

Jan. 24, 1967

D. H. KUTCHERA ETAL

3,299,531

PAPERMAKING MACHINE

Filed Aug. 21, 1964

4 Sheets-Sheet 3

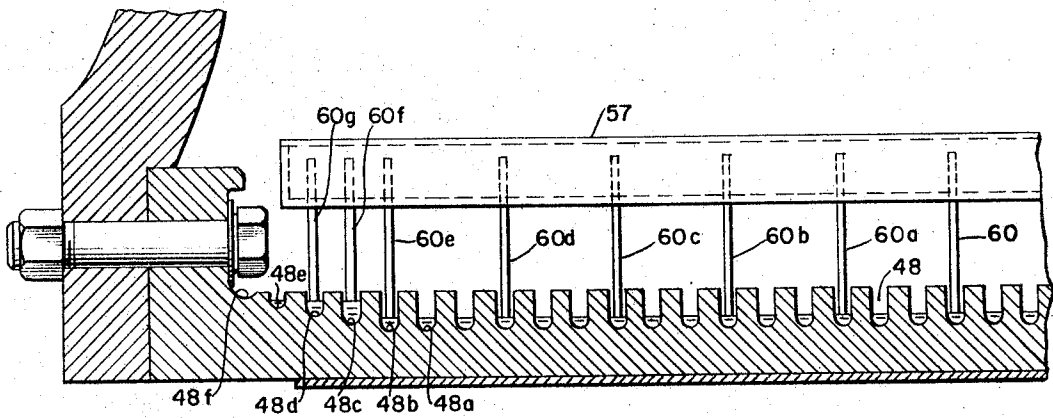


FIG. 2.

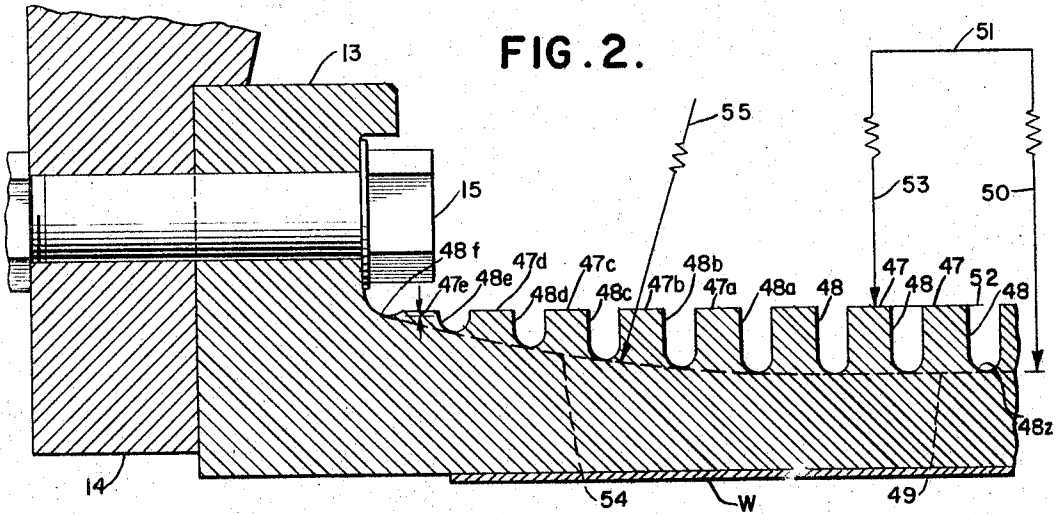
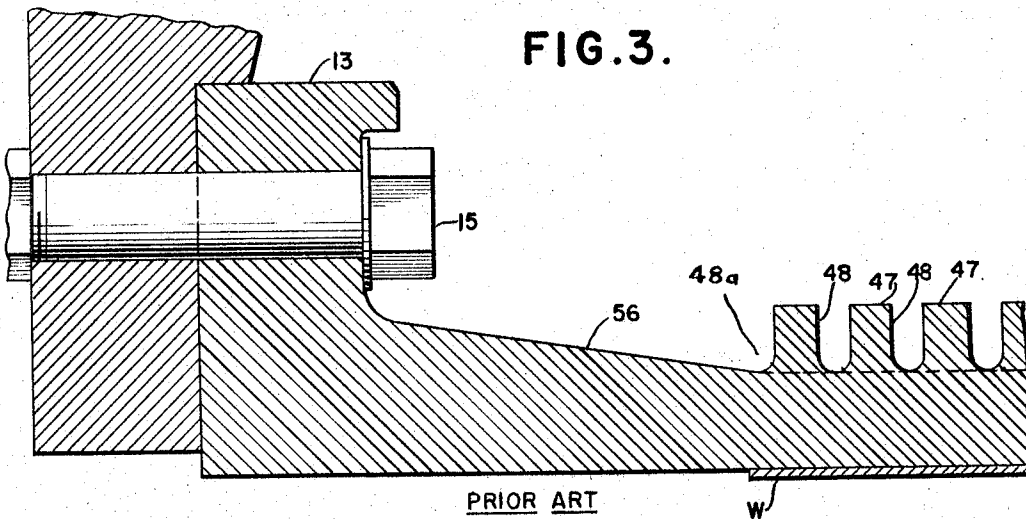


FIG. 3.



PRIOR ART

FIG. 4.

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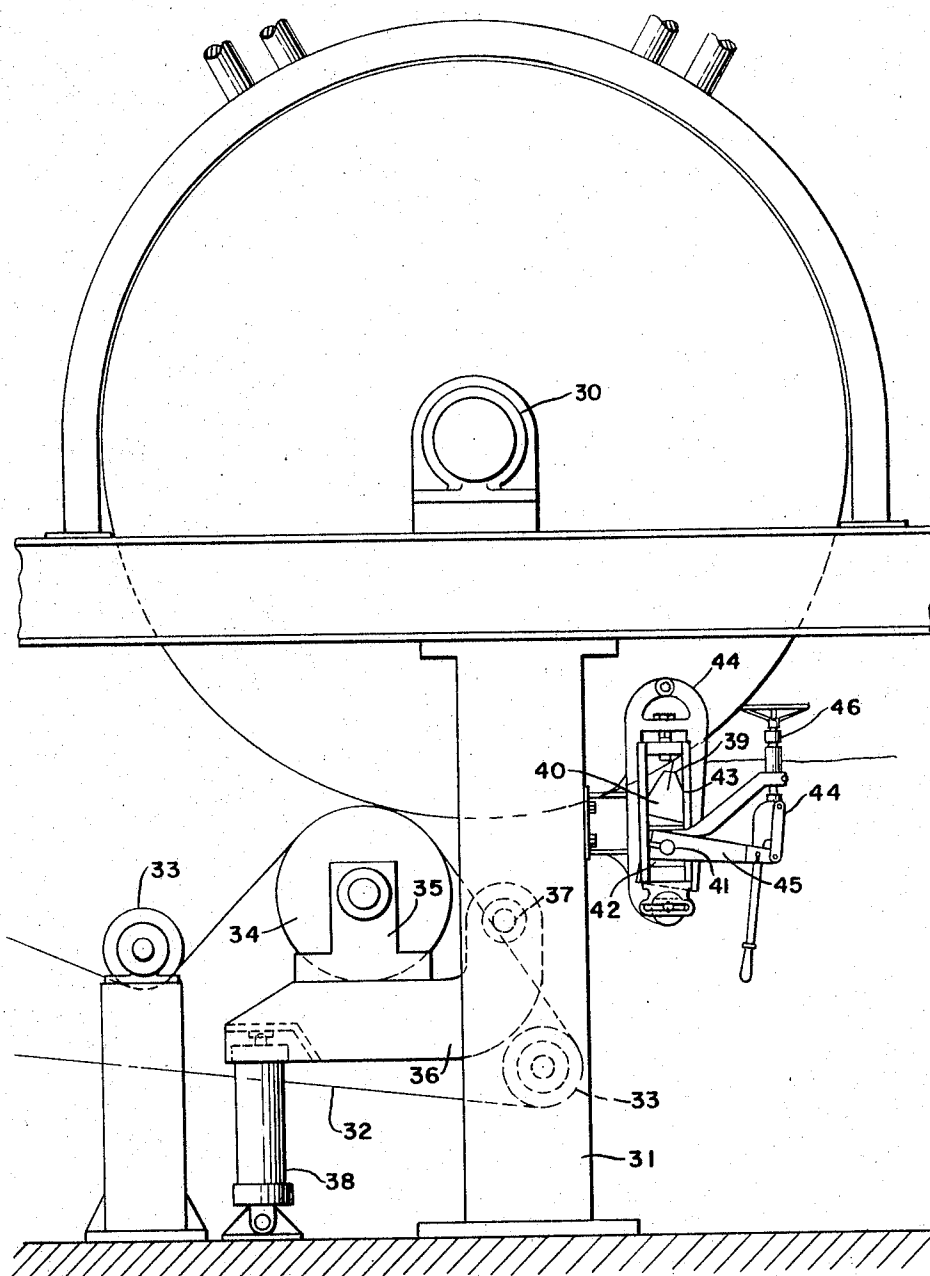


FIG. 5.

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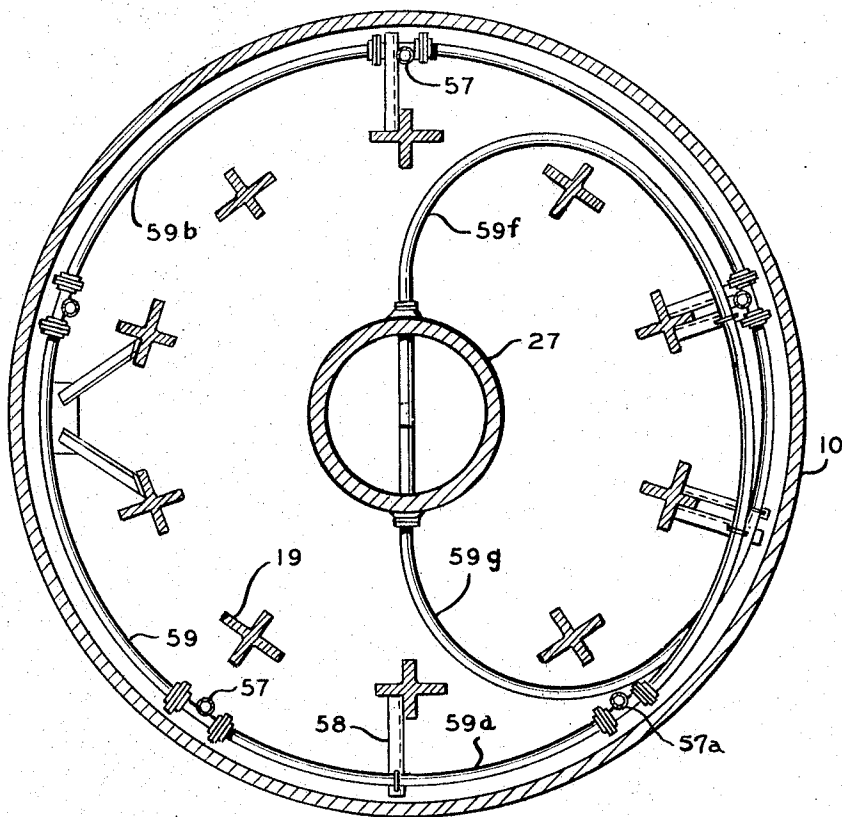


FIG. 6

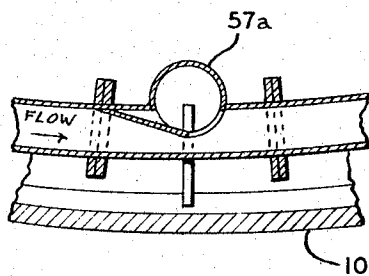


FIG. 7

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PAPERMAKING MACHINE

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3 Claims. (Cl. 34-125)

The invention relates to papermaking machines and, more particularly, to steam heated driers for the paper web made on such machines. Such driers generally include an outer, relatively thin shell mounted on and sealed with respect to a pair of drier heads which, in turn, are fixed to end journals for rotatably supporting the drier in suitable bearings.

It has previously been proposed to provide steam heated driers, particularly for papermaking machines, which have shells formed with internal ribs and grooves, such a construction being shown, for example, in British Patent 939,926, issued to Beloit Iron Works and published on October 16, 1963. The ribs and grooves terminate an appreciable distance (which may be at least 6 to 8 inches) away from the ends of the shell, with relatively long grooves between the last rib on each end of the shell and the adjacent end of the shell. It has also been proposed to provide such a construction as illustrated in this patent with each of the relatively long grooves being replaced by an inwardly tapering truncated conical surface on each end extending from the largest diameter of the grooves substantially to the smaller internal diameter of the ribs at the ends of the shell. The end ribs are substantially in line with the edges of the paper web dried on the drum, and the inwardly truncated surfaces within the drier shell decrease the heat conductivity through the shell adjacent the edges of the sheet to reduce the drying effect on the sheet edges.

It has, however, been found that this construction gives rise to a high localized stress at the very edge of the first internal rib on each end of the shell, and there is also a localized stress (which is not quite as high, however, as that just mentioned) existing in the groove between the two end ribs on each end of the shell. Due to the high localized stresses at these places, the shell is weaker at these places. Also, the shell, due to these stresses, when under steam pressure, becomes relatively too small in the vicinity of the first rib; so that a pressure roll in contact with the drier, which holds a felt carrying the paper web in contact with the drier, does not mate properly with the drier. Also, under these conditions, a doctor blade for doctoring off the paper web from the shell does not fit properly with the shell. In addition, it has been found that neither the long internal grooves on the ends of the shell nor the inwardly tapering truncated conical surfaces provide the exact temperature on the external surface of the drier drum which should exist for neither drying the web edges to too great an extent nor leaving the web edges relatively damp.

It is an object of the invention to provide an improved, internally ribbed, drier shell of such construction that the high local stresses above mentioned do not exist, whereby the drier shell does not have unduly small diameters in the vicinity of the first ribs and in the vicinity of the sheet edges. It is also an object of the invention to provide an improved drier of this type in which the ribs and grooves extend practically to the ends of the shell and in which the ribs and grooves are of such construction that a proper heat transfer is attained in the vicinity of the web edges so that neither undue drying of sheet edges nor wet sheet edges result.

In its preferred form, the invention contemplates an internally ribbed drier shell having ribs which decrease in height at the very ends of the drier shell. The local-

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ized stress conditions as mentioned above are thus overcome, and the transmission of heat through the drier shell adjacent its ends is also properly reduced.

The invention consists of the novel constructions, arrangements and devices to be hereinafter described and claimed for carrying out the above-stated objects, and such other objects, as will be apparent from the following description of a preferred form of the invention, illustrated with reference to the accompanying drawings, wherein:

FIG. 1 is a vertical sectional view of a drier drum having therein a plurality of condensate pickup headers, including a particular header 57a, extending axially within the drum and located adjacent to the inner surface of the shell of the drum;

FIG. 2 is a fragmentary vertical sectional view of the drum taken on an enlarged scale;

FIG. 3 is a view similar to FIG. 2 but on a still further enlarged scale and with certain parts being deleted for the purpose of better illustration;

FIG. 4 is a view similar to FIG. 3 showing a prior art construction;

FIG. 5 is a fragmentary side elevational view of a papermaking machine incorporating the drier drum of the invention;

FIG. 6 is a sectional view taken on plane 6-6 of FIG. 1; and

FIG. 7 is a fragmentary sectional view showing the particular condensate pickup header 57a and adjacent parts, and also taken on plane 6-6 of FIG. 1.

Like characteristics of reference designate like parts in the several views.

Referring now to the drawings, the drier drum illustrated in FIG. 1 comprises a thin cylindrical outer shell 10 which is rigidly secured at its ends to relatively flat ring-shaped heads 11, each of which is supported by a hollow central shaft 12. The shell is provided at each end with an integral bolting flange 13 which is machined to mate with a similar peripheral flange 14 of the adjacent drier head 11. The rigid attachment of the shell to the head may be made by means of a plurality of bolts 15 inserted from the inside of the shell and drawn up by means of nuts on the outside of the head. Each of the heads 11 is provided with a manhole 16 to provide access to the interior of the drier for assembly and maintenance.

A cylindrical section 17 is formed integrally with each of the heads and extends inwardly therefrom. Each of the cylindrical sections 17 is provided at its inner end with a bolting flange 18. A plurality of heavy staying members 19 extend between the heads longitudinally of the drier and connect the oppositely facing bolting flanges 18.

The central shaft 12 is formed in two halves 20 and 21 which are bolted together at the longitudinal center of the drier. Near each end the shaft 12 is provided with an enlarged bolting flange 22 to which the heads 11 are rigidly secured by means of a plurality of bolts. The shaft 12 is extended at each end to provide journals 23 for rotatably supporting the drier, and a shaft extension 24 is provided at one end of the shaft 12 for mounting a driving gear or sprocket or the like.

The central shaft 12 is hollow to provide for the introduction of a heating medium, such as steam, at one end and its removal at the other. A diaphragm 25 is provided between the shaft halves 20 and 21 and provides chambers 26 and 27 in the shaft 12. Steam under pressure is connected by any suitable conduit means with the chamber 26, and the chamber 27 is connected by any suitable conduit means with a steam discharge reservoir or the like, both conduit means extending through the ends of the shaft 12. Steam discharge jets 28 are provided in the diaphragm 25 and connect the

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chamber 26 with the chamber 29 formed by the shell 10 and heads 11.

The drier may be mounted in a papermaking machine as illustrated diagrammatically in FIG. 5. The journals 23 of the shaft 12 may be mounted in bearings 30 which are secured to a supporting frame 31. The wet paper web to be dried is carried by a felt web 32 which travels around felt rolls 33. The paper web is forced against the surface of the drier shell 10 by a pressure roll 34 which is rotatably mounted in brackets 35 attached to arms 36. The arms 36 are each pivoted at 37 to the frame 31, and the pressure roll 34 is forced against the surface of the drier shell 10 by a hydraulic motor 38 which bears against each arm 36.

The dried paper web is removed from the surface of the drier shell by a creping doctor which includes a doctor blade 39 removably secured within a doctor blade holder 40. The blade 39 and holder 40 may be supported by conventional mechanism including shafts 41 carried by the holder 40 and rotatably mounted within guide blocks 42. The blocks 42, in turn, are slidably mounted within a slide assembly 43 attached to a pivot frame 44 carried by the frame 31. Through the slide arrangement provided by guide blocks 42 and slide assembly 43, the vertical position of the doctor blade 39 can be varied as desired to obtain the best creping angle. The doctor blade holder 40 and the blade 39 are pivoted from a toggle mechanism 44 which is attached through lever arm 45 to one of the shafts 41. In addition, a spring loading mechanism 46 is connected through the toggle mechanism 44 to provide a resilient contact for the doctor blade against the surface of the drier shell 10.

According to the invention, the drier shell 10 is provided on its internal surface to within a few inches (6 inches, for example) of the ends of the internal surface with a plurality of circumferentially continuous and axially spaced ribs 47 spaced by grooves 48. The ribs 47 are all of the same radial height, and the grooves 48 separating the ribs 47 have the same radial depth. The bottoms 48z of the grooves are preferably round in cross section, as illustrated, and they terminate in an imaginary cylinder 49 which has a constant radius 50 from the longitudinal center line 51 of the shell 10. The innermost surfaces of the ribs 47 in cross section are flat, and they terminate in an imaginary cylinder 52 which is at a constant distance 53 from the center line 51.

The inner surface of the shell 10, on its ends adjacent each flange 13, is provided with a plurality of grooves 48a, 48b, 48c, 48d, 48e, and 48f, which are of decreasing depth. The grooves provide ribs 47a, 47b, 47c, 47d, and 47e, the innermost surfaces of which are disposed on the cylinder 52, but which decrease in height in accordance with the decreasing depth of the grooves 48a to 48f. The bottoms of the grooves 48a to 48f in cross section of the shell as illustrated in FIG. 3 are disposed on an arc 54 described by a radius 55 which may have a length of 23 inches, for example, and which may well be between 20 inches and 30 inches for a drier of about 140 inches in diameter. It will be noted that all of the ribs 47 and 47a to 47e have substantially the same width in cross section, measured axially of the shell 10.

The above-described construction illustrated in FIG. 3, having the end grooves 48a to 48f, may be contrasted with the prior art shell structure illustrated in FIG. 4. The FIG. 4 drier shell structure includes a truncated conical, inwardly tapering surface 56 which is substituted for the ribs 47a to 47e and the separating grooves 48b to 48f.

During operation, steam condensate forms within the shell 10 and particularly within the grooves 48 and 48a to 48f. The condensate withdrawal system comprises a plurality of pickup headers 57 including a particular

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header 57a; and there may be, for example, 5 or 10 of these distributed about the shell. The headers 57 are supported with respect to the stay members 19 and flanges 18 by means of a plurality of supports 58 which are fastened to both the headers 57 and to the stays 19 and flanges 18.

The headers 57 are each connected to a tube 59 that is disposed in circular form within the shell 10. The tube 59 is made up of a plurality of arced portions, 59a, 59b, etc., and two end portions 59f and 59g, with each of the end portions being connected to the chamber 27.

A plurality of small diameter ejector pipes 60 (see FIG. 2) extend from the headers 57 into the grooves 48 and 48a to 48f. The ejector pipes 60 from each of the headers 57 may be located in each of the grooves 48 and 48a to 48f, in alternate ones of the grooves or in any predetermined pattern with respect to the grooves; and they may be set at different heights within the grooves so as to provide the desired insulating action. It will be understood that the more condensate liquid that remains in a groove the more insulating action there will be, in view of the fact that the condensate is an insulator.

Referring to FIG. 2, it will be observed that the individual ejector pipes 60a, 60b, 60c, 60d and 60e, connected with the particular header 57 that is illustrated, are disposed in separated grooves 48; and each of these ejector pipes is set at a so-called normal depth close to the bottom 48z of its groove to maintain a minimum amount of condensate within the groove so that the heat transfer is at a maximum. There may, instead, of course, be an ejector pipe 60 located in each of these grooves to assure that the condensate remains at a minimum within all of these grooves and to assure maximum heat transfer. Alternately, ejector pipes may be disposed in various groups or patterns of the grooves 48. Ejector pipes 60f and 60g are located in the grooves 48c and 48d, and both of these ejector pipes are raised with respect to the bottoms of the grooves so as to maintain more than the normal amount of condensate within the grooves to, thus, provide some insulating effect by the condensate, lowering the temperature on the outside surface of the shell 10 opposite these grooves more than would be the case if this condensate were not provided. The groove 48e in the arrangement shown in FIG. 2, has purposely been provided without an ejector pipe so as to allow it to fill completely with condensate for thus purposely decreasing the temperature of the shell 10 in the vicinity of the groove 48e. If it were desired in connection with certain widths or weights of web W to instead have the temperature of the shell 10 on its exterior surface higher in the vicinity of the groove 48e, an ejector pipe would be provided for the groove 48e.

In operation, a web W is carried by the drier shell 10, and the drier is rotated. The web W passes from the felt 32 on to the external surface of the shell 10, and the web W is dried on the shell and is creped from the shell by the doctor blade 39. The edges of the web W terminate approximately in alignment with the groove 48e as is shown in FIG. 3. The drier shell 10 of the invention may be made of many different diameters and lengths; however, the web W, for example, may have a width of 169 inches; the shell 10 may have a length of 172¾ inches; and the complete face of the drier, including the heads 14, may have a length of 181½ inches. The overall diameter of the shell 10 may, for example, be 144½ inches. The distance from the outer side of the groove 48f to the center line of the first full-sized groove 48 (the groove next to the first shallower groove 48a) may be 7 inches, for example.

In the prior art construction as shown in FIG. 4, the truncated conical surfaces 56 extended to the grooves 48a, and since there were no additional grooves between the

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ends of the drier shell and the grooves 48a, there were high stress areas at the bottoms of the grooves 48a. There were also high stress areas at the bottoms of the next grooves 48. These high stress areas were weaker than other parts of the shell at the bottoms of these grooves 48a and 48 and also, as a more immediate source of trouble, caused the shell to have too small a diameter in planes passing approximately through the grooves 48a and the adjacent grooves 48. Although this decreased diameter could be measured only in the thousandths of an inch, nevertheless, since very exact dimensions are required for the proper operation of the pressure roll 34 in conjunction with the drier and for the operation of the creping doctor blade 39 in connection with the drier, the exact nip and blade pressures that were proper did not exist. Also, the rate of heat transfer through the truncated conical surfaces 56 was not as required, and a web on these surfaces of the drier could not be given the same drying treatment as in the middle regions of the web if it extended over the truncated surfaces 56, so therefore the web W actually used was limited in width to a location substantially in line with the rib 48.

With our improved construction illustrated in FIG. 3, a wider web W may be uniformly dried since the sides of the ribs 47 and 47a to 47e have steam in contact with them; and there is substantial heat transfer on the interior surface of the drum, since the radial surfaces of the ribs and also their axially extending surfaces on the cylinder 52 are substantially clear of condensate due to centrifugal force. The rate of heat transfer through the end regions of the shell 10 is properly controlled due to the fact that the grooves 48a to 48f successively decrease in depth and the sides of the ribs 48a to 48e correspondingly decrease in radial height. Due to the fact that there are greater thicknesses of metal between the bottoms of the grooves 48a to 48f and the exterior surface of the shell 10, the rate of heat transfer is less in these regions than would be the case if full depth grooves 48 were continued to the end of the shell; however, this is desirable since the shell ends 11 also provide a heating effect for the edges of the web W. It is desired that the grooves 48b, 48c, and 48d be deeper than would be the case if they were disposed on a truncated conical surface similar to the surface 56 in order to provide the proper heating effect for the edges of the web W, and for this reason the bottoms of the grooves 48a to 48f are disposed on the arc 54 described by the radius 55.

The addition of the grooves 48b to 48f to the construction assures that the high stresses previously described in connection with the prior FIG. 4 structure do not exist in the vicinity of each groove 48a and the next groove 48. The action of the grooves 48b to 48f in providing this result may be compared to the case in which a single saw cut is provided in one surface of a beam, in either the lower or upper surface of the beam. The stress in the vicinity of the single saw cut is very high when a bending moment is put on the beam. On the other hand, if a number of saw cuts are provided adjacent this first saw cut, the stress at the first saw cut will be materially reduced. Accordingly, with the structure shown in FIGS. 1, 2 and 3, there is stress in the shell 10 adjacent its ends and there is a bending of the shell; however, the stress is more uniform and the bending is more uniform due to the decreasing depth grooves 48b to 48f provided adjacent the ends of the shell. Also, since the relatively small diameter, peripherally low places have been eliminated from the exterior surface of the shell 10 by the provision of the extra grooves 48b to 48f, there is a more uniform nip pressure between the pressure roll 34 and the drier shell 10 and between the doctor blade 39 and the drier shell; and there is a more uniform dewatering and web transferring action by the pressure roll 34 and a more uniform creping action by the doctor blade 39.

The stayed drier drum construction, including the stays 19 is disclosed and claimed in the U.S. patent of H. E.

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Malmstrom et al. 3,099,543; and as has been quite fully described in this patent, the stays substantially reduce the stresses that exist at the ends of the drier drum shell and in the flanges of the shell that are attached to the flanges of the drum ends. The grooves 48a to 48f that decrease in depth have the advantageous effect of further reducing stress in the shell 10 adjacent to the ends of the shell; and, since the grooves 48a to 48f decrease in depth, they also provide additional strength at the ends of the drier drum.

Although the ribs 47 of the invention have been described and shown as being circular, a helical rib formation may instead be utilized. In the latter case, the grooves 48 may be cut into the shell 10 as a single thread, or the grooves may constitute multiple threads.

As is illustrated in FIG. 3, the grooves 48 are preferably of less width (axially of the shell) than are the ribs 47. The ribs 47, for example, may be $\frac{5}{8}$ inch wide axially of the shell, and the grooves 48 may be slightly less than $\frac{1}{2}$ inch wide. It will be understood, of course, that these dimensions may be varied considerably while still obtaining the advantages of the invention.

As above described, the condensate is removed from the grooves 48 by means of the thin tubes 60 that extend into the grooves 48. Preferably the tubes 60 extend very close to the bottoms of the grooves 48 in the middle region of the shell 10 so as to assure that maximum heat transmission is obtained in this portion of the shell. It will be understood that the water condensate from the steam acts as insulation and retards heat transmission. The heat transmission through the ends of the shell 10, in particular, may be controlled by raising and lowering the condensate withdrawal tubes which are disposed in the grooves 48a to 48f. Therefore, more or less condensate may be allowed to remain in these grooves so as to increase or decrease the heat transmission through the ends of the shell 10 to assure that the edge regions of the web W secure the same drying effect as do the middle regions of the web W.

The spiral threaded construction above mentioned in connection with the condensate withdrawal tubes may be considered advantageous in view of the fact that if one or more of the tubes 60 clogs, the condensate will run through the helical groove and through adjacent tubes 60 for withdrawal of the condensate. Thus, a relatively cool peripheral band that might occur on the drum due to the plugging of the condensate withdrawal tubes 60 in a single groove 48 cannot occur. It will be observed from FIG. 2 that withdrawal tubes 60 may be hung from any of the stays 19 so that the withdrawal tubes may be located practically at any position within the drier shell 10. In the illustrated form of the drier, there may, for example, be 10 to 16 stays 19 equidistantly located around the center of the drier shell, and steam withdrawal tubes 60, if required, suspended from all of these stays.

We wish it to be understood that the invention is not to be limited to the specific constructions and arrangements shown and described, except only insofar as the claims may be so limited, as it will be apparent to those skilled in the art that changes may be made without departing from the principles of the invention.

What is claimed is:

1. A drier drum comprising an outer cylindrical shell, a head on each end of said shell and forming a steam receiving cavity within the shell, a pair of journals on opposite ends of the drum for rotatably mounting the drum, and means for introducing steam into said cavity, said shell on its inner surface being provided with ribs and grooves extending generally circumferentially, said grooves gradually decreasing in depth at the ends of the shell for decreasing the transmission of heat through the shell and for reducing the local stresses at the ends of the shell.

2. A drier drum comprising an outer cylindrical shell, a head on each end of said shell and forming a steam

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receiving cavity within the shell, a pair of journals on opposite ends of the drum for rotatably mounting the drum, and means for introducing steam into said cavity, said shell on its inner surface being provided with ribs and grooves extending generally circumferentially, the innermost surfaces of said ribs being disposed at the same distance from the longitudinal center of the drum and said grooves being of uniform depth in the central region of the shell and gradually decreasing in depth at the ends of the shell with their bottoms at each end of the shell being disposed on an arc, viewing the ribs and grooves in cross section on a plane passing through the longitudinal center of the drum, for decreasing the transmission of heat and for reducing the local stresses at the ends of the shell.

3. A drier drum comprising an outer cylindrical shell, a head on each end of said shell and forming a steam receiving cavity within the shell, a pair of journals on opposite ends of the drum for rotatably mounting the drum, and means for introducing steam into said cavity, said shell on its inner surface being provided with ribs and grooves extending generally circumferentially, the innermost surfaces of said ribs being flat in cross section

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and being disposed on an imaginary cylinder having its center coincident with the longitudinal center of said drum, the grooves in the central region of said shell being uniform in depth and gradually decreasing in depth at the ends of the shell for decreasing the transmission of heat and for reducing the local stresses at the ends of the shell.

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