Nov. 1, 1949 W. MESSINGER 2,486,719

DRIER

Filed March 16, 1946 4 Sheets-Sheet 1

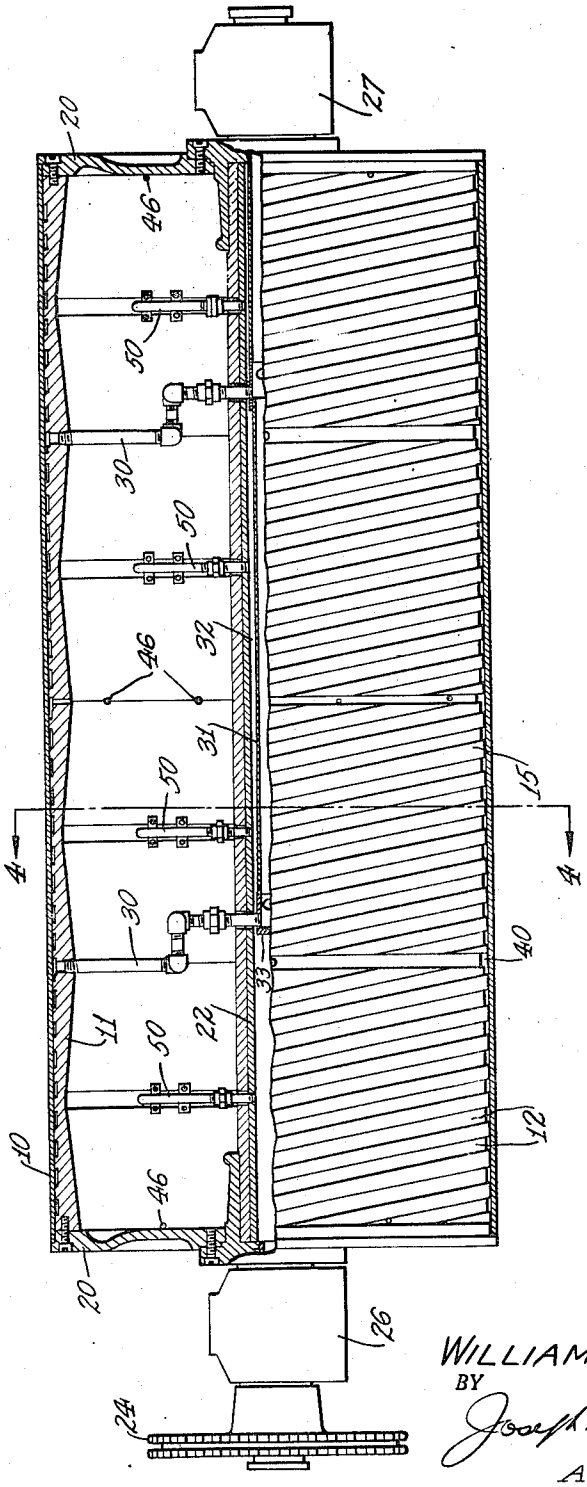

FIG. 1.

INVENTOR.
WILLIAM MESSINGER
BY
Joseph H. Lapschutz
ATTORNEY

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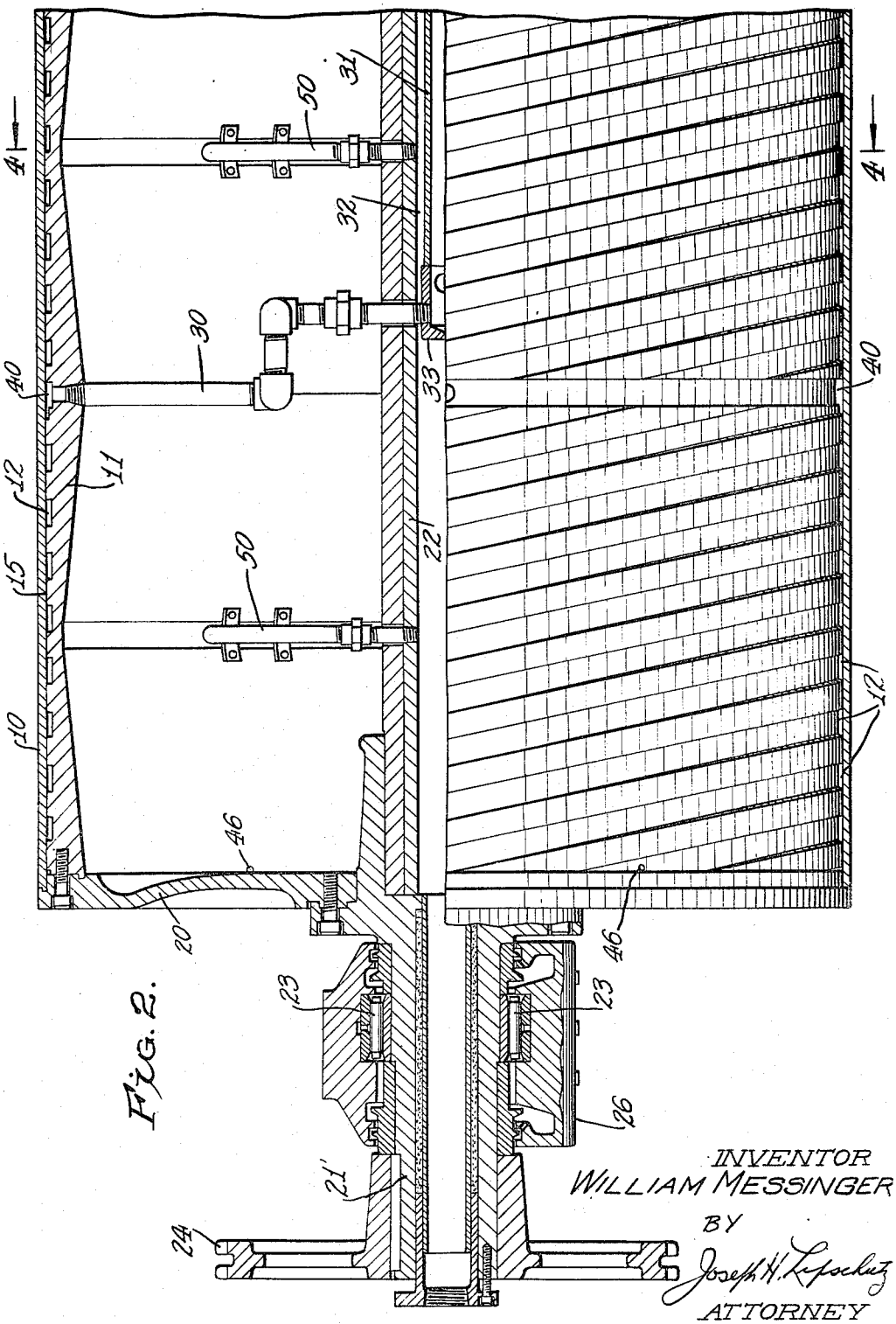

Fig. 2.

INVENTOR
WILLIAM MESSINGER
BY
Joseph H. Lepschutz
ATTORNEY

Nov. 1, 1949 W. MESSINGER 2,486,719

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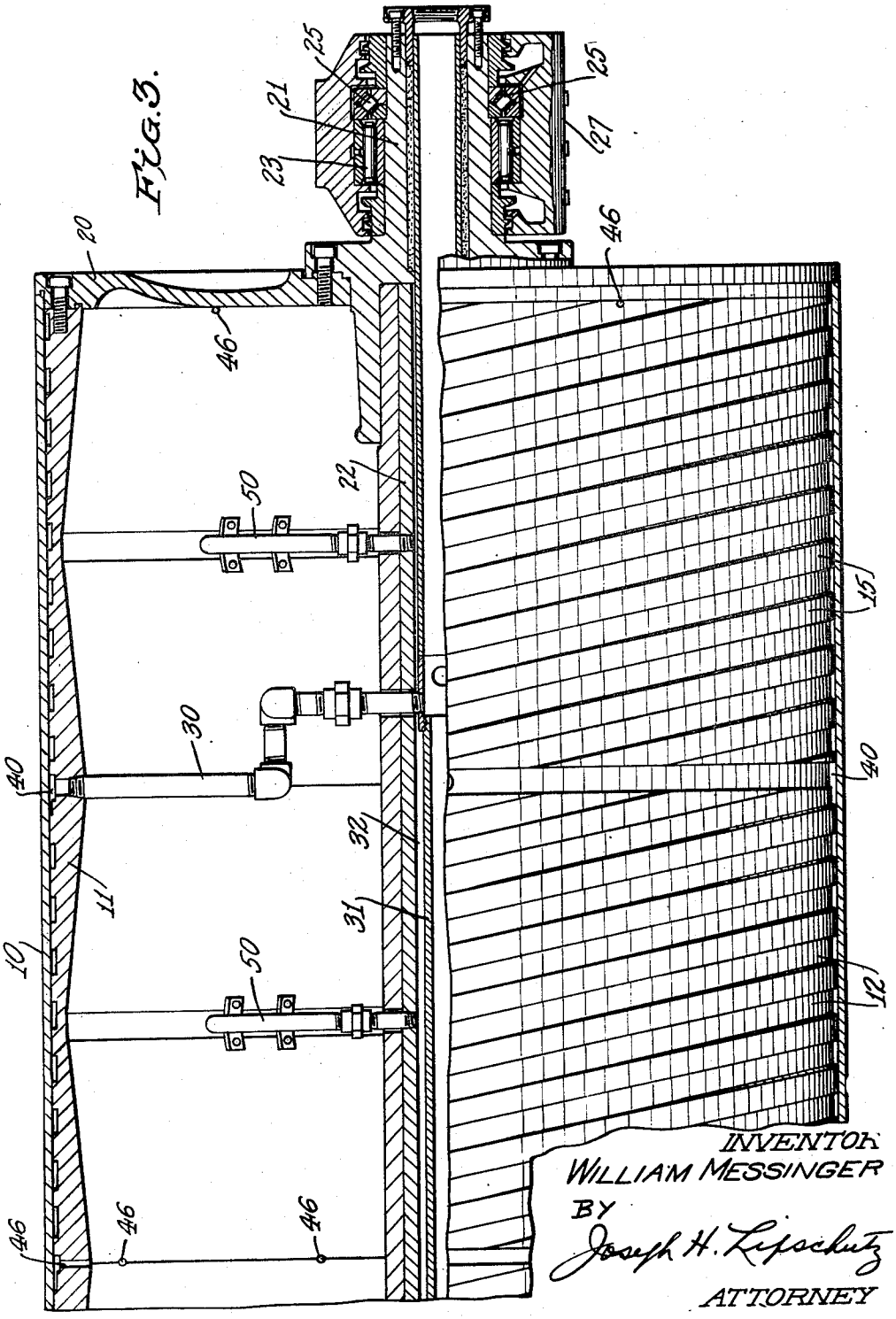
Fig. 3.



INVENTOR
WILLIAM MESSINGER
BY
Joseph H. Lipschutz
ATTORNEY

Nov. 1, 1949 W. MESSINGER 2,486,719

DRIER

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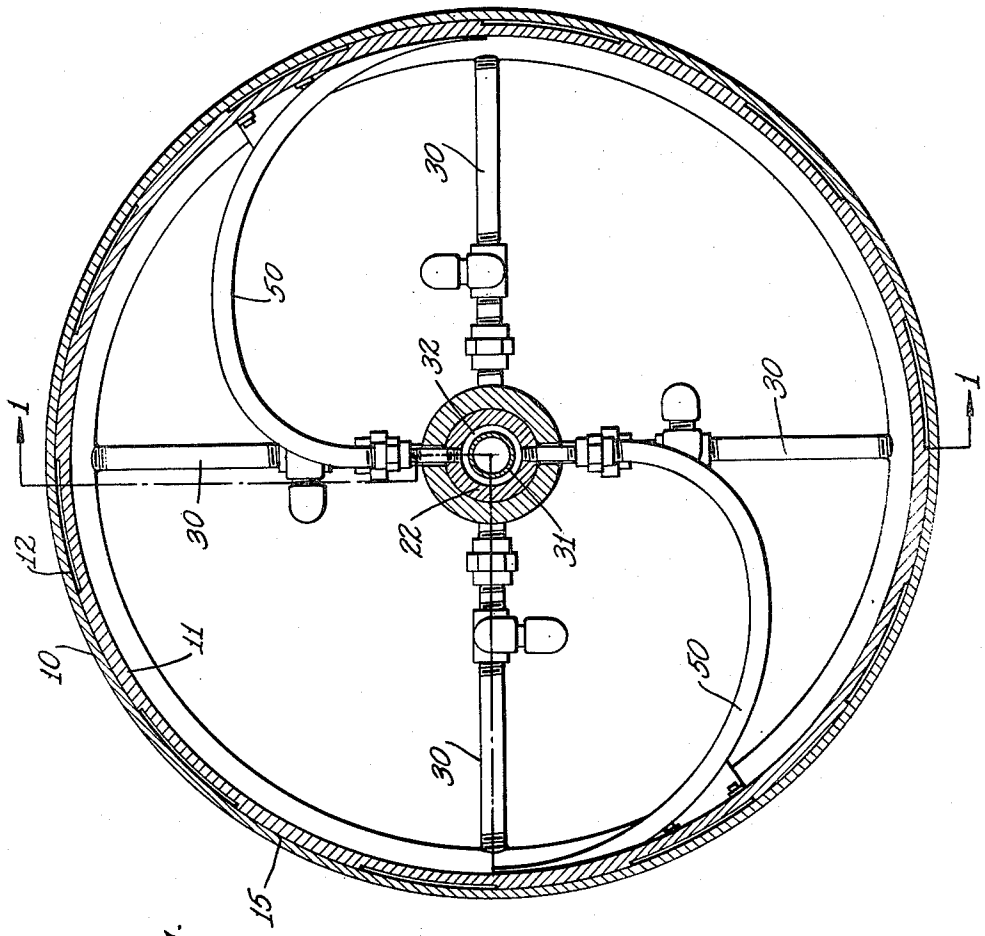

Fig. 4.

INVENTOR.
WILLIAM MESSINGER
BY
Joseph H. Rubinstein
ATTORNEY

Patented Nov. 1, 1949

2,486,719

UNITED STATES PATENT OFFICE

2,486,719

DRIER

William Messinger, Philadelphia, Pa.

Application March 16, 1946, Serial No. 654,848

6 Claims. (Cl. 34—124)

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This invention relates to dryers, particularly of the revolving cylinder type. Such cylinders are adapted to be heated internally, and the heat passing through the cylinder walls is utilized for drying materials passing over the external surface of the cylinder, either in actual contact with the surface or on a belt passing over the surface. Such a dryer is utilized in many arts for continuous drying of a variety of materials such as paper, chemicals and films of liquid or viscous material.

Dryers of this type have given rise to serious problems and contain inherent defects. In order to understand the nature of the problems which a designer of cylindrical dryers must face, the present practice will be briefly outlined. Steam at 40 lbs./sq. in. is admitted into the hollow interior of the cylinder. A portion of the newly entering steam, meeting the large mass of steam and vapor which is at lower temperature, is condensed and produces a shower-like rain. This water falls to the bottom of the cylinder, but the speed of cylinder rotation is sufficient to carry the water in a layer completely around the circumference of the interior wall of the cylinder. Water is a relatively poor conductor of heat compared to steel or cast iron—the usual metals of which dryer cylinders are formed. Further, water fed to evaporating boilers contains air which remains mixed with the steam as it enters the dryer cylinder. In addition to an insulating layer of condensed vapor, there is formed an insulating layer of air. The air may form into pockets retarding heat transmission in specific spots to such degree as to generate what are known as cold spots on the exterior surface of the dryer cylinder.

One problem which has confronted the designer of such cylinders was to produce a sufficiently high temperature within the cylinder so that in spite of the insulating layers of water and air on the interior surface of the cylinder the desired temperature of 220° to 280° F. would nevertheless be obtained on the exterior surface. The only solution heretofore offered by the designers has been ever higher steam pressures within the cylinder, but this meant correspondingly increasing thickness of cylinder wall. For example, in the paper industry, the webs of moist paper issuing from the Fourdrinier are led to massive revolving dryers which may be 12 feet in diameter, 150 inch face width, with a wall 5 inches thick, and weighing 180,000 pounds. Increasing the wall thickness, however, largely defeated the benefits which were expected from

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the higher interior pressures and temperatures since the rate of heat flow is inversely proportional to the thickness of metal traversed. The heat transfer in such thick-walled cylinders was further cut down by the fact that such large-diameter and thick-walled dryer cylinders are customarily not machined in the interior surface. Consequently there is present scale and oxide of the cast or rolled metal which has a heat insulation value equivalent to several inches thickness of metal.

By my invention I propose an entirely new method of designing such dryer cylinders which abandons completely the unsatisfactory design procedure of increasing the steam pressure and, therefore, the cylinder wall thickness, in order to solve the problems created by the insulating effect of the layers of condensed vapor and air. It is one of the principal objects of this invention to provide a design of dryer cylinder which will prevent the formation of such heat insulating layers and thus obviate the necessity for high pressure steam and consequent thickening of the cylinder wall. The reduction in weight is particularly important in the paper industry where the dryer section may contain 50 to 150 dryer cylinders. Not only can the size and weight of each cylinder be reduced by this invention, but the same drying effect can be obtained by a smaller number of cylinders. Reduction of pressure will avoid the danger inherent in excessively thick cylinder walls which crack from fatigue after a few years service and may cause explosions because these dryers contain tons of water of condensation above the boiling temperature and under high pressure.

It is another object of this invention to provide a design of dryer cylinder which utilizes the maximum efficiency of steam and distributes the heat uniformly over the exterior surface of the dryer cylinder. By this design, low pressure steam may be employed and a reduction in cylinder weight is effected.

Further objects and advantages of this invention will become apparent in the following detailed description thereof.

In the accompanying drawings,

Fig. 1 is a side elevation, partly sectioned vertically on the line 1—1 of Fig. 4, of a dryer cylinder embodying one form of my invention, the lower portion of the outer casing having been removed to disclose the underlying shell.

Fig. 2 is an enlargement of the left half of Fig. 1 and showing also the details of the bearing which is sectioned vertically.

Fig. 3 is an enlargement of the right half of Fig. 1.

Fig. 4 is a section taken on the line 4—4 of Fig. 1.

Referring to the drawings, I have disclosed a dryer cylinder which embodies the principle of design constituting my invention. Instead of filling the interior of the cylinder with a large mass of relatively stagnant steam vapor in which layers of air and water accumulate, I provide a dynamic, continuously moving, high-velocity stream of steam in contact with the interior surface of the cylinder, thus preventing accumulation of insulating layers. For this purpose there is provided in addition to the dryer or outer casing 10, an inner shell 11 which fits closely within the casing. Passages following predetermined paths are formed between the adjacent surfaces of casing and shell, and steam at high velocity is forced through the passages. The passages may be formed by cutting multiple spiral grooves 12 in the outer surface of the shell, the ungrooved portions 15 remaining as lands or supporting surfaces for the casing. The casing forms the remaining enclosing surface for the grooves, thus constituting enclosed channels or passages. Each passage is formed with relatively large area and small depth, and the total area occupied by the passages constitutes a substantial portion of the area of the outer surface of shell 11 and inner surface of casing 10. It will be apparent that steam blown through these passages is spread out and every particle of the vapor comes into intimate contact with the surrounding walls of the channel, producing friction therewith.

The casing and shell may be closed at their ends by cylinder heads 20 through which extend trunnions 21, 21' spaced apart by a hollow shaft 22. The trunnions may be supported for rotation in suitable radial and thrust bearings 23 and 25 in bearing housings 26 and 27, and one of the trunnions may have a sprocket, gear or pulley 24 fixed thereto whereby rotation may be imparted to the casing and shell.

For delivering steam to the passages 12, there may be provided radial steam pipes 30 which connect with an axial steam delivery pipe 31 extending through trunnion 21 and part way through the hollow shaft 22 from which it is spaced to provide an annular passage 32. The inner end of the steam delivery pipe is closed by a cap 33. The radial steam pipes extend through the wall of the shell 11 and terminate in circular channels or passages 40 formed in the exterior surface of the casing 10. Channels 40 cut the spiral channels and thus serve to distribute the steam into the multiple spiral passages 12.

The discharge of the steam from the spiral passages is effected by a plurality of radially drilled holes 46 leading into the interior of the shell. The holes may be disposed around the circumference of the shell, substantially at the center and adjacent the ends thereof.

The path of the steam may be traced as entering through the hollow trunnion 21 through the steam delivery pipe 31, thence by way of radial steam pipes 30 to the circular distribution passages 40. From passages 40 the steam enters the multiplicity of spiral passages in which it travels at high velocity. The steam flows in a thin layer equal to the shallow depth of the spiral channel. The steam is thus spread out and every particle of the gas comes into intimate contact with the surrounding metal walls of the channel, producing friction therewith. The steam travels in the spiral grooves until it reaches radial holes 46 where the steam, condensed vapor and any air carried along with the steam will discharge into the interior of the shell. Thus the channels are scavenged of air and water, and it is not possible to build up insulating layers. These are all conditions conducive to rapid heat transmission. Because of the absence of insulating films there is no need for a high temperature difference to urge the flow of heat through the casing wall. Consequently, there is no need to resort to high pressure steam. Instead of 40 lbs./sq. in. now used in some paper dryers, I find that 5 lbs./sq. in. is ample to maintain circulation. This low pressure permits the use of a very thin walled casing 10. This again accelerates heat flow. By employing low pressure steam, there is also gained the advantage of having a greater quantity of heat available because the latent heat of condensation is appreciably higher in the low pressure steam than it is in high pressure steam; approximately 5% more in 5 lbs./sq. in. than in 40 lbs./sq. in.

Vapor, water of condensation and air accumulate in the interior of shell 11. The interior surface of the shell is formed as a series of V's arranged axially. Due to the centrifugal force of rotation, the water will flow into the bottom of the V's from which points the water is evacuated through water discharge pipes 50. Each pipe 50 extends in a plane perpendicular to the axis of rotation, with its open inner end near the bottom of the respective V while its outer end extends through the hollow shaft 22 to open into the annular passage 32 between the steam delivery pipe 31 and the hollow shaft. Each pipe 50 (see Fig. 4) is curved in a direction opposite to that of centrifugal impeller blades to facilitate discharge towards the axis of rotation. The passage 32 is closed at the end where the steam delivery pipe enters but opens into the hollow passage through trunnion 21'. Condensed water and air will thus be blown out by the residual pressure in the interior of the shell, or the flow may be assisted by vacuum.

The foregoing description of the invention is merely illustrative and changes may be made within the scope of the appended claims.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. A rotatable dryer comprising a shaft having a passage therein, a cylindrical outer casing mounted on the shaft, an inner shell, a spiral groove between the casing and the shell, an annular groove intersecting the spiral groove, an outlet connecting the spiral groove with the interior of the inner shell, and at least one pipe connecting the passage with the annular groove for delivering a continuous stream of steam under pressure to the annular groove for flow through the spiral groove and the outlet at relatively high velocity.

2. A dryer as specified in claim 1, in which the outlet opening delivers the discharged steam and entrapped air into the interior of the shell and the inner surface of the inner shell is formed with a plurality of collector grooves along the length thereof for collecting the condensed steam.

3. A dryer as specified in claim 2, in which a drain pipe extends into each collector groove to a point adjacent the bottom thereof.

4. A dryer as specified in claim 3, in which a plurality of outlets are circularly arranged adjacent the ends of the shell and intermediate the ends.

5. A rotatable dryer comprising a shaft having

a steam passage therein, a cylindrical outer casing mounted on the shaft, an inner shell in close contact with the inner surface of the casing and provided with multiple spiral grooves in the outer surface of the shell to form spiral passageways between the inner shell and the casing, an annular groove intersecting the spiral grooves to provide spiral passageways on opposite sides of the annular groove, outlet openings extending from the spiral grooves inwardly through the inner shell at points remote from the annular groove, and at least one passage connecting the steam passage with the annular groove for delivering a continuous stream of steam under pressure to the annular groove to force the steam in opposite directions through the spiral grooves on opposite sides of the annular groove.

6. A drying roll comprising a shaft having a steam passage therein, a hollow roll having a cylindrical outer wall and end closures mounted on the shaft, the wall having a plurality of shallow helical passages therein adjacent to the outer surface of the wall, means connecting the steam passage to the helical passages to deliver steam at high velocity along the helical passages, means to discharge steam, condensate and gases from the helical passages into the interior of the roll at points remote from the connecting means, and conduit means extending into the interior of the roll and terminating adjacent to the wall for discharging the steam, condensate and gases from the interior of the roll.

WILLIAM MESSINGER.

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