Aug. 27, 1963 H. B. MERRITT ETAL 3,101,722

DRUM DRYER

Filed July 29, 1960 5 Sheets-Sheet 1

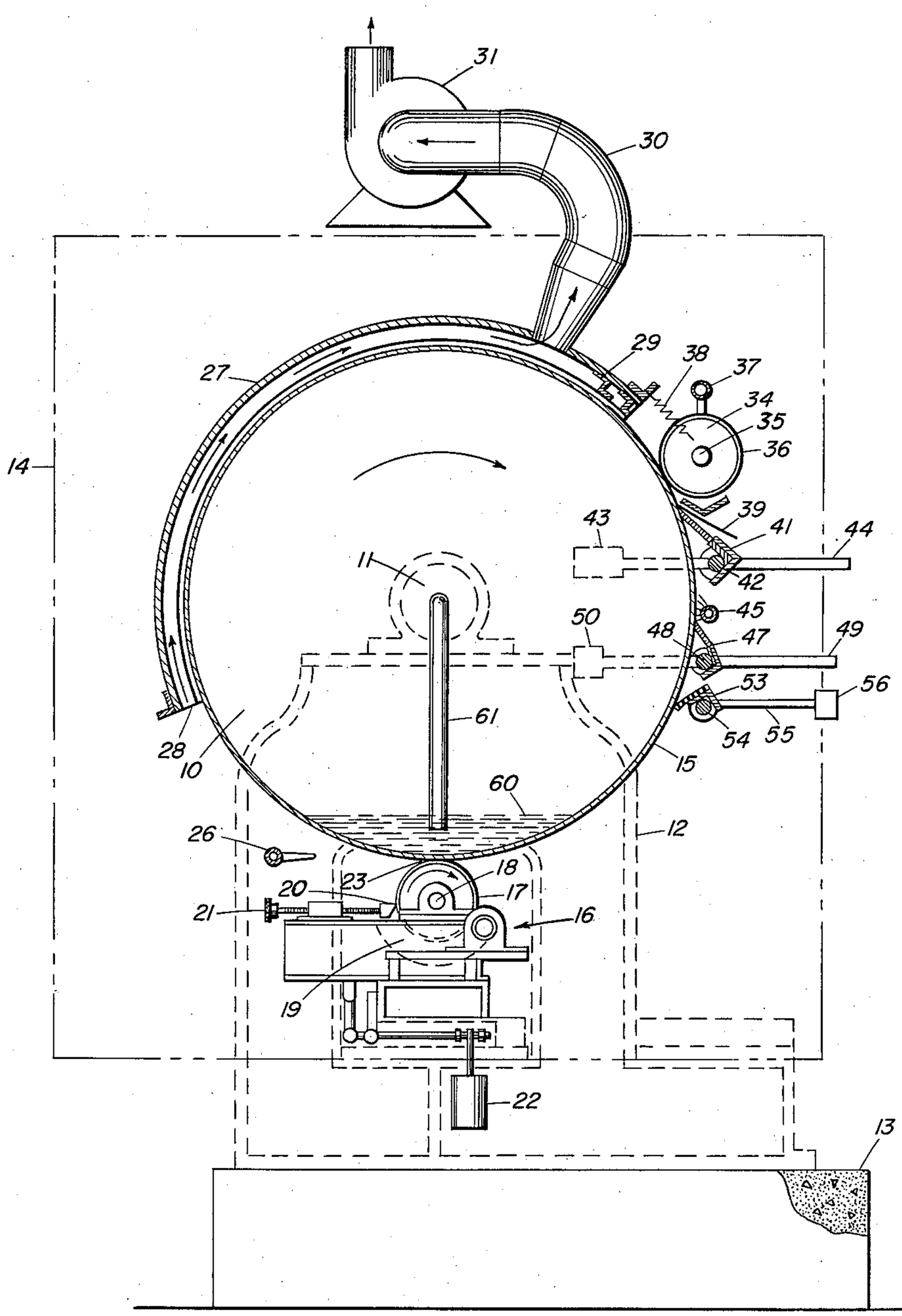

FIG. 1

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DRUM DRYER

Filed July 29, 1960 5 Sheets-Sheet 2

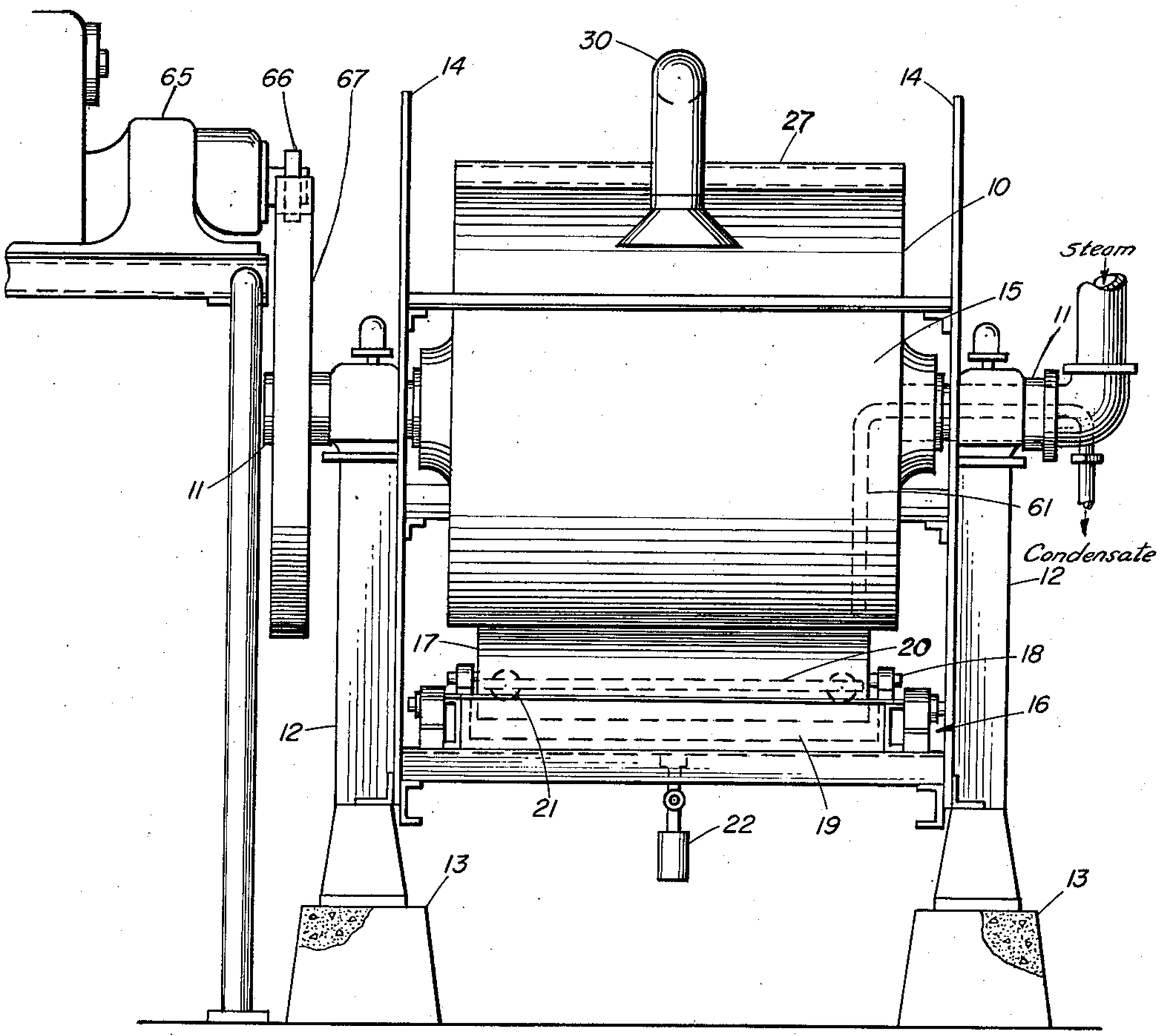

FIG. 2

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DRUM DRYER

Filed July 29, 1960 5 Sheets-Sheet 3

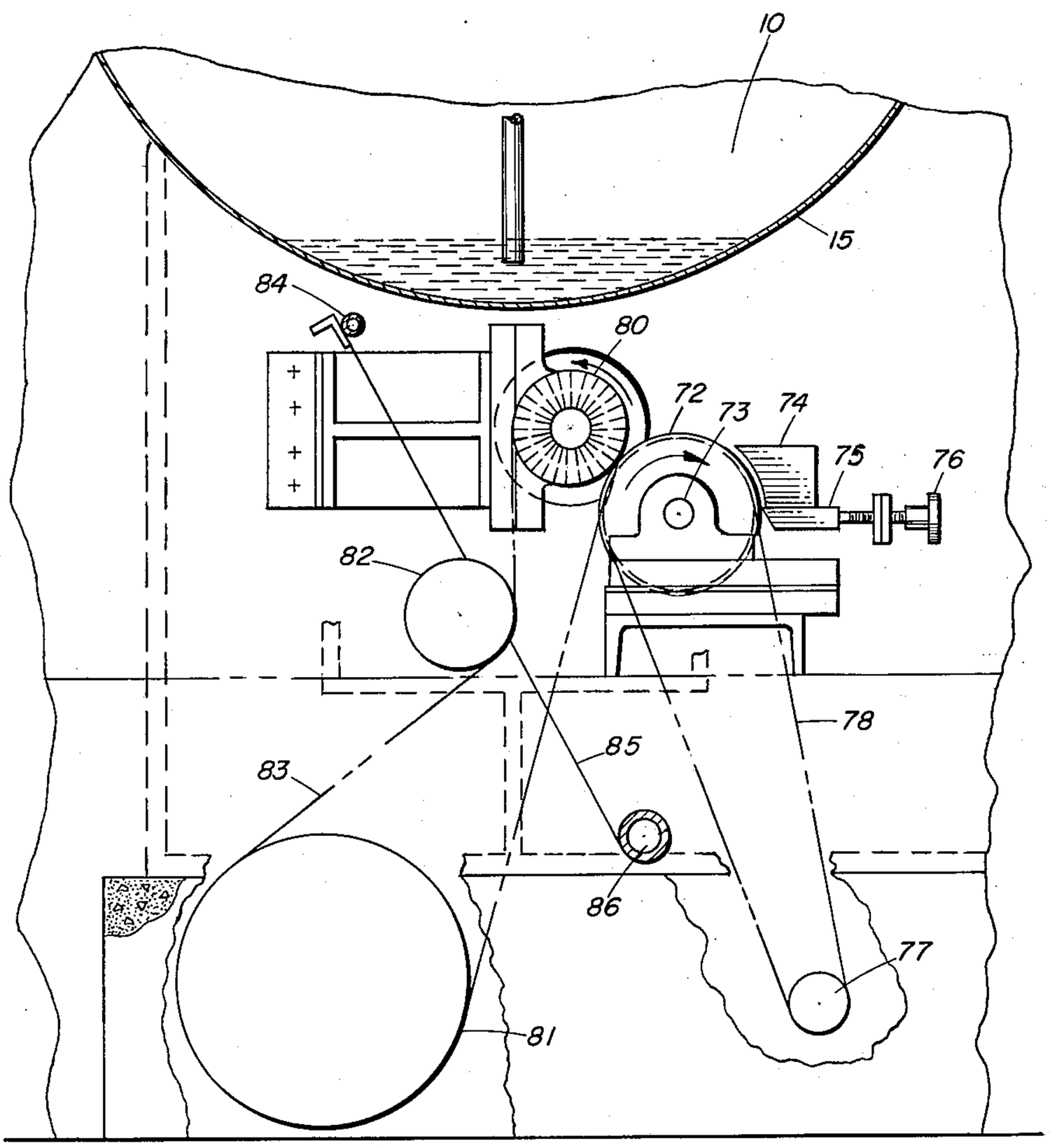

FIG. 3

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DRUM DRYER

Filed July 29, 1960 5 Sheets-Sheet 4

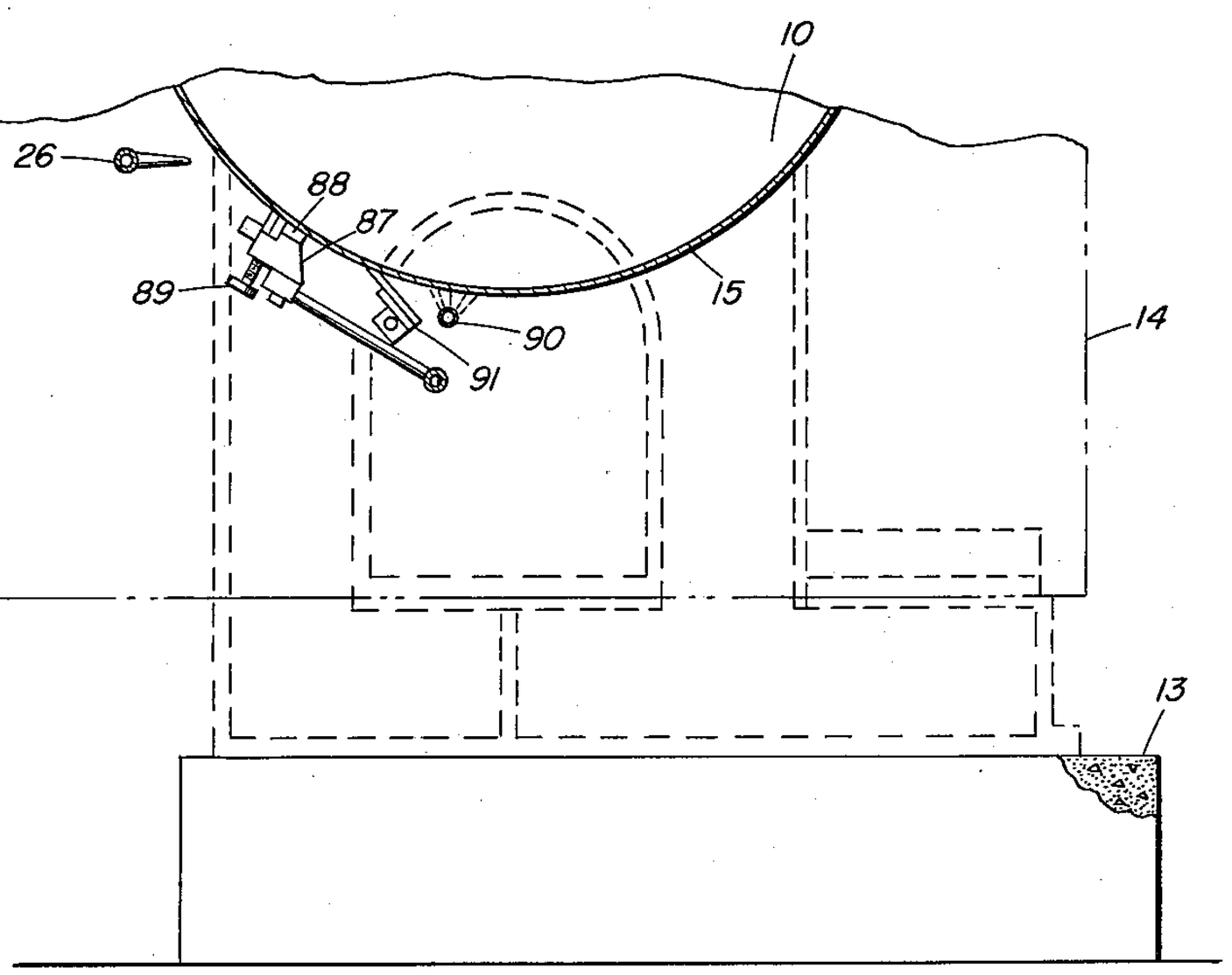

FIG. 4

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Filed July 29, 1960 5 Sheets-Sheet 5

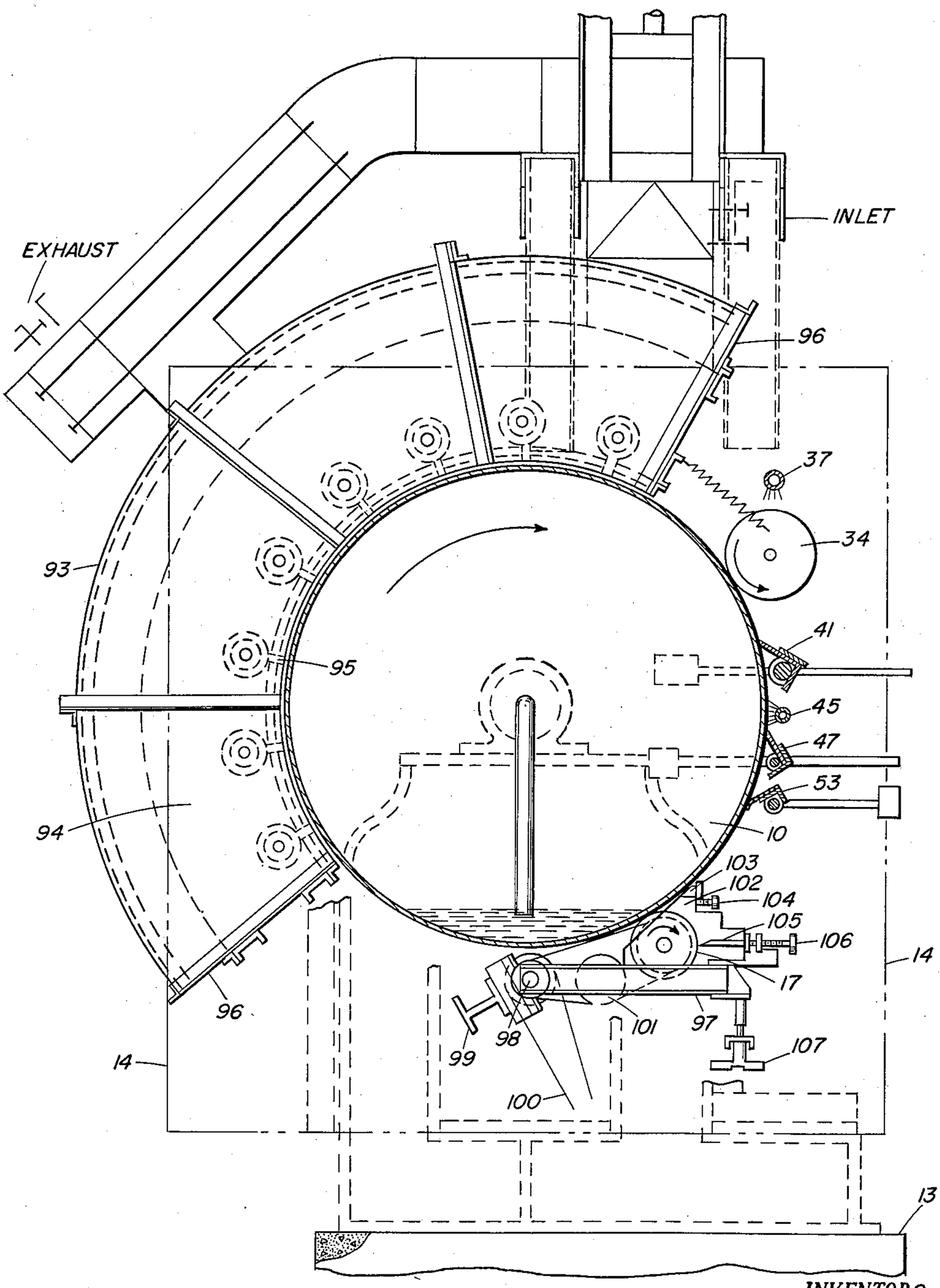

FIG. 5

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DRUM DRYER

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Filed July 29, 1960, Ser. No. 46,303
6 Claims. (Cl. 131—136)

The present invention relates to a drum drying apparatus. More specifically the present invention relates to an apparatus for converting a slurry or suspension into a self-supporting sheet or film.

For the purpose of providing in greater detail the advantages herein afforded, the invention will be described in connection with the preparation of a self-supporting sheet from tobacco slurry or suspension although it will be apparent that the novel method and apparatus may be advantageously used for the preparation of sheet material from dispersions or slurries other than tobacco.

The present invention concerns itself with an efficient compact and relatively inexpensive unit for forming and drying sheet material continuously on a heated cylindrical drum surface. Tobacco sheet produced on the dryer of the invention from natural tobacco leaf, including fines and pieces of stems etc., which would otherwise be waste, is formed into a homogeneous, elastic, flexible, self-supporting and continuous sheet which retains substantially all natural characteristics and properties of tobacco including color, aroma and taste. The converted tobacco sheet product so formed can be utilized in the same manner as natural leaf tobacco to the manufacture of consumer products such as cigars, cigarettes, shredded pipe tobacco and the like.

The present method of producing tobacco sheet is by a belt-line means, see for example U.S. Patent Nos. 2,734,510 and 2,734,513. In the prior art process, tobacco dispersion is cast on a continuous substantially impervious belt or conveyer such as stainless steel and as the belt carries the dispersion along the line it is dried, conditioned, stripped off the belt and wound on a mill roll. This product is then ready for slitting or chopping and processing into tobacco articles. The tobacco sheet belt-line system is costly and requires an inordinately large space for installation. For example in a cigar binder plant approximately 200 feet of stainless steel belt and the mechanisms to support and dry this heavy belt are required. The requirements for a cigarette filler plant using a belt system of this type are even greater. In such installation a straight and unusually long although narrow area is required. In addition to space inconvenience and high equipment cost, the belt system has a relatively low rate of heat transfer per square foot of dryer. Additionally, the belt system because of its flexible belt makes it difficult to obtain a flat casting surface i.e. corrugations in the belt seriously obstruct the deposition of a uniform depth of tobacco slurry. The corrugations are generally caused by uneven stresses in the moving belt. For the foregoing reasons among others it is apparent that the complexity of installation and operation of the prior art plants of this type is a very substantial undertaking. Its magnitude is often discouraging to manufacturers with limited economic means and engineering talent. A small producer desirous of installing a belt-line system is discouraged by the formidable cost and know how involved.

In the system of the present invention a drum dryer unit which avoids the foregoing disadvantages is provided. A substantial cost savings is effected. A relatively small floor space is required for operation. Many of the difficult problems typical of belt-line plants such as belt-tracking are avoided. The operating control problem of sensitive gas fired dryers is eliminated. The product sheet

wind-up and application of dispersion on a drum dryer is intrinsically simplified because the web-forming surface of the drum dryer is not subject to change in its lateral position as is the belt in the belt system.

It is accordingly an object of the present invention to provide a compact driven drying unit for producing a converted tobacco product. Another object of the invention is to provide an improved apparatus for making a continuous web of reconstituted tobacco sheeting. The invention provides a very definite improvement over the prior art apparatus for this purpose. The unit herein involved has the important advantages of low cost and relative compactness. Additional objects and advantages will become apparent from the description of the invention hereinafter more fully described and set forth in the claims.

In the accompanying drawings which form a part of the specification, the several reference characters designate the same or like characteristics.

FIG. 1 is a side elevation of the drum dryer unit with its components for producing a web or sheet material.

FIG. 2 is a front elevation view of the drum dryer and components shown in FIG. 1.

FIG. 3 is a modified arrangement for applying slurry to the drum surface.

FIG. 4 illustrates still another modification for applying slurry to the drum surface.

FIG. 5 is a modified hood arrangement which provides heated jets of air for use in conjunction with the drum dryer showing additionally another slurry applicator device.

Referring to FIGS. 1 and 2, a drum dryer comprising a cylindrical member **10** rotates on its shaft **11** which is journalled in supports **12** which in turn are resting on the suitable base **13**. Adding to the support of the drying cylinder and for mounting various drum surface contacting elements, which will be described more in detail hereinafter, are the rigid side plates **14** preferably fabricated of metal. It will be apparent that other suitable arrangements may alternately be used to support these elements.

As seen more clearly in FIG. 2 the cylindrical rotating drum is driven by a suitable arrangement such as the varidrive motor unit **65** of a type which is commercially available and has an external gear and reducing arrangement **66** and **67**. If desired a tachometer and a mechanicl extension on the speed control (not shown) may be used for remote control of the unit. Steam from an outside source is fed into the interior of the drum through a manifold (not shown) of conventional arrangement to heat the drum surface. Condensate within the drum collects at the base of the drum and is removed from the drum interior through dip pipe **61**.

Shown in FIG. 1 and 2 is a knife roll coater arrangement **16** for applying the slurry to the drum surface. This comprises a roll **17** mounted on a shaft **18**. The surface of the roll **17** is formed of a suitable moderately flexible material such as heat resistant rubber. The roll **17** is partially encased in the slurry trough **19** and is rotated in the direction shown at a surface speed preferably faster than that of the surface of the drum on which the slurry is deposited thereby assuring a solid gas-free slurry deposit. The slurry picked up from the trough is carried by the roll surface until it meets the casting knife **20**. The knife spreads the slurry forming a uniform film on the surface of the roll **17** as the rubber roll surface passes beneath the knife. The film thus formed is picked up from the feed roll **17** at the point **23** by the counter rotating drum surface **15** as the two surfaces meet tangentially.

Because of the relatively limited retention time of the tobacco film on the drum surface compared to the longer conventional belt-line system, it is necessary that the surface of the drum **15** be at a temperature as high

as consistent with acceptable qualities in the product. A hot surface has a drawback in that it causes sputtering, boiling or blistering of the film, a result which would result in a commercially unattractive product. Accordingly, it is necessary to the present invention that the vapor transmission from the deposited film or slurry be accelerated to prevent boiling of the slurry deposited on the drum surface 15. For this purpose, the drum surface, as described in greater detail hereinafter, is locally precooled and secondly, a suitable arrangement to cool the dispersion at the point of contact between roll and drum is employed. For this purpose a forced air jet 26 may be suitably utilized. The air stream from the jet aids materially in keeping the water vapor pressure down and prevents boiling while the dispersion is still in liquid form. We have found also that air impinged on the dispersion immediately after forming on the drum surface also has a very substantial influence in accelerating the drying rate.

A suitable exhaust hood 27, substantially covering all of the upper drum surface is arranged and constructed so as to sweep air over the deposited film through the ingress end 28 and to exhaust the moisture laden vapors through the exhaust device 31 by way of the suction conduit 30. Shown at 29 is a baffle arrangement which prevents the entrance of air from the upper end of the exhaust forcing the path of air to enter at 28.

If desired the dry sheet or film produced on the drum may be and preferably is remoistened before it is doctored off the drum surface. The remoistening step not only beneficiates the quality of the sheet, but greatly assists in the removal of the sheet from the drum surface. For this purpose the remoistening roll 34 supported on shaft 35 and having a felt sleeve 36 is employed.

In operation the remoistening roll provides advantages not available by other means of rewetting such as spraying or brush coating. We having discovered that although the dried web may be doctored off and subsequently wetted to the desired moisture, it is highly preferable that the web be remoistened prior to doctoring. Prior remoistening aids significantly in easing removal from the drum surface. In order to effect this improvement in doctoring the web it is important that the remoistening penetrate throughout the depth of the web. Spraying for example is ineffective for this purpose because by the time the web is impregnated to effectively assist removal it is overwet. The remoistening roll 34 is designed to revolve by adjustable pressure contact with the drum surface. Controlled amounts of water are admitted to the nip formed between the remoistening roll and the drum surface which is pressed into the web. As the sheet traverses by the remoistening roll, it removes excess water thereby precluding overwetting of the web. The amount of water applied by the remoistening roll may be controlled by the height of the water in the nip i.e. an increased height of water affording longer residence time of water on the sheet, and by the pressure adjustment of the remoistening roll against the drum surface.

Shown at 37 is a water feed for the remoistening roll 34 held in contact with the drum surface 15 by the adjustable tension spring 38. After remoistening the tobacco sheet 39, it is doctored from the surface of the drum by the doctor knife 41 pivoted on the bearing 42. Pressure of the doctor knife may be adjusted by any convenient arrangements such as the pressure weight 43 supported by the arm 44.

The following elements described below which are used in preparing the drum surface for the casting of the slurry after removal of the tobacco webs by the doctor knife relate essentially to the cleaning and precooling of the drum surface. Shown at 45 is a cleaning and precooling spray which washes and cools the drum surface. The scavenger 47 pivoted on shaft 48 and adjusted by the arrangement of arm 49 and weight 50 removes any solid residue from the drum surface. The squeegee 53 thereafter removes substantially all moisture from the drum surface. The elements in the cleaning spray 45, scavenger knife 47 and squeegee knife 53 are shown at a substantial distance from the feed roll 17 for purposes of more clearly illustrating the arrangement but it will be understood that these elements are preferably positioned closer to the feed roll in order to take advantage of the temporary precooling effected by the spray 45. A second spray and squeegee may be positioned between the squeegee 53 and rubber roll 17 so as to provide additional precooling. It will be apparent, however, that this may result in additional and therefor undesirable heat transmission losses.

As a further precaution against sputtering and blistering of the slurry deposit caused by boiling of the slurry on the hot surface and resulting in pock holes in the web, advantages are taken of the poor heat transfer property at the bottom of the drum where condensate has a tendency to accumulate on the inside. For this reason the slurry or dispersion is applied at the bottom of the drum surface. As an aid to the fuller utilization of this property of poor heat transfer, the dip pipe 61 is shortened to allow a minor but significant accumulation of condensate. This increases the "insulated" surface, backed up by the accumulated condensate on the inside of the drum, over a workable area at the bottom of the drum.

Shown in FIG. 3 is a alternate form of applicator for applying the slurry to the drum surface. As shown this apparatus comprises a feed roll 72 mounted on a rotating shaft 73 and a slurry or dispersion box 74. Forming the bottom of the dispersion box is a casting knife 75 arranged to produce a uniform web variable in depth by means of the adjusting screw 76. Suitable driving means 77 through the drive 78 operates the feed roll at the appropriate speed. A brush 80 rotated at a rapid speed relative to the drum surface to which the slurry is applied, sprays the slurry on the drum surface 15. The brush is driven by any suitable arrangement such as the variable drive 81 through the system of pulley 82 and the belt 83. Uniform drying may be aided in its initial stages by a water spray 84. A suitable shield 85 is shown for collection of the dispersion overspray. Removal of the overspray is effected through the conduit 86. By use of the brush applicator, precooling of the drum surface is to some extent inherent because the first particles of the dispersion spray from the brush striking the hot surface cool it for the bulk of the dispersion cast by the brush.

In the modification shown at FIG. 4, a casting knife chamber 87 into which the slurry is fed under pressure extrudes a film onto the drum surface. The film is evenly spread on the drum surface by means of the casting knife 88. Adjusting screw 89 is employed to regulate the thickness of the extruded film. A liquid cooling spray 90 and squeegee 91 may be employed to precondition the drum surface.

FIG. 5 is an alternate arrangement for the exhaust of FIGS. 1 and 2. As shown an impingement hood 93 comprising a relatively deep closed structure forms a plenum chamber 94. Within the hood structure air is circulated by means of a blower heated with a suitable source such as electric radiation or gas heaters and impinged on the sheet surface by noozles 95. The nozzles 95 may be of many suitable arrangements. The nozzles employed in FIG. 5 comprise slotted pipes extending transversely across the drum surface. Recycled air is drawn from the drum surface, admixed with fresh air, blown to the plenum chamber for heating and impinged through nozzles onto the drum surface. This arrangement substantially accelerates the drying afforded by the heating means provided internally of the drum. The ends of the plenum hood chamber are suitably closed at 96 to diminish vapor escape. By this arrangement it is possible to significantly increase the drum speed providing from 50–75% higher speed (r.p.m.). The exhaust means for the plenum chamber such as a fan not shown, may be conveniently driven by a motor not shown and controlled by an air flow switch.

The slurry applicator of FIG. 5 comprises a roller applicator **17** suitably mounted in a pivotal arrangement **97**. The construction shown comprises the pivot **98**, a support therefore **99**, suitable driving means **100** connected by belt and pulley arrangement **101**. The device employed in applying the slurry in FIG. 5 comprises a slurry pool or chamber **102** in contact with the surface of the drum **10** to aid in precooling the drum. The slurry pool is suitably sealed at **102** by the flexible blade seal **103** which is provided with a pressure adjusting screw **104**. The slurry chamber is so constructed that the slurry therein contacts about a 90 degree surface area of the applicator roller **17** and includes the casting knife **105** adjustable by means of the screw **106**. A roller clearance adjustment **107** is provided to vary the pressure or clearance of the surface of roller **17** with respect to the drum. The arrangement may contain a temperature controlling recorder and a high temperature limit control of a design commercially available and well-known in the heat exchange art.

In the drum drying system of the invention the product is exposed to heat for only short periods of time relative to a belt-line system. This has the apparent advantage of higher production. Although the product may approach the temperature of the drum surface, there is usually no adverse effect from overheating because of the low residence time.

While only certain specific embodiments of the invention have been shown and described, it is understood that various modifications may be made and details of construction of the apparatus herein set forth.

In order to provide a further understanding of the invention, the following examples are set forth. The specific enumeration of details should not be interpreted as a limitation except as expressed in the appended claims.

Example 1

Composition of slurry:	Parts by weight (dry basis)
Locust bean gum	6
NaCMC (sodium carboxymethyl cellulose)	4
Pulp prepared from Connecticut broadleaf tobacco stems in valley beater	10
Ground tobacco	63
Glycerine	5
Viscosity cp	5000
Percent solids	11

The slurry was prepared by dispersing gums, stem pulp, and finely ground (200 mesh) tobacco in a Cowles dissolver. Solids content was adjusted to viscosity of 4000 to 6000 cps. as measured with a Brookfield Viscometer Model #RVF using spindle #4 at 12 r.p.m. The dispersion was deaerated by subjecting it to a vacuum of 28" before use and it was also homogenized by passing it through a Manton-Gaulin one-stage homogenizer at 4000 p.s.i.

Slurry was applied to the drum by means of the knife roll coater illustrated in FIG. 1. Drum speed was 11 to 13 feet/minute at steam pressure of 16 p.s.i.g.

The full air capacity of the exhaust hood was used. Cooling and cleaning water was used to the extent of maintaining a drum surface temperature of approximately 212° F. at the applicator and 280° F. at the doctor knife. The air cooling device was used in the nip to prevent boiling of the slurry as deposited. The felt roll remoistener was used to facilitate removal of the web from the drum and provide proper moisture content. The drum speed was set so that the sheet was hard dry at the instant it reached the remoistener. The water feed rate to the remoistener was adjusted so that the sheet had a moisture of about 28% but redried from residual heat to a moisture content of 24% when on the mill roll.

Example 2

Base web-composition:	Parts by weight (dry basis)
Tobasso stem pulp*	30
NaCMC sodium carboxymethyl cellulose (high viscosity)	10
Propylene glycol	3

*Prepared by cooking Carolina flue-cured tobacco stems in dilute NaOH (.025 NaOH/stem) at 275° F. for one hour, then refining the mixture by beating to 100 Canadian Freeness in a laboratory Valley beater.

The base web having a concentration of 6% is applied to the top of the drum dryer by means of a casting knife. Finely ground (50 mesh) tobacco dust is immediately blown onto the wet film of base web as it leaves the casting knife enclosure.

A dusting nozzle arrangement (not shown) of known design such as that designated by numeral 36 in U.S. Patent No. 2,734,513 is employed. The ratio of weight of tobacco dust to dry weight of base web is about 9 to 1. Tobacco dust not adhering to the base web is carried off by the air stream through a suitable arrangement connected to the hood, run through a wet collection system and recovered for reuse.

The drum steam pressure is 12 p.s.i.g. Drum speed is about 12 revolutions per minute. The sheet is dried essentially bone dry, then brushed by means of a rotary brush arrangement such as the unit designated by numeral 120 in the aforementioned U.S. Patent No. 2,734,513, while still adhering to the drum to remove loose tobacco dust. The sheet is then remoistened by means of the roll remoistener, the rate of water application to the roll being adjusted to give a finished moisture of 15% in the sheet removed from the drum.

Example 3

The general procedure followed in Example 1 is repeated with the following specified exceptions. A slurry type cigarette filler sheet is prepared on the impingement hood arrangement shown in FIGURE 5.

Composition of slurry:	Parts by weight
NaCMC	10
Mixture of ground burley scrap (80 parts) and ground Virginia flue-cured tobacco (110 parts).	190
Tobacco stem pulp, refined as in Example 1	10

Slurry solids 20.5%; viscosity 19,500 at 37%

A drum speed of 19 feet per minute, with a 1.5 linear speed ratio of roller coater to drum, and a steam pressure of 25 p.s.i. was employed. The weight of sheet tobacco produced is 6.7 gm. per sq. foot, bone dry basis; the sheet moisture is 19.7%, wet basis.

Drum temperatures under the hood were as high as 320° F. compared to a high temperature of 280° F. in Example 1. No significant boiling of the slurry so as to adversely affect the uniformity of the tobacco sheet product occurred.

In preparing the slurries or dispersions in suitable concentrations and viscosities for use with the apparatus of the present invention any of the prior art compositions may be employed. Examples of typical film forming tobacco solutions and dispersions, for example are those present in the hereinbefore mentioned Patent No. 2,734,510.

Additionally, the invention may be suitably adapted for the making of a tobacco web of the type described in U.S. Patent No. 2,734,513 referred to in Example 2 in which a layer of tobacco dust is applied to a layer of film forming material or to a thin layer of tobacco slurry to form a composite sheet of tobacco. The sheet so formed is characterized by its make-up which comprises substantially a web of natural tobacco which has never been subjected to any radical treatment (i.e. not formed into a solution or dispersion) but is merely dry

ground and then bound together into a web for example by a suitable food adhesive.

We claim:

1. An apparatus for forming and drying a self-supporting tobacco sheet from a tobacco slurry comprising a revolvable cylindrical drum having a substantially impermeable film forming surface, means for applying a cooling fluid to successive portions of said surface immediately before applying tobacco slurry and means for depositing tobacco slurry in a continuous layer to the precooled moving surface, directed air means for cooling the deposited slurry, internal heating means within said drum for heating said drum surface to evaporate liquid from the deposited slurry to form a continuous self-supporting tobacco sheet and means to remove the sheet from said surface.

2. The apparatus of claim 1 in which the directed air means for cooling the deposited slurry comprises a forced air jet directed at the area of slurry application on the drum.

3. The apparatus of claim 1 in which the directed air means for cooling the deposited slurry comprises a vacuum hood closely spaced from the drum surface and covering a substantial portion of the drum surface.

4. The apparatus of claim 1 in which the means for depositing the tobacco slurry on the drum surface comprises a brush applicator in combination with a feed and wiping roll for said brush applicator.

5. An apparatus for forming and drying a self-supporting tobacco sheet comprising a revolvable cylindrical drum having a substantially impermeable film-forming surface, means for precooling successive portions of said surface by applying a water spray to said surface immediately before applying tobacco slurry, and means for depositing tobacco slurry in a continuous layer to the precooled moving surface, directed air means for cooling the deposited slurry, internal means within said drum for heating said drum surface to evaporate liquid from the deposited slurry to form a continuous self-supporting tobacco sheet, means for remoistening the dried sheet and means to remove the sheet from said surface.

6. An apparatus for forming and drying a self-supporting sheet from a liquid slurry comprising a revolvable cylindrical drum having a substantially impermeable film forming surface, means for applying a cooling fluid to successive portions of said surface by applying to the surface a liquid compatible with the slurry immediately before applying the slurry and means for depositing the slurry in a continuous layer to the precooled moving surface, means for cooling the deposited slurry, internal heating means within said drum for heating said drum surface to evaporate the liquid from the deposited slurry to form a continuous self-supporting sheet, means for remoistening the sheet and means to remove the sheet from said surface.

References Cited in the file of this patent

UNITED STATES PATENTS

446,247	Carter	Feb. 10, 1891
975,412	Ginn	Nov. 15, 1910
1,312,430	Benjamin	Aug. 5, 1919
1,995,011	Qviller	Mar. 19, 1935
2,278,525	Rich et al.	Apr. 7, 1942
2,308,024	Piker	Jan. 12, 1943
2,327,765	Carver	Aug. 24, 1943
2,405,977	Peters	Aug. 20, 1946
2,556,247	Zeigler et al.	June 12, 1951
2,675,779	Borushko	Apr. 20, 1954
2,747,583	Frankenburg et al.	May 29, 1956
2,845,933	Samfield et al.	Aug. 5, 1958
2,974,364	Lambert et al.	Mar. 14, 1961