July 4, 1967 V. A. STANTON 3,329,378

WOVEN WIRE CLOTH FOR FOURDRINIER MACHINES

Filed March 4, 1966

Fig. 1.

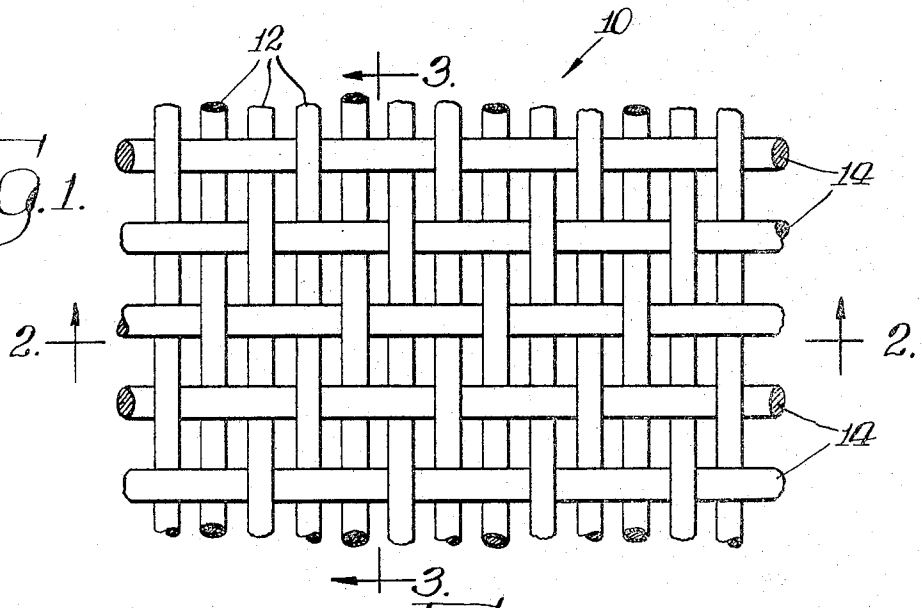


Fig. 2.

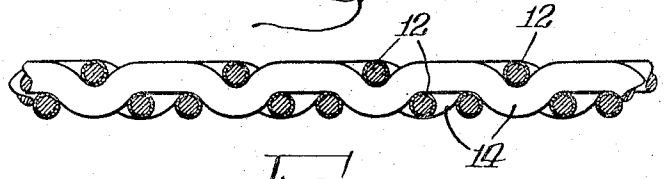


Fig. 3.

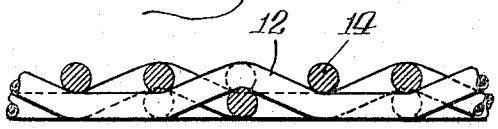


Fig. 4.

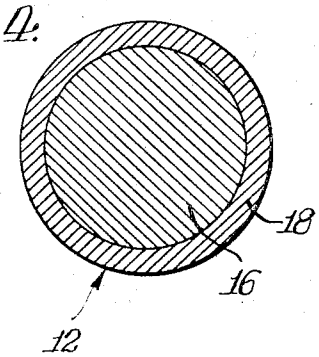
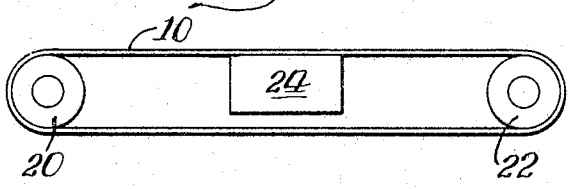


Fig. 5.



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WOVEN WIRE CLOTH FOR FOURDRINIER MACHINES

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8 Claims. (Cl. 245—8)

This application is a continuation-in-part of my pending application Ser. No. 465,231, filed May 24, 1965 which in turn is a continuation-in-part of my application Ser. No. 383,184, filed July 16, 1964 (now abandoned).

The present invention relates to woven wire cloth of the type which is seamed at its ends to form a continuous wire belt for use on Fourdrinier paper-making machines.

In the manufacture of paper on a Fourdrinier machine, it is common to utilize a woven wire cloth in the form of a continuous endless belt which mounted over a pair of rolls, one of which is rotated to drive the woven wire cloth around the rolls and across a suction box disposed between the rolls. Fourdrinier wire cloth is thus subjected to continuous stress and abrasion and must be replaced with some frequency due to wear, fatigue failure, etc., and such replacement is an expensive operation due to the fact that the very costly paper-making machinery must be taken out of service to permit the removal of the old wire cloth and the installation of a new one.

Heretofore, it has been common to weave Fourdrinier wire cloth from warp and weft or shute wires wherein the warp wires are made of phosphor bronze containing approximately 92% copper and 8% tin and the shute wires are made of brass containing approximately 85% copper and 15% zinc. The foregoing known warp and weft wires for Fourdrinier cloth have reasonably satisfactory weaving characteristics and can be usually seamed with good results by using a conventional 1223 degrees F. melting point alloy comprising 54% silver, 22% copper and 24% zinc. However, such materials are not particularly well adapted to withstand the hard wear which is encountered when used on a Fourdrinier machine, and thus their operational life is relatively short, such life varying from one week to a few months depending upon the speed of the machine, the type of paper being manufactured, etc. In a Fourdrinier wire cloth the warp wires extend lengthwise in the direction of movement of the endless belt, while the weft or shute wires are transverse to such direction of movement. It is the warp wires which are subjected to the greatest wear and abrasion and which necessitate the replacement of Fourdrinier wire cloths at rather frequent intervals.

Attempts have been made to extend the life of Fourdrinier wire cloths by utilizing warp wires made of stainless steel which is hadrer than the conventional phosphor bronze material used for the warp wires and will tend to wear longer. However, such efforts have not met with much success due to several problems which more than offset the greater hardness provided by the stainless steel. For example, where stainless steel warp wires are utilized, it is generally necessary to also use stainless steel shute wires, even though the latter are not subjected to excessive wear, because if a softer alloy such as brass or bronze is used for the shute, the stainless warp wires will adversely affect the shute during the weaving operation and cause the shute to be powdered out or cut in two. Accordingly, there is the significant additional expense of providing stainless shute wires even though the latter are not subject to any particular problem of wear.

Another problem results from the fact that stainless steel has the relatively high modulus of elasticity of 28×10^6, and when a solid stainless Fourdrinier wire cloth is run around the rolls of the paper-making machine, it

has a greater tendency to fail by cracking due to fatigue stresses than the phosphor bronze warp wires normally used for Fourdrinier. In addition, as indicated hereinabove, Fourdrinier wire cloth is seamed at its ends to form a continuous endless belt, and the stainless cloth is more difficult to seam than the usual bronze cloth, and some tests have shown that there is more than a normal tendency for stainless steel Fourdrinier wire to fail at the seam. Accordingly, while the hardness of stainless steel will offer certain advantages when used for Fourdrinier wire cloth, it has not come into extensive use for such purpose due to various problems not heretofore solved.

It is an object of the present invention to provide an improved Fourdrinier wire cloth having an unusually long life.

Another object of the invention is to produce Fourdrinier wire cloth as last above mentioned having a relatively hard core and a relatively soft outer layer, the soft outer layer being provided to improve the seaming and weaving characteristics of the wire and reduce the modulus thereof, and being of a thickness which will wear away in certain areas to expose the hard core material after relatively short use on a paper-making machine.

In furtherance of the foregoing objects, and in accordance with a preferred embodiment of the present invention, I provide Fourdrinier wire cloth comprised of warp wires made with a stainless steel core and having an outer layer of copper thereon. The outer copper layer will wear off on the machine side during use of the wire cloth on a paper-making machine sufficiently to expose the inner core of stainless steel. Such exposure of the hard inner core usually occurs within about 24 hours of use or less, because initially there is line contact between the warp wires and machine components such as a suction box causing relatively rapid reduction in the wire cross-section, and as the bearing area increases, the effect of wear on the cross-section of the wire is lessened. Because the copper will wear primarily on the machine side of the wire cloth, such wear will not normally have any significant effect on the mesh of the cloth, and yet the hard stainless core will be exposed in the area which is subjected to the greatest wear in order to substantially extend the life of the cloth.

In addition, because the cross-sectional area of the hard stainless steel core is significantly less than the overall cross-sectional area of the warp wires, the relatively high modulus of elasticity of the stainless is much less of a problem insofar as fatigue failure is concerned, since the effective modulus of the composite wire is reduced. For much the same reason, the weaving characteristics of the composite wire having a relatively hard core and relatively soft outer layer are considerably improved over the characteristics of solid stainless, and even over the usual Phosphor bronze, while offering substantially the same advantages as solid stainless insofar as longer life is concerned. The composite wire cloth is also easier to seam, since the copper can often be seamed with a lower melting point alloy than stainless. A further important advantage of the copper-coated stainless relates to the fact that it is not necessary to use stainless shute wires in combination with the stainless warp wires, and instead softer and less expensive materials such as brass or bronze can be used for the shute. The latter use is possible because the copper outer layer on the stainless steel warp wires will prevent the shute wires from being powdered out or cut in two by the stainless during the weaving operation.

The foregoing and other objects and advantages of the invention will be apparent from the following description thereof.

Now in order to acquaint those skilled in the art with the manner of utilizing and practicing my invention, I shall

describe, in conjunction with the accompanying drawings, certain preferred embodiments of the invention.

In the drawings:

FIGURE 1 is a fragmentary plan view of a Fourdrinier wire cloth constructed in accordance with the present invention, the cloth being of conventional twill weave wherein a warp wire passes over one shute wire, under two shute wires, over one shute wire, etc.;

FIGURE 2 is a fragmentary sectional view, taken approximately along the line 2—2 of FIGURE 1, showing in cross section a plurality of warp wires having a stainless steel core and a copper outer layer;

FIGURE 3 is a fragmentary sectional view, taken approximately along the line 3—3 of FIGURE 1, showing in cross section a plurality of shute wires made of a solid material such as brass;

FIGURE 4 is an enlarged cross section of a warp wire showing a hard stainless steel core having a copper outer layer formed thereon; and

FIGURE 5 is a schematic elevational view showing a Fourdrinier wire cloth mounted on the rolls of a paper-making machine and disposed adjacent a suction box over which the cloth is adapted to be driven.

Referring now to the drawings, there is shown a Fourdrinier wire cloth **10** comprised of a plurality of warp wires **12** and shute wires **14** which are woven in a conventional twill weave wherein each warp wire passes over one shute wire, under two shute wires, over one shute wire, etc. The present invention relates primarily to Fourdrinier wire cloth in meshes in the range of 40 to 100 i.e. 40 to 100 warp wires per inch. By way of example, a 55 mesh wire cloth has 55 warp wires per inch and about 32 to 36 shute wires per inch, and an 80 mesh wire cloth has 80 warp wires per inch and about 62 to 72 shute wires per inch. The diameters of the warp and shute wires vary in accordance with the mesh, and for a 40 mesh the warp would have a diameter of approximately 0.014 inch and the shute would have a diameter of approximately 0.0165 inch, whereas with a 100 mesh the warp would have a diameter of approximately 0.00475–0.00525 inch and the shute would have a diameter of approximately 0.006–0.0065 inch. Accordingly, in Fourdrinier wire cloth of the type to which the present invention relates, the diameter of the warp wires will be in the approximate range of 0.00475 to 0.014 inch, and the diameter of the shute wires will be in the approximate range of 0.006 to 0.0165 inch. The warp wires **12** thus lie in a range of .00001257 to .0002011 square inch in cross-sectional area.

In accordance with the invention, the warp wires **12** are composite wires comprised of a hard inner core **16** and a relatively soft outer layer **18**. The inner core **16** is preferably stainless steel, although in certain instances other materials such as carbon steel may be used as the core material. Certainly, various types of stainless steel may be used depending upon the particular application, but the core material should have an annealed tensile strength of at least 80,000 p.s.i. and must have adequate corrosion resistance to the paper-making solution. The outer coating **18** on the warp wires is of substantially pure copper which can be electrolytically plated on the stainless at a reasonable cost, whereas the cost of plating heavy weights of certain other materials such as bronze would be prohibitive.

One of the advantages of the copper-coated stainless warp is that the copper is easier to seam than the stainless and provides a more durable seam. Thus, it is normally possible in the manufacture of a continuous Fourdrinier wire cloth to seam the warp ends by using a conventional silver alloy having a melting point of 1223 degrees F. and comprised of 54% silver, 22% copper and 24% zinc, whereas solid stainless normally requires a much higher melting point alloy and the seam is substantially less reliable. It should be understood however that in certain applications it may be found desirable to use a gold alloy for

seaming the copper coated stainless warp of the present invention, one example of such alloy being gold flush comprising 82% gold and 18% nickel, with a 50% by weight nickel core. Insofar as the seaming characteristics are concerned, the amount of the copper coating is not critical, and very thin coatings could be used, although in order to achieve substantially all of the objectives of the present invention, the copper coating should comprise at least approximately 10% by weight of the overall composite warp wires, as will be explained more fully hereinafter.

It is important to provide Fourdrinier wire having a warp which is as hard as possible for wear and yet soft enough to have good weaving characteristics and resistance to cracking due to fatigue stresses. In accordance with the present invention the diameter of the stainless steel core is significantly less than the overall diameter of the composite warp wire, and the outer layer of the warp is relatively soft copper. Thus, the effective modulus of elasticity of the composite warp is substantially less than 28×10^6 which would be the modulus if solid stainless were used. Such an arrangement increases the resistance of the Fourdrinier wire to fatigue failure during use, and it substantially improves the weaving characteristics of the warp. In addition, the copper coating lessens reed wear and makes weaving easier than would be the case with solid stainless, since the lubricating effect of the copper decreases the tendency for the stainless to seize and gall the reed. The composite warp wire of the present invention has been found to provide weaving characteristics superior to the phosphor-bronze warp heretofore used. At the same time, the copper outer layer will wear off on the machine side of the wire cloth so as to expose the stainless core after a relatively short time, e.g. 24 hours or less, so that the advantages of the stainless core relative to hardness and longer life are present substantially to the same extent as if a solid stainless warp were used, but without the several disadvantages of the latter.

A further advantage of the copper coating on the stainless is that the stainless core for the warp wires will not be permitted to adversely affect the shute wires, and thus the latter need not be stainless steel and can be made of softer materials such as brass or bronze which are not only less expensive than stainless but also are substantially easier to weave. Examples of such materials which can be used for the shute wires are 83–17 brass or 3% bronze. Brass can normally be used for the shute, but bronze may be preferred where a corrosion problem exists. Various other materials may also be used for the shute in certain applications, but it is preferable that the shute be of a material which is substantially softer than the stainless steel core of the warp, and which has a substantially lower modulus of elasticity than the stainless and a maximum tensile strength of 75,000 p.s.i. In addition to the advantages mentioned hereinabove, the soft copper coating on the warp and the soft shute such as brass provide an interlocking effect which results in less sleaziness.

In order to achieve the advantages of the present invention as discussed hereinabove, it has been found that the outer copper coating for the warp should comprise 10% to 50% by weight of the composite warp wires, the remainder comprising the stainless core. More specifically, it is believed that a preferred range is 20% to 30% copper by weight, the preference being for reasons of economy not to use substantially more copper than is required to achieve the objectives of the invention, and yet provide enough copper to lower the modulus of elasticity of the composite warp wire sufficiently to produce optimum weaving characteristics and resistance to fatigue failure. In addition, by reducing the moduls, there is less load applied to the seam, and this is important, particularly with high speed paper-making machines. By using relatively large amounts of copper, more protection is provided for the soft shute during the weaving operation. The foregoing ranges have been expressed in percent by weight of copper, although the following table provides certain addi-

tional data correlating such percentages with the thickness of the copper coating for a given diameter warp wire.

Total Diameter of Warp Wire (inch)	Thickness of Copper Coating (inch)		
	(10% By Weight)	(25% By Weight)	(50% By Weight)
0.006	0.000135	0.00036	0.00081
0.007	0.0001575	0.00042	0.000945
0.008	0.00018	0.00048	0.00108
0.009	0.0002025	0.00054	0.001215
0.010	0.000225	0.0006	0.00135
0.011	0.0002475	0.00066	0.001486
0.012	0.00027	0.00072	0.00162
0.013	0.0002925	0.00078	0.001755

It will be understood for purposes of the invention that the warp wires need not necessarily be of true circular cross-section. The warp wires may, for example, be flat or oval like in cross-section. For example, warp wire of an original diameter of .0085 inch may be flattened to provide a cross-section measuring .0075 x .00975 inch. An advantage of flat warp is that it provides lateral stability and overcomes the tendency of developing longitudinal ridges especially in high speed paper-making machines.

Typical fourdrinier wire cloth embodying flat warp may, for example, comprise 59 warp wires and 51 shute wires per inch in an over one and under two weave. The shute wires may be of any of the foregoing materials of the present invention and may typically be of a diameter of .011 inch. The foregoing flat warp wire may be used as a replacement for fourdrinier wire embodying 68 warp wires and 52 shute wires per inch in which the warp wires measure .00775 inch in diameter and the shute wires measure .009 inch in diameter. In comparing the last two examples the volume of metal in the flat warp is about 45% greater in the shute direction than round warp and the flat warp fourdrinier cloth is much stiffer in the lateral direction. Other typical examples of flat warp constructions may comprise 63 warp wires and 57 shute wires per inch with the warp wires measuring .00725 x .009 inch in cross-section and the shute wires .009 inch in diameter, and 68 warp wires and 65 shute wires per inch with the warp wires measuring .00675 x .0075 inch in cross-section and the shute wires .0085 inch in diameter. As above described round warp wires of the present invention lies in a range of .016 to .004 inch in diameter or in a range of .0002011 to .00001257 square inch in cross-sectional area. The flat warp wires of fourdrinier cloth of the present invention also lie in the foregoing range of cross-sectional areas of .0002011 to .00001257 square inch.

FIGURE 5 shows the wire cloth **10** formed as a continuous endless belt and mounted on the rolls **20** and **22** of Fourdrinier paper-making machine for passage across a suction box **24**, the direction of movement of the wire cloth **10** being in the direction of the warp wires, the latter being the wires which are subjected to wear which occurs primarily on the inside or machine side of the wire such as from passing across the suction box. It will be understood by those skilled in the art that a paper solution is passed over the wire **10**, and the mesh of the wire is fine enough to prevent the fibers from passing through, but coarse enough to allow the water to be pulled through by vacuum, whereby a wet sheet of paper is left on the moving wire, which paper is picked off the wire and passed through dryers, etc. to produce rolls of paper. It will be, of course, noted that FIGURE 5 is merely a schematic diagram to illustrate the use of Fourdrinier wire, and only a few basic components of a paper-making machine are shown, inasmuch as machines of this type are well known in the art and art almost universally used for paper manufacturing.

I have described hereinabove a preferred embodiment of the present invention wherein the inner core **16** of the warp wire is made of a material having an annealed strength of at least 80,000 p.s.i. and preferably is stainless steel, and wherein the outer coating on the warp wires is of substantially pure copper. However, certain variations in the foregoing criteria may be adopted while still achieving most of the important advantages of the invention. Thus, I have found that while the inner core need not necessarily comprise stainless steel, it should have a high modulus of elasticity of at least 25×10^6 p.s.i., and preferably the modulus of elasticity of the inner core should be in the range of 25×10^6 p.s.i. to 31×10^6 p.s.i. Moreover, while the outer coating need not necessarily be comprised of substantially pure copper, such coating material should have a modulus of elasticity which is substantially less than the modulus for the core material. Thus, the outer coating material should have a modulus of elasticity which does not exceed 20×10^6 p.s.i., and preferably the modulus of elasticity of the material for the outer coating **18** should be in the range of 15×10^6 p.s.i. to 20×10^6 p.s.i.

While I have described my invention in certain preferred forms, I do not intend to be limited to such forms, except insofar as the appended claims are so limited, since modifications and changes within the scope of my invention will readily occur to those skilled in the art, particularly with my disclosure before them.

I claim:

1. In twill type fourdrinier wire cloth for a paper making machine, comprising warp wires having a stainless steel core resistant to corrosion by paper making solutions and having a modulus of elasticity of at least 25×10^6 p.s.i., and a metallic coating on said core, said coating being characterized by being adapted to be worn away at the machine side to expose said cores of said warp wires in a relatively short period of time of operation of said fourdrinier wire in a paper making machine as compared to the period of time of the normal life of said fourdrinier wire, and shute wires of a metal softer than said cores of said warp wires and having an annealed tensile strength substantially less than 80,000 p.s.i.

2. The twill type fourdrinier wire of claim **1** in which said metallic coating comprises approximately 10 to 50% by weight of said warp wires.

3. The twill type fourdrinier wire cloth of claim **1** in which said cores of said warp wires have a modulus of elasticity in the range of 25×10^6 p.s.i. to 31×10^6 p.s.i., and in which said coatings have a modulus of elasticity in the range of 15×10^6 p.s.i. to 20×10^6 p.s.i.

4. The twill type fourdrinier wire of claim **2** in which said warp wires are of a cross-sectional area in the approximate range of 0.00001257 to 0.0002011 square inch.

5. The twill type fourdrinier wire of claim **1** in which said shute wires having diameters in the approximate range of 0.006 to 0.0165 inch.

6. The twill type fourdrinier wire of claim **1** in which said coatings are of copper.

7. The twill type fourdrinier wire of claim **6** in which said copper coating comprises approximately 20 to 30% by weight of said warp wires.

8. The twill type fourdrinier wire of claim **5** in which said shute wires are of a material taken from the group consisting of brass and bronze.

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