July 7, 1959 T. A. HERMAN 2,893,628

SOLID BOWL CENTRIFUGE

Filed Dec. 7, 1954 3 Sheets-Sheet 1

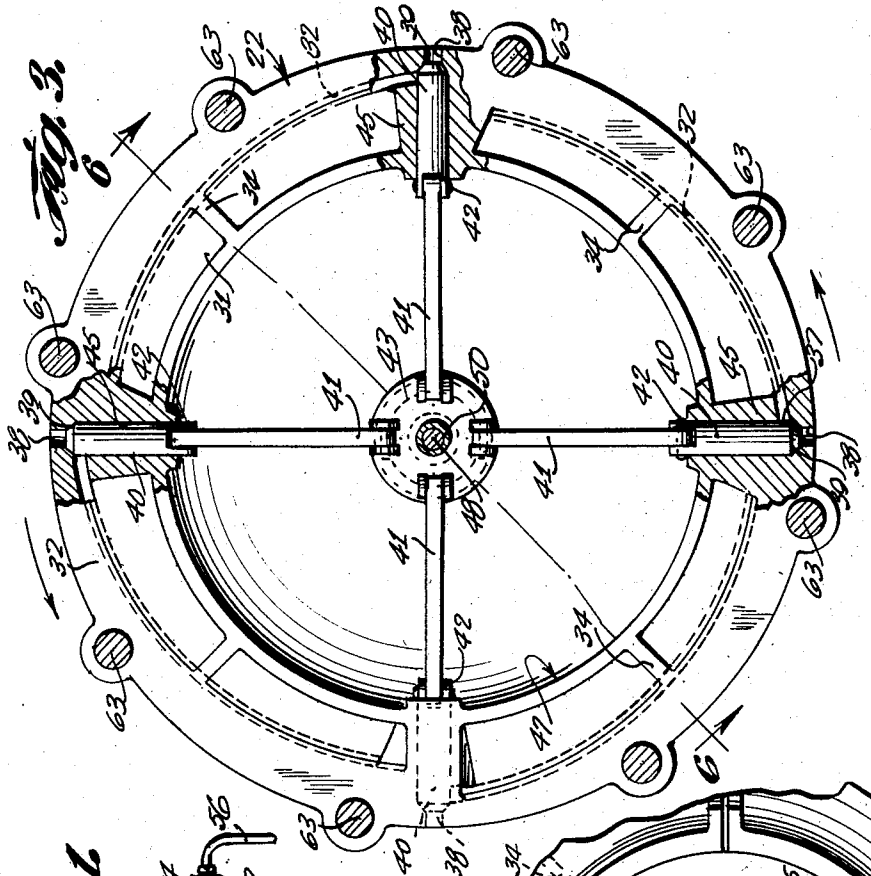


Fig. 3

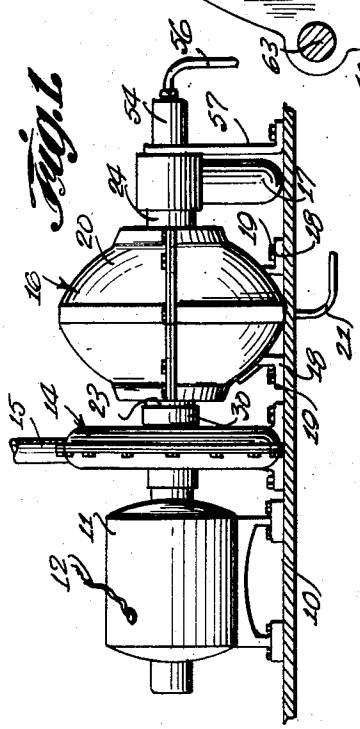


Fig. 1

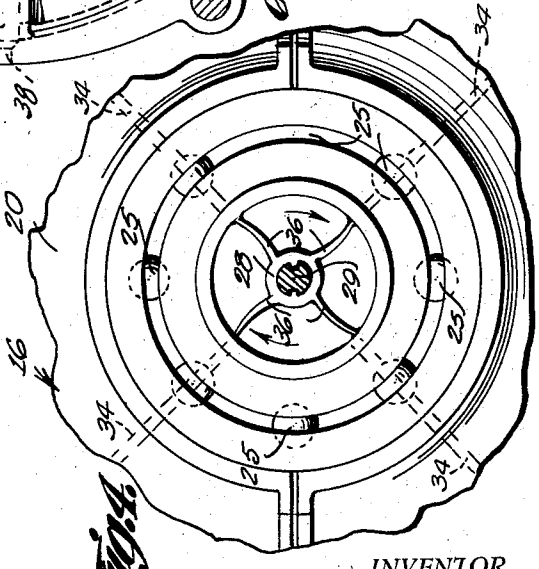


Fig. 4

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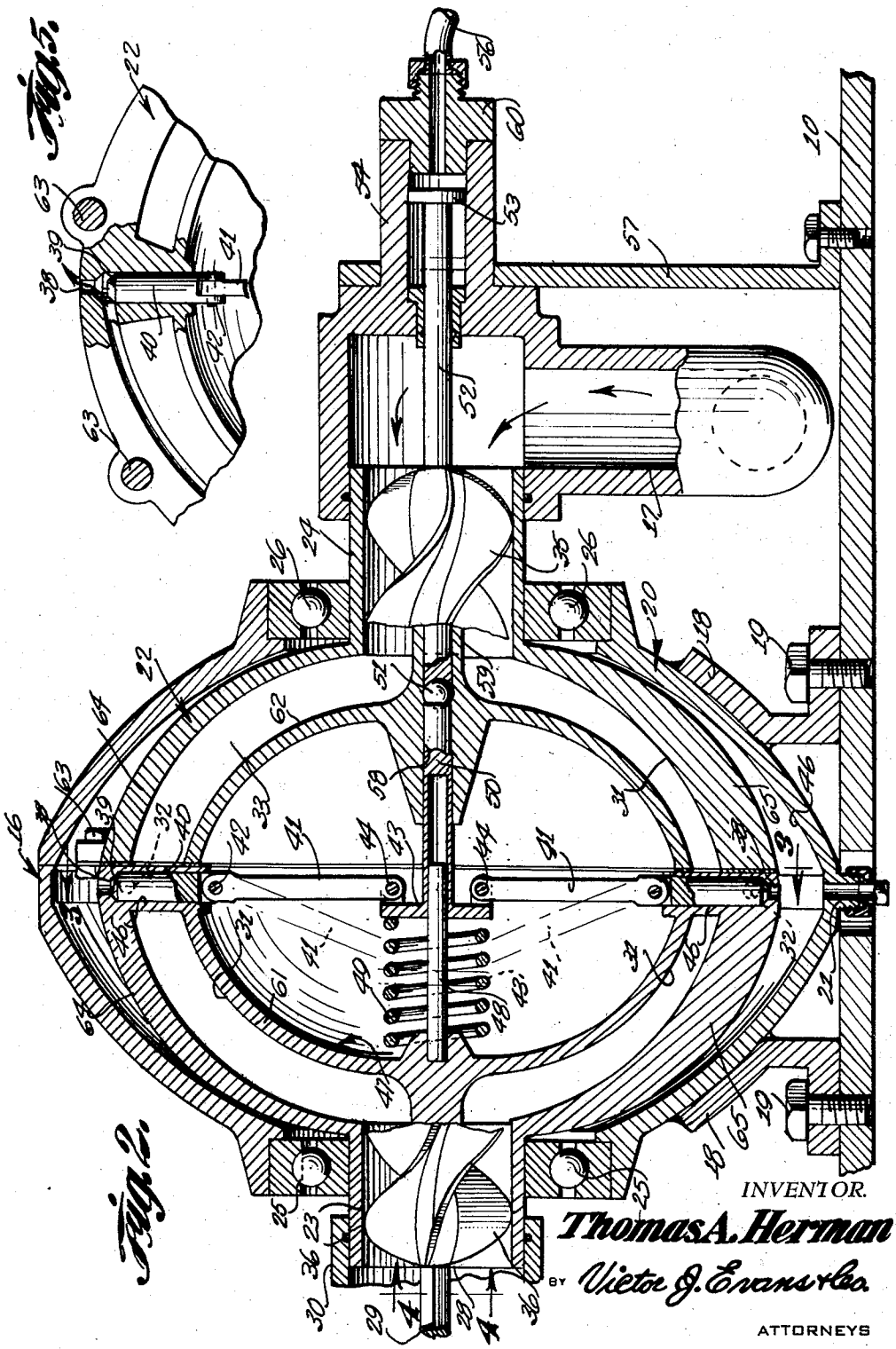


Fig. 2.

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Fig. 6.

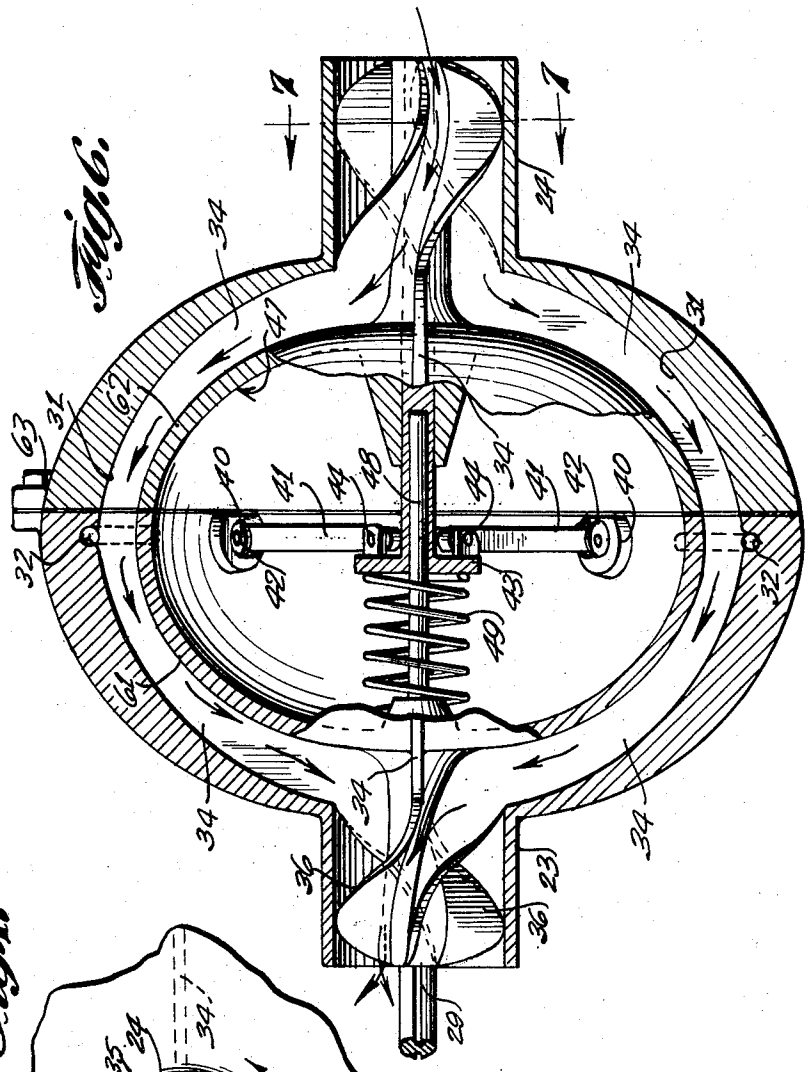
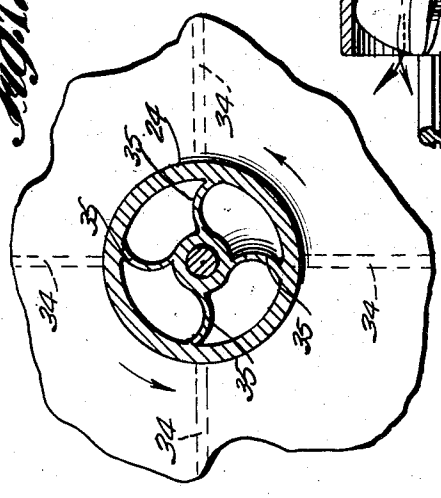


Fig. 7.



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SOLID BOWL CENTRIFUGE

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Application December 7, 1954, Serial No. 473,514

12 Claims. (Cl. 233—20)

This invention relates to a separator, and more particularly to a centrifugal separator and booster for separating impurities or foreign matter from a fluid.

The object of the invention is to provide a separator or centrifuge which will effectively separate or remove impurities or foreign matter from a fluid such as a liquid fuel.

Another object of the invention is to provide a combination separator and booster which is centrifugally operated whereby centrifugal force is used to separate foreign matter from liquids such as liquid fuel that is used to support combustion in a gas turbine engine or the like.

Another object of the invention is to provide a centrifugal booster separator unit which permits the free flow of liquid through passages contained within the body of the machine, the centrifugal force set up by the revolving motion of the machine serving to segregate and cause foreign matter to concentrate in sludge retaining grooves whereby this foreign matter can be expelled from the machine by a self purging mechanism.

A further object of the invention is to provide a centrifugal booster separator which is extremely simple and inexpensive to manufacture.

Other objects and advantages will be apparent during the course of the following description.

In the accompanying drawings, forming a part of this application, and in which like numerals are used to designate like parts throughout the same:

Figure 1 is a side elevational view showing the centrifugal booster separator unit incorporated with a motor and pump.

Figure 2 is a side elevational view of the centrifugal booster separator unit, with parts broken away and in section.

Figure 3 is a sectional view taken on the line 3—3 of Figure 2 and with parts broken away and in section.

Figure 4 is a fragmentary end elevational view of the centrifugal booster separator unit.

Figure 5 is a fragmentary elevational view, with parts broken away and in section, showing a portion of the valve mechanism.

Figure 6 is a sectional view taken on the line 6—6 of Figure 3.

Figure 7 is a sectional view taken on the line 7—7 of Figure 6.

Referring in detail to the drawings, the numeral 10 designates a base or supporting structure, and a motor 11 may be secured to the base 10 in any suitable manner, as for example by means of bolt and nut assemblies. The motor 11 may be connected to a suitable source of electrical energy through the medium of the wires 12. Arranged contiguous of the motor 11 and also supported on the base 10 is a pump 14 which has an outlet pipe 15 extending therefrom, and the outlet pipe 15 is adapted to convey or discharge filtered fluid such as fuel which can be used in aircraft engines and the like. Arranged

contiguous to the pump 14 and secured to the base 10 is a centrifugal booster and separator unit which is indicated by the numeral 16, and a conduit means 17 is provided for conveying the liquid fuel from a suitable source of supply such as a storage tank to the unit 16.

The present invention is directed to the specific construction of the separator unit 16 and the separator unit 16 is constructed so that the fuel or liquid will be continuously subjected to centrifugal action whereby sediment, foreign matter, impurities and the like will be automatically and constantly removed from the liquid so that the clean liquid or fuel can be used in an engine without danger of harming the engine.

Secured to the base 10 is a plurality of brackets 18, and the brackets 18 may be secured to the base in any suitable manner, as for example by means of the bolts 19, Figure 2. Secured to the brackets 18 as by welding, is a stationary hollow housing 20 which is provided with an outlet port 21 whereby foreign matter or impurities which have been removed from the fluid or fuel can be discharged to a suitable receptacle, container or other locality. Rotatably mounted within the stationary housing 20 is a hollow casing 22, and projecting from one end of the casing 22 is a cylindrical collar 23, there being a cylindrical collar 24 extending from the other end of the casing 22. A ball bearing assembly 25 is mounted on the collar 23, while a similar ball bearing assembly 26 is mounted on the other collar 24, and these bearings 25 and 26 serve to insure that there will be an efficient rotatable connection between the casing and housing.

Extending from an end of the casing 22 is a hub 27 which is provided with a socket 28 for receiving therein an end of a drive shaft 29, and the drive shaft 29 may be actuated by the motor 11. Surrounding the collar 23 is a bushing 30 which insures that cleaned fuel leaving the collar 23 will enter the pump 14 to be discharged through the pipe 15. The rotating casing 22 is provided with curved passageways or channels 31 and the incoming fuel or fluid first passes from the conduit 17 then through the collar 24, and then through the passageways 31 and then out through the collar 23. Grooves 32 are arranged outwardly of the channels 31, and the grooves 32 communicate with the channels 31, the grooves 32 serving to receive sediment, foreign matter and the like which is heavier than the liquid fuel and this foreign matter accumulates in the grooves 32 due to centrifugal action as the casing 22 is rotated. Blades or baffles 34 extend into the channels 31. Portions of the blades which are positioned within the collar 24 are indicated by the numeral 35, while the portions of the blades which are within the collar 23 are indicated by the numeral 36, Figure 2.

A valve means is provided for controlling emptying or discharge of the sediment from the grooves 32, and this valve means comprises discharge openings 37 through which the material from the grooves 32 can pass. A plurality of discharge ports 38 are adapted to receive the material from the outlet openings 37, and the sediment or foreign matter from the ports 38 pass to a space 46 within the housing 20, and from the space 46 the foreign matter can be discharged through the conduit 21. A valve seat 39 is arranged contiguous to each of the outlet ports 38, and a valve member 40 is mounted for movement into and out of closing or bridging relation with respect to each of the valve seats 39. The valve members 40 are slidably or reciprocably arranged in bores 45 which are formed in the rotating casing 22. A tappet 43 is slidably mounted in a compartment 47 which is defined by the hollow interior of the casing 22, and a plurality of tie rods 41 each have their inner ends pivotally connected to the tappet 43 by means of pins 44. The

outer ends of the tie rods 41 are pivotally connected to the valve members 40 by means of pivot pins 42.

Projecting into the compartment 47 from the hub 27 is a guide pin 48, and the tappet 43 is slidably mounted on the guide pin 48. A coil spring 49 is circumposed on the pin 48, and one end of the coil spring 49 abuts the tappet 43 to normally urge the parts to the solid line position shown in Figure 2 from the broken line position of Figure 2. The tappet 43 includes an end portion 50 which abuts a bearing or ball member 51 which is movably mounted in a passageway 58, the passageway 58 being formed in an extension 59 which projects from an end of the casing 22. A push rod 52 has its inner end arranged in engagement with the ball member 51, and the push rod 52 is slidably mounted in the passageway 58 in the extension 59. A piston 53 is formed on the outer end of the push rod 52, and the piston 53 is slidably or reciprocably arranged in a cylinder 54, there being a packing 60 closing an end of the cylinder 54. A conduit 56 communicates with the interior of the cylinder 54, and the conduit 56 is adapted to supply or convey air under pressure from a suitable source of supply whereby the piston 53 can be caused to reciprocate so as to cause the spring 49 to be compressed whereby the valve members 40 will move inwardly to permit sediment and the like to pass from the grooves 32 out through the ports 38 and then out through the port 21. A bearing brace 57 is provided for supporting the cylinder 54 and its adjacent parts.

In constructing the casing 22, the casing may be made of a pair of similar sections 61 and 62 which can be connected together by suitable bolt and nut assemblies 63. Portions 65 of the casing 22 may be of greater thickness than other portions 64 of the casing whereby the side of the casing 22 including the portions 65 is thicker and offset since each quadrant of the fuel passage 31 and sludge groove 32 is adapted to lie in an eccentric plane with respect to the center of the machine. The outer periphery only is offset as shown in Figure 2, and the innermost wall or confines of the casing 22 are arranged on a normal concentric plane about their common axis.

Heretofore fuel for turbo-jet aircraft engines and the like has been cleaned by passing the liquid through one or more screens of fine wire mesh, but this type of cleaner is inadequate since it becomes easily clogged by the foreign matter it was designed to retain and this results in a fuel pressure drop which can be serious. When such clogging occurs, it may even be necessary to bypass the fuel around such cleaners or separators and thereby relinquish that entire function for which they were designed. Thus, screen type separators, whether used singly or in multiples are not efficient and reliable for certain jobs. With the present invention centrifugal force is used to separate foreign matter from liquid fuels in such a manner that during the functioning of this force, the basic volume and pressure of the liquid and continuity of free flow will remain constant. The present invention is, therefore, directed to a centrifugal booster separator unit which includes a hollow revolving machine or casing 22 which permits the free flow of liquid through passages 31 therein. Thus, the force of the centrifuge that is set up by the revolving motion of the casing 22 will segregate and cause foreign matter to concentrate in sludge retaining grooves 32 and this foreign matter is expelled from the machine by a self purging mechanism which functions within a central cavity 47 in the casing 22. The baffles 34 which are positioned within the passageways 31, divide the passageways into channels and each of these channels, though independent of the other channels, is slightly interconnected with each other by means or by virtue of a small hole through which the sludge groove 32 passes from one channel to a neighboring channel. These baffles 34 serve as integral reinforcement ribs between the inner and outer walls and they are necessary to confine and route the fuel in a definite directional flow from inlet side to outlet side of the unit. These baffles also continue up into the inlet 24 where they terminate at that extreme end into rotary pump blades 35 and this self contained pumping action will provide the machine with a working pressure of about twenty pounds so that the machine is both a booster and a separator in one unit. The same baffles also continue in the opposite direction and up into the outlet collar 23 where they terminate at their extreme ends into rotary dispersal blades 36 for the purpose of controlling fuel flow.

The sections of the casing 22 may be in the form of a hollow saucer which can be connected together by bolts 63 to form a continuous passage for the fuel from the inlet collar 24 through the channels 31 then through the outlet collar 23. The central cavity 47 is sealed from and is independent of the fuel passages 31 and the compartment or cavity 47 serves to house the purging mechanism as shown in Figure 2.

The housing 20 serves to confine the foreign matter, waste fuel and fumes expelled into it through the discharge ports 38 by the purging mechanism from the sludge orifices 37 and these wastes are in turn carried from the housing 20 by a drain tube 21 to a suitable discharge area.

In actual operation fuel is drawn from a suitable tank and flows in the direction of the arrows in Figure 2 from the conduit 17 to the collar 24 and this fuel is picked up by the pump blade ends 35 of the baffles and this fuel continues from the inlet and is made to flow in an arc to the outer extreme limits of the passages 31 through the channels provided by the baffles 34 which connect the inner and outer walls. After reaching the outer extreme limits of the passages, the fuel reverses direction and converges from the outer passages toward the center until it reaches the outlet collar 23. There the fuel is assisted in discharge by the dispersal action of the blades 36 and these blades 36 serve to reduce turbulence of the fuel being discharged into the pumping unit 14.

The purging mechanism is shown in detail in Figure 2 and in use air can be supplied through the conduit 56 to force the piston 53 from right to left so that the push rod 52 bears against the ball 51 and moves the tappet 43 from the solid line position of Figure 2 to the broken line position of Figure 2. This compresses the retrieving spring 49 and the connecting rods 41 are moved to the broken line position of Figure 2 whereby the valves 40 which are attached to the rods are lifted from their seats 39 to uncover the drain holes 38 and the expelling orifices 37 and when these ports are momentarily uncovered, foreign matter which has collected in the sludge grooves 32 will be forced from the assembly by fuel pressure and centrifugal force into the outer housing 20 to be drained off at 21. When the actuating air pressure is released from the piston 53, all of the moving parts of the purging mechanism will be speedily snapped back to their original positions by the combined pressure of the spring 49 and centrifugal force.

This self purging feature can be actuated by a suitable sensitive mechanism located in the unit so that it will function only when sufficient foreign matter has accumulated so as to disturb the balance of the unit. An alternate method of operating the purging unit is to install an electrical device which will automatically actuate purging at predetermined time intervals as is used to control aircraft running lights.

The power for operating the booster and separator unit is derived from the splined shaft 29 which is inserted with a press fit in the socket 28 of the hub 27. The baffles may continue in a straight line through the casing as continuous baffles and the baffle blades are in line with corresponding impeller pumping blades of the pressure pump 14.

The casing 22 includes the offset portions 65 so that with the fuel passage divided into channels or quadrants by the four baffles 34, the outer periphery or confines of

the fuel passage together with the sludge groove, is adapted to lie in an eccentric plane or orbit about the central rotary axis of the machine, starting at the purging valve on the right which is near the center and ending at the next purging valve on the left which is of greater distance from the center axis. With the outermost confines of the fuel passage and the adjacent sludge groove **32** arranged thusly, foreign matter or sludge will be caused to move in the direction of and to concentrate near the expelling port by the same centrifugal force which caused it to be separated from the fuel and/or liquid. This construction serves to prepare the sludge for quick removal and expedites the purging action by reducing the time element and fuel waste to a minimum. Thus, the outer confines of the fuel passage and sludge groove have their starting point near to the center axis and terminate on their opposite limits at a point of greater distance from the same axis. This eccentric arrangement of the passages **31** and grooves **32** is shown in Figure 3 so that there will be a concentration of sludge at the expelling port to expedite or facilitate the purging of the sludge.

The fluid will flow or move through the passages **31** so that the sludge or foreign matter will pass by centrifugal force into the grooves **32**. The four baffles **34** which divide the fuel passage into four channels do not extend into the grooves **32**. The baffle **34** serves as a reinforcing web intermediate its ends and the baffles **34** terminate in pumping blades **35** in the inlet collar **24**, and the baffles also terminate into dispersal blades **36** which are arranged in the collar **23**. The four baffles **34** are positioned between and equi-distant from the four purging valves and the contour and thickness of the passage **31** and casing **22** is uniform and equal at these four points.

I claim:

1. In combination, a base, a motor supported on said base and adapted to be connected to a source of electrical energy, a pump mounted on said base and driven by said motor, a centrifugal booster and separator unit connected to said pump, means for supplying fluid to the centrifugal booster and separator unit, said centrifugal booster and separator comprising a pair of brackets secured to said base, a hollow housing secured to said brackets, a pipe communicating with the interior of said housing for the egress therethrough of impurities, foreign matter and the like, a casing rotatably mounted in said housing and including a first and second annular collar extending from each end thereof, ball bearings mounted on each collar and interposed between the collar and housing, a hub extending from said casing and positioned within said first collar, there being a socket in said hub, a drive shaft extending into said hub for rotating said casing, there being arcuate channels in said casing communicating with said collars for the passage therethrough of fluid, there being arcuate grooves in the outer portion of said casing communicating with said channels, a plurality of blades, and valve means for controlling discharge of material from said grooves.

2. In combination, a base, a motor supported on said base and adapted to be connected to a source of electrical energy, a pump mounted on said base and driven by said motor, a centrifugal booster and separator unit connected to said pump, means for supplying fluid to the centrifugal booster and separator unit, said centrifugal booster and separator unit comprising a pair of brackets secured to said base, a hollow housing secured to said brackets, a pipe communicating with the interior of said housing for the egress therethrough of impurities, foreign matter and the like, a casing rotatably mounted in said housing and including a first and second annular collar extending from each end thereof, ball bearings mounted on each collar and interposed between the collar and housing, a hub extending from said casing and positioned within said first collar, there being a socket in said hub, a drive shaft extending into said hub for rotating said casing,

there being arcuate channels in said casing communicating with said collars for the passage therethrough of fluid, there being arcuate grooves in the outer portion of said casing communicating with said channels, a plurality of blades, and valve means for controlling discharge of material from said grooves, said means comprising a plurality of spaced ports in said casing communicating with said grooves, valve seats arranged contiguous to said ports, valve members mounted for movement into and out of closing relation with respect to said valve seats, the interior of said casing being hollow to provide a compartment, a guide pin projecting from said hub into said compartment, a tappet positioned in said compartment and slidably mounted on said guide pin, pivotally mounted tie rods extending between said valve members and tappet, a coil spring circumposed on said guide pin and abutting said tappet, a ball pressure bearing abutting an end of said tappet, a push rod projecting through said second collar and abutting said ball pressure bearing, a piston mounted on the outer end of said push rod, a cylinder surrounding said piston, and a conduit for supplying air to said cylinder.

3. In a centrifugal booster and separator, a stationary housing, a casing rotatably positioned in said housing, means for supplying fluid to one end of said casing, means for removing filtered fluid from the casing, there being arcuate passageways in said casing for the passage therethrough of fluid, there being grooves in the outer portion of said casing communicating with said passageways for receiving foreign matter, impurities and the like, and valve means for controlling discharge of material from said grooves, said valve means comprising discharge openings through which the material from the grooves can pass, there being a plurality of discharge ports adapted to receive the material from the discharge openings, a valve seat arranged contiguous to each of the discharge ports, and a valve member mounted for movement into and out of closing or bridging relation with respect to each of the valve seats.

4. A device of the type described comprising: a casing mountable for rotation about an axis and having a plurality of separate longitudinally extending passageways, said passageways extending from an axial inlet to an axial outlet of said casing, said passageways curving from the inlet outwardly to an intermediate point remote from the axis and then curving inwardly toward the outlet, blade means in said casing separating said passageways and extending from within the axial inlet to the axial outlet the portions of the blade means in the axial inlet being spirally disposed to serve as an impeller for driving fluids through said passageways and the portion of said blades in the axial outlet being correspondingly spiralled to serve as an impeller to propel fluids from within said passageway to the outlet, said blade means directing all the fluid in said passage through the curved passageways whereby centrifugal force acts on all the fluid passing through the passageways, said casing being provided with means for receiving solid materials separated from fluids, each of said receiving means opening inwardly into said passageways and being disposed in a plane substantially perpendicular to said axis and adjacent said intermediate point.

5. A device of the type described comprising: a casing for rotation about an axis and having a plurality of separate longitudinally extending passageways, said passageways extending from an axial inlet to an axial outlet of said casing, said passageways curving from the inlet outwardly to an intermediate point remote from the axis and then curving inwardly toward the outlet, blade means in said casing separating said passageways and extending from within the axial inlet to the axial outlet the portions of the blade means in the axial inlet being spirally disposed to serve as an impeller for driving fluids through said passageways and the portion of said blades in the axial outlet being correspondingly

spiralled to serve as an impeller to propel fluids from within said passageway to the outlet, said blade means directing all the fluid in said passage through the curved passageways whereby centrifugal force acts on all the fluid passing through the passageways, said casing being provided with grooves, each of said grooves opening inwardly into said passageways and being disposed in a plane substantially perpendicular to said axis and adjacent said intermediate point.

6. A device of the type described comprising: a casing mountable for rotation about an axis and having a plurality of separate longitudinally extending passageways, said passageways extending from an axial inlet to an axial outlet of said casing, said passageways curving from the inlet outwardly to an intermediate point remote from the axis and then curving inwardly toward the outlet, blade means in said casing separating said passageways and extending from within the axial inlet to the axial outlet the portions of the blade means in the axial inlet being spirally disposed to serve as an impeller for driving fluids through said passageways and the portion of said blades in the axial outlet being correspondingly spiralled to serve as an impeller to propel fluids from within said passageway to the outlet, said blade means directing all the fluid in said passage through the curved passageways whereby centrifugal force acts on all the fluid passing through the passageways, said casing being provided with grooves, each of said grooves opening inwardly into said passageways and being disposed in a plane substantially perpendicular to said axis and adjacent said intermediate point, said casing having radial apertures communicating with said grooves, and means for selectively closing said radial apertures.

7. A device of the type described comprising: a casing mountable for rotation about an axis and having a plurality of separate longitudinally extending passageways, said passageways extending from an axial inlet to an axial outlet of said casing, said passageways curving from the inlet outwardly to an intermediate point remote from the axis and then curving inwardly toward the outlet, blade means in said casing separating said passageways and extending from within the axial inlet to the axial outlet the portions of the blade means in the axial inlet being spirally disposed to serve as an impeller for driving fluids through said passageways and the portion of said blades in the axial outlet being correspondingly spiralled to serve as an impeller to propel fluids from within said passageway to the outlet, said blade means directing all the fluid in said passage through the curved passageways whereby centrifugal force acts on all the fluid passing through the passageways, said casing being provided with grooves, each of said grooves opening inwardly into said passageways and being disposed in a plane substantially perpendicular to said axis and adjacent said intermediate point, and a plurality of blades disposed in planes which longitudinally intersect said axis and extending into said passageways.

8. A device of the type described comprising: a casing mountable for rotation about an axis and having a plurality of separate longitudinally extending passageways, said passageways extending from an axial inlet to an axial outlet of said casing, said passageways curving from the inlet outwardly to an intermediate point remote from the axis and then curving inwardly toward the outlet, blade means in said casing separating said passageways and extending from within the axial inlet to the axial outlet the portions of the blade means in the axial inlet being spirally disposed to serve as an impeller for driving fluids through said passageways and the portion of said blades in the axial outlet being correspondingly spiralled to serve as an impeller to propel fluids from within said passageway to the outlet, said blade means directing all the fluid in said passage through the curved passageways whereby centrifugal force acts on all the fluid passing through the passageways, said casing being provided with grooves, each of said grooves opening inwardly into said passageways and being disposed in a plane substantially perpendicular to said axis and adjacent said intermediate point, and a plurality of blades disposed in planes which longitudinally intersect said axis and extending into said passageways; said blades extending into said inlet and being curved whereby said blades propel fluid passing into the passageways from the inlet.

9. A device of the type described comprising: a casing mountable for rotation about an axis and having a plurality of separate longitudinally extending passageways, said passageways extending from an axial inlet to an axial outlet of said casing, said passageways curving from the inlet outwardly to an intermediate point remote from the axis and then curving inwardly toward the outlet, blade means in said casing separating said passageways and extending from within the axial inlet to the axial outlet the portions of the blade means in the axial inlet being spirally disposed to serve as an impeller for driving fluids through said passageways and the portion of said blades in the axial outlet being correspondingly spiralled to serve as an impeller to propel fluids from within said passageway to the outlet, said blade means directing all the fluid in said passage through the curved passageways whereby centrifugal force acts on all the fluid passing through the passageways, said casing being provided with grooves, each of said grooves opening inwardly into said passageways and being disposed in a plane substantially perpendicular to said axis and adjacent said intermediate point, and a plurality of blades disposed in planes which longitudinally intersect said axis, and extending into said passageways, said blades extending into said inlet and being curved whereby said blades propel fluid passing into the passageways from the inlet, said blades also extending into said outlet and being curved about said axis to reduce turbulence of fluid passing from the passageways through the outlet.

10. A device of the type described comprising: a casing mountable for rotation about an axis and having a plurality of passageways, said passageways extending from an axial inlet to an axial outlet, said passageways curving from the inlet outwardly to an intermediate point remote from the axis and then curving inwardly toward the outlet, said casing being provided with grooves, each of said grooves opening inwardly into said passageways and being disposed in a plane substantially perpendicular to said axis and adjacent said intermediate point, said casing having radial apertures communicating with said grooves, and valve means disposed to move substantially perpendicular to said axis and cooperating with said radial apertures to control discharge of material from said grooves, said valve means comprising discharge openings through which the material from the grooves can pass, there being a plurality of discharge ports adapted to receive the material from the discharge openings, a valve seat arranged contiguous to each of the discharge ports, and a valve member mounted for movement into and out of closing or bridging relation with respect to each of the valve seats.

11. A device of the type described comprising: a casing mountable for rotation about an axis and having a plurality of passageways, said passageways extending from an axial inlet to an axial outlet, said passageways curving from the inlet outwardly to an intermediate point remote from the axis and then curving inwardly toward the outlet, said casing being provided with grooves, each of said grooves opening inwardly into said passageways and being disposed in a plane substantially perpendicular to said axis and adjacent said intermediate point, said casing having radial apertures communicating with said grooves, and valve means disposed to move substantially perpendicular to said axis and cooperating with said radial apertures to control discharge of material from said grooves, said valve means comprising discharge open-

ings through which the material from the grooves can pass, there being a plurality of discharge ports adapted to receive the material from the discharge openings, a valve seat arranged contiguous to each of the discharge ports, and a valve member mounted for movement into and out of closing or bridging relation with respect to each of the valve seats, and means connected with each of said valves within the casing and movable within said casing to move said valves to open and closed position.

12. A device of the type described comprising: a casing mountable for rotation about an axis and having a plurality of passageways, said passageways extending from an axial inlet to an axial outlet, said passageways curving from the inlet outwardly to an intermediate point remote from the axis and then curving inwardly toward the outlet, said casing being provided with grooves, each of said grooves opening inwardly into said passageways and being disposed in a plane substantially perpendicular to said axis and adjacent said intermediate point, said casing having radial apertures communicating with said grooves, and means for selectively closing said radial apertures comprising, valve means movably disposed in said casing to open and close said apertures, and means connected with said valve means and operable to move said valve means between aperture opening and closing positions.

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