

Feb. 20, 1951

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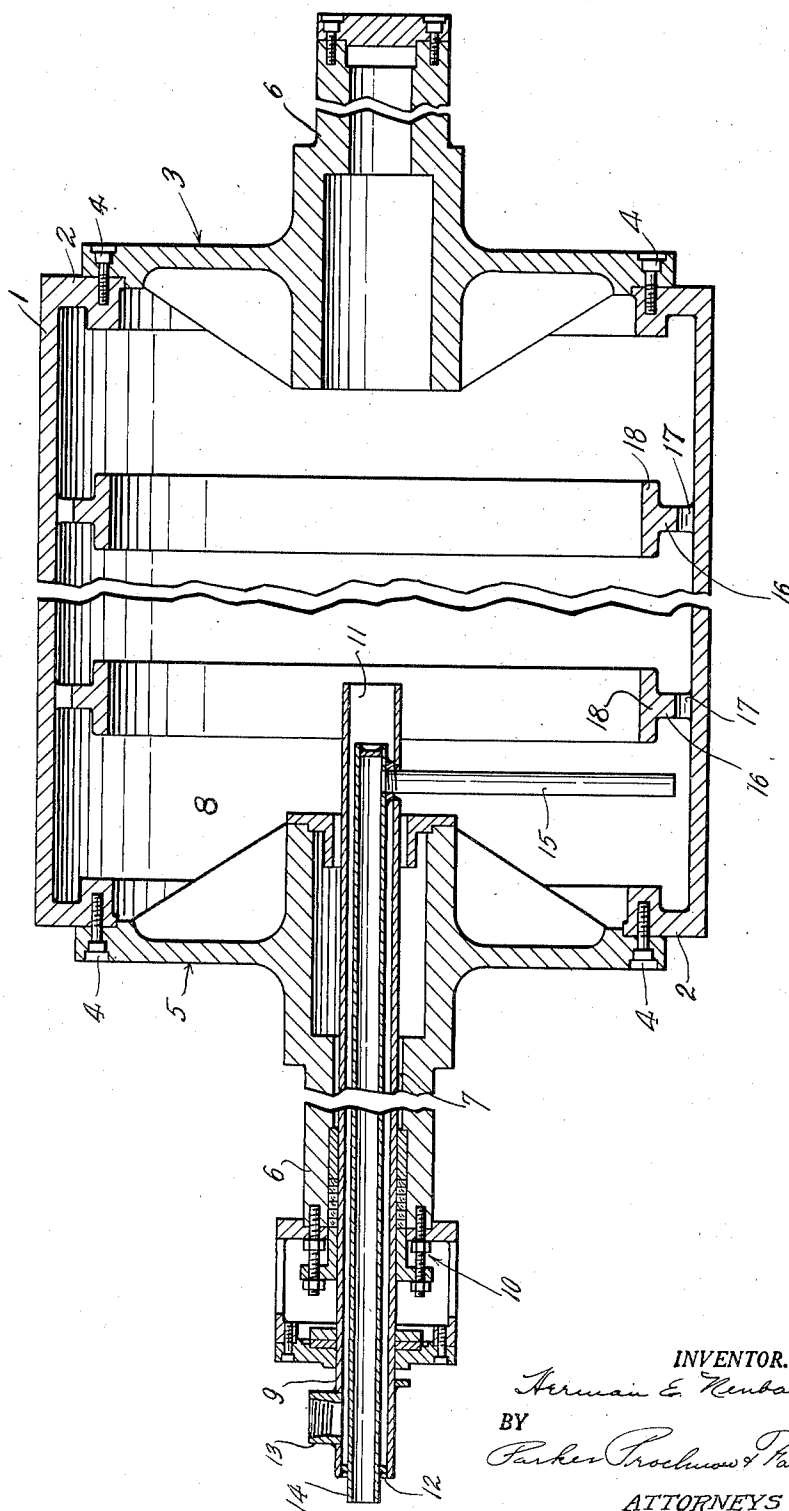
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DRYING DRUM

Filed Nov. 6, 1945

2 Sheets-Sheet 1

Fig. 1.



Feb. 20, 1951

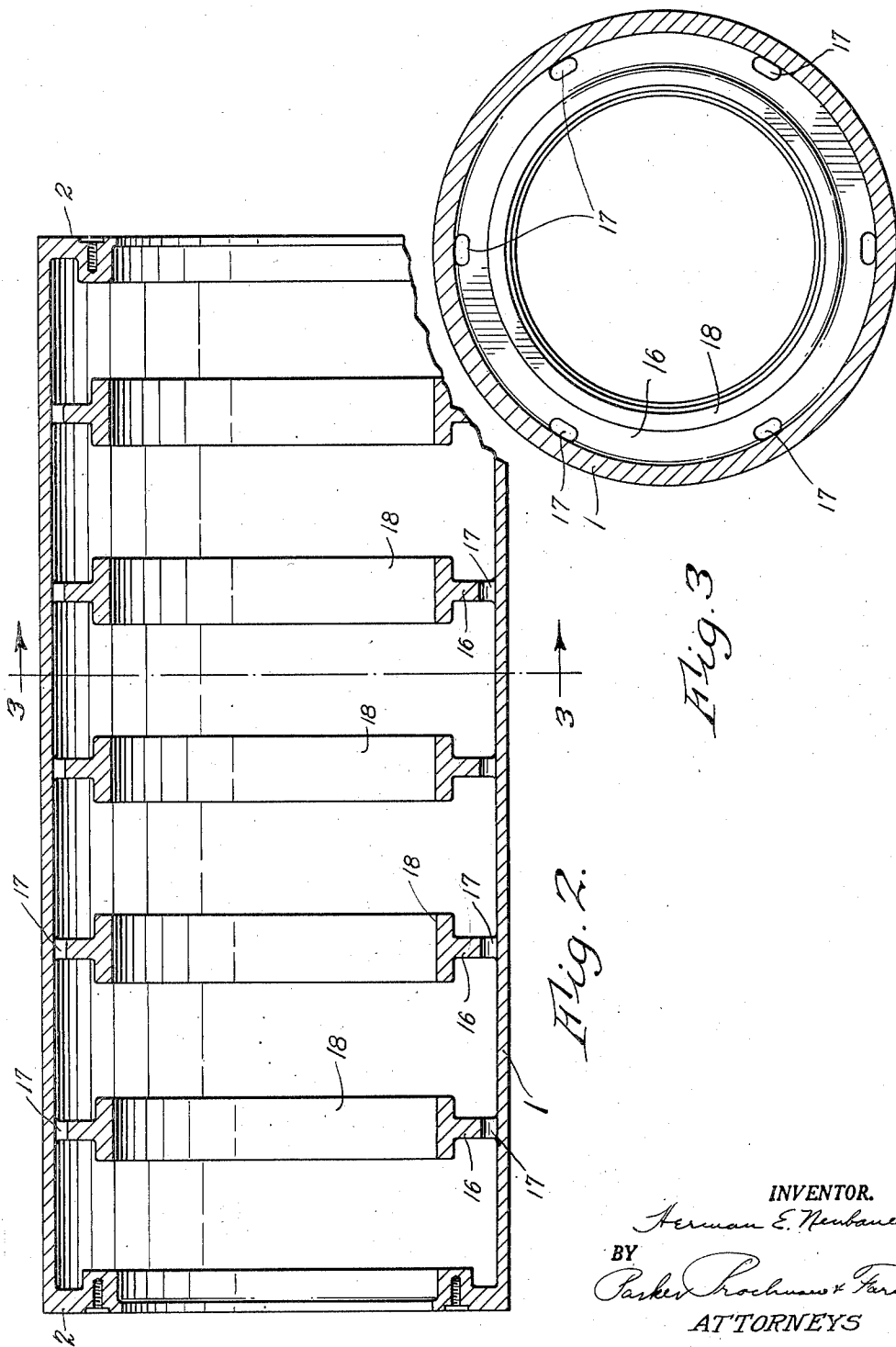
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Filed Nov. 6, 1945

2 Sheets-Sheet 2



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2,542,287

DRYING DRUM

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Application November 6, 1945, Serial No. 627,032

3 Claims. (Cl. 34-124)

1

This invention relates to drums which are employed to dry a film or web in contact with the external surface thereof, by means of heat supplied internally of the drum.

For example in drum dryers, one or more rotating hollow drums, heated by steam delivered to the interior thereof, have progressively applied to the surface thereof a film of liquid which receives heat from the surface of the drum to drive off a desired percentage of the contained moisture, and then the film from which the moisture has been removed is itself removed from the drum, such as by scraping with a suitable blade or knife, sometimes called a doctor blade. Such drums are often of considerable size and length in order to have the desired capacity of drying surface.

These drums must have an accurately machined or finished peripheral surface on which the drying occurs, and irregularities in that surface often cause serious operating difficulties. With a distorted or uneven drying surface, the knife is unable to fully remove the film, since it cannot engage both high and low spots or areas on the drum surface, and this results in unevenness in the drying and reduces the productive capacity of the dryer. Such an unremoved film may thus be over-dried with loss of quality of the product or scorching thereof, and it may also offer substantial resistance to heat transfer to a superposed film with the result that the extra liquid film carried by the unremoved film on a low spot is incompletely dried. Where two of such drums operate in close proximity, as in a double drum dryer, so that the thickness of the film is determined by the clearance between the drums, any distortion or unevenness in either drum surface may result in leakage at the nip between the abutting drums, with loss of product, as well as imperfect removal of the product from the drum surface due to the high and low spots, and uneven thickness of film with resulting unevenness in drying.

When the clearance between the twin drums is small, such as less than 0.015 inch, even small irregularities and distortions in either drum surface become important. In such cases the clearance between the drums must be regulated in accordance with the low spots on the drums, with the result that the high spots are then too close together and carry either a thinner film or none at all, and the capacity of the dryer decreases.

In paper mills, the web of paper, as it approaches the end of the machine and while still damp, passes in succession around a number of

2

heated drums spaced apart horizontally and vertically. These drums are heated internally by steam, are quite long, and machined to a close tolerance, often with a crown in the center to compensate for any sagging. Any variation or change in the contour of the drum may cause the web of pulp or paper to tear. In the course of time, distortion takes place in the peripheral walls of such drums which makes it necessary to refinish them in order to prevent frequent tearing of the web or sheet.

A rotating drum for either of these purposes is subjected to changing internal stresses cause by the continuous change in temperature on the outside surface of the drum in different parts of each rotation of the drum, while the internal surface remains at practically the same temperature.

In each of such examples, the use of internal reinforcing ribs heretofore has been unsatisfactory. The use of longitudinally extending reinforcing ribs will not prevent the type of distortion which occurs in such drums, and such longitudinally extending ribs could not be extended to the end walls of the drums without seriously interfering with the removal of condensed steam from the interior of the drum. Spirally arranged ribs were impractical because they are open to the same objection. Both spiral ribs and those extending lengthwise of the drum also fail to give the necessary rigidity and stiffness to the peripheral wall of the drum.

An object of the invention is to provide an improved drum for drying either films or webs of materials on the surface thereof while the drums are rotating; which will have maximum rigidity, stiffness and resistance to deflection and distortion in use; which may be made of different sizes and lengths; which will operate for long periods of time with a minimum of distortion, deterioration or change in the drum surface; with which the weight of the drum will not be objectionable; with which the drying capacity of the drum will remain substantially constant for long periods of time; with which a pair of such drums operating together, with relatively small clearance between them, will avoid waste and leakage of the liquid to be dried as it is applied to the drums; with which the films or webs will be dried with maximum uniformity and evenness; with which the inner peripheral surface of the drum will be maintained at an approximately constant temperature notwithstanding the variations in temperature to which any part of the peripheral surface of the drum is subjected dur-

ing a revolution; and with which removal of the condensed steam will not be materially interfered with.

Other objects and advantages will be apparent from the following description of an embodiment of the invention, and the novel features will be particularly pointed out hereinafter in connection with the appended claims.

In the accompanying drawings:

Fig. 1 is a longitudinal, sectional elevation through a dryer drum constructed in accordance with this invention and illustrating an embodiment thereof;

Fig. 2 is the longitudinal, sectional elevation through the drum alone, but with parts of slightly different proportions than in Fig. 1; and

Fig. 3 is a transverse, sectional elevation through the same, the section being taken approximately along the line 3—3 of Fig. 2.

In the illustrated embodiment of the invention and referring particularly to Fig. 1, the improved dryer drum includes a generally cylindrical wall 1 having at its ends intumed radial flanges 2. A closure 3 is secured to one end of the wall 1, and extends across the opening at that end of the wall, so as to overlap with the flange 2 and tightly close that end of the wall. This closure 3 may be detachably secured to the flange 2 in any suitable manner, such as by screws 4 which pass through the periphery of the closure 3 into the flange 2. At the opposite end of the cylindrical wall 1 is a somewhat similar closure 5 which is similarly secured to the other flange 2 in the same manner, such as by screws 4. Thus the cylindrical wall 1 is closed at both ends by the closures 3 and 5 to form a closed, hollow drum that is generally cylindrical in shape. The closures 3 and 5 have bearing trunnions or bosses 6 extending from the ends thereof so that the drum may be rotatably mounted in suitable bearings, not shown.

One of these trunnions 6, such as the one on the closure 5, is tubular and open at both ends so as to provide an axial passage 7 opening into the chamber 8 of the drum formed by the wall 1 and closures 3 and 5. The trunnion 6 on closure 3 is closed at its outer end. A tube 9 is disposed in the passage 7 and is held against rotation relatively to the adjacent trunnion through which it passes. A stuffing box or gland 10 is provided on the outer end of the bearing 6 of closure 5 around the tube 9 so as to close the passage 7 except for that through the tube 9. This tube 9 extends into the chamber 8 and there terminates in an open end 11. The outer end of the tube 9 is closed by a disk 12, but adjacent the closed end the tube is provided with a laterally extending boss 13 into which a pipe from a source of steam may be connected. Within the tube 9 is a pipe 14 having an external diameter smaller than the internal diameter of the tube 9, and extending from outwardly beyond the stuffing box 10 along the tube 9 into the chamber 8 and there joined to a detachable, but downwardly extending pipe 15, which, at its lower end, extends into close proximity to the inner periphery of the wall 1. This lower end of the pipe 15 is open, and the outer end of the pipe 14 is suitably connected to a steam trap or other source of suction, or to a siphon device so that a suction will be created at the lower end of the pipe 15 within the chamber 8 of the drum to remove from the drum the steam condensing therein and collecting as a pool in the bottom part of the drum.

The tube 9 and pipe 14 are held against rota-

tion so that the pipe 15 will always extend to the bottom of the drum while the drum is rotating. Suitable means, not shown, is mounted on the bearing 6 of closure 5 to turn the drum at the desired rate. These drums may be used singly or in groups.

The wall 1 of the drum is provided with a plurality of internal, endless, annular rings or ribs 16 which are formed integrally with, or are welded to, the inner peripheral surface of the wall 1 and extend radially but only partially across the chamber 8. These ribs 16 are disposed side by side but spaced apart at intervals along the length of the drum, and are peripherally continuous along the wall 1.

The condensed steam will normally collect in a pool along the bottom part of the drum, and when the drum is rotating it will be spread as a film along the surface of the drum in a peripheral direction to an extent depending upon the speed of rotation and the amount of liquid accumulating in the bottom of the drum. The condensed liquid will flow towards the portion of the drum where it is removed through the pipe 15. In order to facilitate the movement toward the pipe 15 of the liquid collecting in the bottom part of the drum, and keep the depth of the pool to a minimum, the ribs 16 are each preferably provided with one or more ports or apertures 17 disposed in close proximity to the inner periphery of the wall 1. The condensed liquid may thus pass through these ports or apertures to pipe 15 for removal, which reduces the extent to which the film of liquid spreads out along the inner periphery of the drum due to the rotation of the drum. In other words the ports or apertures 17 make it possible to keep the depth of the pool of condensate in the bottom part of the drum to a minimum. There are preferably a plurality of such ports or apertures 17 in each rib, spaced apart in a direction peripherally of the drum, as shown clearly in Fig. 3, so that the condensate in the bottom part of the drum will have the desired freedom of movement toward the inlet end of the pipe 15 while the drum is rotating. Only one suction pipe is required, and yet the pool of condensate in the bottom part of the drum may be kept to a minimum depth.

Each of the ribs preferably also terminates along its inner edge in a lateral flange 18, preferably a double flange extending in both directions from the inner periphery of the rib, generally parallel to the axis of rotation of the drum. These flanges 18 with the rib provide a very rigid stiffening reinforcement for the wall 1 of the drum, and substantial face area in contact with the steam, and when the double flange is used, such a reinforcement is T-shaped in cross section with the head of the T forming the inner periphery of the rib.

The T-shaped cross section, together with the portion of the drum wall to which it is attached, corresponds to the cross section of an I-beam which is recognized as a structure having maximum resistance to deflection and distortion with a minimum of weight, and of depth of the rib. As an illustration of the value of the T-shaped rib with the head of the T spaced from the drum surface, a comparison of the resistance to deflection of a drum with stiffening ribs of different types may be easily made by tests upon a hoop of the same width or depth as the rib or T section, under a load applied to the hoop at two opposite points. Under such tests it can be established that the T-shaped reinforcing rib will in-

crease the resistance to distortion or stiffness of the hoop by about twelve times that of a hoop with no rib, whereas a plain rib of the same width and depth, but without the T flange on its inner periphery, will increase the strength of the hoop by about four times that of a hoop with no rib.

In Fig. 2 the drum is similar to that shown in Fig. 1, but is of full length, to show more effectively the plurality of ribs spaced along the same. Similar parts are given similar reference characters.

Fig. 3 illustrates more effectively than in Fig. 1, the spacing arrangement of the apertures 17 along the rib.

It will be observed that the reinforcing ribs extend into the chamber of the drum where their mass is in good thermal relation with the steam which is usually at a constant temperature, which facilitates transfer of heat from the steam to the peripheral wall by conduction. Consequently heat loss by conduction to the shell is reduced to a minimum, and the stiffening rib itself is not subject to thermal deformation with the shell which is necessarily exposed to temperature variations or differentials. Thus the stiffening rings or ribs are maintained at an approximately constant temperature by a substantially total immersion in the body of steam or other heating fluid.

In double drum dryers as heretofore made without the stiffening ribs, the distortion and irregularity in the surface of the drum became progressively worse with the passing of time, and it is impractical to make the peripheral wall of the drum sufficiently thick to avoid such distortion. Drums having the internal, annular endless stiffening ribs in accordance with this invention, after operation for a substantial period of time in which appreciable distortion would appear if the drums were not stiffened with these ribs, have been found to have no material distortion and no material decrease in their drying capacity.

Standard drums of the same wall thickness without the reinforcing ribs were a continuous source of trouble, and distortion therein was such that a variation in clearance between high and low spots on the drums in much less than a year, would often amount to from .010 to .050 inch. The capacity of such unstiffened drums was reduced as much as 50% because the drums then had to be forced closely together to reduce to a minimum the clearance at the low spots. The drum speed had to be reduced to prevent wet spots on the drums and to remove the moisture from the heavier parts of the film. On the high spots, there would either be no film at all, or a very thin film, and when heat sensitive products were dried, there was considerable overdrying, loss of quality of the product, and sometimes scorching. In order to maintain production when using drums without stiffening ribs and operating under critical conditions, it was necessary to resurface the outside surfaces of the drums at frequent intervals.

These difficulties appear to be fully overcome when the drums are provided with the internal stiffening ribs in accordance with this invention, so that operation of the improved stiffened drums even under critical conditions for relatively long periods of time, without resurfacing, appears to be possible. When the improved drums are used to dry a traveling web of paper as in a paper mill, it is important that there be a rapid transfer

of heat from the steam admitted to the drum to the outer peripheral drum surface, and the ribs act as vanes which provide somewhat better heat transfer from the steam to the wall in contact with the moving web, as well as reducing or eliminating distortion of the drum such as would require resurfacing of the drum surface.

It will be understood that various changes in the details, materials and arrangements of parts, which have been herein described and illustrated in order to explain the nature of the invention, may be made by those skilled in the art within the principle and scope of the invention, as expressed in the appended claims.

15 I claim:

1. In a dryer of the type in which steam is admitted to the interior of a hollow, rotatable, closed drum to heat the exterior drying surface thereof and from which condensation is removed by a pipe extending into the chamber of the drum and downwardly therein into close proximity to the bottom portion of the periphery of the drum, that improvement which comprises an annular T-shaped rib within and intermediate the ends of the drum, having the base end of the leg of the T rigidly attached to the inner periphery of the drum and extending radially of the drum, with the head of the T forming the inner periphery of the rib, the leg of the T being apertured from face to face, and the head of the T being radially nearer the axis of rotation of the drum than the opening of said pipe within said drum, the space at each side of the rib being unobstructed, whereby when the drum is internally heated by steam and the condensed steam is removed through said pipe, the flange formed by the head of the T will be entirely in an atmosphere of steam so as to remain at a relatively constant temperature and will resist substantial distortion of the peripheral wall of the drum.

2. An axially elongated dryer element, which comprises a hollow drum having a cylindrical peripheral shell and end walls closing and supporting the shell, means mounting the drum for rotation about the longitudinal axis of said shell, means for delivering steam to the interior of the drum, a non-rotatable pipe entering the drum through an end wall thereof and along said axis, and within the drum having an open inlet end close to the bottom of the drum, and a plurality of annular, T-shaped ribs on the inner periphery of said shell, spaced apart lengthwise of the drum, each rib having its leg apertured from face to face and rigidly attached at its base to, and peripherally continuous with, the inner peripheral surface of said shell, with the head of the T forming the inner periphery of the rib, extending in a direction lengthwise of the shell, and disposed nearer the axis of rotation of the drum than said open end of said pipe, the space between the ribs and between the ribs and end walls being unobstructed, whereby when the drum is internally heated by steam and the condensed steam is removed through said pipe, the flange formed by the head of the T will be entirely in an atmosphere of steam so as to remain at a relatively constant temperature and will resist substantial distortion of the peripheral wall of the drum.

3. An axially elongated dryer element, which comprises a hollow drum having a cylindrical peripheral shell and end walls closing and supporting the shell, means mounting the drum for rotation about the longitudinal axis of said shell, means for delivering steam to the interior of the

drum, a non-rotatable pipe entering the drum through an end wall thereof and along said axis, and within the drum having an open inlet end close to the bottom of the drum, and an annular rib disposed within and intermediate of the ends of the interior of the drum, rigidly connected to the inner circumferential wall of the shell, and extending therefrom towards the axis of rotation of the drum, the rib being apertured from face to face at a plurality of intervals along said shell and terminating at its inner periphery in a lateral flange that extends parallel to and is concentric with the axis of rotation of the drum, the flange being nearer said axis of rotation than said inlet opening of said pipe whereby when the drum is internally heated by steam and the condensed steam is continuously removed through said pipe, said flange of the rib will be subject to a substantially uniform temperature and will resist substantial deformation of the shell.

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