July 29, 1958 L. HORNBOSTEL 2,844,887

DRYER

Filed Feb. 8, 1957

Fig. 1

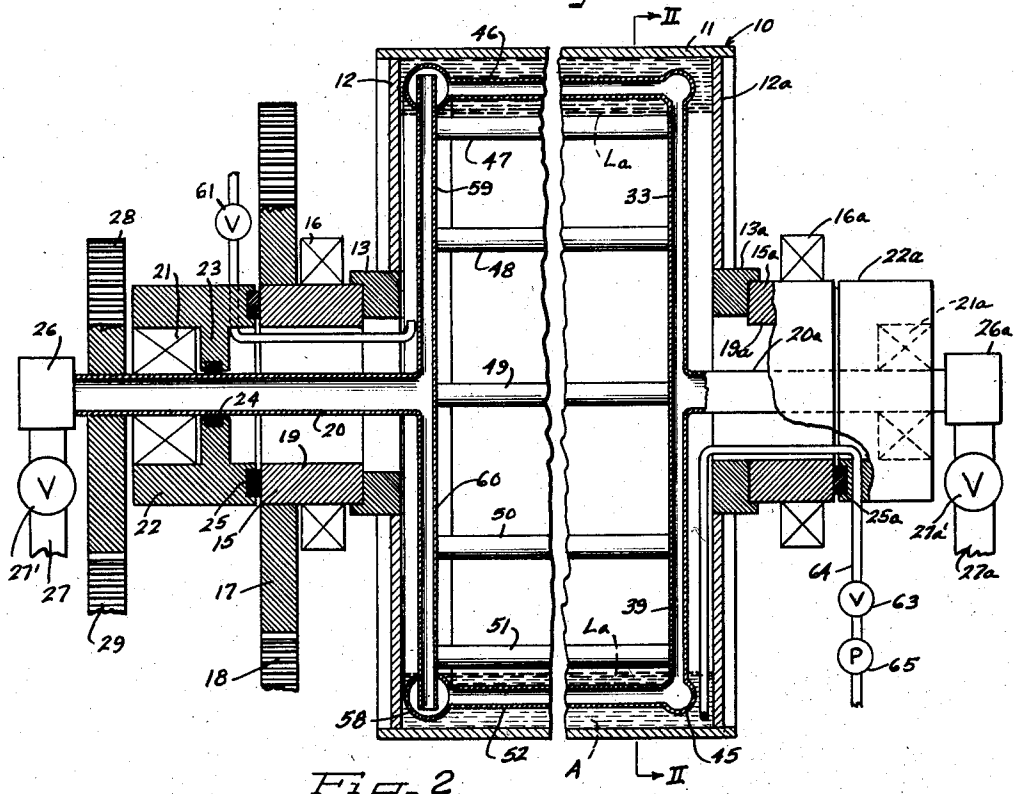


Fig. 2

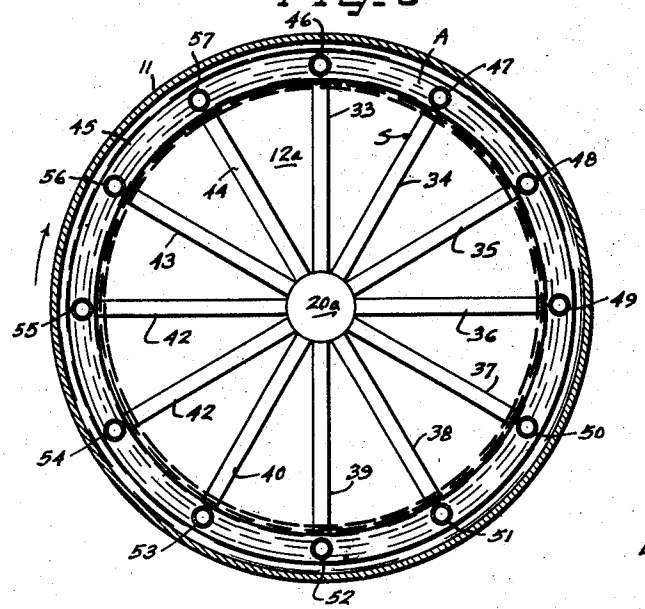
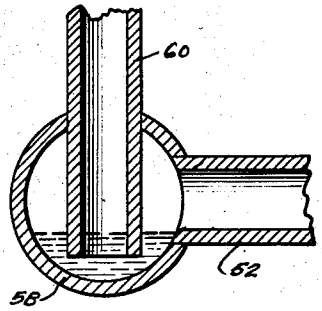


Fig. 3



Inventor
LLOYD HORNBOSTEL

by Kill, Sherman, Meroni, Gross & Simpson Attys.

United States Patent Office 2,844,887 Patented July 29, 1958

2,844,887

DRYER

Lloyd Hornbostel, Beloit, Wis., assignor to Beloit Iron Works, Beloit, Wis., a corporation of Wisconsin

Application February 8, 1957, Serial No. 638,955

5 Claims. (Cl. 34—119)

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

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 rotatably mounted adjacent the inner periphery of the shell for rotation relative to the shell rotation so as to be continuously immersed in the non-volatile liquid which flows freely within the shell and to continuously agitate said liquid.

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 rotatably mounted cylindrical shell, a head closing each end of the shell, and a steam conduit within the shell adjacent the shell interior mounted for rotation relative to said shell.

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 view with parts shown in full view and in sectional 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; and

Figure 3 is an enlarged detail view of the condensate drainage header employed in the practice of the instant 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 **12***a* bolted thereto and extending radially thereacross. Each of the annular heads **12** and **12***a*, respectively, has bolted thereto about its inner periphery an annular journal ring **13**, **13***a*. Journals **15** and **15***a* are secured, respectively, to the journal rings **13**, **13***a* by a suitable means such as screws (not shown); and the journals **15**, **15***a* are rotatably carried in bearings shown diagrammatically at **16** and **16***a*. The bearings **16**, **16***a* thus corotatably mount the journals **15** and **15***a*, the journal rings **13** and **13***a*, the shell heads **12** and **12***a* and the shell **11**.

The direction and speed of rotation of the shell **11** is controlled by a gear **17** corotatably mounted on the journal **15** and driven by a drive gear **18** (shown only partially) connected to a suitable source of power in the usual manner of driving dryer rolls.

Each of the journals **15** and **15***a* is provided with an axially extending bore **19** and **19***a*, respectively. The bore **19** of the journal **15** receives a concentric conduit **20** which is a heat exchange fluid or steam (and condensate) drainage line. The drainage line **20** is rotatably mounted in the bore **19** and the line **20** is mounted for rotation on bearings **21** carried by a fixed sleeve **22** that is positioned as an axial extension of the journal **15**. The sleeve **22** has an inward annular projection **23** carrying sealing strips **24** (formed in an annulus) to receive and position the rotatable condensate line **20** and to seal off the outer extremity of the bore **19** of the journal **15**. An annular packing strip **25** is also carried by the fixed sleeve **22** mounted at contiguous faces between the sleeve **22** and the journal **15** as a seal permitting relative rotation thereof.

The drainage line **20** extends outwardly beyond the fixed sleeve **22** to a fixed union **26** which receives the relatively rotatable drainage line **20** and receives condensate therefrom and disposes of the condensate through a drain line **27** equipped with a valve **27'**. The drain line **20** is also equipped with a corotatable gear **28** connected to a drive gear **29** (shown only partially), so that the drain line **20** may be rotated relative to the gear driven journal **15** both in speed and direction of rotation.

On the right-hand side of Figure 1 the mounting shown is generally the same as that shown in the left-hand side, except that the driven gears **17** and **28** are not required and steam is fed into the system from the right-hand side rather than condensate being drained out of the

system (as on the left-hand side). Accordingly, elements having the same function as those already described on the left-hand side of Figure 1 are given the same reference numeral followed by the letter "*a*." It will thus be seen that a fixed sleeve **22***a* mounts bearings **21***a* which rotatably receive a steam inlet line **20***a*. The steam enters the steam inlet line **20***a* through a source line **27***a* with a control valve **27***a'* therein and a fixed union **26***a*. The annular bore **19***a* of the journal **15***a* receives the steam inlet line **20***a*.

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 (as here shown), even though this is the most convenient and advantageous arrangement. It will be appreciated that the steam inlet and condensate drainage lines may be concentric, as shown in Lloyd Hornbostel U. S. Patent 2,651,114, and thus both lead through the same head in 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***a* leads into the shell **11** through one of the heads **12***a* and a plurality of radial steam pipes **33** through **44** extend from the steam inlet **20***a* at the axis of the shell **11** to an annular steam header **45** adjacent the end of the shell **11** whereat the head **12***a* is located. The radial pipes **33** through **44** are connected to the steam inlet **20***a* and the annular steam header **45** 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 **11** 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 **12***a* may be affixed thereto so that it may be more readily removed for maintenance purposes.

A plurality of heat exchange conduits or heat exchange fluid conduits **46** through **57** are mounted adjacent (but closely spaced from) the inner periphery of the shell **11** longitudinally thereof and in communication with the annular steam header **45** to receive steam therefrom. The conduits **46–57** are peripherally spaced and they extend along substantially the entire length of the shell **11** from closely adjacent one head **12***a* to closely adjacent the opposite head **12**. The conduits **46–57** are secured to the annular steam header **45** to form a sturdy structure; and the conduits extend from the steam header **45** to an annular condensate header **58** which is also secured securely to the conduits **46–57**. Spent steam, condensate or other heat exchange fluid is thus passed from the conduits **46–57** into the drainage header **58** which is positioned closely adjacent to the head **12** and the inner periphery of the shell **11**.

A plurality of radial condensate or drainage pipes extend from the drainage line **20** radially outwardly and into the annular drainage header **58**; and the only radial pipes **59** and **60** that can be seen in Figure 1 are so designated, but 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 **33–44**. Actually, the view of the drainage header **58** comparable to the view of Figure 2 for the steam header **45** would be substantially identical thereto, except that the condensate header **58** is larger than the steam header **45** 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 **52** feeds generally into the center of the drainage header **58**, but the steam conduit **52** is somewhat smaller in size so that the drainage header **58** extends outwardly beyond the steam conduit **52**. The radial drainage pipe **60**, however, extends into the drainage header **58** radially beyond the steam conduit **52** to closely adjacent the radially outward portion of the drainage header **58**. In this way condensate which may be formed in the steam conduit **52** and has flown into the drain header **58** will be thrown by the centrifugal force of the rotating shell **11** against the radially outward portion of the drainage header **58** so as to maintain a condensate level L thereat and the radial condensate pipe **60** extends beneath this level L (which is radially outward from the steam conduit **52**) so that the condensate will be continuously removed through the radial condensate pipe **60** and from there into the axial aligned drainage line **20**.

It will be readily appreciated that the relatively small diameters (i. e. up to 20% of the shell diameter) of the steam conduits **46–57** will permit the use therein of steam of much higher pressure than could be used in the form of steam within the shell **11**. The conduits **46–57** are preferably parallel units positioned 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 and also to effect agitation by relative rotation with the shell, which will be explained. By the use of the instant arrangement, greater heat input is made possible. In order to transfer this heat from the conduits **46–57** to the shell **11** a liquid is maintained in the shell **11**. The liquid A is held uniformly against the entire periphery of the shell **11** by centrifugal force so as to continuously maintain a level L_a around the inner periphery of the shell. Preferably the level L_a is just sufficient to submerge the conduits **46–57**, since a minimum weight of liquid A is desired.

Referring again to Figure 1, it will be noted that the liquid A is fed from a suitable source (not shown) through a valve **61** and an inlet line **62** carried by the fixed sleeve **22** and extending into the shell through the bore **19** of the journal **15**. The liquid A is removed from the shell **11** through a control valve **63** mounted in a drainage line **64** which extends through the fixed sleeve **22***a* through the bore **19***a* of the journal **15** and then radially outwardly along the wall **12***a* to closely adjacent the shell **11** (beneath the level L_a). A pump **65** may be used to evacuate the liquid A or remove the same from the interior of the shell at a desired rate. Actually, in operation it may not be necessary to continuously add and withdraw the liquid A; and this is an advantage of the instant invention because the heat is provided through the steam in the steam conduit system.

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 pressure cannot build up within the drum **11**. A number of relatively non-volatile "oils" may be used. Relatively non-volatile heat exchange liquids (such as "Dowtherm") may also be used. Low melting metals (such as Rose's metal) may also be used. The main requirement is that the liquid A is, in fact, a relatively fluid liquid at the operating temperature 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**. The liquid A will, of course, be in constant movement against the inner periphery of the shell; but it has been found that it is particularly important to effect deliberate agitation of the liquid A. This is accomplished by mounting the steam conduit system for relative rotation with respect to the shell **11**. As will be noted, the lines **20** and **20***a* which carry the steam conduit system corotatably are mounted for rotation on the bearings **21**, **21***a* and drive means in the form of the gear system **28**, **29**, permit rotation of the conduit assembly at different speeds and different directions from the speed and direction of rotation for the shell **11**. This creates turbulence in the liquid A which affords heat transfer through convection rather than simply conduction. As shown in Fig-

ure 2, the steam conduit system, indicated generally by the reference numeral S, is rotated in one direction while the shell is rotated in the opposite direction, as indicated by the arrows. This results in the creation of great turbulence in the liquid A.

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, rotating a heat conductive solid S (in the form of the entire system, or specifically the conduits **46–57**) in the liquid A, and heating the solid S with a fluid such as steam maintained separate and apart from the liquid A, or heating the solid S by condensing a fluid such as steam thereagainst to heat the same.

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

I claim as my invention:

1. A dryer drum comprising a cylindrical shell, a head closing each end of the shell, first means corotatably mounting said shell and said heads, a steam 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, a steam exhaust drainage line leading from the shell through one of said heads receiving steam from said steam conduits, and second means corotatably mounting said steam inlet line, conduits and drainage line for rotation relative to said heads and shell.

2. A dryer drum comprising a cylindrical shell, a head closing each end of the shell, first means corotatably mounting said shell and said heads, a steam inlet line leading into the shell through one of said heads, an annular steam header adjacent one end of the shell, a plurality of radial steam pipes extending from the steam inlet line to said annular steam header adjacent one end of the shell, a plurality of steam conduits mounted adjacent the inside wall of said shell receiving seam from said annular header, a steam exhaust drainage line leading from the shell through one of said heads receiving steam from said steam conduits, and second means corotatably mounting said steam inlet line, conduits, radial pipes, annular header and drainage line for rotation relative to said heads and shell.

3. A dryer drum comprising a cylindrical shell, a head closing each end of the shell, first means corotatably mounting said shell and said heads, a steam 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, an annular steam exhaust header receiving one end of each of said steam conduits, a steam exhaust drainage line leading from the shell through one of said heads receiving steam from said steam exhaust header, and second means corotatably mounting said steam inlet line, conduits, steam exhaust header and drainage line for rotation relative to said heads and shell.

4. A dryer drum comprising a cylindrical shell, a head closing each end of the shell, first means corotatably mounting said shell and said heads, a steam inlet line leading into the shell through one of said heads, an annular steam header adjacent one end of the shell, a plurality of radial steam pipes extending from the steam inlet line to said 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 annular steam header, an annular steam exhaust header receiving one end of each of said steam conduits, a steam exhaust drainage line leading from the shell through one of said heads receiving steam from said steam exhaust header, and second means corotatably mounting said steam inlet line, conduits, radial pipes, annular headers and drainage line for rotation relative to said heads and shell.

5. A dryer drum comprising a cylindrical shell, a head closing each end of the shell, first means corotatably mounting said shell and said heads, a steam 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, a steam exhaust drainage line leading from the shell through one of said heads receiving steam from said steam conduits, second means corotatably mounting said steam inlet line, conduits and drainage line for rotation relative to said heads and shell, and heat exchange fluid inlet and drainage lines, separate and apart from said steam inlet and drainage lines, leading into the shell through at least one of said heads.

References Cited in the file of this patent

UNITED STATES PATENTS

1,672,036	Oltman	June 5, 1928
2,365,271	Hornbostel	Dec. 19, 1944