Oct. 8, 1940. H. E. MARVEL 2,216,921

METHOD AND APPARATUS FOR INTRODUCING SOLIDS INTO A PRESSURE SYSTEM

Filed May 28, 1937 3 Sheets-Sheet 1

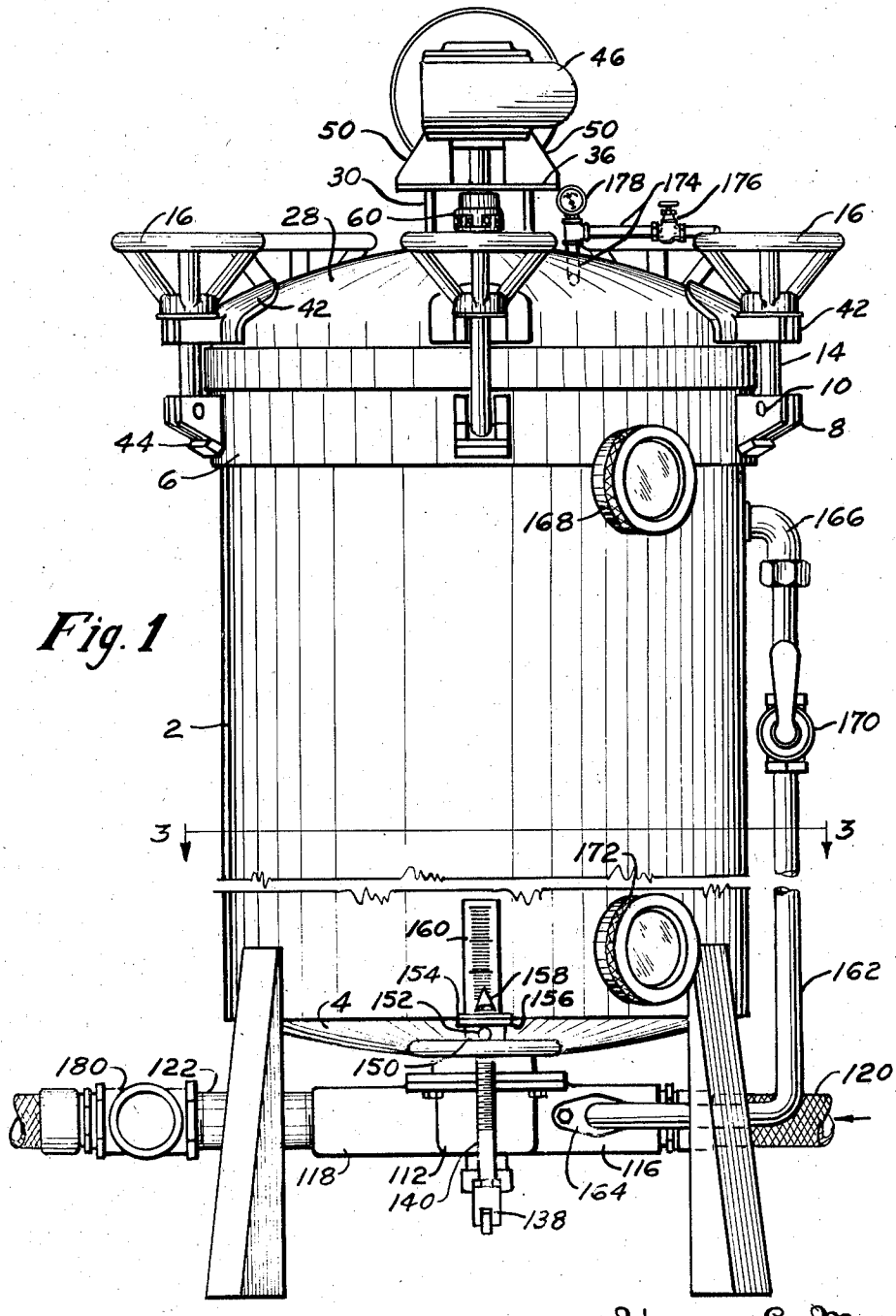


Fig. 1

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METHOD AND APPARATUS FOR INTRODUCING SOLIDS INTO A PRESSURE SYSTEM

Filed May 28, 1937 3 Sheets-Sheet 2

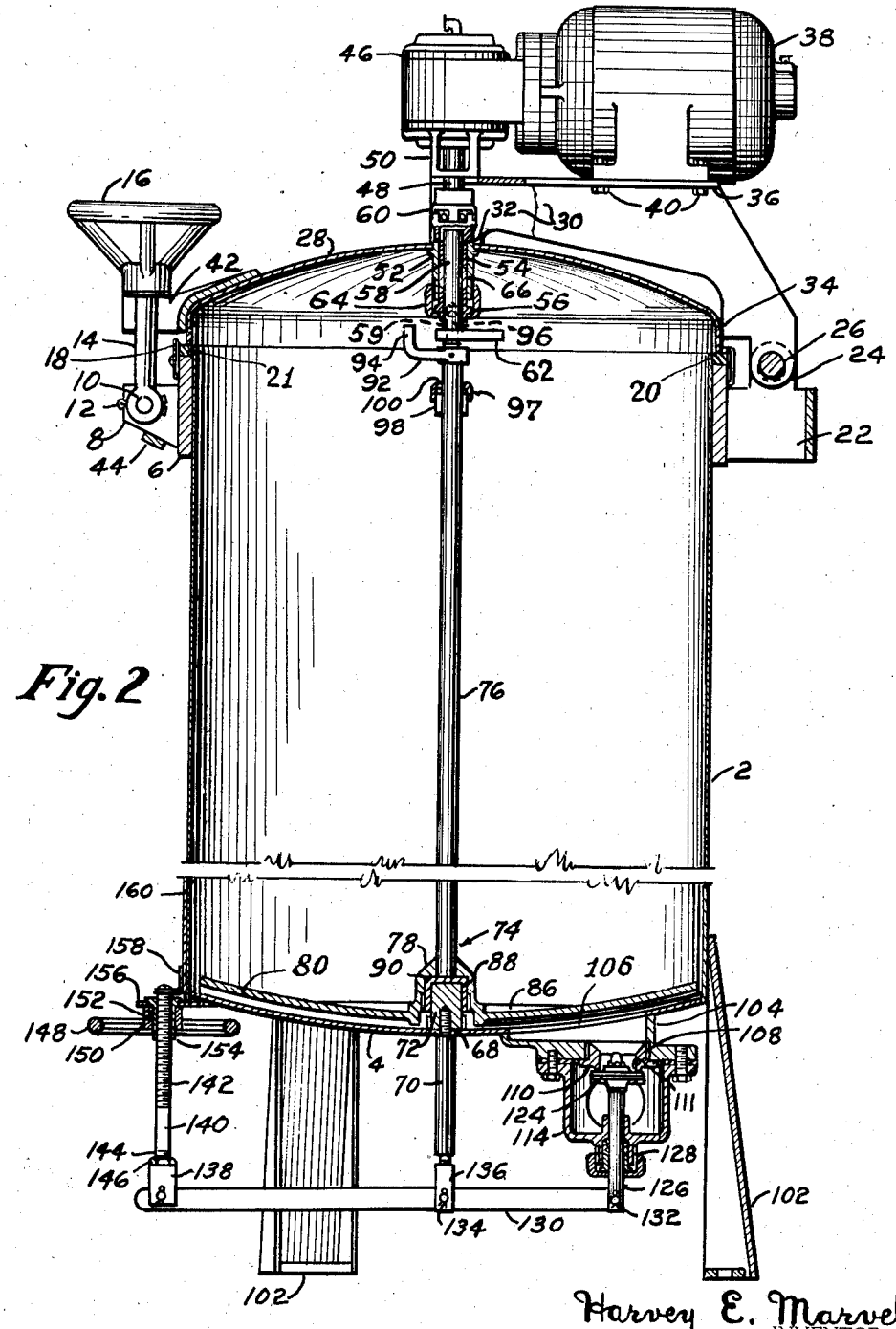


Fig. 2

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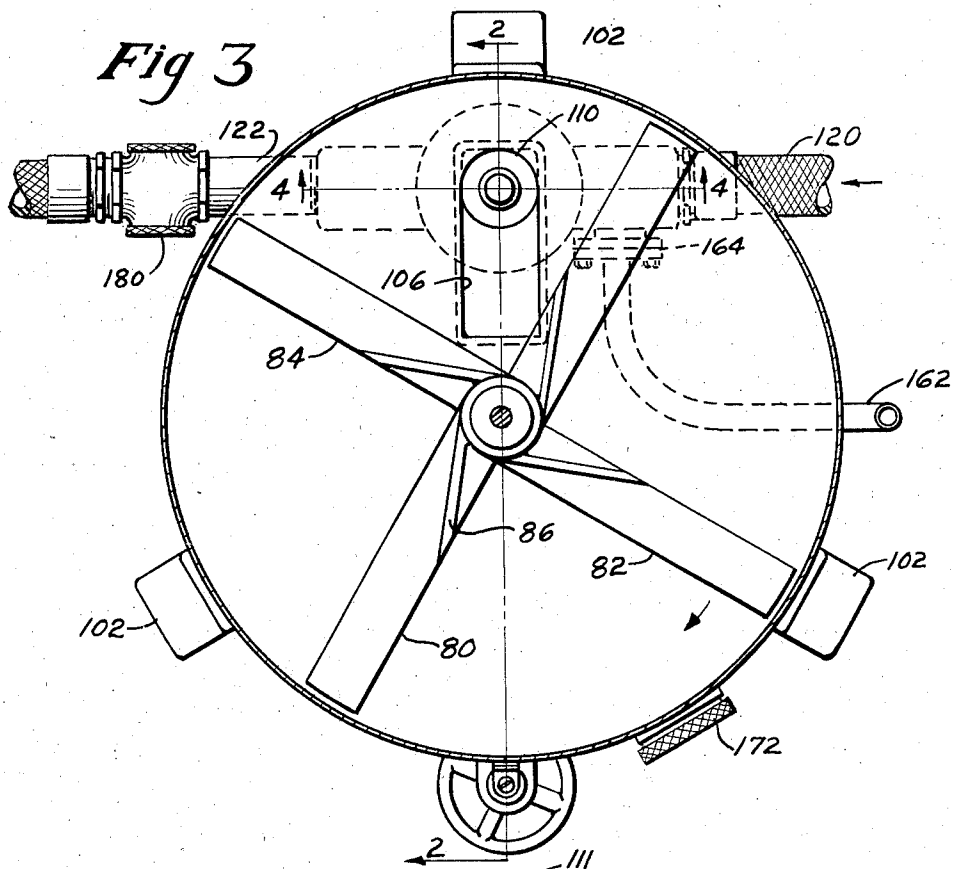
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METHOD AND APPARATUS FOR INTRODUCING SOLIDS INTO A PRESSURE SYSTEM

Filed May 28, 1937 3 Sheets-Sheet 3

Fig 3



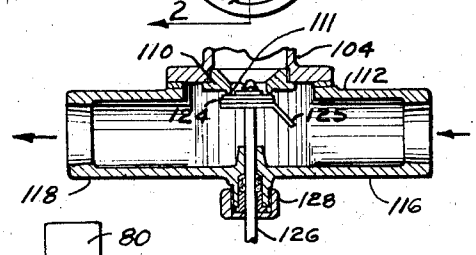


Fig 4

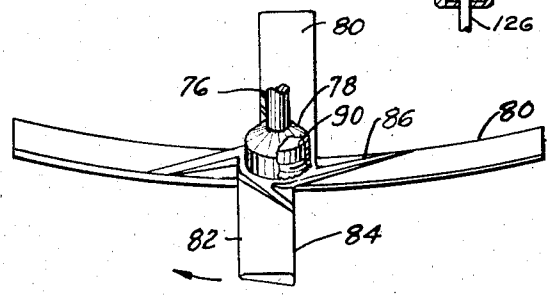


Fig. 5

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UNITED STATES PATENT OFFICE

2,216,921

METHOD AND APPARATUS FOR INTRODUCING SOLIDS INTO A PRESSURE SYSTEM

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Application May 28, 1937, Serial No. 145,326

16 Claims. (Cl. 210—1)

The invention relates to a method and apparatus for introducing solids into a pressure system or, more specifically, for introducing substances such as diatomaceous earth or other filter aids into a stream of unfiltered liquid which is being forced under pressure to a filter.

Heretofore, in systems of the type described, it has been customary to form a suspension of filter aid and unfiltered liquid commonly called slurry and to introduce this slurry in the stream of unfiltered liquid on the discharge side of the main pump by means of a small slurry pump. The reason for this was that the filter aid is usually abrasive and the pumps, which have close fitting and rapidly moving parts, become severely worn. It was preferable to provide an additional pump of small capacity which could be replaced more cheaply than the main pump rather than to subject the main pump to the wear and damage occasioned by the abrasive action of the filter aid. It is needless to say, however, that the replacement of the slurry pump and the repairs for this pump were no small items in the cost of operating such filtering systems. Further it was highly inconvenient to be forced to stop filtering due to break-down of the slurry pump.

Since the filter aid is usually much heavier than liquid in which it is suspended, it was usually necessary to maintain the slurry agitated at all times so that a uniform quantity of filter aid would be introduced in the raw liquid flowing to the filter by the slurry pump. Even with the use of agitators some difficulty was experienced in maintaining the slurry uniform throughout because of the tendency of the filter aid to concentrate at a certain level in the tank.

It is an object of the present invention to eliminate the slurry pump from systems of the type described.

It is a further object of the invention to eliminate the necessity for agitating the filter aid.

It is yet another object to eliminate the formation and maintenance of a slurry mixture as such.

Yet another object of the invention is to materially reduce the size of the equipment necessary to supply filter aid to a filtering system.

Still another object of the invention is to reduce to a minimum the number of moving parts which are subjected to the abrasive action of the filter aid.

A further object of the invention is to provide for the ready removal and replacement of parts which may be subjected to the abrasive action of the filter aid.

Still another object of the invention is to provide for the replacement of worn parts at a minimum of expense.

Another object of the invention is to provide easy access to all parts of the equipment for purposes of cleaning and sterilization.

A further object of the invention is to provide for accurate regulation of the feeding of filter aid to the filter.

It is another object of the invention to provide for a wide range of regulation in the feeding of filter aid to the filter.

It is another object of the invention to provide for the feeding of a substantially solid stream of filter aid into the stream of unfiltered liquid.

It is a still further object of the invention to maintain a substantially solid column of filter aid from which quantities of filter aid are mechanically fed into the stream of unfiltered liquid.

Another object of the invention is to maintain a substantially solid column of filter aid under substantially balanced fluid pressure, and to feed the filter aid mechanically into the stream of unfiltered liquid.

A still further object of the invention is to feed filter aid from a substantially solid column into a stream of filterable fluid under pressure, by mechanically feeding said filter aid through an adjustable orifice while the pressures on opposite sides of the orifice are substantially balanced.

Another object of the invention is to provide a filter aid feeding apparatus which may be recharged without interrupting the filtering operation or necessitating shutting down of the system.

Another object of the invention is to provide a filter aid feeding device which has a substantially smaller size than a slurry tank having the same filter air capacity.

These and other objects of the invention will become apparent from a study of the specification together with the drawings of which:

Figure 1 is an elevation of the filter aid feeding apparatus viewed from the front.

Figure 2 is a vertical section of the filter aid feeding apparatus taken on the line 2—2 of Figure 3.

Figure 3 is a horizontal section taken on the line 3—3 of Figure 1.

Figure 4 is a vertical section taken on the line 4—4 of Figure 3 and showing the details of the valve and receiving member.

Figure 5 is a perspective view, partly broken away of the impeller mechanism.

In the drawings, the numeral 2 designates a container which is preferably cylindrical in shape

and which is provided with a bottom head 4 of generally spherical or dished form to facilitate cleaning and to give strength to the structure. Fixed to the upper portion of the container is a ring 6 which is adapted to support pairs of ears 8 which are equi-distantly spaced about the periphery of the ring. Each pair of ears rotatably supports a wrist pin 10 to which is fastened by means of a cotter pin 12 a clamping bolt 14. Each bolt is threaded at its free end and is adapted to receive a hand wheel 16.

A band 18 telescopically engages the ring 6 and extends beyond the upper edge thereof. This band is fixed to the ring by means of suitable fastenings and serves to form with ring 6 and the upper end of container 6 and an annular channel 20 which is adapted to receive a gasket 21 of rubber or other suitable material.

Attached to the ring 6 as shown in Figure 2 is a U-shaped support 22 forming one member of a hinge. The open end of the support is fixed to the ring as by welding or otherwise attaching the two legs thereof to the ring. Two upstanding projections 24 are formed, one on each leg of the U-shaped support, and these projections are perforated to receive the ends of a hinge pin 26.

A dished head 28 is provided to close the upper end of the container by resting with its peripheral edge, upon gasket 21. Two L-shaped members 30 are arranged in parallel relationship with each other and edgewise with respect to the cover and are welded or otherwise attached thereto at 32 and 34 in Figure 2. A plate 36 is welded or otherwise fixed to the upper edges of said members and forms a base for the motor 38 which is held in position thereon by bolts 40.

The depending legs of the L-shaped members which form the movable section of the hinge, extend between the projections 24 of the U-shaped member, into the path of the hinge pin 26 and are perforated to receive the same. By these means the head 28 is hinged together with the motor and other gear to the container 2 so that access may be had to the interior thereof by swinging the head out of the way.

The perforations in ears 24 are slightly elongated so as to permit a vertical downward motion of the entire head and the mechanism supported thereby so that the gasket 20 may be compressed evenly throughout the entire circumference of the container. Further, as the head is swung on the hinge pin 26, the bow portion of the U-shaped member 22 will be engaged by the outer edges of the portions of the L-shaped members and the amount of rotation of the cover about the hinge pin will be limited to that required to establish a stable open position of the lid.

Bifurcated ears or lugs 42 are welded or otherwise attached to the head 28 in alignment with the pairs of ears 8 and so as to receive the clamping bolts 14 in the bifurcations. Thus it will readily be seen that by drawing the handwheels down upon the lugs 42, the gasket 20 may be evenly compressed to form a pressure seal about the entire top of the container.

A bumper 44 is attached to span each pair of ears 8 and is adapted to engage the shank of clamping bolt to prevent the handwheel from engaging and marring the exterior of the container if it is carelessly released from the grasp of the operator.

Attached in any suitable manner as to be driven by the motor 38 is a speed reducing gear set 46 which causes the shaft 48 to be driven at a speed of about ten or eleven revolutions per minute. The gear set is supported in part by a pair of bracket members 50 which are fixed to the plate 36 and in part by the motor housing.

The head 28 is perforated centrally and is provided with an elongated tubular housing 52 which extends through and is welded or otherwise attached to the head. A bearing 54 and a combined bearing and packing gland 56 fit inside of this housing and serve to support a shaft 58 which at its upper end has attached one part of a flexible coupling 60 and at its lower end has attached a radially extending arm 62. The member 56 has a peripheral collar which is adapted to be engaged by a packing nut 64 so that as the latter is screwed onto the housing 52, the packing 66 which lies between bearings 54 and 56 may be compressed to seal the container. The lower end of shaft 58 is bored out as at 59 so as to form a pilot bearing for the impeller shaft to be described.

The bottom head of the container is also centrally perforated to receive one externally threaded end 68 of a stud 70 which after being inserted through the perforation is welded into place in the container to seal it. A journal member 72 is screwed in place on the end 68 of the stud and serves to locate and hold in position the impeller mechanism designated generally by the numeral 74.

This mechanism comprises a driving shaft 76 which is welded or otherwise suitably attached to a hub 78 which carries blades 80. These are preferably four in number (see Figure 5) and are curved so as to conform rather closely to the curvature of the bottom head 4.

Each blade has a transverse cross-section which is wedge shaped as is clearly shown in Figure 5. The incline of the blade is from the leading edge 82 downward to the trailing edge 84 so that as the blade is rotated in the direction of the arrow in said figure, it will tend to crowd the filter aid with which it comes in contact, downwardly.

Each blade is also provided with a rib 86 which extends above the upper surface of the blade and which extends from near the hub at the leading edge of the blade, transversely and outwardly (diagonally) of the blade to a point located at a distance of approximately one-third the length of the blade from the hub and located on the trailing edge of the blade. This rib is substantially rectangular in cross-section but decreases in depth as it approaches the trailing edge 84 of blade 80 at which point the rib merges entirely with the blade. The rib will, when the blade is rotated in the direction of the arrows in Figures 3 and 5, tend to crowd any filter aid with which it comes in contact, away from the hub.

As is clearly shown in Figure 3, the blades 80 are disposed, when viewed in plan, with their longitudinal axis in advance, in the direction of rotation, of perpendicular intersecting diameters of the hub 78 which are parallel to said blades. By reason of this arrangement, filter aid contacted by the blades is fed radially outward from the shaft 76 as well as circumferentially thereof in the same manner as it is fed by the ribs 86.

The hub 78 is provided with a blind bore 88 which is internally threaded and adapted to receive an externally threaded bushing 90 which serves as a bearing for the journal member 72. Both the bushing and the journal member are

subjected to the abrasive action of the filter aid, but because they are small and simply designed parts and are simply attached, they can be replaced with a minimum of expense and effort.

Fixed to the upper end of the shaft 76 is a radially extending crank 92 having an axially extending tail portion 94 which lies in the path of rotation of the lever 62 which is driven by shaft 58. The shaft 67 is also provided with a pilot journal 96 which extends into a bore in the shaft 58 so that the blades 80 may be held in proper spaced relation with respect to the bottom head 4. The journal 96 is provided with a conical tip which facilitates the entry of the journal in the bore 58 as the upper head 28 is swung to seat on the gasket 20. A channel shaped guide member 97 is supported by angle brackets 98 which are welded or otherwise suitably attached to the interior of the chamber at diametrically opposite points so that one leg of each bracket will lie with a flat side uppermost and will extend inwardly from the container wall on the same diameter (see Figure 2). The guide member is positioned with its channel fitting over said inwardly directed legs and is perforated centrally at 100. It is assembled on the shaft 76 before the crank 92 is attached thereto and serves to maintain the shaft 76 in an upright and central position so that it will readily enter the bearing in shaft 58.

The container 2 and its appurtenances just described are supported by a plurality of legs 102 which raise it a sufficient distance to permit hose or pipe connections and a control mechanism to be arranged below the container.

A discharge member 104 is welded or otherwise attached to the bottom head 4 in alignment with an opening 106 therein. This opening is substantially rectangular in form and is arranged so that its longer axis coincides with a radius of the container.

The discharge casting is provided with an opening 108 into which is fitted by means of screw threads or in any suitable manner a valve seat member 110 which is beveled at its inner end so as to facilitate the movement of filter aid to and through an orifice 111 therein (see Figures 2 and 4).

A member 112 having a deep chamber 114 which is open at its upper end, is attached by means of cap screws to the discharge member 104 so as to receive the filter aid discharged from the latter. The member 112 is provided with an inlet stub 116 and an outlet stub 118 which are internally threaded to receive respectively the couplings of conduit 120 leading from the pump discharge and conduit 122 leading to the filter intake (see Figures 1 to 4). Both stubs communicate with chamber 114.

As shown in Figures 2 and 4, a valve 124 is mounted inside of chamber 114 and is adapted to cooperate with the seat member 110 to regulate the opening 111 of the passageway between the interior of the container 2 and the chamber 114. The stem 126 of the valve projects through the bottom of chamber 114 and through a stuffing box 128.

A deflector 125 is mounted on the valve stem as shown in Figure 4 and is directed upstream toward the inlet stub 116 so that some of the liquid flowing into chamber 114 will be deflected up over the valve so as to wash it constantly to prevent accumulation of filter aid thereon. This promotes an even and constant feed of filter aid.

The lower end of the valve stem is slotted so as to receive one end of a lever 130 and a pin 132 maintains the lever in the slot. The lever has as a fulcrum a pin 134 which is supported in a clevis 136 which threadedly engages the lower end of the stud 70 and which may be adjusted up or down thereon.

The forward end of the lever 130 is pivotally supported in a clevis 138 which is threadedly supported on the lower end of an adjusting shaft 140 which has a long thread 142 at its upper end and a short thread 144 at the lower end. A jam nut 146 locks the clevis in adjusted position.

A hand-wheel 148 is provided with an internally threaded hub 150 and a set screw 152 which is adapted to maintain a selected relation between the hand-wheel and a bushing or sleeve 154 which has a radially extending flange at one end, a reduced bearing portion adjacent said flange and a further reduced portion which is threaded to fit into the internally threaded hub of the hand-wheel. The bushing is internally threaded to receive the upper threaded portion 142 of the shaft 140. A perforated support 156 is welded or otherwise fixed to the lower portion of the container 2 and is adapted to receive the reduced bearing portion of the bushing. Thus the hand-wheel and bushing are rotatably supported in the opening of the support 156 but are held against axial motion relative to it. The long thread 142 of the shaft 140 will thus be drawn into or ejected from the bushing as the hand-wheel is rotated in one direction or the other and the valve 124 will be correspondingly opened or closed.

An indicator 158 is fixed to the upper end of shaft 140 and will be moved by it over the scale 160 which is attached to container 2 to indicate the pounds per barrel of filter aid which will be discharged at a particular valve setting. The scale may of course be calibrated in any suitable unit other than in terms of pounds per barrel if it is desired.

A pressure balancing conduit 162 is connected at one end to the inlet stub 116 by means of a flange 164 or other suitable connection and is connected at its other end to an L fitting 166 which is attached in any suitable manner to the container and which communicates with the interior thereof. The fitting opens into said container at a point slightly below the band 6. The upper sight glass 168 and the L are so arranged that when the level of liquid in the container reaches the center line of the opening leading to the L, the liquid level will just be visible in the sight glass.

A valve 170 is provided in the conduit 162 so that pressure may be cut off from the container.

A lower sight glass 172 is also provided so that the level of the filter aid will become visible to the operator as the filter aid supply approaches exhaustion.

As clearly appears from Figure 1, a vent line 174 is attached to the head 28 and communicates with the interior of the container 2 at the upper portion thereof. A valve 176 is provided in said line to control the flow of fluid therethrough. A pressure gauge 178 may also be provided for the convenience of the operator in controlling the valve 176. Means may be provided for attaching an air hose to the valve 176 if this is desired and the vent is so located in the head 28 that the head may be lifted without interference from such hose.

If desired, a sight glass 180 may be placed in the conduit 122 which leads to the filter intake so

that the operator may visually check upon the quantity of filter aid being fed to the flow line and the uniformity with which it is being fed, to insure that the apparatus is operating properly.

Operation

Assuming that the apparatus has been thoroughly cleaned, the operator will entirely close valves 124 and 170 and insert the impeller mechanism in the container being careful that the bushing 88 and journal member 72 are fully engaged and that the channel member 97 is supported on the rests 98.

An amount of filter aid sufficient to pre-coat and to last throughout the run will now be deposited in the container 2 and the top head 28 with its attached mechanisms will be swung about the hinge pin 26 to a position in which it rests upon the gasket 21. It will be seen that the pilot journal 96 must enter the bore in shaft 58 and this is facilitated by the channel 97 which supports the journal in a central position and by the conical end on the journal which serves to guide the journal into the bore. The fit between the journal and bore is loose so as to eliminate the possibility of the journal binding in the bore.

The hand-wheels 16 are now swung into position over lugs 42 and uniformly drawn down thereon so as to compress the gasket 21 and to seal the container. The vertical motion of the head in response to the operation of the hand-wheels is permitted by the elongated perforations in the ears 24 of the hinge.

The valve 176 in the vent line is opened and with the main pump started, the valve 170 in the conduit 162 is opened and some of the liquid to be filtered is discharged into the container. The valve 176 is closed when the liquid level in the container rises to the center of the sight glass 168. The valve 170 is not closed, and consequently liquid is fed into the container until the air in the upper portion of the container is compressed to the point that the pressure in the container is substantially the same as that in conduits 120, 122 and in chamber 114.

Under these conditions the filter aid, having a greater density than the liquid, will settle into a mass or column in the lower portion of the tank and a definite line of demarcation between the filter aid and the liquid will appear in the sight glass 168 provided of course that the container has been charged with a sufficient quantity of filter aid to bring it to the level of the glass. This line of demarcation is never obliterated but gradually moves downward as filter aid is discharged from the container.

The motor 38 will next be started and lever 62 will rotate and engage the tail 94 of crank 92 whereupon the impeller will be rotated at a speed of between ten and eleven revolutions a minute. Since the speed of rotation is so slow and since the blades of the impeller are not formed so as to lift the filter aid, the column of filter aid will not be disturbed sufficiently to form a suspension but will remain in a sedentary mass in the lower portion of the container.

Next the hand-wheel 148 is operated to move the pointer 158 opposite the graduation on scale 160 which indicates the setting of valve 124 which is necessary for pre-coating. In this position, the valve 124 is open a substantial distance and the rate of discharge of filter aid from the container is high. The rotating blades 80 tend to crowd the filter aid from the container 2 into the discharge member 104 and out through the orifice 111 in valve member 110 into chamber 114. Part of the stream of fluid flowing from stub 116 into the chamber 114 will be deflected by the member 125 over the face of the valve and will keep it washed free of filter aid.

When the pre-coating step of the filtering process is completed, the hand-wheel 148 is again adjusted, this time to reduce the valve opening to the point at which the required pounds of filter aid per barrel of liquid is being discharged from the container. The desired position of the valve may be determined by aligning the indicator 158 with the proper graduation on scale 160.

As the filtering operation goes on, the pressure at the intake of the filter increases and consequently the pressure in chamber 114 increases. However, the pressure in the container 2 is also increased correspondingly because the conduit 162 is maintained open during operation. Consequently the pressure in the container at one side of the valve seat member is at all times substantially the same as that in the chamber 114 and on the other side of the valve seat member. Thus, practically the only effective feeding action is that produced by the impeller blades.

As is clearly shown in Figure 3, the opening 106 in the lower head does not extend to the axis of the rotor. For this reason there may in some cases be a tendency for the central portion of the filter aid column to remain undisturbed near the shaft 76. To prevent formation of such a central column of filter aid, the ribs 86 are provided and it can readily be seen that as the impeller is rotated in the direction of the arrow in Figure 5, the ribs will continuously force centrally disposed filter aid away from the region near shaft 67 and toward the outer ends of the blades 8 where it is in position to be moved to opening 106 and to be crowded therethrough by the impeller blades.

It is to be noted that for the pre-coating operation the valve 124 may be opened a sufficient distance to allow 16 to 20 or more pounds of filter aid to be dispensed in a relatively short time. But while operating the filter after pre-coating the valve 124 may be closed to such an extent that only a small amount of filter aid will be dispensed and this at a constant and uniform rate. With the apparatus embodying applicant's invention the rate of feeding filter aid has been successfully reduced to six-hundredth pound per barrel (.06#/bbl.) of liquid flowing to the filter without in any way sacrificing or disturbing the constancy and uniformity of the discharge of the filter aid.

Near the end of a run the valve 170 may be closed and gas under pressure may be admitted to the container by means of the vent pipe 174, the valve 124 being maintained open so that the filter aid will be forced into the stream of filterable liquid which is passing to the filter.

When the container is empty, the main pump will be shut down, the lines cleared of liquid and the container may be removed from the flow line. Thereupon, the head 28 may be raised and the impeller removed so that the interior of the container may be thoroughly cleaned. The liquid used in cleaning may be discharged through the valve 124 and the member 112 may be thoroughly flushed out by directing a cleansing stream into either of the stubs 120—122. The cleaning operation may be effected in a few minutes.

In the event that the filter aid charge in the container should be so depleted before the end of a run that the level of the mass should appear in the lower sight glass 172, the container may be recharged by shutting down motor 38, closing

valve 170, admitting gas under pressure through vent valve 176 to clear the container and thereafter closing valve 124, removing the gas line and opening vent valve 176 to release the pressure on the container.

Thereupon, the hand-wheels may be released and the head lifted, and an additional supply of filter aid may be dumped into the container. The container may then be again closed and the pressures in the container and flow line may again be balanced by opening valve 170 and closing vent 176 at the proper time, and as soon as the pressures are balanced, the valve 124 may again be adjusted and the feeding of filter aid to the filter may be resumed without an interruption of the filtering operation or a shutting down of the system having occurred. The recharging in the described manner is important for the reason that each time the system is shut down, the coating of filter aid on the filter plates is dropped and as a result, pre-coating must be resorted to before further filtering can be accomplished. Pre-coating necessarily consumes time and filter aid and is to be avoided so far as possible.

Since the filter aid in the container is maintained in the form of a sediment or column instead of as a slurry mixture of a predetermined concentration, it is obvious that a great deal more filter aid may be placed in the device of applicant's construction than in the usual slurry tank having the same volumetric capacity. Or stating it in another way, the size of applicant's apparatus is much less than that of the ordinary slurry tank having the same filter aid capacity.

There are few moving parts which are subjected to the abrasive action of the filter aid, namely journal 72 and bushing 90, and these are readily and cheaply replaceable.

The form of the invention disclosed herein is the preferred form but it is obvious that changes may be made in the form, construction and arrangement of parts without departing from the spirit of the invention. Applicant accordingly does not desire to be limited to the particular form of apparatus disclosed herein but desires to reserve the right to make such changes as fall fairly within the scope of the appended claims.

Having thus disclosed my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. In an apparatus of the kind described, the combination of a sealed container for filter aid material, a flow line for unfiltered liquid, means forming an orifice for establishing communication between said container and said flow line, a conduit between the flow line and the container for establishing and maintaining substantially balanced pressures on opposite sides of said orifice, and means for feeding filter aid material from said container into said flow line through said orifice.

2. In an apparatus of the kind described the combination of a sealed container for filter aid material, a flow line for unfiltered liquid, means forming a filter aid material discharge orifice for establishing communication between said container and said flow line, means for establishing and maintaining substantially balanced pressures on opposite sides of said orifice, and mechanical feeding means for discharging material from said container into said flow line through said orifice.

3. In an apparatus of the kind described, the combination of a sealed container for filter aid material, a flow line for unfiltered liquid, means forming a filter aid material discharge orifice between said container and said flow line, a closure for said orifice, means for relatively adjusting said orifice and closure to adjust the effective size of said orifice, means for establishing and maintaining substantially balanced the pressures on opposite sides of said orifice, and means for discharging material from said container into said flow line through said orifice.

4. The method of introducing finely divided filter aid material into a stream of unfiltered liquid flowing under pressure, said material being of different density than and substantially insoluble in said liquid, said method comprising preliminarily wetting said material with said liquid, segregating said wetted material into a mass distinct from the excess liquid which forms into a body, admitting liquid under pressure from said stream to said body of excess liquid to apply a pressure in one direction on said segregated mass, establishing direct communication between said stream of unfiltered liquid and said segregated mass of material so that said first mentioned pressure will be substantially balanced, and thereafter feeding said material from said segregated mass in regulated quantities into said stream of liquid.

5. The method of introducing finely divided filter aid material through an orifice in a flow line into a stream of liquid flowing therein under pressure, comprising the steps of supporting a mass of said material adjacent said orifice whereby it will be subjected to said liquid pressure from one side of said orifice, applying liquid under pressure from said flow line to the mass of material on the other side of said orifice so that the pressure differential at the orifice is substantially eliminated and feeding said material through said orifice in controlled amounts.

6. The method of introducing finely divided solid filter aid material into a stream of liquid flowing under pressure, said material being of different density than and substantially insoluble in said liquid, said method comprising preliminarily wetting said filter aid material with said liquid, promoting gravity separation of said material and excess liquid, admitting liquid under pressure from said stream to said separated liquid so as to place said material under pressure without disturbing it, establishing direct communication between said stream of liquid and said material so that said first mentioned pressure will be substantially balanced at said point of communication and thereafter mechanically feeding said material into said stream.

7. In a device for feeding finely divided solid material into a flow line, the combination of a source of liquid under pressure connected with said flow line, a sealed container, an orifice therein opening into said flow line, means for adjusting the size of said orifice, feeding means to discharge material from said container through said orifice, comprising an impeller arranged to force said material toward said orifice, power means for actuating said impeller and means for applying flow line pressure to the interior of said container, together with valve controlled means for passing gas into and out of the interior of the container.

8. In a device for feeding finely divided solid material into a flow line in which a stream of liquid flows under pressure, the combination of a sealed container, an orifice therein opening into said flow line, means including a valve opening into said flow line for determining the effective size of said orifice, means for balancing the pressure across said orifice, means cooperating with

said valve for deflecting a portion of said stream of liquid over said valve to clean it continuously, and means for discharging said material from said container through said orifice.

9. In a device for feeding finely divided solid material into a flow line through which liquid flows under varying pressure, the combination of a cylindrical container, an eccentrically disposed orifice therein opening into the flow line, means adjustable externally of said container to vary the effective size of said orifice, a bladed impeller mounted for rotation in said container about the axis thereof and adjacent said orifice, said blades being formed for feeding said material toward and through said orifice, a head for said container hingedly attached thereto and adapted to sealingly engage the container, a drive shaft for said impeller, power means mounted externally of said head and having a power shaft extending therethrough, means for automatically aligning and coupling said shafts as said head is brought into sealing engagement with said container, and means for applying pressure from said flow line to the interior of said container.

10. In an apparatus of the kind described, the combination of a container, an orifice in said container at one side thereof, a chambered member supported adjacent said orifice externally of said container to form a flow line which is in communication with said orifice, a valve mounted in said member adjacent said orifice, and having operating means passing through said member, and adjusting means supported by said container at the side thereof opposite said orifice and connected to actuate said valve operating means.

11. In a device for feeding a comminuted filter aid material into a fluid pressure system, the combination of a pressure chamber, an outlet therefor so disposed that said material will collect thereacross, an inlet to said chamber so disposed as to be normally free of said material, a pressure flow line for unfiltered liquid, connections between said line and said inlet and outlet, and low pressure feeding means comprising an impeller having blades, said outlet being located in the zone of operation of said blades, which are formed to force material from said container through said outlet into said flow line.

12. In a method for introducing finely divided filter aid material into a stream of liquid in a flow line, said material being substantially insoluble in said liquid, the steps of segregating said material in a mass adjacent one side of an opening in said flow line, applying pressure to said mass to substantially balance the fluid pressure at the opposite side of said opening and feeding said material through said opening while maintaining said pressures substantially balanced.

13. In a device for feeding a finely divided filter aid material into a stream of liquid, said material being substantially insoluble in said liquid, the combination of a flow line for said stream, a closed container for said material, means forming an orifice therein communicating with said flow line, means for substantially balancing the pressures in said flow line and said container at said orifice and means for feeding said material through said orifice.

14. In a device for feeding divided solid filter aid material into a stream of liquid, said material being substantially insoluble in said liquid, the combination of a flow line for said stream, a closed container for said material, means forming an orifice connecting said container with said flow line, automatic means for substantially balancing the pressures in said flow line and said container at said orifice and means for feeding said material through said orifice at selectively variable rates.

15. In a device for feeding divided solid material into a stream of liquid, the combination of a flow line for said stream, a container, an orifice therein opening into the flow line, means including a valve opening into the flow line for controlling said orifice, a deflector mounted on said valve, said deflector being directed into the stream against the direction of flow to guide a portion of said stream over said valve.

16. In a device for feeding finely divided solid material into a flow line through which liquid flows under varying pressure, the combination of a container, an orifice in said container opening into the flow line, an impeller for feeding said material through said orifice, said impeller having a driven element, a valve for varying the size of said orifice, said container being formed with a charging opening, a closure mounted for movement into sealing engagement with said opening, power means mounted on said closure and having a drive element, means for automatically connecting said driving and driven elements as said closure is brought into sealing engagement with said opening and means for applying pressure to the interior of the container.

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