

New Concept of Weaving Loom Construction

Abstract

In order to develop the concept of a new weaving loom, the well known method of shed formation along the warp was used, in which the shed is formed with the use of sinkers positioned on the circumference of a rotating drum, as this method allows to achieve the highest possible frequency of shedding. According to the new concept, in order to beat the wefts to the edge of the fabric, the same sinkers are used as the shed formation, significantly simplifying the loom construction. Inserting wefts into the shed is done with the use of yarn grippers which are placed along the warp width in tunnels formed by the same sinkers that form the shed. The gripper's motion is forced by the action directed on the sinkers' walls placed on the drum circumference along a line askew in relation to the drum axis. Such a novel way of inserting the weft is characterised by a simple construction and requires only a small driving energy, and furthermore works quietly. Contrary to hitherto known looms, with construction solutions which require some complex mechanisms (forming the shed, inserting the weft, and beating the weft), all these functions are performed in the loom according to the new concept as a result of the drum rotation.

Key words: weaving loom construction, shed formation, rotating drum, sinkers.

Hitherto known concepts of woven fabric formation

Manufacturing woven fabrics with the use of weaving looms [1, 2] consists in parting warp threads by a shedding mechanism, inserting the weft into the shed with the use of a picking mechanism and feeding the weft to the fabric edge by a beating device. Additionally, the mechanisms which feed the warp and take-up the woven fabric take part in weaving with a loom.

The periodical to-and-fro-motion of the first tree mechanism mentioned—above limits loom productivity and is the cause of vibrations, which also means more noise. All these factors cause that the looms are characterised by low energy efficiency.

In the most often applied looms, the shedding mechanism is constructed in the form of frames in which healds are fastened. The healds are fitted with mails through which the warp threads are drawn. The number of healds depends on the kind of weave as each group of warp threads, which interlace with the weft threads in a different way, must be drawn through separate healds. The to-and-fro-motion of the healds, which cause the warp threads to part and subsequent by the shed to form, take place as a result of the action of the cam or card mechanism.

In order to improve the weaving process, irrespective of using one-shed looms in which a single shed is formed on the whole loom width, multi-shed looms are

also applied, and the following distinguished, among others: looms on which a number of sheds are formed along the warp width and, such looms on which the formation of a number of sheds along the warp takes place at the same time.

The forming of sheds along the warp width is realised with the use of different technical solutions, but the principle of their formation is similar. It consists of parting the warp threads into two groups, forming upper and bottom weft sheets within a zone length many times shorter than the width of the warps.

The zone of a shed thus formed is displaced along the warp width and together with the zone a weft bobbin box is displaced, from which the weft is unwound. The zones of such a shed are displaced one by one along the width of the warp, which as a consequence causes a number of wefts to be inserted into the shed at the same time.

The formation of a number of sheds along the warp was first applied on the loom prototypes of Gentilini-Ripamonti and Szosland [1, 3] and on a loom built by Sulzer textile [4] and presented at the Textile Machine Fair in Paris in 2000.

The formation of sheds on all these looms is performed on the circumference of a drum. Sinker are placed along the generation line of the drum at equal distances, which results in the warp threads being inserted into the spaces between the sinkers or on their external edges. The threads which are placed on the sinkers create one

weft sheet of the shed, whereas its second weft sheet is formed by warp threads which are placed between the sinkers. In the subsequent rows of the sinkers placed on the drum circumference, a change in the warp thread positions occurs according to the kind of weave manufactured.

This construction solution causes that on a certain part of the drum circumference, it is possible to form sheds at the same time, which takes places in a continuous way due to the rotation of the drum. Inserting the weft into the shed on this kind of loom is performed by the pneumatic method, with the use of an air stream, and at the same time the insertion of the weft is performed to form a number of sheds, but w for subsequent sheds this process has a particular time lag. This kind of shed formation led to a shedding frequency hitherto not used.

Applying this shedding solution led to the situation that the mechanisms of inserting the weft into the shed used up to the present are a barrier to increasing loom efficiency. Inserting the weft is performed by different methods, among which the following should be mentioned:

- Displacing it along the shed by a bobbin from which the weft is unwound (shuttle looms, multi-shed looms with sheds formed along the width of the warp).
- Inserting it into the shed by weft unwound from a bobbin placed outside the shed (gripper looms, rapier looms, pneumatic and hydraulic jet looms – looms with a shed formed along the warp width).

On multi-shed drum looms, on which sheds are formed along the warp, inserting the weft with the use of an air stream has been applied up to the present. Such a method of inserting the weft requires the use of large amounts of compressed air, which significantly increases the production cost, and furthermore is a method which is moderately unreliable and requiring very precise control systems.

The displacement of the weft inserted into the shed in the direction of the woven fabric, called beating, can be realised in various ways. The most common ways are the following:

- Beating the weft by a reed mounted on a batten (slay), which is connected with occurrence of great insertion forces which consequently led to a significant limitation of the frequency of the weft insertion.
- Beating the weft by sinkers, which improves the energy balance of the loom, significantly decreasing the noise, and allowing to achieve a satisfying density of the weft in the fabric.

Construction changes in the loom according to the new concept

The new concept consists of using the same sinkers of an appropriate shape in order to form the shed and beat the weft. Guide bars controlled by a card are used to operate the warp threads. A similar solution is known involving warp-knitting machines, but up to the present this has not been applied on weaving looms. The greatest novelty of the proposed construction solution for the loom discussed is applying grippers which are forced as a result of the impact on its walls caused by the sinkers immovably fastened in the machine casing. This is a very simple solution in comparison to the hitherto known and applied mechanism, which has a complex structure and limited frequency of inserting the weft. With respect to using it on a multi-shed loom, the new way of inserting the weft presents great possibilities of increasing the shedding frequency and, at the same time, increasing the loom efficiency. Furthermore, according to the new concept, the formation of gauze weaves is possible on the loom, whereas the manufacturing of these weaves on classical looms, which are used to this day, requires complex mechanisms for shed formation.

A new construction concept for a high-efficiency multi-shed loom

The concept of the weaving loom discussed in this article is the subject of a patent application [5]. The known concept of shed formation along the warp with the use of sinkers displaced on the circumference of a rotating drum was used for construction this multi-shed loom [1, 2, 4.], as this solution enables to achieve the highest shedding frequencies possible. In order to beat the wefts to the fabric edge, the same sinkers which cause shed formation are used, and in this way the loom construction is significantly simplified. The wefts are inserted into the shed with the use of grippers, which are displaced along the width of the warp. The yarn grippers are displaced in a tunnel formed by the sinkers which create the shed along the warp width. The gripper movement is forced by the impact of the sinkers, which are placed on the circumference of the drum

along a line askew to the drum axis, on its walls. Such a novel way of weft insertion is characterised by a very simple construction, requiring only a small driving energy and works silently.

Contrary to the construction solution of the looms known up to the present, which require a number of complex driving mechanisms (forming the shed, inserting the weft, and beating the weft to the fabric edge), in the loom discussed all these actions are performed as a result of the rotation of the drum.

According to the new concept (**Figure 1**), the multi-shed loom is equipped with a rotating drum (1) in the shape of a cylinder. On the external surface, along its generating line, rows of sinkers are mounted (2), which form the sheds and beat the weft. These sinkers are situated in rows at equal distances, which are equal about their thickness. Grooves are milled in the upper edges of these sinkers (3).

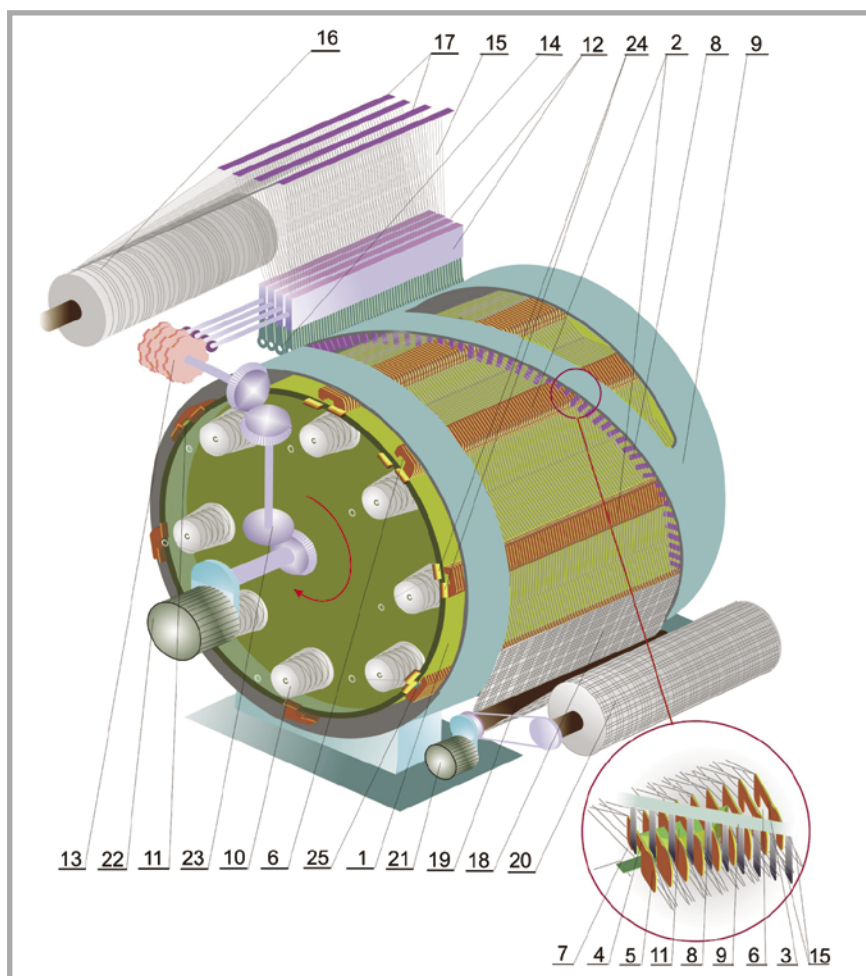


Figure 1. The construction of the new loom according to the new concept; 1 – drum, 2 – sinkers, 3 – grooves, 4 – rectangular part of the sinkers, 5 – involuted part of the sinker, 6 – channel, 7 – slot, 8 – sinkers, 9 – jacket, 10 – bobbins, 11 – gripper, 12 – guide bars, 13 – card, 14 – needle bars, 15 – warp thread, 16 – warp, 17 – back-rests, 18 – fabric, 19 – take up-roller, 20 – cloth roller, 21 – motor, 22 – motor, 23 – transmission, 24 – holders, 25 – scissors.

Each of the sinkers, which form the shed and beat the weft, are rectangular in part (4), whereas the rest of the edge (5) has an involuted shape, unwound from the cylinder surface. In the rectangular part of each sinker, a channel (6) is cut-out with an outlet (7) in the shape of a slot.

The sinker channels (6) form a tunnel in each row to transport the weft. Over the external surface of the cylinder, sinkers (8) are placed of a shape similar to a rectangle, situated along a line askew in relation to the drum axis, and mounted in a non-moving jacket (9) which forms the frame of the loom. Inside the drum, on its left side, bobbins (10) with weft threads are embedded at equal distances on the circumference. The grippers (11), which are courriers of the weft threads, have a near trapezoidal shape with a length of the base (the longest sick), which is equal to, about a dozen times, the distance between the sinkers (2) and the dimensions of the cross-section smaller than those of the channels (6) of these sinkers. Additionally, the loom is equipped with guide bars (12) operated by a card (13). Warp (16) threads (15) are threaded through the holes of the needle bars (14) in a determined order. The warp threads are tensioned by back-rests (17). On the opposite side of the drum, in relation to the guide bars, a woven fabric (18) take-up mechanism is placed, with a take-up roller (19) and a cloth beam (20) which are driven by an electrical motor (21).

The number of guide bars (12) depends on the kind of weave selected and the density of fabric manufactured. The drum (1) is driven by an electric motor (22) which also drives the card (13) with the use of a transmission (23). On the left side of the drum, opposite the rows of sinkers (2), holders (24) are placed in order to tension the weft threads and insert the ends of the threads into the gripper (11) holders. Also on the left side of the drum, in line with the edge of the woven fabric manufactured, scissors (25) are placed with the aim of cutting the weft threads inserted into the shed.

When the drum (1) begins its rotary motion, with dependence on the weave manufactured and the density of the fabric (18) selected, a part of the guide bars (12) is displaced in relation to the rest of them, a segment whose length is equal to half of the distance between the sinkers (2) or a value equal to one distance. As a result of these movements,

the threads (15) of the warp, which are guided through one group of the guide bars (12), are inserted into the grooves (3) of the sinkers (2) and form the upper weft sheet of the shed, whereas the rest of the warp threads (15) make their way between the sinkers (2), creating the bottom weft sheet of the shed. In such a form of the shed, the weft threads are inserted, having been unwound from the bobbins (10). The weft threads are inserted into the sheds through tunnels formed by the channels (6) of the sinkers (2) with the use of the grippers (11). After entering into the tunnels, the grippers (11), which are connected to the ends of the weft threads, slide on the surface of the non-movable sinkers (8), which force their displacement in the tunnels in the direction of the right side of the drum (1). When the gripper (11) reaches the right edge of the drum, the row of sinkers (2), which contains the inserted weft in its tunnel, beat (on their edges (5)) the weft inserted before to the edge of the fabric (18). At the same time, the newly inserted weft comes out from the channel (6) of the sinker (2) through the slot (7), cut by the scissors (25) and liberated from the gripper's (11) tap. This weft is beaten to the edge of the fabric (18) by the edges (5) of the next row of sinkers (2). After the weft thread is disconnected from the grippers (11), the sinkers (8) acting on the opposite edge of the gripper (11) force its motion in the direction of the left side of the drum (1) where the subsequent connection of the weft threads to the grippers' tags take place. In this way the cycle of inserting and beating the weft threads is repeated; the duration of the cycle equals one rotation of the cylinder. The working cycle described is realised by all grippers (11) which displace the wefts along the rows of sinkers (2) of the whole circumference of the drums, which means that during one rotation of the drum, the wefts are inserted, at the same time, into half of all the rows of the sinkers (2) displaced on the circumference of the drum. This solution ensures that the number of inserted wefts per one rotation of the drum is equal to the number of sinker rows on the circumference of the drum.

■ Conclusions

With the application of the new construction concept of the loom, it is possible to built weaving machines with great weaving efficiency, which should result in cheaper production of woven fabrics.

The new weaving machines will be especially suitable for manufacturing woven fabrics with little filling.

The manufacturing of new looms should be cheaper, as they do not include complex devices, which are featured in the loom manufacture today. The new looms should also be more friendly for humans, as they should work more silently, due to the lack of mechanisms working with great frequencies during displacements. Taking into account the extreme differences in the construction of the new loom in relation to the those hitherto known and manufactured, great possibilities exist of manufacturing such weaving machines by new companies which do not have any experience in manufacturing traditional looms.

In order to confirm the new concept of the loom construction presented in this article in practice, a research prototype [6] should be realised. At present a research project has been established with the aim of building a functional model of the new loom concept [6].



Acknowledgment

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