WOVEN WIRE BELT FOR PAPER MAKING MACHINES

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This invention relates to woven wire belts for Fourdrinier paper making machinery. The belt consists of a continuous band of fine wire mesh generally of corrosion resistant metal, such as Phosphor bronze, which when moved over the rolls, suction boxes and equipment are generally subjected to flexing and work hardening, some corrosion and quite bit of abrasion. These belts have relatively short life under a variety of conditions, and it is highly desirable to increase the life of the belts because of the high costs involved in changing them and the high cost of the belts themselves.

Fourdrinier wire belts must have certain characteristics of porosity, uniformity as well as the desired tensile strength, and to provide the optimum characteristics the belts must generally been made of certain types of Phosphor bronze, sometimes with brass weft wires, although Phosphor bronze weft wires have also been used.

The primary function of this Fourdrinier wire mesh is to remove the water from the paper stock in the paper sheet formation. The warp wires generally take the wear and tension as well as most of the fatigue in the operating process.

As an example of the materials, Phosphor bronze alloys were used, about 6 percent tin with the balance copper, but the phosphorous was not controlled. Tougher wires were obtained by using an alloy of 8 percent tin and controlling the phosphorous. The present alloys use possibly 7 or 8 percent tin and phosphorous in the range 0.2 to 0.3 percent, although brass still may be regarded as a satisfactory weft or filler wire costing somewhat less than the Phosphor bronze. In some cases where corrosion is important, use is made of Phosphor bronze alloys containing 3 percent tin for the filler or weft wires. (See article, The Manufacture and Use of Fourdrinier Wire Cloth, by H. E. Hose and J. P. Johnson, Wire and Wire Products, March 1952, p. 249.)

In connection with some uses of Fourdrinier wire a particular problem of belt life has developed in semi-chemical pulp mills whereas in other types of paper making machines round cross section Phosphor bronze Fourdrinier wires have developed useful life expectancies of several weeks. In these semi-chemical pulp mills the life because of the corrosion conditions is reduced to somewhere between five and ten days. A more usual experience is near a limitation of five days. The matter of belt life is important not only in respect to the cost of belts themselves but in respect to the loss of production time, and it has been calculated as costing in the range of $300–$800 an hour of down time.

To improve the results various efforts have been made to develop other materials, and stainless steel Fourdrinier belts have been attempted on numerous occasions. The various efforts with respect to producing stainless steel belts have been fraught with difficulty. Stainless steel is satisfactory so far as tensile strength, corrosion and abrasion resistance, but it has not been found that the alloys presently available could stand up under the reverse bends encountered on a paper machine. Stainless steels would work harder too fast. Fourdrinier wires made of these alloys fail by fatigue, cracking, etc. long before they are worn out with a resultant operational cost which cannot be justified when compared with the cost of Phosphor bronze. (See article by H. E. Hose and J. P. Johnson, Wire and Wire Products, March 1952.)

The main causes of failure have been work hardening, abrasion and corrosion. Abrasion results from the slipping of the wire on the couch roll and dragging on the suction boxes and table rolls. (See "Some Causes of Wear of Fourdrinier Wires," published March 1951 in PulP and Paper, Canada, p. 87.)

A very simple explanation has been provided for the failure of stainless steel wires under certain conditions in the following citation, which citation explains that where stainless steel wires have been tried they have repeatedly failed with dismal results and fractures which developed quite rapidly, generally because of the work hardening under reverse bends. A simple study of the stress involved showed that because of the high modulus of elasticity (29,000,000) of stainless steel and the low endurance strength (25,000 p.s.i.) of stainless steel in comparison with Phosphor bronze which has a modulus of elasticity for 5 to 8 percent Phosphor bronze of 12,000,000-13,000,000 that the stainless steel can only stand about one-quarter of the strain of Phosphor bronze.


Accordingly, 1,000,000 cycles is considered good life for a Fourdrinier wire at 90,000 p.s.i. stress (TAPPI, May 1954 (vol. 37, No. 5), p. 207, "Mechanics of Stress and Strain Occurring in a Fourdrinier Wire," by John Lyall.)

We have, therefore, attempted to develop a Fourdrinier wire in the face of this known failure of stainless steel, and we find we have been able to produce it in a particular combination of a strand of a multiplicity of fine stainless steel wires cabled around a core of a copper alloy or other corrosion resistant alloys of a copper brazing alloy, such as Phosphor bronze, or any alloy which would form a suitable interfacial bond with the stainless steel.

In connection with stainless steel, we make the stainless steel of the AISI 300 series, such as type 304, i.e., 18 percent chromium, 8 percent nickel steel, and types 316, 317, 321 and 347, or any corrosion resistant alloy. The primary object of the present invention is to provide an improved Fourdrinier wire belt made from round cross section wires and embodying characteristics of fatigue, strength, mesh and porosity, comparable to the usual wire belts but having improved wear and fatigue properties, as well as corrosion resistance.

The objects relating to the foregoing are to provide such a belt that will withstand the wear and acid conditions involved in the semi-chemical pulp mills and the like in order to attain greatly increased life and to enable the belts with the aforesaid characteristics to be made of a material that is of high strength, good wear and fatigue characteristics and which is corrosion resistant. We have accomplished our purpose by means of a strand of stainless steel wire which is drawn and brazed around a core.

A further object of the present invention is to develop an improved Fourdrinier belt made primarily from stainless steel employing smaller diameter wires which are brazed together around an alloy of copper to provide a belt of improved flexibility, corrosion resistance and wear resistance that will not have the objectionable cold working and fatigue of a stainless steel wire belt in and of itself.

A still further object of this invention is to provide an improved Fourdrinier wire belt for all types of pulp mills where the abrasion resistance and work hardening char-
characteristics of stainless steel would be particularly advantageous.

Other objects and further objects of the present invention will be apparent from the following description and claims, and are illustrated in the accompanying drawings, which, by way of illustration, show a preferred embodiment of the present invention and the principles thereof, and what is now considered to be the best mode in which to apply these principles. Other embodiments of the invention embodying the same or equivalent principles may be used and structural changes may be made as desired by those skilled in the art without departing from the invention.

In the drawings:

FIG. 1 is a schematically perspective view of a Fourdrinier belt embodying the features of the invention;
FIG. 2 is a perspective view of the inner or wear surface of the belt;
FIGS. 3 and 4 are cross-sectional views taken respectively along the lines 3-3 and 4-4 of FIG. 2;
FIG. 5 is a greatly magnified, sidewise elevational view of one of the warp strands of the belt; and
FIG. 6 is a cross-sectional view of the strand shown in FIG. 5.

For purposes of disclosure the invention is schematically illustrated in FIG. 1 of the drawings as being embodied in a Fourdrinier wire belt 10 made from woven wire mesh, and having the ends joined by a conventional seam 11. The wire mesh from which the belt 10 is made is shown at an enlarged scale in FIG. 2 which illustrates the inner or wearing surface of the belt, and the wire mesh of the belt is made up of weft wires 19 and warp wires 20. The wires 19 and 20 may be of the same diameter and the weft wires 19 are of solid round cross section and are made of stainless steel. However, the warp wires 20, under the present invention, are of a special form and construction which enables these wires to provide good wear resistance while at the same time providing a high degree of corrosion resistance and good characteristics of flexibility which enable the warp wires 20 to undergo the repeated bending required in the paper making machine without objectionable cold working or fatigue.

Of course, it will be understood that the weft wires 19 being of solid material may be of other material resistant to the corrosion conditions which are not as severe on the weft wires, and these weft wires may be of Phosphor bronze, possibly nickel-plated wires, under some conditions plastic-coated wires and under other conditions possibly brass wires or three percent tin Phosphor bronze.

In connection with this material, Phosphor bronze may be used as well as other copper alloys particularly brazing alloys having melting points above 800°F. and providing an interfacial bonding with the stainless steel. These would be the 4-9 percent tin, 0.2-0.3 percent phosphorous, with the balance copper, Phosphor bronze as well as other copper alloys.

It will be recognized that different weaves may be employed, particularly those woven in the art, but as herein shown, the wire mesh from which the belt 10 is made is woven in an over one, under two twist pattern so that the warp wires on the inner surface of the belt provide long knuckles 120 for engagement with the opposed surfaces in the machine, such as the surfaces of the rolls, the suction boxes and the like.

On the outer or forming surface of the mesh the warp wires 20 have shorter knuckles 220. Similarly, but in a reverse relation, the weft wires 19 have long outer knuckles 119, and shorter inner knuckles 219, it being noted, however, that the weft knuckles 119 and 219 are less pronounced than the warp knuckles, as is well known in the wire failing of this general type.

The warp wires or strands 30 are made up of a plurality of outer wires 22 stranded about a core wire 21, and the core wire and the two outer wires are united by an intermediate or internal matrix 24 of a brazing material, such as Phosphor bronze. The specific manner in which the strand 20 is produced is illustrated in the copending application of Ardelle Glase, Serial No. 15,398, filed March 21, 1960, and the details of the production of the strand are incorporated herein by reference to the aforesaid application.

BROADLY CONSIDERED, the strand 20 is made from an initial strand of seven wires which is drawn as a unit to the form shown in FIG. 6 of the drawing. The initial strand embodies a quantity of brazing material uniformly distributed throughout the length of the strand, and in the annealing operations that are involved in the drawing, the brazing material flows between the adjacent surfaces of the several wires of the strand so as to form the matrix 24. The matrix 24 unites the drawn brazed strand 20 with an interspersed bonding material, and yet the drawn brazed strand 20 is capable of repeated flexure and reverse bending to the extent required in paper making machines without objectionable cold working and with improved fatigue resistance.

The strands 20 are drawn and are made so that the end wires 19 are of extremely small diameter, in the order of one one-hundredth of an inch or less, and since the weft wires 19 are made of stainless steel and the warp strands 20 are made primarily from stainless steel the fabric as a whole possesses high strength so as to maintain uniformity of mesh and be free of slenderness; and since both the warp and weft present wearing surfaces of stainless steel, the wear characteristics of the belt 10 are unusually good. Moreover, the stainless steel of the weft wires 19 and the warp strands 20 is highly resistant to corrosion so that in use there is no appreciable weakening of these wires due to corrosion. The warp and weft wires, of course, are soft annealed so as to be adapted for the weaving operation.

The drawn brazed stainless steel warp strand 20 and the solid stainless steel weft wires 19 thus present the same general characteristics of high strength, high resistance to wear, and high resistance to corrosion, but, in addition, and in cooperation with such desirable common characteristics, the drawn brazed stainless steel warp strand 20 which is subject to the greatest crimping action in the weaving process, and which is subjected to high speed and repeated flexure and reverse bending in the use of the belt, possesses different characteristics of flexibility and bendability. The solid wire 19 and the 20 so that these different characteristics contribute material advantages in the weaving operation as well as in preventing or delaying fatigue failure of the belt when in use.

Thus, in respect to the weaving operation, it is recognized that it is desirable to attain a relatively high weft count in woven goods to fabricate for paper machine wires, and this is dependent at least in part on the action of the warp wires in the beating operation. When the beating operation is performed, the extent to which the new warp wire may be forced or bent toward the previous weft wire is determined in a large measure by the relative stiffness or flexibility of that warp wire, and care must be exercised to avoid crimping of the warp wires to an excessive extent beyond the elastic limit of the metal from which they are made. With the warp made from the drawn brazed stainless steel strand 20 it has been found that the beating operation may be performed and carried to an extent comparable to the beating operation that is normally used in fabrics made from Phosphor bronze, so that comparative porosity may be attained in the woven wire fabric of this invention, and in this beating operation the strand 20 is crimped to the desired extent without unduly exceeding the elastic limit of the material from which the strand 20 is made.

In the beating operation, the matrix 24 of the strand 20 maintains the individual outer wires 22 of the strand 20 in fixed relation to each other so that the outer wires 20 do not become separated at the knuckles such as the relatively sharp outer knuckles 220, and hence the warp
strands 20 present smooth outer surfaces that cooperate with the fibers of the paper pulp in the normal and expected manner.

The strand 20, because of the novel characteristics of relative flexibility above described, also possesses high resistance to fatigue in the use of the belt. Thus, when the warp wires 20 of the belt are repeatedly flexed during high speed operation of the paper machine, such fixture produces no objectionable cold working of the metal, and this is particularly important and constitutes an unexpected achievement in that stainless steel when used in the prior experimental paper machine belts has failed in most instances because of the cold working and fatigue of the warp wires. We are unable to determine precisely why this fatigue resistance is obtained where the wire or strand 20 is made almost entirely from stainless steel, but we believe that it is due primarily to the stranded character of the wire 20 which enables the required degree of bending to take place somewhat in the same manner as in the individual strands of a cable or the like, and the fineness factor of the individual elements of the drawn braided strand imparts a feature allowing fine wire to endure a great deal more flexing than coarser or solid wire. In practice, however, it has been determined that the fixture of the warp strands 20 does not induce appreciable cold working or fatigue of the metal of the strand, and this contributes in a large measure to the successful use of stainless steel as the basic material of the warp wires in the belt.

With experimental belts constructed as above described a run of thirty-four days has been obtained in a semi-chemical pulp mill, and this represents a great advance over the usual or expected five day life that has been obtained from prior art Fourdrinier belts. Furthermore, it may be pointed out that failure of the present belt in the aforesaid test was not caused by tears or breaks in the body of the wire mesh, but was caused by failure at the seam 11.

From the foregoing description it will be apparent that the present invention provides an improved Fourdrinier belt having improved characteristics which render the same useful in all types of paper mill operations including use in highly acid environments, and that the belts of the present invention possess an extremely long useful life so as to provide a great saving insofar as loss of machine time may be concerned.

Thus, while we have illustrated herein a preferred embodiment of our invention, it is to be understood that changes and variations may be made by those skilled in the art without departing from the spirit and scope of the appending claims.

We claim:

1. Woven wire fabric for paper making machines comprising interwoven warp and weft wires, said warp wires being drawn brazed cabled strands in which the outer elements are formed from stainless steel and are united throughout their length by an internal matrix of copper material.

2. Woven wire Fourdrinier belt for paper making machinery comprising interwoven warp and weft wires, said warp wires being of cabled stainless steel wire being formed from drawn brazed cabled wire with the outer elements of stainless steel and the core of a corrosion resistant copper alloy, said weft wires being of strong corrosion resistant material.

3. The fabric of claim 1 in which the weft wires are of stainless steel.

4. The fabric of claim 1 in which the copper material is Phosphor bronze.

5. The fabric of claim 1 in which the warp wires are of austenitic stainless steel.

6. Woven wire fabric for paper making machinery comprising interwoven fine gauge warp and weft wires of smooth round cross section, said warp wires being drawn brazed and cabled strands having individual outer wires of stainless steel with the outer wires forming a smooth rounded sector shaped cover, a core wire forming a polygonal shaped brazed interfacial bond between said stainless steel wires, said core extending in a thin filament between said sector shaped stainless steel wires.

7. Woven wire fabric for paper making machines comprising interwoven fine gauge warp and weft wires of round cross section and with knuckles produced in both warp and weft wires, said warp wires being drawn brazed strands having individual outer wires and a core wire, at least the outer wires being of stainless steel, and with the cross sections of the outer wires in the form of truncated sectors and of the core wire in the form of a polygon having its sides opposed to the inside surfaces of the truncated sectors of the outer wires, and a matrix of brazing metal disposed between the opposed surfaces of the wires of the strand throughout the length of the strand and brazed to such opposed surfaces.

No references cited.