Indian Journal of Fibre & Textile Research
Vol. 33, March 2008, pp. 93-96

Design of an automatic parallel type jute bag making machine

Abhijit Mahapatra[a], Umesh S Patkar &
Rajesh W Lanjewar

Central Mechanical Engineering Research Institute,
Durgapur 713 209, India

and

Shibendu Shekhar Roy

National Institute of Technology, Durgapur 713 209, India

Revised received 3 July 2007; accepted 20 September 2007

An attempt has been made to design a jute bag making machine in which all operations, like fabric cutting, hemming, mid-folding and herackle stitching, are carried out automatically in a single setup to produce parallel type jute bags of industrial standards. The salient design features of indigenously developed first prototype of an automatic jute bag making machine have been described. The proposed machine comprises four major units, like fabric cutting and conveying unit, simultaneous mouth edge folding and stitching unit, mid folding and material guidance unit, and simultaneous parallel side stitching unit. The motor drives, sensors and actuators are synchronized and automated by programmable logic controller. The proposed machine can produce bags of uniform quality with mouth edge folded, hemmed and parallel side stitched in one single integrated setup at higher productivity compared to present manual system.

Keywords: Actuator, Jute bag, Parallel type bag, Programmable logic controller, Sensor
IPC Code: Int. Cl.[8] D05B

Jute bags are being preferred to replace plastic bags for packaging of agricultural products, like sugar, vegetable and fruits, because of growing awareness about the harmful effects of plastic bags. The present demand of jute bags cannot be met with the existing state-of-the-art followed in jute industries for bag making because the bags are manufactured by stand-alone cutting and sewing machine with the help of number of operators and helpers. An industrial survey reveals that a balanced setup for making parallel type jute bags consists of one shear cutting machine, twelve numbers of single needle double thread chain stitching machines and six machines for single needle double thread overlock stitching. All operation, such as material movement, edge folding or mouth hemming, feeding to stitching machines, mid-folding of bags and herackle stitching are carried out manually. Hence, the existing system cannot avoid the drawbacks in the manufacturing of jute bags. Firstly, the quality production rate depends on the efficiency and willingness of the operators. Secondly, the above-mentioned operations are labour intensive. Thirdly, the manufacturing plant occupies large floor area. To overcome these drawbacks, fully automated bag making machines have been a long felt need. However, from prior art details, it is found that there is no exclusive machine of this type specified for bag making which is capable of doing all operations right from mouth hemming with edge folding to parallel side stitching in a single set up automatically in a synchronized manner. However, there are few designs of semi-automatic or partly automatic machine for making bags from plastic mesh, fabric, cloth, etc. One US patent [1] discloses a bag making machine wherein bag is made from flat tubular web of plastic. Another US patent [2] describes a bag stitching machine wherein a fabric material is transported to a fixed sewing machine. Here, one seam of the bag is sewn followed by transportation at 90° for sewing of next seam. Such types of bags are commonly known as 'L' type bags. This machine is not suitable for parallel sides stitched and mouth hemmed bag that is commonly known as parallel type bag. Other related patents[3,4] show an apparatus for producing pillowcases, bags and the like wherein continuous material is cut into individual sections before folding. The bags are sewn by moving sewing machines. This system may be suitable for manufacturing pillowcases and bag made of stiffer fabric but not suitable for manufacture of jute bags of the intended specifications from coarse and less stiff jute fabric. The machine does not have any provision for mouth edge folding which is essential for the parallel type jute bag. Another patent [5] shows the bag making machine in which the fabric material is unwound and folded before being taken to other operations, such as cutting and two side stitching. In this machine, simultaneous hemming and parallel sides stitching are not possible. Hence, this machine is not suitable for producing parallel type bags.

Therefore, in the present work, an indigenous parallel type jute bag making machine has been

[a]To whom all the correspondence should be addressed.
E-mail: abhi_mahapatra@yahoo.co.in

designed to provide integration of sequential process through computerized control in order to achieve full automation. This will facilitate manufacturing of parallel type jute bags in a single setup from continuous supply of fabric material by controlled process of unwinding, cutting of fabric to required length, simultaneous both edge folding and stitching to form hemmed mouth followed by mid-folding and parallel side stitching.

Description of New Machine

The machine (Fig. 1a) comprises several successively arranged work stations, namely cutting station, hemming station and herackle station at which various operations are performed in the manufacture of the bags. The process starts at cutting station where a bale of fabric roll is wound on the mandrel (1). The availability of feedstock is monitored by a photo sensor and controlled by programmable controller (PLC). The fabric is unwound continuously from the fabric roll at required feed rate by the pull of two rubberized rollers of feed roller assembly (2). Then the fabric is made to pass through the guide roller assembly (3) and dancing roller assembly (4) that minimizes the misalignment and maintain required tension in the fabric. The conveyor assembly I (5) consists of a set of top and bottom flat belts running over two pairs of rollers respectively to pull the fabric intermittently. This assembly ensures perfect tension in the fabric material and aid smooth flow of the fabric. The fabric flows underneath the top shearing blade in shearing assembly (6). The infrared sensor positioned on the grippers of gripper assembly I (7) senses the fabric end and actuates the pneumatic grippers to grip the fabric and pull it. The pneumatically actuated gripper slides on a pair of rail and is connected to a motor driven timing belt for back and forth motion. After a required length of the fabric is pulled by the gripper (as indicated by position sensor), the pneumatic cylinder attached to the top blade of shearing assembly is actuated. The top blade shears off the fabric on the edge of the bottom blade. The cut length fabric is pulled further till the gripper position reaches another infrared sensor such that the cut fabric is aligned with the hemming station (in transverse direction with respect to the cutting station). The grippers of gripper assembly I (7) releases the fabric after the material is sensed by infrared sensors positioned on the second pair of grippers of gripper assembly II (8). The cut length fabric is transferred to the hemming station. As

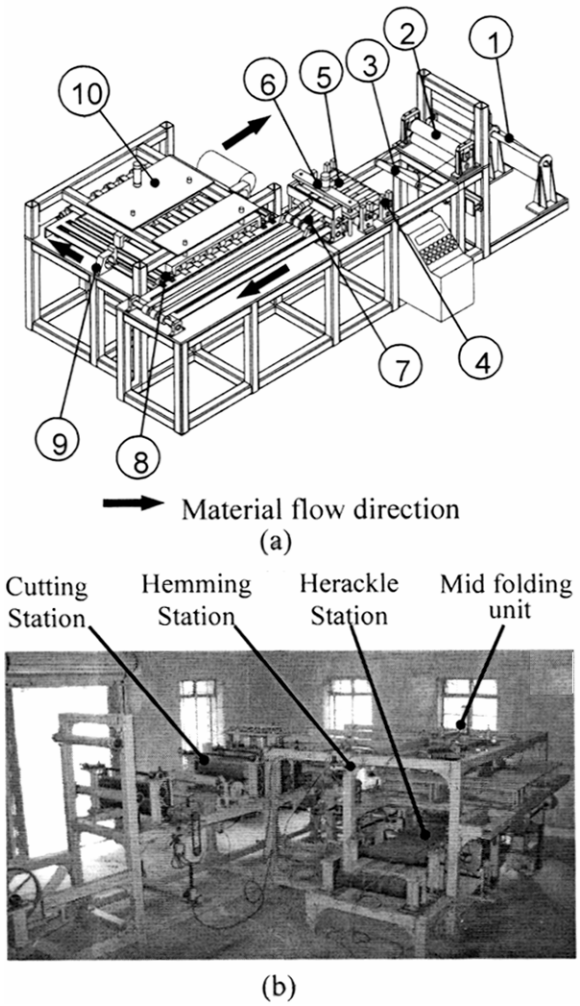

Fig. 1 — (a) Schematic view and (b) perspective view of automatic jute bag making machine [1-mandrel, 2-feed roller assembly, 3-guide roller assembly, 4-dancing roller assembly, 5-conveyor assembly I, 6-shearing assembly, 7-gripper assembly I, 8-gripper assembly II, 9-stitching machines and 10-mid-folding unit]

the fabric moves through a set of top and bottom conveyor belts in the hemming station, the edges pass through simultaneous multi-edge folding and stitching unit. In the mean time, the pair of gripper of cutting station returns back to its home position at twice the speed of the forward movement**.**

In hemming station, as the fabric comes out of edge folder device, fabric edges get folded and at the entrance to the stitching unit, the appropriate sensor enacts the single needle two threaded chain stitching machines (9) to operate in tandem so that both the folded edges are chain stitched at a pitch of 10 mm. The stroke of stitching units and speed of material movement are synchronized to ensure smooth

functioning all along the process. After stitching, the thread cutter sensor senses the position of the fabric and actuates the thread cutter. The extended thread from the fabric is cut and the hemmed fabric moves into the mid-folding unit (10). If there is thread breakage during stitching of edges, the thread breakage sensor operates and brings the system to a halt. When the hemmed stitched material is perfectly aligned in the mid-folding zone, the gripper releases and the position sensor in the mid-folding unit actuates the solenoid of the pneumatic cylinders. The vertical plunger cum mid-folder, actuated by pneumatic cylinder, moves downward. The mid-folding arrangement is so designed such that the set of spring loaded rollers holds the material under tension. As the plunger descends vertically, it folds the material exactly at the mid portion of the fabric. The folded fabric is pushed in between conveyors of mid-folding unit and is then carried downward in the longitudinal direction to the herackle station.

In the herackle station, the top and bottom conveyor belts pull, press and orient the fabric in longitudinal direction. As the fabric reaches the stitching unit, the sensors are activated for switching on a pair of over-lock sewing machines to perform over-lock stitching operations at 12 mm pitch on both the parallel edges. Similar to hemming stitching head, the combination of thread breakage and thread cutting sensors will ensure proper functioning of the process. The combination of 6 motor drives (3 phase AC) with frequency controllers, 13 pneumatic actuators and 53 sensors at various positions (provide a perfect feed back signal to PLC) in the machine is synchronized and automated by PLC to form a complete bag. It is to be noted that the entire operation for producing a bag is performed through closed loop control system with flexibility for various interactive modes of operation, such as fully automatic, semi-automatic and manual mode.

The key features and specifications of the developed prototype are:

Type of input material	: Jute fabric roll
Width of the jute fabric	: 570 mm
Type of edge fold	: Dual fold
Pitch of chain stitch at mouth hemmed	: 10 mm
Pitch of over-lock stitch at parallel side	: 12 mm
Number of bags per hour	: 150
Total power consumption	: 6.0 kW
Overall size	: 6000×3000×1750 mm
Output from the machine	: Mouth edge folded hemmed and parallel side stitched bag
Size of the bag	: 940mm × 570mm

The proposed machine (Fig. 1b) is provided with a unique design of automatic edge folding of the jute fabric with the help of spiral shaped tapered dual edge folder at simultaneous multi-edge folding and stitching unit. Also the mid-folding unit, which folds the jute fabric automatically, and the material guidance are some of the unique features in the design.

A comparative study of the proposed system and present system has been made. Based on the industrial survey, in the present system a total of 12 manpower is involved for manufacture of single line production facility jute bags of given specification. The total time consumed for the production of one bag per man is approximately 75 s and the total bags produced per man per hour is approximately 48 bags.

In the proposed system, the independent operations are synchronized to perform sequential operations through PLC. The total cycle time programmed to produce one bag of similar kind is 24 s, i.e. the total cycle time per bag per man will be approximately 24 s. The total bags produced per man per hour will be approximately 150 bags. The proposed machine has the following advantages: (i) the bags will be produced with all operations automated in a single continuous line of production, (ii) the productivity of the proposed machine will be three times more that of the manual process in terms of per man hour, (iii) the quality of the bag will be high and consistent due to elimination of human intervention, (iv) the machine requires one operator and a helper for the whole operation, and (v) the machine is energy efficient and occupies comparatively less floor space area.

The developed automatic machine will provide complete solutions for appropriate mechanization and synchronization to minimize manual operation and the drawbacks present in the manual operations for making jute bags. The new machine will provide uniform quality of mouth edge folded, hemmed and parallel side stitched machine in one single integrated machine at more than 3 times higher productivity compared to present system and most importantly will reduce manpower requirement to a single person for complete operation.

Acknowledgement

The authors gratefully acknowledge the hard work put by Mr S Muralidhar, Dr N P Mukherjee and other team members for the development of this machine. The authors are also grateful to National Centre for Jute Diversification, Kolkata for their financial support and to Ghanashyam Singh Lotey (GSL) Textile, Ludhiana, for manufacturing the prototype.

References

1 Takeo Yanai, Bag making machine, *US Pat 5009740* (to Nippon Flute Co., Ltd., Irumagun, Japan), 23 April 1991.

2 Berg Harold Bernard, Bag stitching machine, *US Pat 3459142* (to Burd, Maccachron, Bradddock, Bartz & Schwarty), 5 August 1969.

3 Elwyn D Jones, Robert Lauzon & Bruno Wetter, Bag folding machine, *US Pat 4840609* (to Glopak Inc., Montreal, CA), 20 June 1989.

4 Gregory A Ball, Byron E Moore & Hoyt W Beam, Apparatus for fabricating pillowcases, *US Pat 4621585* (to Cannon Mills Company 'Kannapolis, NC), 11 November 1986.

5 Scott A Brewer & David E Frye, Bag making machine, *US Pat 5590612* (to Wagner & Middlebrook), 7 January 1997.