

[54] SHUTTLE ARRANGEMENT FOR A CIRCULAR LOOM FOR A TAPE YARN

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[57] ABSTRACT

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A shuttle arrangement for a circular loom for tape yarn, consisting of a plurality of shuttles arranged horizontally, wherein the inner sides of said shuttles are supported by means of a pair of guide rings and the outer sides of said shuttles are guided by a shuttle race arrangement, and a pushing device is mounted on a cam disc for traversing said shuttle, on which disc a heald lifting projection for inducing the shedding motion of the heald frames is mounted and, furthermore, said shuttle is provided with a weft placing ring and a weft yarn tension regulating device, and said pushing device is provided with positively rotating rollers for pushing the shuttle.

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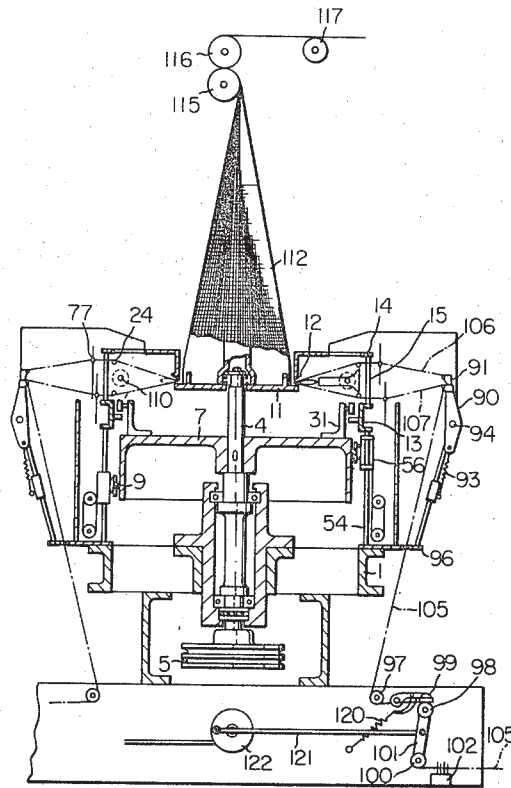
[58] Field of Search..... 139/12, 1, 16

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7 Claims, 13 Drawing Figures



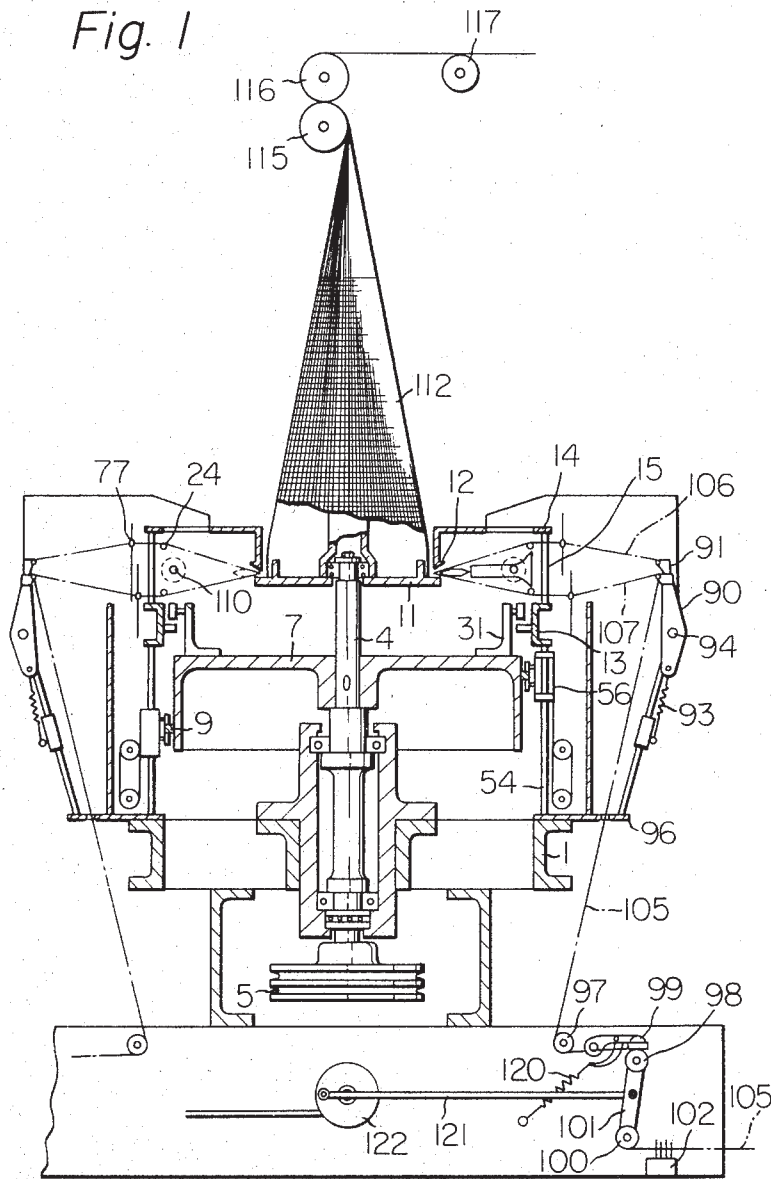
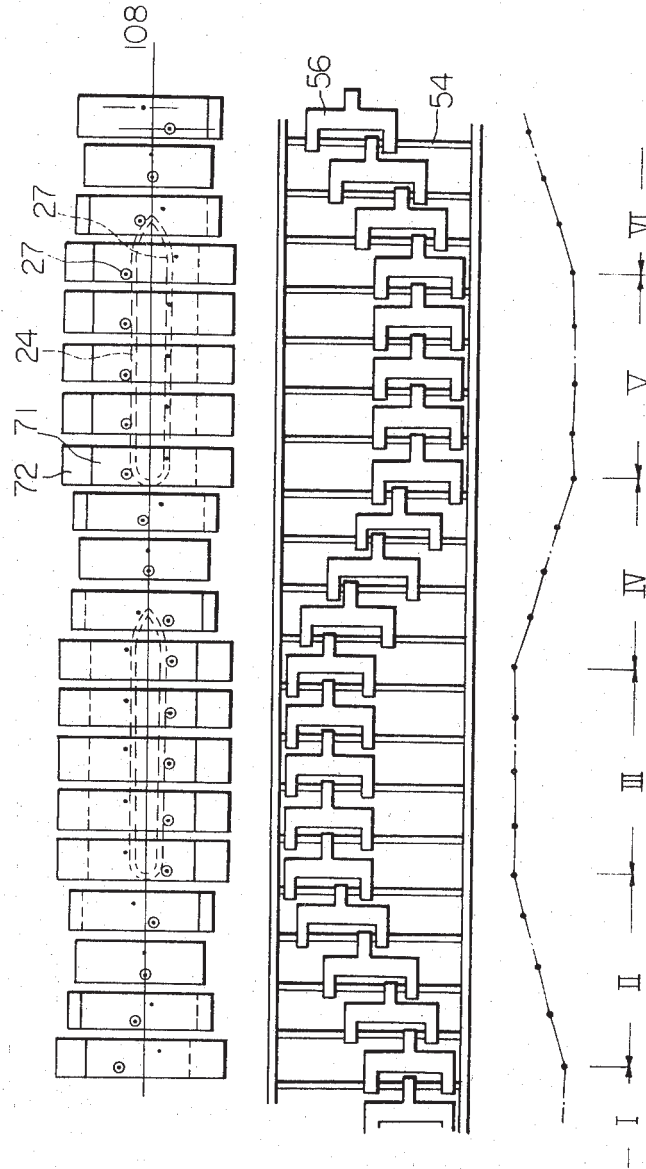


Fig. 3



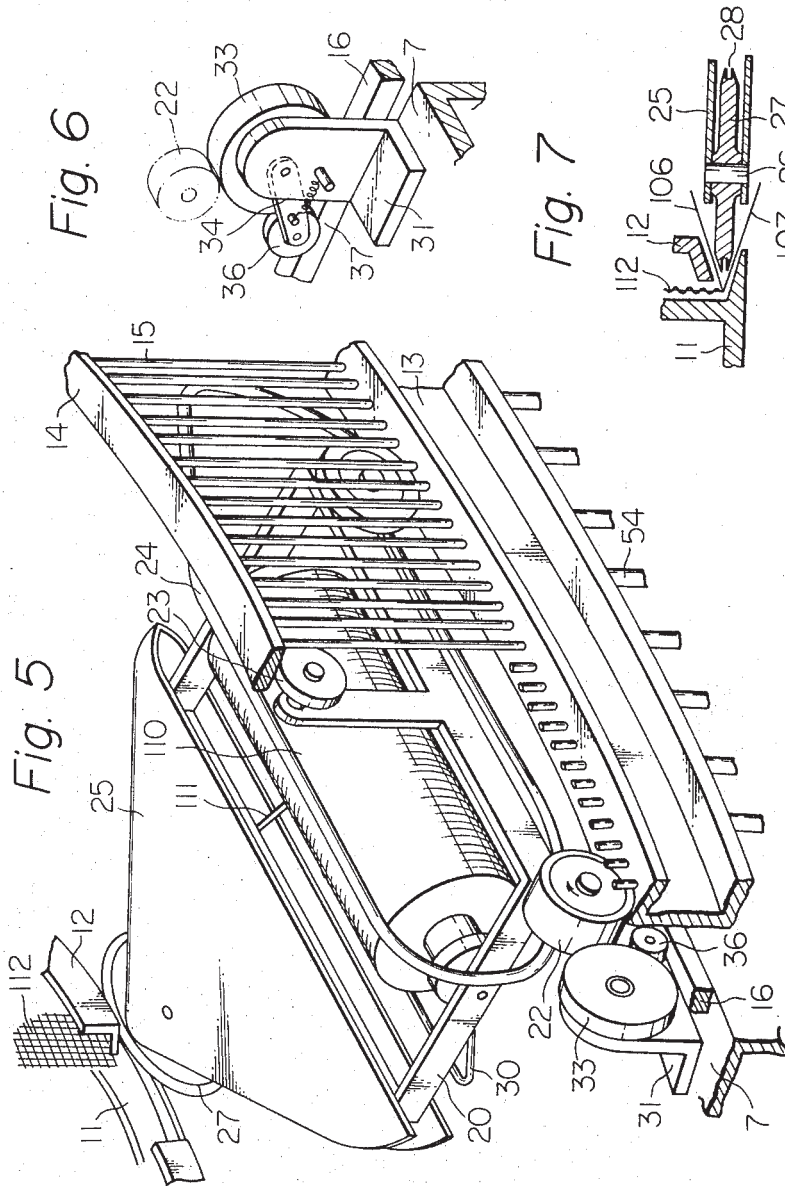


Fig. 8

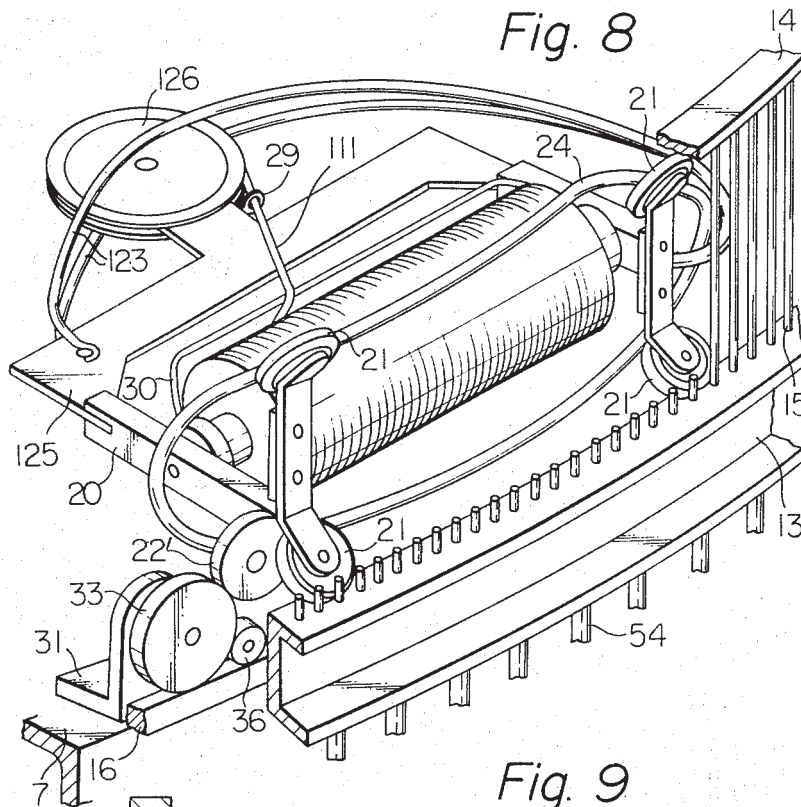
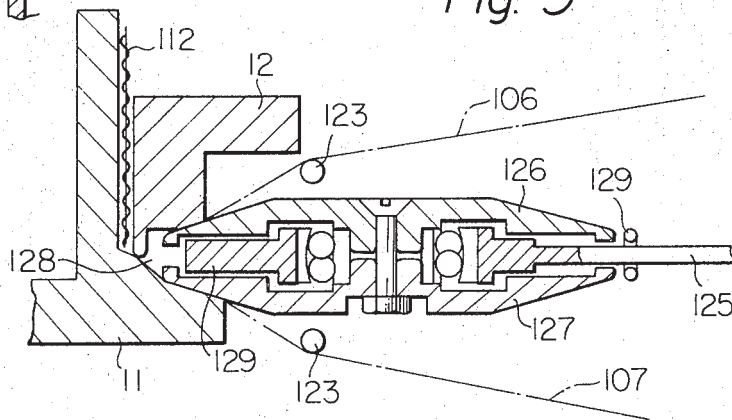
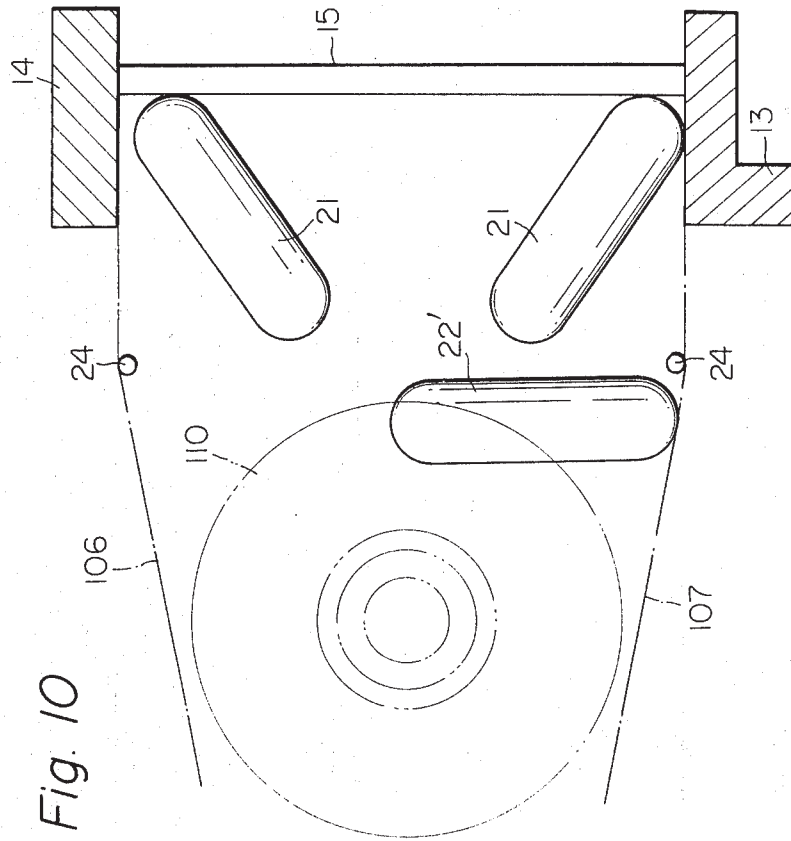
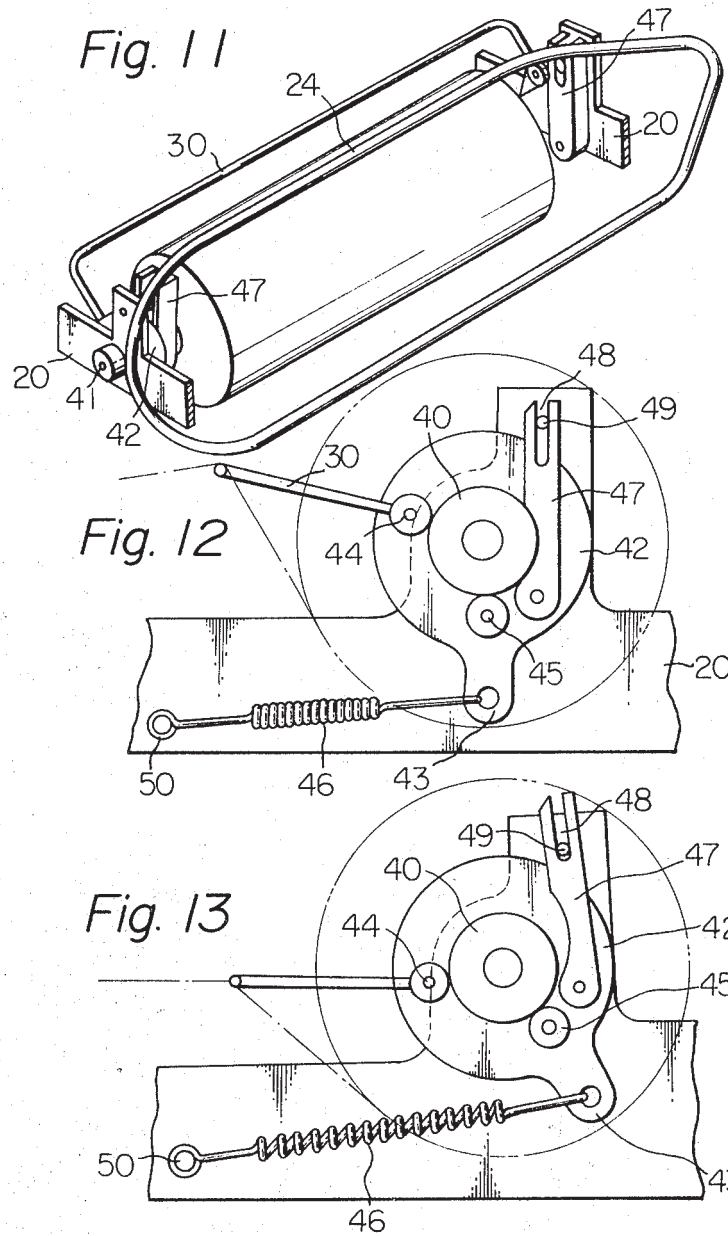


Fig. 9







SHUTTLE ARRANGEMENT FOR A CIRCULAR LOOM FOR A TAPE YARN

the present invention relates to a shuttle and a pushing apparatus for said shuttle, which are used for a circular loom in the manufacture of a tubular fabric from tape yarn or the like.

A flat fabric similar to the tubular fabric of plain weave design manufactured on a circular loom which is provided with the shuttle and pushing apparatus for said shuttle of the present invention, is now being manufactured on any type of conventional loom or shuttleless loom, such as a rapier loom or the like. However, the fabric woven on such loom generally has a drawback which is the existence of a twisted portion on the tape yarn within the fabric. The generation of such drawback cannot be avoided as long as the weft yarn is axially unwound or withdrawn from a pirn or cone which is stationary, i.e., said yarn is withdrawn axially and some twists are inevitably applied thereon. This means that a fabric without such drawback cannot be manufactured on such a loom.

The outstanding feature of a tubular fabric manufactured by a circular loom which is provided with the device of the present invention, is that such fabric has no twisted weft yarns. This is because the weft yarn is unwound tangentially from the weft yarn package on a shuttle, i.e., by the turning of said package on its axis.

Within a tubular fabric, the distance between the neighbouring warp tape yarns is inversely proportional to the number of warp yarns within the tubular fabric. This is because the diameter of said fabric manufactured on one loom is always the same even if such fabric is woven from different numbers of warp yarns or various tape yarns of different width. With regard to the weft tape yarn within a tubular fabric the distance of the neighbouring weft yarns arranged in the woven fabric is determined by the winding speed of said fabric. Furthermore, when a tubular fabric made of a tape yarn is manufactured on a circular loom, a beating operation for the weft yarn is not employed.

In the case of a circular loom, a shuttle must be forcibly pushed through the space or shed which is defined by the upper and lower warp yarn sheets. To mechanically induce such movement of the shuttle along its circular passage, the pushing of the shuttle must be effected from the outside of the warp yarn shed, i.e., either from the area above the upper warp sheet, or from underneath the lower warp sheet. Such forcible pushing can be done through an intermediate material, i.e., a warp yarn sheet of tape yarn, and such pushing can be accomplished without damage to said tape yarn because of its high stiffness. In the case of the conventional loom, during one cycle of operation only one weft yarn can be inserted from one side of the fabric across the width of the fabric to the other side of the fabric, and then beaten into the fabric. This is because only one shuttle can be picked into the warp yarn shed by means of a picking stick for each cycle of operation. However, with the circular loom a plurality of shuttles can be accommodated. As each shuttle is carrying one weft package, within one revolution of said circular loom, the same number of warp yarns as shuttles can be woven into a tubular fabric. In other words, if the shuttle travelling speeds of both looms are equal, the production rate on a circular loom is a multiple of the production rate on a conventional loom, and this multi-

ple corresponds to the number of shuttles accommodated on the circular loom. This means that a circular loom is a machine of high production rate compared to a conventional loom. Furthermore, although a fabric made from a circular loom is always tubular, it can, if required, be made of a flat fabric by cutting the tubular fabric along its longitudinal direction. But only one kind of fabric, i.e., sheet like fabric, can be manufactured on a conventional loom.

There is also a drawback on a circular loom provided with a shuttle being pushed from the outside of the lower warp yarn sheet by means of a roller which is merely rotatably mounted on a pushing device. This drawback is caused by the existence of some slippage between the lower warp sheet and the roller, which supports a shuttle in its given position, and which rotates on said warp sheet when it travels along the shuttle race. If the rotation of said roller is not smooth, the warp yarn lying between the roller of the shuttle and the upper surface of the shuttle race will be dragged from its normal position, and sometimes wound around the roller. Such condition can result in the drawback of breaking or splitting said warp yarn. Once this winding on the roller occurs, there is a chance that the warp yarn will become firmly held by the rollers of the shuttle and pushing device. Thus the smooth separation of the warp yarn from the surface of the roller is highly restricted. When the above-mentioned condition occurs, it results in the warp yarn tension of said warp yarn becoming high, which in turn restricts the smooth circular movement of the shuttle. In addition, sometimes, the warp yarn is damaged or broken because of the unsmooth separation of the warp yarn from the surface of the roller.

Therefore, tubular fabrics of good quality, i.e., of closely arranged weft yarn cannot be manufactured by a circular loom without a weft yarn guiding member.

With respect to the arrangement of the weft yarn into a fabric, when said fabric is woven on a type of circular loom using a shuttle not provided with a weft yarn guiding member as in the present invention, the weft yarn can be arranged by means of the tension of some warp yarns within the upper and lower warp yarn sheets, instead of the beating of said weft yarn into the shed. But as long as the weft yarn being laid in the warp yarn shed is not straight or is not arranged close to the fell of the fabric, which is the case with the existing circular loom, the inserted condition of the weft yarn within the fabric must be loose.

The object of the present invention is to provide a shuttle and its driving apparatus, which has no such drawbacks as mentioned above.

In order to attain this object, the shuttle of the present invention is provided with a weft placing ring and also a weft yarn tension controlling apparatus, and a driving apparatus for said shuttle which is provided with a positively rotating driving roller.

When considering the ideal weaving condition, an equal yarn tension for every warp yarn is important while the weaving operation is in progress. But in the case where a warp yarn tension apparatus is not provided for each warp yarn, such equal yarn tension for every warp yarn cannot be realized.

A similar condition exists for the weft yarn being arranged in the warp yarn shed, and being withdrawn from the weft yarn package on the shuttle. To control the variation of the weft yarn tension, which occurs

during a weaving period, the shuttle must be provided with a weft yarn tension control apparatus, which acts to release the frictional relation between the weft package and its holding device when the weft yarn tension becomes higher than normal, and when the weft yarn tension becomes very lower than the normal, the apparatus brakes the rotation of the weft package. By this means, the yarn tension of the weft yarn being arranged in the warp yarn shed can always be maintained within an allowable range, and there is no chance that the woven tubular fabric will contain any floating portions of weft yarn, because such floating portion generally appear on fabric when the tension of said weft yarn is outside the allowable range. As the weft yarn tension is always maintained in its allowable range by the controlling action of this weft yarn tension control apparatus, a good quality of tubular fabric can be woven on a circular loom which is provided with the above-mentioned devices of the present invention. Furthermore as the tension does not become to so high that it will damage the yarn, the weft yarn can be prevented from breakage.

Further features and advantages of the present invention will be clear from the ensuing description, reference being made to the accompanying drawings, wherein:

FIG. 1 is a sectional view of a circular loom which is provided with the devices of the present invention;

FIG. 2 is a plane view of the circular loom shown in FIG. 1, which shows an arrangement of the warp yarns, the shuttles and the heald frames;

FIG. 3 is an explanatory and developed view showing the relationship of a plurality of shuttles, a plurality of pairs of heald eyes, and the shedding elements in the present invention;

FIG. 4 is a detailed sectional side view showing the main functional parts in the circular loom as shown in FIG. 1;

FIG. 5 is an explanatory perspective view showing the arrangement of the shuttle and its driving apparatus in the present invention;

FIG. 6 is a perspective view of the shuttle driving apparatus viewed from the opposite side to that of the drawing of FIG. 5;

FIG. 7 is a partial and sectional view of the weft yarn arranging elements of the present invention;

FIG. 8 is a similar view to FIG. 6, but showing a modified embodiment;

FIG. 9 is a similar view to FIG. 7, showing a modified embodiment;

FIG. 10 shows the arrangement of the roller on the shuttle and the shuttle race for the same in the present invention;

FIG. 11 is an explanatory perspective view of the warp yarn tension control apparatus mounted on a shuttle, in the present invention;

FIG. 12 is a side view of the apparatus shown in FIG. 11 when the weft yarn tension is very low;

FIG. 13 is a side view similar to FIG. 12, but when the weft yarn tension is very high.

Generally, when a tubular fabric with, for example, a circular peripheral length of 1,200 mm, is made of tape yarn with, for example, a width of 1.5 mm, then 800 warp tape yarns or less ($1,200/1.5 = 800$) must be prepared. Such number of the warp yarns are withdrawn and unwound from the beam or the packages

mounted on the creel, and fed to the fell of the woven tubular fabric from all directions of the circle.

Such feeding of the warp yarns is generally by means of the two warp feeding devices which are arranged on both sides of the circular loom. In the circular loom, the shuttle with one weft yarn package may pass through the shed which is defined by the upper warp yarn sheet and the lower warp yarn sheet, and by the movement of said shuttle the weft yarn is laid as near as possible to the fell of the tubular fabric. When the relative relationships of the warp yarn sheets are altered, said weft yarn can be woven into a fabric of plane design.

The warp yarn density and the weft yarn density within a tubular fabric generally is 16 warp yarns and 16 weft yarns per 25 mm width and length of the fabric respectively, and sometimes it is 12 or 14 warp and weft yarns per 25 mm.

In the case of weaving such tubular fabric from tape yarn, a circular loom of the present invention as shown in FIG. 1 is used. On such a circular loom, a plurality of warp yarns 105, unwound from the two groups of the warp yarn packages, are fed to the loom after passing through the warp feeding devices, provided on both sides of the loom. Such warp feeding device consists of a comb guide 102, a unit of the braking roller 98, a swing arm 101, a swing guide roller and a braking shoe apparatus 99, and also a unit of a connecting rod 121 and a driving disc 122. After leaving said feeding device, the warp yarns can enter the holes of the perforated plate 96 from the surface of the guide roller 97. Such perforated plate 96 is situated above the level of said guide roller 97, but below the warp shedding line of the warp yarns.

A plurality of holes, the number of which is the same as or more than the number of warp yarns, are provided on the perforated plate 96. The warp yarns are guided by the warp yarn guide rollers 97, on which said yarns are arranged side by side, and afterward they are rearranged such that each warp yarn passes through one of the holes on the perforated plate 96. Then all of the warp yarns are directed upward, so that they form a cone, with its larger diameter at the top. At the top of said cone the same number of guiding members are arranged on the members 90 as the number of the warp yarns. At the same level as said top of the cone a guide ring 11 is mounted on the shaft 4. By this arrangement the warp yarn can extend from the hole of the perforated plate 96 to the guiding member on the member 90, and then enter the circular fell of the woven tubular fabric 112, which is guided by said guide ring 11. As shown in FIG. 2, all of the warp yarns are divided into eight groups, i.e., eight sections I through VIII, that is, each of the warp yarns shown in FIG. 2 represents all of the warp yarns within one section. Four shuttles are arranged concentrically with equal angular distance therebetween.

As shown in FIG. 4, all of the warp yarns are divided into two sheets of warp yarns 106 and 107. One of the two sheets will be lifted while another will be lowered from the level of the warp line 108 by the so called shedding motion device, so that an upper warp yarn sheet and a lower warp yarn sheet are formed. When all of the warp yarns 105 are divided into an upper warp yarn sheet 106 and a lower warp yarn sheet 107, a transverse opening of triangular shape is formed between them, and through this opening a shuttle with

one weft package 110 can travel along the horizontal circular path. By the circular movement of the shuttle the weft yarn 111 unwound from the weft yarn package 110 on the shuttle can be laid as near as possible to the fell of the tubular fabric 112, so that said weft yarn 111 can be woven into the tubular fabric 112 in a plane weave design. The tubular woven fabric 112 thus woven can be lifted and folded into a flattened tubular fabric and then taken up by means of a pair of take up rollers 115 and 116 as shown in FIG. 1. After that the fabric travels over the upper surface of the delivery guide roller 117 and then it can be transported to a winding apparatus, cutting apparatus, fusing apparatus or printing machine.

In the present invention, the warp lines of the warp yarns are arranged horizontally and, as the shuttle travels along its horizontal circular path around the circular fell of the woven tubular fabric, the weft yarn or yarns are laid as near as possible to said circular fell.

One typical arrangement of the shuttle is shown in FIG. 4. In the arrangement of FIG. 4 a shuttle race consists of a bottom shuttle race 13, the cross section of which is shaped like a block "C," and a top shuttle race 14 shaped like a large ring. Between the top shuttle race 14 and the bottom shuttle race 13, which are of the same diameter, a plurality of shuttle guide rods 15 are vertically arranged with equal distance therebetween, so that a warp yarn can freely pass between the neighbouring rods 15. The height of said rods 15 must be equal to or slightly longer than the maximum height of the shed of warp yarn.

The diameters of said top and bottom shuttle races 13 and 14 are larger than the diameter of the inner and upper guide rings 11 and 12. Said shuttle races 13 and 14 and said guide rings 11 and 12 are arranged concentrically, and between them a shuttle can be mounted. The guide ring 11 is mounted on the shaft 4 which is rotatably mounted on the frame 1, as shown in FIG. 1. But the rotation of the inner ring 11 is so restricted by the woven tubular fabric 112 that the ring 11 will not rotate at all, while the shaft 4 is rotating, because such woven tubular fabric covers the wire guide (not shown) provided on the inner guide ring 11. As the upper surfaces of the flange of the inner guide ring 11 is formed in the shape of a cone, the outer edge of which is lower than the inner edge, and also the bottom surface of the upper guide ring 12 is formed in the shape of a cone, the space defined by the surfaces of the cones is a ring of V shaped cross section, and the apex of said V shaped cross section is in the above-mentioned horizontal plane.

A shuttle, as shown in FIGS. 4, 5 and 7, is provided with a shuttle frame 20, on which a weft yarn package 110 is accommodated and held by means of the holding roller arrangement, on which arrangement the front and back bottom rollers 22 and one upper roller 23 are rotatably mounted on said shuttle frame 20. At the opposite side of the frame 20 from the side where these rollers are mounted, a ring supporting member 25 of hair pin shape is adjustably mounted on said frame 20. Said ring supporting member 25 has a triangular surface, and at one of the apexes of said triangle a weft placing ring 27 is rotatably mounted between the two inner surfaces of the supporting member 25. The outer edge of said weft placing ring 27 is so shaped that it has a tapered surface, the inclination of which is approximately equal to or less than the angle defined by the in-

clined surfaces of the flanges of the inner guide ring 11 and the upper guide ring 12.

When the shuttle thus constructed is arranged between the shuttle race (13, 14 and 15) and the pair of guide rings 11 and 12, the two bottom rollers 22 of the shuttle are directly mounted on the upper surface of the bottom shuttle race 13, while the upper roller 23 on the shuttle acts to prevent undesirable upward movement of the shuttle by moving against the bottom surface of the top shuttle race 14. By placing the weft placing ring 27 on the upper surface of the flange of the inner guide ring 11, the shuttle can be held steady horizontally, while moving around said guide ring 11.

At a lower level than that of said shuttle race and guide rings, a cam disc 7 is mounted on the shaft 4, so that it can rotate together with the shaft 4. On the outside surface of said cam disc 7 a curved heald lifting projection 9, which acts as the source of the shedding motion for the warp yarn, is provided. The turning motion of said cam disc 7 is transported from a motor not shown, via a pulley 5 as shown in FIG. 1.

On the upper surface of said cam disc 7, the same number of pushing roller brackets 31 as there are shuttles are secured. Rotatably mounted on the top of the bracket 31 is a pushing roller 33. As shown in FIGS. 5 and 6, one end of a swingable arm 34 is pivotably mounted on the axle on which said pushing roller 33 is mounted, and at the opposite end of said arm 34 a driving roller 36, which is always in contact with said pushing roller 33, is rotatably mounted. Between said arm 34 and the bracket 31, a spring 37 is arranged so that said roller 33 can be pulled downwardly. A rail 16 shaped like a circular ring is directly secured on the inside surface of the bottom shuttle race 13, as shown in FIGS. 4 and 5, and said driving roller 36 is in contact with the upper surface of said rail 16. From this arrangement, when the cam disc 7 rotates, the driving roller 36 rotates on the upper surface of said rail 16 under the spring pressure, and this means that the pushing roller 33 is always positively turned.

In the circular loom as shown in FIG. 1, a plurality of guide rods 54 are arranged between the bottom surface of the bottom shuttle race 13 and the upper surface of the frame 1, and slidably mounted on each guide rod 54 is a sliding piece 56. As shown in FIG. 3, said sliding pieces 56 are displaced upwardly and downwardly along the guide rods 54, which displacement is induced by the curved surface of the heald lifting projection 9 provided on the cam disc 7 as shown in FIG. 4. This curved surface is indicated in the lower part of FIG. 3 by dots at different heights connected by a solid line. As shown in FIG. 4, a plurality of eyes 77 on the heald wires, are arranged outside of the shuttle race (13, 14 and 15). As said eyes 77 on the heald wires are mounted on the heald frames (not shown in FIG. 4) and said heald frames are connected to said sliding pieces 56 by means of the connecting members (not shown), when one of the heald frames 71 is moved upward, one of the heald frames 72 is moved downward, so that the relative positions of the eyes 77 of the heald frames 71, which are indicated by the solid dot in FIG. 3, and the eyes 77 of the heald frames 72, which are indicated by the dot and circle, can be altered according to the upward or downward movement of the sliding pieces 56, the movement of which is induced by the heald lifting projection 9 on the cam disc 7 as shown in FIG. 4. As shown in FIG. 3, the warp guide rod 24 of

the shuttle, shown by a broken line, is always arranged in the position, where the shed is open, and the warp yarns guided by the eyes 77 are always in contact with the upper and lower horizontal portions of the warp guide rod 24. By this means the shedding of the warp yarn 105 can be accomplished.

When the cam disc 7 rotates, the pushing roller 33 mounted on the bracket 31 pushes the shuttle so that it travels around its circular path. In this case, the rotational peripheral speed of the pushing roller 33, which is positively turned by means of the positive rotation of the driving roller 36 as mentioned above, is so selected that it is equal to the rotational peripheral speed of the roller 22 which rotates on the lower yarn sheet 107 lying on the bottom shuttle race 13.

Between the bottom roller 22 and the pushing roller 23 there is always some of the warp yarns which have been separated from the lower warp yarn sheet 107, and one side of said warp yarns is in contact with the surface of the bottom roller 22, while the other side of warp yarns touches the surface of the pushing roller 23. Therefore even if the rotation of the roller 22 becomes unsmooth, such warp yarns can be positively moved at their normal moving speed by the effect of the positive rotational speed of the pushing roller 23. By this arrangement of the pushing roller 23, which is rotating positively, and the bottom roller 22 on the shuttle, there is no chance of disturbance of the smooth separation of any of the warp yarn from the surface of the bottom roller 22 which could result in damage to or breakage of the warp yarn.

As shown in FIGS. 5 and 7, the shuttle of the present invention is provided with a weft placing ring 27, which is arranged as close as possible to the inner guide ring 11 and the upper guide ring 12. Furthermore a circular weft placing groove 28 of trapezoid cross section, as shown in FIG. 7, is formed on the outer peripheral surface of said weft placing ring 27, so that such groove can guide the weft yarn being arranged into the shed.

As shown in detail in FIG. 7 the tapered bottom surface of the edge of said weft placing ring 27 is so mounted on the tapered surface of the inner guide ring 11, that the lower warp yarn sheet 107 is lying between them. Therefore, the rotational movement of the shuttle around the inner guide ring 11 induces the rotation of the weft placing ring 27 with almost no slippage. Thus the weft yarn 111 unwound from the weft yarn package 110 on the shuttle, as shown in FIG. 5, engages in and is guided by the circular weft placing groove 28. By the rotation of the weft placing ring 27, almost without slippage, as mentioned above, the weft yarn 111 of short length can be arranged into the shed of the warp in such a manner that it can extend tangentially from the groove 28 to the weft yarn which is already laid at the fell of the woven fabric.

As the outside of the weft placing ring 27 is arranged as close as possible to the inner guide ring 11, and the vertical cylindrical surface of said ring 11 acts to guide the woven tubular fabric 112, which is pulled up, the edge of the tape yarn can be arranged close to the fell of the woven fabric 112. Then the weft yarn 111 thus arranged can be woven into a fabric 112 when the relative positions of the upper warp yarn sheet and the lower warp yarn sheet are reversed.

As the weft yarn 111 is positively guided by the weft placing groove 28, and also as the weft yarn 111 extends from the groove 28 to the weft package 110 on

the shuttle, and the withdrawal of said weft yarn 111 from the weft package 110 takes place in a direction perpendicular to the axis of the package 110, i.e., side-wardly, there is no chance of the weft yarn 111 being twisted. This means that no twisted portions of weft yarns 111 appear within the tubular fabric 112 woven on the circular loom of the present invention.

Another embodiment of the shuttle, as shown in FIGS. 8, 9 and 10 is similar to the shuttle shown in FIGS. 5 and 7. In this embodiment, the arrangement of two bottom rollers 22 and one upper roller 23 is replaced by four positioning rollers 21. Such rollers 21 are so arranged that two of them are upper positioning rollers and the other two are lower positioning rollers. As shown in FIG. 10, each roller 21 is so positioned and inclined that it is directed to one of the corners defined by the shuttle guide rods 15 and either the bottom surface of top shuttle race 14 or the top surface of bottom shuttle race 13. Further, in this embodiment the back bottom roller 22 of the first described embodiment is replaced by a roller 22', which is positioned away from the bottom shuttle race 13, and there is no contact between the roller 22' and the upper surface of the bottom shuttle race 13.

The arrangement of the ring supporting member 25 and the weft placing ring 27 of the first described embodiment are replaced in this embodiment by a ring supporting member 125, a pair of torque wires 123 and upper and lower weft placing guide drums 126 and 127. After the weft yarn 111 is withdrawn upwardly from the weft package 110 and moves over the guide rod 30, the yarn 111 is guided by a weft guide eye 29, fixed on said member 125, so that it is directed tangentially to the bottom of the groove provided on the weft placing ring of this embodiment. The weft placing ring of this embodiment consists of a stationary disc 129 formed on a projecting portion of the ring supporting member 125, and upper and lower weft placing guide drums 126 and 127. The facing surfaces of said upper and lower weft placing guide drums 126 and 127 define together with the outer surface of said stationary disc 129, a weft placing groove 128. That is, at the center of said stationary disc 129 the pair of weft placing guide drums 126 and 127 are rotatably mounted.

In this embodiment of the shuttle, as shown in FIG. 8, the upper and lower warp yarn sheets 106 and 107, can be guided by means of the warp yarn guide rod 24 and the torque wires 123, so that optimum open shed of both said warp yarn sheets 106 and 107 is maintained. The two torque wires 123 are so arranged that, in the event two groups of the warp yarns are separated from the upper warp yarn sheet 106 and the lower warp yarn sheet 107, respectively, and the height between the lowered and raised warp yarn groups is less than the fully opened shed defined by the upper and lower yarn sheets 106 and 107, said wires can act to move said warp yarn groups back into the upper and lower warp yarn sheets after the torque wires pass between the two warp yarn groups.

As the weft placing groove 128 is defined by the outside surface of the stationary disc 129 together with the facing surfaces of the weft placing guide drums 126 and 127, the tension on the weft yarn 111 is properly maintained by the sliding friction caused by the sliding movement of the weft yarn 111 on the outside surface of the stationary disc 129.

The weft yarn tension regulating device, as shown in FIGS. 11, 12 and 13, is mounted on the shuttle of the present invention. Such device consists of a pair of package holder frames 42, which are rotatably mounted on center shafts 41 provided on both sides of the shuttle frame 20. Two holding rollers 44 and 45 are rotatably mounted on the side faces of said package holder frames 42, with a distance therebetween which is less than the diameter of the package 110 to be held by them, so that the bobbin 40 is held between the two package holder frames 42. One braking lever 47 is mounted on the side face of each package holder frame 42, and its bottom end is pivotally mounted so that the side of the braking lever 47 can touch the surface of the bobbin 40, there is a three point contact on the surface of the bobbin 40 by the lever 47 and the rollers 44 and 45. On the upper end of said braking lever 47, a longitudinal recess 48 is provided, and into this recess a pin 49 on the frame 20 is always engaged. A projection 43 is provided at the bottom portion of the package holder frame 42, and between said projection 43 and a pin 50 on the frame 20, as shown in FIGS. 12 and 13, a spring 46 is arranged. Furthermore, a weft guide rod 30 is secured to both package holder frames 42.

Regulation of the weft yarn tension is performed by the weft yarn tension regulating device as follows.

As long as the tension rate of the weft yarn being woven is normal, the weft guide rod 30 is situated at its normal operating position. Such position is situated above the warp line 108 as shown in FIG. 4. In this case the weft yarn 111 unwound from the surface of the package 110 is obliquely withdrawn upwardly from the package 110, and then over the surface of the weft guide rod 30 mounted on both package holder frames 42, and finally the weft yarn 111 enters either the weft placing groove 28 of the weft placing ring 27, of the first described embodiment, or the weft placing groove 128 via the weft guide eye 29, of the last described embodiment. From there the weft yarn 111 extends tangentially from the groove 28 or 128 to the fell of the woven fabric 112.

If the tension of the weft yarn 111 being woven becomes very higher than its normal rate, the weft guide rod 30 is pushed downwardly against the spring force of the spring 46, sometimes down to the level of the warp line 108 as shown in FIG. 4, which turns the bobbin holder frame 42 as shown in FIG. 9 counterclockwise. As a result of the turning of the package holder frame 42, the three point contact on the bobbin 40 formed by the holding rollers 44 and 45 and the side of the braking lever 47 is released. This is because the relative relation of the braking lever 47 and the holding rollers 44 and 45 is widened. In this case the pin 49 on the frame 20 will slide along the recess 48 of the braking lever 47, and the bobbin 40 can rotate freely on the holding rollers 44 and 45, i.e., more of the weft yarn 111 is withdrawn from the package 110 due to the high tension on the weft yarn 111, and the high tension is eventually released. Therefore, there is no chance that the weft yarn 111 will be broken due to the generation of very high yarn tension.

If the tension of the weft yarn 111 becomes very lower than normal, the spring force of the spring 46 acts to turn the package holder frame 42 in the clockwise direction in the drawings against the downward pushing force applied on the weft guide rod 30 by the weft yarn tension. This results in the distance between

the holding rollers 44 and 45 and the side of the braking lever 47 becoming less, and the bobbin 40 becomes more forcefully held by the three contact points of the holding rollers 44 and 45 and the side of the braking lever 47. This means that the unwinding of the weft yarn 111 from the package 110 is stopped and the tension of the weft yarn 111 being woven is increased until the tension on the weft yarn 111 returns to normal.

Of course, as long as the normal tension of the weft yarn 111 is maintained by the friction generated between the bobbin 40 and the three contact points, the extended length of the spring 46 does not change.

As the shuttle of the present invention is provided with the above-mentioned weft yarn tension regulating device, the weft yarn 111 being woven can always be maintained within an allowable normal tension range. Thus the arrangement of the weft yarn 111 within the woven fabric 112 is always good, and a good quality woven tubular fabric 112 can be woven by the circular loom provided with the shuttle of the present invention.

As shown in FIG. 2, a plurality of the shuttles can be used in the circular loom of the present invention. In the example shown in FIG. 2 of one arrangement of the shuttles, four shuttles are arranged at four positions and the heald frames are divided into eight sections, I through VIII. Each section consists of four pairs of heald frames, and one heald frame contains 12 head wires. This means that $(12 \times 2 \times 4 \times 8 =)$ 768 weft yarns 111 can be fed to the circular loom.

As shown in FIGS. 2 and 3, at the sections I, III, V and VII the warp yarns 105 are in the open shed condition, while at the sections II, IV, VI and VIII the warp yarns 105 are in the altering shed condition, and four shuttles are positioned corresponding to the sections I, III, V and VII, respectively. As an example, a weft yarn 111 extended from the shuttle at the section III to the fell of the tubular fabric 112 can be woven into the fabric 112 within the section II, because in said section the relative relation of the upper and lower warp yarn sheets are altered by the shedding motion. Consequently, with the present invention during one revolution of the cam disc 7 four weft yarns 111 can be woven into a fabric.

If we assumed that a tubular woven fabric should have sixteen wefts within a 25 mm length, a length of $(25/16 \times 4 =)$ 6.25 mm of such a tubular woven fabric can be manufactured within one revolution of the cam disc 7 of the present invention. This makes the circular loom of the present invention a high production machine. When this fact is combined with the fact that the tubular fabric which can be manufactured on the circular loom of the present invention, has a very good quality, it is obvious that the present invention is very advantageous.

What is claimed is:

1. A shuttle arrangement for a circular loom for tape yarn, comprising:

- an inner guide ring, which guides the lower warp yarn sheet, and also guides the woven tubular fabric;
- an upper guide ring which defines a V shaped area together with said inner guide ring, within which area a weft yarn is inserted into the shed defined by the upper and lower warp yarn sheets, and also which guides the upper warp yarn sheet;
- a shuttle race, provided with a top shuttle race and a bottom shuttle race, and a plurality of shuttle guide rods, and between said rods a warp yarn can

freely pass, and the diameter of said shuttle race is larger than the inner or upper guide rings, and this shuttle race and said inner and upper guide rings are arranged concentrically, so that the shuttle can be horizontally held between this shuttle race and said pair of the guide rings;

a shuttle provided with a weft yarn package arranged horizontally and the inner portion of said shuttle can be inserted into the space defined by said inner guide ring and upper guide ring, while the outer portion of the shuttle is guided by said shuttle race and, furthermore, said shuttle is provided with a roller by which a pushing force is applied to the shuttle so that the shuttle can travel along its circular path;

a shuttle driving apparatus, which is mounted on a rotating cam disc provided with a curved projection so as to induce the shedding motion of the heald frame, and which is provided with a pushing roller for pushing said roller on the shuttle, and a driving roller for positively driving said pushing roller.

2. A shuttle arrangement as claimed in claim 1, wherein the shuttle comprises:

a frame on which is mounted the weft yarn package, and a plurality of rollers, some of which engage the upper and lower surfaces of the shuttle race, and one of which rollers is situated at the back of the shuttle, so as to be effected by the pushing force against said roller on the shuttle;

a warp guide rod which guides the upper and lower warp yarn sheets;

a weft placing ring mounted on the frame of the shuttle, which can be inserted into the space defined by the inner and upper guide rings so that the weft yarn can be arranged as close the fell as possible.

3. A shuttle arrangement as claimed in claim 2, wherein the shuttle further comprises:

a weft placing ring provided with a weft placing groove on its outermost periphery, so that said groove can guide the weft tape yarn.

4. A shuttle arrangement as claimed in claim 2, wherein the shuttle further comprises:

a weft placing ring provided with a weft placing groove, which is defined by a stationary periphery of a stationary disc and the facing surfaces of an upper and lower weft placing guide drum, which drums are arranged coaxially to said stationary

disc.

5. A shuttle arrangement as claimed in claim 3, wherein the shuttle further comprises:

a weft tension regulating device, which holds the package in its correct position on the shuttle, so as to brake the bobbin when the tension of the weft yarn becomes very low, and free the rotation of the weft yarn package when the tension of the weft yarn is very high.

6. A shuttle arrangement as claimed in claim 5, wherein the weft tension regulating device comprises:

a pair of package holder frames, which are rotatably mounted on a frame of the shuttle;

a pair of holding roller, the distance between which is less than the diameter of the bobbin of the weft yarn package, mounted on said each of the package holder frame, so that the bobbin mounted on said rollers is held between the two package holder frames;

a braking lever, one end of which is pivotally mounted on said package holder frame, and the other end of which is provided with a longitudinal recess, and said lever is so arranged that one of its sides touches the bobbin so that together with said two holding rollers there is a three point contact with the surface of the bobbin;

a pin mounted on the frame of the shuttle so that it is always engaged in said longitudinal recess;

a spring which is arranged between the frame of the shuttle and each package holder frame;

a weft guide rod mounted on both of the package holder frames.

7. A shuttle arrangement as claimed in claim 1, wherein the shuttle driving apparatus further comprises:

a pushing roller bracket mounted on the cam disc, and onto which said pushing roller is mounted;

a swing lever, one end of which is mounted on said pushing roller bracket, while on the other end of which said driving roller is mounted;

a spring arranged between said swing lever and the pushing roller bracket;

and, furthermore, the bottom shuttle race is provided with a rail on its outside surface, so that said driving roller is pulled against the upper surface of said rail by means of said spring.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,871,413 Dated March 18, 1975

Inventor(s) Soichi Torii

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 6, line 22, "can" should be --cam--

Column 7, line 21, insert --said-- before "warp yarns"

Column 7, line 28, "distrubance" should be --disturbance--

Signed and sealed this 27th day of May 1975.

(SEAL)
Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents
and Trademarks