Dec. 27, 1955 W. A. KOOLS 2,728,358

METHOD OF WEAVING WIRE CLOTH

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Fig. 1.

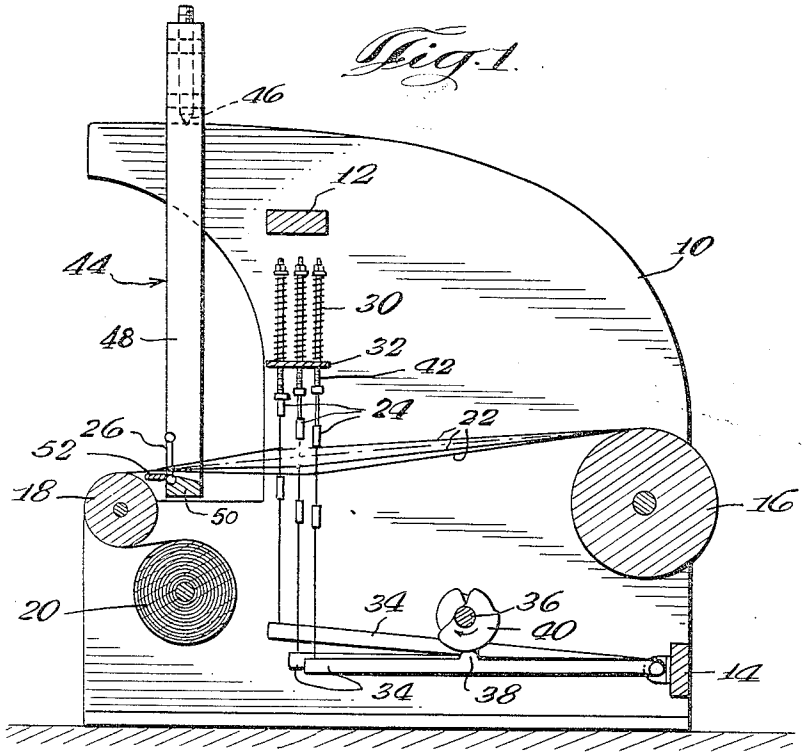


Fig. 6.

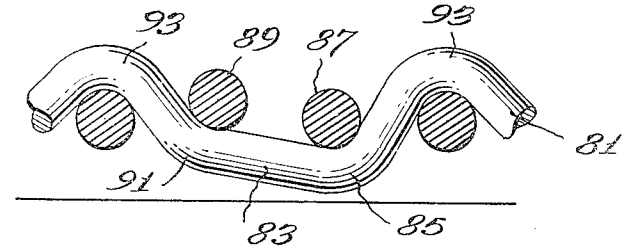
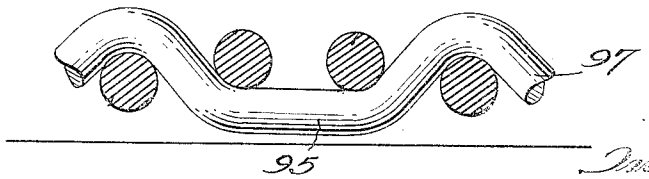


Fig. 7.



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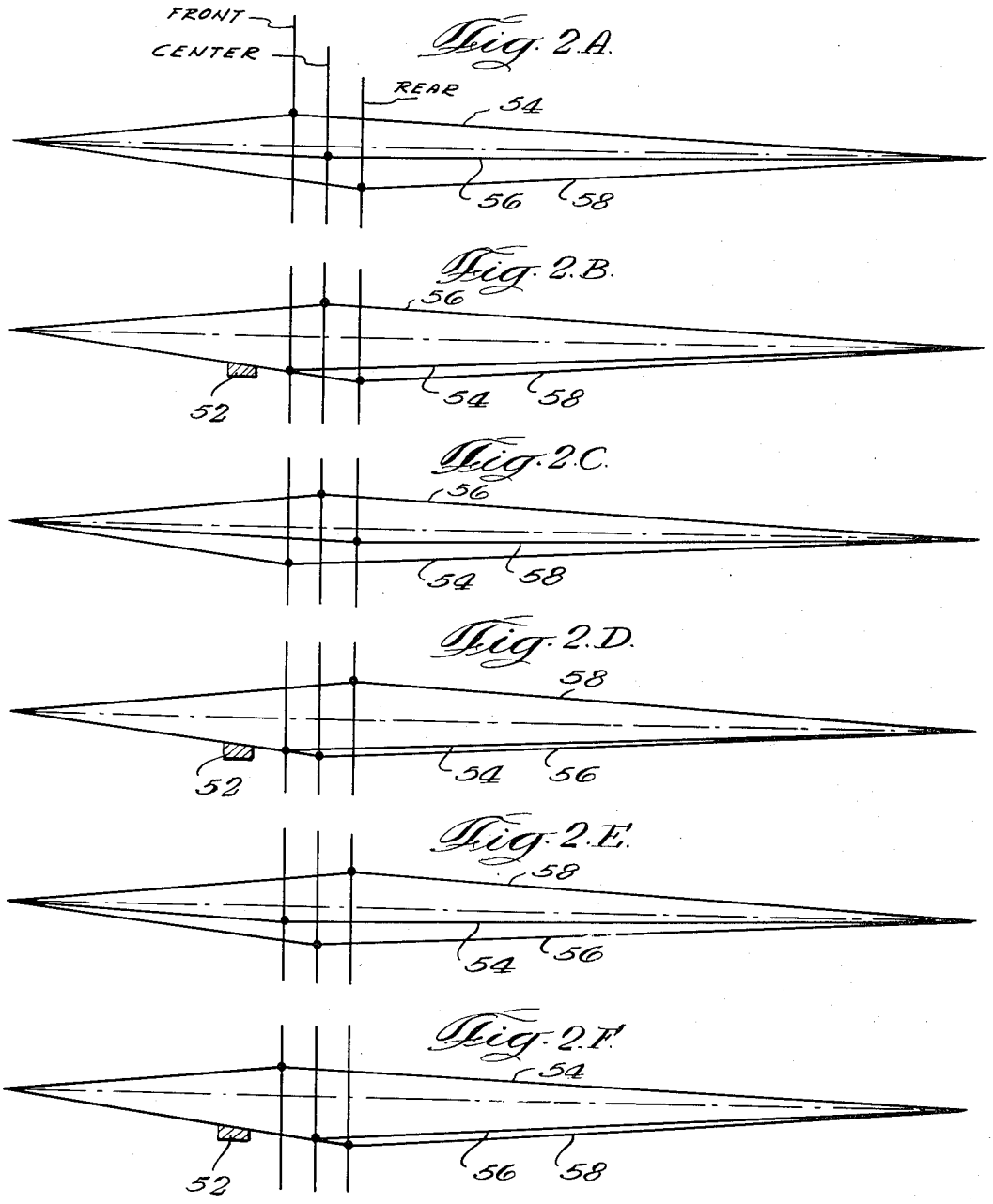


Fig. 2.A.

Fig. 2.B.

Fig. 2.C.

Fig. 2.D.

Fig. 2.E.

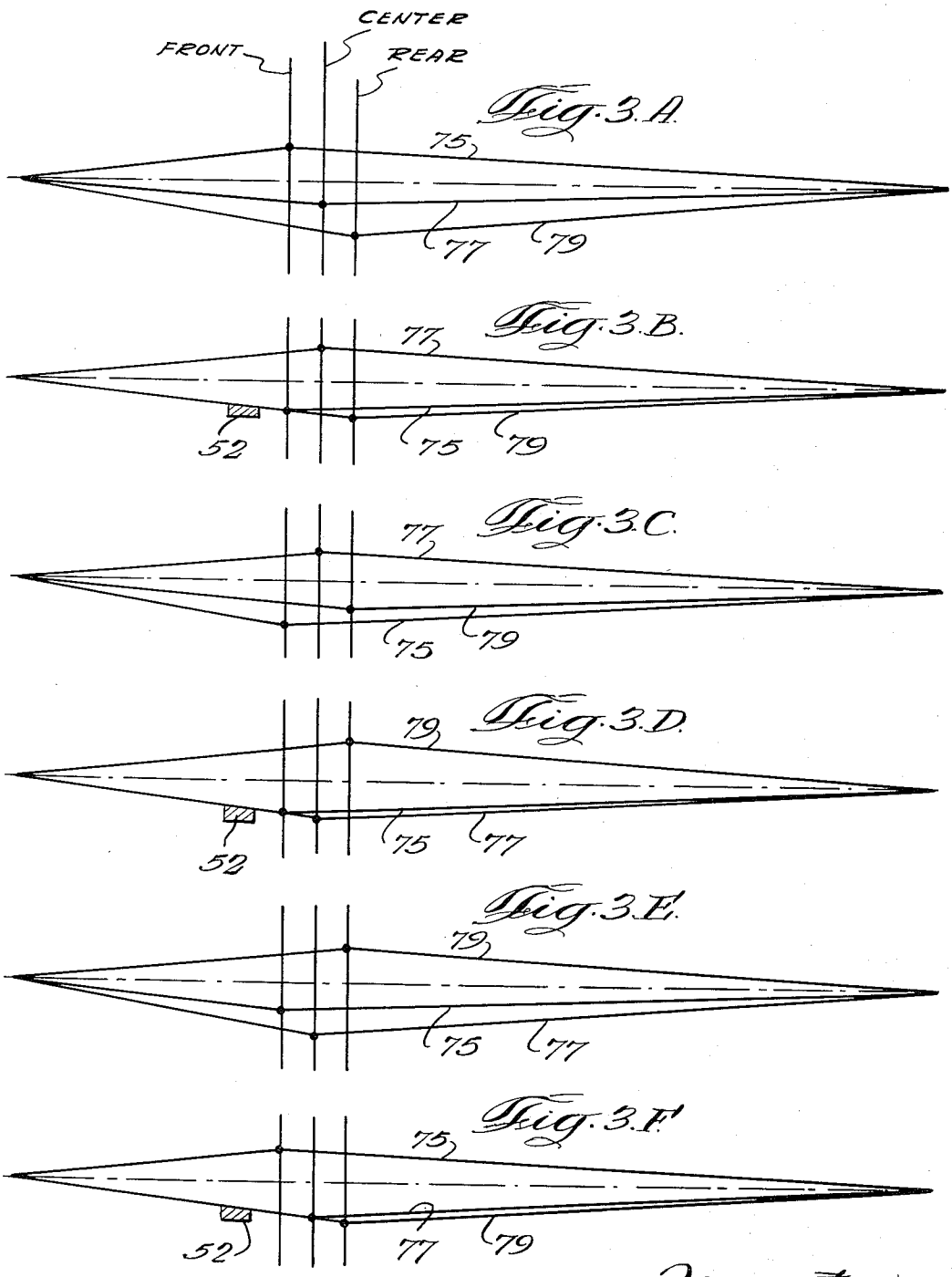
Fig. 2.F.

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METHOD OF WEAVING WIRE CLOTH

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METHOD OF WEAVING WIRE CLOTH

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Fig. 4

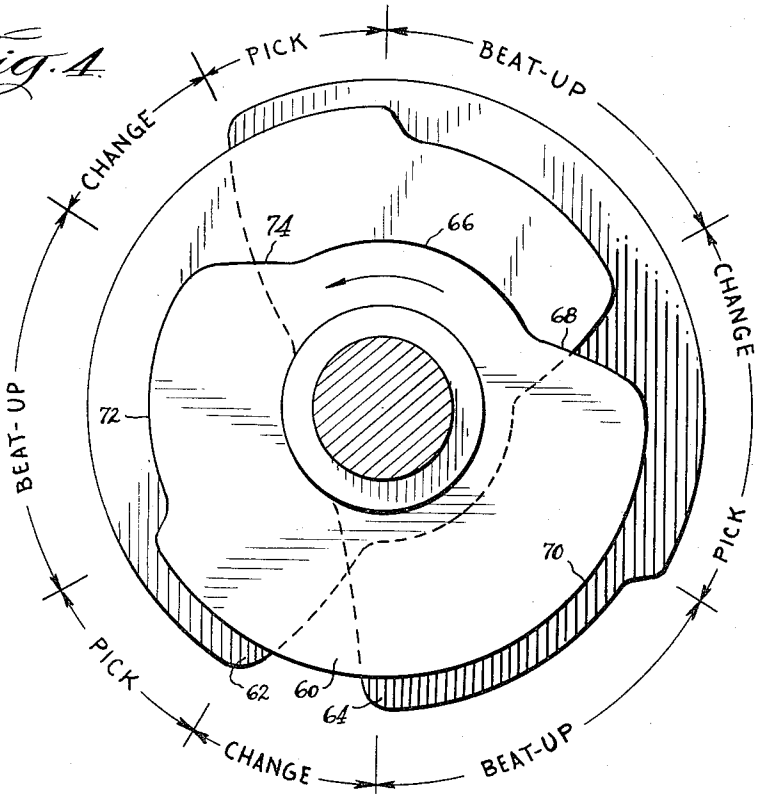
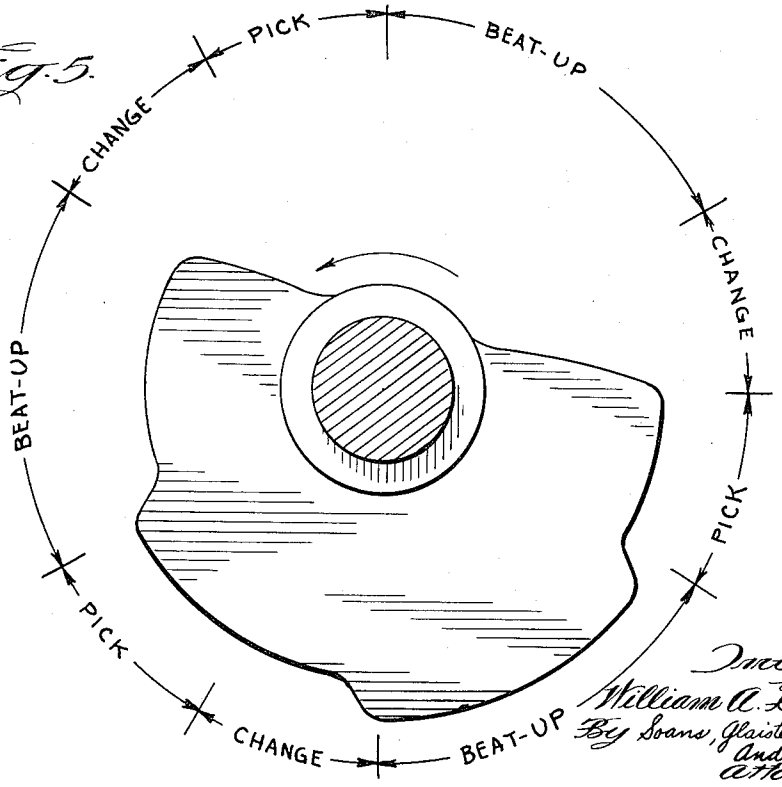


Fig. 5



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2,728,358

METHOD OF WEAVING WIRE CLOTH

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Application May 11, 1953, Serial No. 354,257

10 Claims. (Cl. 139—55)

This invention is concerned with the weaving of wire cloth and is particularly directed to improving the characteristics of the type of twill wire cloth which is intended for use as the forming wire of a Fourdrinier paper machine.

There are many considerations which enter into the selection of a particular type and mesh of weave in a Fourdrinier wire, two of the more important ones being the tendency of the wire to leave a mark upon the paper web, and the useful life of the wire. A majority of the Fourdrinier wires used today are of the twill weave, and although several types of twill have been experimented with from time to time, the "one-up-two-down" twill has become, for practical purposes, the standard for twill woven wires. The wire cloth is either welded, brazed or soldered into an endless belt which is entrained around a series of rolls in the forming section of the Fourdrinier machine, with the long crimp or knuckle of the warp wire disposed to contact the rolls, suction boxes, etc., of the machine. Theoretically, this places a greater length of the warp wires in contact with the rolls, and other conditions being equal, would increase the life of a twill-woven wire over that of the plain weave. As a matter of actual fact, however, the methods of weaving twill wire cloth which prevail in the industry produce in the warp wires of the cloth an unsymmetrical or non-uniform long crimp which is deeper at one end than at the other, and which therefore contacts the rolls of the paper machine along only a small portion of its length, called the "heel." In some Fourdrinier wires, this condition is improved by rolling the wire between pressure rolls after it is woven in order to flatten the long crimp or knuckle, and thus at least partially eliminate the "heel," but this additional operation necessarily increases the cost of rolled wire raising its price in the present market by about 5 per cent. Accordingly, the principal object of the invention hereinafter described is to provide a method of weaving twill wire cloth which will produce a symmetrical and uniform long crimp in the first instance, thereby increasing the life of Fourdrinier wires and reducing their paper-marking tendencies without increasing their cost.

It will be understood, of course, among those skilled in the art that a twill cloth may be woven with one set of warp wires raised and the remainder of the warp wires lowered, or conversely, that one set of warp wires may be lowered and the majority raised. Therefore, throughout this specification, when reference is made to a one-up-two-down twill, or to any other type of twill, it is immaterial whether the one or more sets of warp wires which are separated from the majority to form the shed, are raised or lowered. For the sake of convenience, however, the method of the invention will be described in connection with the more conventional practice of forming the shed by raising one set of warp wires above the remaining warp wires, and by reference to a one-up-two-down twill weave, which is the twill weave most commonly used for Fourdrinier wires.

Briefly, the method of the invention contemplates a

regulation of the relative tensions of the lower warp wires, i. e., those which are being formed into the long crimp, during the beat-up of the shute wire into the fell of the cloth. It has been discovered that if, during the beat-up of the shute wire, a greater tension is maintained in that set of lower warp wires which formed the top of the shed for the insertion of the next previous shute wire, than in the remaining lower warp wires, the "heel" which occurs in the long crimp of twill cloth woven in accordance with prevailing practice, can be eliminated, and a symmetrical, uniform bottom crimp or knuckle produced.

The invention will be better understood by reference to the accompanying drawings in which there is illustrated one form of loom mechanism adapted for carrying out the method of the invention.

In the drawings:

Figure 1 is a more or less diagrammatic sectional representation of an undercam wire loom showing, for the sake of clarity, only those portions which are essential in arriving at an understanding of the invention;

Figures 2A to 2F are line diagrams indicating the relative positions of the warp wires during one cycle or round in the weaving of a one-up-two-down twill wire cloth in accordance with the invention;

Figures 3A to 3F are similar line diagrams illustrating the positions of the warp wires during one cycle of weaving by a modified form of the method indicated by Figure 2;

Figure 4 is a diagrammatic illustration of the outlines of the harness cams of an undercam loom for achieving the shedding motions represented by Figure 2;

Figure 5 is a similar diagram showing the outline of a single cam for achieving the shedding motions illustrated in Figure 3, only one of a set of three similarly shaped cams being shown;

Figure 6 is a magnified longitudinal cross-section of a short segment of twill wire cloth woven by the prevailing methods and illustrating the unsymmetrical long crimp of the warp wire; and

Figure 7 is a similar cross section of a segment of twill wire cloth produced in accordance with the method of the invention.

It is understood among those skilled in the art, that other variable factors remaining constant, the tension of the warp wires is determined by the amount by which the warp wires are moved away from the warp line in the formation of the shed, the greater the movement of the heddle frames or harnesses from their respective positions at which the warp wires lie in the warp line, the greater the resulting tension in the warp wires. In the specific illustrations to follow, it is therefore proposed to achieve the regulation of warp tension which underlies the method of the invention, by providing a differential shedding motion in which the bottom line of the shed, or bottom shed, as it is commonly called, is split after the loom has picked, so as to maintain a difference in tension between certain of the several sets of lower warp wires during the beat-up on the shute wire. It is recognized, however, that the requisite tension differential may be achieved in other ways, and the systems of shedding hereinafter specifically described are therefore to be considered as illustrative, rather than as limiting, of the invention.

Referring now to the drawings, the loom illustrated in Figure 1 is of a undercam type in which each of the heddle frames or harnesses is positioned independently of the others by means of a cam-actuated treadle operating against the force of a spring which tends to raise the heddle frame.

The loom comprises a pair of side frames **10** connected together by upper and lower tie beams **12** and **14** and providing journals for a warp beam **16**, a breast roll **18**

and a cloth roll 20. In the loom shown in Figure 1, the weaving action takes place from right to left, the warp wires 22 leaving the warp beam, passing through the heddle frames 24 and the reed 26, the cloth 28 being taken up by the breast roll and passed to the cloth roll. The three heddle frames shown are suspended by means of rods or the like, from springs 30 mounted on a plate 32 supported from the side frames 10, and the lower ends of the heddle frames being connected by cables or the like to individual treadles 34, each of which is pivotally mounted on the lower tie beam 14. The cam shaft 36 is disposed about mid-way along the length of the treadles, the follower 38 of each treadle being urged against the periphery of its associated cam 40 by the heddle spring. As the cam shaft rotates, each harness is alternately depressed and elevated by its associated cam and heddle spring respectively, following the path of movement determined by the outline of the cam. While the extent of the heddle motion is normally determined completely by the throw of its cam, there is also provided for each heddle frame a stop screw 42 against which the upper end of the heddle frame may abut to determine the upper limit of its travel.

The lay 44, shown in the beat-up position in Figure 1, is suspended from the tops of the side frames 10 by a knife edge 46 or other suitable pivot. It consists of the usual side arms or swords 48 connected by the lay beam 50 which provides support, in a manner not shown in detail, for the reed 26. Extending forwardly from the beam of the lay is a shuttle race 52 on which the lower warp wires lie when the loom picks. It will be apparent from Figure 1 that when the lay 44 is drawn rearwardly for the passage of the shuttle, it is elevated somewhat above its position at the beat-up.

One sequence of heddle motions for accomplishing the desired relationship of tensions in the lower sets of warp wires in the weaving of a one-up-two-down twill in accordance with the invention is shown diagrammatically in Figure 2. In this case, the shed is formed by raising one of the three sets of warp wires above the warp line and maintaining the two remaining sets depressed below the warp line in substantially co-planar relationship for the passage of the shuttle. Then, after the loom picks and before the shute wire is beat-up into the fell of the cloth, one of the lower sets of warp wires is elevated so as to relieve its tension, while maintaining the other set in the fully depressed position so as to maintain a higher tension in the lower one of the two bottom sets of wires. In each case, the set of lower warp wires in which the higher tension is maintained is the set which formed the top of the shed during the beat-up of the previous shute wire. This sequence of shedding motions therefore results in six different positions of the warp wires in the weaving of a one-up-two-down twill, these positions being indicated by the diagrams "A" through "F" inclusive of Figure 2.

In Figure 2A, the three sets of warp wires 54, 56 and 58, associated respectively with the front, center, and rear heddle frames, are arranged for the beat-up of the first shute wire of the round or sequence. The front heddle is fully raised, the rear heddle is fully depressed, and the center heddle occupies an intermediate position. In this case, therefore, the warp wires associated with the rear heddle frame are tensioned to a greater extent than those associated with the center heddle.

In Figure 2B, the warp wires are disposed for the next succeeding pick of the loom. In this case, the warp wires 56 associated with the center heddle form the top of the shed, and the warp wires 54 and 58 associated with the front and rear heddles constitute the bottom of the shed, the latter two sets of wires being co-planar and in contact with the shuttle race 52 for the passage of the shuttle. After the loom picks, the three sets of warp wires are moved to the position indicated in Figure 2C.

It will be noted that the position of the wires in Figure 2C differs from that of Figure 2B only in that the warp wires 58 associated with the rear heddle are raised slightly so as to relieve their tension, while maintaining the tension in the warp wires 54 associated with the front heddle, and this is the position which the warp wires assume for the beat-up of the second shute wire of the round. After the beat-up of the second shute wire, the warp wires are moved to the positions of Figure 2D for the next pick.

In Figure 2D, the warp wires 58 associated with the rear heddle now form the top of the shed and those associated with the front and intermediate heddles constitute the bottom of the shed for the passage of the shuttle. After the loom picks, the warp wires are then disposed as indicated in Figure 2E for the beat-up of the third shute wire of the round. Again it will be noted that the disposition of Figure 2E differs from that of Figure 2D only in that the warp wires 54 associated with the front heddle have been raised so as to relieve their tension as compared with the tension that is maintained in the warp wires 56 associated with the intermediate heddle.

After the beat-up of the third and final shute wire of the round, the heddles are moved from the position of Figure 2E to the position of Figure 2F for the insertion of a shute wire to start a new round, following which the sequence of positions 2A to 2F is repeated.

From the foregoing, it will be noted that each of the heddle frames in turn passes from the fully raised position to the fully depressed position, and thence to an intermediate position at which the tension in the warp wires associated with the heddle frame is relaxed as compared with the other warp wires, particularly the other lower set. In each case, the set of lower warp wires in which the greater tension is maintained is the set which formed the top of the shed during the beat-up of the previous shute wire.

A system of three cams for achieving the foregoing shedding motions in the undercam loom arrangement of Figure 1 is shown diagrammatically in Figure 4. There it will be noted that the three cams 60, 62 and 64 are similar in outline, but that the cams are displaced 120 degrees from each other on the cam shaft, and that the throw of the cams increases progressively from the cam 60, associated with the front harness, to the cam 64, associated with the rear harness, as is customary. Each of the cams comprises a minor-radius "dwell" portion 66, corresponding with the raised position of its associated heddle, and which in the illustrated cams, occupies a 90 degree segment of the cam outline. Then, proceeding in a direction opposite to the indicated direction of the rotation of the cams, the next 30 degree segment 68 of the cam outline moves the treadle downwardly to its fully depressed position, bringing the warp wires associated therewith down on to the shuttle race. The greater radius dwell 70, which corresponds to the fully depressed position of the heddle frame, occupies a 150 degree segment of the cam outline, and is followed immediately by another dwell 72 of approximately 60 degrees duration which corresponds to the intermediate position of the heddle. In the next and final 30 degree segment 74 of the cam outline, the heddle is raised again to the upper position.

As indicated by the cam diagram of Figure 4, the change of the heddle frames from the fully raised position to the fully lowered position takes place in a rotation of the cam shaft of 30 degrees; a space of 30 degrees is allotted for the picking of the loom, and this is followed by an allotment of 60 degrees for the beat-up, this sequence occurring three times in each cycle of weaving a one-up-two-down twill. It will be understood by those skilled in the art, however, that these allotments must necessarily vary from loom to loom and are dependent upon the width of the loom, its speed,

and other factors. The arrangement of Figure 4 therefore is intended primarily for the purpose of illustration.

A modified shedding arrangement for achieving the same overall result is illustrated in Figures 3 and 5, in connection with the weaving of a one-up-two-down twill. In this case, as before, the shed is formed by raising one of the several sets of warp wires, while maintaining the remaining sets in a depressed position to constitute the bottom of the shed for the passage of the shuttle. However, after the shuttle is passed, and as the lay moves forward to beat the shute wire in the fell of the cloth, one of the lower sets of warp wires is depressed still farther while the other set, or sets if there be more than one, are raised above the position which they occupied when the loom picked. In this manner, as with the system of shedding of Figures 2 and 4, a greater tension is maintained in the lower set of warp wires of the split bottom shed, but the tension differential which can be achieved is greater than before, other variable factors remaining constant. In this case, however, it is essential that the splitting of the bottom of the shed take place after the lay begins its forward motion in order to provide the necessary clearance for the further depression of the lower wires of the split bottom shed.

Referring to Figures 3A to 3F inclusive, which show the six dispositions of the three sets of warp wires during a single cycle or round of weaving a one-up-two-down twill with the modified shedding arrangement, Figure 3A represents the positions of the three sets of warp wires **75**, **77**, and **79** at the beat-up of the first shute wire of the round. The front heddle is raised, the rear heddle is fully depressed, and the center heddle occupies an intermediate position slightly below the warp line.

In Figure 2B, the three sets of warp wires are arranged for the next pick of the loom, the warp wire **77** associated with the center heddle being fully raised, and the wires **75** and **79** associated with the front and rear heddles being depressed, substantially co-planar, and lying on the shuttle race **52**.

Figure 3C shows the position of the three sets of warp wires for the beat-up of the second shute wire of the round. The bottom of the shed is again split, the wires **75** associated with the front heddle being slightly depressed, the wires **79** associated with the rear heddle being slightly raised from the positions which they occupied in Figure 3B.

In Figure 3D, the three sets of warp wires are arranged for the third and last pick of the sequence, the wires **79** associated with the rear heddle being fully raised, and the front and center heddles being lowered with their associated wires **75** and **77** lying on the shuttle race **52**.

In Figure 3E, the three sets of wires are arranged for the beat-up of the last shute wire of the round, this disposition of the warp wires differing from that of Figure 3D, only in that the front heddle has been raised to position its associated warp wires **75** closer to the warp line, and the intermediate heddle has been further depressed to position its associated wires **77** farther away than before from the warp line.

Figure 3F shows the disposition of the warp wires for the insertion of the first shute wire of the next sequence or round.

In each case, as with the shedding arrangement of Figures 2 and 4, each heddle frame, at the beat-up of successive shute wires, occupies in order the fully raised position, the fully depressed position, and then the intermediate position, so that the set of lower warp wires in which the greatest tension is maintained during the beat-up is the set which formed the top of the shed during the beat-up of the previous shute wire.

The cam outline for achieving the shedding motions of Figure 3 is shown diagrammatically in Figure 5.

In this case, the outline of only one of the cams is shown, but it will be understood as before that three cams, each rotated 120 degrees from the other, are provided, and that the throw of the cams increases progressively from that associated with the front heddle to that associated with the rear heddle.

The difference between the results of the method of the invention and the results of the prevailing methods, will be apparent from Figures 6 and 7. Figure 6 shows the conformation of a warp wire **81** in a segment of one-up-two-down twill wire cloth woven by the prevailing methods. It will be apparent that the long bottom crimp or knuckle **83** is uneven, having a deeper and sharper bend or "heel" **85** in the first or leading portion of the knuckle, i. e., the bend which is formed by the beat-up of the first shute wire **87** under which the warp wire passes. On the beat-up of the succeeding shute wire **89**, the brunt of the force of beating up the shute wire is borne by the adjacent warp wires, with the result that the final bend **91** of the lower crimp **83** is less pronounced. It will be apparent that insofar as Fourdrinier wire is concerned, the capabilities of the twill weave for greater wire life cannot be fully realized with the twill wires woven by prevailing methods, without subsequent treatment, because the wear on the long crimp **83** cannot be evenly distributed. Furthermore, the short top crimp **93**, as well as the crimping of the shute wires, is more pronounced, with the result that there is a greater tendency toward marking of the paper web than is the case with a Fourdrinier wire woven in accordance with the present invention, shown in Figure 7. In the latter, it will be noted that the long bottom crimp **95** of the warp wire **97** is symmetrical and parallel with the plane of the cloth, there being no "heel," as in the case with the conventional twill wire. Other factors being equal, therefore, the life of a Fourdrinier wire woven in accordance with the method of the invention may be increased substantially over the conventional wire and will, as a corollary of the uniform bottom crimp, exhibit a lesser tendency to mark the paper web.

While the invention has been described in connection with the weaving of a one-up-two-down twill wire cloth, which is the commonly used twill weave for Fourdrinier wires, it is believed to be equally applicable to other types of twills, the essence of the invention being the maintenance of a greater tension, during the beat-up of the shute wire, in that set of warp wires which form the top of the shed during the beat-up of the previous shute wire.

The features of the invention believed to be new and patentable are set forth in the appended claims.

I claim:

1. In the weaving of twill wire cloth with a plurality of interspersed sets of warp wires each set of which is successively separated from the other sets to form a shed for the insertion of a shute wire, the improvement which comprises maintaining a greater tension in one of said other sets of warp wires than in the remainder of said other sets during the beat-up of the shute wire, said one set being the set which occupied the separated position for the insertion of the previous shute wire.

2. In the weaving of twill wire cloth with a plurality of interspersed sets of warp wires on a loom having an equivalent number of heddles each of which is separated in turn from the remaining heddles to form a shed for the insertion of a shute wire, the improvement which comprises the positioning of one of said remaining heddles more remote from the separated heddle than the others of said remaining heddles during the beat-up of the shute wire thereby to maintain in the warp wires associated with said one heddle a greater tension than in the warp wires associated with the others of said remaining heddles, said one heddle being the one which

occupied the separated position for the insertion of the previous shute wire.

3. In the weaving of twill wire cloth with a plurality of interspersed sets of warp wires on a loom having an equivalent number of heddles each associated with one of said sets and each of which is separated in turn from the remaining heddles to form a shed for the insertion of a shute wire, the improvement which comprises the positioning of all but one of said remaining heddles closer to the separated heddle than said one heddle during the beat-up of the shute wire, thereby to maintain a greater tension in the warp wires associated with said one heddle than in the warp wires associated with the others of said remaining heddles, said one heddle being the one which occupied the separated position during the beat-up of the previous shute wire.

4. In the weaving of twill wire cloth with a plurality of interspersed sets of warp wires on a loom having an equivalent number of heddles each associated with one of said sets and each of which is raised in turn above the remaining heddles to form a shed for the insertion of a shute wire, said remaining heddles being positioned relative to one another so as to align their associated warp wires in a substantially common plane during the passage of the shuttle through the shed, the improvement which comprises raising all but one of said remaining heddles after the insertion of the shute wire and during the beat-up without closing the shed, thereby to maintain in the warp wires associated with said one heddle a greater tension than in the remainder of the lower warp wires during the beat-up of the shute wire into the fell of the cloth, said one heddle being the one which was raised to form the shed for the insertion of the previous shute wire.

5. In the weaving of twill wire cloth with a plurality of interspersed sets of warp wires on a loom having an equivalent number of heddles each associated with one of said sets and each of which is raised in turn above the remaining heddles to form a shed for the insertion of a shute wire, said remaining heddles being positioned relative to one another so as to align their associated warp wires in a substantially common plane during the passage of the shuttle through the shed, the improvement which comprises depressing one of said remaining heddles and elevating the others of said remaining heddles after the insertion of the shute wire and during the beat-up without closing the shed, thereby to increase the tension in the warp wires associated with said one heddle and to decrease the tension in the other lower warp wires when the shute wire is beat into the fell of the cloth, said one heddle being the one which was raised to form the shed for the insertion of the previous shute wire.

6. In the weaving of a one-up-two-down twill wire cloth, the improvement which comprises splitting the bottom of the shed for the beat-up of the shute wire, thereby to maintain a higher tension in the lower warp wires

of said shed bottom than in the upper wires of said shed bottom, the lower set of bottom warp wires being those which formed the top of the shed for the insertion of the previous shute wire.

7. In the weaving of a one-up-two-down twill wire cloth, the improvement which comprises splitting the bottom of the shed after the insertion of the shute wire and before the beat-up by elevating one of the bottom sets of warp wires thereby to maintain a greater tension in the lower warp wires of said shed bottom than in the upper wires of said shed bottom during the beat-up, the said lower warp wires being those which formed the top of the shed for the insertion of the previous shute wire.

8. In the weaving of a one-up-two-down twill wire cloth, the improvement which comprises splitting the bottom of the shed during the beat-up by depressing one of the sets of bottom warp wires while raising the other set thereby to maintain a greater tension in the lower warp wire of said shed bottom than in the upper warp wires of said shed bottom when the shute wire is beat into the fell of the cloth, said lower warp wires being those which formed the top of the shed for the insertion of the previous shute wire.

9. In the weaving of twill wire cloth with a plurality of interspersed sets of warp wires each set of which is successively separated from the other sets to form a shed for the insertion of a shute wire, the improvement which comprises increasing the tension in one of said other sets of warp wires and reducing the tension in the remainder of said other sets of warp wires for the beat-up of the shute wire, said one set being the set which occupied the separated position for the insertion of the previous shute wire.

10. An improved method of shedding in the weaving of twill wire cloth on a loom, which comprises moving each heddle in turn from an intermediate position on one side of the warp line to an isolated position on the other side of the warp line and thence to a position on said one side of the warp line more remote from said warp line than said intermediate position thereby to effect a greater tension in the warp wires at said last mentioned position than at said intermediate position, and thence back to said intermediate position, the shute wire being inserted in the shed formed between the warp wires of the heddle in said isolated position and the warp wires of the heddles in the other of said positions, one of said heddles being in its isolated position, another being in said last mentioned position and the remainder of the heddles occupying their intermediate positions when the shute wire is beat-up into the fell of the cloth.

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