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Methods of Mounting Saw-Toothed Metallic Wire on The Taker-In and Other Rollers of Carding Machine

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***Abstract* —** Two methods are used for mounting saw-toothed metallic wire on different rollers of carding machine. The taker-in roller of the machine is generally grooved one way starting from one end of the roller to the other end and metallic toothed wires are mounted into the grooves. In course of time teeth of wires are worn out as they interact with fibers and impurities. As a result quality of product is deteriorated gradually. So the general practice is to replace the worn-out wires with new ones. Close observation of gradual wearing out of wire teeth reveals that due to oblique disposition of the teeth, only one of the two transitional edges of the front face of the teeth is mainly worn out leaving the other transitional edge intact. This paper explains one patented method and proposes another novel one that utilizes this unworn transitional edge and thus improves quality of yarn and increases longevity of the wear. The first method proposes taker-in with grooves starting from both ends of the roller. Application of this method will enable spinners to utilize both the transitional edges of taker-in teeth by dismounting the wires from the groove first after some use and then mounting the same wire on the roller again but into the grooves that start from other end of the roller. The second method proposes use of two types of wires on the bare taker-in roller; one type is toothed and another is without teeth. They are mounted on the roller side by side and alternately. Incorporation of tooth-less bare strip of wire gives obliqueness to the toothed wire. This method also will allow utilization of unworn edge of teeth by dismounting the wire first after some use and then mounting them on the roller starting from other end of it.

***Index Terms*—** Carding, metallic wire, front face of wire teeth, transitional edges, obliqueness of wire teeth.

I. Introduction

CARDING is regarded as the heart of short-staple spinning. In processing sequence of spinning machines, the task of carding machine is to open fiber or flocks to individual fibers which is performed primarily by taker-in and finally by cylinder-flats region. Figure- 1 shows the diagram of carding machine for processing short-staple fibers. Fiber material (lap or card mat from blow room) is fed at the feed zone of carding machine. Two circles at the beginning of the left side of the diagram are transport rollers in case of chute feed system; in case of lap feed system the top circle is the lap and the bottom one is the lap roller.

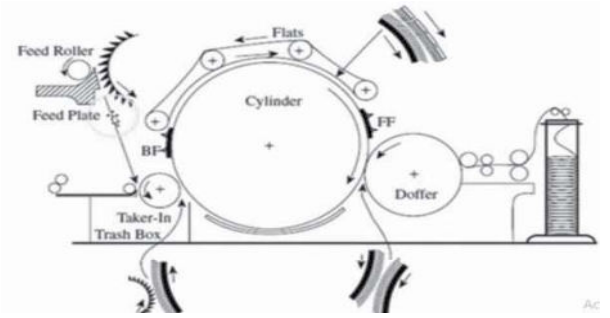

Fig. 1. Technological diagram of carding machine.

Then the fiber material proceeds between feed roller and feed plate and comes under the action of rotating taker-in (also called licker-in). Taker-in is clothed with saw-toothed metallic wire.

Taker-in opens fiber material and then transfers it to the cylinder. Impurities or foreign materials fall under taker-in into trash box. Transfer of fibers from taker-in to the cylinder takes place thanks to stripping (doffing) disposition of wires on the surface of the two rollers (figure- 2).

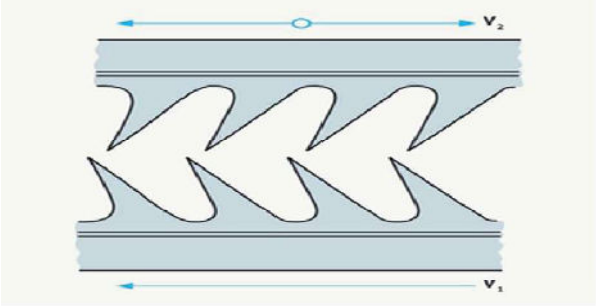

Fig. 2. Stripping disposition of wires.

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In stripping disposition, teeth on the two surfaces extend in the same direction. Here there is a deliberate transfer of fibers from the surface of taker-in to the surface of cylinder. However, the surface speed of cylinder v_1 must be greater than that of the taker-in. In practice the value is around two.

Cylinder is the largest working roller in carding machine which is also clothed with saw-toothed metallic wire. In the figure, the cylinder revolves clockwise and takes fiber material to the revolving flats (or flat bars). Flats also possess flexible or semi-rigid pointed wires. Carding action takes place between cylinder wire and flats' wire. As a result of carding, fibers are individualized. Short fibers and some impurities are taken away by the flats. Flats are cleaned by brush roller. Individualized fibers retain on cylinder surface.

From the cylinder the individualized fibers are transferred to the doffer (which is also a roller with clothed metallic wire). Then the fibers are taken from doffer in web form by the stripping device.

The web of fibers passes between calendar rollers and comes out as sliver (rope of untwisted fibers) .The sliver proceeds toward coiler mechanism and deposited in the can.

Taker-in is the first working organ of carding machine that interacts with fiber tufts and reduces the tufts to micro-tuft-lets and individual fibers [1].

Figure 3 shows taker-in zone where metallic wire (1) of taker-in with center O_T is acting on the fiber fringe (5) held by the feed plate (2) and the feed roller (3).

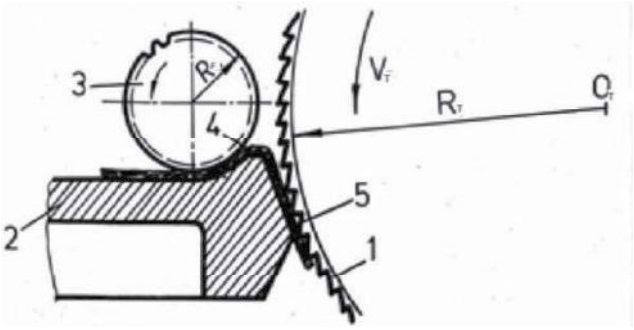

Fig. 3. Taker-in zone of carding machine.

By construction the taker-in is a cast roller with a diameter of around 230 mm which is covered with saw-toothed metallic wire clothing. The wire is made from round wire by rolling through several stages and given the shape of a saw-toothed flat strip with desired values of height, pitch and inclination of the teeth, base of strip and other parameters (fig. 4 and table 1 a &1 b).

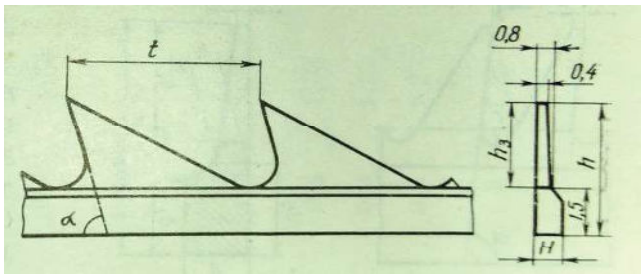

Fig. 4. Saw-toothed metallic wire.

Table-1(a) Parameters of taker-in wire in grooved roller method.

Type of metallic wire	Base width of metallic wire, H, mm	Height of metallic wire,h_1,mm	Height of tooth, h_3, mm
1	1.1	4.5	2.5
2	1.1	6	4
3	1.1	6	4
4	1.1	6	4

Table-1(b) Parameters of taker-in wire in grooved roller method (Continuation).

Type of metallic wire	Distance between teeth, t, mm	Angle of inclination of front face of tooth with base, α, degree	Number of teeth per 1 cm^2
1	5	60	8
2	6.5	75	6
3	6.5	60	6
4	8	90	5

Tables 1(a) and 1(b) show some practical values of parameters of taker-in wire (fig.4). The metallic wire of type- 1 is used for processing higher grades of cotton and type- 4 is used for lower grades of cotton with higher content of impurities. Types 2 and 3 represent intermediate grades.

In figure- 5, ABCD represents the cross section of the tip of a wire tooth which is a very small area and EFG is the area attached to the base. If we consider AEFD as the front face of the tooth then the two transitional edges are AE and DF.

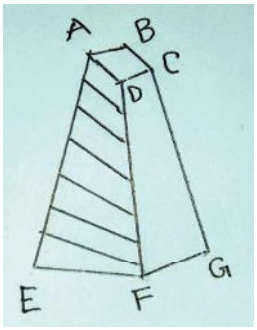

Fig. 5. Perspective view of a saw tooth of taker-in wire.

The interaction of fibers with teeth of wire clothing leads to individualization of about 50% of the fibers and elimination of most of the foreign impurities (80-90%) in the taker-in zone [2]. However the toothed clothing i.e. metallic wire of taker-in is worn out in course of production process as teeth come in contact with fibers and foreign impurities. Figure- 6 shows gradual wearing out of metallic wire.

Fig.6. Gradual wearing out of metallic wire.

The worn out clothing cannot interact with the fiber mass properly and consequently the quality of ultimate yarn is deteriorated. So the general practice is to replace the worn out clothing with new ones after processing a definite amount of fiber. The percentage of impurities is also taken into account as higher percentage of impurities in the fiber reduces the longevity of the clothing.

Close observation of the gradual wearing out of clothing teeth in the taker-in of the machine reveals that due to oblique disposition of the wire strip on the helical grooves, only one of the two transitional edges of front face teeth is mainly worn out in course of time in production process leaving the other transitional edge of it intact (fig 7)

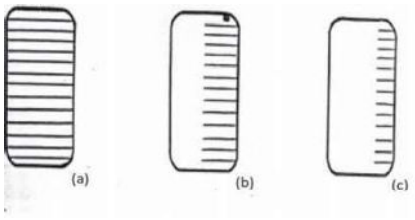

Fig. 7. Gradual wearing out of front face of a saw- tooth of the wire.

Figure 7(a) shows intact front face of a tooth before any interaction with fiber and impurities (AEFD in fig– 5). Fig- 7(b) shows the half worn front face where wearing out of the face starts from the left side (transitional edge AE in fig- 5) and proceeds to the right side (toward transitional edge DF in fig- 5). Fig- 7(c) shows that the front face of the tooth is almost worn out leaving small area unworn in the right side (close to transitional edge DF in figure- 5).

This paper has explained one proposed method described in a patent [5] and introduced another method to utilize this transitional edge which has not undergone wear and tear. By applying these methods the quality of yarn is improved and the longevity of clothing wire increased.

It may be mentioned here that the number of teeth (wire points) per square inch on taker-in is around 40 which is significantly less than those on the other rollers or components of the machine namely cylinder (680 wire points/sq. inch), flats (530 wire points/sq. in.)[6] and doffer (380 wire points/sq. in.). The size of taker-in teeth and distance between points are also comparatively large. This is essential to avoid fiber damage. Because the teeth of fast revolving taker-in are meant to disentangle and open a tangled mass of fibers held between slowly revolving feed roller and stationary feed table at the entrance of the machine. After opening by the taker-in, the fibers are individualized better by close-set finer teeth of cylinder and points of flats. (People use large comb teeth with large dents for combing tangled hair to prevent hair damage and then use comb with close-set finer teeth). Higher wire point density on cylinders (and other rollers) is obtained by mounting very thin wire base on them compared to taker-in wire base. As a result after mounting, wires are almost perpendicular to the axis of the rollers and the obliqueness of the wire is close to zero. Under such condition the fibers are hooked mostly by both the transitional edges of front face of cylinder teeth and both the transitional edges are simultaneously worn out. So the proposed methods will not be practically applicable to rollers other than taker-in.

Pinned taker-in rollers developed in 1972 are used in some carding machines like Trutzschler's card (DK760, TC03) instead of toothed taker-in. Since pins are perpendicular to the surface of taker-in, they do not possess obliqueness and there are no distinct transitional edges of front face of pins. The pins on taker-in are less effective for opening tangled mass of fiber compared to teeth on taker-in. Therefore three pinned taker-in rollers of same size are incorporated in the carding machine of 'Trutzschler' whereas in most carding machines including latest carding machines of leading manufacturer 'Rieter' (C70, C 80) only one toothed taker-in roller is used.

II. USUAL METHODS OF MOUNTING METALLIC WIRE ON CARDING ROLLERS

There are two methods of mounting of wire strip on the shell of the carding rollers. In the first method, helical grooves are cut on the surface of the roller and then metallic wires are mounted into the grooves (grooved roller method or multi-start mounting method). This method is used for taker-in where

normally 6 to 8 helical grooves are cut on the surface of the bare roller having a lead of 1 inch. As a result, six start taker-in rollers have six parallel grooves and eight start taker-in rollers have eight parallel grooves. The metallic wires are then fixed into the grooves, starting from one end of the taker-in to the other end by a special machine.

In the second method no grooves are cut on the roller and a single strip of wire clothing is mounted on the bare roller also running from one end of the roller to the other end of it (groove-less roller method). This method is generally used for mounting metallic wire on cylinder, doffer and stripping rollers. This method is also applied for taker-in. The width of the tooth base for taker-in in this case is greater (2.5mm, H in table 2 a), fig.4 compared to the base of wire used in multi-start method i.e. groove roller method (1.1mm, H in table 1 a).

Table-2 (a) Parameters of saw toothed taker-in wire in groove-less roller method (Fig.4).

Type of metallic wire	Base width of tooth, H, mm	Height of metallic wire,h_1,mm	Height of tooth, h_3, mm
1	2.5	6	4
2	2.5	6	4
3	2.5	6	4

Table-2 (b) Parameters of saw toothed taker-in wire in groove-less roller method (Continuation).

Type of metallic wire	Distance between teeth, t, mm	Angle of inclination of front face of tooth with base, α, degree	Number of teeth per 1 cm^2
1	6.5	75	6
2	6.5	85	6
3	6.5	105	6

In table-2 types 1, 2, 3 are used in groove-less method for taker-in (Fig.4). Type 1 is used for processing cotton with less impurities, type-2 for cotton with higher percentage of impurities and type- 3 is used for synthetic fibers. From the table-2, it is evident that base width is 2.5 mm whereas in the table-1 the base width is 1.1 mm. It is also seen that the angle of inclination (α) is different namely 75^0, 85^0 and 105^0 for the three different types.

Fig-8 shows metallic wire for groove less roller method.

Parameters of metallic wire used in groove less roller method for different types of roller are given in the table- 3 (a) & table- 3 (b), (Fig.8)

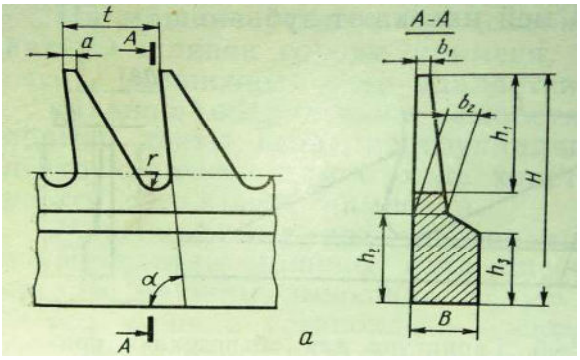

Fig. 8. Metallic wire for groove-less roller method

Table-3 (a) parameters of metallic wire for different rollers of carding machine for groove-less mounting (Fig.8).

Type of metallic wire	Base width of tooth, B, mm	Height of the wire, H_1, mm	Height of tooth, h_1,mm	Distance between teeth, t, mm
1 (for taker-in)	1.2	4	2.3	3.2
2 (for cylinder)	0.7-1	3.5 - 4	1.2, 1.3	1.3 (1.8)
3 (for doffer)	0.7 - 1	4	2.3	1.6 – 2.5

Table-3 (b) parameters of metallic wire for different rollers of carding machine for groove-less mounting (Continuation).

Type of metallic wire	Angle of inclination of front face of tooth with base, α, degree	Width of the tip of tooth, b_1, mm	Width of tooth at base, b_2, mm
1 (for taker-in)	70	0.15	0.4
2 (for cylinder)	75-80	0.15	0.4
3 (for doffer)	65-70	0.15	0.4

The advantages of 2nd method are higher evenness of roller surface and simplicity of mounting process. However, in the first method (i.e. in multi start mounting) the fiber mass is treated better that leads to improvement of quality of ultimate yarn [3].In multi-start mounting (in grooved roller method) due to space between grooves and width of wire base, the teeth disposition on the roller is oblique and hence the teeth of a particular turn of the clothing strip are spread to some extent across the width of the machine and not confined at a place or point on it. So large numbers of fibers are treated by the teeth of the turn and as a result, the effectiveness of interaction between fiber mass and the teeth of the taker-in is increased [4]. Besides, due to oblique disposition of the teeth contact between fiber and tooth increases. The time of contact is also prolonged. All these plus

points lead to better disintegration of fiber mass and extraction of foreign impurities.

In case of 2nd method (groove less roller method) a single strip of wire with less base width runs from one end of the roller to the other end. Therefore, the teeth of a particular turn are almost perpendicular to the axis of the roller. As a result, the obliqueness of the teeth to the roller axis is almost zero.

III. EXPLANATION OF A PATENTED METHOD OF MOUNTING METALLIC WIRES ON TAKER-IN ROLLER

The unworn edge of the two transitional edges of metallic wire tooth mentioned above can be utilized if we dismount it from the groove of taker-in roller (sometime after first mounting and use) and fix it firmly on the roller again but starting from the other end of it. Usually taker-in rollers are grooved one way starting from one end of it to the other end along the width of the machine. In respect of multi start mounting a different disposition of grooves on the carding roller was proposed in the patent [5] wherein grooves start from both ends of the roller i.e. , from the left end to the right end and also from the right end to the left. Application of such a roller in carding machine will enable spinners to utilize both the transitional edges of wire teeth by dismounting the wires from the groove first after some use and then mounting the same wire on the roller again but into the grooves that start from other end of the roller. Thus, in this method the same clothing wire will be used two times which should increase the longevity of clothing and improve the quality of the ultimate product. Some more elaboration to the method is added here.

As the grooves are cut on the carding roller from the left and right ends, the left-start grooves and the right-start grooves intersect. The points of intersection of the left-start and the right-start grooves are placed on the same straight lines on the surface of the roller. For a six start roller the number of such straight lines will be 12. Figure 9 shows the surface of the carding roller and the above mentioned 12 straight lines which are also characterized by hexagonal patterns of projected surface between the grooves.

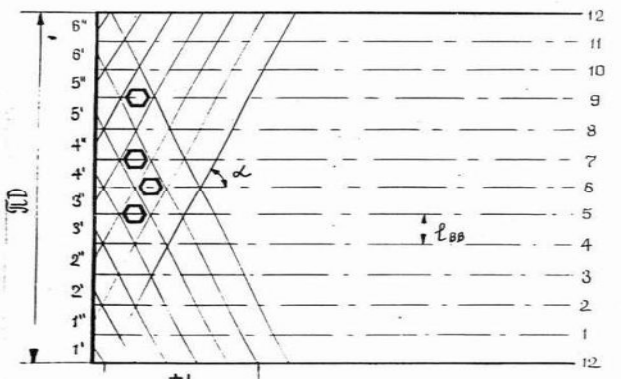

Fig. 9 .Surface of carding roller with left-start and right-start grooves.

This type of carding roller (with left start and right start grooves) is suitable for taker-in because of comparatively greater obliqueness of wire teeth that leads to wearing out of only one of the two transitional edges of front face of the wire teeth and thus creates opportunity of utilizing the other unworn edge.

IV. PROPOSED NOVEL METHOD OF MOUNTING METALLIC WIRES ONTAKER-IN

Here a novel method of mounting clothing wire on bare taker-in roller is being proposed. In this method two types of metallic wires will be used; one is toothed and another one is without teeth. They are mounted on the roller side by side and alternately (Fig 10 a).

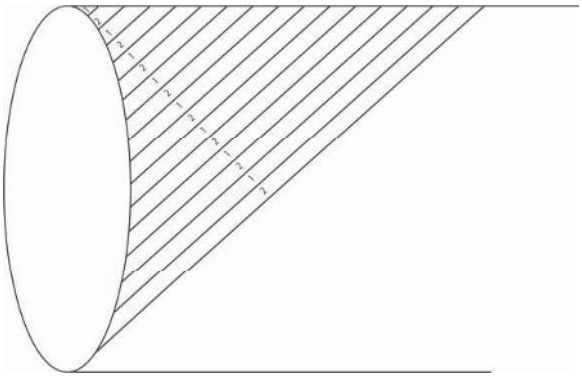

Fig. 10. a Disposition of toothed strips 1 and bare strips 2 on the surface of taker-in roller for first mounting of the wire.

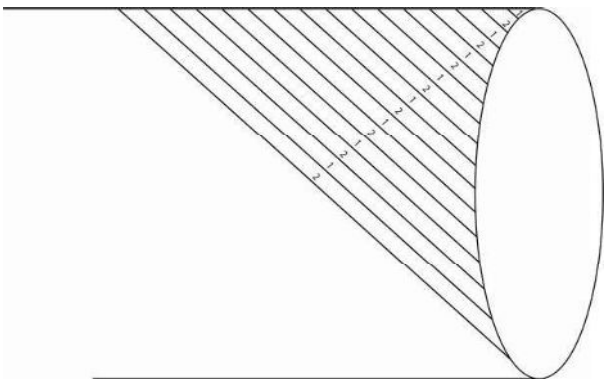

Fig. 10. b Disposition of toothed strips 1 and bare strips 2 on the surface of taker-in roller in mounting of the wire for reuse.

In the above figures, 1 and 2 represent toothed strips and bare strips respectively.

Thus succession of metallic wires with teeth and without teeth runs on the roller along the width of the machine. The advantages of this method are like no need of cutting grooves on the roller, higher evenness of roller surface, and simplicity of mounting process. Besides this method of mounting gives rise to oblique disposition of wire teeth thanks to use of bare strips between toothed strips which increases interaction between fibers and teeth. This method also enables utilization of the unworn transitional edge by dismounting the wires first and then mounting them on the roller starting from other end of it (Fig 10 b).

V. CONCLUSION

This paper explains one patented method of mounting metallic wire on taker-in of carding machine and introduces a novel one.

In-multi start mounting of taker-in with metallic wire, the unworn transitional edge of front face of teeth may be utilized by changing direction of mounting on the taker-in roller. As a result, longevity of wire will be increased and quality of the product improved as effectiveness of interaction between wire teeth and fibers increases.

The method of mounting of alternate toothed and bare strips on taker-in will provide higher evenness of clothing on bare taker-in roller and simplicity of mounting. Use of alternate toothed and bare strips will increase obliqueness of the wire teeth leading to better interaction between fiber and clothing teeth and ultimately better quality of yarn. The method will also enable utilization of unworn transitional edge of teeth by dismounting the wires after some use and then mounting the same wires on the roller starting from other end of it. As a result wire longevity will be increased with improvement of quality of product.

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