United States Patent

[11] 3,630,380

[72] Inventors **August C. Barnebl**
Stamford;
Franz Bliem, Norwalk, both of Conn.

[21] Appl. No. **853,842**
[22] Filed **Aug. 28, 1969**
[45] Patented **Dec. 28, 1971**
[73] Assignee **Dorr-Oliver Incorporated**
Stamford, Conn.

[54] **ROTARY VACUUM DRUM FILTERS**
33 Claims, 27 Drawing Figs.

[52] **U.S. Cl.** **210/404**
[51] **Int. Cl.** **B01d 33/06**
[50] **Field of Search** 210/392, 402, 404

[56] **References Cited**

UNITED STATES PATENTS

872,616	12/1907	Fairchild	210/404 X
1,558,038	10/1925	Mount	210/404 X
1,948,947	2/1934	O'Keefe	210/402
3,363,774	1/1968	Luthi	210/404

Primary Examiner—Reuben Friedman
Assistant Examiner—T. A. Granger
Attorneys—Theodore M. Jablon and D. M. Mezzapelle

ABSTRACT: A rotary vacuum drum filter wherein the external filter compartments are provided with both leading and trailing filtrate drainage pipes, and separate vacuum control means are provided for each set of pipes, functioning and timed relative to each other in such a manner as to attain optimum filtrate drainage from the compartments.

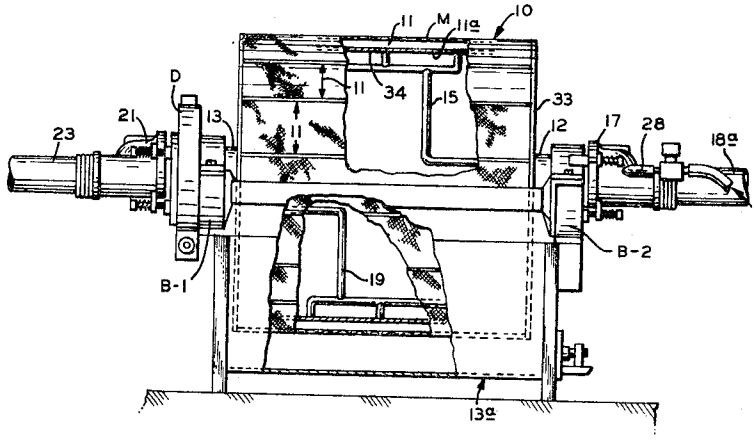


FIG. 1

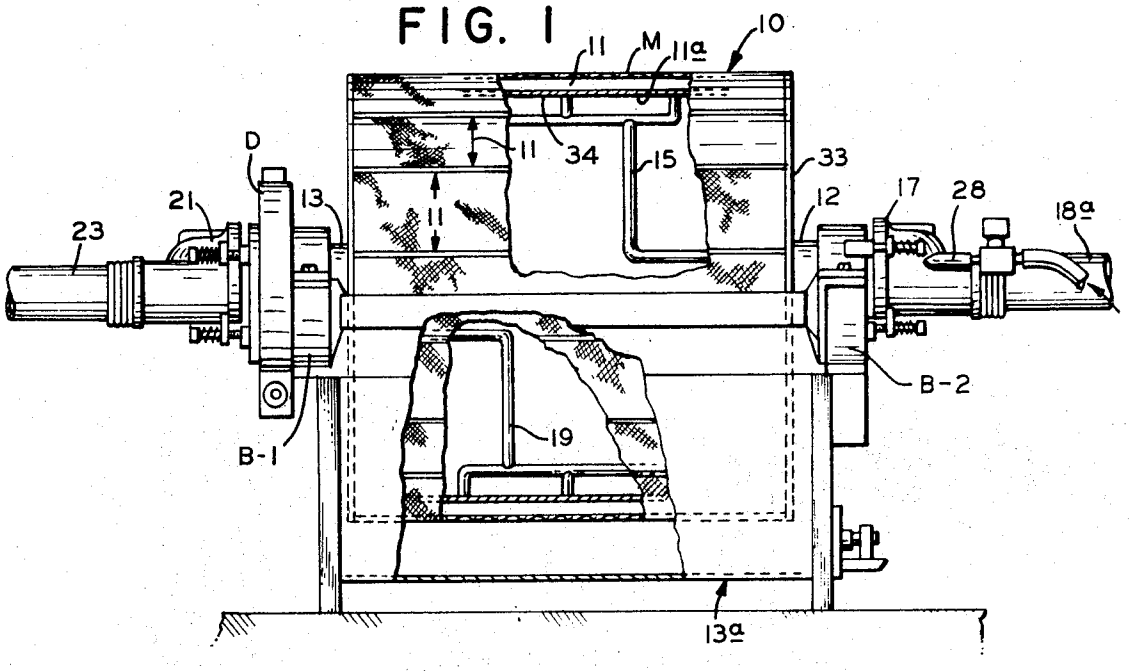
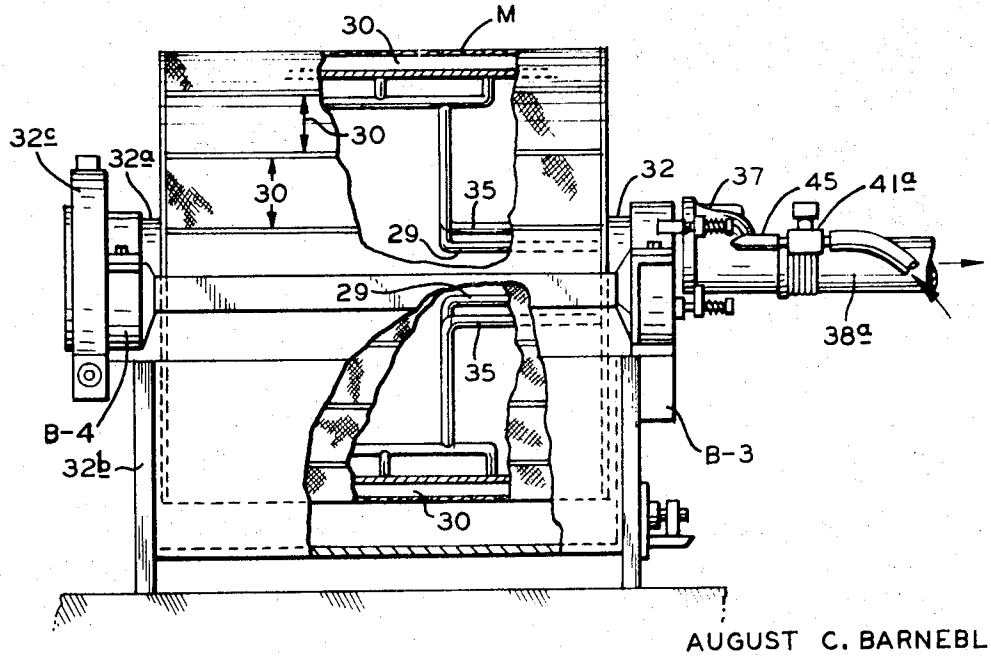


FIG. 12



AUGUST C. BARNEBL
FRANZ BLIEM
INVENTORS.

BY: Theodore M. Jablon

ATTORNEY.

FIG. 2

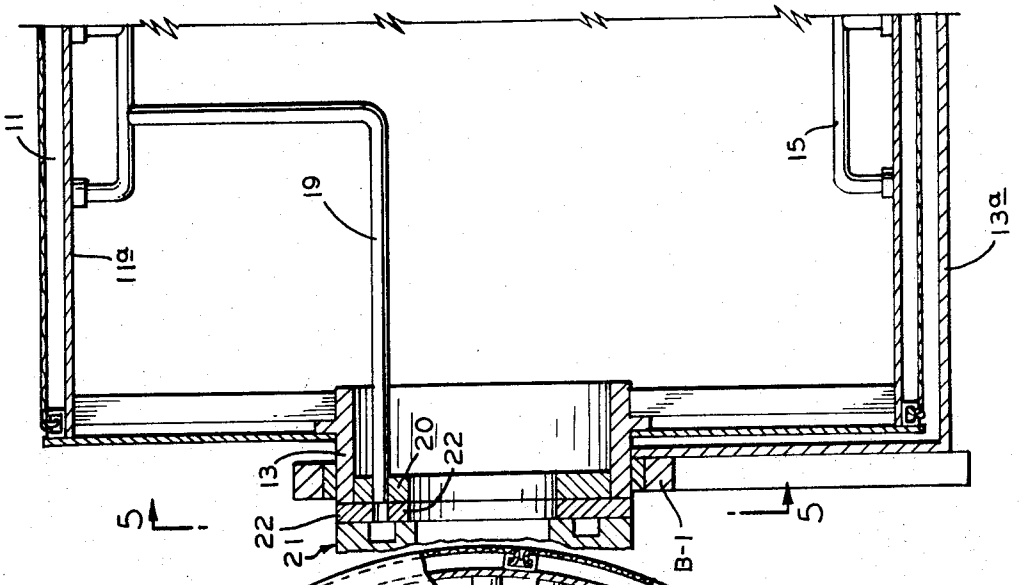


FIG. 5

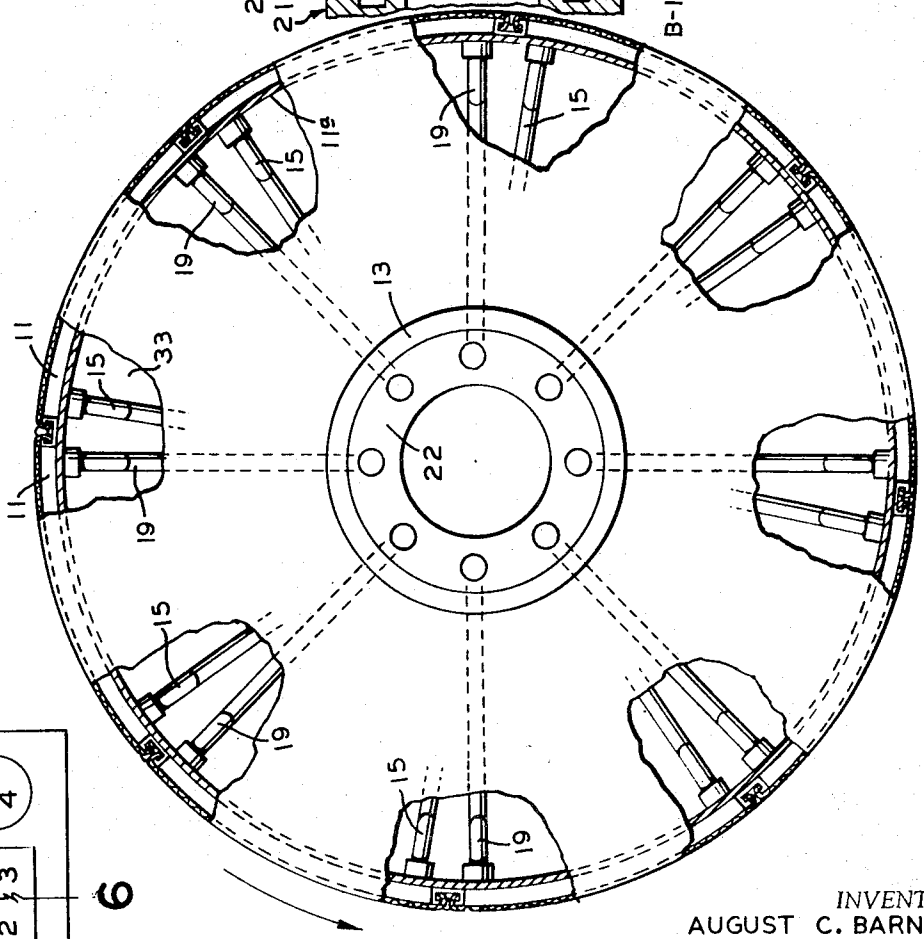
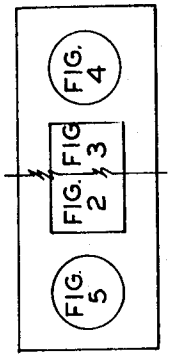


FIG. 6



INVENTORS.
AUGUST C. BARNEBL
FRANZ BLIEM
BY Theodore M. Jablon
ATTORNEY.

FIG. 4

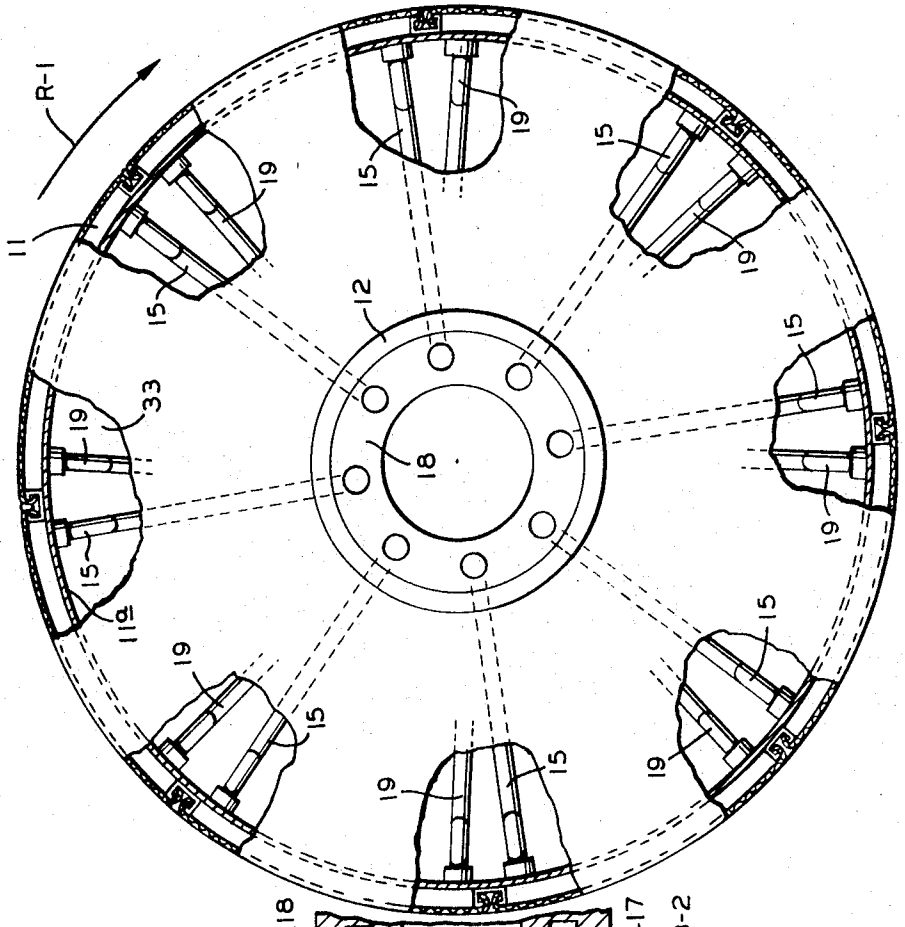
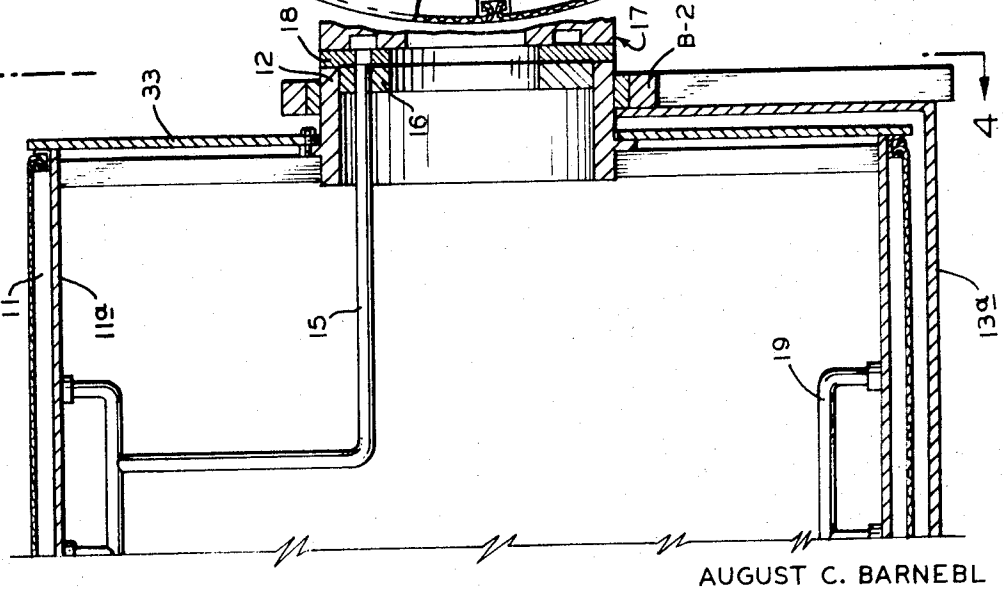


FIG. 3



AUGUST C. BARNEBL
FRANZ BLIEM
INVENTORS.
BY: Theodore M Jablon
ATTORNEY.

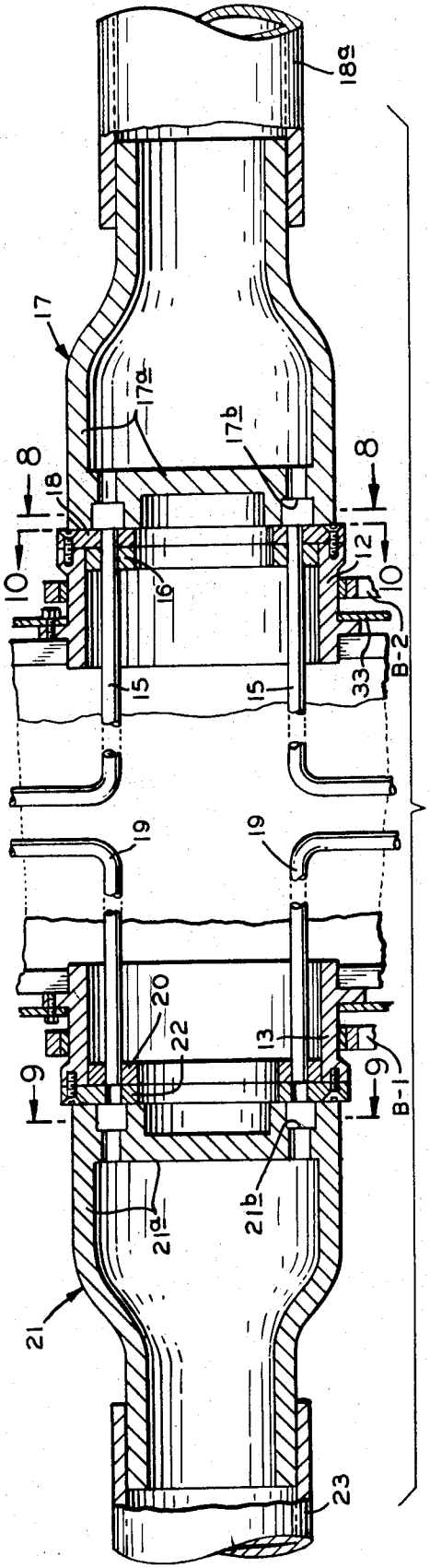


FIG. 7

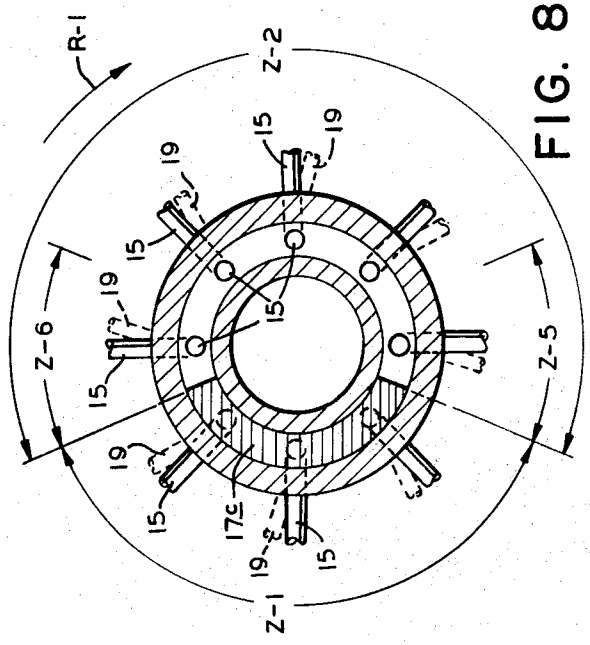


FIG. 8

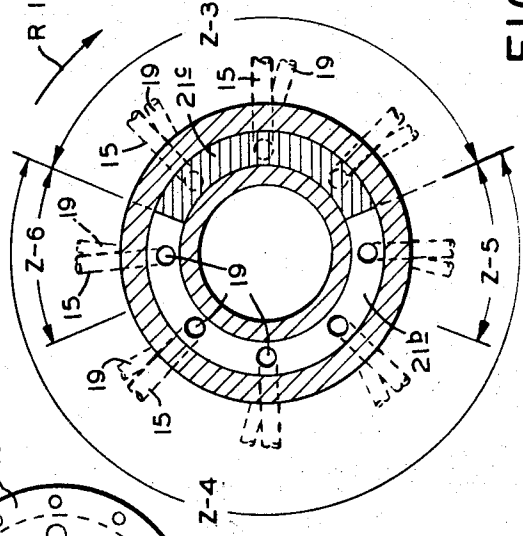


FIG. 9

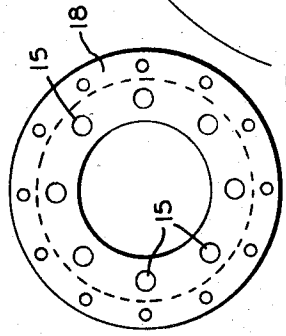


FIG. 10

AUGUST C. BARNEBL
FRANZ BLIEM
INVENTORS.

BY: Theodore N. Jablon

ATTORNEY.

FIG. 18

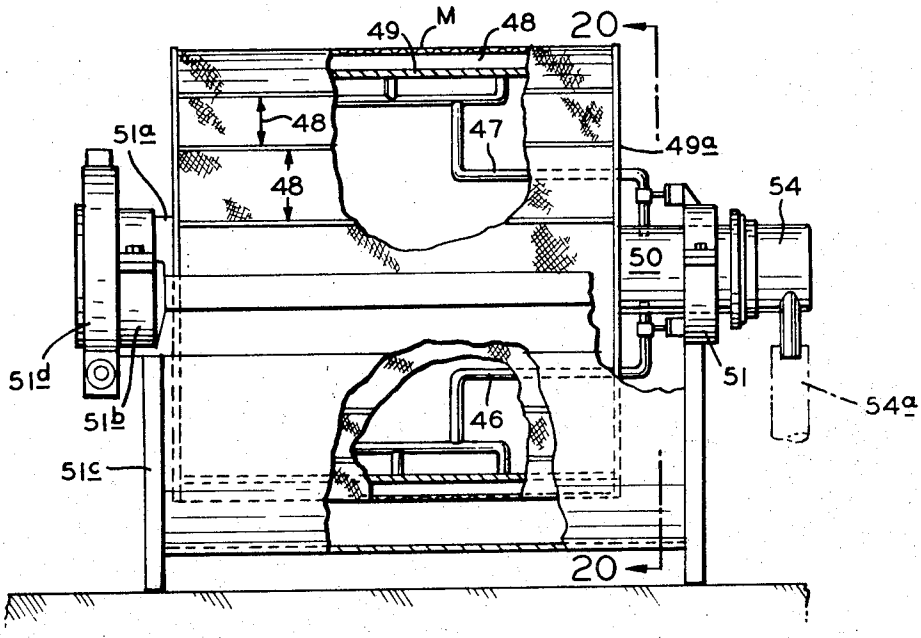


FIG. 17

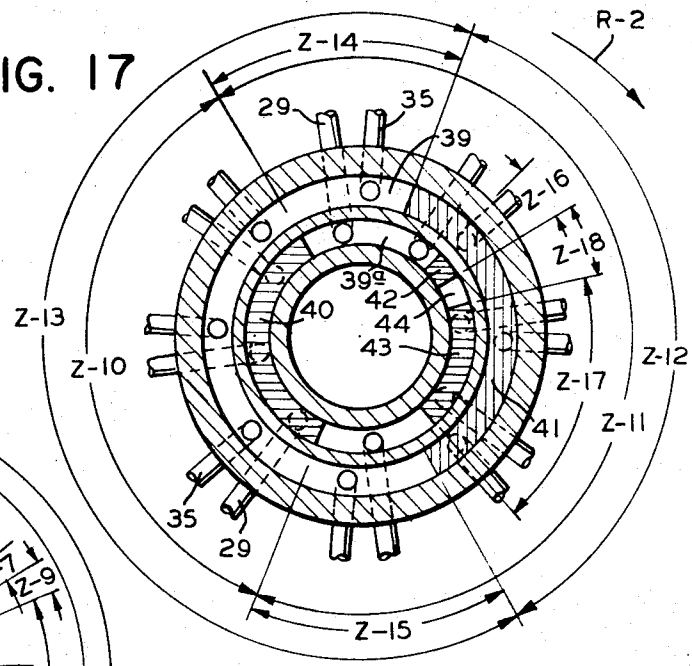
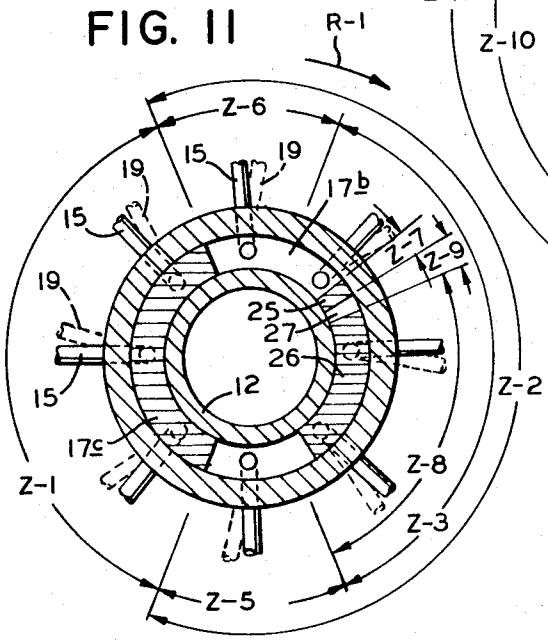


FIG. 11



AUGUST C. BARNEBL
FRANZ BLIEM
INVENTORS.

BY: Theodore M. Jablon

ATTORNEY.

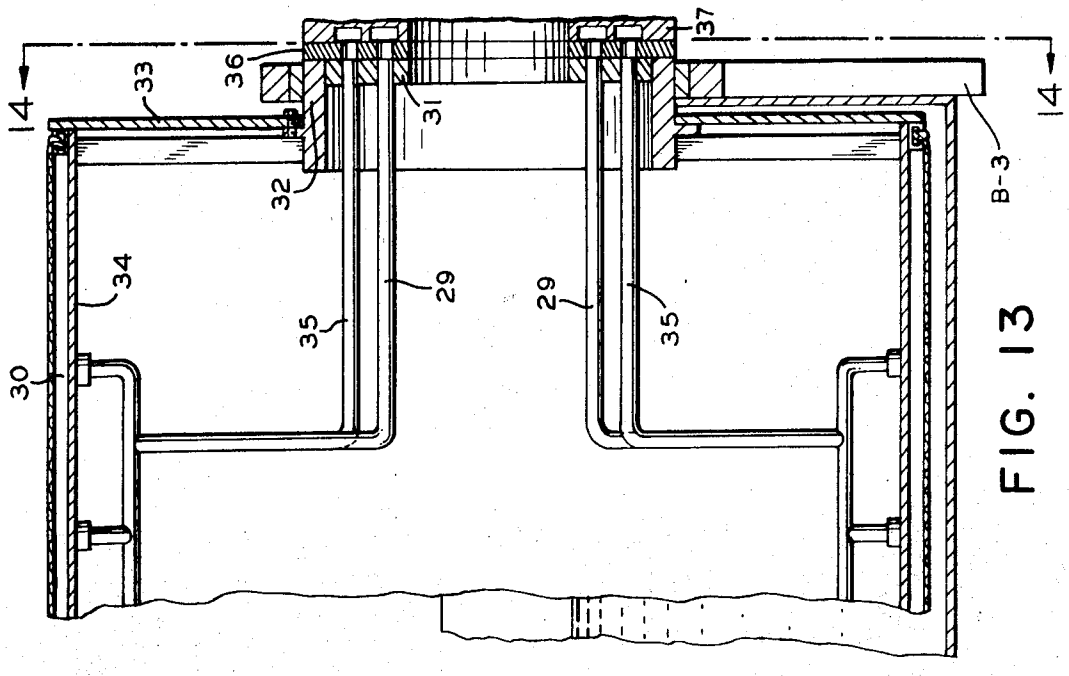


FIG. 13

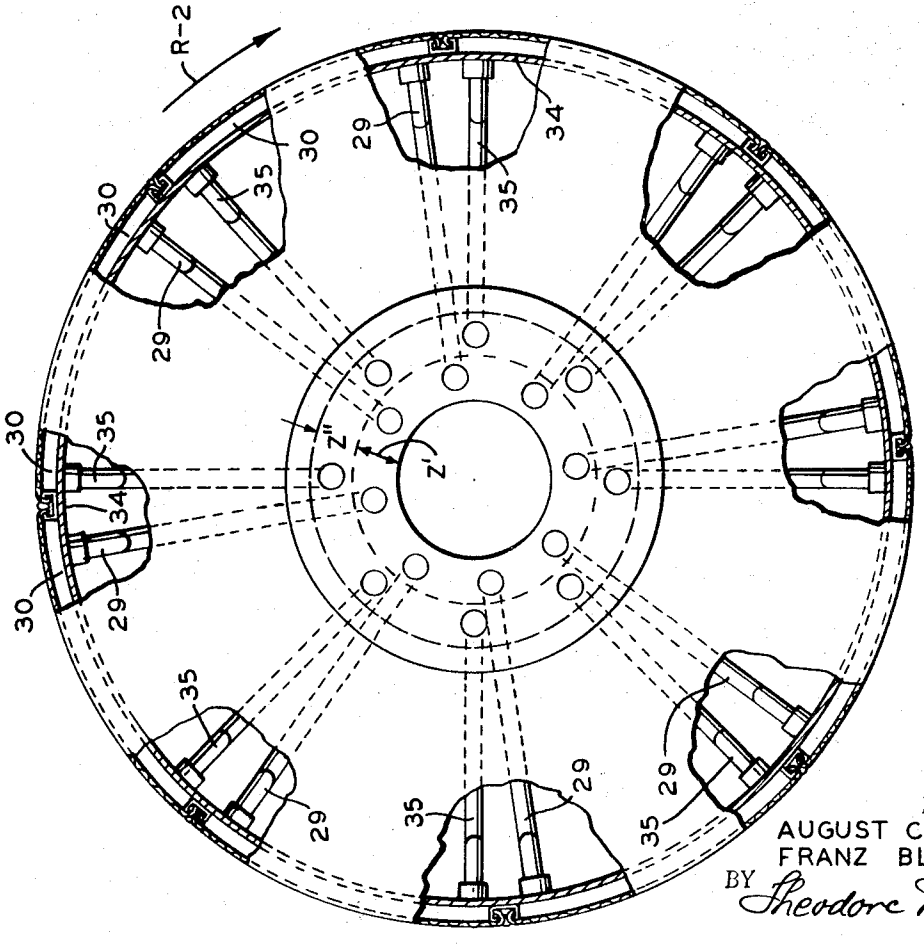


FIG. 14

INVENTORS.
AUGUST C. BARNEBL
FRANZ BLIEM
BY Theodore M. Jablon
ATTORNEY.

FIG. 15

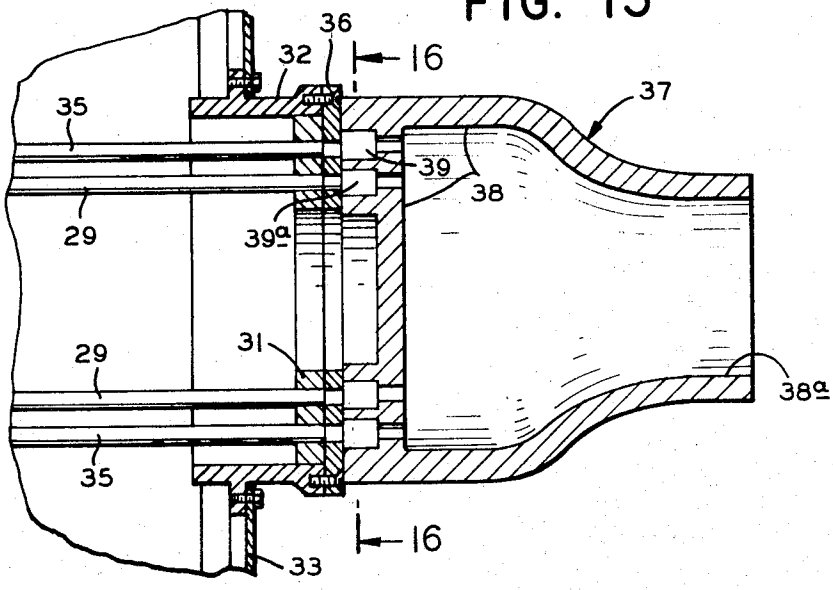
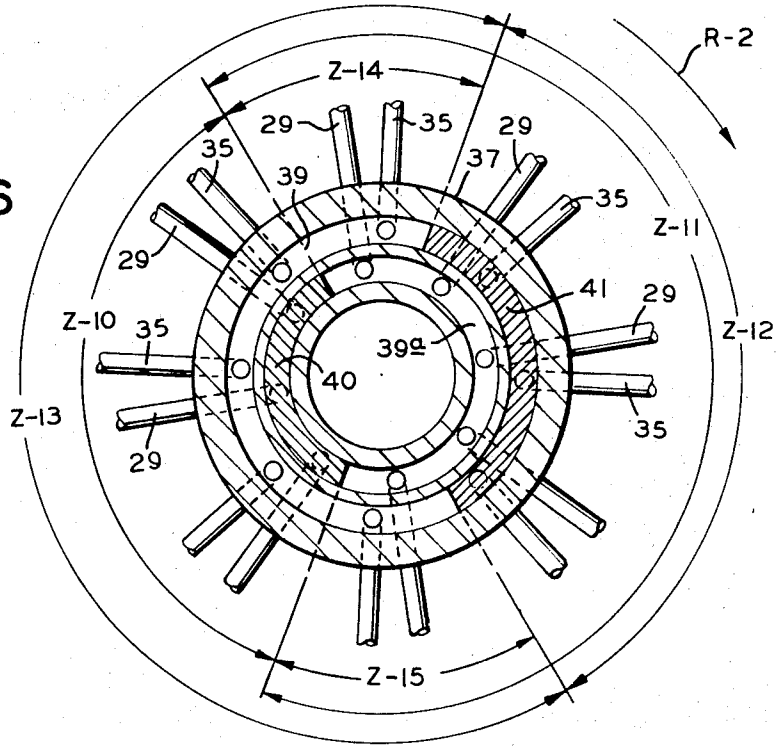


FIG. 16



INVENTORS.
AUGUST C. BARNEBL
FRANZ BLIEM
BY Theodore M. Jablon
ATTORNEY.

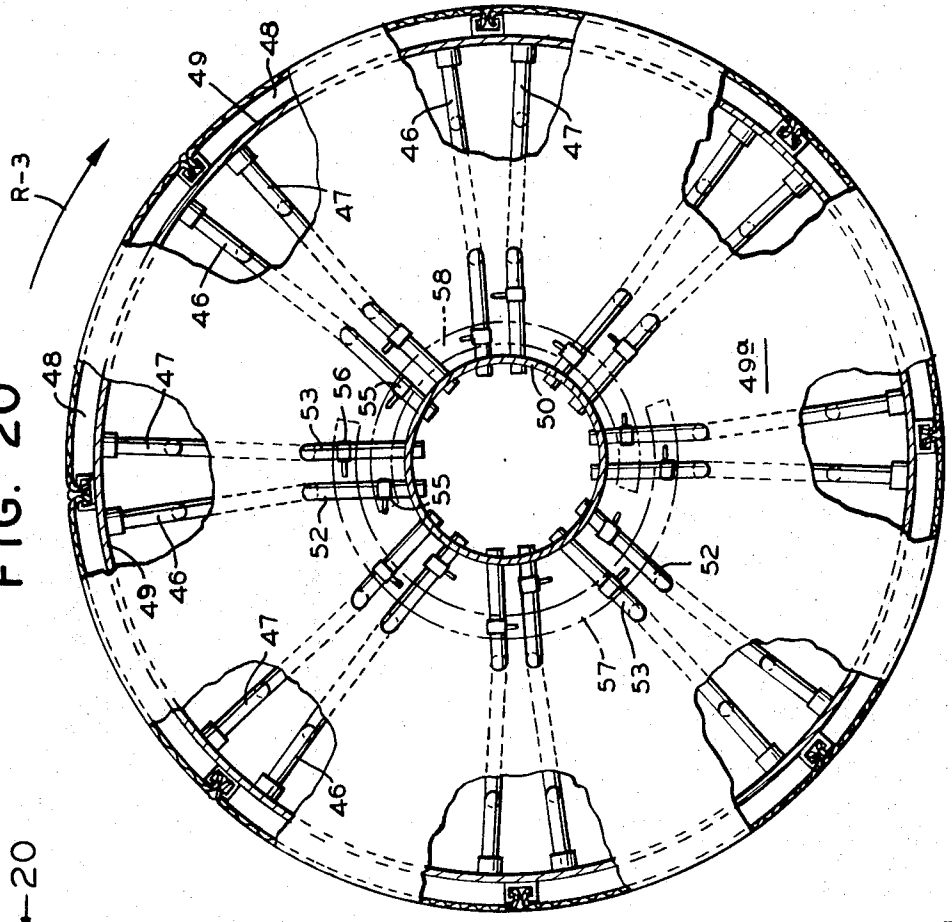


FIG. 20

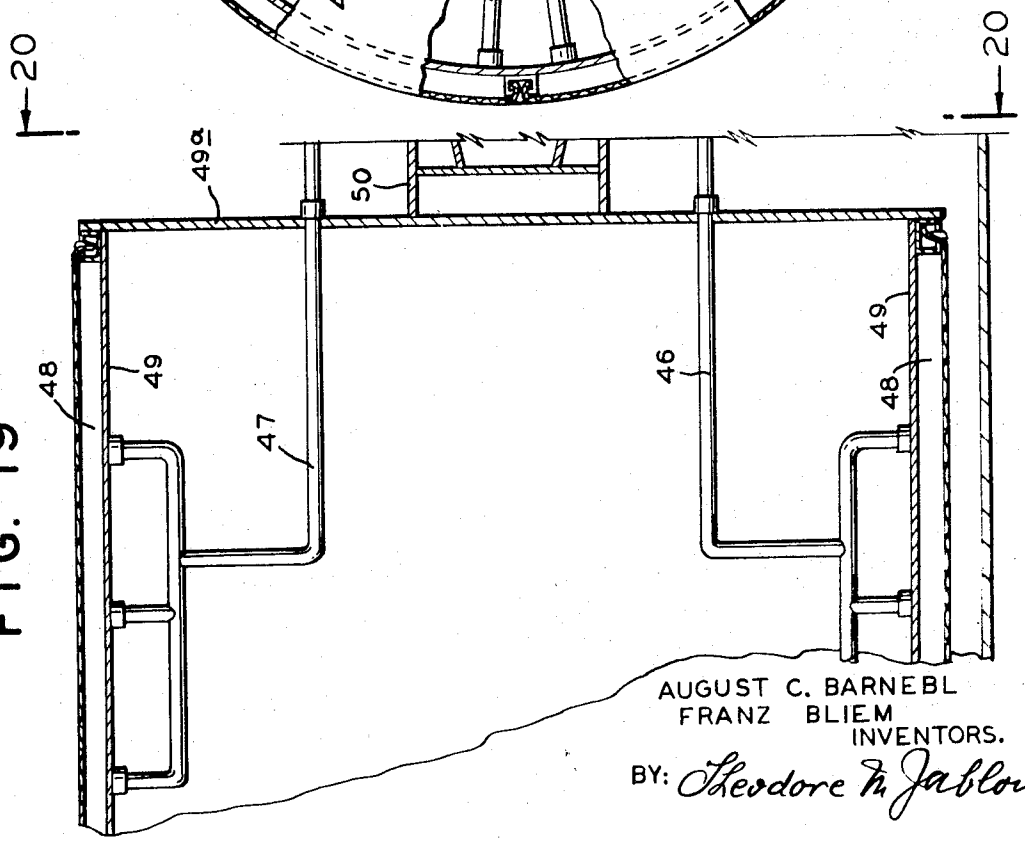
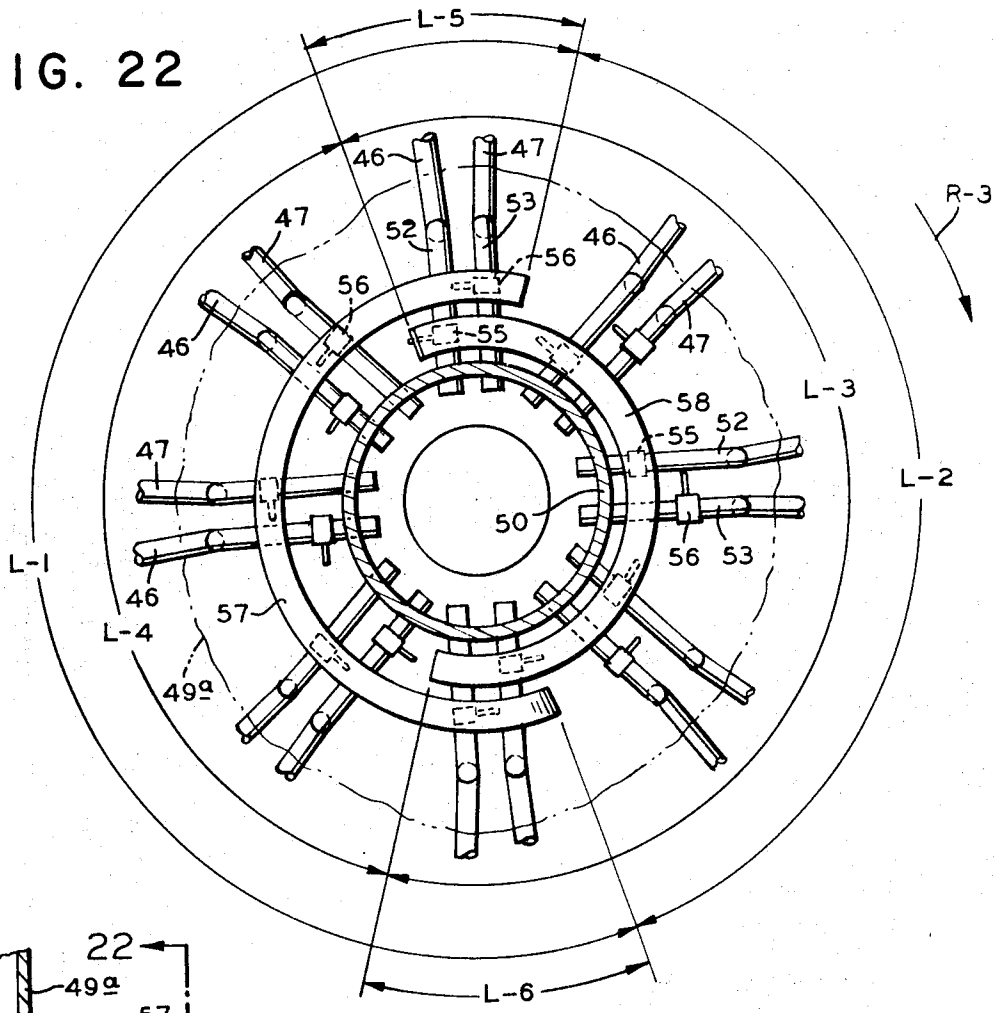


FIG. 19

AUGUST C. BARNEBL
FRANZ BLIEM
INVENTORS.
BY: Theodore M. Jablon
ATTORNEY.

FIG. 22



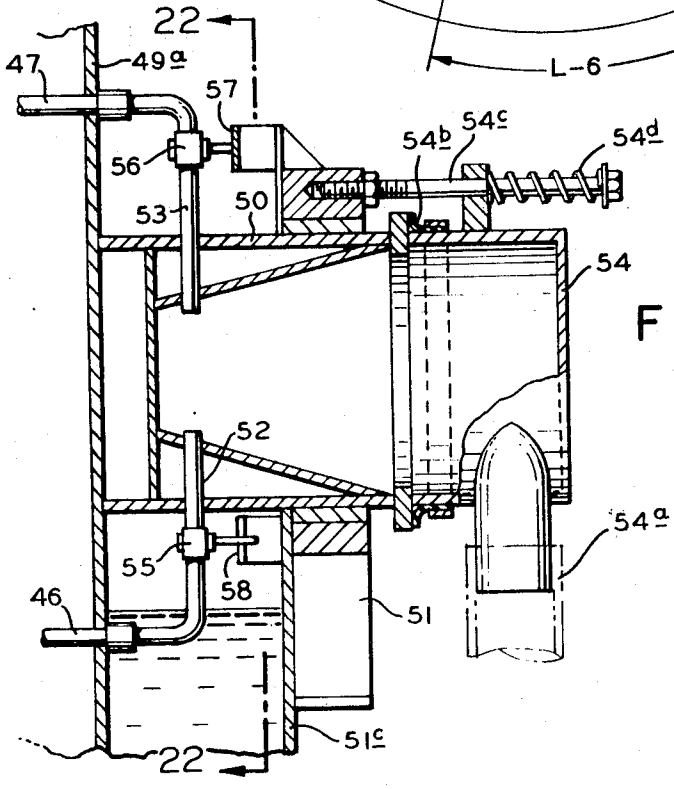


FIG. 21

AUGUST C. BARNEBL
FRANZ BLIEM
INVENTORS.
BY: Theodore M. Jablon
ATTORNEY.

FIG. 23

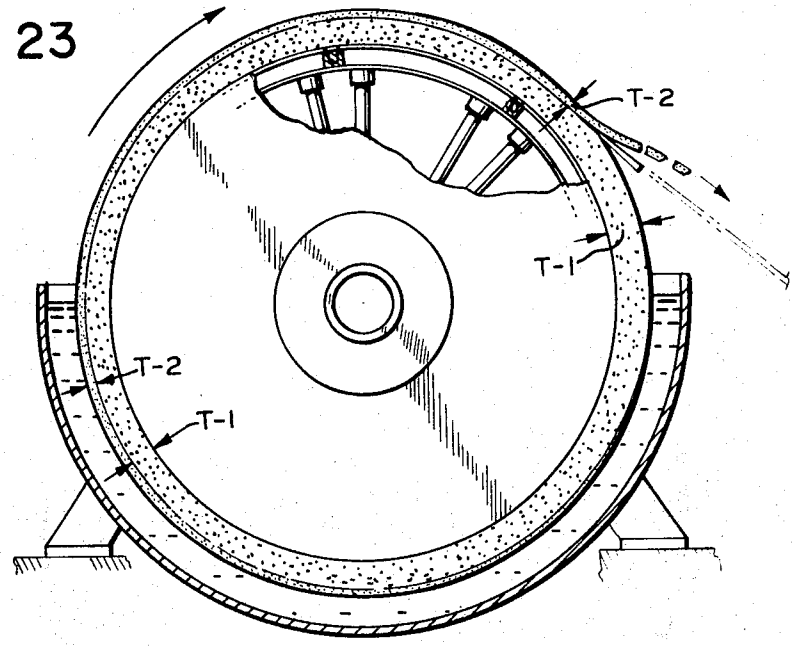
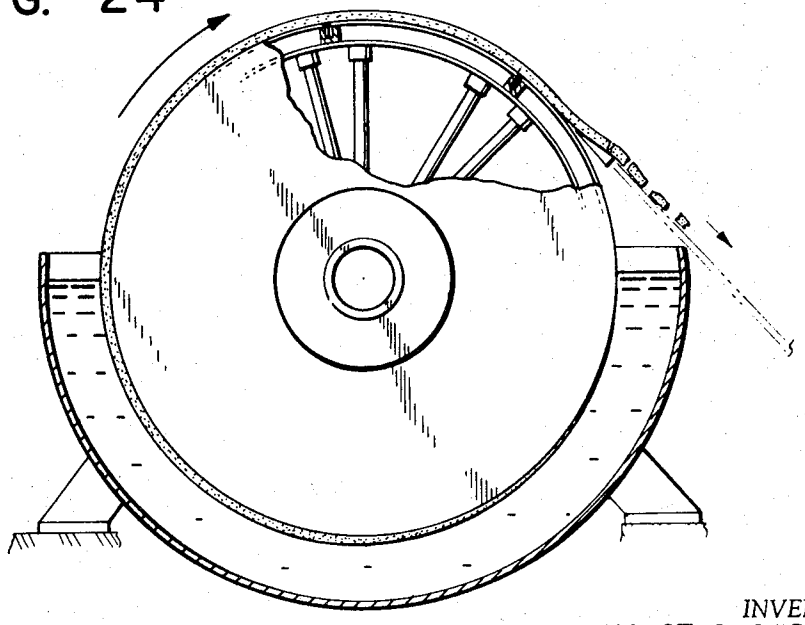


FIG. 24



INVENTORS.
AUGUST C. BARNEBL
FRANZ BLIEM
BY Theodore M. Jablon
ATTORNEY.

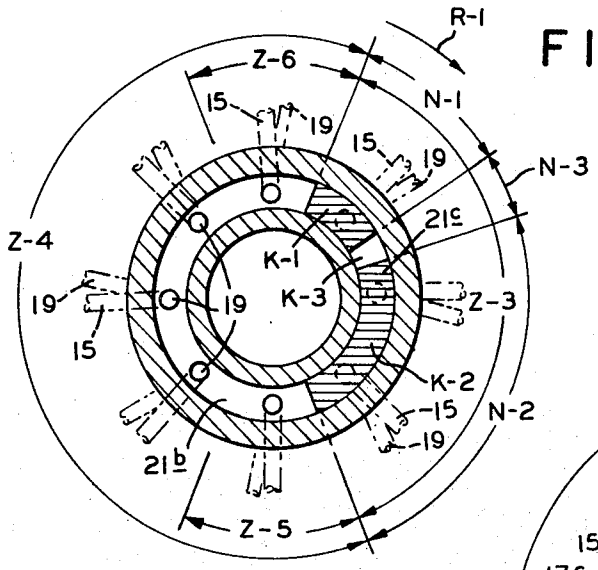


FIG. 25

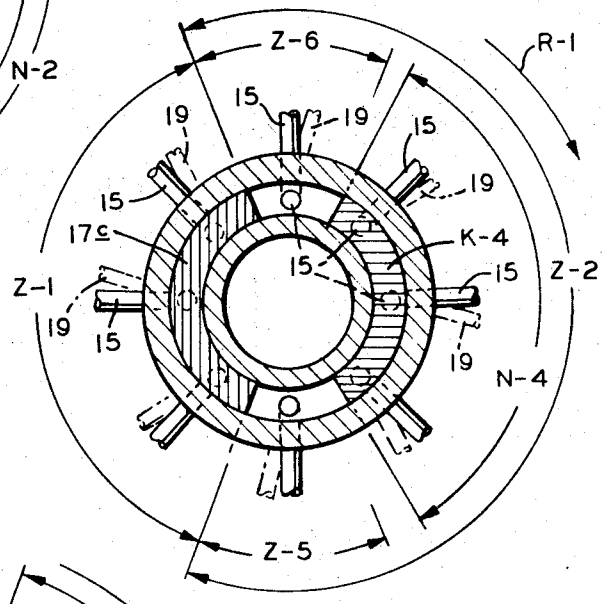


FIG. 26

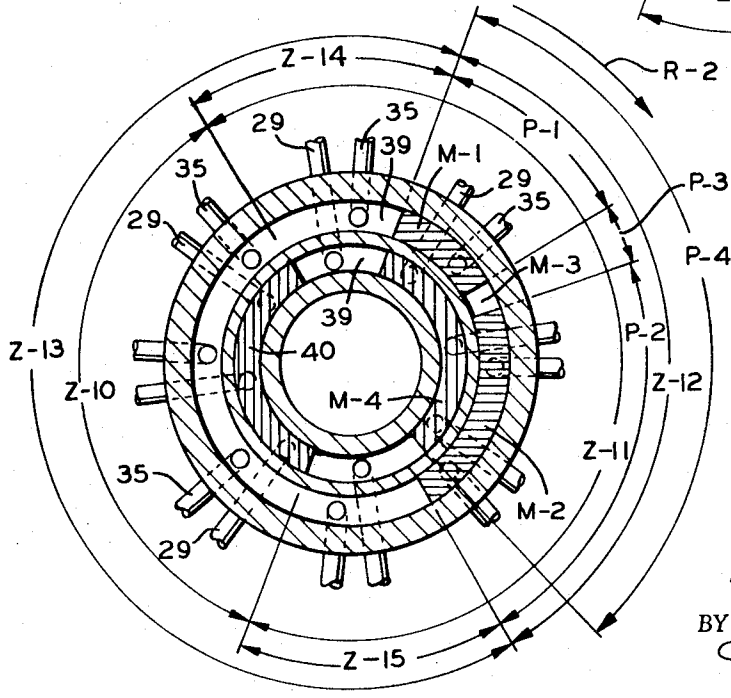


FIG. 27

INVENTORS.
AUGUST C. BARNEBL
FRANZ BLIEM
BY Theodore M. Jablon
ATTORNEY.

ROTARY VACUUM DRUM FILTERS

This invention relates to improvements in continuous rotary vacuum drum filters of a type wherein the filter drum rotates about a horizontal axis, partially immersed in a body of pulp or slurry contained in a tank.

As the drum rotates through a filtration cycle, a vacuum maintained inside the drum causes filter cake to be formed upon the drum continuously, which filter cake after emergence thereof from the pulp at the ascending side of the drum is continuously removed and delivered at the descending side.

More particularly, this invention relates to the problem of effectively draining filtrate liquid from the filter unit in a manner whereby filtration efficiency is improved in terms of optimum utilization of available filter area and in terms of dryness of the filter cake, by substantially preventing filtrate liquid from getting trapped in the filter drum during the filtration cycle.

This problem and the importance of obtaining improved drainage will appear more clearly from the following conditions.

A filter unit embodying this invention may be of the type wherein the filter drum comprises a cylindrical shell having end trunnions whereby the drum is mounted for rotation upon the tank. The shell has provided externally thereon longitudinal external filter compartments coextensive with the drum axis, arranged side by side along the periphery of the shell, and subjected to vacuum filtration in the course of the filtration cycle.

Filtrate drainage pipes or ducts leading from each filter compartment terminate in the end plate or the tube plate of one of the trunnions cooperating face-to-face with the stationary so-called trunnion valve which controls the filtration cycle.

In the trunnion valve the so-called bridges or bridge blocks adjustably positioned in the valve housing cooperate with the terminal face of the trunnion and with the end of the filtrate discharge pipes therein, in such a manner as to admit vacuum suction to the filtration compartments as and where required by the filtration cycle. Those zones in the filtration cycle where vacuum suction through the valve is shut off by the bridge blocks, are termed neutral zones.

A filter operating cycle may comprise a vacuum cake forming or pick up zone effective during submergence of the filter chambers in the pulp, a vacuum cake drying zone effective after emergence of the filter chambers from the pulp, and a neutral or air supply zone at the descending side of the filter drum, allowing the filter cake to be detached and removed from the filter media before reentry of the filter chambers into the pulp. An interposed cake washing zone also under vacuum may precede the cake drying zone, between the cake forming zone and the cake drying zone. A neutral zone may also then be provided between the cake forming zone and the washing zone, in order that a strong filtrate liquor might be collected separate from weak liquor or spent wash liquor flowing from the cake washing and drying zones.

Another example of a filtration cycle applicable to this invention is the so-called precoat filter operation whereby the entire filter area of the filter drum remains covered by a layer or precoat of substantial thickness of a filter aid material under vacuum during the entire filtration cycle. A thin layer of filter cake collected on the precoat layer is continuously scalped off together with a slight amount of the precoat material by a doctor blade at the descending side of the drum. Because of the sealing effect of the precoat layer no neutral zones or bridge blocks are needed in the trunnion valve except for instance where separate recovery of strong liquor and weak spent wash liquor is required by the filtration cycle.

Whatever the mode of operation or the character of the filtration cycle, optimum filtrate drainage and consequent minimum cake moisture have been difficult or impossible to attain because of contradictory drainage conditions existing for the filter compartments at the ascending side and at the descending side of the filter drum.

That is to say, when the filtrate drainage pipes are connected to the leading ends of the respective filter chambers, filtrate liquid is trapped in the pockets formed by the trailing or lower portion of the filter chambers at the ascending side of the drum. This trapped liquid renders ineffective a corresponding part of the filter area above the pulp level on the ascending side.

When the filtrate drainage pipes are connected to the trailing ends of the respective filter chambers, a problem exists for the filter compartments at the descending side of the drum, in that liquid trapped in the leading or lower portion of the compartments finds its way back into the filter cake being discharged from the drum, increasing the amount of residual moisture in the cake.

Even where the compartments each have a leading and a trailing filtrate drainage pipe, similar drawbacks are experienced, resulting in the loss of effective filter area and in an undue amount of residual moisture in the filter cake. This loss is due to the fact that air short-circuiting occurs through the trailing pipes as well as through the leading pipes at certain points of the filtration cycle, whereby some liquid gets trapped at the ascending side as well as at the descending side of the filter drum.

It is among the objects of this invention that the above outlined filtrate drainage problems and losses in effective filter area be avoided and that the residual moisture in the filter cake be minimized by causing the filtrate liquid to be positively drained and removed from the respective lowest points of the compartments throughout the filtration cycle.

To this end, the invention provides a set of leading drainage pipe connections as well as a set of trailing drainage pipe connections to the compartments. Separate vacuum control means are provided for each set of drainage pipes, so constructed and arranged that filtrate collecting pockets are eliminated and the previously ineffective filter areas are rendered effective and productive towards moisture removal and the delivery of a drier cake.

The vacuum control means, for example in the case of precoat filter operation, may be so constructed and arranged that the two sets of drainage pipes are supplied with vacuum in a substantially complementary manner. In other words, the leading pipes are blocked off or closed at the ascending side, while the trailing pipes on that side are left free to function to their full advantage in draining liquid under vacuum from the lowest trailing point of the ascending filter compartments. The trailing pipes in turn are blocked off or closed at the descending side, while the leading pipes on that side are left free to function to their full advantage in draining liquid under vacuum from the then lowest leading point of the descending filter compartments.

In the case of a filtration cycle which calls for the removal of filter cake formed directly upon the filter media, the control means may be so constructed and arranged that a neutral zone of vacuum shutoff is provided at least during cake discharge and until the filter compartments from which the cake has been removed, will have become fully resubmerged in the pulp. This may comprise an air supply–or air blow back zone for effecting or expediting the detachment of the filter cake from the filter media.

According to one embodiment of the invention, the trailing pipes terminate in one of the end trunnions of the drum, while the leading pipes terminate in the other end trunnion. Each of the trunnions has a separate control means or trunnion valve, connected to a vacuum receiver.

In another embodiment the trailing pipes as well as the leading pipes terminate in one and the same trunnion, cooperating with a vacuum control means or trunnion valve designed to provide vacuum to the leading and to the trailing pipes selectively in the manner required by the operating cycle of this invention.

According to still another embodiment, the vacuum control for the operating cycle of this invention is provided by stationary cams activating individual valves provided in the trailing pipes and in the leading pipes.

The cam control of the valves is so timed as to admit vacuum suction to the filter compartments selectively through the leading pipes and the trailing pipes in the manner called for by the operating cycle of the invention.

One feature of the invention lies in the provision of an operating cycle which comprises a predetermined first lateral zone at the ascending side of the drum, during which the leading pipes are closed, while the trailing pipes are open, a predetermined second lateral zone at the opposite descending side of the drum during which the trailing pipes are closed, while the leading pipes are open, a third zone at the bottom between the lower ends of the first-mentioned two lateral zones, during which both the trailing pipes and the leading pipes are open, and/or a fourth zone at the top between the upper ends of the first-mentioned two lateral zones, during which both the trailing pipes and the leading pipes are open.

Other features lie in operating the invention with different types of filtration cycles.

Other features and advantages will hereinafter appear.

FIG. 1 is a side view of the rotary vacuum drum filter with parts broken away to illustrate one embodiment of the invention, featuring separate trunnion valves for the trailing pipes and for the leading pipes respectively.

FIGS. 2 and 3 taken together represent an enlarged vertical longitudinal sectional view of the filter drum of the FIG. 1 embodiment, adapted for precoat filter operation.

FIG. 4 shows a cross-sectional view taken on line 4—4 in FIG. 2, illustrating the vacuum control for the trailing pipes by one of the two trunnion valves.

FIG. 5 shows a cross-sectional view taken on line 5—5 in FIG. 3, illustrating the vacuum control for the leading pipes by the other of the two trunnion valves.

FIG. 6 is a diagram showing the interrelationship of FIGS. 2, 3, and 4.

FIG. 7 is a fragmentary view of the filter drum of FIGS. 1 to 5, showing a vertical longitudinal section of the two trunnion valves opposite each other, and the associated trunnions.

FIG. 8 is a cross-sectional view taken on line 8—8 of the left-hand trunnion of FIG. 7, showing the bridge block arrangement for the vacuum control of the trailing pipes.

FIG. 9 is a cross-sectional view taken on line 9—9 of the right-hand trunnion valve of FIG. 7, showing the bridge block arrangement for the leading pipes.

FIG. 10 is a cross-sectional view taken on line 10—10 of FIG. 7, showing the disposition of the trailing pipes terminating in the left-hand trunnion, identical to the disposition of the leading pipes in the right-hand trunnion.

FIG. 11 is a cross-sectional view similar to FIG. 9 of the right-hand trunnion valve, except for a bridge block arrangement to allow for blowback removal of the filter cake.

FIG. 12 is a side view of a rotary vacuum drum filter with parts broken away to illustrate a second embodiment of the invention, featuring a single trunnion valve for vacuum control of both the trailing pipes and the leading pipes.

FIG. 13 is an enlarged fragmentary vertical longitudinal sectional view of the filter drum of FIG. 12, showing both the trailing pipes and the leading pipes terminating in one trunnion, although in different concentric zones.

FIG. 14 is a cross-sectional view taken on line 14—14 of FIG. 13, showing the trailing pipes and the leading pipes cooperating with corresponding concentric zones and bridge blocks in the associated trunnion valve.

FIG. 15 is a vertical longitudinal sectional view of the trunnion valve of the embodiment of FIGS. 12, 13, and 14 illustrating the cooperative relationship between the two sets of drainage pipes and the trunnion valve.

FIG. 16 is a cross-sectional view taken on line 16—16 in FIG. 15, showing the bridge block arrangement adapted for precoat filter operation.

FIG. 17 is a cross section similar to FIG. 15, but including a bridge block arrangement to allow for blow back removal of the filter cake.

FIG. 18 is a side view of a rotary vacuum drum filter with parts partly broken away to illustrate a third embodiment of the invention, wherein vacuum control is effected by cams activating individual valves provided in the trailing and in the leading pipes.

FIG. 19 is a fragmentary vertical longitudinal section of the filter drum of FIG. 18.

FIG. 20 is a cross section taken on line 20—20 in FIG. 19.

FIG. 21 is a vertical longitudinal section of the vacuum control means of the FIG. 18 embodiment.

FIG. 22 is a cross section taken on line 22—22 in FIG. 21 showing the disposition of the arcuate cams controlling the individual valves and defining the filtration cycle.

FIG. 23 is a diagrammatic cross-sectional view of a rotary vacuum drum filter, illustrating a precoat filter operation.

FIG. 24 is a diagrammatic cross-sectional view of a rotary vacuum drum filter.

FIGS. 25 and 26 illustrate a different back blow arrangement for the FIG. 1 embodiment having two trunnion valves.

FIG. 27 illustrates a different back blow arrangement for the FIG. 12 embodiment having one trunnion valve.

The filter unit according to the embodiment in FIG. 1 and the related detail FIGS. 2 to 10, has a filter drum 10 with external filter compartments 11 provided upon a cylindrical shell 11*a* which in turn has end trunnions 12 & 13 whereby the shell is mounted on bearings B–1 and B–2 for rotating upon a tank 13*a*. Vacuum suction applied to the filter compartments through a trunnion valve, causes a filter cake to be formed upon the filter media M of the compartments moving through a body of pulp in the tank during the rotation of the drum in the clockwise direction of arrow R–1 (see FIG. 4) by a drive mechanism D.

In one type of vacuum drum filter operation, the so-called precoat filter operation illustrated in FIG. 23, a layer of substantial thickness of a filter aid material T–1 is maintained by suction upon the entire filter area of the drum throughout the entire filtration cycle. A relatively thin layer of filter cake T–2 is allowed to form upon this precoat layer, which filter cake together with a small amount of the filter aid material is scalped off at the descending side of the drum. Accordingly, in this mode of operation, vacuum is applied to all filter compartments throughout the entire filtration cycle, with the precoat layer sealing or shielding the compartments against the atmosphere.

In another type of filter operation illustrated in FIG. 24 the filter cake formed directly upon the filter media, emerging from the pulp at the ascending side of the drum may be subjected sequentially to washing and to drying still exposed to the vacuum in respective washing and drying until it reaches a zone of cake removal and until the respective compartment from which the cake has been removed will have become resubmerged in the pulp at the beginning of a new filtration cycle.

Whatever the mode of filter operation or the type of the filtration cycle, according to this invention each of the filter compartments has what is herein termed a leading pipe or duct 15 which extends within the shell 11*a* from the leading side of the compartment to the trunnion 12 at the right-hand end of FIG. 7 (see also in FIGS. 3 & 4). These leading pipes terminate in a tube plate or end plate 16 of the trunnion, equally spaced about the axis of the drum. This trunnion and the leading pipes therein cooperate with a first trunnion valve 17 (see FIG. 7) which has face-to-face contact with a customary wear plate 18 fixed to the trunnion against the endplate 16 thereof. The trunnion valve has a vacuum connection 18*a* to a source of vacuum supply such as a vacuum receiver or the like here not shown.

Each filter compartment (see FIGS. 1, 2, 5, 7) also has what is herein termed a trailing pipe or duct 19 which extends within the shell 11*a* from the trailing side of the compartment to the trunnion 13. These trailing pipes terminate in a tube plate or end plate 20 of trunnion 13, equally spaced about the drum axis. This trunnion and the trailing pipes therein cooperate with a second trunnion valve 21 which has face-to-face contact with a customary wear plate 22 fixed to the trun-

nion against the end plate 20 thereof. This trunnion valve has a vacuum connection 23 which may lead to the same source of vacuum supply that serves the first trunnion valve 17.

The first trunnion valve 17 has a valve housing 17*a* formed with an annular groove 17*b* coaxial with the drum axis, and facing the adjoining ends of the leading pipes 15. The annular groove contains a bridge block 17*c* (see FIG. 8) controlling the operation of the leading pipes by closing their communication with the vacuum supply in a zone Z–1 at the ascending side of the drum, while exposing them to the vacuum in an opposite zone Z–2 at the descending side.

The second or left-hand trunnion valve 21 has a valve housing 21*a* formed with an annular groove 21*b* coaxial with the drum axis, and facing the adjoining ends of the trailing pipes 19. This annular groove contains a bridge block 21*c* (see FIG. 9) controlling the operation of the trailing pipes in that it closes their communication with the vacuum supply in a zone Z–3 at the descending side of the drum, while exposing them to the vacuum in an opposite zone Z–4 at the ascending side of the drum.

The bridge blocks 17*c* and 21*c* or zones Z–1 and Z–3 respectively are opposite and substantially complementary to each other. However, in a preferred embodiment illustrated in FIGS. 2 to 6 the arrangement and extent of the zones relative to each other is such that the filtration cycle may also comprise a transitional bottom zone Z–5 between the lower ends of zones Z–1 and Z–3, wherein both the leading pipes and the trailing pipes are open to the vacuum, and a transitional top zone Z–6 between the upper ends of zones Z–1 and Z–3, wherein both sets of pipes are open to the vacuum. In this embodiment therefore, the zones Z–1 and Z–3 may be called the lateral zones relative to the relatively narrow top bottom zones Z–5 and Z–6.

Accordingly, in this embodiment of the invention the filter compartments rising from the pulp at the ascending side are subject to vacuum only through the trailing pipes 19 in zone Z–4. Thus, filtrate liquor is allowed to drain rapidly and freely from the then lowest points of the compartments, subject to the combined effect of both gravity drainage and vacuum suction. In this way, filtrate liquor is prevented from getting trapped in the compartments, and detracting from the effective filter area, and also prevented from being carried over from the ascending to the descending side where it would remoisturize the filter cake.

On the descending side, however, where the compartments reenter the pulp (see FIG. 8) they are subject to vacuum only through the leading pipes 15 passing through zone Z–2. Here again, filtrate liquor is allowed to drain rapidly and freely from the then lowest points of the compartments, subject to the combined effect of both gravity drainage and vacuum suction, avoiding the drawbacks of reducing the effectiveness of the filter area, and remoisturizing the filter cake.

While the foregoing mode of operation with a bridge block arrangement providing selective or complementary vacuum controls for the two sets of drainage pipes, lends itself particularly to the above mentioned precoat filter operation (see FIG. 23), there is shown in FIG. 11 a bridge block arrangement provided in trunnion valve 17, defining the filtration cycle wherein no precoat layer of filter aid material is applied (see FIG. 24). In that case, the filter compartments at the descending side must be blocked off against the vacuum in a cake discharge zone where the filter media are exposed to the atmosphere during and after cake discharge and until they have become resubmerged in the pulp. Conventionally, this zone or mode of operation may include an air blowback for dislodging the cake from the filter cloth.

Accordingly, in FIG. 11 the annular groove in trunnion valve 17 contains additional bridge blocks 25 and 26 providing neutral zones Z–7 and Z–8 respectively at the descending side. These blocks are spaced from each other so as to form between them a port 27 defining a cake blowoff zone Z–9 which through duct 28 provided in the valve housing (see FIG. 1) communicates with compressed air supply. Thus, with the drum rotating in the direction of arrow R–1, the block 25 or neutral zone Z–7 allows for transition of the leading pipes from vacuum suction to blow back pressure, while block 26 or neutral zone Z–8 closes the leading pipes against the atmosphere following cake discharge in the blow back zone, and until the respective filter compartment denuded of filter cake has become resubmerged in the pulp. It will be remembered that during this cake discharge phase of the operating cycle the trailing pipes on the descending side remain closed by bridge block 21*c* in the opposite left-hand trunnion valve 21, so that the vacuum required for maintaining the operation of the filter unit will not be broken at any time during the filtration cycle.

A second embodiment of the invention illustrated in the filter unit of FIG. 12 and in the related detail FIGS. 13 to 16, has both the leading and the trailing drainage pipes extending from the filter compartments to a single trunnion valve of special construction, and herein termed the compound trunnion valve.

Accordingly, there are leading pipes 29 extending from respective filter compartments 30 of the filter drum to an inner annular zone Z′ (see FIG. 14) of a tube plate 31 which closes the end of a trunnion 32 fixed to the end plate 33 of the cylindrical shell 34 of the drum. Trailing pipes 35 extend from respective filter compartments to an outer annular zone Z″ (see FIG. 14) of the tube plate concentric with the inner zone Z′ and with the drum axis. The pipes are spaced evenly from one another about the drum axis in their respective zones Z′ and Z″. A wear plate 36 is fixed to the trunnion face-to-face with the tube plate 31, and has holes that register with the pipes.

At the opposite end the drum has a trunnion 32*a*, which together with trunnion 32 supports the drum for rotation upon a tank 32*b*, with a drive mechanism 32*c* rotating the drum in clockwise direction of arrow R–2 (see FIG. 14).

Cooperating face-to-face with the wear plate 36 is a trunnion valve 37 of special construction having a housing 38 with vacuum connection 38*a* (see FIG. 15). This housing is formed with an outer annular groove 39 and with an inner annular groove 39*a*, both grooves facing the wear plate, and registering respectively with the outer annular zone Z″ and with the inner annular zone Z′, and thus with the leading pipes and with the trailing pipes respectively.

To provide separate and independent vacuum controls for each of the two sets of filtrate drainage pipes in accordance with the invention, one bridge block 40 (see FIG. 16) is contained in the inner groove 39*a* of the valve housing, whereby the leading pipes 29 are blocked off in a zone Z–10 at the ascending side of the filter drum, but are exposed to vacuum effect through the valve housing in a larger complementary zone Z–11 at the descending side. Another bridge block 41 is contained in the outer annular groove 39 of the housing, whereby the trailing pipes 35 are blocked off in a zone Z–12 at the descending side of the drum, but are exposed to vacuum effect in a larger complementary zone Z–13 at the ascending side.

As in the above described first embodiment of the invention, both sets of pipes are open to vacuum effect in a top zone Z–14 and in a bottom zone Z–15, which zones are functionally interposed between the top ends and the bottom ends respectively of the lateral block-off zones Z–10 and Z–12. These interposed relatively narrow zones represent transitions between the lateral zones Z–10 and Z–12, with the drum rotating in the direction of arrow R–2.

While the embodiment of FIGS. 12 to 16 lends itself to the aforementioned precoat filter operation, FIG. 17 shows the single trunnion valve 37 converted or adapted to cake blowoff filter operation simply by the insertion of supplemental bridge blocks in the inner annular groove 39*a* and the provision of a compressed air connection 41*a* (see FIG. 12) in the valve housing.

Accordingly, the inner groove 39*a* in addition to the bridge block 40 at the ascending side contains bridge blocks 42 and

43 providing neutral zones Z–16 and Z–17 respectively at the descending side. These blocks are spaced from each other so as to constitute between them a port 44 defining a cake blowoff zone Z–18 which through a duct 45 (see FIG. 12) provided in the valve housing communicates with a compressed air supply. Thus, with the drum rotating in the direction of arrow R–2, the block 42 or neutral zone Z–16 provides for transition for the leading pipes from a vacuum suction zone to a blowback pressure zone. Block 43 or neutral zone Z–17 closes the leading pipes against the atmosphere during and after cake discharge in the blow back zone, and until the respective filter compartment denuded of filter cake has become resubmerged in the pulp for the beginning of a new filtration cycle. At this point it will be remembered that during and after cake discharge the trailing pipes 35 on the descending side remain closed by bridge block 41 in the outer annular groove, so that the vacuum effect required for the operation of the filter unit will not be broken at any time during the filtration cycle.

In a third embodiment of this invention as illustrated in the filter unit of FIG. 18 and in the related detail FIGS. 19 to 22, the drainage pipes are equipped with individual cam controlled valves instead of the above described trunnion valves. These individual valves are normally closed, but are actuated to open by stationary cam devices cooperating with the rotating filter drum. The timing is such that the leading pipes and the trailing pipes are opened and closed in the complementary manner comparable to the operation of the above described second embodiment in FIGS. 12 to 16.

Accordingly, there are leading pipes 46 and trailing pipes 47 extending from respective filter compartments 48 and from the interior of the cylindrical shell 49 through end plate 49*a* of the shell. The outside end portions of the pipes converge radially inwardly (see FIG. 20) so as to terminate in a hollow trunnion 50 fixed to end plate 49*a*, and supported in bearing 51. An opposite trunnion 51*a* has a bearing 51*b*, both bearings 51 and 51*b* supporting the filter drum for rotation on a tank 51*c* containing the pulp. Drive mechanism 51*d* for rotating the drum is located adjacent to the bearing 51*b*. The outwardly exposed radial end portion of the two sets of pipes are designated 52 for leading pipes, and 53 for the trailing pipes. The outer open end of the trunnion 50 cooperates face-to-face and in sealing relationship with a stationary header 54 having a connection 54*a* to a source of vacuum supply not shown. An annular lip 54*b* provides the seal. Horizontal guide bolts 54*c* fixed in trunnion bearing 51, and each surrounded by a compression spring 54*d*, support and maintain the header 54 in cooperative position relative to, and coaxial with the trunnion 50 of the filter drum.

The outwardly exposed radial end portion 52 of the leading pipes 46 have individual spring-loaded valves 55 located on an inner circle and normally closed. The exposed radial end portions 53 of the trailing pipes have similar individual spring-loaded valve 56 also normally closed and located on an outer circle concentric with said inner circle and with the drum axis.

A first stationary arcuate cam rail 57 cooperating with valves 56 of the trailing pipes (see FIGS. 20, 21, 22) is shown supported by the bearing 51. The arcuate length of this cam rail engaging the valves 56 represents a zone L–1 wherein the trailing pipes are open at the ascending side, but are closed in a smaller complementary zone L–2 on the descending side.

A second stationary arcuate cam rail 58 concentric with cam rail 57 and with the drum axis (see FIGS. 20, 21, 22) and similarly supported, cooperates with the valves 55 of the leading pipes. The arcuate length of cam rail 58 represents a zone L–3 wherein the leading pipes 46 are open at the descending side, but are closed in a smaller complementary zone L–4 at the ascending side of the filter drum.

The two arcuate cam rails 57 and 58 herein termed the outer and the inner cam rail respectively, have overlapping upper end portions, the extent of the overlap representing an interposed top zone L–5 where both the leading and the trailing pipes are open. A similar overlap of the lower end portions of the cam rails represents an interposed bottom zone L–6 wherein both the leading and the trailing pipes are open.

While in this embodiment the cam-controlled valves 55 and 56 have been described as being normally closed, it will be understood that these valves could be constructed to be normally open, with the controlling arcuate cams being correspondingly arranged in a manner which is the reverse of that shown in FIG. 22.

Reverting to the embodiment of FIG. 1, the back blow arrangement thereof shown in FIG. 9 may be modified as shown in FIGS. 25 and 26. That is to say, whereas in FIG. 9 the back blow is through the leading pipes 15 in the cake discharge zone, the bridge blocks in FIGS. 25 (valve 21) and FIG. 26 (valve 17) are constructed and arranged so as to provide for back blow through the trailing pipes 19. Accordingly, in FIG. 25 there are bridge blocks K–1 and K–2 defining neutral zones N–1 and N–2, spaced from each other to define between them a blow back port K–3 or blowback zone N–3. This blowback through the trailing pipes 19 requires that the leading pipes 15 be blocked off at the descending side (see FIG. 26) as by a bridge block K–4 or neutral zone N–4.

Reverting to the embodiment of FIG. 12, the back blow arrangement thereof shown in FIG. 17 may be modified as shown in FIG. 27. That is to say, whereas in FIG. 17 the back blow is through the leading pipes 29 in the cake discharge zone, the bridge blocks in FIG. 27 (valve 37) are constructed and arranged so as to provide for back blow through the trailing pipes 35. Accordingly, in FIG. 27 there are bridge blocks M–1 and M–2 defining neutral zones P–1 and P–2, spaced from each other to define between them a blow back port M–3 or blow back zone P–3. This blow back through the trailing pipes 35 requires that the leading pipes 29 be blocked off at the descending side (see FIG. 27) as by a bridge block M–4 or neutral zone P–4.

With respect to the embodiment in FIG. 18, it will be understood that similar modifications are applicable, for instance with respect to having separate vacuum controls for the leading pipes and for the trailing pipes at respective opposite ends of filter drum, and also having various blow back arrangements corresponding to those described above relative to the embodiments of FIG. 1 and FIG. 12.

I claim:

1. A rotary vacuum drum filter which comprises a tank containing pulp to be subjected to filtration,

a filter drum comprising a cylindrical shell having end trunnions whereby said shell is supported for rotation on said tank, external filtrate compartments coextensive with the axis of rotation of the drum, and arranged side by side about the periphery of said shell and entering the pulp at the descending side of the drum, and emerging from the pulp at the ascending side during a filtration cycle,

a set of trailing filtrate drainage pipes extending from the trailing ends of the respective compartments, and having delivery ends terminating in a trunnion of said drum, and adapted to withdraw through said trunnion filtrate liquid collecting at the trailing end of said compartments while moving upwardly at said ascending side of the drum and through a first filtrate withdrawal zone extending along at least a substantial portion of the ascending side of the drum,

a set of leading drainage pipes extending from the leading ends of said compartments and having filtrate delivery ends terminating in a trunnion of said drum, and adapted for withdrawing filtrate liquid collecting at the leading end of said compartments during their movement downwardly at said descending side of the drum and through a second filtrate withdrawal zone extending along at least a substantial portion of the descending side of the drum,

vacuum supply means communicating with the filtrate delivery ends of said trailing pipes and of said leading pipes, for effecting filtrate withdrawal through said trailing pipes during their movement through said first filtrate

withdrawal zone, and through said leading pipes during their movement through said second filtrate withdrawal zone, incident to rotation of the drum,

first control means for controlling the supply of vacuum from said supply means to said trailing pipes and said leading pipes, so constructed and arranged that the vacuum supply is kept open for the trailing pipes during their movement upwardly through said first filtrate withdrawal zone, and that the vacuum supply is kept closed for the leading pipes during their movement through said first zone,

and second control means for controlling the supply of vacuum from said supply means to said trailing pipes and said leading pipes, so constructed and arranged that the vacuum supply is kept open for the leading pipes during their movement downwardly through said second filtrate withdrawal zone, and that said vacuum supply is kept closed for the trailing pipes during their movement downwardly through said second zone.

2. A rotary vacuum drum filter which comprises a tank containing pulp to be subjected to filtration,

a filter drum comprising a cylindrical shell having end trunnions whereby said shell is supported for rotation on said tank, external filtrate compartments coextensive with the axis of rotation of the drum, and arranged side by side about the periphery of said shell, and entering the pulp at the descending side of the drum, and emerging from the pulp at the ascending side of the drum during a filtration cycle,

a set of trailing filtrate drainage pipes extending from the trailing ends of the respective compartments, and having filtrate delivery ends terminating in the one of said trunnions, and adapted to withdraw through said trunnion filtrate liquid collecting at the trailing end of said compartments while moving upwardly at said ascending side of the drum and through a first filtrate withdrawal zone extending along at least a substantial portion of the ascending side of the drum,

a set of leading filtrate drainage pipes extending from the leading ends of said compartments, and having filtrate delivery ends terminating in the other trunnion of the drum, and adapted for withdrawing filtrate liquid collecting at the leading end of said compartments during their movement downwardly at said descending side of the drum and through a second filtrate withdrawal zone extending along at least a substantial portion of the descending side of the drum,

first vacuum supply means associated with said one trunnion, for effecting filtrate withdrawal through said trailing pipes while moving through said first filtrate withdrawal zone, incident to rotation of the drum,

first control means cooperatively associated with said first supply means and said one trunnion, for controlling the supply of vacuum from said first supply means to said trailing pipes and said leading pipes, said control means being so constructed and arranged that the vacuum supply is kept open for the trailing pipes during their movement upwardly through said first filtrate withdrawal zone, and that the vacuum supply is kept closed for the leading pipes during their movement through said first zone,

second vacuum supply means associated with said other trunnion, for effecting filtrate withdrawal through said leading pipes while moving through said second filtrate withdrawal zone, incident to the rotation of the drum,

and second control means cooperatively associated with said second supply means and said other trunnion, for controlling the supply of vacuum from said second supply means to said trailing pipes and said leading pipes, said control means being so constructed and arranged that the vacuum supply is kept open for the leading pipes during their movement downwardly through said second filtrate withdrawal zone, and that the vacuum supply is kept closed for the trailing pipes in their movement through said first zone,

3. The filter according to claim 2, wherein said first and said second vacuum control means are furthermore so constructed and arranged that mutually adjoining trailing and leading pipes of mutually adjoining filtrate chambers are both open to vacuum suction while passing through a bottom zone extending between the lower ends of said filtrate withdrawal zones.

4. The filter according to claim 2, wherein said first and said second vacuum control means are furthermore so constructed and arranged that mutually adjoining trailing and leading pipes of mutually adjoining filtrate chambers are open to vacuum suction while passing through a top zone extending between the upper ends of said filtrate withdrawal zones.

5. The filter according to claim 2, wherein said first vacuum control means comprise a first trunnion valve cooperating with the adjacent ends of the trailing pipes, and constructed and arranged so as to open and close said pipes in the respective filtrate withdrawal zones,

and wherein said second control means comprise a second trunnion valve cooperating with the adjacent ends of the leading pipes, said trunnion valve being constructed and arranged so as to open and close said pipes in the respective filtrate withdrawal zones.

6. The filter according to claim 2, wherein at least one of said trunnions has a closed inner end and an open outer end, wherein a stationary valve head associated with the open end of said trunnion is constructed and arranged to provide vacuum supply to the interior of the trunnion, wherein one set of said pipes have exposed outer end portions connected to the interior of said trunnion, thus to be subject to the vacuum effect maintained therein, wherein each of said outer end portions of said pipes is provided with an individual valve operable to open or close communication with the vacuum, and wherein stationary cam means are provided effective to operate said valves incident to the rotation of said drum, in such a manner as to admit vacuum suction from said trunnion to the associated filtrate withdrawal zone.

7. A rotary vacuum drum filter which comprises a tank containing pulp to be subjected to filtration,

a filter drum comprising a cylindrical shell having end trunnions whereby said shell is supported for rotation on said tank, external filtrate compartments coextensive with the axis of rotation of the drum, and arranged side by side about the periphery of said shell, and entering the pulp at the descending side of the drum, and emerging from the pulp at the ascending side of the drum during a filtration cycle.,

a set of trailing filtrate drainage pipes extending from the trailing ends of the respective compartments, and having filtrate delivery ends terminating in one of said trunnions, and adapted to withdraw through said trunnion filtrate liquid collecting at the trailing end of said compartments while moving upwardly at said ascending side of the drum and through a first filtrate withdrawal zone extending along at least a substantial portion of the ascending side of the drum,

a set of leading filtrate drainage pipes extending from the leading end of said compartments, and having filtrate delivery ends terminating in said one trunnion of the drum, and adapted for withdrawing filtrate liquid collecting at the leading end of said compartments during their movement downwardly at said descending side of the drum and through a second filtrate withdrawal zone extending along at least a substantial portion of the descending side of the drum,

vacuum supply means associated with said one trunnion, for effecting filtrate withdrawal through said trailing pipes while moving through said first filtrate withdrawal zone, and filtrate withdrawal through said leading pipes while moving through said second filtrate withdrawal zone, incident to the rotations of the drum,

first control means associated with said trunnion and with said vacuum supply means for controlling the supply of vacuum from said supply means to said trailing pipes and said leading pipes, said control means being so constructed and arranged that the vacuum supply is kept open for the trailing pipes during their movement upwardly through said first filtrate withdrawal zone, and that the vacuum supply is kept closed for the leading pipes during their movement through said first zone,

and second control means cooperatively associated with said vacuum supply means and with said trunnion, for controlling the supply of vacuum from said supply means to said trailing pipes and said leading pipes, said control means being so constructed and arranged that the vacuum supply is kept open for the leading pipes during their movement downwardly through said second filtrate withdrawal zone, and that the vacuum supply is kept closed for the trailing pipes during their movement through said second zone.

8. The filter according to claim 7, wherein said first and said second vacuum control means are furthermore so constructed and arranged that mutually adjoining trailing and leading pipes of mutually adjoining filtrate chambers are both open to vacuum suction while passing through a bottom zone extending between the lower ends of said filtrate withdrawal zones.

9. The filter according to claim 7, wherein said first and said second vacuum control means are furthermore so constructed and arranged that mutually adjoining trailing and leading pipes of mutually adjoining filtrate chambers are open to vacuum suction while passing through a top zone extending between the upper ends of said filtrate withdrawal zones.

10. The filter according to claim 7, wherein one of said trunnions has a terminal tube plate for connection with the outer ends of said trailing pipes and of said leading pipes, arranged in respective concentric zones in said terminal plate, and wherein said control means comprise a trunnion valve constructed and arranged so as to cooperate with the respective concentric zones to provide vacuum suction in the respective filtrate withdrawal zones of the filtration cycle.

11. The filter according to claim 7, wherein

one of said trunnions has a closed inner end and an open outer end, wherein a stationary valve head associated with the open end of said trunnion is constructed and arranged to provide vacuum supply to the interior of the trunnion, wherein said trailing pipes as well as said leading pipes have exposed outer end portions connected to the interior of said trunnion, thus to be subjected to the vacuum effect maintained therein, wherein each of said outer end portions of said trailing and leading pipes is provided with a valve operable to open or close communication with the vacuum, wherein first stationary cam means are provided effective to operate the valves of the trailing pipes incident to the rotation of the drum, in such a manner as to admit vacuum suction from said trunnion to the associated filtrate withdrawal zone at the ascending side of the drum, and second stationary cam means are provided effective to operate the valves of the leading pipes.

12. The filter according to claim 1, wherein said second control means are constructed and arranged to provide a neutral zone effective to allow for cake discharge at the descending side of the drum.

13. The filter according to claim 2, wherein said second control means are constructed and arranged to provide a neutral zone effective to allow for cake discharge at the descending side of the drum.

14. The filter according to claim 3, wherein said second control means are constructed and arranged to provide a neutral zone effective to allow for cake discharge at the descending side of the drum.

15. The filter according to claim 4, wherein said second control means are constructed and arranged to provide a neutral zone effective to allow for cake discharge at the descending side of the drum.

16. The filter according to claim 5, wherein said second control means are constructed and arranged to provide a neutral zone effective to allow for cake discharge at the descending side of the drum.

17. The filter according to claim 6, wherein said second control means are constructed and arranged to provide a neutral zone effective to allow for cake discharge at the descending side of the drum.

18. The filter according to claim 7, wherein said second vacuum control means are constructed and arranged to provide a neutral zone effective to allow for cake discharge in the filtration cycle at the descending side of the drum.

19. The filter according to claim 8, wherein said second vacuum control means are constructed and arranged to provide a neutral zone effective to allow for cake discharge in the filtration cycle at the descending side of the drum.

20. The filter according to claim 9, wherein said second vacuum control means are constructed and arranged to provide a neutral zone effective to allow for cake discharge in the filtration cycle at the descending side of the drum.

21. The filter according to claim 10, wherein said second vacuum control means are constructed and arranged to provide a neutral zone effective to allow for cake discharge in the filtration cycle at the descending side of said drum.

22. The filter according to claim 11, wherein said second vacuum control means are constructed and arranged to provide a neutral zone effective to allow for cake discharge in the filtration cycle at the descending side of the drum.

23. The filter according to claim 1, wherein said second control means are so constructed and arranged as to maintain vacuum suction along the entire descending side of the drum, effective to allow for precoat filter cake scalping operation.

24. The filter according to claim 2, wherein said second control means are so constructed and arranged as to maintain vacuum suction along the entire descending side of the drum, effective to allow for precoat filter cake scalping operation.

25. The filter according to claim 3, wherein said second control means are so constructed and arranged as to maintain vacuum suction along the entire descending side of the drum, effective to allow for precoat filter cake scalping operation.

26. The filter according to claim 4, wherein said second control means are so constructed and arranged as to maintain vacuum suction along the entire descending side of the drum, effective to allow for precoat filter cake scalping operation.

27. The filter according to claim 5, wherein said second control means are so constructed and arranged as to maintain vacuum suction along the entire descending side of the drum, effective to allow for precoat filter cake scalping operation.

28. The filter according to claim 6, wherein said second control means are so constructed and arranged as to maintain vacuum suction along the entire descending side of the drum, effective to allow for precoat filter cake scalping operation.

29. The filter according to claim 7, wherein said second control means are so constructed and arranged as to maintain vacuum suction along the entire descending side of the drum, effective to allow for precoat filter cake scalping operation.

30. The filter according to claim 8, wherein said second control means are so constructed and arranged as to maintain vacuum suction along the entire descending side of the drum, effective to allow for precoat filter cake scalping operation.

31. The filter according to claim 9, wherein said second control means are so constructed and arranged as to maintain vacuum suction along the entire descending side of the drum, effective to allow for precoat filter cake scalping operation.

32. The filter according to claim 10, wherein said second control means are so constructed and arranged as to maintain vacuum suction along the entire descending side of the drum, effective to allow for precoat filter cake scalping operation.

33. The filter according to claim 11, wherein said second control means are so constructed and arranged as to maintain vacuum suction along the entire descending side of the drum, effective to allow for precoat filter cake scalping operation.

* * * * *