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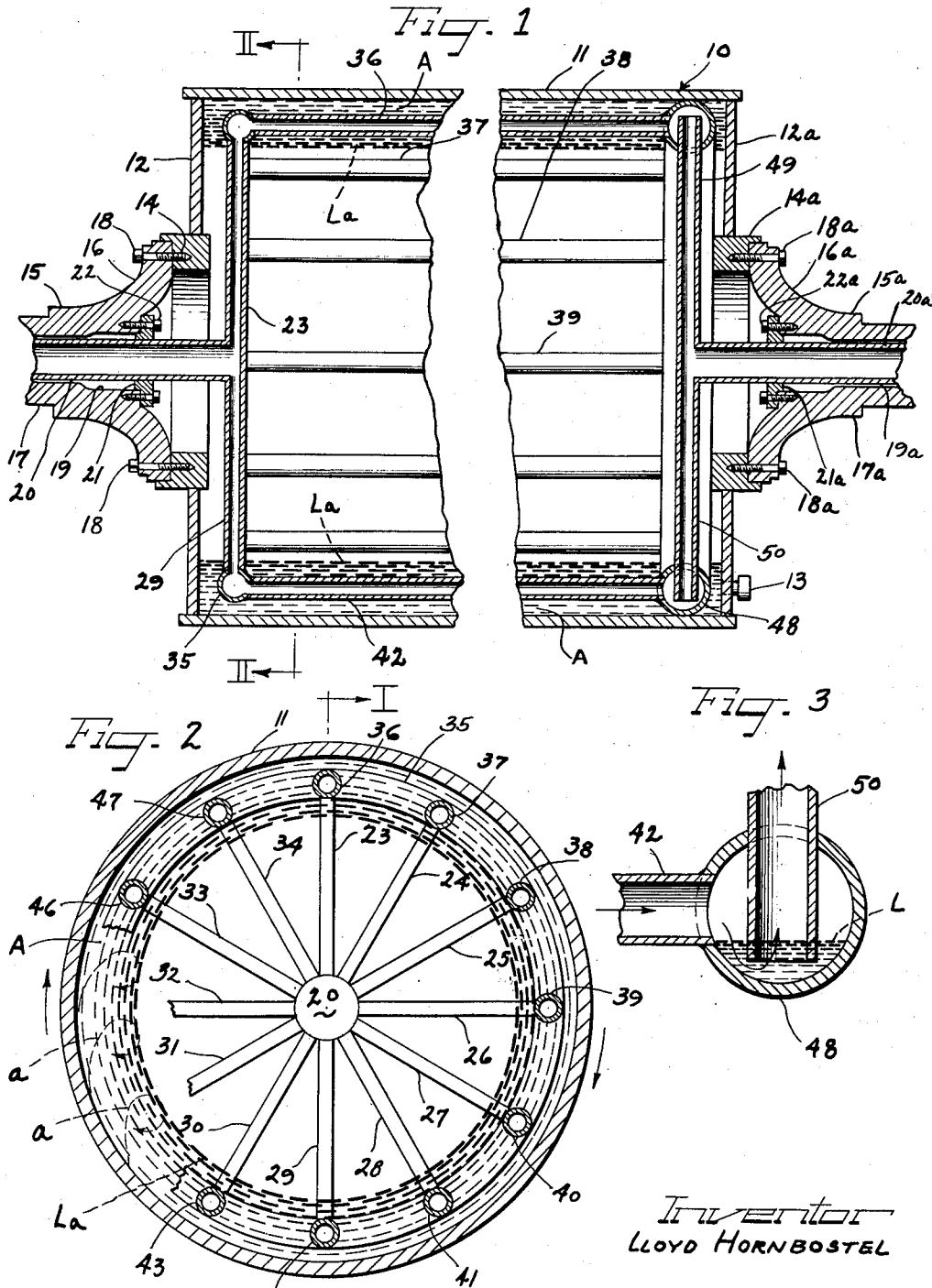
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DRUM DRIER MECHANISM

Filed Nov. 25, 1955

2 Sheets-Sheet 1



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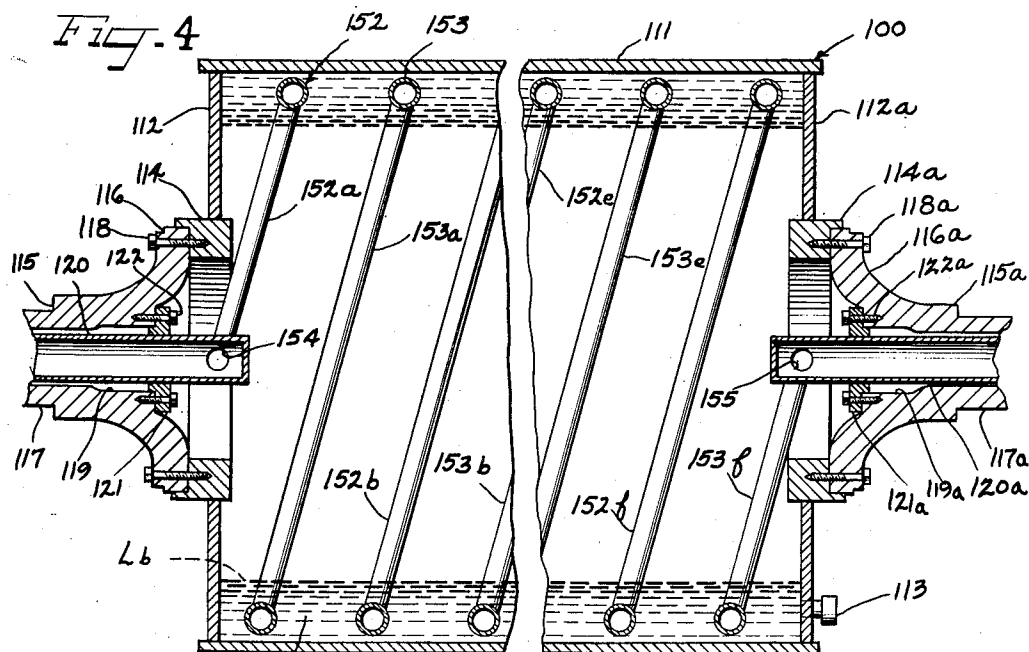
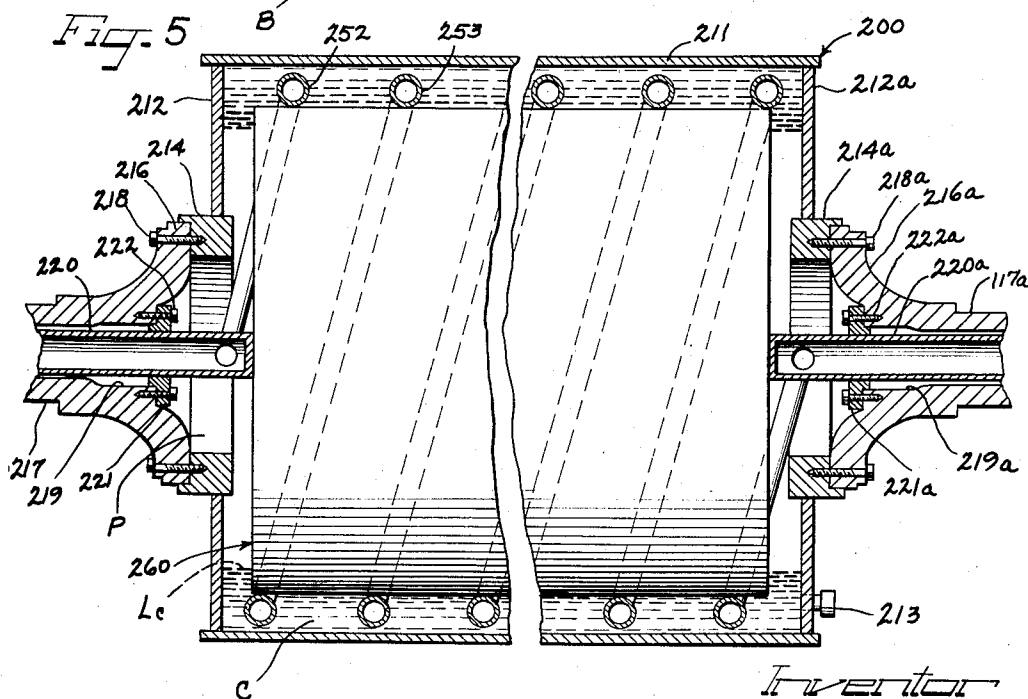
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1

2,909,849

DRUM DRIER MECHANISM

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4 Claims. (Cl. 34—124)

The instant invention relates to a dryer drum for a paper machine, and more particularly, to an improved dryer drum structure.

As conventionally employed in the art, dryer drums for paper machine drying sections generally consist of a cylindrical shell, spaced heads extending radially across the shell to close the open ends thereof and carrying means for journaling the shell for rotation, and means for introducing a heat exchange fluid into the interior of the shell. The Yankee dryer drum has generally the same structural arrangement, as now used in the art, except that the Yankee dryer drum is ordinarily of substantially greater size than the dryer drums in the conventional dryer section of a paper machine. Nevertheless, in each case these dryer drums (whether the large Yankee dryer drum or the smaller conventional drum) have certain operating limitations. The strength requirements for the shell define a minimum thickness therefor; and the greater the thickness of the shell the slower the heat transfer therethrough. Also, the higher the steam pressure within the shell, the greater the thickness required therefor. In view of this, there are definite limitations in shell size and usable steam pressure for any given shell, so that the maximum capacity of the shell for drying purposes is also limited.

As will be appreciated, a given shell structure can withstand only a certain maximum steam pressure therein and this maximum steam pressure which may be maintained within the shell determines the maximum amount of heat which can be supplied to the shell and thus the maximum amount of drying which can be effected by passing a paper web over the shell. For years these limitations have been recognized and the industry has continued to use the conventional dryer drum structure.

In contrast, the instant invention is based upon the discovery that the usual heat exchange fluid, namely, steam may be confined in small pipes or conduits within the shell; and this steam (or any other heat exchange fluid such as hot oil) may thus be forced into the shell at pressure substantially greater than the pressure which the shell itself could ordinarily stand. Heat transfer from the heat exchange fluid within the small pipes or conduits is effected, according to the present invention, by the use of a relatively non-volatile liquid (which does not build up a pressure comparable to the heat exchange fluid at the temperatures involved) and the fluid is maintained in uniform contact with the inner periphery of the shell by centrifugal force during rotation of the shell. The small pipes or conduits carrying the heat exchange fluid are thus mounted adjacent the inner periphery of the shell so as to be continuously immersed in the non-volatile liquid which flows freely within the shell.

It is, therefore, an important object of the instant invention to provide an improved dryer drum structure.

It is another object of the instant invention to provide an improved method of heating a dryer drum.

Still another object of the instant invention is to provide an improved dryer drum comprising a cylindrical

2

shell, a head closing each end of the shell, and a steam conduit within the shell adjacent the shell interior.

Other and further objects, features and advantages of the present invention will become apparent to those skilled in the art from the following detailed disclosure thereof and the drawings attached hereto and made a part hereof.

On the drawings:

Figure 1 is a sectional view with parts shown in elevation taken substantially along the longitudinal axis of rotation of a dryer drum of the present invention;

Figure 2 is a sectional elevational view taken substantially along the line II—II of Figure 1;

Figure 3 is an enlarged detail view of the condensate drainage header employed in the practice of the instant invention; and

Figures 4 and 5 are views comparable to Figure 1 showing other embodiments of the invention.

As shown on the drawings:

The reference numeral 10 indicates generally a dryer drum of the present invention including a cylindrical shell 11 having open ends closed by annular heads 12 and 12a bolted thereto and extending radially thereacross. Each of the annular heads 12 and 12a, respectively, has bolted thereto about its inner periphery an annular journal ring 14 and 14a.

Journals 15 and 15a, each having peripheral mounting flanges 16 and 16a and axially extending axle portions 17 and 17a are secured respectively to the annular journal rings 14 and 14a by screws 18 and 18a. Each of the journals is provided with an axially extending bore 19 and 19a. The bore 19 of the journal 17 receives a concentric conduit 20 which is a heat exchange fluid or steam inlet conduit. The conduit 20 is secured in the bore 19 by a centering plate 21, the plate 21 being secured to the journal 17 by suitable screws 22.

In like manner, the bore 19a of the journal 17a receives a concentric conduit 20a which is held in place by a centering plate 21a affixed to the journal 17a by screws 22a. The conduit 20a is a heat exchange fluid drainage line, or preferably a condensate drainage line for use with steam. As mentioned, the conduit 20 is preferably a steam inlet line.

As those skilled in the art will readily appreciate, the instant invention does not require that the steam or heat exchange fluid be fed into one end of the shell 11 and taken out from the other end, even though this is the most convenient and advantageous arrangement, as is here shown in Figure 1. It will be appreciated that the steam inlet and condensate drainage lines may be concentric, as shown in Lloyd Hornbostel U.S. Patent No. 2,651,114, and thus both lead through the same head into the shell 11. In such case, it would be preferable to extend either the steam inlet or the condensate drain line the full axial length of the shell 11 so as to simulate the arrangement here shown.

As best shown in Figure 2, the steam inlet line 20 leads into the shell 11 through one of the heads, in this case, the head 12 and a plurality of radial steam pipes 23 through 34 extend from the steam inlet 20 at the axis of the shell 11 to an annular steam header 35 adjacent the end of the shell 11 whereat the head 12 is located. The radial pipes 23 through 34 are connected to the steam inlet 20 and the annular steam header 35 so as to provide fluid communication therebetween. In this respect, it should be noted that it is generally preferable to have the conduit system within the shell formed as an integral part and this may require a change in the conventional dryer drum structure in that one of the heads 12 or 12a may be affixed thereto so that it may be more readily removed for maintenance purposes. Also, a fluid inlet capped pipe 13 for the shell interior is mounted in one head 12a to fill and empty the shell but this is a

3

matter of mechanical expediency which does not form a part of the instant invention.

A plurality of heat exchange conduits or heat exchange fluid conduits 36 through 47 are mounted adjacent (but closely spaced from) the inner periphery of the shell 11 and in communication with the annular steam header 35 to receive the steam therefrom. The conduits 36—47 are peripherally spaced and they extend along substantially the entire length of the shell 11 from closely adjacent the one head 12 to closely adjacent the opposite head 12a. The conduits 36—47 are secured to the annular steam head 35 to form a sturdy structure; and the conduits extend from the steam header 35 to an annular condensate header 48 which is also secured to the conduits 36—47. The spent steam or other heat exchange fluid is thus passed from the conduits 36—47 into the drainage header 48 which is positioned closely adjacent to the head 12a and the inner periphery of the shell 11.

A plurality of radial condensate or drainage pipes extend from the drainage line 20a radially outwardly and into the annular drainage header 48; and only the radial pipes 49 and 50 can be seen in Figure 1. It will be appreciated that it is preferable to employ radial drainage pipes in an arrangement substantially the same as that shown for the radial steam pipes 23—34, so that more than the two drainage pipes 49 and 50 here shown are employed in the instant structure. Actually, the view of the drainage header 48 comparable to the view of Figure 2 for the steam header 35 would be substantially identical thereto, except that the condensate header 48 is larger than the steam header 35 and extends radially outwardly a slightly greater distance for reasons which will be explained in the next paragraph.

Referring now to Figure 3, it will be seen that the steam conduit 42 feeds generally into the center of the drainage header 48, but the steam conduit 42 is somewhat smaller in size so that the drainage header 48 extends radially outwardly beyond the steam conduit 42. The radial drainage pipe 50, however, extends into the drainage header 48 radially beyond the steam conduit 42 to closely adjacent the radially outward portion of the drain header 48. In this way condensate which may be formed in the steam conduit 42 and flowed into the drain header 48 will be thrown by the centrifugal force of the rotating shell 11 against the radially outward portion of the drainage header 48 so as to maintain a condensate level L thereat and the radial condensate pipe 50 extends beneath this level L (which is radially outward from the steam conduit 42) so that condensate will be continuously removed through the radial condensate pipe 50 and from there into the axially aligned drainage line 20a.

It will be readily appreciated that the relatively small diameters (i.e. about 2 to 20% of the shell diameter) of the steam conduits 36—47 will permit the use therein of steam of much higher pressure than could be used in the form of free steam within the shell 11. The conduits 36—47 are preferably parallel units closely to the shell 11 as here shown; but they may also be arranged as helical coils, etc., the main purpose being to supply heat as close to the shell as possible. In this way, much greater heat input is made possible. In order to transfer this heat from the conduits 36—47 to the shell 11 a liquid is maintained in the shell 11. The liquid A is held uniformly against the entire inside periphery of the shell 11 by centrifugal force so as to continuously maintain a level L_a around the inner periphery of the shell 11 which will submerge the conduits 36—47. Preferably the level is just sufficient to cover the conduits 36—47, since a minimum weight of liquid A is desired.

The liquid A employed is a heat conductor, of course, so that heat may be conducted readily therethrough to the shell 11 and it is also a substantially non-volatile liquid so that excessive vapor pressures are not built up within the drum 11. A number of relatively non-vol-

4

atile "oils" may be used relatively non-volatile heat exchange liquids (such as Dowtherm) may also be used. In order to obtain best conductivity low melting metals (such as Rose's metal) may be used. The main requirement is that the liquid A is in fact a relatively fluid liquid at the operating temperatures so that it can be maintained against the inner periphery of the shell 11 in a substantially uniform manner by the centrifugal force generated through conventional rotation of the shell 11; and the liquid A will, of course, be in constant movement against the shell 11 so that turbulence therein will afford heat transfer through convection (in a greatly accelerated manner). As shown by the arrows a, a in Figure 2, the traveling inner periphery of the shell 11 gives a maximum velocity to the liquid film immediately adjacent thereto; whereas the liquid A at the level L_a tends through inertia to resist movement so that turbulence in the direction indicated by the arrows a, a is constantly created. Turbulence creating flow devices may also be used.

Although the heat exchange fluid ordinarily preferred for use in the practice of the instant invention is steam because of its availability, it will be appreciated that other heat exchange fluids such as heated oils, etc. may be employed in the practice of the instant invention.

It will thus be seen that the instant invention comprises a method of heating a dryer drum shell 11 which comprises holding a relatively non-volatile liquid A uniformly against the entire inside periphery of the shell 11 with centrifugal force, immersing a heat conductive solid (in the form of the conduits 36—47) in the liquid A, and heating the solid conduits with a fluid such as steam maintained separate and apart from the liquid A, or heating the solid conduits by condensing a fluid such as steam thereagainst to heat the same.

Referring to Figure 4, the reference numeral 100 indicates generally another dryer drum embodying the invention, in a view comparable to the view of Figure 1 wherein parts having identical functions to the parts shown in Figure 1 are indicated by the same reference numeral, only in the 100 series. The cylindrical shell is thus 111 and it is closed by heads 112 and 112a bolted thereto. Each of the heads 112 and 112a, respectively, has bolted thereto about its inner periphery an annular journal ring 114 and 114a and one of the heads 112a has a capped drain and inlet conduit 113 which may be used to flow heat exchange fluid into the shell 111 or drain the same therefrom.

Journals 115 and 115a, each having peripheral mounting flanges 116 and 116a and axially extending axle portions 117 and 117a are secured respectively to the annular journal rings 114 and 114a by screws 118 and 118a. Each of the journals 115 and 115a is provided with an axially extending bore 119 and 119a. The bore 119 of the journal 115 receives a concentric conduit 120 which is a heat exchange fluid (steam) inlet conduit; and the conduit 120 is secured in the bore 119 by a centering plate 121 secured to the journal 115 by suitable screws 122.

In like manner, the bore 119a of the journal 115a receives a concentric conduit 120a which is held in place by a centering plate 121a affixed to the journal 115a by screws 122a. The conduit 120a is a heat exchange fluid drainage line, or preferably a condensate drainage line for use with steam, which is preferred for use in the invention.

In the embodiment 100, steam conduits within the shell are provided in the form of spiral pipes 152 and 153. As will be seen from Figure 4, the steam inlet conduit 120 feeds through a radially aligned aperture 154 into a first loop 152a of one of the spiral pipes 152, which sweeps rearwardly from the opening 154 and upwardly to closely adjacent the shell 111 and then sweeps forwardly (in the front half of the drum 100 not shown in the view of Figure 4) and downwardly to start the second loop 152b of the spiral. The spiral pipe 152 continuously follows

closely to the inner periphery of the shell 111 through a number of loops until at the right-hand side of the shell the last loop 152f sweeps backwardly and upwardly and then connects into the drain conduit 120a through a radially aligned opening (not shown) which is substantially opposite to an opening 155 in the drain conduit 120a which receives the last loop 153f of the second of the pair of spiral pipes 152 and 153. It will also be appreciated that the second spiral pipe 153 is fed steam through a radially aligned opening (not shown) that is opposite the opening or inlet 154 in the inlet conduit 120. The first loop of the spiral conduit 153 is thus shown at 153a at the left-hand side of the drum 100 in Figure 4. It will be appreciated that other spiral pipe arrangements may be employed and this is merely an example of a type of spiral piping arrangement which may be found more advantageous or more easily constructed than the arrangement of Figure 1. In the operation of the drum 100 a liquid B, such as the liquid A hereinbefore described, is held uniformly against the inside periphery of the shell 111 by centrifugal force so as to continuously maintain a level L_b around the inner periphery of the shell which will just submerge the helical conduits 152 and 153.

Referring now to the drum 200 of Figure 5, wherein parts comparable to the parts shown in Figure 1 are indicated by the same reference numeral in the 200 series rather than the 100 series, it will be seen that the entire structure in Figure 5 is the same except for a centrally mounted drum or cylinder 260 around which the spiral conduits 252 and 253 are wrapped. The centrally positioned drum is secured to the inner ends of the inlet conduit 220 and the drain conduit 220a so as to fill up substantially the entire volume within the shell 211 and to leave only a relatively small annular chamber between the shell 211 and the outer periphery of the drum 260 and this chamber is filled with a liquid C which is the same as the liquids A and B in the previously described devices, except that the liquid C need not be held against the inner periphery of the shell 211 by centrifugal force but is combined thereagainst by the presence of the centrally positioned drum 260. As here shown, a level L_c is maintained by centrifugal force in the drum 200, but it will be appreciated that the entire inside of the drum 200 not filled by the inside drum 260, which would include hollow portions P of the trunnion might be filled with liquid without interfering in any way with the operation of the instant device. The drum 260 thus affords means which will permit the operation of the dryer 200 at slower speeds. The drum 260 is, of course, a hollow closed body so as to have minimum weight, but to afford additional supporting structure for the spiral conduits 252 and 253 and the interior of the shell 211 generally.

It will be understood that modifications and variations may be effected without departing from the spirit and scope of the novel concepts of this invention.

I claim as my invention:

1. A dryer drum comprising a cylindrical shell, a head closing each end of the shell, a stem inlet line leading into the shell through one of said heads, a plurality of radial steam pipes extending from the steam inlet at the shell axis to an annular steam header adjacent one end of the shell, a plurality of steam conduits mounted adjacent the inside wall of said shell receiving steam from said inlet line through said radial pipes, said conduits

being rotatable during rotation of the drum, a condensate drainage line leading from the shell through one of said heads receiving steam from said steam conduits, and a fluid heat exchange medium interiorly of the drum and essentially entirely covering the steam conduits during rotation of the drum to transfer heat from said conduits to the shell.

2. A dryer drum comprising a cylindrical shell, a head closing each end of the shell, a stem inlet line leading into the shell through one of said heads, a plurality of steam conduits mounted adjacent the inside wall of said shell receiving steam from said inlet line, and being rotatable simultaneously with the shell, an annular condensate header receiving one end of each of said steam conduits, and a condensate drainage line leading from the shell through one of said heads receiving steam from said steam conduits through said condensate header, the steam conduits being substantially immersed in a fluid heat exchange medium impelled outwardly during rotation of the shell into contact with the inside wall thereof to transfer heat from said conduits to the shell.

3. A dryer drum comprising a cylindrical shell, a head closing each end of the shell, a stem inlet line leading into the shell through one of said heads, a plurality of steam conduits mounted adjacent the inside wall of said shell receiving steam from said inlet line, said conduits being rotatable during rotation of the shell, an annular condensate header receiving one end of each of said steam conduits, a plurality of radial condensate pipes extending into said annular condensate header radially beyond the steam conduits received thereby, and a condensate drainage line leading from the shell through one of said heads receiving steam from said steam conduits through said condensate header and pipes, the shell being constructed to permit unrestricted outwardly impelled flow of a fluid heat exchange medium into contact with the shell inside wall circumferentially therearound and in covering relation with the steam conduits to transfer heat therefrom to the shell.

4. A dryer drum which comprises, a cylindrical shell closed at opposite ends, one of said ends receiving a steam inlet line and the other of said ends a condensate discharge line, a plurality of steam conduits adjacent the shell inner wall communicating with the steam inlet line and mounted for simultaneous rotation with the shell, and a condensate header connecting with the steam conduits and with the condensate discharge line, the shell interior providing an essentially open chamber for containing a fluid heat exchange medium to be impelled outwardly during rotation of the shell to substantially cover the steam conduits and transfer heat therefrom to the shell.

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