting means affixed to said stop means for varying the position of said stop means relative to said open smaller end in proportion to the depth of fluid and particulate matter in said closed space of said housing means; and

outlet valve means connected to said housing means closed space and adjustable to maintain said depth of fluid and particulate matter and said stop means position relative to said open smaller end at predetermined positions.

2. Apparatus as set forth in claim **1** wherein said conduit means resilient lining material comprises:

cured urethane polymer affixed in uniform thickness to the interior surface of said conically shaped conduit means.

3. Apparatus as set forth in claim **1** which is further characterized to include:

first indicator means for indicating the fluid pressure within said input conduit means; and

second indicating means for indicating the fluid pressure within said output conduit means.

4. Apparatus as set forth in claim **2** which is further characterized to include:

first indicator means for indicating the fluid pressure within said input conduit means; and

second indicator means for indicating the fluid pressure within said output conduit means.

5. Apparatus as set forth in claim **1** which is further characterized to include:

stop cock means disposed through said housing means at an uppermost position to permit passage of air therethrough.

6. Apparatus as set forth in claim **1** wherein said adjusting means comprises:

float means disposed within said housing means closed space; and

connecting means extending vertically from said float means into secure connection with said stop means.

7. Apparatus as set forth in claim **1** wherein said stop means comprises:

first conically-shaped flange means having smaller and larger open ends with said smaller end sealingly connected about the conduit means smaller end; and

stop plug means shaped similar to the interior of said conically-shaped flange means and affixed to said adjusting means for variable insertion within said conically-shaped flange means.

8. Apparatus as set forth in claim **7** wherein said adjusting means comprises:

float means disposed within said housing means closed space; and

connecting means extending vertically from said float means into secure connection with said stop means.

9. Apparatus as set forth in claim **1** wherein said adjusting means comprises:

push-rod means affixed to said stop means and being vertically disposed in said housing means closed space;

actuating means for imparting vertical movement to said push-rod means;

sensing means for detecting the liquid level within said

closed space and providing an output indication proportional thereto; and

control means energized by said sensing means output to control said actuating means such that said stop means is positioned at a proportionate distance from said conduit means smaller end.

10. Apparatus as set forth in claim **9** wherein said actuating means comprises:

hydraulic cylinder means controlled by said control means to vertically adjust said push-rod means.

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U.S. Cl. X.R.

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