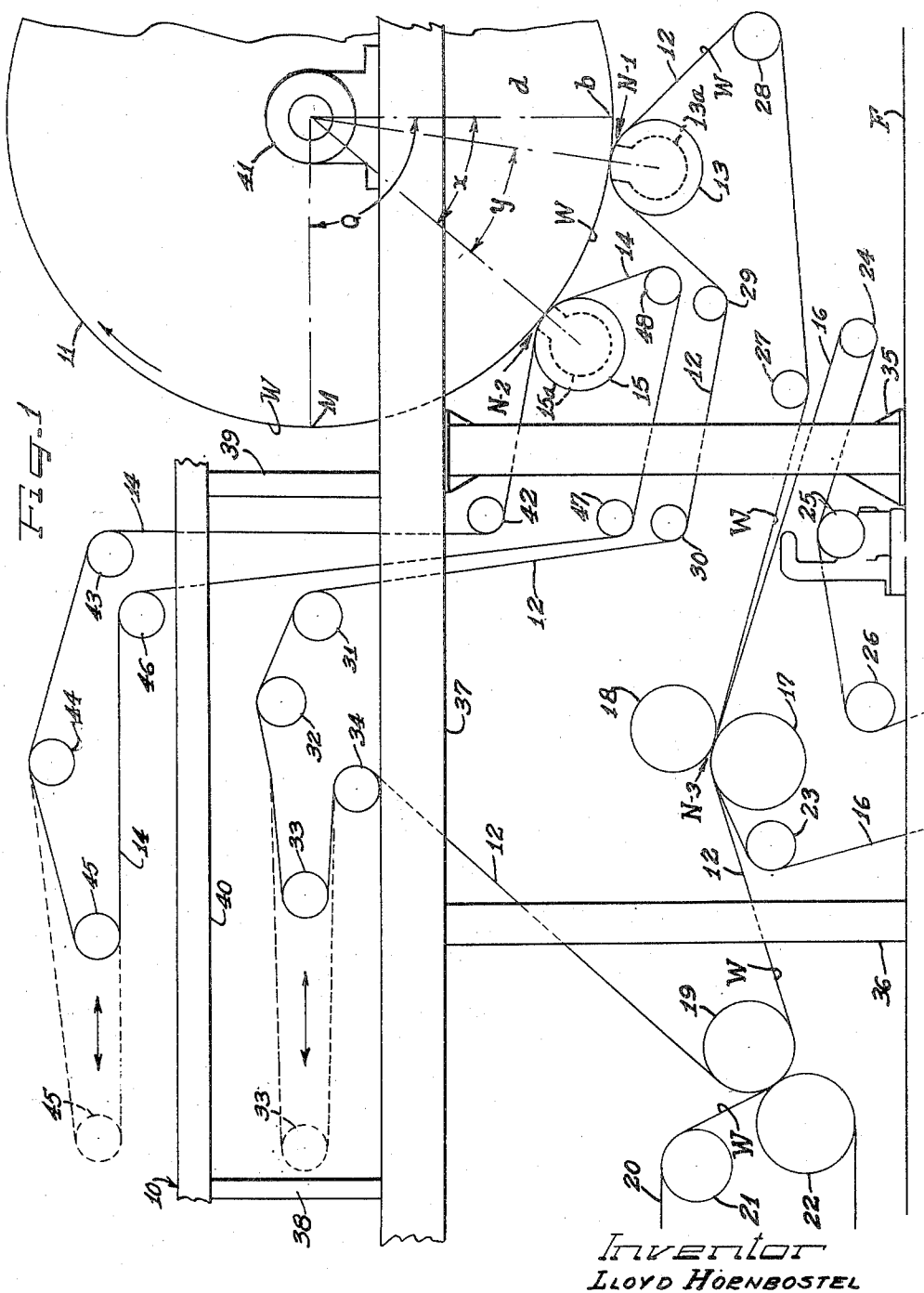


L. HORNOSTEL

PAPER MACHINE DRYER ASSEMBLY

Filed July 6, 1954

3 Sheets-Sheet 1



by Hill, Sherman, Meroni, Gans & Lingler Attys.

March 12, 1957

L. HORNBOSTEL

2,784,652

PAPER MACHINE DRYER ASSEMBLY

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3 Sheets-Sheet 2

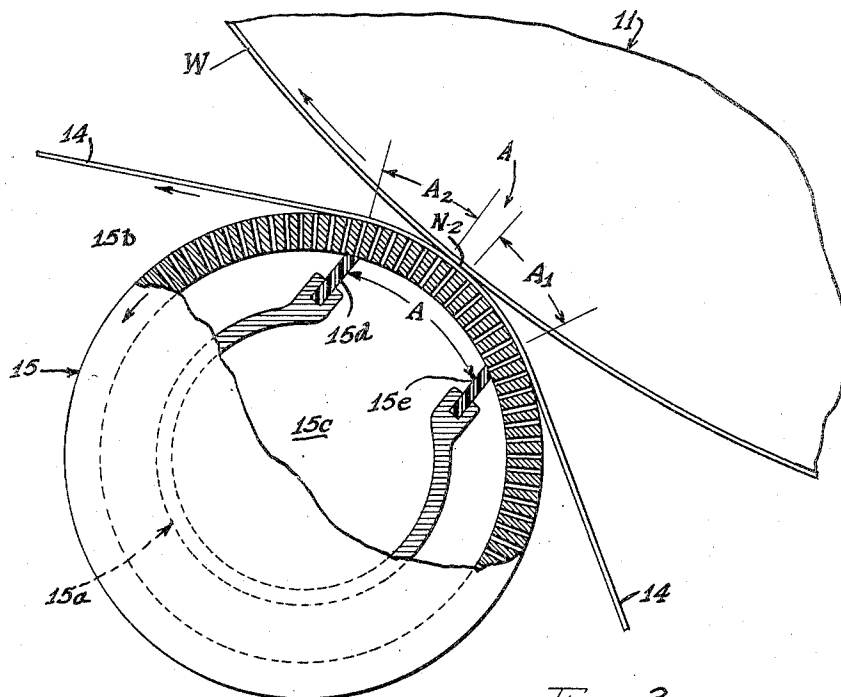
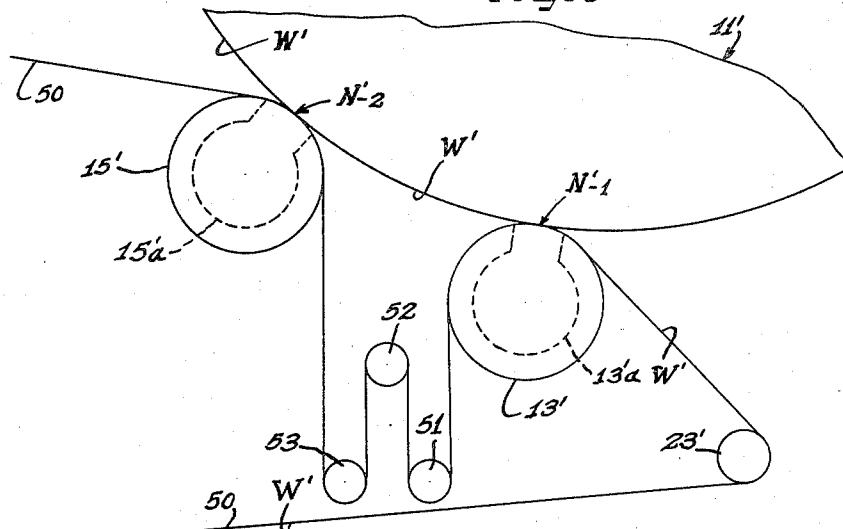
$$F_1 \approx 2$$


Fig. 3



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March 12, 1957

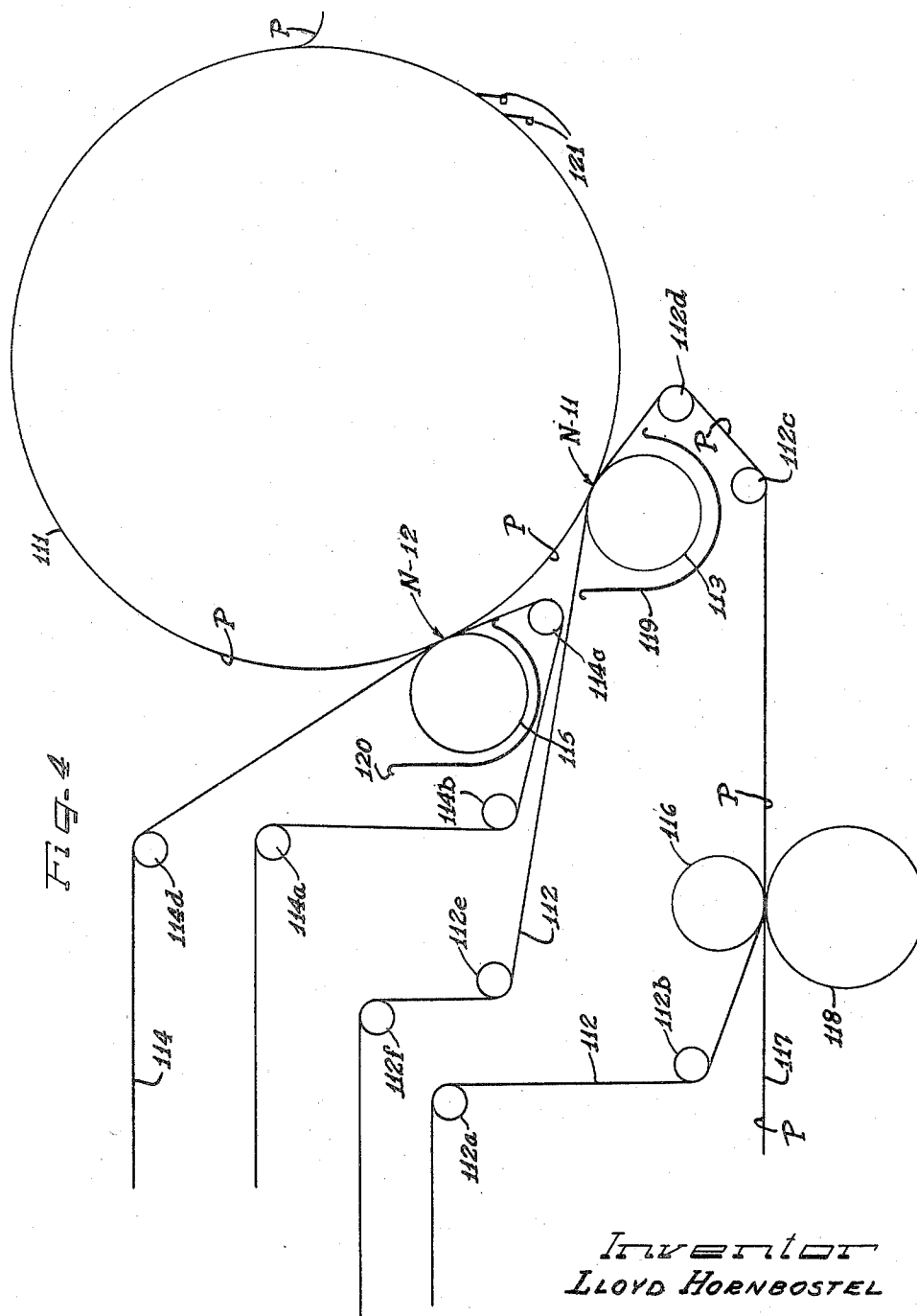
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PAPER MACHINE DRYER ASSEMBLY

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3 Sheets-Sheet 3



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2,784,652

PAPER MACHINE DRYER ASSEMBLY

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Application July 6, 1954, Serial No. 441,607

4 Claims. (Cl. 92—49)

The invention relates to an improved apparatus and method for the formation of paper webs, and more particularly, to an improved paper machine of the type generally referred to as a "Yankee machine" and an improved method of treating a paper web therein.

As a rule, machine glazed papers are made on a Yankee machine; and such a machine may have a cylinder or fourdrinier wet end, and may have a number of presses or auxiliary dryers of the usual type. The characteristic feature of the Yankee machine is the large Yankee dryer drum, having a diameter of from about 9 feet to about 15 feet, that is made of cast iron or steel and has a very high polish imparted to the outside cylindrical surface. Soft material, such as paper web, will develop a fine glazed, smooth surface if it is pressed against the heated finely polished dryer drum surface during the drying of the web. There are certain limitations or difficulties in connection with the operation of machines of this type, however. If the paper contains too little moisture when it comes in contact with the dryer drum, often it will not glaze well; but in some cases this may be remedied by wetting the surface of the paper with a fine spray or steam jet. On the other hand, the sheet must not be too wet. In general, the temperature of the dryer drum must be carefully controlled, since it must be cool enough to take the paper from the felt at the initial transfer nip and it must be hot enough to dry the paper in about three quarters of a revolution of the dryer drum. If the capacity of the machine is to be increased, presses can be positioned ahead of the dryer drum; but this is not a complete solution to the problem, since it is necessary to have a certain amount of moisture in the paper web when it is first applied to the dryer drum, and this moisture must be removed while the web is moving on the dryer drum. Since the maximum temperature of the dryer drum is limited by the necessity for having a cool enough temperature to permit initial pick up of the web, the total amount of moisture which may be driven out of the web by the heat from the dryer drum is limited and the capacity is limited, accordingly. In addition, it is often difficult to hold the web against the dryer drum at precisely the desired pressure to obtain a given desired result and this problem must also be taken into consideration in the successful operation of machines of this type.

The instant invention provides a unique answer to the problems heretofore involved in the operation of machines of this type. In accordance with the teachings of the instant invention, one or more additional press rolls, beyond the one required to first apply the web to the dryer drum, are mounted in press nip defining relationship with the dryer drum, so as to accomplish additional dewatering of the web carried on the drum. The function of the dryer drum in heating the moist web is in no way impaired by the presence of an additional press roll, because the web continues to heat up at a given rate dependent upon the heat supplied by the dryer drum. On the other hand, dewatering of the web, particularly during the

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initial stages thereof, is greatly accelerated by the use of an additional press roll. The total amount of travel for the web held against the dryer drum surface is in no way altered, even though initial dewatering is greatly accelerated. Also, a second pressing of the web against the dryer drum is provided, so as to afford better control of the extent to which the web is to be pressed against the dryer drum, as well as better control of the dewatering of the web on the dryer drum. Dewatering of the web on the dryer drum is thus accomplished by a combination of evaporation and pressing; and pressing of the web against the smooth dryer drum surface is thus better controlled by the use of successive pressing means.

It is, therefore, an important object of the instant invention to provide an improved paper machine and an improved method for making paper.

It is a further object of the instant invention to provide an improved method of treating a moist paper web, that comprises pressing the paper web between a felt covered roll and smooth heated surface to transfer the web to the surface, then while carrying the web on such surface heating the web up to substantially the evaporation temperature of the moisture therein and again pressing the web between a felt covered roll and the smooth heated surface.

Still another object of the instant invention is to provide an improved paper machine, comprising a Yankee dryer drum, a first press roll defining a first nip with the underside of the drum, a felt passing through said first nip for effecting transfer of a wet web thereat onto the drum, and a second press roll defining a second nip with the drum spaced from the first nip for dewatering a web passing through the second nip.

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

On the drawings:

Figure 1 is a partially diagrammatical view of a paper machine press and dryer section embodying the instant invention;

Figure 2 is an enlarged detail view, with parts broken away and parts shown in section, showing the cooperation between a press roll and the Yankee dryer drum in one embodiment of the invention;

Figure 3 is primarily a diagrammatical view showing a different felt arrangement from that shown in the structure of Figure 1 associated with the dryer drum; and

Figure 4 is essentially a diagrammatical view of a paper machine showing an embodiment of the instant invention differing from the embodiments shown in Figures 1, 2 and 3.

As shown in the drawings:

In Figure 1, the press and dryer section of a paper machine is shown, indicated generally by the reference numeral 10, comprising a Yankee dryer drum 11, a first looped felt 12, a first press roll 13 within the loop of the first felt 12 and defining a first press nip N-1 with the drum 11, a second looped felt 14, a second press roll 15 within the loop of the second felt 14 and defining a second press nip N-2 with the drum 11, a third looped felt 16, a third press roll 17 within the loop of the third felt 16, a fourth press roll 18 within the loop of the first felt 12 and positioned above the third press roll 17 and defining therewith a third press nip N-3, and a pick up roll 19 within the loop of the first felt 12 and positioned to pick up a paper web W on the traveling surface 20.

As here shown, the traveling surface 20 is a Fourdrinier wire (although it might also be a take off from a cylinder machine) which forms the web W on the up-

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per surface thereof and then turns downwardly over a couch roll 21 and is reversed around a lower turning roll 22. The pick up roll 19, which is preferably a suction pick up roll, covered by the first felt or transfer felt 12 picks the web W off the run of the wire 20 between the couch roll 21 and the turning roll 22 and carries the web W on the underside of the transfer felt 12 over to the press nip N-3 defined by the superimposed press rolls 17 and 18. The third looped felt or press felt 16 which is guided by the turning rolls 23, 24, 25 and 26 (plus others which are positioned below the floor F and not shown in this drawing) is trained over the lower press roll 17 and effectively prevents the transfer of the web W to the surface of the lower press roll 17. Instead, the web continues on the bottom side of the transfer felt 12, which is trained through the nip N and over the surface of the upper press roll 18. The transfer felt 12 is also mounted on a plurality of guide rolls 27, 28, 29, 30, 31, 32, 33 and 34. It will further be noted that the roll 33, which assists in guiding the travel of the first felt 12, is also movable as indicated by the two headed arrow, in a generally horizontal direction to the position designated in dotted lines as 33' for the purpose of applying the desired tension to the felt 12. A similar tensioning arrangement (not shown) is, of course, provided for the third felt 16.

After the web W passes through the nip N-3 defined by the rolls 17 and 18, the web W is retained in the underside of the transfer felt 12 and passes with the transfer felt 12 beneath the guide rolls 27 and 28, reversing around the guide roll 28 and being carried on the felt 12 into the nip N-1 defined by the drum 11 and the first press roll 12. The first felt 12 passes through the first nip N-1 for the purpose of effecting the transfer of the web W thereat onto the surface of the drum 11. As thus shown, the felt 12 continues on around the guide rolls 29, 30, 31, 32, 33 and 34, during which travel it may be subjected to heat or other drying conditions, and the first felt finally returns to the suction pick up roll 19.

The web W, having been transferred onto the surface of the dryer drum 11 at the first nip N-1 at the underside of the drum 11 is carried by the drum 11 on the uprunning underside of the drum 11.

As here shown, the general assembly is supported by upright posts 35 and 36 which support a main horizontal beam 37 and which, in turn, supports additional upright posts 38 and 39 for carrying a secondary horizontal beam 40. The general supporting arrangement for paper machines is well understood by those skilled in the art and the various support members 35, 36, 37, 38, 39 and 40 are merely indicated to show generally the support structural arrangement; and it will be appreciated that the various bearing mountings (not shown) etc. for the press and guide rolls are suitably carried by this overall structural arrangement. The dryer drum 11 is mounted on a suitable bearing arrangement 41 associated with the main beam 37, in the usual manner for mounting a Yankee dryer drum. In general, the first quadrant Q₁ of travel of the rotating dryer drum 11 is indicated as the uprunning underside of the drum 11 (and this portion of the peripheral drum travel extends from the lowermost or bottom b of the drum periphery to the middle point M of the unrunning side of the drum 11).

In general, the first press roll 13, which effects the initial application of the web W to the surface of the drum 11 provides the first press nip N-1 at a point just within the first quadrant Q₁ or just slightly over on the uprunning side of the underside of the drum 11.

In the practice of the instant invention, the second press roll 15 also associated with the drum 11 is preferably positioned so as to define the second press nip N-2 also within the first quadrant. Among other things,

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the best water removal or water drainage from the press nip N-2 is obtained if the press nip is defined in the first quadrant Q₁. Also, it is desirable to effect the removal of as much moisture as can be removed by pressing at the second press nip N-2 prior to any appreciable evaporation of moisture because of the heat supplied by the drum 11. As will be appreciated, pressing of the web W after a certain amount of evaporation of moisture has taken place, and/or pressing the web W at a second press nip outside of the first quadrant Q₁ may possibly effect some improvement in operation; but superior results in the operation of the instant device are obtained by positioning the second press nip N-2 within the first quadrant and at approximately the location at which the web will be heated up just to the evaporation temperature of the moisture. In general, the angular displacement "x" of the second nip N-2 from the vertical should be in the neighborhood of 30 to 50° (and preferably about 40°) in order for the web W to have the requisite amount of travel on the surface of the drum 11 after the last pressing action which it is subjected to, in accordance with the teachings of the instant invention. Also, the first press nip N-1 whereat the web W is transferred to the surface of the drum 11 should be spaced angularly from the vertical a distance "d" of about 5-15°. Preferably, the distance d is about 10° and the angular distance between the first nip N-1 and the second nip N-2 is between 20° and 40°, being preferably about 30°.

Preferably, the second press roll 15 which defines the second press nip N-2 with the drum 11 is provided with a felt covering in the form of the second press felt 14, which is mounted on a series of guide rolls 42, 43, 44, 45, 46, 47 and 48, the roll 45 being movable horizontally as far as the position 45' indicated in light lines for the purpose of applying the desired tension to the belt 14. Unless the roll 15 is covered with the felt 14, it is necessary to use a special covering such as a rubber covering (and no suction gland) so as to prevent removal of the web W from the surface of the drum 11 by the roll 15. As here shown in Figure 1, however, both the first press roll 13 and the second press roll 15 are suction rolls having positioned therein suction glands 13a and 15a, respectively, straddling the first and second nips N-1 and N-2, respectively.

Referring to Figure 2, which shows a more detailed enlarged view of the cooperating relationship between the second suction press roll 15 and the drum 11 at the second press nip N-2. As will be seen, the suction press roll 15 comprises a rotatably mounted perforate shell 15b having suitably mounted therewithin a fixed non-rotary suction gland 15a which defines a central suction chamber 15c and carries packing strips 15d and 15e which cooperatively gauge the inside of the rotary shell 15b and are maintained in spaced position to expose the inside of the shell 15b to the reduced pressure of the central suction chamber 15c and thereby to define the total suction area A provided by the gland 15a. It will further be noted that the gland 15a, or expressed in other terms, the suction area A provided by the gland 15a, straddles the second nip N-2 exposing a suction area A₁ on the oncoming side and a suction area A₂ on the offrunning side of the nip N-2, each of which is greater than the area A₃ of the nip N-2. As will be appreciated, because of the compressibility of the web W and the felt 14, the nip N-2 is only theoretically the thickness of a line and actually has a slight "area" A₃. On the other hand, the instant machine is operated to very great advantage by the use of a suction gland which provides exposed suction areas A₁ and A₂ on both the oncoming and offrunning sides of the nip N-2 which are substantially greater in area (i. e., from about 2 or 3 to about 15 to 20 times greater) than the area A₃ of the nip N-2. At least, the exposed area A₁ or A₂ is greater than the area A₃ that the felt is covered by or contacts the web W.

This affords an unusual advantage in that air may be sucked in rapidly through the oncoming side exposed area A_1 so as to additionally dry the felt 14 just before engagement with the web W and also so as to improve greatly the efficiency of the gland in removing water which may tend to run back down from the nip $N-2$, as it is squeezed out of the web W . In addition, the exposed area A_2 on the offrunning side of the nip $N-2$ permits the passage of air through the felt 14 after it has been separated from the web W so as to effect an immediate opening of the pores in the web 14 and a substantial drying thereof, thereby relieving the burden of the dryers for the felt 14, if such are used. In addition, the rapid separation of the felt 14 and the web W immediately after the nip $N-2$, coupled with the inflowing rush of air over the top of the felt 14 and into the gland 15a, serves to "break" a vacuum which tends to build up on the off-running side of the nip $N-2$. This vacuum would serve to pull water through the nip $N-2$ and also might serve to urge the web W away from the surface of the drum 11. The felt 14 is so guided by the various guide rolls, including particularly the rolls 42 and 48, that it covers completely the area A of the gland 15a, so that all air and moisture entering the gland must pass through the felt 14.

It is particularly advantageous also to provide the same felt guide arrangement for the felt 12 and the same straddling gland arrangement for the first suction roll 13 as that provided in connection with the suction roll 15. Although certain of the advantages which might be obtained on the oncoming side of the first nip $N-1$ will not be obtained unless the web W is separated from the felt 12 just before entering into the nip $N-1$, the advantages mentioned in connection with the suction roll 15 are obtained at the offrunning side of the nip $N-1$.

Referring to Figure 3, an unusual advantage that is obtained in the practice of the instant invention, particularly by the use of the straddling gland structure in the suction rolls is that separate felts need not be employed for each of the two suction rolls. For example, in Figure 3 each of the structural elements which is substantially identical to a structural element shown in Figures 1 and 2 is designated by the prime of the reference numeral shown in Figures 1 and 2. In Figure 3, it will be seen that a single transfer felt 50 (at the lower portion of Figure 3) carries the web W' on the bottom side thereof around a turning guide roll 28' and up to the first press nip $N'-1$ defined by the drum 11' and the first press roll 13', having a straddling suction gland 13'a therein, and the felt 15 then separates from the web W' which is transferred to the drum 11' passing around the guide rolls 51, 52, 53 (which may also be included in a dryer section) then up to the second press nip $N'-2$ defined by the second press roll 15' and the drum 11'. The suction glands 13'a and 15'a both straddle the nips $N'-1$ and $N'-2$ and the felt 50 covers the entire exposed areas of each of these glands 13'a and 15'a (in the manner shown in Figure 2). The particular advantage here involved is that the single felt 50 may be used for both press nips because of the unusual drying effect which is obtained at the offrunning side of the first nip $N'-1$ and at the oncoming side of the second nip $N'-2$.

As will be appreciated, the number of press rolls which may be used to act against the web after it has once been placed on the drum surface is not limited to a single roll, and there may be a number of such press rolls, each functioning in substantially the same manner (although a plurality of such rolls would serve to effect greater dewatering of the web than could ordinarily be achieved with a single roll). Also, such rolls may be suction rolls or plain rolls. In Figures 1, 2 and 3, the press rolls have been described as suction rolls, but in Figure 4 the press rolls are shown as plain rolls.

Referring now to Figure 4, it will be seen that Figure 4 shows generally a device which comprises a Yankee dryer drum 111, a first looped felt 112 (trained about the

guide rolls 112a, 112b, 112c, etc.), a first press roll 113 within the loop of the first felt 112 and defining a first press nip $N-11$ with the drum 111, a second looped felt 114 (trained about the guide rolls 114a, 114b, 114c etc.), which is separate and apart from the first felt 112, a second press roll 115 within the loop of the second felt 114 and defining a second press nip $N-12$ with the drum 111, and a pick up roll 116 within the loop of the first felt 112 to pick up a paper web P on the travelling wire 117. In general, the similarly positioned rolls and drum shown in Figure 4, as well as the felts, are given reference numerals which are one hundred more than the reference numeral assigned to a corresponding element of structure in Figure 1; and the relative angular positions of the rolls 113 and 115 and the drum 111 are substantially the same as those indicated in connection with the corresponding rolls and drum in Figure 1.

As will be seen from Figure 4, the paper web P travels along the top of the forming wire 117 until it is picked up by the pick up roll 116 covered by the felt 112; and the forming wire is reversed in direction over the couch roll 118. The paper web then is retained on the underside of the travelling felt 112 around the guide rolls 112c and 112d and up to the first press nip $N-11$ defined by the drum 111 and the first press roll 113. As shown, the press roll 113 is a plain roll and a save-all 119 is suitably positioned surrounding the press roll 113 to assist in carrying away the water removed at the press nip $N-11$. The transfer felt 112 in passing through the first press nip $N-11$ effects the transfer of the paper web P from the felt 112 to the surface of the drum 111 and the felt 112 passes on around its loop (here shown only partially) during which it is dried and prepared for reuse. The paper web P starts to heat up as soon as it is applied to the surface of the drum 111 and as it reaches approximately the temperature at which evaporation of the moisture therein will take place, the paper web P enters into the second press nip $N-12$, which is defined by the second press roll 115 and the drum 111. The press roll 115 has a felt 114 separate and apart from the felt 112 which covers the press roll 115 at the nip $N-12$ and assists in dewatering the paper web P at the nip $N-12$ and prevents removal of the paper web P from the surface of the dryer drum 111 at this point. Again, a save-all 120, or similar guard, is provided to retain and direct the flow of water pressed from the paper web P at the second press nip $N-12$. On the downcoming underside of the drum 111 doctors 121 are positioned so as to effectively scrape all paper particles from the smooth dryer drum surface. Doctors (not shown) are, of course, used in the operation of the drum 111 of Figure 1 also.

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

I claim as my invention:

1. In a paper machine, in combination, a Yankee dryer drum, a first suction press roll defining a first nip with the underside of the drum, a felt passing through said first nip for effecting transfer of a wet web thereat onto the drum, a second suction press roll defining a second nip with the drum peripherally spaced 20° to 40° from the first nip for dewatering a web passing through the second nip, and a second felt separate and apart from the first felt passing through the second nip, said second nip being at approximately the location at which the web is heated up just to the evaporation temperature of the moisture therein.

2. In a paper machine, in combination, a Yankee dryer drum, a first suction press roll defining a first nip with the underside of the drum, a first felt passing through said first nip for effecting transfer of a wet web thereat onto the drum, a second press roll defining a second nip with the drum peripherally spaced 20° to 40° from the first nip, a suction gland in said second press roll straddling said second nip and exposing on both the oncoming and

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offrunning sides of the second nip a suction area that is greater than the area of the second nip, and a second felt trained about said second press roll and completely covering said suction gland, said second nip being at approximately the location at which the web is heated up just to the evaporation temperature of the moisture therein.

3. In a paper machine, in combination, a Yankee dryer drum, a first press roll defining a first nip with the under-side of the drum, a first suction gland in said first press roll straddling said first nip and exposing on both the on-coming and offrunning sides of the first nip a suction area that is greater than the area of the first nip, a first felt completely covering said first suction gland and passing through said first nip for effecting transfer of a wet web thereat onto the drum, a second press roll defining a second nip with the drum peripherally spaced 20° to 40° from the first nip for dewatering a web passing through the second nip, a second suction gland in said second press roll straddling said second nip and exposing on both the oncoming and offrunning sides of the second nip a suction area that is greater than the area of the second nip, and a second felt trained about said second press roll and completely covering said second suction gland, said second nip being at approximately the location at which the web is heated up just to the evaporation temperature of the moisture therein.

4. In a paper machine, in combination, a Yankee dryer drum, a first looped felt, a first suction press roll within

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the loop of said first felt and defining a first press nip with said drum, a second looped felt, a second suction press roll within the loop of said second felt and defining a second press nip with said drum peripherally spaced 20° to 40° from the first nip, a third looped felt, a third press roll within the loop of said third felt, a fourth press roll within the loop of said first felt and positioned above said third press roll defining therewith a third press nip, and a pick up roll within the loop of said first felt to pick up a paper web on a traveling surface, said second nip being at approximately the location at which the web is heated up just to the evaporation temperature of the moisture therein.

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