Nov. 26, 1968 N. DELNERO 3,412,458

FOURDRINIER WIRE

Filed Aug. 8, 1966

Fig. 1.

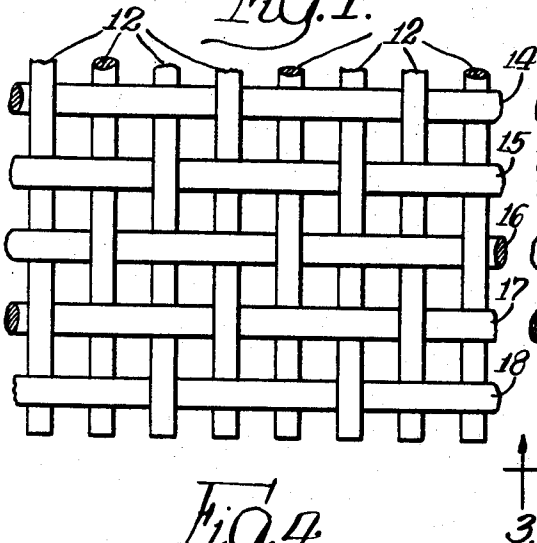


Fig. 2.

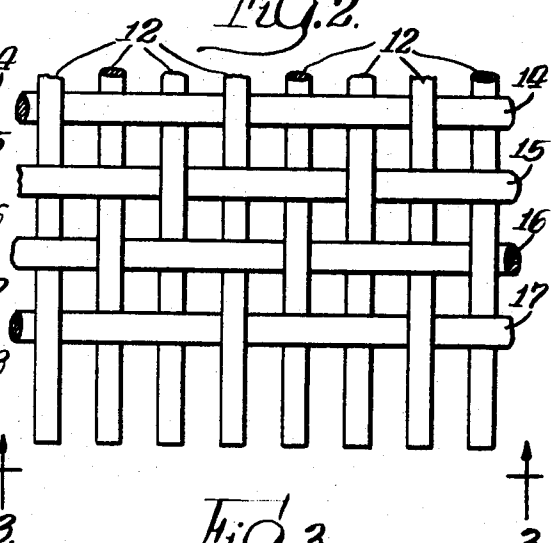


Fig. 4.

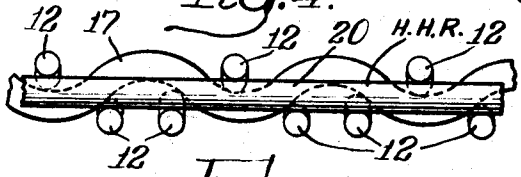


Fig. 3.

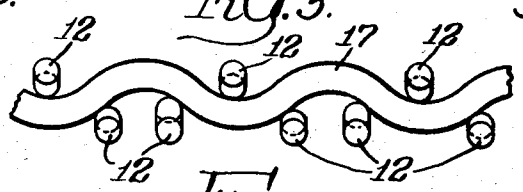


Fig. 5.

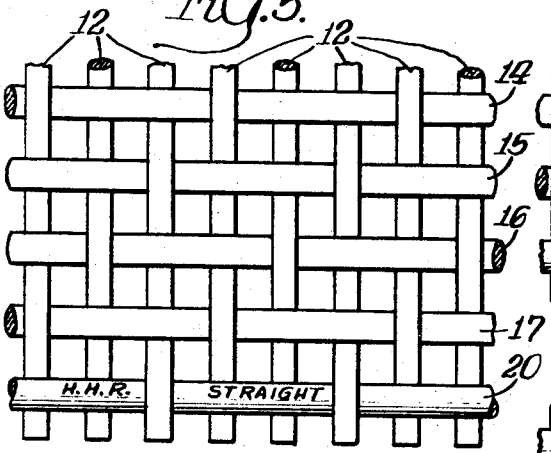


Fig. 6.

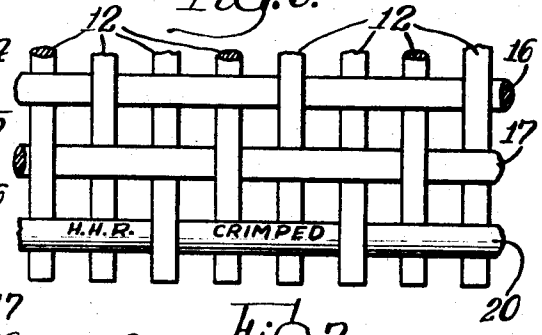


Fig. 7.

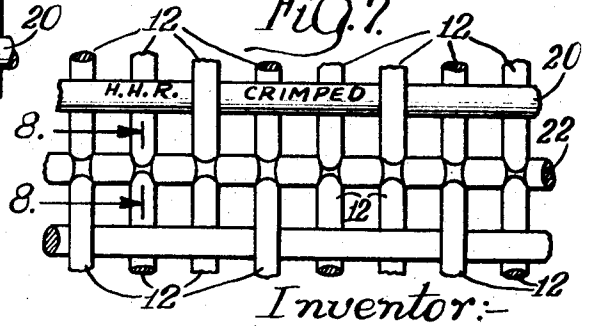
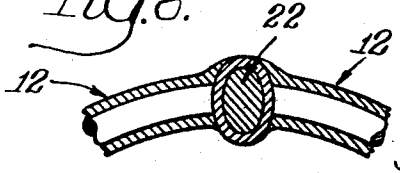


Fig. 8.



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FOURDRINIER WIRE

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The present invention relates to fourdrinier wire for use on fourdrinier paper making machines.

It is known that highly satisfactory fourdrinier wire may comprise composite warp wires having a hard inner metal core and a relatively soft outer metal layer. Typically, the inner core should have an annealed tensile strength of at least 80,000 p.s.i., and it has been found that stainless steel and carbon steel are satisfactory in this regard. The outer metal coating, as noted, is soft relative to the inner core, and is characterized by having a modulus of elasticity not exceeding 20×10^6 p.s.i. Such outer coating may comprise 10%–50% by weight of the warp wires with the preferred range being 20% to 30% by weight. A preferred material for such outer coating is copper which can be electrolytically plated on the stainless steel at reasonable cost. Conventional shute wires of known materials such as copper alloys of brass or bronze have utility with the aforementioned warp wires for the fourdrinier wire in that the outer coating on the stainless steel warp will prevent the shute wires from being powdered out or cut in two by the warp wires during the weaving operation.

In connection with fourdrinier wire cloth as above described, difficult problems have been encountered in effecting seaming of the opposite ends of the warp wires to form an endless belt due to the low melting temperature of the aforementioned copper alloys of brass or bronze which do not exceed 1925° F.

It is known that high melting temperatures seaming alloys which diffuse through the copper coating of the warp for bonding with the stainless steel core provide for satisfactory brazing of the opposed ends of the warp wires. Typical known brazing materials, characterized by melting temperatures in the range of 1500° F. to 2100° F., and suitable for forming a seam may be grouped as follows:

Gold-copper alloys
Gold-nickel alloys
Gold-copper-nickel alloy
Gold-nickel-chromium alloy
Gold-copper-silver alloys
Nickel-chromium-boron-silicon-iron alloys
Nickel-chromium-boron-silicon alloys
Nickel-chromium-silicon alloys
Copper-manganese-nickel alloys
Nickel-chromium-phosphorous alloys
Nickel-phosphorous alloys

Specific typical alloys of the aforementioned group are as follows:

Permabraze 130 composed of 82% gold, and 18% nickel, and a melting temperature of about 1740° F.

Permabraze 129 composed of 30% gold and 3% nickel, balance copper and characterized by a melting temperature of 1740° F. to 1886° F.

Permabraze 402 composed of 50% gold and 50% copper having a melting temperature of 1740° F. to 1787° F.; and

Permabraze 050 composed of 75% gold, 5% silver and balance copper, having a melting temperature of 1625° F. to 1640° F.

The last referred to brazing compositions and many others are commercially available from Hardy and Harmon of New York City, New York.

According to the present invention, a seam may be made by brazing opposed ends of the warp wires of fourdrinier cloth of the foregoing characteristics by embodying a high heat resistance shute wire characterized by a melting temperature of 1925° F. or greater at the warp ends at least at one end of the woven fourdrinier cloth.

One group of alloys having melting temperatures as above mentioned are the copper-nickel alloys. It has been found that an alloy of 10% nickel and balance of copper is satisfactory. Another such alloy is nickel-silver composed of 65% copper, 18% nickel and 17% zinc, and having a melting point of about 2030° F. Also, a pure copper shute can be used in that it has a high enough melting temperature so that it does not melt during seaming with the foregoing brazing materials. A further shute wire suitable for use adjacent the seam may be composed of 20% nickel and 80% copper core, or any of many other alloys, and plate 15% to 30% copper by weight thereon to provide a composite material which will not melt during the seaming operation.

The present invention is of particular utility in instances when during weaving of the fourdrinier cloth a defect occurs. In such instances a high heat resistance shute wire of the last noted class of materials may be inserted in the fourdrinier cloth at the ends of the warp wires at the defect. The inserted shute wire may be crimped, if desired, as by rolling, to in effect weave it with the warp wires. Thereafter, the ends of the several warps at the inserted shute may be trimmed and the other ends of warp wires at the other end of the cloth disposed in opposing relation to form the cloth into an endless loop. Thereafter, the opposed ends of the warp wires may be seamed, for example, by a ribbon seam shute composed of seaming or brazing materials as aforenoted on, for example, a 50% by weight nickel core. The high heat resistant shute wire inserted into the cloth permits brazing of the seam shute without damaging the fourdrinier cloth. Thus, in the weaving of fourdrinier wire say of a desired length of 120 feet, a defect occurs at some length less than that, say for example at 90 feet, the wire may be salvaged to form a 90 foot endless loop by embodying the aforementioned high heat resistance shute in the fourdrinier wire, and seam the opposed ends of the warps to complete a smaller fourdrinier wire. The present invention thus provides an important economical advantage in that the woven fourdrinier wire of lengths less than a particularly desired length need not be scraped.

A preferred embodiment of the invention is shown in the accompanying drawings in which:

FIGURE 1 is a plan view of one end portion of a fourdrinier wire in which the ends of the warp wires are to be seamed to the ends of the warp wires at the other end of the fourdriner wire;

FIGURE 2 is a plan view of the portion of fourdrinier wire of FIGURE 1 from which a shute adjacent the outer ends of the warp wires has been removed to open the warp wires comparable to a shade in a weaving operation;

FIGURE 3 is an end view of the fourdrinier wire of FIGURE 2 looking toward the outer ends of the warp wires with the view being taken on the line 3—3 of FIGURE 2 looking in a direction indicated by the arrows;

FIGURE 4 is an end view of the fourdrinier wire of FIGURE 3 and showing a high heat resistant shute wire inserted adjacent the outer ends of the warp wires;

FIGURE 5 is a plan view of the fourdrinier wire of FIGURE 4;

FIGURE 6 is a plan view of the fourdrinier wire of FIGURE 5 after rolling of the end thereof at the high resistant shute to crimp the latter and embed it in woven engagement with the warp wires likes a conventional shute wire;

FIGURE 7 is a plan view of the one end portion of the fourdrinier wire of FIGURE 6 and in which the outer ends of the warp wires thereat are seamed to the outer ends of the warp wires at the other end portion of the fourdrinier wire to form the fourdrinier wire into an endless loop; and

FIGURE 8 is a detail cross sectional view taken on the line 8—8 of FIGURE 7 looking in the direction indicated by the arrows and illustrating the seam seaming the opposite ends of the warp wires of FIGURE 7.

Referring now to the drawings, there is shown in FIGURE 1 a portion of fourdrinier wire comprising a plurality of warp wires **12** and a plurality of shute wires **14, 15, 16, 17** and **18**. The fourdrinier wire cloth **10** may typically have meshes in the range of 40–100 i.e., 40–100 warp wires per inch. By way of example, a 55 mesh wire cloth has 55 warp wires per inch and about 32–36 shute wires per inch, and an 80 mesh wire cloth has 80 warp wires per inch and about 62–72 shute wires per inch. The cross sectional areas of the warp wires may vary in accordance with the mesh and for a 40 mesh the warp wires may be of a cross sectional area of .0002011 and the shutes may be of a diameter of approximately 0.0165 inch whereas with a 100 mesh the warp wires may be of a cross sectional area of approximately .00001257 and the shutes of a diameter of approximately 0.006–0.0065 inch. A typical fourdrinier wire in the mesh range noted thus may comprise warp wires having a cross sectional area in a range of .00001257–.0002011 with the diameter of the shute wires in the approximate range of 0.006–0.0165 inch.

The warp wires **12** as best seen in FIGURE 8 are composite wires composed of an inner stainless steel core **16**, and a relatively soft outer metal layer **18**. The inner core **16** is preferably stainless steel although in certain instances other metals, such as carbon steel, may be used. Various types of stainless steel may be used depending upon the particular application, but a previously mentioned the core metal should have an annealed tensile strength of at least 80,000 p.s.i. and should have adequate corrosion resistance to the paper making solution. Also, as previously stated the outer coating **18** of the warp wires may be of substantially pure copper. The copper coated stainless warp is of particular advantage in providing an effective seam for seaming opposite ends of the warp wires as will be below described.

Insofar as the seaming characteristics of the present invention are concerned, the amount of the copper coating on the warp wires is not critical and very thin coatings could be used, although it is preferable that the copper coating should comprise at least 10% by weight of the overall composite warp wires. It is known that the copper coating of the warp wires functions as a heat sink dissipating the heat during the seaming operation to effect brazing of the adjacent ends of the warp wires to each other. In the foregoing fourdrinier wire cloth, it is desirable to have a warp having a hard core for efficient wear characteristics and a soft outer coating to give good weaving characteristics and resistance to cracking due to fatigue stresses. Preferably, 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 copper coated 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 of solid stainless, since the lubricating effect of the copper decreases the tendency for the stainless to seize and gall the reed. The composite warp wires above noted have been found to provide weaving characteristics superior to the phosphorous-bronze warp heretofore used. 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, for example, 24 hours or less, so that the advantages of the stainless core relative to hardness and longer life are at present substantially the same as if a solid stainless warp was used, but without the several disadvantages of the latter.

A further advantage of the copper coating on the stainless of the warp is that the stainless core for the warp wires will not adversely affect the shute wires of the fourdrinier wire.

By using relatively large amounts of copper, more protection is provided for the shutes during the weaving operation. The foregoing ranges have been expressed in percent by weight of copper, although the following table provides certain additional data correlating such percentages with the thickness of the copper coating for a given diameter of 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. 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 above noted foregoing materials 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 .008 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. 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 the Fourdrinier cloth also lie in the foregoing range of cross-sectional areas of .0002011 to .00001257 square inch.

The several shutes of the Fourdrinier wire as before stated may be composed of the conventionally known copper alloys such as brass or bronze. In instances where corrosion problems exist, bronze would be the preferred metal for the shutes. It will be understood that other materials may also be used for the shutes but it is preferable that such shutes be of metal which is substantially softer than the stainless steel core of the warp wires and which has a substantially lower modulus of elasticity than the stainless steel and a maximum tensile strength of 75,000 p.s.i.

The copper coating of the work wires preferably is in a range of 20% to 30% by weight for reasons of economy so as not to use substantially more copper than is re-

quired to achieve satisfactory warp wires and yet provide enough copper to lower the modulus of elasticity of the composite warp wires sufficiently to produce optimum weaving characteristics, resist fatigue failure, and function as a heat sink. In addition, by reducing the modulus there is less load applied to the seam and this is important particularly with high speed paper making machines.

The shutes of the Fourdrinier wire of the aforenoted copper alloys of bronze or brass are of low heat resistance and are characterized by a melting temperature of around 1925° F.

In the weaving of Fourdrinier wire **10** as shown in FIGURE 1 should a defect occur before completion of the desired length of the Fourdrinier wire, the wire to the extent to which it has been woven may be salvaged by practicing the present invention. In this regard, assuming such a defect has occurred in the Fourdrinier wire **10** of FIGURE 1, at least one shute, such as shute **18** adjacent the outer ends of the warp wires at one end of the Fourdrinier cloth may be removed from the cloth by moving it somewhat downwardly and in the direction of the axes of the warp wires to open the warp ends similar to the function of a shade in the weaving of the cloth. FIGURE 2 is a plan view of the Fourdrinier wire with the shute **18** removed and FIGURE 3 shows the outer ends of the warp wires **12** spaced apart or opened.

In accordance with the present invention, a high heat resistant shute wire characterized as aforenoted and as shown at **20**, is layed in the Fourdrinier wire in place of the removed shute **18**. After incorporation of the high heat resistant shute **20** in the Fourdrinier wire, the end of the Fourdrinier wire thereat may then be rolled to crimp the shute **20** in woven relation with the warp wires in the manner of the remaining shutes of the Fourdrinier wire. After incorporation of the high heat resistant shute **20** in the Fourdrinier wire, the warp ends adjacent thereto may then be trimmed in preparation for joining such ends with opposed end portions of the warp wires at the other end of the cloth.

Referring now to FIGURE 7, there is shown a shute seam **22** for brazing opposed end portions of the warp wires at opposite ends of the Fourdrinier wire.

The seam shute **22** as above mentioned may be composed of any of the aforementioned brazing materials over a nickel or other suitable core and characterized by a melting temperature in the range of 1500° F. to 2100° F. As best seen in FIGURE 8, the brazing material diffuses through the copper coating of the warp wires and bonds with the stainless core providing a strong seam. Preferably, as shown in FIGURE 7, a high heat resistant shute as aforedescribed is provided at each side of the seaming shute 22. However, should there be but one high heat resistant shute the heat to the seam is applied from the side of such shute to protect the shutes at the other side of the seam shute from the heat of the brazing operation. In employing either one or two high heat resistant shutes the copper coating on the stainless steel warp wire dissipates the heat of the seaming operation protecting the remaining shutes from damage and also the stainless steel cores of the warp wires. Indeed the seaming temperature of the brazing material which is in excess of the temperature of conventional seaming solders effects a strong bond between opposed ends of the stainless steel cores of the warp wires. The copper coatings of the warp wires also importantly serve to keep the outer surfaces of the stainless steel cores clean so as to form a good braze between the opposed ends of the warp wires.

While there has been shown and described preferred embodiments of the invention, it will be understood that various modifications and rearrangements may be made therein without departing from the spirit and scope of the invention.

The invention claimed is:

1. The method of seaming fourdrinier wire cloth composed of warp wires having a relatively hard metal core made of a material having a modulus of elasticity of at least 25 x 10^6 p.s.i., and an outer metal coating on said hard core made of material having a modulus of elasticity which does not exceed 20 x 10^6 p.s.i., said outer coating comprising approximately 10%–50% by weight of said warp wires, a plurality of first shutes extending transversely of said warp wires, said first shutes being of materials having a melting temperature less than 1925° F. comprising the steps of removing at least one of said first shutes from at least one end of said fourdrinier wire, substituting a second shute wire characterized by a melting temperature in excess of 1925° F. for said removed first shute warp wires, positioning the ends of the warp wires at opposite ends of said fourdrinier cloth in opposing relation to form said fourdrinier cloth into an endless loop, and then connecting said opposed ends of said warp wires by brazing material diffused through the coatings of and bonded to the cores of said warp wires.

2. The method of claim **1** characterized by removing said first shute at said one end of said fourdrinier cloth in a manner to open said warp wires thereat for substitution of said second shute wire in substantially woven relation with respect to said warp wires.

3. The method of claim **1** characterized by removing said first shute at said one end of said fourdrinier cloth to open said warp wires thereat for substitution of said second shute wire in substantially woven relation with respect to said warp wires, and the step of trimming said warp ends at said one end of said cloth prior to aligning of the ends of the warp wires at opposite ends of said fourdrinier cloth for forming said fourdrinier cloth into an endless loop.

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RICHARD J. HERBST, *Primary Examiner.*