

## SPECIFICATION

### Weaving Tubular Fabrics

The present invention relates to a method for weaving tubular fabrics with various different weaves in a circular loom and a circular loom for carrying out the method.

Bags formed from woven fabrics of a plain weave structure utilizing tapes of synthetic resins, such as polypropylene and polyethylene resins or synthetic resin strands, such as multifilament yarns or cords of synthetic resins, as warps and wefts, have been widely used for transportation and storage of granules, such as grains, sugar, fertilizers and synthetic resin pellets. This is because these bags are strong and light in weight. These bags can be made from a tubular fabric produced by using an ordinary power loom, but there is a tendency to use circular looms having a high weaving efficiency for the manufacture of the tubular fabric to be formed into these bags. Therefore, there have been various attempts to use circular looms, not only in Japan but also other industrially advanced countries. As a typical case of producing a tubular-fabric practical circular loom, there can be mentioned a circular loom previously proposed by us, for example, the circular loom disclosed in U.S. Patent No. 3,871,413, or the circular loom which has been manufactured and sold by the British Company, Fairbairn Lawson Machinery, Ltd.

As is well known, in a circular loom of the above-mentioned type, an even number of shuttles are mounted on an annular shuttle guide member so that said shuttles can travel along this guide member, and an engaging means such as press rollers, to be engaged with the corresponding shuttles, respectively, are moved along the shuttle guide member. Each shuttle is pressed by the corresponding engaging means and is propelled along the shuttle guide member. Wefts taken out from the respective shuttles are fabricated with warps sequentially opened on both the upper and lower sides of the respective shuttles by healds, and a tubular fabric is thus formed. In this case, several healds are supported by heald frame, and many heald frames are arrayed in two rows in a circular manner. A set composed of an inner heald frame and an outer heald frame in the circular array is moved up and down by a cylindrical cam mechanism which rotates in synchronism with the advance of the shuttle, and the individual sets are successively opened. A set of heald frames forming a shed in a shedding mechanism consists only of an inner heald frame and an outer heald frame. Therefore, with the conventional circular loom, only the plain woven fabrics could be obtained but other woven fabrics with different weaves could not be obtained.

When granules, such as grains, being contained in the bags made of a tubular fabric obtained by a circular loom were to be transported or stored, a stack of the bags tended to slip and/or fall because the surface of the plain

weave forming the bags was relatively smooth and slippery. To prevent a stack of bags from slipping and/or falling, the bags should be provided with rough surfaces capable of preventing slipping. For example, in a woven fabric constituting a bag, if a warp or a weft is floating on two or more wefts or warps, the floating warps or wefts may produce slipping resistance, so that slippage among the bags can be prevented.

To weave fabrics other than in the plain weave (or the modification of plain weave), as in the case of operating the ordinary power loom, each set of heald frames, which corresponds to the number of healds utilized in the ordinary power loom, must be composed of more than two heald frames. With the shedding mechanism of the conventional circular looms in which the heald frames are moved up and down by a cylindrical cam mechanism, however, it is difficult to employ more than two heald frames to constitute a set of frames. If it is attempted to design a shedding mechanism to be capable of moving three or more heald frames up and down, the structure will become very complicated and the weaving speed will be decreased, and such a loom will be impractical.

The object of this invention therefore is to provide a method of weaving various woven fabrics, other than the plain woven fabrics using a shedding mechanism, utilized for more than two shuttles, which comprises a plurality of heald frames that are arrayed in two rows in a circular manner, the same as in a conventional arrangement, and a cylindrical cam mechanism for moving the heald frames in the upper and lower directions, as well as to provide a circular loom for carrying out the above method.

Another object of this invention is to provide a tubular woven fabric for making anti-slipping bags by way of the abovementioned method.

These and other objects have been attained by the method and apparatus as follows. Namely, in a circular loom having two or more shuttles, a method of weaving tubular fabrics is characterized by using at least one shuttle of which the tip portion is upwardly or downwardly deviated out of its center line, and keeping part of the warps on a warp line during the shedding motion when the wefts are being inserted by said shuttle having a deviated tip portion, wherein said shuttle having a deviated tip portion advances to engage with the warps kept on said warp line, and said warps are moved upwardly or downwardly by the deviated tip portion as said shuttle having a deviated portion advances.

A circular loom comprising at least one shuttle of which the tip portion is upwardly or downwardly deviated out of its center line, and at least one heald having an elongated mail i.e. eye of heald, said elongated mail having such a size that the warps passed therethrough are allowed to stay on a warp line when a heald moves in at least one direction between its upward and downward shedding motion. The length of the

elongated mail should desirably be equal to the length of the shed or twice the length of the shed.

A tubular fabric woven in a circular loom is characterized in that the tubular fabric is woven in accordance with the above-mentioned method.

The invention will be explained below in detail with reference to the accompanying drawings.

#### Brief Description of the Drawings

Figure 1 is a perspective view of a circular loom according to an embodiment of the present invention;

Figure 2 is a partial plan view illustrating a main portion of the circular loom of the present invention shown in Figure 1;

Figure 3 is a partial cross-sectional view illustrating a main portion of the circular loom of Figure 1 along line III—III in Figure 2;

Figure 4 is a perspective view schematically showing a shed forming mechanism of the circular loom illustrated in Figure 1;

Figure 5 is a plan view schematically showing a shuttle used for the circular loom illustrated in Figure 1;

Figure 6 is a plan view illustrating healds of various types used for the circular loom of this invention;

Figure 7 is a front view schematically showing shuttles of various types used for the circular loom of the present invention;

Figure 8 is a view for illustrating a relation between the shuttle and the warps according to this invention;

Figure 9 is a front view schematically showing heald frames for passing the warps illustrated in Figure 8; and

Figures 10 to 14 are views of designs illustrating relations among the weaves obtained by the method and circular loom of the present invention, the shuttle and the healds.

#### Detailed Description of the Preferred Embodiments of the Invention

In the circular loom 1 illustrated in Figure 1, a main portion 4 having shedding means and weft-inserting means is mounted in a frame 9, and the shedding means and weft-inserting means are driven by an electric motor 5 installed in a lower portion of the frame 9 via a first power transmission mechanism (not shown). Tubular fabric take-out means 8 mounted on the frame 9 above the main portion 4 is driven by a second power transmission mechanism (not shown) connected to the take-out means 8. Since the second power transmission mechanism is driven by the first power transmission mechanism via a drive transmission rod 11, the take-out means 8 is driven in synchronism with the main portion 4. Warps 3 of a number necessary for weaving a desirable tubular fabric 2 are fed to a pair of creels 6 disposed at symmetrical positions on both sides of the main portion 4 (only one creel disposed on the right side is illustrated in Figure 1) from a plurality of yarn packages 6a rotatably mounted to feed the warps, and are then fed to the main

portion 4 via warp feed-out means 7. The tubular fabric 2 formed by the main portion 4 of the circular loom 1 is upwardly taken out by the take-out means 8 and is guided toward winding means (not shown) as indicated by an arrow.

As shown in Figures 2 and 3, the main portion 4 of the circular loom comprises a vertical shaft 14 rotatably supported, through a pair of roll bearings 17, by a bearing 15 secured to a central opening of a disc-like frame 16 fixed to a base plate 9a of the frame 9; a grooved pulley 18 fastened to the lower end of the vertical shaft 14; a cylindrical cam mechanism 19 fastened to the shaft 14 at a position above the disc-like frame 16; a shed forming mechanism which will be mentioned later, is operated by an annular cam 19a of the cylindrical cam mechanism 19; a plurality of sets, for example four sets of shuttle propelling mechanisms 23, secured to a support member 22 fixed to the shaft 14 above the cylindrical cam mechanism 19; annular guide means 25 consisting of upper and lower guide members 25a, 25b for guiding a pair of wheels 26b, 26c (see Figure 5) that are provided at the front and rear portions on both sides of a main body 26a of the shuttle 26; a horizontal disc-like guide member 27 rotatably supported at the top of the shaft 14 to guide another wheel 26d of the shuttle 26; an annular guide 29 which is stationally supported, via an intermediate member 28, by support arms 24c maintaining a small clearance with respect to the annular edge of the horizontal disc guide member 27 such that the tubular fabric 2 can be guided; eight frame members 24a secured to the disc-like frame 16; arms 24b fixed to every other frame members 24a; a plurality of yarn guides 39 secured to the frame members 24a; a plurality of dancing levers 40 for adjusting the tension of the warps, which are rotatably fastened to the frame members 24a; and a control unit 41 which operates when the turn of the dancing levers 40 has exceeded a predetermined range. As shown in the drawings, the warps 3 are guided from the creels 6 to the dancing levers 40 via guide rolls 7a rotatably supported by the frames 9b and the yarn guides 39, and a shed is formed by a shed forming mechanism which is closely illustrated in Figure 4. The shuttle 26 propelled by the shuttle propelling mechanism 23 (refer to Japanese Patent Application No. 1,485,29/78) is inserted in the thus formed shed to form the tubular fabric 2. The tubular fabric 2 is guided toward a fabric guide member 31 through the annular clearance defined between the circular edge of the horizontal disc guide member 27 and the annular guide 29, taken up toward the upper direction (in a direction indicated by an arrow in Figure 3), and is taken up by a roll by means of a winding device (not shown) via the take-out means 8.

In the above-mentioned circular loom 1, as shown in Figure 4, the shedding means consists of a plurality of vertical guide rods 20 fixed to the peripheral flange portion of the disc-like frame 16, a cam follower holding member 37 slidably

mounted on the guide rods 20, an annular cam 19a protruded beyond the periphery of the cylindrical cam mechanism 19, a pair of cam followers 37a, 37b which are rotatably mounted on the holding member 37 so that they have rolling contact with the cam 19a from the upper and lower direction, heald frame guides 46 mounted on the upper annular guide member 25a to guide a pair of heald frames, i.e., to guide an inner heald frame 45a and an outer heald frame 45b (heald frame guides have also been mounted on the lower annular guide member 25b, but they are not shown in Figure 4), belts 47a, 47b for connecting the two heald frames 45a, 45b so that the heald frames 45a, 45b move alternately in the upper and lower direction in order to form a shed, and a belt guide 34a, 34b (see Figure 3) mounted on the peripheral flange portion of the disc-like frame 16 to guide and support the belts 47a, 47b. Since the holding member 37 to which the cam followers 37a, 37b are attached is connected to the belt 47b by a pin member 37c, a vertical movement is given to the heald frame 45a by the vertical movement of the holding member 37. The vertical movement is transmitted to the other heald frame 45b through the belts 47a 47b. Therefore, the outer heald frame 45b moves up and down in a reversed manner with respect to the inner heald frame 45a. The heald frames 45a, 45b are each provided with an equal number of healds 48 (the individual healds will be mentioned later), and vertical rods 50 of a number corresponding to the number of healds 48 are firmly positioned like a vertically oriented grid between the upper and lower opposing guide members 25a, 25b which are constituting the annular guide means 25. The shape of the cam surface of the protruded annular cam 19a is so designed with respect to the heald frames 45a, 45b that a fully opened shed is formed. By alternately passing the neighboring warps 3 through the mails of the healds 48, a shed is allowed to form for constituting a plain woven fabric by rotating the cylindrical cam mechanism 19. Since plural pairs of the above-mentioned heald frames 45a, 45b are annularly arrayed along the periphery of the cylindrical cam mechanism 19 adjacent to each other, the pairs of heald frames 45a, 45b successively form sheds of an identical shape accompanying the rotation of the horizontal cylindrical cam mechanism 19. Accordingly, tubular fabric 2 of a plain weave can be obtained by propelling a plurality of shuttles 26, for example, by propelling four shuttles 26 in the case of this embodiment by means of the shuttle propelling mechanism 23 (see Figure 3) supported by the support member 22 (see Figure 3) so as to correspond to the formation of the sheds.

As mentioned already, the shuttle 26 is so supported as to run by means of wheels 26b, 26c and 26d between the pair of upper and lower guide members 25a, 25b of the annular guide means 25 and the horizontal disc-like guide member 27 in concentric with the guide members

25a, 25b. Although this embodiment employs four shuttles 26, it is of course allowable to employ two or three or five or more shuttles. A roller 26e which comes into rolling contact with a propelling member of the shuttle propelling mechanism is rotatably provided at the rear portion of the main body 26a of the shuttle 26 (the shape of the main body will be mentioned later in detail), as shown in Figure 5. A pair of brackets 26f provided on the main body 26a supports a weft bobbin 69 so that it is allowed to rotate about the axis thereof. One bracket 26f for removably attaching the weft bobbin 69 is pivoted by a support member 26i protruded from the main body 26a. The above-mentioned wheel 26d is rotatably provided at a tip portion of a rod 26h pivoted to the tip portion of the main body 26a. A groove is formed in the circumference of the wheel 26d so as to guide the wefts. The rod 26h is rotatably coupled by a pin 26l to the tip of a connection member 26g which is pivoted to the tip portion of the bracket 26f. A yarn 70, taken out from the weft bobbin 69 held by the bracket 26f of the shuttle 26, is introduced into the guide groove of the wheel 26d via a yarn guide 26j and a yarn guide 26k which are mounted on the connection member 26g, and is taken out from the bobbin 69 with the movement of the shuttle 26.

As shown in Figures 2 and 3, the shuttle propelling mechanism 23 consists of a support member 22 which rotates about the vertical shaft 14 of the annular guide means 25, four horizontal shafts 23a installed on the periphery of the support member 22 at positions symmetrical with respect to the vertical shaft 14, a roller (not shown) rotatably supported on a lever held by the shaft 23a to roll on the annular guide member 25b of the annular guide means 25, and a push roller 23b rotatably supported at the tip portion of the horizontal shaft 23a. The push roller 23b rolls to come into contact with the roller 26e (see Figure 5) of the shuttle 26 from the back side thereof. The horizontal shaft 23a comes into contact with a push lever 19b mounted on the upper surface of the cylindrical cam mechanism 19 and rotates about the vertical shaft 14 being pushed by the push lever 19b.

In the circular loom constructed as mentioned above, when the vertical shaft 14 is rotated by the electric motor 5, the cylindrical cam mechanism 19 fastened to the vertical shaft 14 is also rotated, whereby a plurality of heald frame pairs (45a, 45b) are successively caused by the annular cam 19a to move up and down thereby to form sheds which move with the rotation of the annular cam 19a. On the other hand, the push lever 19b rotates together with the cylindrical cam mechanism 19 and pushes the horizontal shaft 23a of the shuttle propelling mechanism so that it rotates about the vertical shaft 14. As the horizontal shaft 23a rotates, the push roller 23b installed on the tip of the horizontal shaft 23a comes into contact with the roller 26e at the rear end of the shuttle to propel the shuttle 26. Hence,

the shuttles 26 advance in synchronism with the sheds which are successively formed.

The annular cam 19a for controlling the vertical movements of the heald frames 45a, 45b has been so designed that the inner heald frame 45a and the outer heald frame 45b move in the upper and lower directions opposite to each other for each shuttle, i.e., for each insertion of weft. Hence, a plain woven fabric can be obtained if the weaving is carried out using ordinarily employed healds and conventional shuttles.

According to this invention, some warps can remain on the warp line during the shedding motion i.e., remain on a line subtended by warps when the shed is closed, and then the warps are lowered or raised in a direction opposite to the shedding motion of the heald frames (which may be rising or lowering) supporting the healds through which the warps are passed. As a result weaves other than the plain weave can be obtained. Accordingly, the warps cross the wefts in a state different from the plain weave.

Further, according to this invention, a heald of a special shape is used to anchor any warps on the warp line during the shedding motion, and a shuttle having a specially designed main body 26a is used to raise or lower the warps on the warp line.

Figure 6 shows healds of various shapes used for this invention. A heald Ha is an ordinarily employed one having an ordinary mail. The warp passed through the heald Ha moves up and down responsive to the shedding motion of the heald frame supporting the heald Ha. A second heald Hb has an elongated mail which is downwardly extending from the center of the heald and works to lower the warp. The size of the mail should be at least longer than half the length i.e. height of the shed and should desirably be slightly longer than the length of the shed. The warp passed through the heald Hb is allowed to lower like the warp passed through the ordinary heald Ha when the heald frame supporting the heald Hb is lowered, but stays on the warp line owing to the elongated mail even when the heald frame is raised. Referring to Figure 4, the outer heald frame 45b is raised to a shedding position, six healds are supported by the heald frame 45b, and the heald second from the left is the above-mentioned heald Hb having an elongated mail for lowering the warp. Unlike other warps 3a, the warp 3b passed through the heald Hb does not rise but stays on the warp line.

The third heald Hc has an elongated mail upwardly extending from the center of the heald and works to raise the warp. The size of the mail should be at least longer than half the length of the shed, and should desirably be slightly longer than the length of the shed. The warp passed through the heald Hc stays on the warp line when the heald frame supporting the heald Hc is lowered and is raised together with the heald frame when it is raised like the yarns passed through ordinary healds Ha.

The fourth heald Hd works to guide the warp

and has an elongated mail extending in the upper and lower directions from the center of the heald. The size of the mail is at least longer than the length of the shed, and is desirably slightly longer than two times the length of the shed. The warp passed through the heald Hd is always allowed to stay on the warp line irrespective of the shedding movement of the heald frame supporting the heald Hd.

Figure 7 is a front view illustrating shuttle bodies 26a of various shapes used for the present invention. A shuttle SA of the type A illustrated in the upper stage of Figure 7 is an ordinarily used one, which is symmetrical in the upper and lower directions with respect to the center line. The shuttle SB of the type B illustrated in the middle stage of Figure 7 has a tip which is upwardly deviated above the center line by a distance  $h$ . The shuttle SB has a function to lower the warp staying on the warp line during the shedding motion. A shuttle SC of the type C illustrated in the lower stage of Figure 7 has a tip which is downwardly deviated below the center line by a distance  $h$ , and has a function to raise the warp staying on the warp line during the shedding motion.

Below are mentioned the function of the shuttle SB for lowering the warp and the state of the warp with reference to Figures 8 and 9. In Figure 8, the shuttle SB advances toward the direction of the arrow. It is assumed that the warps in Figure 8 are passed through the healds of a pair of heald frames (hereinafter referred to as heald frame pair) illustrated in Figure 9. Such heald pairs are arrayed in many numbers. Figure 8 illustrates the yarns passed through the healds of seven heald pairs. A first heald frame  $F_1$  (inner or outer heald frame) shown in Figure 9 supports three healds, in which the middle heald Hb works to lower the warp and the other two healds Ha are ordinary ones. A second heald frame  $F_2$  (outer or inner heald frame) supports three healds which are all ordinary healds Ha. Referring to Figure 8, the first heald frames  $F_1$  of a number of heald frame pairs are successively raised, and the second heald frames  $F_2$  are successively lowered to form sheds. Referring to Figure 8 again, warps 3a, 3b 3a of the first heald frame  $F_1$  and warps 3a', 3a', 3a' of the second heald frame  $F_2$  are arrayed in alignment on the warp line in front of the shuttle SB. The warps 3a, 3a' are those passed through ordinary healds Ha, and the warp 3b is that passed through the heald Hb for lowering the warp. The warps are shed being divided into the upper and lower directions as the shuttle SB approaches; but the warp 3b passed through the heald Hb for lowering the warp remains on the warp line. Although the tip of the shuttle SB has been upwardly deviated by a distance  $h$ , the warps 3a, 3a' passed through ordinary healds of the first and second heald frames are greatly moved toward the upper direction or the lower direction to shed before the tip of the shuttle reaches, so that the warps are not engaged with the tip of the shuttle. On the

other hand, the warp 3b passed through the heald Hb for lowering the warp comes into engagement with the deflected tip of the shuttle SB and is lowered along the tip of the shuttle SB as it advances. Thus, the warp 3b is caused to sink

beneath the wefts to cross the despite the fact that the first heald frame  $F_1$  is raised or despite the fact that the heald Hb through which the warp 3b is passed is raised. This means that the warp which would have crossed the wefts being floated thereon in the plain weave is now caused to sink beneath the wefts by the function of the warp-lowering heald Hb and the warp-lowering shuttle SB to give the reversed results.

In the below-mentioned cases, the warps and wefts are crossed (i.e., warps cross above and below the wefts) in a reversed manner in the case where ordinary healds Ha and an ordinary shuttle HA are used.

First, when the weft is inserted by the warp-lowering shuttle SB while the warp-lowering heald Hb is being raised (the warp is positioned on the warp line) as shown in Figure 8, the warp sinks beneath the weft to cross it.

Second, when the weft is inserted by the warp-raising shuttle SC while the warp-raising heald Hc is being lowered, the warp floats on the weft to cross it.

Third, when the warp guide heald Hd is used, the warp is always positioned on the warp line irrespective of the vertical movement of the heald; the warp sinks beneath the weft to cross it when the weft is inserted by the warp-lowering shuttle SB, and the warp floats on the weft to cross it when the weft is inserted by the warp-raising shuttle SC. Therefore, the warps and wefts will often cross each other in a reversed manner in the case where ordinary healds and shuttles are used.

In other cases, the warps and wefts cross each other as they do when ordinary healds and shuttles are used. For example, when the warp-lowering heald is being lowered, the warp sinks beneath the weft to cross it no matter which shuttle SA, SB or SC is used to insert the weft.

A variety of types of woven fabrics can be obtained if the above-mentioned methods are taken into consideration. In this case, the number of the wefts in a complete weave (i.e., one-repeat) is determined by the number of the shuttles used for the circular loom. For example, in the embodiment illustrated in Figures 1 through 5, employing four shuttles, the number of the wefts in a complete weave is two or four. If six shuttles are employed for a circular loom, the complete weave will have two or three or six wefts. Thus, the maximum number of the wefts in one complete weave is equal to the number of the shuttles employed for a circular loom. On the other hand, the warps in one complete weave will acquire any given number greater than two, and the maximum number will become equal to the total number of the warps fed to the circular loom.

In connection with the woven fabrics obtained by the method of this invention and the circular

loom, below are illustrated relations among the woven fabrics, the shape of the healds and the shape of the shuttles with reference to some embodiments.

Figure 10 shows a weave obtained using four shuttles. In this case, a complete weave is constituted using four wefts and six warps. In the drawing, a mark  $\boxtimes$  represents a warp that is above the weft at the point of interlacing, and a mark  $\square$  represents a weft that is above the warp. Symbols  $S_1$ ,  $S_2$ ,  $S_3$  and  $S_4$  denote a first shuttle, a second shuttle, a third shuttle and a fourth shuttle, respectively, and symbols A, B and C denote the types of the shuttle as illustrated in Figure 7. Symbols  $F_1$  and  $F_2$  denote the first heald frame and the second heald frame, respectively and symbols Ha, Hb and Hc denote the types of healds (refer to Figure 6) supported by the heald frames  $F_1$ ,  $F_2$ . The individual wefts are inserted by the shuttles of the types specified by the symbols written on the left side of the fabric diagram. The individual warps are passed through the healds of the heald frames specified by the symbols written on the upper side of the fabric diagram, and are cause the shedding operation.

To obtain the weave shown in Figure 10, ordinary shuttles SA are used for the first and third shuttles, the warp-raising shuttle SC is used for the second shuttle, and the warp-lowering shuttle SB is used for the fourth shuttle. On the other hand, the warp-raising heald Hc is supported by the first heald frame  $F_1$ , followed by two ordinary healds Ha, and the warp-lowering heald Hb is supported by the second heald frame  $F_2$  followed by two ordinary healds Ha. With the fabric shown in Figure 10, a warp is floating on three wefts, and a weft is floating on three warps in one complete weave.

An anti-slip bag for containing granules can be obtained by using a tubular fabric which is partially made up of the weave illustrated in Figure 10. That is to say, with the weave illustrated in Figure 10, the warps and wefts are floating above the surface of the cloth. Therefore, when the bags are stacked, the wefts and wefts, or the warps and warps of the upper and lower bags engage with each other creating frictional resistance. Preferably, the bags should be so woven and produced that the weave shown in Figure 10 is located at the central portion of the bags.

In addition to the weave shown in Figure 10, the weaves illustrated in Figures 11 through 14 as well as any other weaves may be used for the anti-slip bags, provided they have warps and wefts floating above the surface of the cloth.

The weave shown in Figure 11 is prepared using four shuttles, like that of Figure 10. Three types of shuttles A, B and C are used. The number of the warps in one complete weave is four, and the healds are arrayed in the order to Ha, Ha, Hb and Hc.

Figure 12 shows another weave possible in tubular woven fabric, obtained by using four shuttles. In this case, only the warp-lowering

shuttles SB and the warp-raising shuttles SC are employed. The healds are ordinarily used healds Ha and warp guide healds Hd (refer to Figure 6).

Figure 13 shows a further example of a weave possible in tubular woven fabric, obtained by using three shuttles. The shuttles SB, SA and SC are arrayed in the order mentioned, the healds Ha, Hb and Ha are arrayed and supported by the first heald frame  $F_1$  in the order mentioned, and the healds Ha, Ha, Hc are arrayed and supported by the second heald frame  $F_2$  in the order mentioned.

Figure 14 shows an example of a weave possible in tubular woven fabric, obtained by using two shuttles (or an even number of shuttles, such as four, six, or the like). The warp-lowering shuttle SB and the warp-raising shuttle SC are used, and the ordinarily used heald Ha and the warp guide heald Hd are used, to effect the weaving.

The foregoing were mentioned only as some examples of the weaves that can be obtained using a circular loom, in accordance with the method of the present invention. It will be obvious that very many weaves are obtainable by suitably selecting the combination of shuttles and healds and the combination of moving directions (rising or lowering movement) of the heads and the shuttles during the shedding motion. Figures 10 through 14 show modifications of the weaves other than the plain weave when a cam for plain weaving (which is so shaped that two groups of warps are alternately moved up and down for each shuttle) is used as an annular cam 19a for controlling the shedding motion of the healds. It will therefore be obvious that various other weaves are obtainable, provided the annular cam 19a has a different shape (for example, a shape so that a pair of warp groups are alternately moved up and down for every two shuttles).

According to the present invention, a variety of weaves not attainable with conventional circular looms can be produced by the combination of the functional effects created by the above-mentioned modified shuttles and healds; that is even though sets of two heald frames are utilized, that is a plurality of heald frames arranged with two circular concentric arrangements like in conventional circular looms is utilized, various fabric constructions besides the plain weave can be created by utilizing the above-mentioned modified shuttles and the modified healds as the parts thereof, while maintaining a simple shedding mechanism as in conventional circular looms. As mentioned above, in the present invention the modified shuttles and the modified healds are applied to produce various fabric constructions besides plain weave. It is also very important to recognize that the conventional circular loom can be simply modified to utilize the

technical idea of the present invention by partially utilizing the above-mentioned modified shuttles and modified healds, thereby enabling the creation of the various fabric constructions besides plain weave.

Moreover, this invention makes it possible to weave tubular woven fabrics for making anti-slip bags.

Furthermore, if the size of the elongated mail of the modified healds is selected to be slightly longer than the size of the shed of slightly longer than two times of the size of the shed, excess tension is not exerted on the warp, even when it is raised or lowered.

### Claims

1. A method of weaving tubular fabrics in a circular loom having two or more shuttles characterized by using at least one shuttle of which the tip portion is upwardly or downwardly deviated out of its center line, and keeping part of the warps on a warp line during a shedding motion when the wefts are being inserted by said shuttle having deviated tip portion, wherein said shuttle having the deviated tip portion advances to engage with the warps kept on said warp line, and said warps are moved upwardly or downwardly by the deviated tip portion as said shuttle having the deviated tip portion advances.
2. A circular loom comprising two or more shuttles and a number of healds, characterized in that at least one shuttle is provided with a tip portion upwardly or downwardly deviated out of its center line, and at least one heald has an elongated mail, said elongated mail having such a length that a warp passed therethrough is allowed to stay on the warp line when the healds move in at least one direction during upward and downward shedding motions.
3. A circular loom according to claim 2, wherein an elongated mail of a heald extends downwardly from the center of the heald, the size of which mail is at least longer than half of the length of the shed.
4. A circular loom according to claim 2, or 3 wherein an elongated mail of a heald extends upwardly from the center of the heald, the size of which mail is at least longer than half of the length of the shed.
5. A circular loom according to claim 2, 3 or 4 wherein an elongated mail of a heald extends upwardly and downwardly from the center of the heald, the size of which mail is at least longer than the length of the shed.
6. A tubular fabric woven in a circular loom, characterized in that the tubular fabric is woven in accordance with the method as claimed in claim 1.



shuttles SB and the warp-raising shuttles SC are employed. The healds are ordinarily used healds Ha and warp guide healds Hd (refer to Figure 6).

Figure 13 shows a further example of a weave possible in tubular woven fabric, obtained by using three shuttles. The shuttles SB, SA and SC are arrayed in the order mentioned, the healds Ha, Hb and Ha are arrayed and supported by the first heald frame F<sub>1</sub> in the order mentioned, and the healds Ha, Ha, Hc are arrayed and supported by the second heald frame F<sub>2</sub> in the order mentioned.

Figure 14 shows an example of a weave possible in tubular woven fabric, obtained by using two shuttles (or an even number of shuttles, such as four, six, or the like). The warp-lowering shuttle SB and the warp-raising shuttle SC are used, and the ordinarily used heald Ha and the warp guide heald Hd are used, to effect the weaving.

The foregoing were mentioned only as some examples of the weaves that can be obtained using a circular loom, in accordance with the method of the present invention. It will be obvious that very many weaves are obtainable by suitably selecting the combination of shuttles and healds and the combination of moving directions (rising or lowering movement) of the heads and the shuttles during the shedding motion. Figures 10 through 14 show modifications of the weaves other than the plain weave when a cam for plain weaving (which is so shaped that two groups of warps are alternately moved up and down for each shuttle) is used as an annular cam 19a for controlling the shedding motion of the healds. It will therefore be obvious that various other weaves are obtainable, provided the annular cam 19a has a different shape (for example, a shape so that a pair of warp groups are alternately moved up and down for every two shuttles).

According to the present invention, a variety of weaves not attainable with conventional circular looms can be produced by the combination of the functional effects created by the above-mentioned modified shuttles and healds, that is even though sets of two heald frames are utilized, that is a plurality of heald frames arranged with two circular concentric arrangements like in conventional circular looms is utilized, various fabric constructions besides the plain weave can be created by utilizing the above-mentioned modified shuttles and the modified healds as the parts thereof, while maintaining a simple shedding mechanism as in conventional circular looms. As mentioned above, in the present invention the modified shuttles and the modified healds are applied to produce various fabric constructions besides plain weave. It is also very important to recognize that the conventional circular loom can be simply modified to utilize the

technical idea of the present invention by partially utilizing the above-mentioned modified shuttles and modified healds, thereby enabling the creation of the various fabric constructions besides plain weave.

Moreover, this invention makes it possible to weave tubular woven fabrics for making anti-slip bags.

Furthermore, if the size of the elongated mail of the modified healds is selected to be slightly longer than the size of the shed of slightly longer than two times of the size of the shed, excess tension is not exerted on the warp, even when it is raised or lowered.

### Claims

1. A method of weaving tubular fabrics in a circular loom having two or more shuttles characterized by using at least one shuttle of which the tip portion is upwardly or downwardly deviated out of its center line, and keeping part of the warps on a warp line during a shedding motion when the wefts are being inserted by said shuttle having deviated tip portion, wherein said shuttle having the deviated tip portion advances to engage with the warps kept on said warp line, and said warps are moved upwardly or downwardly by the deviated tip portion as said shuttle having the deviated tip portion advances.

2. A circular loom comprising two or more shuttles and a number of healds, characterized in that at least one shuttle is provided with a tip portion upwardly or downwardly deviated out of its center line, and at least one heald has an elongated mail, said elongated mail having such a length that a warp passed therethrough is allowed to stay on the warp line when the healds move in at least one direction during upward and downward shedding motions.

3. A circular loom according to claim 2, wherein an elongated mail of a heald extends downwardly from the center of the heald, the size of which mail is at least longer than half of the length of the shed.

4. A circular loom according to claim 2, or 3 wherein an elongated mail of a heald extends upwardly from the center of the heald, the size of which mail is at least longer than half of the length of the shed.

5. A circular loom according to claim 2, 3 or 4 wherein an elongated mail of a heald extends upwardly and downwardly from the center of the heald, the size of which mail is at least longer than the length of the shed.

6. A tubular fabric woven in a circular loom, characterized in that the tubular fabric is woven in accordance with the method as claimed in claim 1.