July 7, 1959 E. J. JUSTUS ET AL 2,893,136

PAPER MACHINE DRYER CONDENSATE CONTROL

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Fig. 1

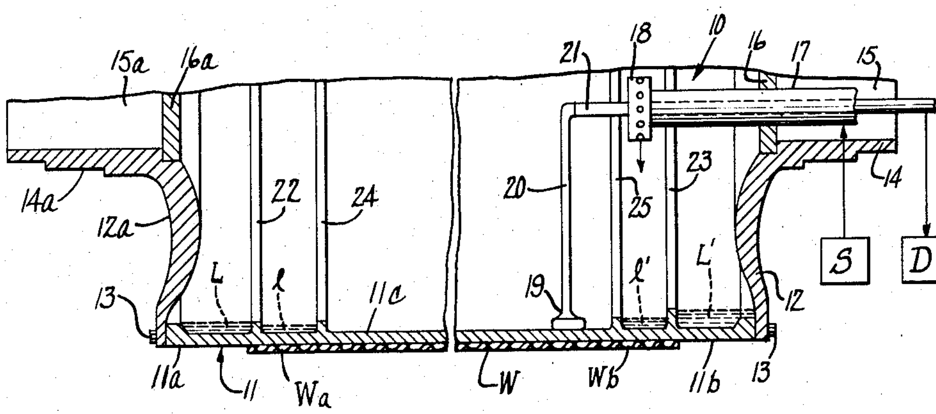


Fig. 2

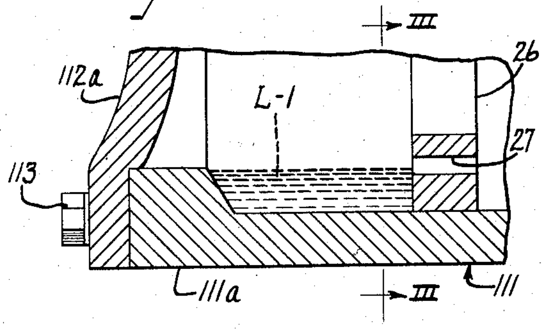


Fig. 3

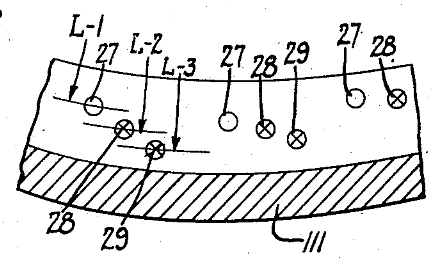


Fig. 4

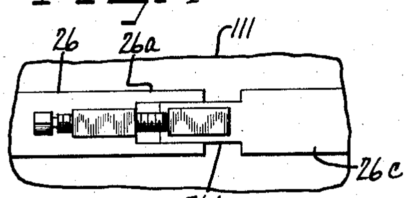
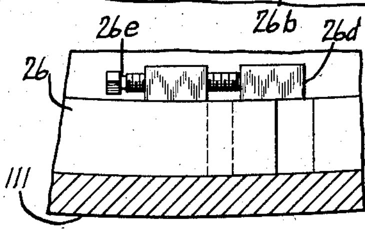


Fig. 5



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PAPER MACHINE DRYER CONDENSATE CONTROL

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6 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. 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 steam into the interior of the shell and drawing condensate therefrom. 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) has certain operating limitations.

In the prior art paper machine dryers, steam is admitted to the interior of the dryer and is in contact with the entire interior surface of the dryer, the inner cylinder wall being subject, therefore, to uniform temperature. Condensate forms on the inner surface of the cylinder and the condensate layer depth is substantially uniform at the minimum thickness or depth obtainable with siphon equipment used. The outer wall of the dryer, however, is subject to variations in temperature. For example, the moist paper web may not extend the full length of the cylinder shell, so as to leave the ends thereof uncovered by the paper. Also, the paper web passing over the cylindrical shell may not be dried to the same extent in the central portion as it is at the edges thereof. In addition, the rate of drying or rate of water evaporation from the web may vary across the width thereof, because of prior irregularities in the processing of the web, or different characteristics in the web, or different draft conditions in the dryer. In particular, however, the dryer surface in the region of the heads is not cooled by the passing damp sheet and it is subjected to cooling only from the ambient air which, of course, may vary greatly in relative humidity and/or temperature. In general, the cooling effect at the end reaches of the shell is less than that in the intermediate portion.

The instant invention provides a simple and economical means for overcoming this difficulty. It will be appreciated that the tendency for the ends of the shell to become overheated, or more greatly heated than the intermediate portion, results in a tendency to overdry the edges of the web adjacent thereto, as well as an unnecessary heat loss. In the instant invention, however, means are provided for maintaining a layer of predetermined depth of condensate against the inner periphery of the end portions of the shell to reduce heat transfer from the steam to the shell body in these regions. It will be appreciated that the instant invention may be employed to reduce heat transfer from the steam to any particular portion of the shell desired, although the main problem here solved is that of reducing heat losses at the shell ends and reducing overheating of the shell ends.

The prior workers in the art have proposed countless devices for minimizing the depth of condensate layer continuously forming on the inner shell surface. In contrast, the instant invention resides in the use of means for maintaining a greater condensate layer in a predetermined portion of the shell (for example, at the ends thereof) for the purpose of reducing heat transfer and heat loss at this region of the shell. In addition, the instant invention provides means for controlling the depth of condensate in such regions, so as to control the rate of heat transfer to the shell by, in effect, placing an insulator layer (of condensate) between the live steam and the cylinder shell.

It will be appreciated that the dryer drums operate at speeds sufficient to cause the condensate to be retained in substantially uniform depth around the entire inner periphery of the shell because of centrifugal force. Accordingly, the instant means employed to maintain a different condensate depth at selected axial portions of the shell are in the form of axially spaced circumferential dams, or a single circumferential dam axially spaced from one of the shell heads to maintain a predetermined level of condensate between such dam and the shell head.

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

Another object of the instant invention is to provide an improved dryer drum having means therein to retain a layer of condensate that is controllable in radial thickness, in order to regulate heat transfer rate from the heating fluid in the dryer drum to the outer periphery of the dryer.

A further object of the instant invention is to provide a dryer drum having means to position a retained layer of condensate therein to suit the heating requirements of a web trained over the dryer drum.

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 partial sectional elevational view of a dryer drum embodying the instant invention;

Figure 2 is an enlarged detail view of another embodiment of the instant invention, shown in a fragmentary sectional elevational view;

Figure 3 is a fragmentary detail elevational sectional view taken substantially along the line III—III of Figure 2;

Figure 4 is a fragmentary plan view of a connected portion of a circumferential dam used in the practice of the instant invention; and

Figure 5 is an elevational view of the connected portion shown in Figure 4.

As shown on the drawings:

The reference numeral **10** indicates generally a dryer drum of the present invention, only the lower half of which is shown in Figure 1 in sectional elevation for simplification of the description of the instant invention. The dryer drum **10** includes a cylindrical shell **11** having open ends closed by annular heads **12** and **12***a*, secured to the ends of the shell **11** by bolts **13** and extending radially across the ends of the shell **11**. Journals **14**, **14***a* are integrally formed with the heads **12**, **12***a*, respectively, and extend axially outwardly therefrom to be received by suitable bearings (not shown) for rotatably mounting the drum **10**. Each of the journals **14**, **14***a* is provided with an axial bore **15**, **15***a*. The axial bore **15***a* at one end is sealed off by a plate **16***a* in the particular structure here shown, whereas the opposite axial bore **15** mounts a plate **16** which receives a steam inlet header **17** connected to a suitable source of steam S (as shown diagrammatically). The steam flows from the source S through the steam inlet line **17** which leads into the shell **11** through the head **12**, and the steam enters the interior of the shell **11** through an apertured head **18**.

The steam within the shell **11** is continuously condensed and the condensate deposits as a film on the inner periphery of the shell **11**. The condensate thus formed collects along the inner periphery of the shell **11** and is maintained thereagainst in a substantially uniform thickness of liquid by virtue of centrifugal force resulting from the rotation of the dryer drum **10**. A siphon nozzle **19** placed against the central inner periphery of the shell **11** picks up condensate and returns the same through a radially aligned pipe **20** to a central condensate header **21** which is concentrically mounted within the steam inlet header **17** and passes out through the shell head **12** into suitable receiving means such as a drain D (shown diagrammatically).

The foregoing disclosure relating to the dryer drum **10** describes a typical prior art structure. It will be appreciated that the steam inlet line may lead through one head and the condensate line through the opposite head. Other variations in the arrangement of the elements consistent with the knowledge of the prior art are of course permitted. The instant invention provides a means for controlling the heat transfer through the shell **11** at various points. As indicated in Figure 1 a web W is trained about the outer periphery of the shell **11**, but this web W leaves exposed end portions **11***a* and **11***b* of the shell **11**, which are cooled only by ambient atmosphere. The web edges W*a* and W*b* may also be dryer than the main body of the web W, or may be inclined to dry more rapidly, if subjected to the same amount of heat.

As will be seen from Figure 1, a circumferential dam **22** is mounted on the inner periphery of the shell **11** at the shell end **11***a* adjacent the head **12***a*. The circumferential dam **22** is aligned approximately with the extreme edge of the web W, so that the end portion of the shell **11** between the head **12***a* and the dam **22** is the end portion **11***a* of the shell **11** which is not covered by the web W. The circumferential dam **22** cooperating with the head **12***a* maintains a level L of condensate against the inner periphery of the shell **11**. This level L is substantially the same throughout the periphery in this end portion **11***a* of the shell because of centrifugal force. The level L of condensate, however, functions as an insulator reducing the rate of heat transfer from the live steam within the shell **11** to the outer shell periphery in the region **11***a*. In this way heat losses to the ambient atmosphere are reduced readily, simply and economically. At the opposite end of the shell **11** there is mounted a circumferential dam **23** which cooperates with the head **12** to maintain a level L' of condensate therebetween on the inner periphery of the shell end **11***b* which functions in the same manner as the level L of condensate at the opposite end of the drum **10**.

If the drum **10** is to be operated at speeds below which "rimming" of the condensate occurs in the channel between the dams and end heads, paddles or baffles (not shown) can be mounted in the channels to reduce rotation of the condensate with the drum. Thus in slow speed paper machine producing heavy weight sheets or boards the centrifugal force developed in a slow rotating drum may not be sufficient to insure movement of the condensate with the drum to "rim" the liquid around the inner periphery of the drum. Transfer paddles or baffles spaced circumferentially across the channels will "drive" the liquid with the drum.

It will be noted that these circumferential dams **22** and **23** are axially spaced annular members on (and integral with) the inner periphery of the shell **11** spaced a short distance from the heads **12** and **12***a*. The circumferential dams **22** and **23** extend inwardly a short predetermined distance, so that condensate may flow over such dams toward the central portion of the shell **11**, if

excess condensate builds up between the dams **22** and **23**, and the heads **12**, **12***a*. The dams **22** and **23** thus project inwardly a short distance to retain condensate at each end of the shell **11** while permitting flow of excess condensate thereby toward the intermediate region or central portion **11***c* of the shell **11**. It is apparent that the siphon **19** functions in the intermediate portion **11***c* of the shell **11**, since it is important to keep the condensate film at a minimum thickness in this region in order to obtain best heat transfer conditions.

It will also be noted from Figure 1 that an additional annular ridge **24** is mounted in closely spaced relation to the ridge **22**, so as to align a space therebetween with the edge portion W*a* of the web W. The ridge **24** functions similarly to the ridge **22**, except that the ridge **24** does not extend inwardly as far and the level *l* of condensate retained thereby opposite the web edge W*a* is less than the level L of condensate maintained adjacent the head **12***a*. In this way more heat is transmitted from the live steam within the shell through the shell **11** and to the web edge W*a* than is transferred through the shell end portion **11***a*, but less heat is transferred to the web edge W*a* than is transferred to the main body of the web W through the central or intermediate shell portion **11***c*. A circumferential dam **25** at the other end of the shell functions in the way the dam **24** functions to maintain a level *l'* of condensate between the dams **23** and **25** that is lower than the level L' between the head **12** and the dam **23**.

As will be appreciated, the means for maintaining the level of condensate against the shell wall need not be in the form of a dam (such as the dams **22**, **23**, **24** and **25**) wherein the control means is provided in the form of the top of the dam over which the condensate flows. Instead, as shown in Figure 2, a circumferential dam **26** may be provided with an aperture **27** therein for maintaining a condensate level L–1. In Figure 2 parts corresponding to the parts in Figure 1 are indicated with the same reference numeral in the 100 series, so it is apparent that Figure 2 shows a shell **111** with an uncovered shell end **111***a* and a head **112***a* secured thereto by bolts **113**. The circumferential dam **26** of Figure 2 extends around the entire inner periphery of the shell **11** and is provided with a plurality of apertures **27** through which condensate may flow toward the central portion of the shell **11**, but which serve to control the condensate level L–1.

As shown in Figure 3, a plurality of apertures at levels **27**, **28** and **29** are provided in the annular ridge **26** for maintaining levels L–1, L–2, L–3, respectively. Only the apertures **27** are open in Figure 3 (with the apertures **28** and **29** plugged), so that the level L–1 is maintained, but when it is desired to operate at a different condensate level, the holes **28** or the holes **29** may be unplugged.

As shown in Figures 4 and 5, if the circumferential dam or annular ridge is not integral such as the ridge **22** and is a separate element such as the ridge **26**, then it may be mounted within the shell **111** by a number of ways. As shown in Figures 4 and 5, the annular member **26** may be split at one end **26***a* to receive a boss portion **26***b* at the opposite end **26***c*, with a stop **26***d* mounted on the boss portion **26***b*. Adjustable means in the form of a set screw **26***e* is carried by the split end **26***a* and acts against the stop **26***d* so as to urge the annular ridge **26** into tight contact with the inner periphery of the shell **111**. Other means may, of course, be employed for mounting the ridge **26** so as to permit subsequent changes in position thereof.

It will also be appreciated that the instant invention affords a unique advantage with respect to the control of heat input to the web throughout an entire dryer section, which may include as many as 50 dryer drums. In such an arrangement the dams within the dryer drums are positioned at different locations throughout the dryer section, so that the amount of heat input to the central portion of the web may be correlated with that to the web edges (*Wa* and *Wb*). In other words, these dams may be positioned so as to produce a contoured curve of total heat input to the web. For example, in a paper machine having a dryer section of 50 dryers, the dams can be successively moved toward the center of the machine in such a manner that the edges of the web would receive a heat input of 60% of the input at the center of the machine or dryer, and by proper arrangement, the total heat input at intermediate points is precisely adjusted to the desired moisture profile, and/or to the particular characteristics of drying due to ventilation and other factors.

In such a paper machine dryer section, the circumferential dams within the dryer drums are moved progressively inward toward the center of the drums (in the direction of web travel) from the oncoming to the off-running side of the dryer section, and with such dams mounted in the drums in this manner a substantially uniform ratio between the heat input to the central portion of the web and that to the edges may be maintained throughout the length of the dryer section.

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.

We claim as our invention:

1. A dryer drum comprising a cylindrical shell, a head closing each end of the shell, a steam inlet line leading into the shell through one of said heads, axially spaced annular members on the inner periphery of the shell spaced from said heads for restricting flow of condensate from the regions of said shell adjacent the heads to the intermediate region of the shell, and a condensate drainage line communicating with the inner surface of the shell only between said members and leading from the intermediate region of the shell through one of said heads receiving steam and condensate from the shell.

2. A dryer drum comprising a cylindrical shell, a head closing each end of the shell, a steam inlet line leading into the shell through one of said heads, annular ridges on the inner periphery of the shell near but spaced from the heads at each end of the shell projecting inwardly a short distance to retain condensate at each end of the shell while permitting flow of excess condensate thereby toward an intermediate region of the shell, and a condensate drainage line communicating with the inner surface of the shell only between said ridges and leading from the intermediate region of the shell through one of said heads receiving steam and condensate from the shell.

3. A dryer drum comprising a cylindrical shell, a head closing each end of the shell, a steam inlet line leading into the shell through one of said heads, annular ridges on the inner periphery of the shell near but spaced from the heads at each end of the shell projecting inwardly a short distance to retain condensate at each end of the shell, said ridges having apertures therein controlling the level of condensate at the shell ends while permitting flow of excess condensate thereby toward an intermediate region of the shell, and a condensate drainage line communicating with the inner surface of the shell only between said ridges and leading from the intermediate region of the shell through one of said heads receiving steam and condensate from the shell.

4. A dryer drum comprising a cylindrical shell, a head closing each end of the shell, a steam inlet line leading into the shell through one of said heads, annular ridges on the inner periphery of the shell near but spaced from the heads at each end of the shell provided with condensate level control means for maintaining a level of condensate in the space between each ridge and the head adjacent thereto while permitting flow of excess condensate thereby toward an intermediate region of the shell, and a condensate drainage line communicating with the inner surface of the shell only between said ridges and leading from the intermediate region of the shell through one of said heads receiving steam and condensate from the shell.

5. A dryer drum comprising a cylindrical shell, a head closing each end of the shell, a steam inlet line leading into the shell through one of said heads, a pair of closely spaced annular ridges on the inner periphery of the shell near but spaced from each head in the shell, said ridges being provided with condensate level control means for maintaining a level of condensate in the space between each pair of ridges and in the space between each head and the nearest ridge thereto while permitting flow of excess condensate thereby toward an intermediate region of the shell, and a condensate drainage line communicating with the inner surface of said shell only between said ridges and leading from the intermediate region of the shell through one of said heads receiving steam and condensate from the shell.

6. A paper machine dryer section containing a plurality of dryer drums successively contacting a web traveling therethrough from the oncoming to the off-running end of the dryer section, each of said dryer drums comprising a cylindrical shell for engaging the web, a head closing each end of the shell, a steam inlet line leading into the shell through one of said heads, circumferential dams on the inner periphery of the shell near each end thereof maintaining a level of condensate on the side thereof adjacent the shell end, and a condensate line communicating with the inner surface of the shell on the other side only of said dams and leading therefrom through one of said heads; the dams in each of said shells being placed successively closer to the middle of the shell from the oncoming to the off-running end of the dryer section so as to effectively maintain a desired ratio of heat input to the central web portion with respect to heat input to the web edge portions.

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