Aug. 18, 1953 G. ENGSTROM 2,648,914

ROTARY STEAM DRIER

Filed Feb. 12, 1952 2 Sheets-Sheet 1

Fig. 1.

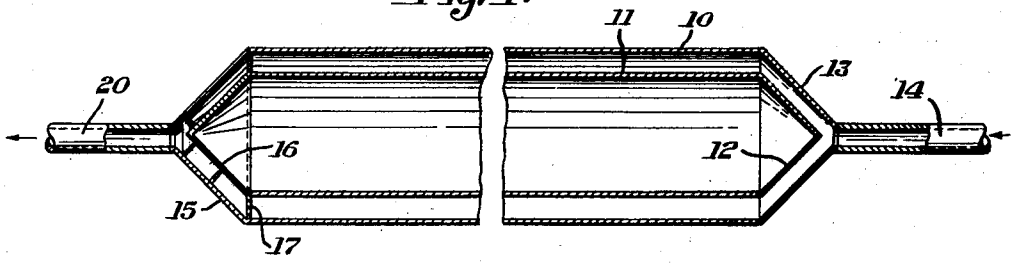

Fig. 2.

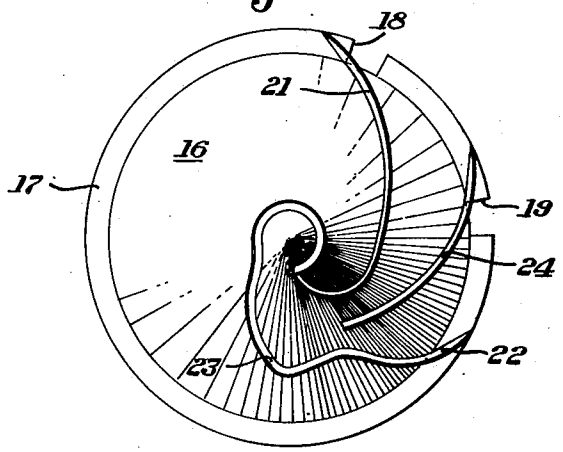

Fig. 3.

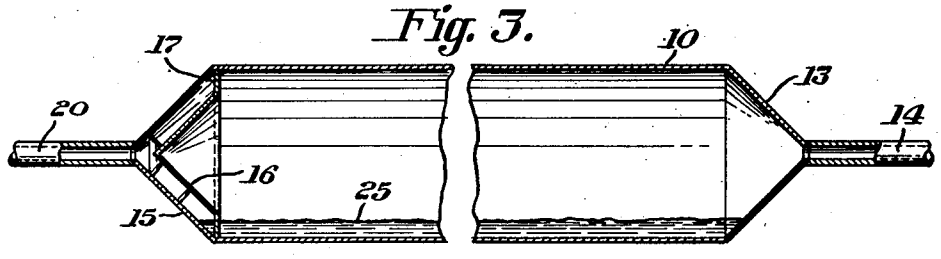

Fig. 4.

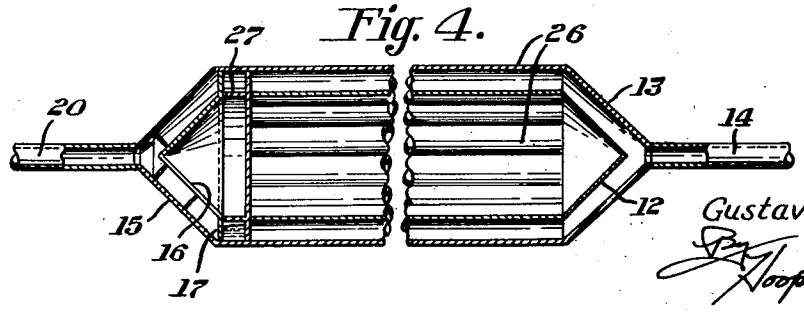

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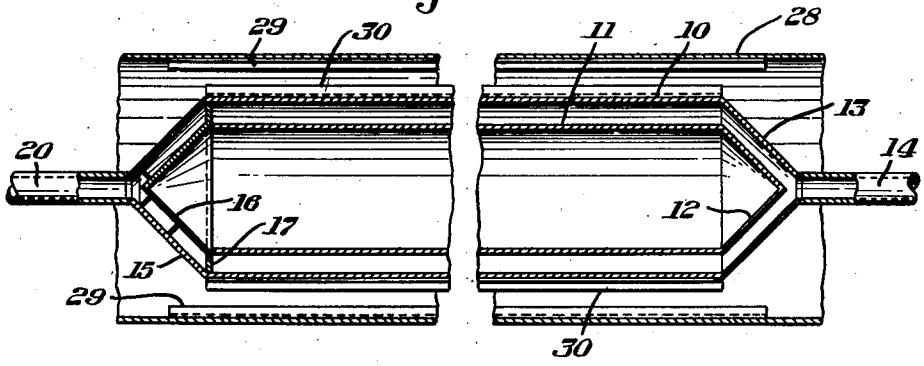
Fig. 5.



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ROTARY STEAM DRIER

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Application February 12, 1952, Serial No. 271,111

7 Claims. (Cl. 34—124)

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This invention relates to steam driers and particularly to an improvement therein by means of which condensed moisture can be readily removed from the interior thereof. Rotary steam driers are used in numerous applications where rapid drying of a film of material is desired. For instance, in the paper industry rotary driers are used to dry the paper web leaving the paper-making machine. Likewise, many comminuted materials such as synthetic resins, plastics, cement, sand, gravel or other such materials may be passed over or through a rotary drier to remove moisture or other volatile components. In any such application large quantities of steam are required to pass into the drier to maintain the drying surface at a sufficiently high temperature to effectively dry the web in contact with the surface of the drier. The exchange of heat from the steam inside the drier to the film of material on the walls of the drier results in the condensation of considerable amounts of steam into water, which water collects in the bottom of the rotating drier and tends to hang on the walls of the drier as it rotates. This collected moisture is undesirable because it tends to cool the portion of the drier with which it is in contact to a temperature below the temperature of the steam and results in increased condensation and decreased drying efficiencies of the drier. Since the driers of this type are rotated about a horizontal axis it is impossible to remove this condensed water excepting through the axis of the drum. This situation creates the problem of elevating the condensed water from its position at the bottom of the rotating drier to the level of the axis of the drier in order to remove it from the interior of the drum. Many devices have heretofore been proposed for accomplishing the removal of this condensed water from the interior of the rotating drier. These proposed devices have not been entirely satisfactory for many reasons. Generally, they have depended upon the auger principle and have attempted to carry the steam and water from one end to the other of the drum in a series of channels which spiral along the interior of the drier. Such devices carry whatever condensed water is formed along the surface of the drier in the channel and tend to spread it over a greater area than would be the case if it were simply permitted to fall to the bottom of the drum. Thus while carrying the water out of the drum they actually give it a greater contact with certain portions of the drum surface than wold be the case with an equal quantity of water on the bottom of the drum in the ordinary fashion.

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I provide a rotary steam drier in which these difficulties of the prior art driers are avoided. I provide a rotatable drier comprising generally a drying surface, means for introducing a heated fluid medium in heat exchange relationship with said drying surface, means collecting cooled fluid resulting from removing the heat from the heated fluid medium, means for periodically removing a portion of the cooled medium and carrying it along a conical helicoidal path to a point on the axis of rotation of the drier and means carrying the cooled medium from said point to discharge it out of the drier. I preferably use steam as the heated fluid medium.

I provide a rotary steam drier having preferably a single hollow outer steam chamber or in larger sizes, a single hollow chamber surrounding the periphery of the drum formed by an internal drum of smaller diameter. This permits the use of smaller quantities of steam at higher velocity within the interior of the drum than in the case of a single large drum. One end of the drier is cone-shaped, the apex of the cone opening into a discharge pipe on the axis of the drier, an internal cone is provided the walls of which are substantially parallel to the outer cone, said inner cone being spaced apart from the outer cone by an annular ring connecting the periphery of the base of the inner cone with the base of the outer cone thereby forming a hollow conical chamber in the end of the drier. Two spaced-apart openings are preferably provided from the interior of the drier into the interior of the conical chamber.

Means are provided within the hollow conical chamber to carry the water entering the openings from the interior of the drier along the surface of the cone to discharge at the apex of the cone as the drier is rotated. The means for carrying the water to the apex of the cone is preferably in the form of an outer baffle or guideway made up of at least three conical helicoidal flights, and an internal baffle or flight intermediate the two openings and within the boundaries of the outer baffle. The outer baffle is preferably made up of a conical helicoidal flight beginning at a point adjacent to and leading the first of two openings to enter the condensed water when the drum is rotated and terminating at a point adjacent the apex of the cone where it joins with the second member of the outer baffle. The second member is developed from two conical helicoids which intersect intermediate the distance from the base of the cone to the apex to form a water-retaining pocket. This second member begins at a point spaced from and trail-

ing the last of the openings to enter the condensed water and joins the first member enclosing the apex of the cone within the outer baffle. The internal baffle is in the form of a partial helicoid beginning at a point adjacent to and in front of the last opening to enter the condensed water and terminates at a point intermediate the first and second members of the outer baffle and adjacent the point where the two helicoids of the second member join to form a water-retaining pocket.

I have not attempted to explain or detail all of the novel features of my invention but have simply drawn attention to particular features and have outlined the advantages thereof. Other details, objects and advantages of the invention will become apparent as the following description of a present preferred embodiment thereof proceeds.

In the accompanying drawings I have shown a present preferred form of apparatus embodying the features of my invention and several modifications thereof in which

Figure 1 is a vertical section of a drier according to my invention;

Figure 2 is a perspective view of the condensate removing flights and the inner cone of a drier according to my invention;

Figure 3 is a modified form of my invention particularly adapted for smaller drying rolls;

Figure 4 is another modified form of my invention;

Figure 5 is a form of my invention particularly adapted for drying comminuted or finely divided material.

Referring more particularly to the drawings there is provided an outer cylindrical shell 10 and an inner cylindrical shell 11 spaced apart therefrom. An inner cone 12 attached to one end of the inner shell 11 forms with an outer cone 13 connected to one end of the outer cone a passage for delivering steam entering the interior of the outer cone 13 through an inlet pipe 14 through the center of the axis of rotation. The inlet pipe 14 passes through the interior of a supporting shaft carrying the drier in the usual manner and is connected to a source of steam by well-known means which it is deemed unnecessary to describe.

The opposite end of the outer shell 10 is connected to an outer cone 15 and the inner shell to an inner cone 16. The space between the inner cone 16 and outer cone 15 is closed off from the space between the inner shell 11 and the outer shall 10 by an annular ring 17. A pair of openings 18 and 19 spaced apart from each other in this annular ring 17 communicate from the space between cones 15 and 16 to the space between shells 10 and 11. An outlet pipe 20 is connected to the apex of the outer cone 15 for removing water, steam or other condensate from between the cones 15 and 16. This outlet pipe 20 like inlet pipe 14 passes through a supporting shaft and is connected to a drain pipe in well-recognized manner.

A conical helicoidal flight 21 begins at a point adjacent to and leading the opening 18 which first enters the liquid to be removed as the drier rotates. This flight 21 terminates adjacent the apex of the cone conformed by the inner shell 16. A second flight 22, made up of two conical helicoids which are brought together intermediate their ends to form a well 23, begins adjacent to and following the last opening 19 to enter the liquid to be removed as the drier

rotates and connects with the flight 21 at its terminus adjacent the apex of the cone. These two flights 21 and 22 are welded or otherwise fixed to the inner cone 16 and the outer cone 15 to form an internal guideway carrying condensate from the openings 18 and 19 and discharging it through the pipe 20 at the apex of the conical end 15. An intermediate flight 24, also of conical helicoidal shape, is placed intermediate the leading flight 21 and the trailing or following flight 22 beginning at a point on the annular ring 17 between the openings 18 and 19 and terminating at a point spaced from the apex of the inner cone 16. This intermediate flight 24 carries condensate entering the space between the inner cone 16 and outer cone 15 through the opening 18 to a point spaced from the apex of the inner cone 16 when the condensate is discharged into the well 23 in the trailing flight 22. This intermediate flight 24 is also welded or otherwise fixed to both the inner and the outer cones.

In operation of the drier of this invention steam or other heating medium is introduced into the space between the inner shell 11 and outer shell 10 by means of the inlet pipe 14 and the space between the inlet cones 12 and 13. As the outer shell 10 contacts the material to be dried a portion of the heating medium, especially steam, will be condensed into liquid and will collect at the lowest point between the two shells. As the drier rotates (counter-clockwise viewing Figure 2) the opening 18 passes into the condensate which flows therethrough into the space between the leading flight 21 and the intermediate flight 24. Continued rotation carries the second opening 19 into the condensate which flows through it into the space between the intermediate flight 24 and the trailing flight 23. In the meantime the condensate which flowed through the opening 18 follows the intermediate flight 24 and as the drier rotates is discharged into the well 23 in the trailing flight 22. This condensate is then discharged through the outlet pipe 20 and is immediately followed by the condensate which entered from the opening 19 and followed the trailing flight 22.

The arrangement of internal flights at the discharge end of the drier of my invention permits the removal of condensate from the interior of the drier without danger of flow back and with the maximum of efficiency.

In Figure 3 I have shown a drier according to my invention in which only an outer shell 10 and an outer inlet cone 13 is used. The outlet end is made up in precisely the same way as in the embodiment illustrated in Figures 1 and 2 and described above. In this embodiment the condensate falls directly to the bottom of the shell and forms a pool 25 which in turn feeds through the openings 18 and 19 into the discharge flights 21, 24 and 22 which carry it to the outlet pipe 20.

In Figure 4 I have illustrated still another embodiment of my invention. In this form a series of horizontal pipes 26 or ducts extend across the entire surface of the interior of the drier shell. These pipes 26 are fed by an outer 13 and inner 14 inlet cone as in the embodiment shown in Figures 1 and 2. The pipes 26 discharge into a collector ring 27 which extends around the circumference of the drum at the discharge end and collects the condensate from the pipes 26. This condensate collects at the lowest point in the ring 27 from which it flows

into the openings 18 and 19 onto the discharge flights 21, 24 and 22 which carry it to the discharge pipe 20.

In Figure 5 I have illustrated an embodiment of my invention particularly adapted for drying comminuted or finely divided materials such as sand, gravel, cement and ground synthetic resins. In this form an outer cylindrical shell 28 surrounds the drier and rotates therewith. A series of flanges 29 extend radially inwardly from the interior of the shell 28 and a corresponding series of flanges 30 extend radially outwardly from the surface of the dried. The finely divided material is thus carried around the drier with the rotating drums. The entire drier apparatus is tilted with its axis at an angle to the horizontal so as to discharge the dried material at the lower end.

While I have illustrated and described a present preferred embodiment of the invention and several modifications thereof, it is to be distinctly understood that it may be otherwise variously embodied within the scope of the following claims.

I claim:

1. A rotatable drier comprising a drum having an outer cylindrical drying surface, means for introducing a heated vapor in heat exchange relationship with said drying surface, means inside the drum collecting condensate resulting from removing the heat from the heated vapor, a pair of spaced-apart conical surfaces having an annular ring connecting the bases thereof to form a conical chamber therebetween, the outer of said surfaces being connected at its base to the outer cylindrical drying surface, spaced-apart openings in said annular ring communicating with the fluid-collecting means, means beginning adjacent the openings and cooperating with the conical surfaces to carry condensate along a conical helicoidal path from said openings to a point on the axis of rotation of the drier and means carrying the condensate from said point to discharge it out of the drier.

2. A rotatable drier comprising an outer cylindrical drying surface, means for introducing a heated vapor in heat exchange relationship with said drying surface, means collecting condensate resulting from removing heat from the heated vapor, a pair of spaced-apart conical surfaces having an annular ring connecting the bases thereof to form a conical chamber therebetween, a pair of spaced-apart openings in said annular ring communicating with the fluid-collecting ring, a conical helicoidal baffle member beginning at a point adjacent to and leading the first of the two openings to enter the condensate when the drum is rotated and terminating at a point adjacent the apex of the cone, a second baffle member including two conical helicoids intersecting intermediate the distance from the base of the conical chamber to the apex to form a water-retaining pocket, said second member beginning at a point spaced from and trailing the last of the openings to enter the condensate and joining the first helicoidal member to enclose within them the apex of the conical chamber and the two openings in the annular ring, an intermediate baffle beginning at a point between the first and second baffles and terminating at a point adjacent the intersection of the two conical helicoids making up the second baffle and means carrying the condensate from the apex of the conical chamber to discharge it out of the drier.

3. A rotatable drier comprising an outer cylindrical drying surface, an inner cylindrical shell spaced from the outer drying surface and forming therewith a chamber, means for introducing heated vapor into the chamber between the outer drying surface and the inner shell, means for collecting condensate resulting from removing heat from the heated vapor by the outer drying surface, a pair of spaced-apart conical surfaces having an annular ring connected to the bases thereof to form a conical chamber therebetween, a pair of spaced-apart openings in said ring communicating between the conical chamber and the chamber between the outer surface and the inner shell, a conical helicoidal baffle member beginning at a point adjacent to and leading the first of the two openings to enter the condensate when the drum is rotated and terminating at a point adjacent the apex of the cone, a second baffle member including two conical helicoids intersecting intermediate the distance from the base of the conical chamber to the apex to form a water-retaining pocket, said second member beginning at a point spaced from and trailing the last of the openings to enter the condensate and joining the first helicoidal member to enclose within them the apex of the conical chamber and the two openings in the annular ring, an intermediate baffle beginning at a point between the first and second baffles and terminating at a point adjacent the intersection of the two conical helicoids making up the second baffle and means carrying the condensate from the apex of the conical chamber to discharge it out of the drier.

4. A rotatable drier comprising an outer cylindrical drying surface, a plurality of parallel axially extending pipes contacting the drying surface, means for introducing heated vapor into one end of said pipes, means at the opposite end of said pipes for collecting condensate resulting from removing heat from the heated vapor by the outer drying surface, a pair of spaced-apart conical surfaces having an annular ring connected to the bases thereof to form a conical chamber therebetween, a pair of spaced-apart openings in said ring communicating between the conical chamber and the means for collecting condensate, a conical helicoidal baffle member beginning at a point adjacent to and leading the first of the two openings to enter the condensate when the drum is rotated and terminating at a point adjacent the apex of the cone, a second baffle member including two conical helicoids intersecting intermediate the distance from the base of the conical chamber to the apex to form a water-retaining pocket, said second member beginning at a point spaced from and trailing the last of the openings to enter the condensate and joining the first holicoidal member to enclose within them the apex of the conical chamber and the two openings in the annular ring, an intermediate baffle beginning at a point between the first and second baffles and terminating at a point adjacent the intersection of the two conical helicoids making up the second baffle and means carrying the condensate from the apex of the conical chamber to discharge it out of the drier.

5. A rotatable drier comprising an outer cylindrical drying surface, means for introducing heated vapor in heat exchange relationship with said drying surface, means collecting condensate resulting from removing heat from the heated vapor, a pair of spaced-apart conical surfaces having an annular ring connecting the bases thereof to form a conical chamber therebetween,

a pair of spaced-apart openings in said annular ring communicating between the conical chamber and the condensate collecting means, a pair of connected conical helicoidal baffles beginning adjacent said openings and enclosing said openings and the apex of the conical chamber, said helicoids running in a direction counter to the direction of rotation of the drier, an inverse curve intermediate the ends of the conical helicoid of said pair which is in trailing position during rotation of said drier, said inverse curve forming a condensate gathering pocket, an intermediate semihelicoidal baffle beginning at a point between the spaced-apart openings and terminating adjacent the condensate gathering pocket to discharge condensate into said pocket and means carrying the condensate from the apex of the conical chamber to discharge it out of the drier.

6. A rotatable drier comprising an outer cylindrical drying surface, an inner cylindrical shell spaced from the outer drying surface and forming therewith a chamber, means for introducing heated vapor into the chamber between the outer drying surface and the inner shell, a pair of connected conical helicoidal baffles beginning adjacent said openings and enclosing said openings and the apex of the conical chamber, said helicoids running in a direction counter to the direction of rotation of the drier, an inverse curve intermediate the ends of the conical helicoid of said pair which is in trailing position during rotation of said drier, said inverse curve forming a condensate gathering pocket, an intermediate semihelicoidal baffle beginning at a point between the spaced-apart openings and terminating adjacent the condensate gathering pocket to discharge condensate into said pocket and means carrying the condensate from the apex of the conical chamber to discharge it out of the drier.

7. A rotatable drier comprising an outer cylindrical drying surface, a plurality of parallel axially extending pipes contacting the drying surface, means for introducing heated vapor into one end of said pipes, means at the opposite end of said pipes for collecting condensate resulting from removing heat from the heated vapor by the outer drying surface, a pair of spaced-apart conical surfaces having an annular ring connected to the bases thereof to form a conical chamber therebetween, a pair of spaced-apart openings in said ring communicating between the conical chamber and the means for collecting condensate, a pair of connected conical helicoidal baffles beginning adjacent said openings and enclosing said openings and the apex of the conical chamber, said helicoids running in a direction counter to the direction of rotation of the drier, an inverse curve intermediate the ends of the conical helicoid of said pair which is in trailing position during rotation of said drier, said inverse curve forming a condensate gathering pocket, an intermediate semihelicoidal baffle beginning at a point between the spaced-apart openings and terminating adjacent the condensate gathering pocket to discharge condensate into said pocket and means carrying the condensate from the apex of the conical chamber to discharge it out of the drier.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,693,934	Millspaugh	Dec. 4, 1928

FOREIGN PATENTS

Number	Country	Date
262,704	Great Britain	Dec. 16, 1926
278,882	Great Britain	Oct. 20, 1927