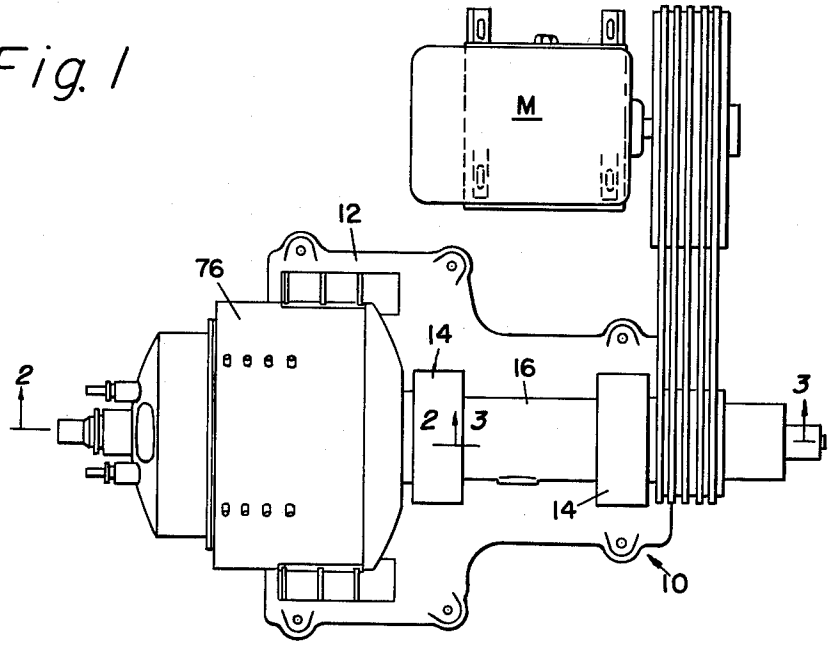
June 9, 1964 F. P. GOOCH 3,136,722

PUSHER-TYPE CENTRIFUGE

Filed Oct. 18, 1961 3 Sheets-Sheet 1

Fig. 1



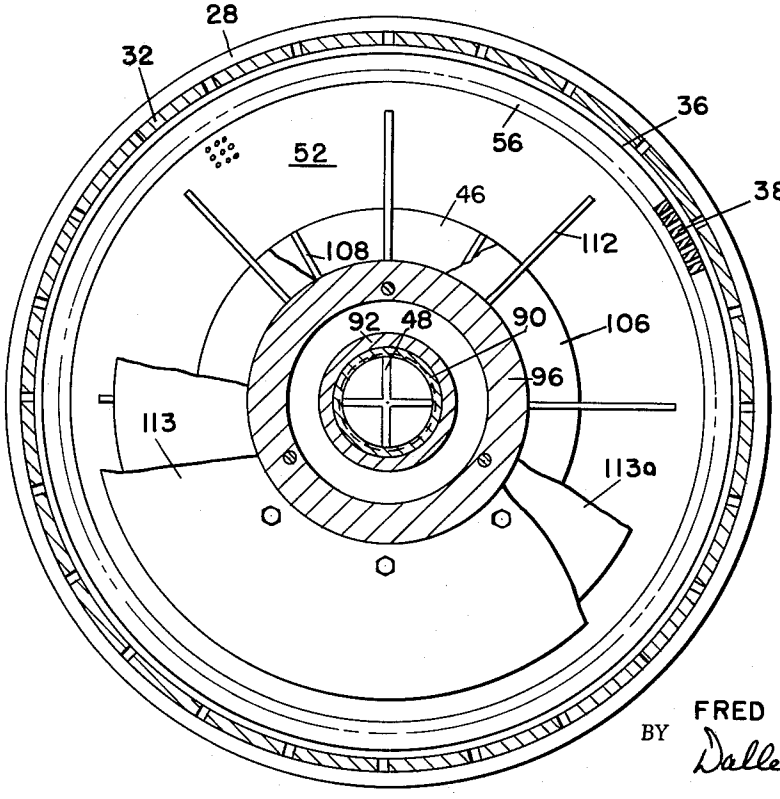


Fig. 4

INVENTOR.

BY FRED P. GOOCH

Dallett Hoopes

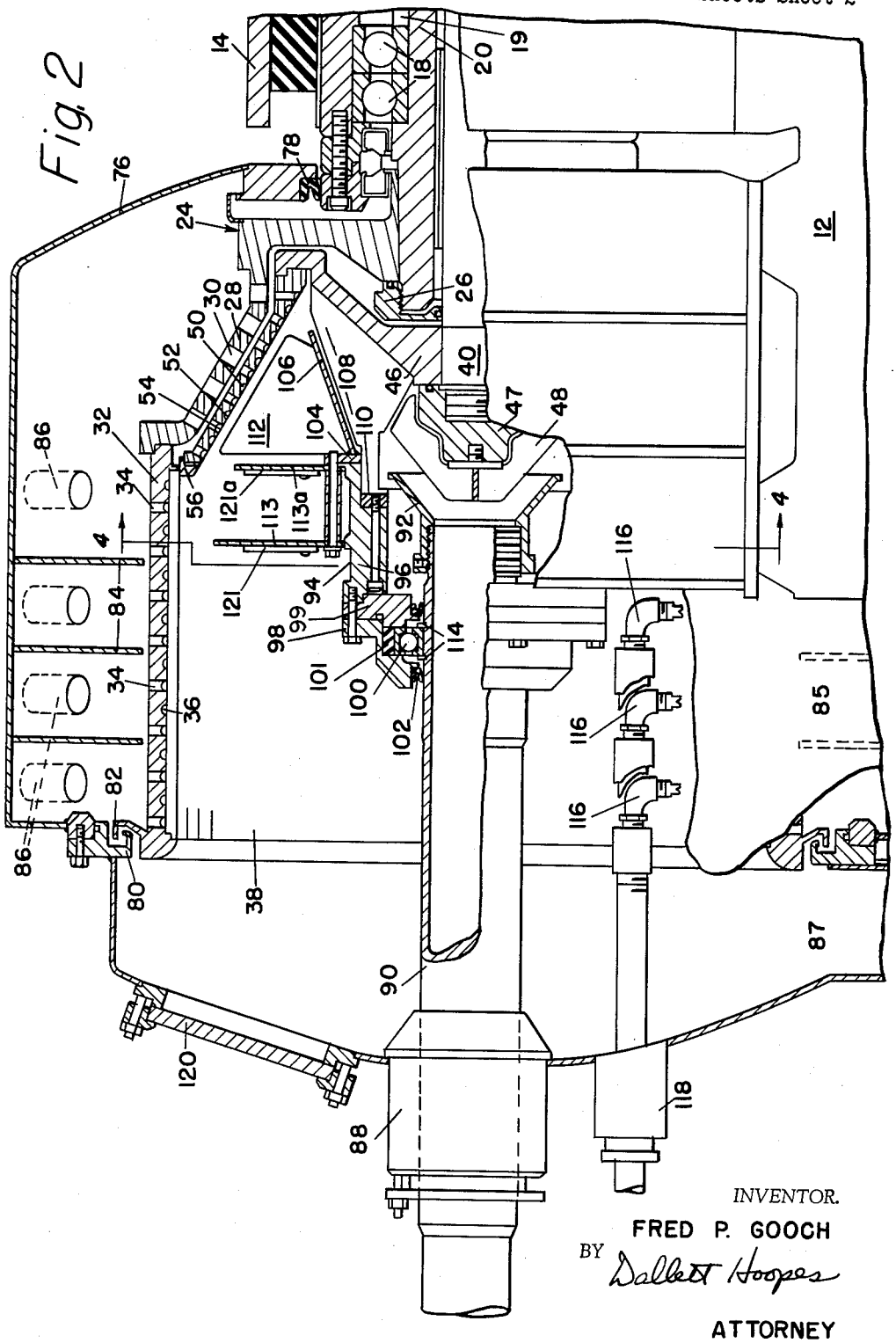
ATTORNEY

June 9, 1964 F. P. GOOCH 3,136,722

PUSHER-TYPE CENTRIFUGE

Filed Oct. 18, 1961 3 Sheets-Sheet 2

Fig. 2



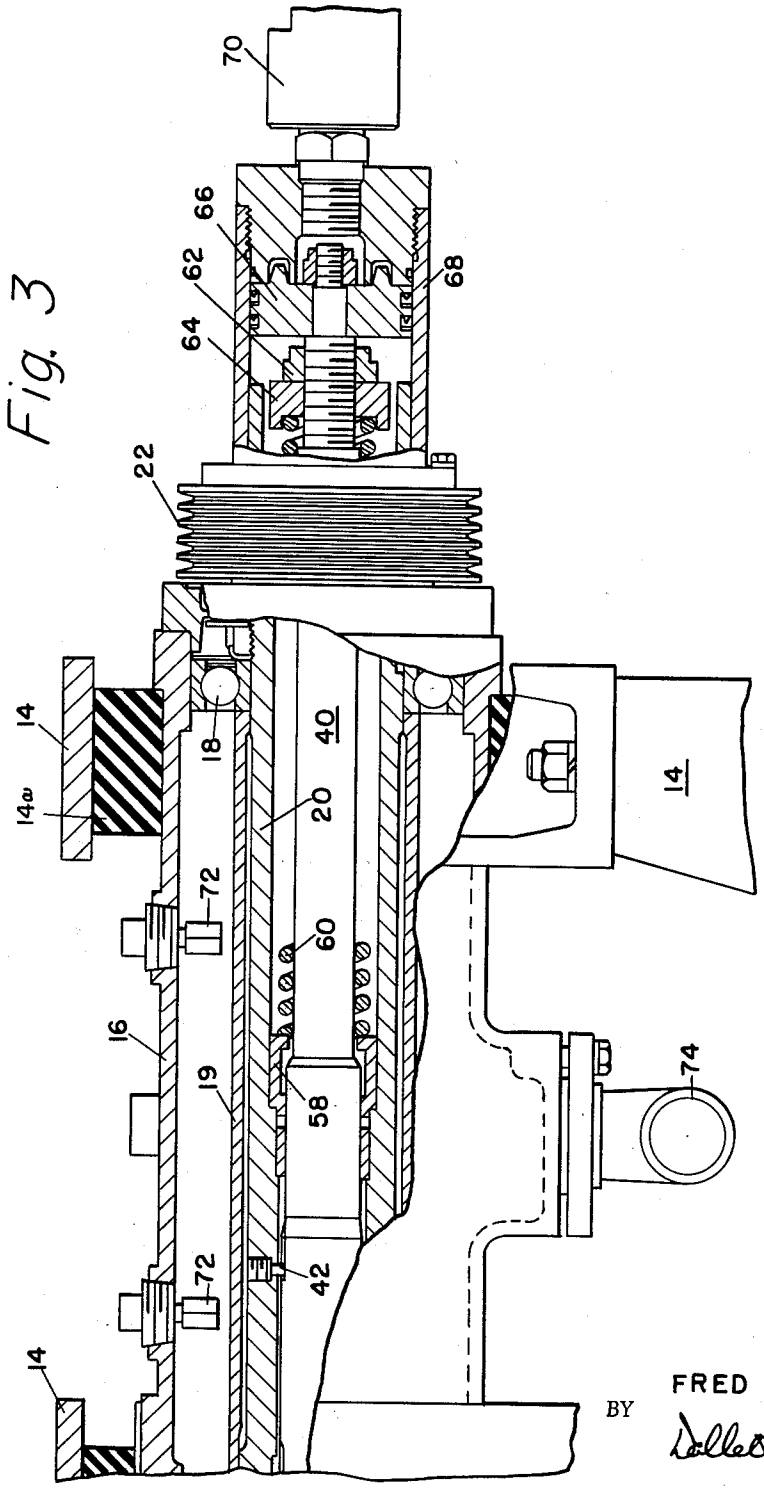
INVENTOR.
FRED P. GOOCH
BY Dallett Hoopes
ATTORNEY

June 9, 1964 F. P. GOOCH 3,136,722

PUSHER-TYPE CENTRIFUGE

Filed Oct. 18, 1961 3 Sheets-Sheet 3

Fig. 3



INVENTOR.
FRED P. GOOCH
BY Dallett Hoopes
ATTORNEY

United States Patent Office

3,136,722
Patented June 9, 1964

3,136,722

PUSHER-TYPE CENTRIFUGE

Fred P. Gooch, Moline, Ill., assignor to Pennsalt Chemicals Corporation, a corporation of Pennsylvania

Filed Oct. 18, 1961, Ser. No. 145,811
5 Claims. (Cl. 210—376)

This invention relates to the separation of solids from a liquid by centrifugal force. More specifically this invention relates to a continuous dehydrator of the "pusher" type comprising a perforate rotor enclosing a rotating reciprocable pusher member which, in reciprocating, advances solids axially along the perforate rotor toward discharge.

An example of an apparatus of the general nature of that of the present invention is disclosed in the U.S. Patent 1,842,464 which issued January 26, 1932 to Ter Meer. The prior art has recognized the advantages to be gained in constructing the pusher member of gentle frusto-conical shape and providing it with a perforate draining surface to which the feed is delivered. By such construction of the pusher member, or inner rotor as it may be regarded, a great deal of liquid is thrown off of the solids without the need for the power necessary to accelerate the liquid at the radius of the outer rotor. Additionally, by facing the perforate inner rotor toward the discharge end of the outer rotor, the liquid thrown off while the solids are on the inner rotor is thrown directly outward without need for diverting channels or passages to avoid recontact of the liquid with the partially dehydrated solids on the outer rotor. Drainage is hence more effective.

While the devices of the prior art have to some extent accomplished their desired purpose, namely the dehydration of solids using reduced power by virtue of the inclined draining surface they have fallen short in at least one respect. In order to provide compactness for purposes of conserving plant floor space, and more importantly, to keep to a minimum the length of the rotating inner rotor to reduce inertial problems and power requirements, the inclined draining surface has been made too abrupt to be effective. Alternatively, the feed mixture has been introduced directly to the inner rotor at a distance greatly spaced from the axis of the rotor causing rapid acceleration and shear to the extent that there has been, for instance, crystal breakage.

Crystal breakage is undesirable because it results in reduction of crystal size to permit passage of more crystal material through the openings in the outer rotor with the liquid discharge. In addition, the operator who may have taken great pains to "grow" crystals to a desired size before centrifuging wishes to maintain the crystals at that size if at all possible. Often their size will determine crystal properties. For instance, it is recognized that large crystals flow and fall with greater uniformity and ease than smaller crystals, and that large crystals tablet (for instance, in the making of aspirin) better than small crystals. Additionally, large crystals having less surface exposure per unit weight will dissolve at a slower rate than small crystals, and therefore ammonium sulphate crystals used as fertilizer will diffuse into the soil at a slower rate if crystals are large. Finally, and most importantly, large crystals because they are believed, rightly or wrongly, to be more pure, have greater sales appeal than small crystals.

By the apparatus embodying my invention I have eliminated the drawback of the prior devices, retaining their advantages. More specifically, by gradually accelerating the feed mixture toward the drain surface of the inner rotor, I have considerably reduced solids breakage while not increasing the power demands appreciably to rotate

the inner rotor. Moreover, by my invention desired results are obtained without sacrificing the compactness which was an attribute of the prior art devices.

This invention embodies other novel features, details of construction and arrangement of parts which are hereinafter set forth in the specification and claims, and illustrated in the accompanying drawings, wherein:

FIGURE 1 is a top plan view of an apparatus embodying the invention;

FIGURE 2 is an enlarged elevational view partly in section taken on the line 2—2 of FIGURE 1;

FIGURE 3 is an elevational view partly in section taken on the line 3—3 of FIGURE 1; and

FIGURE 4 is a sectional view taken on the line 4—4 of FIGURE 2 and showing portions of the structure peeled away to illustrate the relation of parts beyond the plane 4—4 of FIGURE 2.

Briefly, in a centrifugal continuous solids drier of the pusher type having an outer perforate rotor and an inner frusto-conical perforate rotor facing the discharge end of the outer rotor, the invention involves the provision of an imperforate distributing shell circumposing an axial feed tube and adapted to gently accelerate the feed mixture to the perforate frusto-conical inner rotor.

"Acceleration" as used herein, unless otherwise indicated may be taken to mean tangential acceleration.

Referring more specifically to the drawings, an apparatus embodying the invention is shown in FIGURE 1 and generally designated 10. Its rotating elements may be driven by a suitable motor M which is conveniently of a conventional type. The apparatus 10 comprises a base or frame member 12 adapted to be secured as by bolts to a suitable support surface. Intermediate its ends the frame 12 mounts upstanding brackets 14 which by means of resilient spacers 14*a* (FIG. 3) horizontally support the shaft housing 16. Preferably the spacers 14*a* are radially disposed peripherally spaced blocks. Concentrically secured within the shaft housing 16 are a plurality of aligned ball-bearing units 18 (FIG. 3) to the center races of which is affixed the tubular outer rotor drive shaft 20. The bearing units are spaced by tubular spacer 19. As shown in FIG. 1 a multiple belt drive from motor M engages a multiple pulley 22 mounted on the rightward end of the tubular drive shaft 20, whereby the shaft 20 is driven at the appropriate speed.

FIGURE 2 represents that in a zone adjacent its leftward end shaft 20 is tapered and receives the correspondingly central opening of the outer rotor 24. The extreme end of the shaft 20 is threaded and receives a securing nut 26, assuring co-rotation of shaft 20 and rotor 24. The rotor 24 includes a frusto-conical portion 28 which is formed with a plurality of large openings 30 for reasons which will appear. The frusto-conical portion 28 mounts the cylindrical basket 32 comprising the outer rotor proper. The basket 32 is formed with evenly spaced radial holes 34 and carries on its inner surface a plurality of uniformly spaced annular grooves 36 in communication with the holes 34. For most applications a bar screen 38 is secured across the inner face of the basket, such screen comprising bars extending in axial direction and being held in position by means well known in the art. To simplify the drawings the bar screen 38 is shown only partially in FIGURE 2.

Mounted for coaxial rotation with the tubular shaft 20 is the inner rotor drive shaft 40. For convenience the shafts 20 and 40 may be linked for co-rotation by a key 42 in the shaft 20 which engages in a groove in the inner shaft 40. Alternatively, the frictional engagement of shaft 40 inside shaft 20 may cause corotation.

As shown in FIGURE 2 the leftward end of shaft 40

is formed with a tapered zone and receives the hub element **46** of the inner rotor. The nut **47** holds the hub element to shaft **40**. The radial vanes **48** are secured to the end of the nut. The hub element **46** is frusto-conical in shape as shown in FIGURE 2 and inclines toward the right as its outer perimeter is approached. Adjacent its perimeter the hub element mounts the frusto-conical perforate section **50** which comprises the inner rotor proper. In a manner similar to the basket **32** section **50** is formed with uniformly spaced annular grooves **52** and communicating openings **54**. The outer periphery of the section **50** carries on its radial face an annular push element **56** which is positioned adjacent the screen **38**.

As indicated in FIGURE 3 the opening through the hollow shaft **20** is provided intermediate its ends with a reduced bushing **58** against which abuts one end of an axial spring **60**, disposed about the shaft **40**. Adjacent its rightward end the shaft **40** is threaded and engaged by a nut **62** supporting a flanged collar **64** against which the opposite end of spring **60** abuts. There is an urging, therefore, by spring **60** to return the inner rotor including push element **56** to the retracted position. Supplying the force to drive the section **50** toward the open end of the outer rotor **32** is the piston **66** secured axially to the extreme end of shaft **40** and operable in the cylinder **68**. The piston **66** is activated by fluid communicating with the cylinder **68** through the fitting **70**, conveniently of conventional design.

To provide for lubrication of the bearings **18**, spaced heads **72** mounted in the housing **16** are adapted to direct oil at the bearings, respectively. Used oil will drain out fitting **74** for subsequent recirculation. For simplicity, lubrication lines are not shown in the drawings.

Surrounding the outer rotor **32** and anchored to the frame **12** is the cylindrical cover element **76**. At its rightward end the cover element **76** is formed with an enlarged boss featuring a seal **78** adapted to engage leftward extensions of the shaft housing **16**. Adjacent its opposite end, cover **76** is provided with an annular flange element **80** cooperating with an axially disposed fin **82** on basket **32** to provide an interlocking seal precluding recombination of extracted liquid within the cover with the solids discharge.

As shown in FIGURE 2 the cover may be formed with a plurality of inward annular partitions **84** compartmenting the cover into the desired number of drain zones. As illustrated each drain zone is provided with a drain outlet **85**. Flush tubes **86** are also provided for cleaning out the drain zones if necessary. The zone **87** receives the solids discharge.

The leftward end of the cover **76** mounts an axial packing gland **88** of conventional design which receives in liquid-tight fit the feed tube **90** through which the feed slurry or the like, is introduced into the machine. The leftward end of the feed tube **90** is attached to a flexible pipe (not shown) to permit movement of tube **90**.

The outlet end of tube **90** is reduced and threaded exteriorly and receives a correspondingly threaded discharge flange **92** which gently fans outward and is threadedly adjustable toward and away from radial vanes **48** secured to the nut **47**. The distal end of the flange **92** may be in substantially the same plane as push element **56** to give the unit maximum compactness.

FIGURE 2 indicates that in its preferred form the outlet from feed tube **90** is closely circumposed by a feed distribution shell broadly designated **94**. The shell **94** includes a collar **96** to which is bolted a pair of annular plates **98**, **99** shaped to hold clampingly the outer race of a ball-bearing unit **100** circumposed by shock element **101**. As FIGURE 2 indicates, the inner race snugly engages about feed tube **90**, and the plates **98**, **99** each carry appropriate seals **102** to preclude axial seepage of feed along the outside of the tube **90**.

Adjacent its rightward end collar **96** has secured a ring **104** to which may be welded the smaller end of an axially disposed frusto-conical flaring distributor **106**, along which solids introduced to the apparatus are gently accelerated as they move outward. The acceleration means comprise the vanes **108** secured to the hub element **46** as by welding and at their opposite end to a ring **110** which is bolted to the collar **96** as shown.

Thus by virtue of the present structure, the vanes **108** as well as the flaring distributor **106** reciprocate and rotate with the inner rotor **50**. It will be noted that slurry passing through the outlet of the feed tube **90** by means of flange **92** is deposited on the inner face of collar **96** and thence moves outwardly along the flaring distributor **106** being gradually accelerated by the vanes **108**. From the larger end of the distributor **106**, the feed is deposited on the perforate frusto-conical section **50** and is immediately denuded of a large portion of its liquid as its movement from the axis of the apparatus along section **50** continues. The extracted liquid passes out openings **54** and **30** to be thrown directly out in the cover **76**.

Additional wings **112** secured to and extending radially outward from the distributor **106** assure the continued tangential acceleration of the feed.

Cake levelers **113** and **113***a* are secured to ring **104** as shown.

The feed, partially deliquefied, is hence delivered over push element **56** to the inner end of the perforate basket **32**. As with pusher type apparatuses of the prior art, cake builds up in annular layer on the basket **32** and is urged leftwardly with each reciprocation, that is each leftward movement of section **50**. Upon each leftward movement dry solids discharge is thrown over the outer end of the basket **32** for appropriate collection at zone **87**. The succeeding abrupt rightward movement of the section **50** including push element **56** leaves adjacent element **56** an open area on basket **32** which is immediately filled by solids moving outward along section **50**.

To assure evenness of feed to the apparatus it has been found desirable to maintain even spacing between flange **92** and nut **47**. This, of course, has required the reciprocation of the feed tube **90**. In the apparatus embodying the present invention this has been effectively accomplished by forming the feed tube **90** with a pair of spaced grooves (FIGURE 2) into which are received a pair of snap rings **114**. The snap rings **114** in protruding radially outward from tube **90** provide shoulders for the inner race of bearing unit **100**, forcing co-reciprocation of the tube **90** with the unit **100**.

As has been achieved in the prior art, rinsing of the partially dried solids may be effected by one or more washing heads **116** which are supported on pipes held in appropriate bushings **118** in the leftward end of the apparatus as shown in FIGURE 2. The pipes may be adjusted in the bushings **118** and may be reciprocated with the feed tube **90** by suitable brackets, if desired. Preferably, as shown, a plurality of heads **116** are used and each are arranged to direct rinse toward the basket over the respective drain zones **85** for reasons well known in the art.

To observe action of the solids in the machine, a window **120** may be provided in the cover **76**. Windows **121** and **121***a* may also be provided across openings in the cake levellers **113** and **113***a*.

In using feed mixture such as a slurry of ammonium sulfate crystals in the mother liquor, it is found that the crystals discharging in deliquefied form from the present apparatus are of substantially the same size as those in the feed and that there is a minimum loss of crystal material to the liquid discharge. Hence it is assumed that the frusto-conical distributor **106** coupled with the vanes **108** assure the gradual acceleration of the crystals to the tangential velocity of section **50** at its inner periphery, such gradual acceleration eliminating the shear and the other disturbances which cause crystal breakage.

The use of the apparatus in processing ammonium sul-

fate crystals is merely illustrative. The device is useful in deliquefying many solids. It is useful in, for instance, the removal of ice from water or other liquids, the separation of table salt from water, and the removal of polyvinyl chloride from its mother liquor.

It is therefore to be understood that the above particular description is by way of illustration and not of limitation, and that changes, omissions, additions, substitutions and/or other modifications may be made without departing from the spirit of the invention. Accordingly it is intended that the patent shall cover, by suitable expression in the claims, the various features of patentable novelty that reside in the invention.

I claim:

1. A compact centrifugal continuous solids drier of the pusher type comprising in combination an outer cylindrical rotor having a liquid-draining surface composed of smooth spaced bars disposed longitudinally thereof and an inner rotor coaxial within the outer rotor and defined by a central portion and an outer frusto-conical perforate portion, the larger end of the frusto-conical portion comprising an annular push surface and facing an open end of the outer rotor, means for rotating the rotors together, means for reciprocating the inner rotor relative to the outer rotor, a feed tube extending axially into the said open end of the outer rotor and terminating in an outlet, the margin of the outlet being flared and spaced from the central portion of the inner rotor, an imperforate flaring distributor shell mounted for rotation with the inner rotor, the smaller end of the shell closely circumposing the flared outlet of the feed tube, the larger end of the shell disposed adjacent the inner periphery of the outer frusto-conical portion of the inner rotor, and vane means positioned radially and extending between the frusto-conical portion and the shell, and the shell and the central portion, respectively, to assure that the solids maintain the angular velocity of the respective elements as they traverse them, whereby solid material in a slurry introduced through the feed tube is gently accelerated by the shell to the frusto-conical portion, is progressively drained on the frusto-conical portion as acceleration gently continues, and is deposited at each reciprocation in annular cake form on the outer rotor for additional draining and subsequent discharge, the smooth bars of the cylindrical outer rotor presenting draining surface with minimum likelihood of solids abrasion.

2. A centrifugal continuous solids drier as described in claim 1 wherein the flaring distributor shell is mounted on the inner rotor and the smaller end of the shell is rotatably secured about the feed tube and means are provided to lock the shell for axial movement with the feed tube, whereby the feed tube reciprocates with the inner rotor.

3. A centrifugal continuous solids drier as described in claim 1 wherein the means for reciprocating the inner rotor relative to the outer rotor comprises spring means to retract abruptly the inner rotor and fluid pressure motor means to drive the inner rotor out.

4. A centrifugal continuous solids drier as described in claim 1 wherein an annular cake-leveling dam is mounted to reciprocate with the inner rotor and disposed toward the open end of the cylindrical rotor from said annular push surface.

5. A centrifugal continuous solids drier as described in claim 1 wherein additional vane means are radially disposed and mounted on the central portion adjacent the axis thereof and extend into the flared margin of the outlet of the feed tube.

References Cited in the file of this patent

UNITED STATES PATENTS

1,842,464	Ter Meer	Jan. 26, 1932
2,367,961	Piponius	Jan. 23, 1945
2,685,370	Ruegg	Aug. 3, 1954
2,755,934	Ruegg	July 24, 1956
2,806,603	Van Der Molen	Sept. 17, 1957
2,828,021	Ruegg	Mar. 25, 1958
3,087,621	Gooch	Apr. 30, 1963
3,123,557	McPhee et al.	Mar. 3, 1964

FOREIGN PATENTS

590,969	Great Britain	Aug. 1, 1947
750,531	Great Britain	June 20, 1956
1,024,145	France	Jan. 7, 1953
1,079,551	Germany	Apr. 7, 1960