(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 236 015 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
12.01.2005 Bulletin 2005/02

(21) Application number: **99951769.1**

(22) Date of filing: **05.10.1999**

(51) Int Cl.[7]: **F26B 11/16**, F26B 25/04, F26B 17/28, F26B 17/20

(86) International application number:
PCT/US1999/023112

(87) International publication number:
WO 2001/025709 (12.04.2001 Gazette 2001/15)

(54) **BATCH SLUDGE DEHYDRATOR**

DISKONTINUIERLICHER SCHLAMMENTWÄSSERER

DESHYDRATEUR DE BOUES A FONCTIONNEMENT DISCONTINU

(84) Designated Contracting States:
AT BE CH CY DE DK ES FI FR GB GR IE IT LI LU MC NL PT SE

(43) Date of publication of application:
04.09.2002 Bulletin 2002/36

(73) Proprietor: **Rubicon Development Company, L.L.C.**
New Orleans, LA 70130-2646 (US)

(72) Inventors:
- **BOLTON, Danny, R.**
  Brownwood, TX 76801 (US)
- **BIGHAM, David, L.**
  Novice, TX 79538 (US)

(74) Representative: **Vleck, Jan Montagu**
Reddie & Grose,
16 Theobalds Road
London WC1X 8PL (GB)

(56) References cited:

EP-A- 0 031 604
EP-A- 0 209 349
EP-A- 0 231 584
WO-A-86/02150
CH-A- 265 601
DE-U- 8 706 191
FR-A- 2 091 660
GB-A- 789 439

- **RAOUZEOS G ET AL: "DRYING OF INDUSTRIAL SLUDGES AND DISTILLATION RESIDUES WITH TOTAL SOLVENTS RECOVERY USING KNEADERS-DRYERS" DRYING. INTERNATIONAL DRYING SYMPOSIA,GR,THESSALONIKI: ZITI EDITIONS, 1998, pages 1-8, XP000788176 ISBN: 960-431-468-8**

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid. (Art. 99(1) European Patent Convention).

EP 1 236 015 B1

Description

Technical Field

[0001] This invention relates to sludge dehydration, more particularly to a sludge dehydrator that operates in a batch mode.

Background Art

[0002] The disposal of waste sludge is of increasing concern due to ever tighter environmental regulations. One general type of solution for dealing with such waste is the dehydrator disclosed in our United States Patent No. 5,566,469. While this dehydrator has been effective and economical for its designed purpose, there has been substantial room for improvement with regard to efficiency and cost, as well as the through capacity of the device.

[0003] Another means of dehydration is disclosed in United States patent number 3,800,865. US Patent No. 3,800,865 provides dehydrating apparatus as defined in the preamble of claim 1.

[0004] A problem with US 3,800,865 is that material at the edges of the tank is not heated as well as the material located near the centre of the tank against the vanes.

[0005] The present invention provides a batch sludge dehydrator as defined in independent claim 1 to which reference should now be made.

Summary of The Invention

[0006] The sludge dehydrator of the present invention incorporates a system using indirect heat and a batch mode to obtain substantially improved performance in sludge dehydration.

Brief Description of the Drawings

[0007] A more complete understanding of the invention and its advantages will be apparent from the Detailed Description taken in conjunction with the accompanying Drawings, in which:

Figure 1 is a partially broken-away end view of dehydrating apparatus constructed in accordance with the present invention;
Figure 2 is a perspective view of an agitator useful with the invention;
Figure 3 is a schematic view illustrating the flow of heated oil through the apparatus; and
Figure 4 is a schematic view illustrating the system of the present invention in operation.

Detailed Description of the Preferred Embodiment

[0008] Referring initially to Figures 1-4, where like numerals indicate like and corresponding elements, a dehydrating apparatus 10 includes a chamber 12 for receiving material to be dehydrated in an inner cavity 14 with material to be dehydrated. Chamber 12 is cylindrical about a horizontal, longitudinal, central axis 16.

[0009] Chamber 12 has a heating annulus 18 adapted and arranged to receive heated thermal fluid from a thermal fluid heater 20 (Figures 3, 4). Heating annulus 18 is formed by inner and outer chamber walls 22, 24. Outer chamber wall 24 is insulated, and the inner chamber wall 22 is adapted to heat, wet material in the inner cavity 14 by conduction through the inner chamber wall 22.

[0010] A rotatably-mounted agitator 26 is adapted to agitate material in the inner cavity 14 when the agitator 26 rotates in a first direction and convey the material out of the inner cavity 14 when the agitator rotates in the other, second direction. In Figures 1 and 2, the first direction is illustrated by arrow 28, and the other, second direction is illustrated by arrow 30.

[0011] The agitator 26 is adapted and arranged to receive heated thermal fluid from the thermal fluid heater 20 to heat the agitator 26 and thereby heat the wet material in the inner cavity 14 by conduction.

[0012] The agitator 26 is mounted for rotation about the central axis 16 of the chamber 12. The agitator 26 includes a tubular shaft 32 along the central axis 16 adapted to receive heated thermal fluid at a first end 34 thereof and return thermal fluid at the other, second end 36 thereof (Figures 3,4).

[0013] A plurality of transverse discs 38 are fixed at substantially equally-spaced locations along the shaft 32. The discs have substantially equal dimensions, with disc outer diameter dimensions "D_1" begin substantially less than an inner diameter dimension "D_2" of the inner cavity 14. Substantial annular gaps 40 between the discs 38 and the inner chamber wall 22 are provided.

[0014] As best shown in Figure 3, the discs 38 are hollow bodies having internal cavities 42. A first disc 44 in closest proximity to the shaft first end 34 is adapted to receive heated thermal fluid from the shaft first end 34. A last disc 46 in closest proximity to the shaft second end 36 is adapted to return heated thermal fluid to the shaft second end 36. Adjacent pairs of discs 38 are connected at their peripheries 48 by hollow wiper tubes 50 extending between radially-extending, hollow, connecting arms 52 to permit the flow of heated fluid from disc to disc along the shaft from the first end 34 to the second end 36. Wiper tubes 50, as best shown in Figure 1, are in close proximity to the inner chamber wall 22 such that material is wiped and agitated when the agitator is rotated in the first direction. An angled conveyor bar 54 extends at an acute angle from each wiper bar 50 in the direction of the second direction of agitator rotation.

[0015] Each disc 38 has radial walls 56, 58 defining open, wedge-shaped sectors 60. The sectors 60 are indexed along the shaft 32, as best shown in Figure 2. The connecting arms 52 are aligned with the radial walls 56, 58, such that the conveyor bars 54 push dried ma-

terial through the sectors 60 when the agitator rotates in the second direction.

[0016] In operation, as best shown in Figures 3 and 4, the invention is an indirectly heated dehydration system used to evaporate moisture from solids. The system consists of the following primary components: dehydration chamber 12; dehydration chamber agitator 26; thermal fluid heater 20 wet material storage/feed hopper 101; dry product discharge conveyor and bag rack 100; and wet particulate scrubber/condenser 102.

[0017] Dehydration Chamber 12. The stationary dehydration chamber 12 is comprised of a cylindrical inner chamber 14 with either thermal fluid coils or preferably another cylindrical chamber surrounding it creating an annulus 18 between the two to allow for the passage of a heated thermal fluid. The dehydration chamber 12 has a thermal fluid inlet port 104, a thermal fluid discharge port 106, a material inlet port 108, a material discharge port 110, an exhaust vapor discharge port 112 and doors 114 for access to the internal workings of the machine. The entire combustion chamber is surrounded by an insulation blanket 116.

[0018] Agitator 26. The rotating agitator 26 inside of the dehydration chamber is fabricated from a series of hollow discs 38 welded to a common shaft 32. These hollow discs 38 have a 40 degree wedge-shaped sector 60 cut out of them to allow the wet material being dehydrated to level out over the entire length of the chamber and to let the dry material pass between the discs when it is being discharged. The agitator 26 is supported by the shaft 32 extending through bearings mounted at both ends of the dehydration chamber. Thermal fluid rotary unions 118 are located at either end of the shaft 32 to allow the fluid to enter the rotating shaft. All of the discs 38 are connected by wiper tubes 50 which allow for the passage of thermal fluid from one disc 38 to the next. The fluid is pumped into the end of the agitator shaft 32 where a blank steel flange 120 (Figure 3) is welded inside of the shaft past the first disc 44. A flange 122 is similarly welded inside the last disc 46 on the other end. Holes are cut in the shaft 32 inside of the first disc 44. This allows the fluid to enter the first disc 44, travel from one disc 38 to the next through the wiper tubes 50 and connecting arms 52, and exit the agitator 26 through the shaft 32 at the opposite end. The wiper tubes 50 have a flat face on one side and an angled conveyor bar 54 on the other. The flat face moves into the material when the system is in the dehydration mode and the angled conveyor bar 54 moves into it when the system is in discharge mode.

[0019] Wet Material Storage/Feed Hopper 100. The material storage/feed hopper 100 has a rotating wiper mechanism 124 that maintains a constant feed of material to a screw auger 126 positioned in the bottom. The screw auger 126 conveys the material from the hopper 100 to the dehydration chamber 12 through a feed tube 128 attached to the sludge inlet port 108.

[0020] Thermal Fluid Heater 20. The gas, or electric, thermal fluid heater 20 heats the fluid that is pumped through the dehydration chamber annulus 18 and agitator discs 38. The thermal fluid system is closed-loop. The fluid existing the dehydrator is pumped back through the heater, reheated and sent back to the dehydrator.

[0021] Dry Product Discharge Bag Rack and Conveyor 101: The dried solids are discharged from the dehydration chamber 12 into a conveyor 130 that transfers the material to a receptacle 132. These receptacles can be bags, dumpsters, silos, rolloff hoppers, etc.

[0022] Wet Scrubber/Condenser 102: The vapors from the dehydrator 12 exit the dehydrator through a ducting 134 that has numerous water spray nozzles 136 positioned in it. This water spray helps to cool the gas stream and collect the particulate that is emitted from the dehydrator exhaust port 112 prior to entering the venturi scrubber/cyclone 138 where a higher efficiency scrubbing/cooling effect occur.

[0023] PRINCIPALS OF OPERATION. The material to be dried is placed into the material storage/feed hopper. An automatic slide gate is located inside of the dehydration chamber at the opening of the material inlet port which opens when the unit is being filled and closes when the unit is in the dehydration or discharge mode. The hopper will fill the dehydration chamber to the correct level based upon a predetermined time interval. When the dehydration chamber has been filled, the dehydration process begins with agitator rotation in the correct direction and the heated fluid being pumped through the dehydration chamber and agitator. At the beginning of the drying cycle, when the material is at its wettest, the thermal fluid is maintained at a higher temperature. Toward the end of the cycle, when the material is drier, the temperature of the oil is reduced to keep it from reaching the ignition point. This prevents the scorching, or burning of the material. In the dehydration mode, the flat sides of wiper tubes are working toward the material. During this period, the material is agitated, lifted and churned continuously, exposing it to as much of the heated surface area of the agitator tubes, discs and cylinder walls as possible. Once it has been determined that the material is dry, either on a timed cycle or by a temperature sensor, the system will automatically open the material discharge port door and reverse the direction of the agitator so that the angled conveyor bars are working toward the material. With each revolution, the angled conveyor bars move the material toward, and through, the discharge port opening and deposits it in the dry material conveyor. The dry material is sent from the conveyor to a receptacle, or bag. After the dehydrator is emptied, the system automatically closes the discharge port door and refills with wet material to begin the next dehydration cycle. Since the system is sealed, the exhaust from the dehydrator is virtually a pure vapor. The air scrubber/condenser is designed to remove the particulate which may be entrained in the exhaust stream and condense as much of the vapor as possible

back to a liquid.

Claims

1. Dehydrating apparatus (10) comprising:

a chamber (12) for receiving wet material to be dehydrated; and
a rotatably-mounted agitator (26) with the chamber (12), the agitator (26) being adapted to agitate material in the chamber (12) when the agitator (26) rotates in a first direction and convey the material out of the chamber (12) when the agitator (26) rotates in the other, second direction;
with the agitator (26) being adapted and arranged to receive heated thermal fluid from a thermal fluid heater (20) to heat the agitator (26) and thereby heat the wet material in the inner cavity (14) by conduction;
with the agitator (26) being mounted for rotation about a central axis (16) of the chamber (12);
the agitator (26) including a tubular shaft (32) along a central axis (16) adapted to receive heated thermal fluid at a first end (34) of the shaft (32) and return thermal fluid at the other, second end (36) of the shaft (32);
with a plurality of transverse discs (38) fixed at substantially equally-spaced locations along the shaft (32);
with the discs (38) being hollow bodies having internal cavities (42), a first disc (44) in closest proximity to the shaft first end (34) being adapted to receive heated thermal fluid from the shaft first end (34), and a last disc (46) in closest proximity to the shaft second end (36) being adapted to return heated thermal fluid to the shaft second end (36); and **characterized by**
adjacent pairs of discs (38) being connected at their peripheries (48) by hollow wiper tubes (50) extending between radially-extending, hollow, connecting arms (52), to permit the flow of heated fluid from disc to disc along the shaft (32) from the first end (34) to the second end (36), and the wiper tubes (50) being in close proximity to the inner chamber wall (22) such that material is wiped and agitated when the agitator (26) is rotated in the first direction.

2. The apparatus of claim 1 with an angled conveyor bar (54) extending at an acute angle from each wiper tube (50) in the direction of the second direction of agitator rotation.

3. The apparatus of claim 2 with each disc (38) having radial walls (56, 58) defining open, wedged-shaped sectors (60), the sectors (60) being indexed along the shaft (32), with the connecting arms (52) aligned with the radial walls such that the conveyor bars (54) push dried material through the sectors (60) when the agitator (26) rotates in the second direction.

Patentansprüche

1. Entwässerungsvorrichtung (10), die Folgendes umfasst:

eine Kammer (12) zur Aufnahme von zu entwässerndem nassem Gut; und
einen drehbar montierten Rührer (26) mit der Kammer (12), wobei der Rührer (26) die Aufgabe hat, Gut in der Kammer (12) zu rühren, wenn der Rührer (26) in einer ersten Richtung rotiert, und das Gut aus der Kammer (12) zu befördern, wenn der Rührer (26) in der anderen, zweiten Richtung rotiert;

wobei der Rührer (26) so gestaltet und angeordnet ist, dass er erhitztes Wärmefluid von einem Wärmefluiderhitzer (20) erhält, um den Rührer (26) und dadurch das nasse Gut im Innenhohlraum (14) durch Leitung zu erhitzen;

wobei der Rührer (26) für eine Rotation um eine mittlere Achse (16) der Kammer (12) montiert ist;

wobei der Rührer (26) eine röhrenförmige Welle (32) entlang einer mittleren Achse (16) aufweist, die so gestaltet ist, dass sie erhitztes Wärmefluid an einem ersten Ende (34) der Welle (32) empfängt und Wärmefluid am anderen, zweiten Ende (36) der Welle (32) zurückführt;

wobei eine Mehrzahl von transversalen Scheiben (38) an im Wesentlichen gleichmäßig beabstandeten Stellen entlang der Welle (32) befestigt ist;

wobei die Scheiben (38) Hohlkörper mit Innenhohlräumen (42) sind, wobei eine erste Scheibe (44) in nächster Nähe zum ersten Wellenende (34) so gestaltet ist, dass sie erhitztes Wärmefluid vom ersten Wellenende (34) aufnimmt, und wobei eine letzte Scheibe (46) in nächster Nähe zum zweiten Wellenende (36) so gestaltet ist, dass sie erhitztes Wärmefluid zum zweiten Wellenende (36) zurückführt; und **dadurch gekennzeichnet, dass** benachbarte Paare von Scheiben (38) an ihren Peripherien (48) durch hohle Wischerröhren (50) miteinander verbunden sind, die zwischen radial verlaufenden hohlen Verbindungsarmen (52) verlaufen, um den Fluss von erhitztem Fluid von Scheibe zu Scheibe entlang der Welle (32) vom ersten Ende zum zweiten Ende (36) zuzulassen, und wobei sich die Wischerröhren (50) nahe an der inneren Kammerwand (22) befinden, so dass Gut gewischt und

gerührt wird, wenn der Rührer (26) in der ersten Richtung rotiert.

2. Vorrichtung nach Anspruch 1 mit einem abgewinkelten Fördererstab (54), der in einem spitzen Winkel von jeder Wischerröhre (50) in der zweiten Rührerrotationsrichtung verläuft.

3. Vorrichtung nach Anspruch 2, wobei jede Scheibe (38) radiale Wände (56, 58) hat, die offene, keilförmige Sektoren (60) definieren, wobei die Sektoren (60) entlang der Welle (32) indexiert sind, wobei die Verbindungsarme (52) so auf die radialen Wände ausgerichtet sind, dass die Fördererstäbe (54) getrocknetes Gut durch die Sektoren (60) drücken, wenn der Rührer (26) in der zweiten Richtung rotiert.

Revendications

1. Appareil de déshydratation (10) comprenant :

une chambre (12) pour recevoir une matière mouillée à déshydrater ; et
un agitateur monté de manière rotative (26) avec la chambre (12), l'agitateur (26) étant adapté pour agiter la matière dans la chambre (12) quand l'agitateur (26) tourne dans un premier sens et pour acheminer la matière hors de la chambre (12) quand l'agitateur (26) tourne dans l'autre deuxième sens ;
l'agitateur (26) étant adapté et agencé pour recevoir un fluide thermique chauffé depuis un réchauffeur de fluide thermique (20) afin de chauffer l'agitateur (26) et ainsi chauffer la matière mouillée dans la cavité interne (14) par conduction ;
l'agitateur (26) étant monté pour tourner autour d'un axe central (16) de la chambre (12) ;
l'agitateur (26) comportant un arbre tubulaire (32) le long d'un axe central (16) adapté pour recevoir un fluide thermique chauffé à une première extrémité (34) de l'arbre et renvoyer le fluide thermique vers l'autre deuxième extrémité (36) de l'arbre (32) ;
une pluralité de disques transversaux (38) étant fixés à des emplacements sensiblement équidistants le long de l'arbre (32) ;
les disques (38) étant des corps creux ayant des cavités internes (42), un premier disque (44) le plus proche de la première extrémité d'arbre (34) étant adapté pour recevoir un fluide thermique chauffé depuis la première extrémité d'arbre (34), et un dernier disque (46) le plus proche de la deuxième extrémité d'arbre (36) étant adapté pour renvoyer le fluide thermique chauffé vers la deuxième extrémité d'arbre (36) ; et **caractérisé par**
des paires adjacentes de disques (38) connectées au niveau de leur périphérie (48) par des tubes racleurs creux (50) s'étendant entres des bras de connexion creux, s'étendant radialement (52), afin de permettre l'écoulement du fluide chauffé de disque en disque le long de l'arbre (32) depuis la première extrémité jusqu'à la deuxième extrémité (36), et les tubes racleurs (50) étant proches de la paroi de chambre interne (22) de manière à racler et agiter la matière quand l'agitateur (26) est tourné dans le premier sens.

2. Appareil selon la revendication 1, comportant une barre transporteuse inclinée (54) s'étendant en formant un angle aigu depuis chaque tube racleur (50) dans le sens du deuxième sens de rotation de l'agitateur.

3. Appareil selon la revendication 2, chaque disque (38) ayant des parois radiales (56, 58) définissant des secteurs en forme de coins, ouverts (60), les secteurs (60) étant indexés le long de l'arbre (32), les bras de connexion (52) étant alignés avec les parois radiales de telle sorte que les barres transporteuses (54) poussent la matière séchée à travers les secteurs (60) quand l'agitateur (26) tourne dans le deuxième sens.

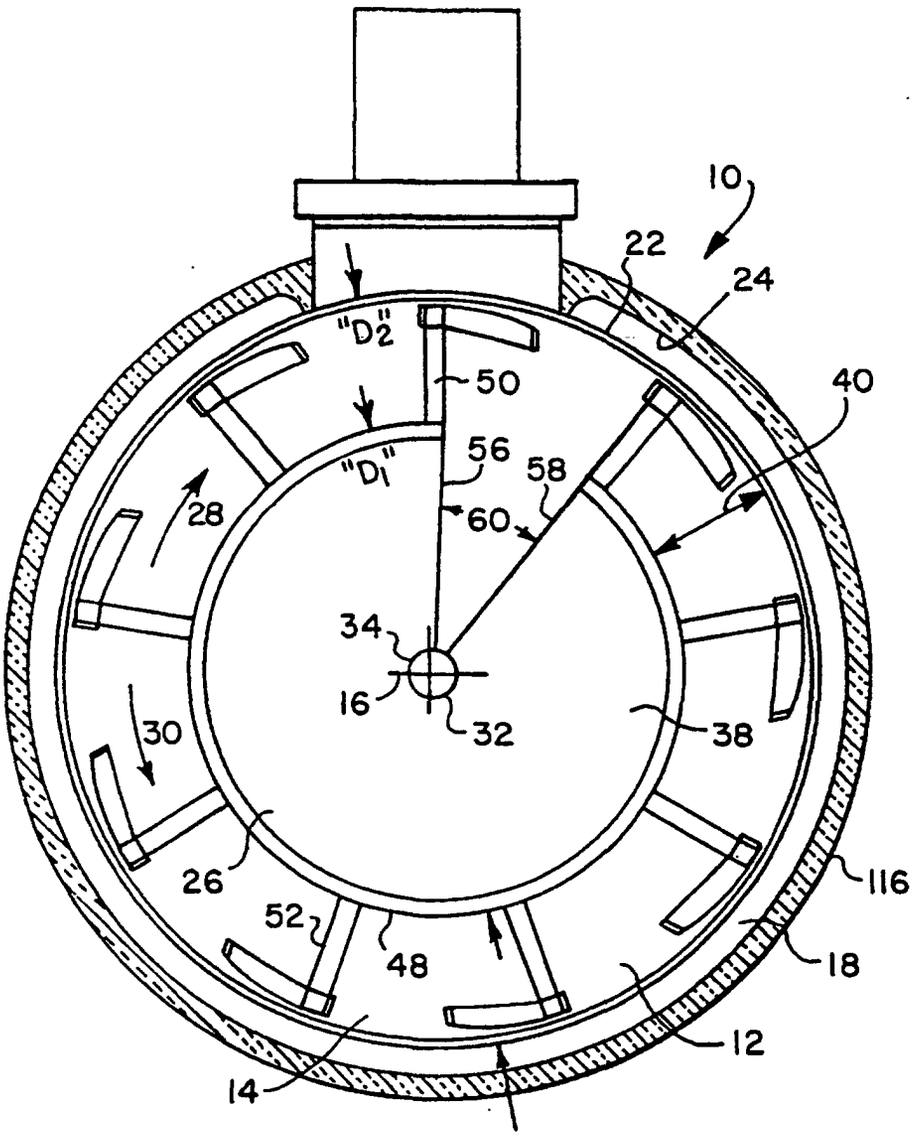


FIG. 1

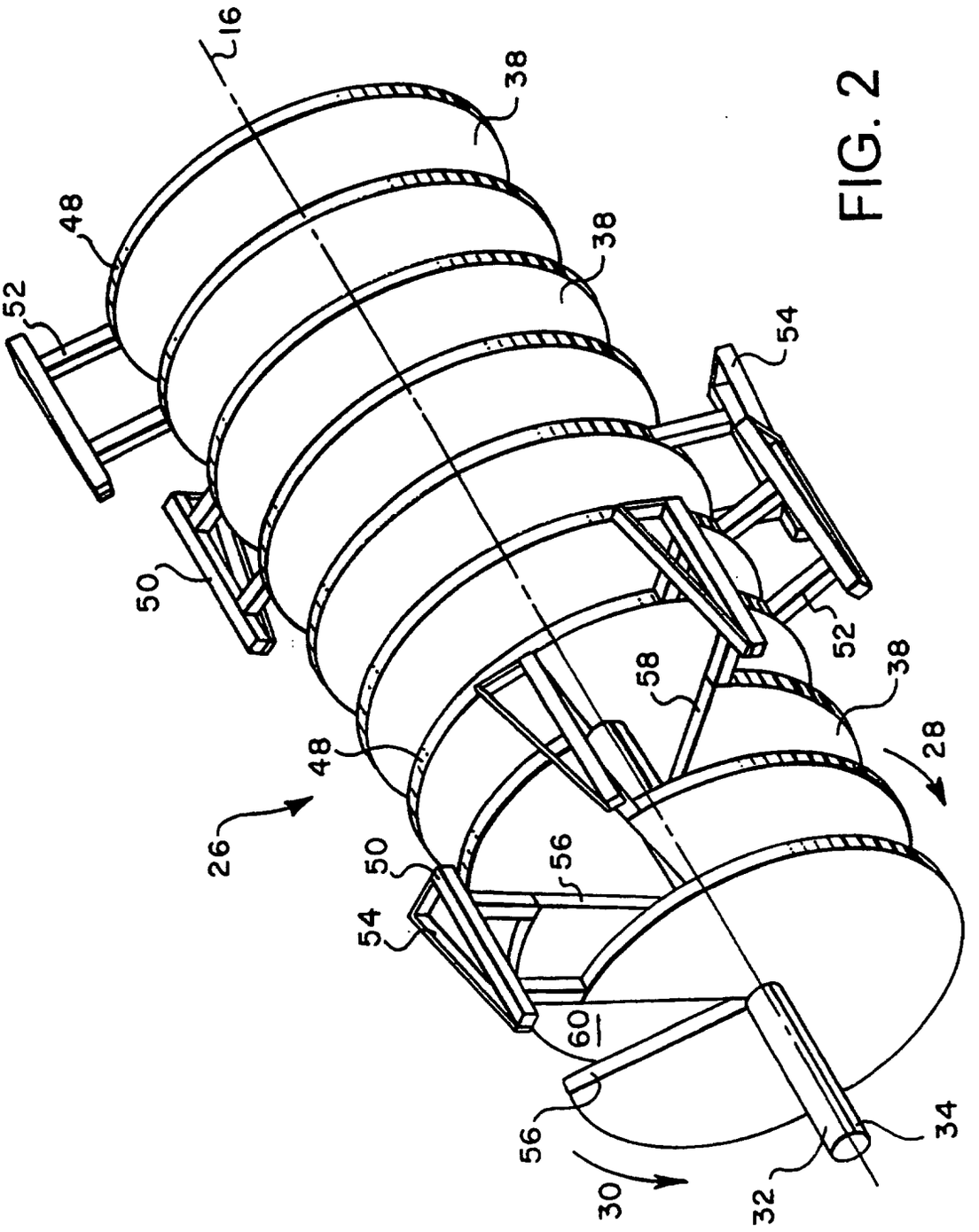


FIG. 2

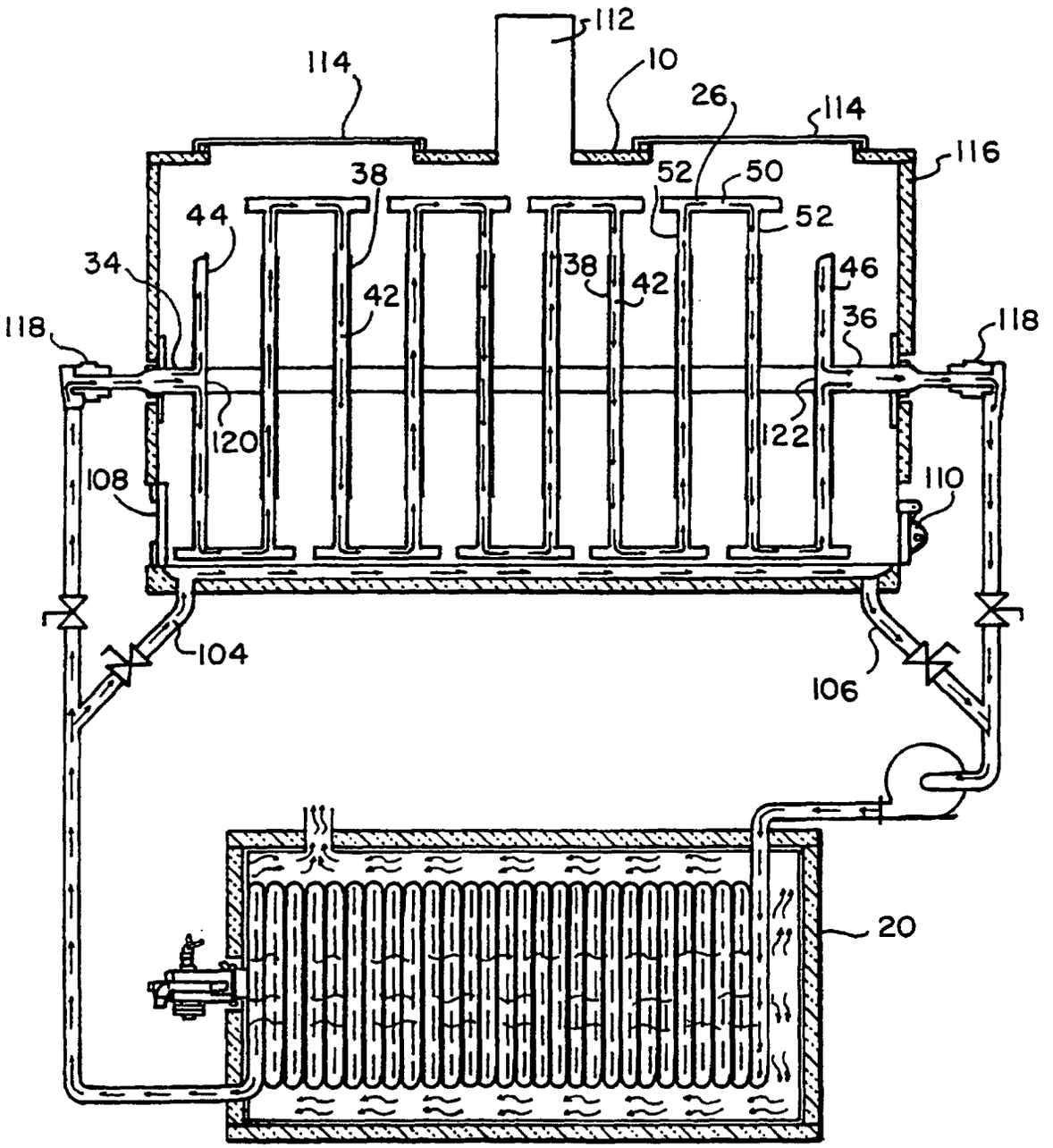

112
114
10
26
114
116
38
52
50
44
52
34
38
42
46
42
36
118
118
120
122
108
110
104
106
20

FIG. 3

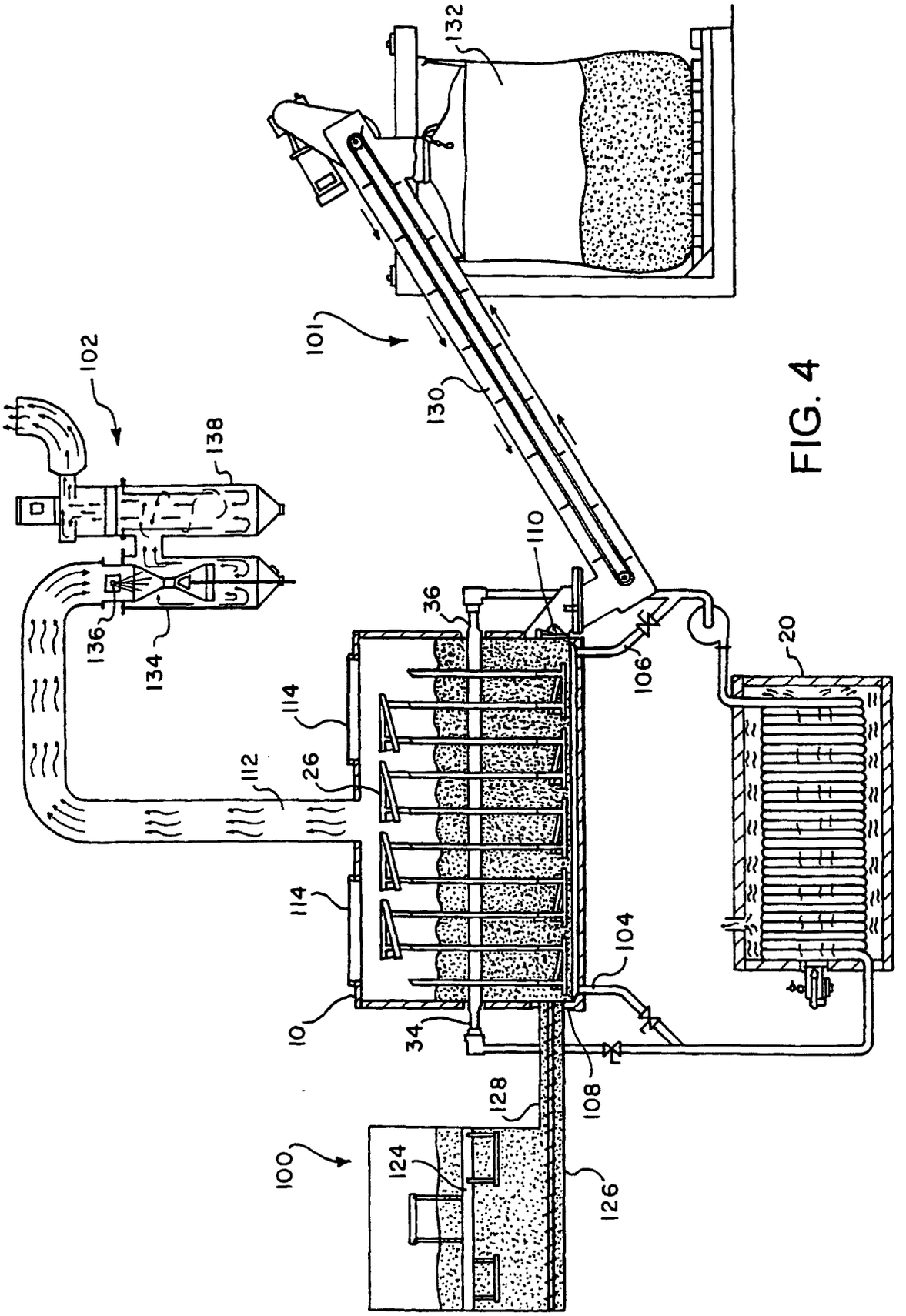

132
101
102
130
138
110
36
136
134
106
20
114
112
26
114
104
10
34
108
128
100
124
126

FIG. 4