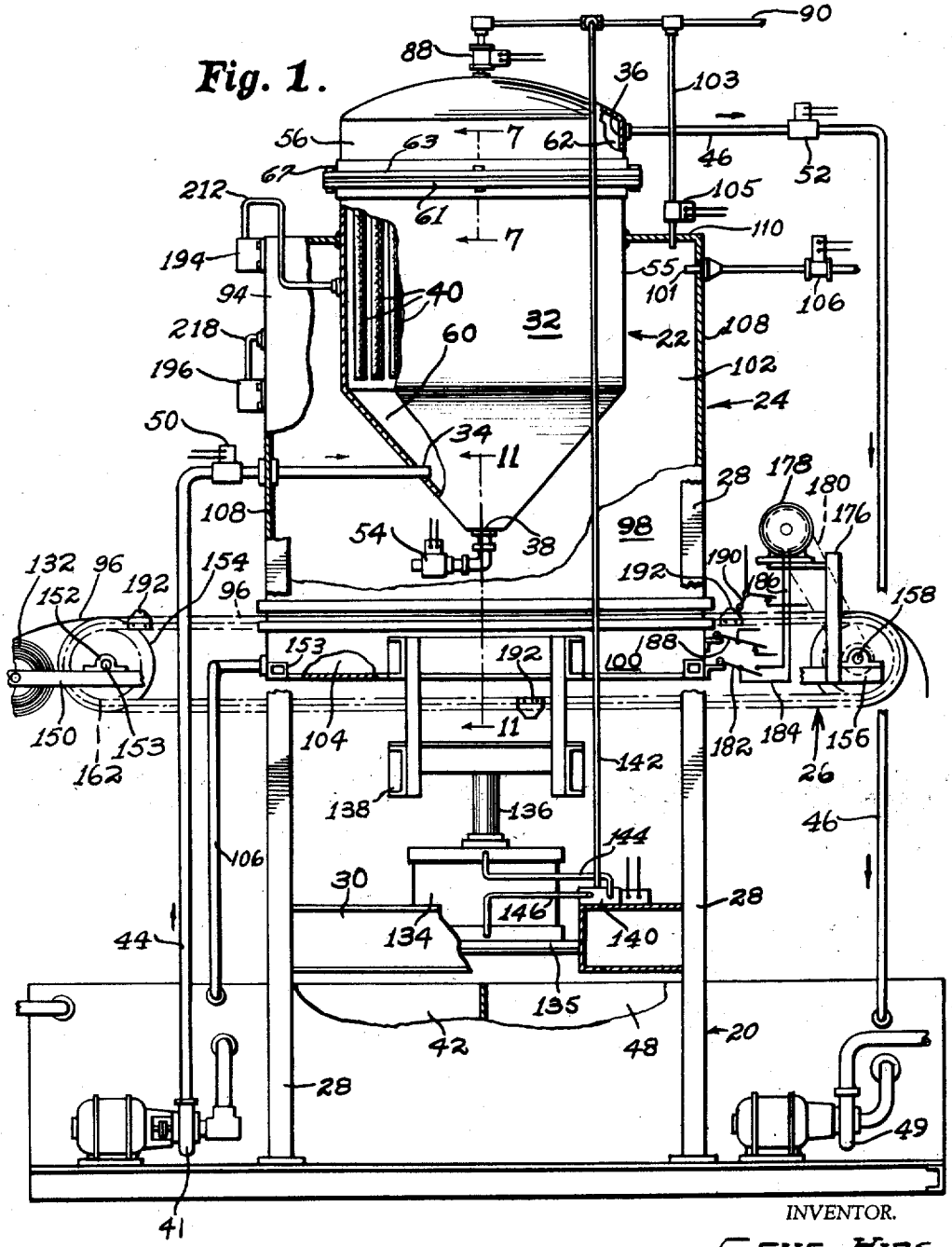
April 13, 1965 G. HIRS Re. 25,761

FILTER APPARATUS

Original Filed Feb. 19, 1958 5 Sheets-Sheet 1

Fig. 1.



INVENTOR.

GENE HIRS.

BY

Wallace P. Lamb

ATTORNEY.

April 13, 1965 G. HIRS Re. 25,761

FILTER APPARATUS

Original Filed Feb. 19, 1958 5 Sheets-Sheet 2

Fig. 2.

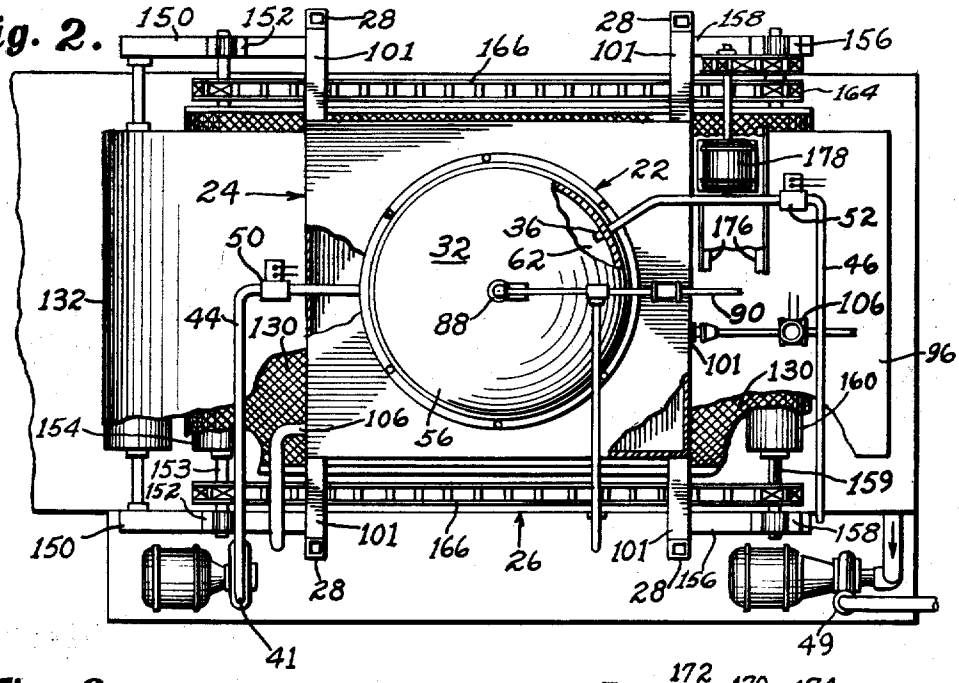


Fig. 3

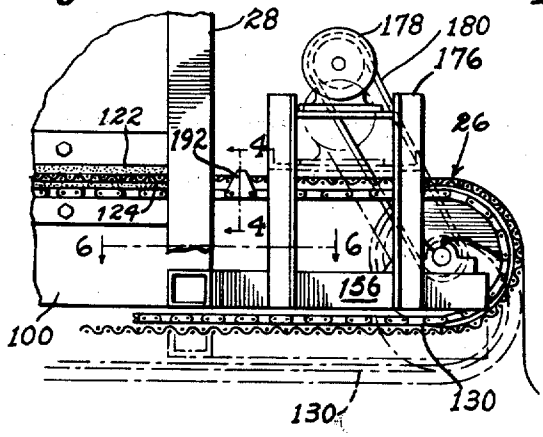


Fig. 5.

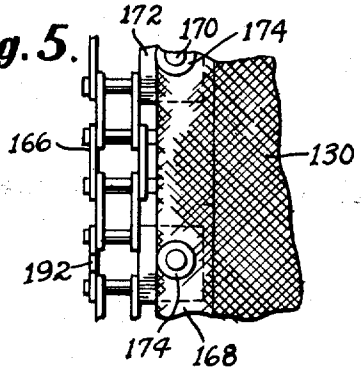


Fig. 4.

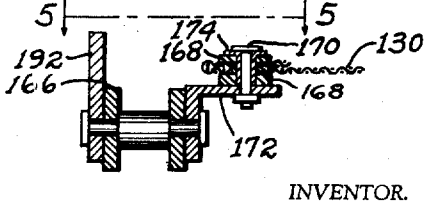
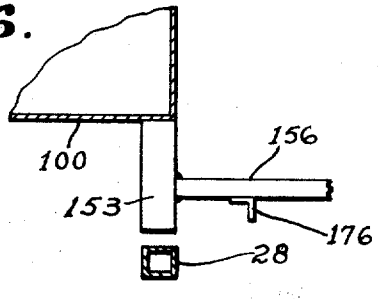


Fig. 6.



INVENTOR.
GENE HIRS.
BY
Wallace P. Lamt
ATTORNEY.

April 13, 1965 G. HIRS Re. 25,761

FILTER APPARATUS

Original Filed Feb. 19, 1958 5 Sheets-Sheet 3

Fig. 7.

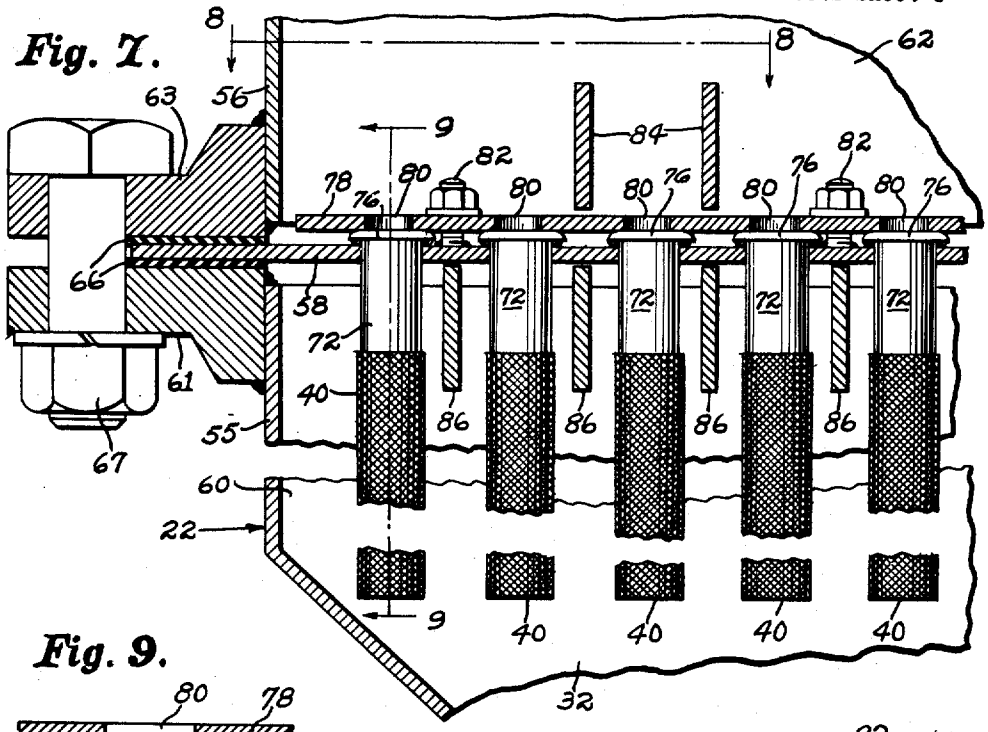


Fig. 9.

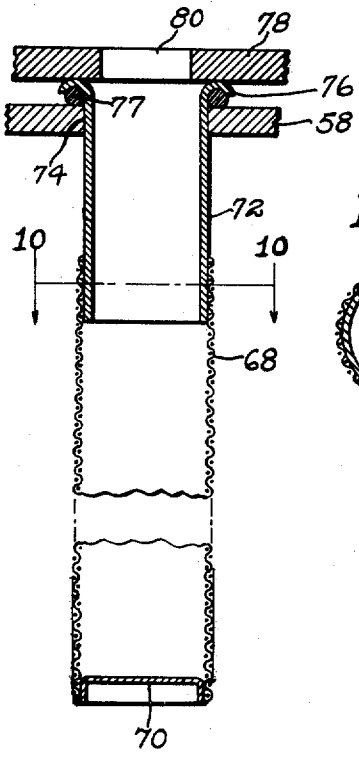


Fig. 10.

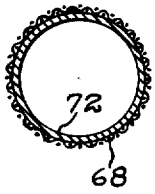
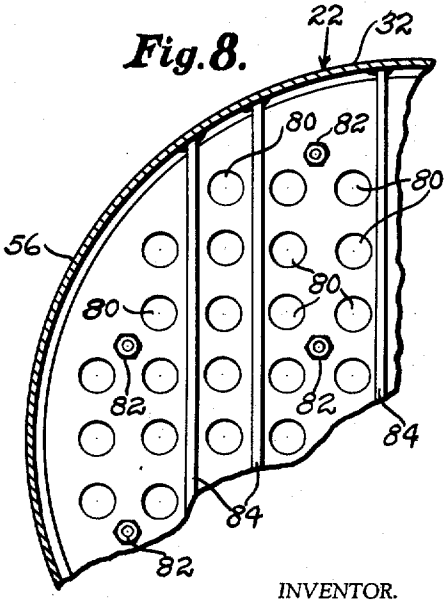


Fig. 8.



INVENTOR.
GENE HIRS.
BY
Wallace P. Lamb
ATTORNEY

April 13, 1965 G. HIRS Re. 25,761

FILTER APPARATUS

Original Filed Feb. 19, 1958 5 Sheets-Sheet 4

Fig. 11.

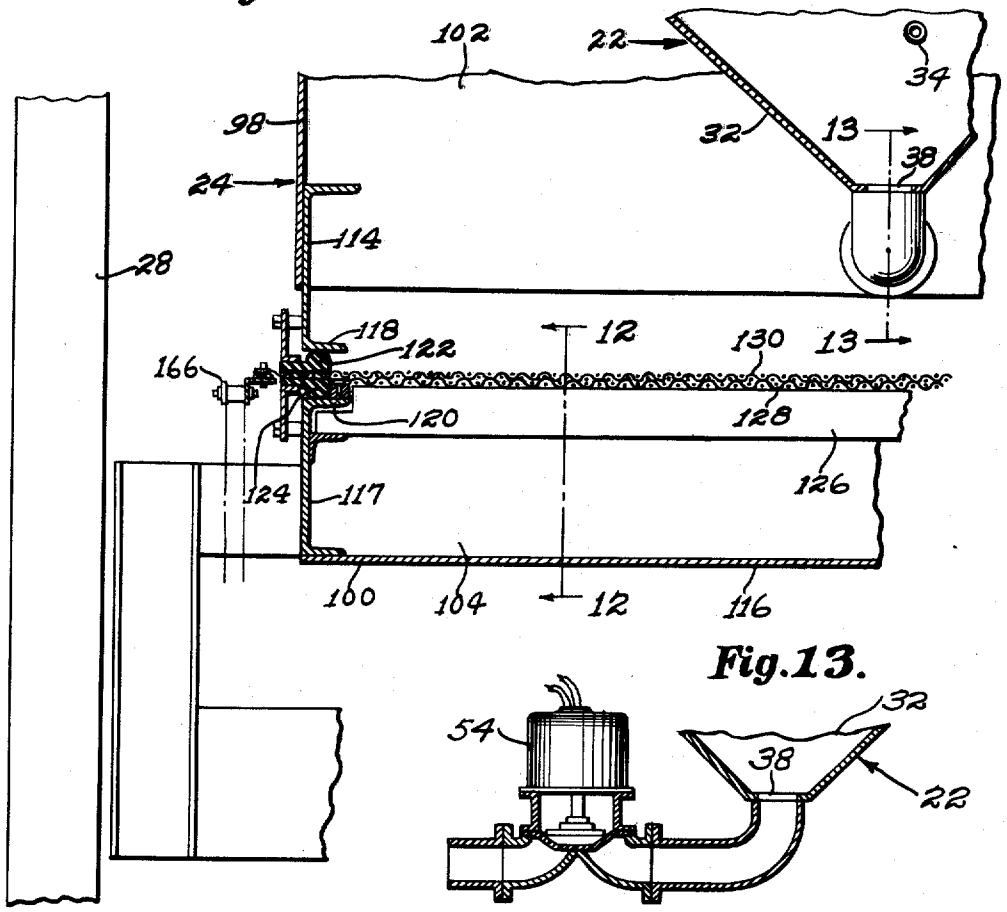
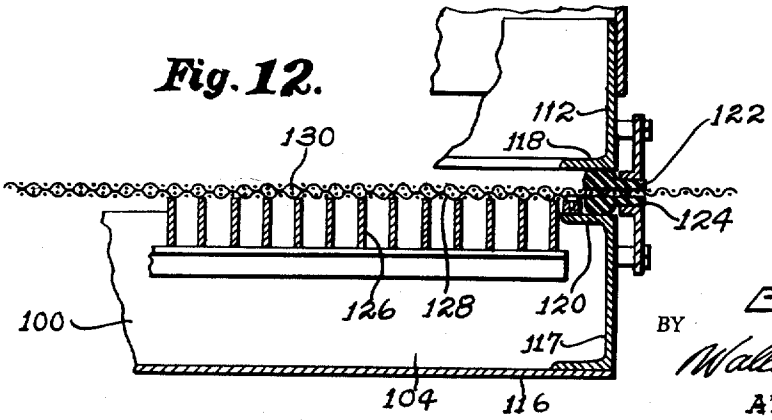


Fig. 13.

Fig. 12.



INVENTOR.
GENE HIRS.
BY Wallace P. Lamb
ATTORNEY.

April 13, 1965 G. HIRS Re. 25,761

FILTER APPARATUS

Original Filed Feb. 19, 1958 5 Sheets-Sheet 5

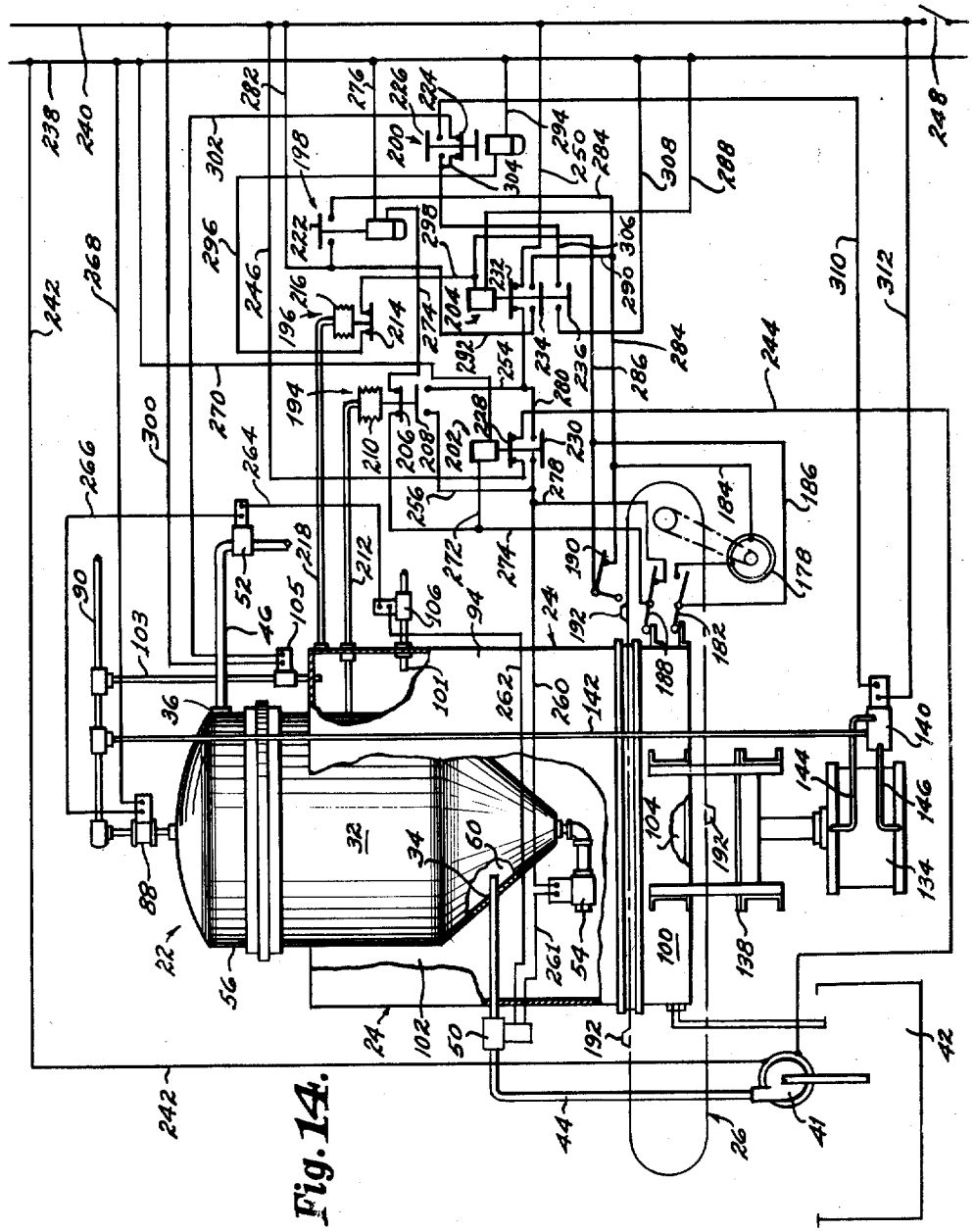


Fig. 14.

INVENTOR.
GENE HIRS.
BY
Wallace P. Lamb
ATTORNEY.

United States Patent Office

Re. 25,761
Reissued Apr. 13, 1965

25,761

FILTER APPARATUS

Gene Hirs, 17208 Greenview Road, Detroit, Mich.

Original No. 2,982,412, dated May 2, 1961, Ser. No. 716,085, Feb. 19, 1958. Application for reissue Apr. 30, 1962, Ser. No. 193,054

3 Claims. (Cl. 210—108)

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

This invention relates generally to filtering apparatus and particularly to high capacity liquid filtering apparatus.

It is an object of my invention to provide an improved liquid filtering apparatus of increased efficiency.

Another object of my invention is to provide an improved liquid filtering apparatus of a character such that foreign matter filtered from the liquid is periodically removed and filtering operation resumed without any appreciable loss of filtering time.

Another object of my invention is to provide a filter apparatus of the above mentioned character in which the operation of removing the foreign matter from the filter is accomplished without any appreciable loss of liquid.

Another object of the invention resides in the novel construction of a filter apparatus including primary and secondary filters.

A further object is to provide a control system which in response to pressure conditions in both heads of the filter apparatus controls cycling operation of the apparatus to remove foreign matter from the apparatus in such manner as to provide quick return of the primary filter to filtering operation.

Other objects of the invention will become apparent from the following detail description, taken in connection with the accompanying drawings in which:

FIG. 1 is an elevational view of my filter apparatus having parts broken away and in section;

FIG. 2 is a plan view having parts broken away and in section;

FIG. 3 is a fragmentary vertical sectional view of the apparatus including the discharge and drive end of a conveyor;

FIG. 4 is a cross sectional view taken along line **4—4** of FIG. 3;

FIG. 5 is a fragmentary plan view, taken in the direction of the arrows **5—5** of FIG. 4;

FIG. 6 is a horizontal sectional view taken along the line **6—6** of FIG. 2;

FIG. 7 is an enlarged fragmentary vertical sectional view, taken along the line **7—7** of FIG. 1;

FIG. 8 is a horizontal sectional view, taken along the line **8—8** of FIG. 7;

FIG. 9 is an enlarged vertical sectional view, taken along the line **9—9** of FIG. 7;

FIG. 10 is a cross sectional view, taken along line **10—10** in FIG. 9;

FIG. 11 is an enlarged vertical sectional view, taken along line **11—11** of FIG. 1;

FIG. 12 is a vertical sectional view, taken along line **12—12** of FIG. 11;

FIG. 13 is a vertical sectional view, taken along line **13—13** of FIG. 11; and

FIG. 14 is a diagrammatic view of the filter apparatus including its electrical controls and circuitry therefor.

Referring to the drawings by characters of reference, my filter apparatus comprises, in general, a support or frame structure **20**, a relatively small volume high capacity primary filter **22**, a relatively large volume low capacity secondary filter **24**, and a dirt removal conveyor **26**. The filter **24** is mounted on the frame **20** and the filter **22** and conveyor **26** are both mounted on the filter **24**, th filter **22** being directly above the conveyor **26**.

Any suitable frame **20** may be used, the present fram comprising essentially four posts **28** which are space apart such that they form the corners of a rectangula frame. The posts **28** are rigidly connected together b cross members including a lower cross member **30**. A shown in FIGS. 1 and 2, side pairs of the posts **28** ar spaced apart to clear the conveyor **26** which passes there between.

The filter **22** comprises a container **32** having an inle **34** for liquid to be filtered, an upper outlet **36** for filtere liquid, and a lower outlet or discharge **38** for foreig matter filtered from the liquid. Disposed within the cor tainer **32** is a filter media comprising a plurality of ir dividual filter elements or tubes **40** which are dispose between the container inlet **34** and the outlet **36**, the di charge **38** being on the same sides of the filter tubes as th inlet **34**. Collectively, the filter tubes **40** present a larg filter media to accommodate high capacity rate of filtra tion. In order to provide a high capacity filtering ope ation, a pump **41** is employed to deliver contaminate liquid to container **32** at a pressure in excess of atmo pheric pressure. In the present disclosure, contaminate liquid is delivered to a tank **42** below conveyor **26** when the pump **41** forces the liquid into container **32** throug a supply pipe **44** that is connected to the container inl **34**. From the outlet **36**, a pipe **46** conducts clean liqu from the container to a tank **48**, whence the liquid ma be delivered by a pump **49** to one or more points of us A normally open solenoid valve **50** controls the inlet **3** another normally open solenoid valve **52** controls the ou let **36** and a third, but normally closed solenoid valve **5** controls the discharge **38**. These valves have their po tions automatically reversed in connection with a cleani operation of container **32** which is hereinafter describ in detail.

The filter container **32** is preferably cylindrical in sha and constructed of two secured together sections inclu ing a lower relatively large section **55** and an upper re tively small section **56**. Separating the opposed ends the container sections **55** and **56** is a plate **58** which vides container **32** into a lower filter chamber **60** and upper outlet chamber **62**. Carried by and dependi from the plate **58** into filter chamber **60** are the fil medium tubes **40** which can be arranged in staggered lation so that a large number of tubes can be contain within the filter chamber **60**. An outer margin of t plate **58** around the entire periphery thereof is held tween annular flanges **61** and **63** respectively of the co tainer sections **55** and **56**, and gaskets **66** are displac on tightening down nuts **67** to provide a fluid tight jo between the container sections.

The filter tubes **40** may each comprise a fine, wire me body **68** of cylindrical shape having the lower end the of reinforced by a metal cap **70** and the upper end re forced by an open ended metal sleeve **72**. The sleeves extend respectively through holes **74** in plate **58** a each sleeve is provided on its upper end with an annu flange **76**. Beneath each of the flanges **76** is a gasket which seats on the upper surface of plate **58**. A clan ing plate **78** rests on the flanged upper ends of the slee **72** having holes **80** aligning with sleeves **72** to establ communication between chamber **60** and **62** by way of filter screen tubes **40**. The clamping plate **78** is dra down toward plate **58** by nuts on studs **82** that are wel to plate **58**, as indicated. The clamping plate **78** t displaces the gaskets **76** to seal the joints between sleeves **72** and plates **58** and **78** so that all of the c taminated liquid must pass through the filter screens flow to the outlet chamber **62**. Above and below plates **58** and **78**, in close proximity thereto, is a num

spaced horizontal reinforcing ribs 84 and 86. The up- ribs 84 have their opposite ends welded to the side the upper section 56 of container 32 and similarly, the er ribs 86 have their opposite ends welded to the side the lower section 55 of the container. These ribs 84 d 86 not only reinforce the container sections 55 and in the regions of their opposed ends, but also reinforce tes 58 and 78 against undue deflection under the high ssures developed in the container. In this regard, it l be seen in FIG. 7 that the longitudinal edges of ribs and 86 are respectively in close proximity to the op- site surfaces of the plates 58 and 78.

As is well known, filter media becomes clogged with eign matter which reduces the filter rate and must be moved if high filtering efficiency is to be maintained. moval of the foreign matter requires a shut-down iod which in the past was of necessity of such long ation as to appreciably decrease filtering efficiency. the filter apparatus embodying my present invention, above mentioned shut-down period for all practical poses has been eliminated as the shut-down period been reduced to an interval substantially equal to period required to discharge all of the foreign matter m filter 22 into filter 24, an interval having no appre- ble effect on the efficiency of the filtering operation. this end, I provide, on shut down of the filter opera- n, for effecting a reverse flow and back pressure ough head 32 to quickly discharge all of the foreign tter and unfiltered liquid from the discharge 38 of con- ner 32. This may be accomplished by introducing pressed air into the outlet chamber 62 under control a normally closed solenoid valve 88. An air line 90 ling from a source of compressed air connects to the of filter container 32. It will be seen that air intro- ed into outlet chamber 62 will flow counter to flow liquid during filtering and as a consequence will dis- ge substantially all of the foreign matter from the r tubes 40, the air pressurizing the container 32 and cing the foreign matter and unfiltered liquid to the y outlet open at the time, namely, discharge 38. Air oduced into the container 32 to effect a blow-down result in there being a pressure in the container in ess of atmospheric pressure until all of the liquid and eign matter has been discharged and air escapes from harge 38 whereupon the pressure will decrease. As wn, a lower portion of the filter container 32 is prefer- conically shaped, tapering downwardly to the dis- rge 38 to induce evacuation of the dirt, sludge, etc. n the container. In instances where the liquid being red is not of great value, such as water, the discharge may be connected directly to a sewer. However, re expensive liquids, such as fine cutting oils, chemi- , pharmaceuticals, etc. are filtered, the unfiltered liquid chamber 60 at the shut-down time may be saved by harging it into the filter 24.

he relatively large filter 24 includes a container 94 a filter media 96. In order to provide for removal he foreign matter from container 94, the container is structed of two separable sections including an upper l section 98 and a lower vertically movable section . Structural members 101 are welded to the upper ainer section 98 and to the frame posts 28 to rigidly unt the container section on the frame. The filter ia 96 extends horizontally through container 94 be- en the container sections 98 and 100, the media 96 perating with upper section 98 to provide a filter nber 102 and with lower section 100 to provide a n chamber 104. By this arrangement, the unfiltered id draining into outlet chamber 104 may be saved returned to the tank 42 by means of a return pipe

The inlet to the drain or filter chamber 102, as iously mentioned, is the discharge 38 from filter 22. ollowing the discharge of the foreign matter from harge 38 into filter chamber 102, the latter is pres- ed to expedite filtration through filter medium 96.

This may be accomplished by introducing air under pressure into chamber 102 from a branch line 103 of main air line 90 under control of a normally closed solenoid valve 105. It will be understood that an air pressure greater than atmospheric pressure will be maintained on the head of unfiltered liquid in chamber 102 until all of the liquid has been discharged into lower chamber 104. An air vent 101 is provided for chamber 102 and is controlled by a normally closed solenoid valve 106.

The filter container 94 may be box-shaped having upright walls 108 and a top wall 110. A reinforcing frame extending into the lower end of upper section 98 and around the four walls 108 thereof is constructed of channel structural members 114 arranged with their webs upright and welded flat against the inner surfaces of walls 108. A similar reinforcing frame having a bottom plate 116 welded to the lower flanges of channel members 117 provides the lower section 100 of the container. The opposed flanges, as at 118 and 120 respectively of sections 98 and 100 provide excellent seating surfaces for a pair of gaskets 122 and 124, secured to said flanges.

Within the lower container section 100 is a grate-like supporting structure 126 which may be welded to section 100, the upper edges of the grate members being in substantially the same horizontal plane as the gasket seating flanges 120 of the lower section 100. A heavy screen 128 which overlies and is attached to the upper end of section 100 is supported by the grate 126 and in turn supports the upper lead side of a liquid pervious belt 130 of conveyor 26. The belt 130 may be made of any suitable material, such as, nylon or other pliable material. The belt 130 carries and is covered by the filter media 96 which may be a paper filter medium feeding onto the feed end of the belt 130 from a supply roll 132. When the lower container section 100 is in its normal raised position shown, the gaskets 122 and 124 grip the filter paper 96 and the belt 130 and are displaced to provide a fluid tight joint.

A power element or air cylinder 134 may be used to raise and lower the container section 100 and to hold the gaskets 122 and 124 compressed in the normally closed position of the container section. The air cylinder 134 may be mounted on a platform 135 constructed on the lower frame cross members 30 and includes the usual cylinder wherein a pist (not shown) carries a connecting rod 136. A yoke 138 rigidly connects the connecting rod 136 to the container section 100, the yoke 138 straddling the conveyor and container section 100. This yoke may be fabricated by welding channel structural members together, and arms of the yoke 138 may be welded to the side channel members of the container section 100.

A solenoid valve 140, connected by a branch line 142 to the air line 90 controls operation of the cylinder 134. A branch pipe 144 connects the solenoid to the upper end of cylinder 134, and a similar branch pipe 146 connects the solenoid 140 to the lower end of the cylinder 134. Normally, or during filtering operation, the solenoid 140 establishes connection between the source of compressed air and the lower end of cylinder 134 to hold the lower container section 100 in its raised or closed position.

The conveyor 26 is carried by the movable section 100 of the container 94 and thus moves with said section as the container is opened and closed. It will be apparent that it is the function of the conveyor 26 to remove the foreign matter from container 94 and replace the filter media therein during the period that the container is open. At the feed end of conveyor 26, laterally spaced extensions 150 welded to the lower container section 100 carry aligned mountings 152 which support a shaft 153 for a guide or spool 154 about which the belt 130 is guided, the belt as shown being of the endless type. Similarly, the discharge end of the conveyor 26 has a pair of laterally positioned extensions 156 which are

welded to spacers 157 which in turn are welded to container section 100 and carry mountings 158 for a shaft 159 on which a spool 160 is provided to guide the belt 130. Fixed to the outer ends of shaft 153 is a pair of sprockets 162, and fixed to shaft 159 is a like pair of sprockets 164. Around the corresponding pairs of the sprockets 162 and 164 travel chains 166 to which the belt 130 is attached for travel therewith.

Opposite edges of the belt 130 are preferably bound and reinforced by double thicknesses of a closely woven fabric, such as canvas strips 168, sewn to margins of the belt proper (see FIG. 4). The belt 130 may be attached at spaced intervals along its bound edges to the chains 166 by any suitable fasteners, such as small bolts and nuts 170 shown. At suitable distances along the chains 166, links thereof have inturned horizontal flanges 172 to which the belt is attached. Preferably, eyelets 174 are fastened in and to the bound edges of the belt to receive the bolts and reinforce the canvas binding the areas of the bolts.

Carried by the conveyor extensions 156 is a support or mounting 176 for an electric motor 178 which when energized drives the conveyor 26 to remove the foreign matter from container 94. The mounting 176 is a fabricated structure which may be welded or otherwise secured to the extensions 156 and extends up and over or straddles the conveyor belt 130. In conventional manner, the motor 178 drives through a speed reducer (not shown) and drive belt or chain 180 to drive the shaft 158.

The conveyor motor 178 is energized or started in response to predetermined opening movement of container section 100 so as to insure that the conveyor will never be operated when the head is closed. A switch 182 having its contacts connected by leads 184, 186 to motor 178 is normally open and allowed to close on predetermined opening movement of lower container section 100. A similar, but normally closed switch 188 opens when the container 94 opens, the function of switch 188 being hereinafter fully described in connection with the description of the circuitry of FIG. 14. Another, and normally closed switch 190 is actuated in response to a predetermined distance of travel of conveyor belt 130 to de-energize conveyor motor 178. That is, the conveyor is stopped after the belt 130 has moved a distance such that the foreign matter has been removed from container 94 and, of course, a clean piece of the paper filter medium 96 has been moved into the container. To open switch 190 at the proper time, one of the conveyor chains 166 may carry spaced, cam-like actuators 192. As will be later more fully understood, the opening of switch 190 breaks a holding circuit of motor 178.

It will be understood that the filter 22 of my apparatus has a relatively long filtering period which is interrupted for a short period when the pressure in the filter 22 increases due to clogging of the filter media to a pressure indicating a need for the filter cleaning operation. At the preselected pressure, a pressure responsive control or switch 194 initiates a cycling operation to clean and return filter 22 quickly to filtering operation and in a somewhat longer period filter and remove the foreign matter from filter 24 and return the latter filter to normal operation before filter 22 again requires cleaning. The control system includes a second pressure responsive control or switch 196 that responds to changes in pressure in chamber 102 of filter 24 in the control of the apparatus.

Referring particularly to FIG. 14, the control system includes a delayed action control or switch 198, a second delayed action control or switch 200, a relay 202, and a second relay 204. The pressure responsive control 194 is diagrammatically represented as comprising a normally closed switch 206 and a normally open switch 208, the movable contacts of which are actuated by a pressure responsive element or bellows 210 that is connected by a conduit 212 to chamber 60 of filter 22. Similarly, the pressure responsive control 196 comprises a switch 214 that normally is closed and is connected to a bellows 216 which is communicatively connected by a conduit 218 to chamber 102 of filter 24. The delayed action relay 198 includes a normally closed switch 220 and a normally open switch 222 actuated by the usual coil. Similarly, the delayed action control 200 includes a normally closed switch 224 and a normally open switch 226, actuated by the delayed acting coil shown. Relay 202 is the well known type having in this instance two switches including a normally closed switch 228 and a normally open switch 230. Relay 204 is similar to relay 202, but has three switches including a normally closed switch 232, and two normally open switches 234 and 236.

With respect to the electrical circuitry, the numerals 238 and 240 designate the main electric power lines. From line 238, a lead 242 connects to one terminal of the motor that drives pump 41, and from the other terminal of said motor, a lead 244 connects to a fixed contact of relay switch 228 which has its other fixed contact connected by a lead 246 to the other main line 240. Thus, since switch 228 is normally closed, pump 41 operates continuously during the filtering operation providing, of course, that main line switch 248 is closed.

A lead 250 from main line 240 connects to one of the fixed contacts of relay switch 232 and a lead 252 connects the other fixed contact of switch 232 to one of the fixed contacts of pressure switch 208. From the other fixed contact of pressure switch 208, a lead 256 connects to a lead 260 which connects to one terminal of the discharge control solenoid 54. The solenoid 54, inlet solenoid 50, air vent solenoid 106, return line solenoid 52, and the air blow-down solenoid 88 are connected serially and to main line 238 by interconnecting leads 261, 262, 264, 266 and 268. This circuit is energized when the pressure in the filter head 32 increases to a predetermined pressure that will close the pressure switch 208. Relay 202 is also energized when pressure switch 194 closes, the coil of relay 202 being connected by a lead 270 to the main lead 238 and by a lead 272 to a lead 274 that connects one fixed contact of pressure switch 206 to limit switch 188. The other fixed contact of pressure switch 206 is connected by a lead 274 to one end of the coil of delayed action control 198 which has its other end connected by a lead 276 to main line 238. The limit switch 188 has a fixed contact connected by a lead 278 to lead 260 which is also connected to one of the fixed contacts of relay 230. The other fixed contact of relay switch 230 is connected to lead 254 by a lead 280 which in part provides the following holding circuit for relay 202: From main line 240 through leads 250, 280, relay switch 230, lead 278, limit switch 188, leads 274, 272, coil of relay 202, and lead 270 to the other main line 238.

The delayed action switch 222 has one of its fixed contacts connected by a lead 282 to the main line 240 and the other fixed contact connected by a lead 284 to the fixed contact of the conveyor actuated limit switch 190. A lead 286 connects the movable contact of limit switch 190 to one end of the coil of relay 204 which has the other end of its coil connected by a lead 288 to the other main line 238. A lead 290 connects one of the fixed contacts of relay switch 234 to lead 284, and a lead 292 connects the other of the fixed contacts to lead 282 and thus to main line 240. One end of the coil of delayed action relay 200 is connected to main line 238 by a lead 294 and the other end of the coil is connected by a lead 296 to one of the fixed contacts of pressure responsive switch 214. The other of the fixed contacts of pressure switch 214 is connected by a lead 298 to lead 286 and thus through limit switch 190, lead 284, switch 222 and lead 282 to main line 240.

A lead 300 from main line 240 connects to one of the

rminals of the air blow-down solenoid **105** which has ie other terminal connected by a lead **302** to one of the xed contacts of switch **224** of the delayed action control **00**. The other fixed contact of switch **224**, connects by ads **304** and **306** to one of the fixed contacts of relay **36** which has its other fixed contact connected by a lead **08** to main line **238**. Leads **304** and **306** also connect to ne of the fixed contacts of delayed switch **226** and from ie other fixed contact a lead **310** connects to one terminal f solenoid **140** which has its other terminal connected) main line **240** by a lead **312**.

GENERAL DESCRIPTION OF OPERATION

In general, my liquid filter apparatus operates as fol-)ws: Assuming that line switch **248** is closed and the :veral controls are in their normal position shown, the ump delivers liquid to be filtered from tank **42** to filter **2** wherein the liquid is filtered under the pressure created y pump **41** and the clean liquid is delivered by pipe **46**) tank **48**. When the filter media in filter **32** clogs such iat the resultant back pressure reaches a predetermined ressure, the discharge valve **54** is automatically opened nd the filter pressurized to discharge the foreign matter nd unfiltered liquid into filter **24** whereupon filter **32** uickly returns to filtering operation. Following the dis-harge of the foreign matter from filter **22** into filter **24**, ie latter is pressurized to force drainage of the unfiltered quid through the filter media **96** for return to tank **42**. he container of filter **24** is then automatically opened nd conveyor **26** operates to remove the foreign matter :om the container and replace the filter media therein. he conveyor **26** then stops and the container of filter loses before the inner filter **32** again discharges its foreign iatter and unfiltered liquid into filter **24**.

DETAIL DESCRIPTION OF OPERATION

The control devices and other operable and moving arts of the apparatus are in their normal positions, or ositions which they assume during the filtering operation. ssuming again that line switch **248** is closed, pump **41** /ill be operating, since relay switch **228** is closed, and the ump will deliver liquid to be filtered from tank **42** irough supply pipe **44** to the filter container **32**. As reviously mentioned, the capacity of pump **41** is such iat the liquid completely fills the filter **22** and is main-ained under a pressure in excess of atmospheric pres-ure to provide a high rate of filtration. The liquid passes ito filter chamber **60** through the normally open inlet **50** nd then through the filter media tubes **40** where foreign iatter is filtered out of the liquid. Passing through the lter tubes **40**, the clean liquid flows into the outlet cham-er **62** of container **32** from which the liquid flows through he normally open outlet valve **52** and is then conducted y pipe **46** to the clean liquid storage tank **48**.

The foreign matter filtered from the liquid by the filter ubes **40** eventually clogs the filter media with accom-anying increase in liquid pressure in filter chamber **60** nd when this pressure reaches a predetermined pressure t which it is calculated that the filter tubes **40** require leaning, pressure responsive control **194** is actuated. This opens pressure switch **206** and closes pressure switch **08**. The opening of pressure switch **206** has no imme-liate effect other than to delay energization of the coil of lelayed action relay **198**, but the closing of pressure witch **208** initiates an automatic cycling operation of the pparatus to effect the cleaning out of both filters **22** and **4** and the returning of filter **22** immediately to filtering peration. The closing of pressure switch **208** closes the ircuit of solenoids **54**, **50**, **106**, **52** and **88**, and also closes he circuit of relay **202**. Closing of the circuit of sole-oids **54**, **50**, **106**, **52** and **88** reverses these valves such hat the discharge solenoid **54**, and solenoids **106** and **88** re opened and solenoids **50**, **52** are closed. The circuit of these solenoid valves is as follows: From main power ine **240**, through lead **250**, the closed switch **232**, lead

254, the now closed pressure switch **208**, leads **256**, **260**, solenoid **54**, lead **261**, solenoid **50**, lead **262**, solenoid **106**, lead **264**, solenoid **52**, lead **266**, solenoid **88** and through lead **268** to the other main power line **238**. Simultaneously with the closing of the above traced circuit, the circuit of relay **202** is closed, the relay circuit being as follows: From main line **240**, through lead **250**, relay switch **232**, lead **254**, the now closed switch **208**, lead **256**, lead **278**, limit switch **188**, leads **274**, **272**, relay **202**, and lead **270** to the other main line **238**. The energizing of relay **202** opens the relay switch **228** and closes the relay switch **230**. The opening of switch **228** opens the circuit of the motor of pump **41** to stop the pump, and the closing of switch **230** provides a holding circuit for relay **202** as pressure switch **206** opens when the pressure decreases in filter **22**. The circuit of the motor of pump **41** is as follows: From the main power line **240**, through lead **246**, relay switch **228**, lead **244**, the motor of pump **41**, and lead **242** to the other main power line **238**.

When the electrical circuit of the solenoids **54**, **50**, **106**, **52** and **88** closed, the solenoid **88** opened which introduced compressed air into the top of the filter **22** for the purpose of blowing air in reverse direction to liquid flow to backwash and flush all foreign matter from the filter tubes **40** and pressurize the filter container **32** to force all of the foreign matter out of the now open discharge solenoid **54** into filter head chamber **102**. When about all of the foreign matter and unfiltered liquid has been discharged from filter chamber **60**, the air then flows from the discharge and as a consequence the air pressure in chamber **60** falls. When this happens, the pressure responsive control **194** responds to the decreased air pressure closing its switch **206** and opening its switch **208**. The opening of switch **208** has no effect on the circuit of the solenoids **54**, **50**, **106**, **52** and **88**, since this circuit is complete through relay switch **230**. However, the closing of pressure switch **206** closes the circuit of the delayed action relay **198**. The circuit of the delayed action relay is as follows: From main power line **240** through lead **250**, relay switch **232**, lead **280**, the still closed holding circuit switch **230**, lead **260**, solenoid **54**, lead **261**, solenoid **50**, lead **262**, solenoid **106**, lead **264**, solenoid **52**, lead **266**, solenoid **88**, and lead **268** to the other main power line **238**. After an interval to assure that all of the foreign matter and unfiltered liquid have been evacuated from filter chamber **60**, the delayed action relay **198** operates to close switch **222**. The closing of switch **222** energizes relay **204**, the circuit of which is as follows: From main power line **240** through lead **282**, switch **222**, lead **284**, limit switch **190**, lead **286**, the coil of relay **204**, and lead **288** to the other main line **238**. The energizing of relay **204** opens switch **232** and closes switches **234** and **236**. The opening of switch **232** breaks the circuit of the solenoids **54**, **50**, **106**, **52** and **88** and as a consequence these solenoids return to their normal positions or positions they assume during filtering operation. When switch **232** opened, it deenergized relay **202** opening switch **230** and closing switch **228**. The opening of switch **230** has no effect at this time since switch **232** is also open, but closing of switch **228** closes the circuit of the motor of pump **41**. It will be understood, of course, that the return of solenoids **54**, **50**, **106**, **52** and **88** to their normal positions and the starting of pump **41** occurs substantially simultaneously.

The aforementioned closing of relay switch **236** energizes the air pressure control solenoid **105** and the simultaneous closing of relay switch **234** establishes a holding circuit for relay **204**. The circuit of the solenoid **105** is as follows: From the main power line **240** through lead **300**, solenoid **105**, lead **302**, switch **224**, lead **304**, lead **306**, the now closed relay switch **236** and lead **308** to the other main power line **238**. The holding circuit established by the closing of relay switch **234** is as follows: From the main power line **240**, through leads **282**, **292**, the now closed relay switch **234**, leads **290**, **284**, limit switch **190**, lead **286**, the coil of relay **204**

and through lead **288** to the other main power line **238**.

The energizing of the solenoid **105** opens the valve thereof to permit compressed air to enter and pressurize the filter chamber **102** to force the liquid through the filter **132** into the drain chamber **104**. Pressurizing the filter chamber **102** opens the pressure responsive switch **214** to keep the circuit of the delayed action control **200** open. When substantially all of the liquid has been forced from the filter chamber **102** into the drain chamber **104**, the pressure in the chamber **102** has decreased such that pressure switch **214** closes and energizes the delayed action relay **200**. The circuit of relay **200** is as follows: From the main power line **240**, through leads **282**, **292**, the still closed switch **234**, leads **290**, **284**, limit switch **190**, leads **286**, **298**, the now closed pressure switch **214**, lead **296**, the coil of delayed action relay **200** and through lead **294** to the other main power line **238**. The relay **200** after an interval acts to open its switch **224** and close switch **226**. The opening of switch **224** deenergizes solenoid **105** to discontinue flow of compressed air into chamber **102**. The closing of relay switch **226** closes the circuit of the solenoid **140** that controls the power element **134**. The circuit of the solenoid **140** is as follows: From the main power line **240** through lead **312**, solenoid **140**, lead **310**, the now closed switch **226**, lead **306**, the still closed relay switch **236**, and through lead **308** to the other main power line **238**. The power element **134** now acts to move the lower section **100** of container **94** preparatory to removal of the foreign matter from the container. As the section **100** starts moving down it releases switch **188** which opens to break the holding circuit of relay **202**, deenergizing the relay approaching its fully open position the section **100** allows switch **182** to close. The closing of switch **182** closing the circuit of the conveyor motor **178** which then drives the conveyor **26**. When all of the foreign matter has been removed from container **94**, one of the cams **192** on the conveyor chain engages and opens limit switch **190** which breaks the holding circuit of relay **204**, thus stopping the conveyor motor **178**. The deenergizing of relay **204** opens relay switch **236** which deenergizes the solenoid **140** of the power element **134** which then acts to move the lower section **100** of container **94** upward to closed position. As the section **100** moves upward, it opens motor switch **182** and closes switch **188**. The filter **24** is now ready to receive the next discharge of foreign matter and unfiltered liquid from the filter **22**.

From the foregoing description, it should now be appreciated that I have provided a new and improved liquid filter apparatus of the type having a relatively long filtering operation and a relatively short filter clean-out operation. In this connection it will be understood that the filtering operation is only shut down for the relatively short time that it requires to force all of the foreign matter and unfiltered liquid out of the filter head. By discharging the foreign matter and unfiltered liquid from the primary to the secondary filter, operation of the primary is resumed without any appreciable loss of filtering time, and removal of the foreign matter from the secondary filter is accomplished after resumption of operation of the primary filter. The foreign matter is removed from the secondary filter and the unfiltered liquid is saved and returned to the primary filter before it is again time for discharge of the primary filter into the secondary. In addition, it will be seen that I have provided for automatic cycling of both filters between filtering and cleaning operations and that the cleaning out operations are both initiated upon increase in pressure in the primary filter to a pressure indicative of undesirable clogging of the primary filter.

While I have shown and described my invention in considerable detail, it will be understood that the invention is to be limited only by the scope of the appended claims.

What I claim is:

1. In a filter apparatus a sludge disposal unit including separable container sections, means movable between said sections to remove the sludge therefrom after the sections have been separated, normally inactive power means operable to separate said sections, control means operatively connected to activate said sludge removing means and initiated by the separating movement of said sections, a delayed action control operatively connected to activate said power means, a pressure filter having a sludge outlet in communication with said container, a normally closed valve controlling said sludge outlet, and [a] control *means* responsive to a predetermined increase in pressure in said filter and operatively connected to effect both the opening of said sludge outlet valve and activation of said delayed action control.

2. In a liquid filter apparatus, a pair of upper and lower separable container sections normally cooperable to form a closed container, power means operable to separate said sections, [the lower] one of said sections having an inlet for sludge and contaminated liquid and *the other of said sections* having an outlet for the filtrate, a filter media member disposed between said sections, a second member associated with said filter media member, one of said members movable through said container between said sections to remove sludge therefrom after said sections have been separated, means operable to move said one member and operatively connected for activation by the separation movement of said sections, normally inactive means operable to effect a differential pressure on opposite sides of said filter media to force liquid from the sludge through said media to said outlet, a filter having a sludge outlet in communication with said inlet of said container, a normally closed valve controlling said sludge outlet, [a] control *means* responsive to a clogged condition of said filter to open said valve and operatively connected to initiate operation of said normally inactive means, and [a] control *means* responsive to a predetermined decrease in pressure in said container as the liquid is evacuated therefrom and operatively connected to initiate operation of said power means and also deactivate said normally inactive means.

3. In a liquid filter apparatus, an upper stationary container section having a top wall, a lower container section forming a container with the upper section and movable to a position in spaced apart relationship to said upper section, said lower section having an outlet, a filter media extending through said container between said sections and movable when said sections are in spaced apart relationship to remove sludge from the container, means operable to move said lower section to said position, delayed action means controlling activation of said moving means, means operable to move said filter media activated by movement of said lower section to said position, a filter mounted on the top wall of said container and extending downwardly thereinto having a sludge outlet, an inlet to said filter for contaminated liquid, an outlet from said filter for filtrate, a compressed air inlet to said filter, a normally open valve controlling said inlet, a normally open valve controlling said filtrate outlet, a normally closed valve controlling said sludge outlet, a normally closed valve controlling said compressed air inlet, said valves reversible, a pump operable to supply contaminated liquid to said inlet and maintain a pressure in said filter in excess of atmospheric pressure, a filter media separating the contaminated fluid inlet and the sludge outlet from the filtrate outlet and the compressed air inlet, and [a] control *means* responsive to a predetermined increase in pressure in said filter to reverse said valves and simultaneously therewith initiate operation of said delayed action control.

(References on following page)

References Cited by the Examiner

The following references, cited by the Examiner, are of record in the patented file of this patent or the original patent.

UNITED STATES PATENTS

826,390	7/06	Van Law	210—258
920,909	5/09	Brewer	100—112
2,152,900	4/39	Manning	210—77
2,303,262	11/42	Dunmire	196—46.1
2,366,903	1/45	Harms et al.	210—108
2,494,534	1/50	Armstrong	210—130
2,828,862	4/58	Johnson	210—82

REUBEN FRIEDMAN, *Primary Examiner.*

HERBERT L. MARTIN, *Examiner.*