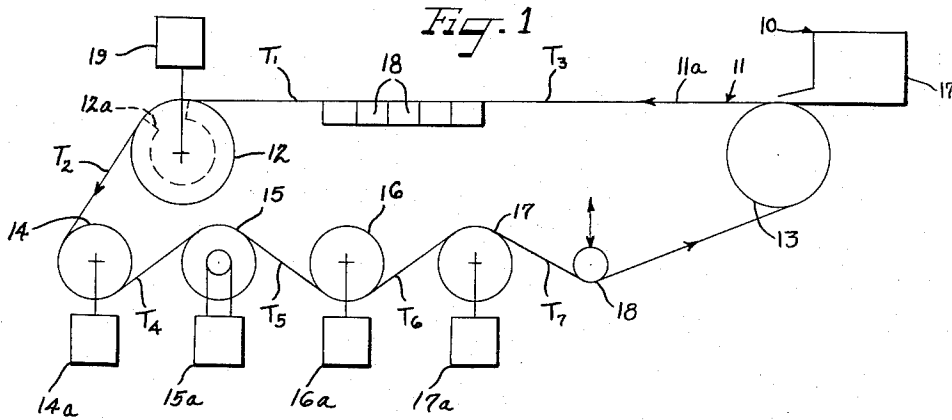


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L. HORNOSTEL ET AL
PAPER MACHINE FORMING WIRE

2,992,681

Filed Sept. 22, 1955



PRIOR ART Fig. 2

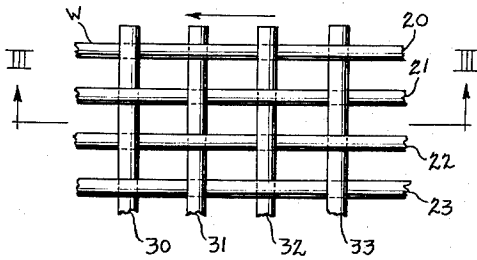
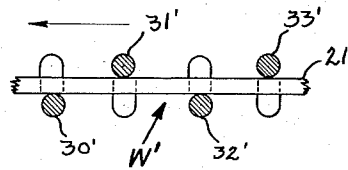


Fig. 5



PRIOR ART Fig. 3

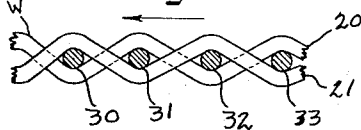


Fig. 6

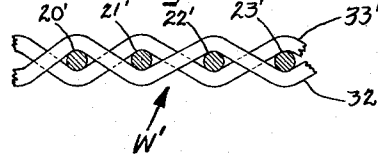


Fig. 4

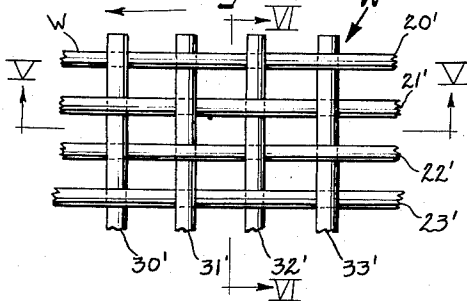
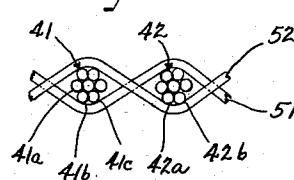


Fig. 7



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2,992,681

PAPER MACHINE FORMING WIRE

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2 Claims. (Cl. 162—348)

The instant invention relates to Fourdrinier type paper making machines, and more particularly, to an improved Fourdrinier type paper machine forming wire and to an improved method and apparatus for driving a looped traveling band or forming wire, such as the forming wire of a Fourdrinier type paper making machine.

Although the instant invention may have application in a number of fields, it is uniquely adapted to the operation of paper machines, and particularly to the operation of the forming wires in paper machines, and the invention will be described in detail with respect to this particular aspect. In the operation of the forming wire heretofore in paper machines, the forming wire was mounted with an upper run extending from a breast roll at the rear end to a suction couch roll at the forward end of the top reach of the wire, with suction boxes beneath the top reach and adjacent the couch roll, and the bottom reach or return reach of the looped wire is supported on a number of return rolls. Heretofore, it had been the accepted practice to drive the forming wire through the suction couch roll (or suction couch rolls, if a pair of suction couch rolls are used at the forward end of the loop). Helper drives might connect the main drive (associated with the suction couch roll) to drives for other rolls, so that these rolls might be driven at the speed of the travelling wire to avoid frictional drag during engagement therewith, but were not used to drive the wire. In the case of the breast roll, drive mechanisms therefor had not been successful, because of the tendency for driving of the breast roll to cause irregularities in the smooth operation of the wire just beyond the breast roll whereat initial web formation takes place. The minimum tension on the wire occurs generally in the region of the breast roll. As the wire passes over the suction boxes, a substantial frictional drag is applied to the wire and the tension on the wire is at a maximum between the suction boxes and the (first) suction couch roll. Depending upon the general type of the paper machine, this maximum tension in present day paper machines may range from as little as about 20 pounds per inch to as much as about 100 pounds per inch, but is usually about 30–60 pounds per inch (of width).

As a typical example of a modern-day paper machine operation, the wire may be about 200 inches wide and have a travelling speed of 2000 feet per minute with a total Fourdrinier load of 250 horsepower. The suction couch roll in such a paper machine is the drive roll. Since an appreciable amount of tension must be maintained on the wire at all parts of the travel thereof, the tension on the wire at the offrunning side of the suction couch roll is usually about 12 pounds per inch. The maximum tension between the suction boxes and the suction couch roll (or at the forward side of the suction boxes) is 12 pounds per inch plus the amount of tension imparted to the wire by the 250 horsepower work input at the couch roll, which may be calculated as follows:

$$\frac{250 \text{ H.P.} \times 33,000 \text{ ft.-lb./min.}}{2000 \text{ ft./min.} \times 200 \text{ in.}} = 20.6 \text{ lb./in.}$$

$$\text{Total max. tension} = 12 + 20.6 = 32.6 \text{ lb./in.}$$

The foregoing indicates the operating conditions for a typical paper machine; and operating conditions such as these have been used for a number of years in paper machines. The operation herein described often result

in a wire change about once every three to five days, which is necessitated by ordinary wear on the wire. The wire changes involves a production shut down of an appreciable period of time plus the cost of a new wire (which itself may be as much as \$4,000.00), although the production loss is the greatest financial loss here involved. For years, this has been recognized as one of the necessary costs of the operation of a paper machine because it was universally assumed that the wire wear was caused primarily by the suction boxes. It will also be appreciated that, in view of the extremely expensive nature of paper machines and also the highly developed skill of engineers installing such paper machines, the paper machine operators do not make random changes in the operation of the paper machines, nor do they look with any favor toward suggestions by their own or the installing engineers concerning radical departures in the paper machine arrangement. There is too much at stake to risk such substantial losses, when the operation of the usual paper machine was at least sufficient to produce what amounts to an economically adequate result.

For one thing, the general design of the forming wire itself has not changed appreciably over a number of years. The wire is actually a woven product obtained by weaving warp wires in generally parallel peripheral alignment with respect to the ultimate wire loop (or aligned in the direction of travel for the wire) with chute or cross-wires. Heretofore, the cross-wires were substantially straight or uncrimped extending generally perpendicular to the warp wires in the direction of travel, and the warp wires were woven in a generally serpentine configuration over one cross-wire, under the next, over the next, etc. This had been standard wire design for a number of years using the conventional bronze wires employed in the formation of the paper machine forming wire.

The instant invention, however, is based upon the discovery that certain specific alterations can be made in the wire design so as to increase the wire life several hundred percent, or to as much as two or three weeks. In combination with the alterations in the wire design or structure, it has also been found that altered drive means or driving arrangements can be used to obtain still greater wire life. For one thing, it has been found that altering the forming wire structure so as to employ substantially straight warp wires and pre-crimped or curving cross-wires to weave the serpentine path results in a unique improvement in wire life. Also, the use of this improved wire structure in an arrangement wherein driving of the forming wire is not carried out with the suction roll or suction couch roll, but rather is carried out using a plain surfaced roll or rolls results in a still greater improvement in wire life.

It is, therefore, an important object of the instant invention to provide an improved forming wire, and an improved method and apparatus for driving of the forming wire in a paper machine or the like.

Another object of the instant invention is to provide an improved Fourdrinier type paper making machine comprising a looped forming wire having an elastic modulus in tension of at least 15,000 pounds per inch of width, and a plurality of supporting rolls driving the wire peripherally of the loop.

Still another object of the instant invention is to provide an improved method of forming paper in a Fourdrinier type paper machine that comprises providing a looped forming wire with an elastic modulus in tension of at least 15,000 pounds per inch, flowing stock onto the wire, and frictionally engaging the wire to drive it over stationary suction boxes and a rotary suction couch roll to dewater the stock therethrough; and to provide an improved wire for use in said method.

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 diagrammatic view of a Fourdrinier machine wire arrangement;

FIGURE 2 is a detail top plan view of a portion of a forming wire of the type used in the prior art;

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

FIGURE 4 is a detail top plan view of a portion of a wire embodying the instant invention;

FIGURE 5 is a sectional detail view taken substantially along the line V—V of FIGURE 4;

FIGURE 6 is a sectional detail view taken substantially along the line VI—VI of FIGURE 4; and

FIGURE 7 is a detail sectional view similar to that of FIGURE 6, except showing a different embodiment of the instant invention.

As shown on the drawings:

In FIGURE 1, the wire arrangement for a Fourdrinier type machine indicated generally by the reference numeral 10 comprises a looped forming wire 11 and a plurality of rolls supporting the wire 11 including a perforate surfaced suction roll 12 (with suction area 12a) within the loop of the wire 11, a breast roll 13, a turning roll 14, and plain surfaced return rolls 15, 16 and 17, plus an adjustable tensioning roll 18.

The upper run 11a of the wire 11 passes over the breast roll 13, at which an inlet box 17 flows stock onto the upper run 11a of the wire 11. The direction of travel of the wire is indicated by arrows; and it will be seen that the wire passes over the breast roll 13 and travels forwardly therefrom over suction boxes 18 which are stationary and which dewater the web carried on the wire 11 as it passes over the suction boxes. The wire 11 then travels forward from the suction boxes 18 and over the couch roll 12 and then around the turning roll 14 and finally over the return rolls 15, 16 and 17 and the tensioning roll 18. There may, of course, be a number of additional return rolls positioned within or without the loop of the wire 11 in the prior art arrangement.

In the prior art machines, suitable drive means in the form of a motor 19 was connected to the couch roll 12 by any suitable connection and substantially the entire driving of the wire 11 was accomplished at the couch roll 12 so that substantially the entire tension change took place thereover. For example, in the prior art, the tension T_1 just after the suction boxes 18 would be 32.6 pounds per inch, and the tension T_2 just after the suction roll 12 would be 12 pounds per inch. The tension change over the turning roll 14 and the return rolls 15, 16 and 17 would be negligible so that the tension T_3 just before the suction boxes 18 would also be about 12 pounds per inch. In actual practice, the maximum tension T_1 between the suction boxes 18 and the suction roll 12 ranged in the prior art from at little as about 20 pounds per inch to as much as about 100 pounds per inch, although the maximum tension T_1 is usually 30 to 60 pounds per inch in most paper machines. The suction boxes 18 are stationary and they apply a rather substantial drag to the wire 11 passing over, so that the tension T_3 before the suction boxes 18 will often be found to be within the range of about 10% to about 50% of the maximum tension T_1 , but in no case in the prior art has T_3 exceeded 15 pounds per inch. Expressed in other terms, the tension increase ($T_1 - T_3$) across the suction boxes is usually about 10 to 60 pounds per inch; and in the prior art the couch roll furnished 80 to 100% of the wire drive, thus creating a tension drop $T_1 - T_2$ substantially equal to $T_1 - T_3$. Using an arrangement such as that here described in connection with the prior art, the wire 11 must be changed about every three to five days. In some instances helper drives are employed for the turning roll 14 and return rolls 15,

16 and 17 so that such rolls will be driven at the speed of the wire 11 to avoid frictional drag on the wire 11, but such helper drives did not impart in the prior art any actual drive to the wire 11 so as to effect a tension reduction thereover. As previously mentioned, a separate drive for the breast roll 13 is not ordinarily practical because it is important that the wire top run 11a be uniformly tensioned when it receives the stock from the head box 17.

Referring now to the actual distinctions shown in FIGURE 1 over the prior art, it will be seen that drive mechanisms are provided for each of the rolls 14, 15 and 16, as indicated diagrammatically at 14a, 15a, 16a and 17a, respectively. A main drive mechanism 15a (as here indicated with double lines interconnecting the drive mechanism 15a and the roll 15) is provided for the return roll 15. In the usual paper machine arrangement, the main drive 15a is a speed regulated drive which has direct mechanical connection to the motor; and as previously mentioned, the main drive heretofore was the drive for the couch roll 12. This change is particularly important, as will be brought out hereinafter, and in the instant device the main drive, which serves to control the actual wire speed, is the drive 15a for the return roll 15.

Torque regulated helper drive mechanisms 19, 14a, 16a and 17a are also used preferably in the practice of the instant invention to impart rotary movement to the rolls 12, 14, 16 and 17, respectively, but only the rolls 14, 16 and 17, which are imperforate surfaced rolls, are driven so as to actually assist in driving the wire 11. In helper drive mechanisms, the usual arrangement calls for a variable voltage D.-C. electric motor which drives the roll 14, 16 or 17 at predetermined torque to impart predetermined drive to the roll. As will be appreciated, a helper drive such as the helper drive 19 might be used merely to rotate the roll 12 for example at the speed of the wire so as to avoid dragging the wire over the roll; and this is also possible in connection with the operation of the rolls 14, 16 and 17, although not preferable. In actual practice, the paper machine of FIGURE 1 is preferably driven so that the maximum tension T_1 is about 55 pounds per inch, the tension T_2 at the offrunning side of the couch roll 12 is about 50 pounds per inch, the tension T_4 at the offrunning side of the turning roll 14 is about 45 pounds per inch, the tension T_5 at the offrunning side of the main drive roll 15 is about 30 pounds per inch, the tension T_6 at the offrunning side of the return roll 16 is 25 pounds per inch and the tension T_7 at the offrunning side of the last return roll 17 is 20 pounds per inch which is also substantially the tension T_3 at the oncoming side of the suction boxes 18. This results in an improvement in wire life, using the prior art wire structure, such that the wire life is increased to as much as two weeks; but it has been found that a comparable improvement in wire life can be obtained using the prior art drive arrangement and an improved wire structure to be described herein, or a still greater increase in wire life to as much as three weeks can be obtained using the improved wire structure herein described as well as the improved drive arrangement just described in connection with FIGURE 1.

Although it is not desired to limit the invention to any particular theory, it is now believed that there is an explanation for the unexpectedly superior results here obtained. First of all, elaborate tests have been made recently to ascertain the character of the forming wire and its various properties which might lead to answers to the various problems presented in this art; and it has been found that forming wires used in the prior art have all had an elastic modulus in tension of 6,000 pounds per inch to 10,000 pounds per inch, at the very best. A higher elastic modulus was not recognized as being desirable in the prior art. In fact, there was no appreciation in the prior art concerning differences in the moduli of elasticity or any possible effect that this particular

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property might have on wearing of the wire. As previously calculated, however, the tension change in a typical prior art paper machine (primarily across the couch roll) may involve as much as 20.6 pounds per inch. Since the prior art forming wire was elastic to a certain extent it follows that changes in length would have to take place at the point where changes in tension take place. Such changes are continuous in character and the magnitude thereof depends upon the speed of the traveling wire. For example, in a wire traveling at a speed of 2000 feet per minute and having a modulus of 8,600 pounds per inch, the change in length of the wire continuously taking place at the main drive couch roll of the prior art may be calculated as follows, where ΔL is the change in length:

$$8600 \text{ lbs./in.} = \frac{20.6 \text{ lbs./in.}}{\frac{\Delta L}{2000 \text{ ft./min.}}}$$

$$\Delta L = \frac{20.6 \text{ lbs./in.} \times 2000 \text{ ft./min.}}{8600 \text{ lbs./in.}}$$

$$\Delta L = 4.8 \text{ ft./min.}$$

This means that there was constant sliding or slipping, better described as "creepage," taking place between the wire and the driving couch roll in the prior art. This constant slippage or creepage resulted in excessive wear on the wire. This explains why greatly reduced wire wear can be obtained by driving the wire with an imperforate surfaced roll, such as the roll 15, which will not have the abrading effect on the wire that the perforate surfaced couch roll has. In this respect, the prior art concept of employing the couch roll as the main drive roll for imparting 80 to 100% of the drive to the wire is contradicted completely and, instead, it has been found that it is important to use plain surfaced rolls, such as the rolls 14, 15, 16 and 17 to impart 75 to 100% of the drive to the wire and, in fact, it has been found particularly advantageous to employ imperforate surfaced rolls 15 and 17, positioned outside of the loop of the wire 11, to impart at least 50% of the drive to the wire, and preferably as much as 75% or more. As will be appreciated, the advantages here obtained may be obtained using a tension drop of 0 or even less across the couch roll and across any other rolls positioned within the loop of the wire 11, if further advantage is to be taken of the use of driving rolls positioned outside the loop of the wire.

Still another important aspect of the instant invention, however, resides in the use of a forming wire of altered or improved structure, and this aspect of the invention can best be described in connection with FIGURES 2-7, inclusive. Referring first to FIGURES 2 and 3, it will be seen that the prior art wire W comprised a plurality of generally parallel warp wires 20, 21, 22, 23, etc. which were aligned peripherally with respect to the loop of the wire and extended in the direction of wire travel (as indicated by the arrow in FIGURES 2 and 3). Cross-wires 30, 31, 32, 33, etc. were also provided and the cross-wires were substantially uncrimped, or extended in straight lines. The warp wires, as indicated in FIGURE 3, passed over and under the cross-wires and wove a generally serpentine path, whereas the cross-wires remained substantially straight. This structure came about as a result of the particular weaving methods which have been used for some time in the prior art without any thought that a different structure could be used or might be desirable.

In contrast, the instant invention provides as one of its features the changing of the general structure of the forming wire W of the prior art so as to obtain a structure of a wire W' shown in FIGURES 4, 5 and 6. As will be seen in FIGURE 4, wherein corresponding elements are given primed reference numerals, there does not appear to be much difference in the top plan view

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of the wires W and W', but FIGURE 5 which is a view corresponding to FIGURE 3 shows clearly that the warp wire 21' is a straight wire, whereas the cross-wires 30', 31', 32', 33', etc. clearly weave a serpentine path over and under successive warp wires. This is also brought out in FIGURE 6, which shows a view at right angles to the view of FIGURE 5 and it will be noted that the overall appearance of the view of FIGURE 6 is comparable to the overall appearance of the view of FIGURE 3, but these views are taken at right angles to each other using different wire structures. In making the wire structure W', it may be desirable to pre-crimp the cross-wires 30', 31', etc. or it may be desirable to change the weaving apparatus to assure that the warp wires or longitudinally extending wires 20', 21', etc. will remain substantially straight. The change in structure embodied in the wire structure W' results in an increase in the elastic modulus (using the same bronze wires) at least up to 15,000 pounds per inch. This increase in elastic modulus greatly reduces the tendency for the wire to wear (far out of proportion to the mere increase in the modulus from that used in the prior art), thereby indicating that the wearing of the wire involves certain unknown factors.

It has been found, however, that increasing the elastic modulus in tension to at least 15,000 pounds per inch is of particular importance in obtaining advantages in reduction in wire wear. Changing of the wire structure to the structure W' here indicated is preferable, although certain other advantages may be obtained, for example, by using stronger metals such as "Monel" metal in weaving the forming wire and changing the sizes of the wires employed in weaving the forming wire. Particularly, it is advantageous to employ warp wires that are at least about twice as big as the cross-wires in cross-sectional area, and preferably even more up to about five times as big. The wire sizes may not be totally disproportionate. The increase in the modulus is, of course, unlimited as far as advantages of the invention are obtained, since a modulus of infinity would presumably result in no wear at all at a driving roll.

The arrows in FIGURES 4 and 5 indicating the direction of travel of the wire in these views bring out more clearly the differences in structure between the wire of FIGURE 2 and the wire of FIGURE 4.

In FIGURE 7, a view is shown comparable to the view of FIGURE 6 (i.e. at right angles to the direction of travel of the wire) for a different wire structure embodying the instant invention. In FIGURE 7, the warp wires 41, 42, etc. actually comprise a bundle of smaller wires formed together in a cable, the smaller wires being indicated as 41a, 41b, etc. and 42a, 42b, etc. The cross wires 51, 52, etc. are, of course, crimped or weave a serpentine path over and under successive warp wires in the manner hereinbefore described, whereas the warp cables 41 and 42 remain substantially straight. In the embodiment of FIGURE 7 a plurality of wires 41a, 41b, etc. are combined in the cable 41 so as to obtain a cross-sectional area in the cable 41 that is about three or four times as big as the cross-sectional area of the cross wire 51, but a combination of wires 41a, 41b, etc. is used in order to impart the desired flexibility to the warp cable 41 while effecting the desired increase in the elastic modulus in tension.

In its broadest aspects, the invention herein resides in an improved method of forming paper in a Fourdrinier type paper machine, that comprises providing a looped forming wire W' with an elastic modulus in tension of at least 15,000 pounds per inch, flowing stock onto the wire and, frictionally engaging the wire to drive it over stationary suction boxes and a rotary suction couch roll to dewater the stock therethrough. Also, an aspect of the invention comprises carrying out the foregoing process while maintaining the warp wires in the forming wire W' in substantially straight alignment in the direction of travel over the suction box. The wire must, of course,

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be supported with at least one perforate surface in the form of the suction boxes and another perforate surface in the form of the couch roll and the wire must be driven over these surfaces. As the wire W' is urged over such perforate surfaces as the suction boxes 18 and the couch roll 12, the wire is also urged against both of these perforate surfaces by creating a pressure differential across the wire.

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. In a Fourdrinier type paper making machine, a looped forming wire having substantially straight warp wires in generally parallel peripheral alignment extending in machine direction and cross wires extending transverse to machine direction and woven over and under successive warp wires, and a plurality of rolls supporting the wire loop and driving the wire peripherally of the loop.

2. In a Fourdrinier type paper making machine, a looped forming wire having substantially straight warp wires in generally parallel peripheral alignment extending in machine direction and cross wires extending transverse to machine direction and woven over and under

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successive warp wires and about one-half to one-fifth the cross-sectional area of the warp wires, and a plurality of rolls supporting the wire loop and driving the wire peripherally of the loop.

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