Coth roll doffing machine for Indian powerloom industry

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A cloth roll doffing machine has been designed to overcome the constraint of cramped working condition in Indian powerloom industry. It is expected to be rugged and easy to manufacture. A single device can service many looms and can ease the strain on a worker.

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The operation of doffing a full cloth roller from a loom and loading an empty one in its place requires a lot of physical strain on the person working on the loom. Automation of this operation has been achieved by a few manufacturers either by incorporating an automatic fabric beam change system in the loom (e.g. Picanol B-8900 “Delta”)1 or with drive-by carts (e.g. Genkinger Hubtex).2 They require motor power as input and sophisticated electronic controls. Such mechanisms do have their place in a modern loom shed. However, a majority of the powerloom operators of India, who run 170000 looms amongst them, are not in a position to avail these “auto-doffing systems” because of various reasons, such as (i) there is very little space between looms in a typical powerloom operator’s factory. It is not possible to manoeuvre the drive-by carts within this space (ii) these systems are costly and (iii) the powerloom operators are not in a position to maintain them since the electronic components need a clean environment and temperature control to last long.

In the absence of mechanised doffing systems, the cloth rollers are mostly dumped in the aisles. This makes them susceptible to soiling. The few designs available in patent literature3–6 do not address the specific requirements of Indian powerloom industry.

Thus, there is a need for a cloth roller auto-doffing machine which does not require motor power as input, does not use electronic sensors or controls and can be operated by a single operator. In addition, a single machine should be capable of servicing many looms. This requires the machine to be mounted on wheels and narrow enough to pass between rows of looms. The design features of such a machine have been described in this paper.

Design of Machine

Removal of the full cloth roll and mounting of the empty cloth roll are two separate operations. Only those designs were explored in which these were performed either in the same motion or happened sequentially. The mechanical advantage was kept large since the cloth roll is quite heavy. The final design consists of four subassemblies:

Subassembly 1 – Structure with holder for lifting the full cloth roll from the loom and mounting the empty cloth roll on the loom.
Subassembly 2 – Arms for lifting empty cloth roll and carriage for depositing full cloth roll.
Subassembly 3 – Arrangement for disengaging full cloth roll from friction drive of loom.
Subassembly 4 – Base, supported on wheels.

The Subassembly 1 of the machine, as shown in Fig. 1, has been designed with these in mind. Rotation of handle H would drive a lead screw L1. This would drive another lead screw L2 through belts B1 and B2. Assuming no slippage at the belts, the motion of the two lead screws will be synchronous. Timing belts with appropriate grooves on the shafts can be used to ensure that there is no slippage. The upper half of both L1 and L2 would have left handed threads while the lower halves of L1 and L2 would have right handed threads. Thus, the pair of nuts N1a and N1b will have right handed internal threads while N2a and N2b will have left handed internal threads. With the rotation of handle H, the nuts N1 and N2 will move in opposite directions. The cloth roll carrier carrying an empty cloth roll is supported by nuts N2a and N2b.
As the empty cloth roll translates downward, it crosses the hinged joint S. This allows one-way movement to the empty cloth roller, i.e. the empty cloth roll is allowed to move down, but once it has crossed the joint S, it cannot move up. An isometric view of the hinged joint is shown in Fig. 2. When the motion of the lead screw is reversed, the nuts N2a and N2b start moving up. The empty cloth roll is pushed out from the cloth roll holder by the joint S.

Figure 3 shows the nuts (N1a and N1b) for supporting the arms which will lift the filled cloth roll from a loom. The wheel (W) provides a changing pivot to the arm (A) lifting the full cloth roller (Fig. 4). This is necessary since upward movement of the nut (N1a or N1b) causes the contact point between the nut and the arm (A) of the doffing device to translate along the length of the arm. The arm (A) and carriage for full cloth roller (C), which have been named Subassembly 2, are shown in Fig. 4. As the arms lift the full cloth roller from the loom, it rolls on the arm and is deposited in the carriage (C).

In the following description, it is assumed that the cloth roller on a loom is driven by a friction drive which can be disengaged from the cloth roller by pressing a spring mounted lever downward. This can be done by pushing down a lever supported by springs with a large force of about 100 - 150N. The mechanism for doing this (Subassembly 3) is shown in Fig. 5. When the lead screw (L) is rotated by rotating the handle (Ha), the plate (P) moves down and pushes down the relevant lever. This performs the disengagement.
The Subassemblies 1, 2 and 3 are mounted on a base supported on wheels (Subassembly 4). The wheels can be spherical so that the unit can be pushed close to the loom easily. Alternately, they may be designed on the castor principle. This will lead to greater manoeuvrability but will support lower loads compared to axially mounted wheels of similar material.

An isometric view of the complete machine is shown in Fig. 6. As the apparatus is wheeled to the front of a loom and moved close to it, the spring supported lever comes under the plate P of Subassembly 3. The plate is moved downward by rotating the handle Ha. This disengages the cloth roller from the friction drive.

The handle H is next rotated which rotates the two lead screws. This causes the nuts on the upper and lower halves to move vertically but in opposite directions. The nuts supporting the empty cloth roller start moving downward and the nuts supporting the arm carrying the load move upward. The arms lift the cloth roller from the loom. As the arms approach a vertical position, the cloth roller rolls down the arms and lands in the carriage provided for this purpose. The fabric is still connected to the loom. Hence, it unrolls partially from the cloth roller.

By the time the handle H is rotated to its limiting position, the cloth roller holder E has taken the empty cloth roll past the stoppers. Now, the handle H is rotated in the opposite direction. This causes the cloth roller holder to move up and the arms to move down (towards a more horizontal position). The empty cloth roller is pushed out of the holder by the one way stopper and it falls in the grooves at the end of the arms. The arms are in a more horizontal position compared to when the full cloth roller rolled out from the groove and landed in the carriage C. This ensures that the empty cloth roller stays in the groove and does not start rolling down the arms. The handle H is rotated till the arms come down and mount the empty cloth roller on the loom. The position of the entire apparatus is not changed during the operation. This causes the arms to swing through the same positions during the raising and lowering operations. This, in turn, ensures that the empty cloth roller is placed in exactly the same position from where the full cloth roller was taken – which is required in the doffing mechanism. The fabric is cut manually close to the carriage. The loose end of the fabric attached to the loom is wound on the empty cloth roller. The purpose of delaying the fabric cutting operation till this stage is to ensure that a long length of fabric is available for wrapping onto the empty cloth roller. The plate P is moved up by rotating the handle Ha. This allows the friction drive to re-engage with the cloth roller. The apparatus is moved away from the loom to remove the full cloth roller from the carriage C and mount an empty cloth roller in the holder E.

The machine described above can perform the task of doffing a cloth roller from a conventional loom while working within constrains mentioned in the
introduction. It can pass through narrow aisles between looms. Disengagement of friction roller from cloth roller and removal of cloth roller from loom is achieved by sequential motions. The two different actions of removal of full cloth roller from loom and loading of empty cloth roller on loom are performed with a single motion by rotating a handle in two directions. By replacing the two handles with motorised inputs (e.g. rotary actuators) the machine can also be used with lower human effort.

The advantage of such a device in the Indian powerloom industry is obvious. Apart from easing the task of doffing a heavy cloth roller, it will discourage the current practice of dumping cloth rollers in the aisles. This will improve quality of fabric. The proposed design is simple enough to be fabricated in a small workshop. The absence of any electronic controls allows the unit to be used in rugged conditions.

References