Oct. 12, 1965 J. E. WATSON 3,211,606

PAPER MAKING WIRE

Filed Nov. 25, 1960 2 Sheets-Sheet 1

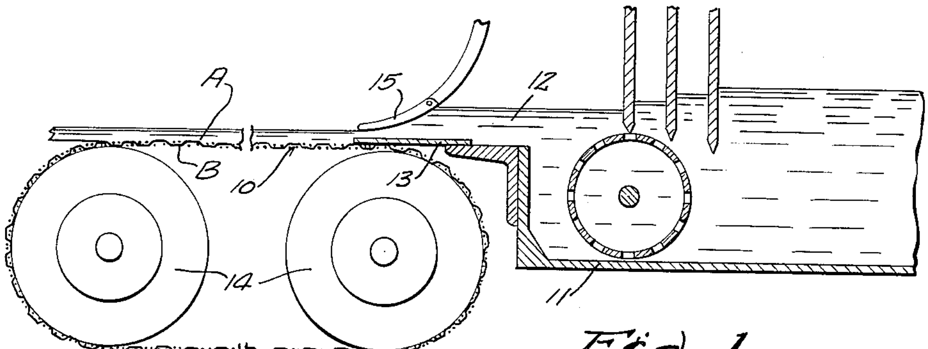

Fig. 1

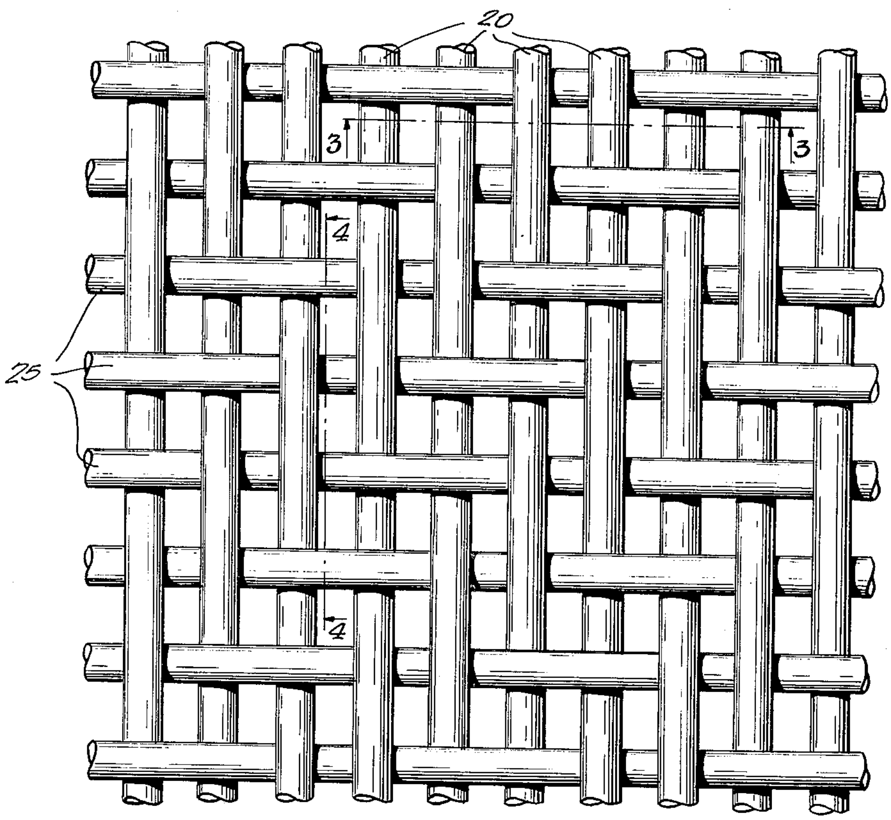

Fig. 2

INVENTOR.
JAMES E. WATSON
BY
Wheeler, Wheeler & Wheeler
ATTORNEYS

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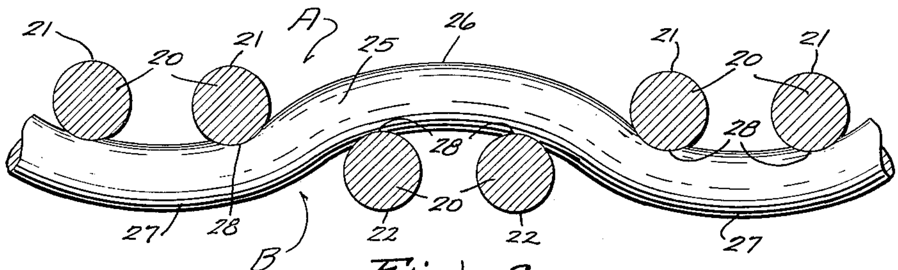

Fig. 3

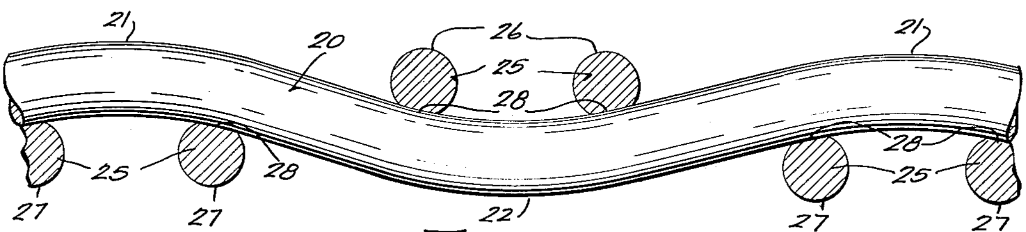

Fig. 4

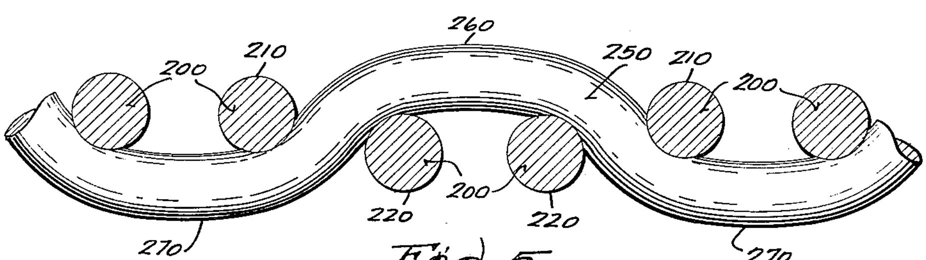

Fig. 5

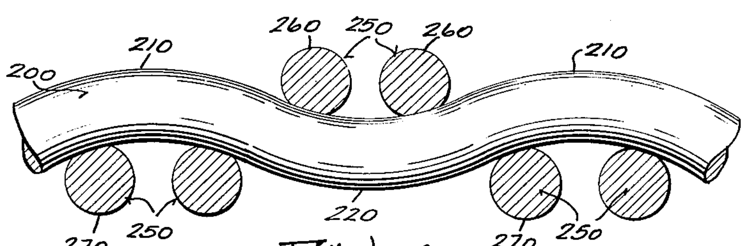

Fig. 6

INVENTOR.
JAMES E. WATSON

BY

Wheeler, Wheeler + Wheeler
ATTORNEYS

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PAPER MAKING WIRE

James E. Watson, Appleton, Wis., assignor to Wisconsin Wire Works, Appleton, Wis., a corporation of Wisconsin

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This invention relates to a method of making paper and full twill weave wire used therein.

The definition of "twill" as commonly used in describing a Fourdrinier wire is a weave in which the warp strands cross over one and under two while the shute strands cross under one and over two. The term "full twill" as used herein refers to a weave in which both warp and shute strands cross over two and under two. Such a weave may be produced by using four heddle frames operating in sequence as follows:

1 and 4 up
4 and 3 up
3 and 2 up
2 and 1 up

the sequence thereupon being repeated. A diagonal pattern is ordinarily a pronounced feature of full twill and is emphasized in the weaving of wire by the fact that the knuckles of full twill weave have heretofore been asymmetrical. Full twill weave in meshes exceeding 100 mesh is commonly used in filters but filter mesh of full twill weave would not be appropriate for the wire of a paper making machine both because it would not give adequate drainage and because the asymmetrical knuckles would pattern the paper.

A full twill weave paper making wire for use in connection with the present invention differs from previously known paper making wire not only in being full twill weave but in being substantially symmetrical in its knuckle structure. For print paper manufacture the wire desirably has its relatively broad warp and shute knuckles in common planes on its paper making face to provide greatly increased an improved pulp support surface. Due to the breadth and the symmetry, a relatively large portion of each knuckle contributes to the support of the pulp. The resulting paper has little or no wire mark and therefore provides a far superior surface for printing.

Despite the increased support area and increased bearing area of full twill weave wire made as herein disclosed, there is not only no reduction in drainage but in many cases, an increase in the facility with which the liquid drains from the pulp. There is very definitely improved fiber orientation and retention to produce paper more rapidly and to produce paper of better quality than heretofore. In consequence it is possible to use about three different meshes to cover the entire range of paper making requirements in lieu of six or seven meshes which is the minimum heretofore required.

Moreover, a full twill weave wire wears longer than the conventional wire, does not curl, produces the desired retention and orientation without being subjected to oscillation and has less tendency to crack along the edges than standard wires as heretofore known.

It will of course be understood that both the warp and shute diameters may be varied to achieve certain results. However, the preferred practice of the present invention deviates from standard practice in the use of shute wire which is smaller in gauge than the warp. For example, with 70 mesh warp of .00775" wire, the present invention contemplates the use of 60 mesh shute, of .00725". In normal practice the shute would be .008" or larger.

The improved fiber orientataion is attributable to the lack of any longitudinal or diagonal pattern. Reference has already been made to the fact that print paper made

as herein disclosed has little or no wire mark. The full twill weave with symmetrical knuckles providing greatly increased support surface not only eliminates wire mark but eliminates the diagonal pattern of valleys or grooves which is characteristic of a twill weave which does not have symmetrical knuckles. If the wire has a weave such that there are well-defined grooves or valleys having any component of direction longitudinally of the wire, there will be a tendency for the fiber to be oriented parallel to this pattern by lodging in such grooves.

The present invention contemplates the use of a wire which either has a substantially planiform support surface or, for tissue manufacture, a wire having slight ribs at right angles to the path of wire movement whereby further to interfere with the natural tendency of the fibers to align themselves in the direction of such an advance.

In the making of tissues, there is additional deviation from conventional practice in that the shute knuckles, rather than the warp knuckles, are raised. In all paper manufacture, despite all efforts to adjust the stock speed to that of the wire, there is an inevitable tendency to align the fiber longitudinally of the wire. This is particularly noteworthy when tissue is being made. Also the short fibers and filler tend to be lost through the mesh while the longer fibers remain with longitudinal orientation. Conventionally this results in tissue paper which tears much more easily longitudinally of the web than transversely thereof, the ratio of tensile strength usually ranging from 3 to 1 to 7 to 1. If the wire is full twill and the shute knuckles are raised slightly above the warp knuckles as herein disclosed, the relative tensile strength in a direction transversely of the web is very greatly increased by the random orientation of the fiber. Also there is much greater retention of the short length fiber which would normally escape during initial deposit of the pulp. The ratio is reduced below 2 to 1 on the average. The transverse tensile strength is three times as great as heretofore.

In summary, there is better formation resulting from random fiber distribution; there is freer drainage; there is better stock retention which not only reduces loss of short fiber but results in better use of expensive fillers; better printing surfaces are provided, the two faces of the paper being substantially alike; the belt has longer life, requires less power to drive it, guides more easily on the paper machine, and occasions less wear on suction boxes, requires no oscillation, has less tendency to crack on the edges.

In the drawings:

FIG. 1 is a fragmentary diagrammatic view of the portion of a paper making machine which includes the stock box and the wire.

FIG. 2 is a very much enlarged fragmentary detail view in plan of a full twill wire made in accordance with the invention.

FIG. 3 is a fragmentary detail view taken in cross section on the line **3—3** of FIG. 2.

FIG. 4 is a fragmentary detail view in cross section taken on the line **4—4** of FIG. 2.

FIG. 5 is a view similar to FIG. 3 showing a modified embodiment.

FIG. 6 is a view similar to FIG. 4 showing the embodiment of FIG. 5.

The diagrammatic showing in FIG. 1 exemplifies the invention by showing one type of paper making machine. Except for the wire **10** which has the special mesh hereafter described, FIG. 1 is intended to represent one type of generally conventional apparatus in which a head box **11** discharges the stock or furnish **12** over a lip **13** onto the paper making face A of the wire **10**, the support face B of which is mounted on a drum or drums **14**, one of which constituted means for driving the wire. In the type of machine selected to exemplify the invention, an adjustable slice or gate **15** regulates the flow of the stock from the stock box onto the moving wire. The stock or furnish conventionally comprises pulp in an aqueous vehicle but reference thereto is by way of example and not by way of limitation. The paper making wire **10** is an endless screen, the ends of its warp strands being in butt connection between shute strands at normal spacing.

The wire **10** differs from conventional practice in many respects, some of which have been enumerated above. In the first place, contrary to conventional practice, the paper making area of the wire is a full twill in which each of the warp strands **20** and the shute strands **25** crosses over two and under the next two, the points of crossing being offset in both directions so that the knuckles present diagonal patterns as shown by the shading in FIG. 2 and hereinafter described.

While the use of shute strands of smaller gauge than the warp strands is not an essential feature of the invention it is a preferred feature. In this respect the practice of the present invention differs sharply from conventional practice wherein the shute is ordinarily as large or larger than the warp. In one particular wire, I use 70 warp strands to the inch, each strand being .00775 in diameter. The shute strands in this wire are 60 to the inch and .00725 in diameter. In wire of this character the shute would normally be .00825 or larger in diameter and 58 shute strands would be used to the inch. Whereas conventional twill has openings ranging from square to rectangular in a longitudinal direction, the full twill of the present invention has openings which ordinarily vary from square to rectangular in a transverse direction.

FIGS. 3 to 6 are reproductions of actual photomicrographs enlarged 125 times. (The drawings, however, are slightly reduced in scale.) FIG. 3 shows a shute strand 25 in profile and warp strands **20** in section. One noteworthy feature of the wire herein disclosed consists in the fact that all of the warp strands **20** are spaced substantially uniformly transversely of the wire as clearly appears in FIG. 3.

Moreover, the structure is substantially symmetrical in all respects, the knuckles **21** of the warp strands **20** being offset upwardly for substantially the identical distance that the knuckles **22** are offset downwardly. Moreover, the upwardly offset knuckles **26** of the shute strand **25** are substantially at the level of the knuckles **21** of the warp strands **20** while the downwardly formed knuckles **27** of shute strand **25** are substantially at the identical level of the knuckles **22** of the warp strands **20**.

Not only are the several strands uniformly spaced but it will be observed that each knuckle is substantially symmetrical on a relatively long radius of curvature as it passes over or under the strands which it crosses. This shape can be altered by warp tension and by the physical specifications of the warp and by control of the position of the shed at time of beat up. Thus the knuckle **26** which is at the top center as viewed in FIG. 3 is approximately midway between the knuckles **22** over which it crosses and it is also approximately centered beneath the knuckles **21**. The slope of the curve of the knuckle to the left is approximately identical with its slope to the right.

FIG. 4 shows the warp strand profile of the same wire, the warp being shown at **20** with upward knuckles at **21** and a downward knuckle at **22**. The shute strands **25** shown in section have upward knuckles **26** and downward knuckles **27**. As in the shute strand profile of FIG. 3 symmetry is evident, the shute strands being substantially uniformly spaced and the knuckles of the warp strand **20** being symmetrically curved.

As will be noted, there is some deformation of the shute strand rather than the warp strand wherever the wires cross. Thus, in FIG. 3, the shute strand **25** has been somewhat grooved transversely at **28** during beat up by the pressure engagement of the warp strand **20**. In each instance the groove **28** is also apparent in FIG. 4 in a certain amount of flattening of the shute strands **25**. This is partly attributable to the use of a smaller gauge shute strand than is conventional in semi-twill for a given mesh; and partly due to the physical specifications of the warp and shute as to yield point, tensile strength and elongation; and partly due to the form of the shed used in the loom; and partly due to the relative tension imposed on the strands and on the heddles which control them; and partly due to control of the rapidity and impact of beat up. These various factors are impossible of defintion mathematically but their control is within the skill of the art once it is pointed out what result is to be accomplished. Actually, lighter impact is used to beat up the full twill as disclosed than is used in making the semi-twill as heretofore used. The deformation of the strands results in pressure interlock of the strands at points of crossing to stabilize the resulting wire against diagonal distortion when used in a paper machine.

The wire shown in FIGS. 5 and 6 is likewise full twill and is specifically designed for production of light tissues under ten pounds. One difference lies in the fact that at least on the paper-making face the knuckles **260** of the shute strands **250** rise materially above the level of the knuckles **210** of the warp strands **200**. Each depressed knuckle **270** of the shute strand **250** is similarly offset from the levels of the depressed knuckles **220** of the warp strand **200**, although this is an incidental fact having no advantage in fiber formation.

Another difference concerns the mesh. The mesh of the wire shown in FIGS. 5 and 6 is 75 x 100 as compared with a mesh of 75 x 58 in the wire shown in FIGS. 3 and 4. These are representative meshes within a range of meshes suitable for various grades of paper. It will be noted that the openings in the mesh are elongated longitudinally in the direction of the warp in the construction shown in FIGS. 3 and 4 and are elongated laterally in the direction of the shute or weft strands in the embodiment shown in FIGS. 5 and 6. The increase in the number of shute strands not only compensates for some reduction in bearing and support surfaces due to the offset knuckles of the warp but it also is an important factor in random orientation of the fiber. In practice this has been found to contribute materially to the cross-machine strength of the paper, reducing the ratio of machine direct strength to cross-machine strength to a value below 2 to 1. Experimentally ratios of 1 to 1 have been approximated.

In general, when the wire is to be used in the production of tissue, a smaller and softer shute wire is used. It is very important for the purposes of the present invention that all warp and shute wires respectively be uniform in their respective physical characteristics—tensile strength, elongation yield, size, and surface finish. It is also very important that the weaving conditions be uniformly repetitive.

As in most wire weaving, it is desirable in the making of either embodiment as herein disclosed that the tension on the heddles be desirably adjusted for ¼ inch line wire or thereabouts. In other words, the shed is centered from 1⁄16 to ½ inch below a plane which is tangent to the supply guide roll and the breast roll. It is also true of both embodiments that the shute wire is preferably (not necessarily) of smaller cross section than the warp and that the impact in beat up is ordinarily lighter than required for a semi-twill.

Preferably, though not necessarily, the shed of the loom is reversed before beat up, thus locking the weft between the warp wires immediately before beat up occurs. This makes it easier to achieve the uniform symmetry of the high knuckles of the weft without appreciable lateral distortion of the warp, thus preserving the uniform distribution of the drain openings through the wire.

Despite the finer mesh, and the greater extent and broader bearing of the knuckles of full twill, the full twill gives drainage which is comparable to a much larger mesh of semi-twill. Hence, despite the better fiber retention and orientation, drainage proceeds rapidly. The expensive fillers are, of course, retained along with the fiber, thus reducing loss of filler as well as loss of fiber.

I claim:

1. A paper making wire comprising an endless screen of full twill weave and comprising warp strands of at least approximately seventy mesh and shute strands in pressure interlock therewith at points of crossing, said pressure interlock functioning to stabilize the wire against diagonal distortion, the warp strands and shute strands having knuckles in a symmetrical organization in which individual knuckles are curved symmetrically and the warp strand knuckles have substantially identical offset upwardly and downwardly and the shute strand knuckles have at least substantially as much offset as the warp strand knuckles.

2. A paper making wire comprising an endless screen of full twill weave and comprising warp strands of at least approximately seventy mesh and shute strands in pressure interlock therewith at points of crossing, said pressure interlock functioning to stabilize the wire against diagonal distortion, the warp strands and shute strands having knuckles in a symmetrical organization in which individual knuckles are curved symmetrically and the warp strand knuckles have substantially identical offset upwardly and downwardly and the shute strand knuckles have at least substantially as much offset as the warp strand knuckles, the warp strands and shute strands defining a mesh having generally rectangular openings substantially uniform in size of a form elongated transversely of the wire in the direction of the shute strands.

3. A paper making wire comprising an endless screen of full twill weave and comprising warp strands of at least approximately seventy mesh and shute strands in pressure interlock therewith at points of crossing, said pressure interlock functioning to stabilize the wire against diagonal distortion, the warp strands and shute strands having knuckles in a symmetrical organization in which individual knuckles are curved symmetrically and the warp strand knuckles have substantially identical offset upwardly and downwardly and the shute strand knuckles have at least substantially as much offset as the warp strand knuckles, the warp strands and shute strands defining a mesh having generally rectangular openings substantially uniform in size of a form elongated longitudinally of the wire in the direction of the work strands.

4. A paper making wire comprising an endless screen of full twill weave and comprising warp strands of at least approximately seventy mesh and shute strands in pressure interlock therewith at points of crossing, said pressure interlock functioning to stabilize the wire against diagonal distortion, the warp strands and shute strands having knuckles in a symmetrical organization in which individual knuckles are curved symmetrically and the warp strand knuckles have substantially identical offset upwardly and downwardly and the shute strand knuckles projecting upwardly on the paper making face of the wire to a level which is higher than the level of the warp strand knuckles.

References Cited by the Examiner

UNITED STATES PATENTS

1,103,943	7/14	Coups	139—425.5
1,678,941	7/28	Helman	139—425
1,920,495	8/33	Brown	139—425
1,927,498	9/33	Lindsay et al.	139—425.5
2,007,862	7/35	Hurxthal	245—10
2,199,417	5/40	Purves	139—425.5
2,227,669	1/41	Parrett	139—425.5 X
2,462,604	2/49	Boucher	139—425.5 X
2,728,358	12/55	Kools	139—425
2,992,681	7/61	Hornbostel et al.	

OTHER REFERENCES

"Monel Wire Screen and Filter Cloth," Bulletin H-3, pp. 5, 6 and 7, by the International Nickel Company, Inc., 1940.

"Pulp and Paper Manufacture," vol. 3, 1953, pages 92, 120 and 121.

DONALD W. PARKER, *Primary Examiner.*

RICHARD D. NEVIUS, RUSSELL C. MADER, *Examiners.*