RECENT DEVELOPMENTS ON CONFUSOR AND BOOSTER JET CONTROLLING SYSTEMS IN AIR JET LOOMS

A dissertation presented for the Postgraduate
Diploma Course in Textile Industries

by

JAMES CHATTA

Being an account of work carried out in the
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supervision of Dr. K. Hepworth

Department of Textile Industries,
University of Leeds,
LEEDS, LS2 9JT.

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The author wishes to express his sincere appreciation to Dr. K. Hepworth, B.Sc., Ph.D., for his invaluable guidance, assistance and advice throughout the course of this work.

Dedicated to

My Wife

CONTENTS

INTRODUCTION

INTRODUCTION

When weft is inserted through a shed by means of a jet of air, the air and weft are ejected from a nozzle and the weft is carried forward by friction with the surrounding jet.

The weft has mass so it has to be accelerated and it is also acted on by gravity so that it tends to fall onto the lower warp sheet unless the flow of air supports it.

If it touches a warp thread, the friction against that will be much greater than that with the air streams and the weft will quickly come to a stop. The air stream itself is slowed down by friction with the surrounding, more or less stationary air, and this may give rise also to turbulence causing disposal of the jet and may result in the weft being deflected from its path.

Two major classes of development have enabled the distance that the weft thread can be carried to be increased beyond the initial very limited value of the early jet looms. These involve (a) the use of "confusor" plates to conserve the air stream and (b) the use of additional jets to maintain the flow of air. The confusor may be extension of the reed or be reed-like plates having their planes parallel to the warp threads which can, therefore, fairly easily slip between them when the shed changes. Their aim is to enclose the jet and prevent it intermixing with the outside air. Because these series of plates cannot form a closed tube, they are only partially successful in this; the degree of success depends on the design of the plates.

to leave the plates so that during beat-up the weft will lie freely in the shed which the plates, if they are not actually part of the reed, can be withdrawn or can pass below the cloth and therefore not interfere with the beat-up action. The holes in the plates through which the jet and weft pass must, therefore, have exit slots for the weft or in some other way not be completely bounded. But there is then the tendency for the air to escape through these slots and so the momentum of the jet is depressed; there is also the danger that the air will carry the weft out through the slot.

The patents reviewed in this dissertation have the general objectives of carrying weft yarn over greater distances while avoiding these problems and, at the same time, economising in the use of compressed air which is rather expensive to produce.

CHAPTER 1

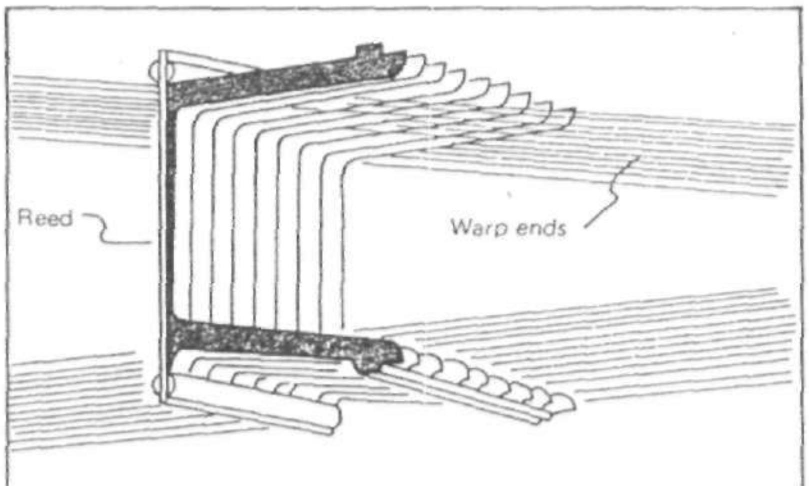
Historical Review

Historical Review

John C. Brooks[1,2] in 1914 was the first inventor to provide means for carrying a loose thread through the warp shed without the employment of a mechanical device. Although it was a technological breakthrough in terms of noise control within the weaving shed and the success achieved in using a relatively low weight weft carrying device, that is compressed air, the device encountered some practical problems. The prototype of the air jet loom is shown in Figure 1 with feeding mechanism provided in the form of a nozzle in both sides of the loom. A thread cutting device is provided to cut the thread during the alternate picks from each nozzle after weft insertion. The compressed air in the pipe is supplied to the air nozzles by means of cams and the individual picks are measured out by means of a rack driven by the sector and pinion.

In 1929, Eugene H. Ballou[1,3] invented two weft controlling devices. Firstly was the use of a suction nozzle to draw the inserted pick from the opposite side of the loom to straighten out the bends or kinks and held by a pair of nippers arranged to work adjacent to the discharge-orifice. The drawing action also prevents the pick-length from being displaced within the shed opening prior to the beating-up action. After weft insertion, the weft is parted at a point between the air nozzle and the adjacent selvedge and the yarn-end projecting from the discharge-orifice of the air nozzle is held to prevent it from being blown back into the air passage by air movement from the nozzle at the opposite side of the loom. The invention used air-motivating mechanism combining air-forcing action and air withdrawing action in a continuous alternation.

Besides the use of suction nozzles, Ballou provided a guide reed to prevent the weft yarn from getting entangled with the warp threads and also to confine the air stream. However, those ideas did not prove successful in practice. Ballou's guide reed is shown in Figure 2.



Ballou's guide reed

Figure 2

The Heywood Wakefield Company[4] in the United States of America patented an invention adapted to incorporate stiff wefts in a fabric used in the covering for the frame structure of certain vehicles and articles of furniture by means of a pair of rolls situated at one side of the shed and a pair of flared spring fingers disposed

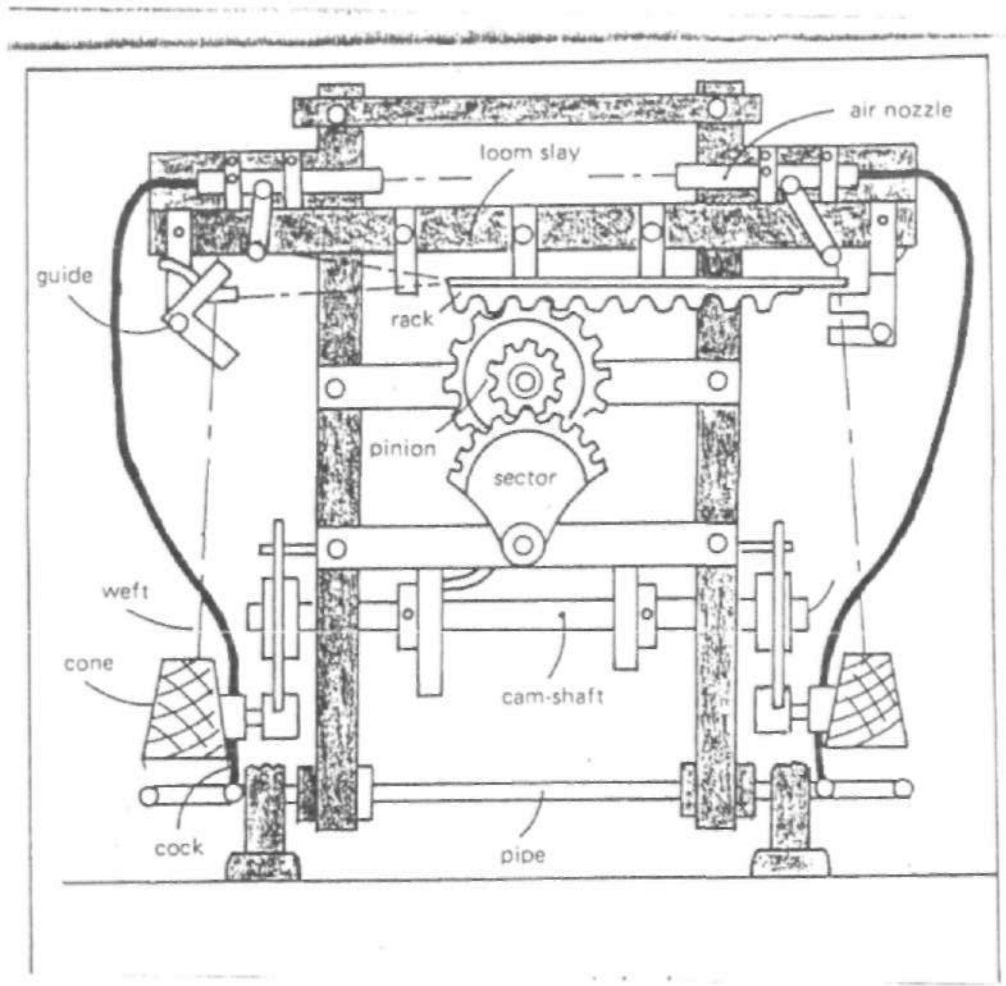

air nozzle
loom slay
guide
rack
pinion
sector
weft
cone
cam-shaft
cock
pipe

Figure 1

at the other side adapted for engagement by the stiff weft being inserted to cushion the insertion, thereby preventing its rebound or buckling. The air jet from the discharge nozzles 47a, as shown in Figure 3, project the weft to assume proper positioning in the shed and more particularly, to straighten the weft before it is engaged by and bound between the two sets of strands 1a of the shed.

In the control mechanism, a cam, 42, in surface contact with a rocking lever, 44, imparts rocking movement to open and close a valve in the casing, 45, interposed in the air feed pipe, 46.

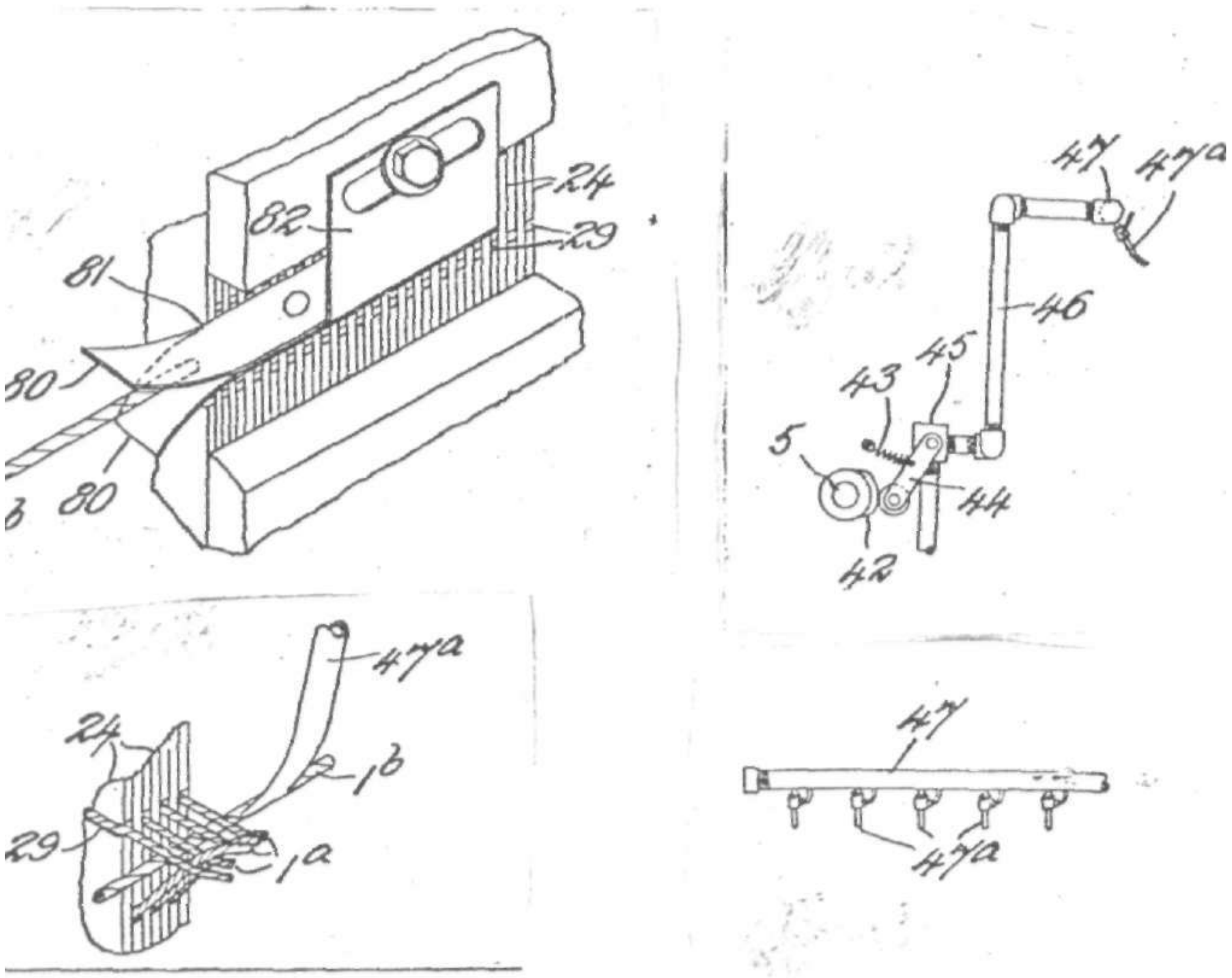


Figure 3A

Max Paabo[5] related his invention to a loom using a nozzle for blowing the weft thread through the shed. The nozzle, according to Paabo, was mounted on the loom lay which has the disadvantage, particularly when producing broad textile fabrics, of the loop of thread getting entangled with adjacent machine parts during the passage of currents of air. Paabo, therefore, arranged the unwinding mechanism and the nozzle stationary on the loom, and they do not take part in the reciprocating movement of the sley. The unwinding device is adapted in such a way that the thread is sufficiently guided up to the moment when the length of thread is thrown through the shed by the air blast. The nozzle is so constructed that the forward end of it is longer than the rear end, and therefore the air escaping through the forward end has a greater frictional action on the yarn and thus acts as an injector. Another problem which Paabo looked into critically was the development of the loop during weft insertion caused by a sharp drop in air velocity relative to that of the yarn. In his proposed solution, mobile shutters were provided and arranged above and below the warp layers which form the shed (Figure 3B) and in this way obtained a slower drop in air velocity.

The idea of an air jet loom was contemplated in Czechoslovakia since the end of World War II[6] which led to Czechoslovakian Patent No. 83775 on a device represented in Figure 4 and the pick insertion method illustrated in Figure 5. The arrangement of the device is similar to that of Paabo's, where the jet nozzle is fixed on the frame of the loom and not on the sley, so that the movement of the sley is utilised to tension the pick after insertion.

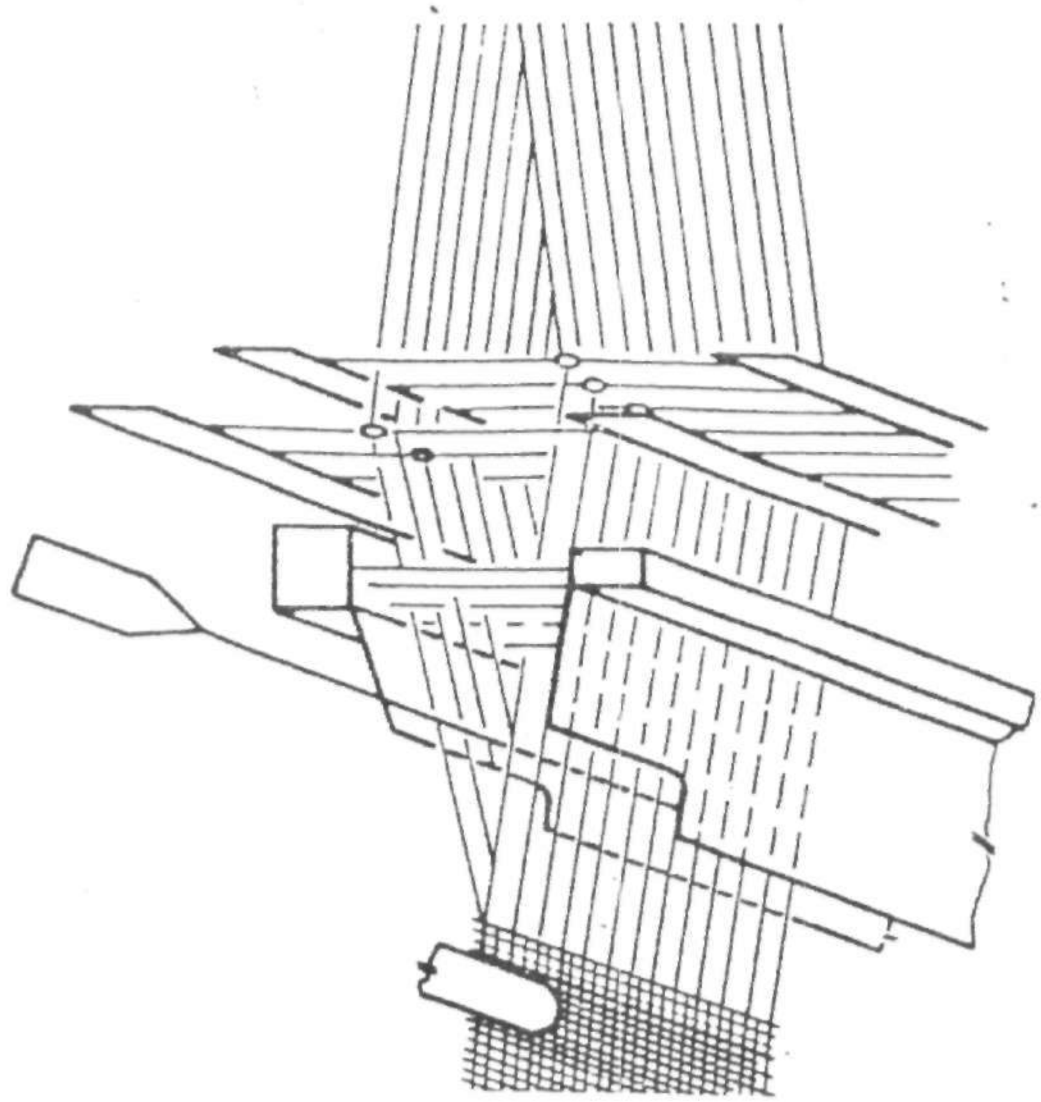


Figure 3B

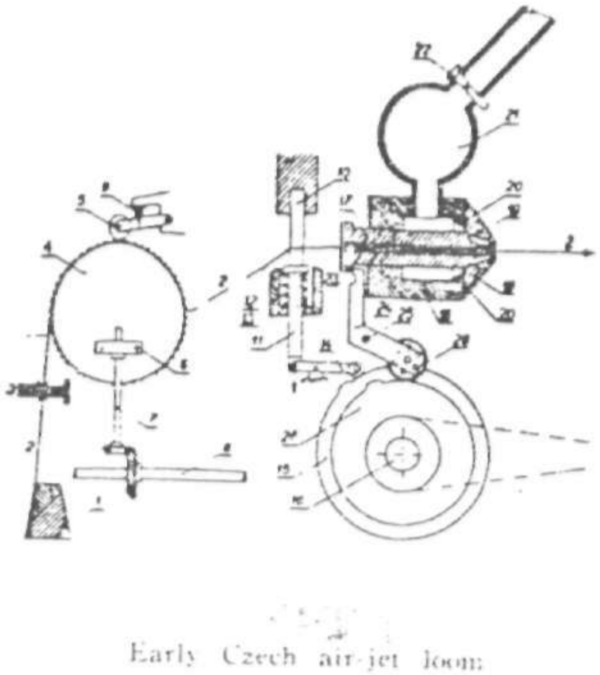


Figure 4

Early Czech air-jet loom

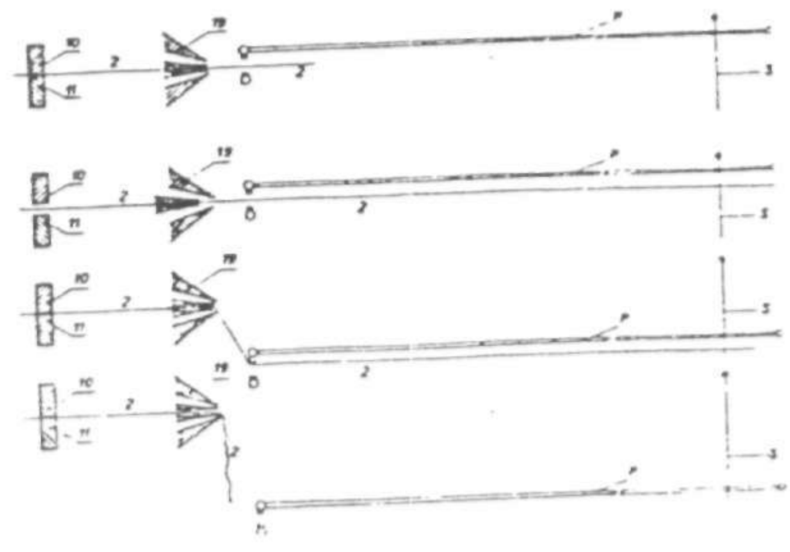
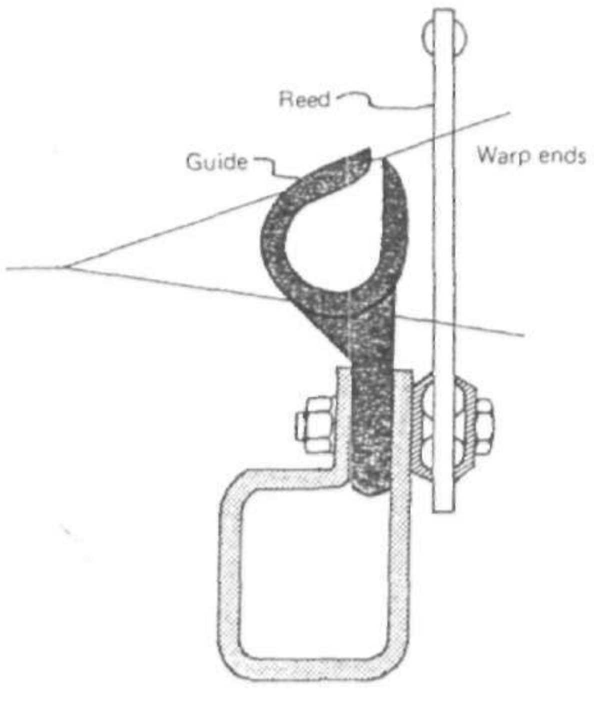


Figure 5

The reed width of the original P45 air jet loom built by Vladimir Svarty of Czechoslovakia limited its commercial application and therefore efforts were made to increase it. Eventually, the confusor was proposed as a further improvement, published in Czechoslovak Patent No. 92490 in 1956.[2]

It is a system of special segments for the control of the air jet in the shed and to separate the weft yarn from the layers of warp threads. The aim is to achieve wider looms, higher speeds and lower rates of breakages, both warp and weft. Figure 6 shows the confusor.



Air guide system

Figure 6

CHAPTER 2

Passive Confusor

Passive Confusor

In air jet weaving looms, the arrangement for directing the jet of pressure air to pick the weft thread through the whole width of the shed has to be designed so as to prevent to the utmost any losses of air and thus maintain the speed required. In one of the earlier inventions, a passive confusor was designed with the arrangement to cover the weft exit slot with one of the warp end sheets at the moment of picking the weft. In operation, however, this solution is very precarious as the shed position has to be maintained accurately which is very difficult, particularly with weaves other than plain. Further, a proposed solution was to cover the exit slot with a device such as balls, brushes and so on; but the applicants claimed that air leakages occur in all the stated cases. These slots, however, disturb the aerodynamic conditions in the confusor as the air leaks out through them and carries with it the weft that is being pushed through. In 1970, Karel Vystral and Josef Nespechal patented[7] a device to obviate the above problem by providing the confusor with a conical inner surface with its apex pointing in the direction of the picking as shown in Figures 1A and 1B, and a portion 7, opposite the exist slot 4, has an incline relative to the plane of the aperture greater than that of other parts. In Figures 2A and 2B the confusor is provided with cylindrical surfaces, but with its apex pointing opposite to the direction of weft picking. With this arrangement, as claimed by the applicant, the region of the maximum speed is shifted from the slot towards the portion 7, thereby achieving the right flight of the weft through the confusor.

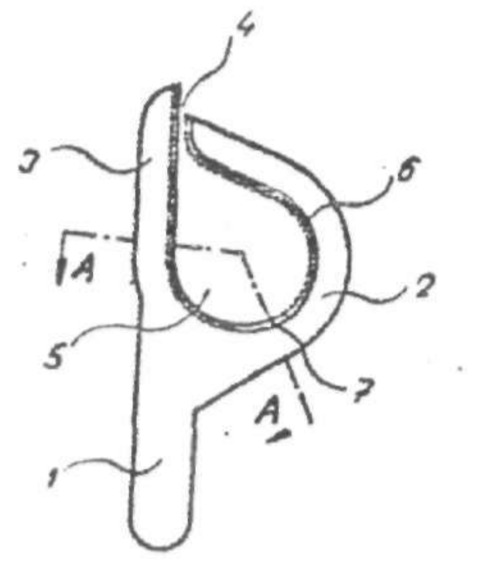


Figure 1A

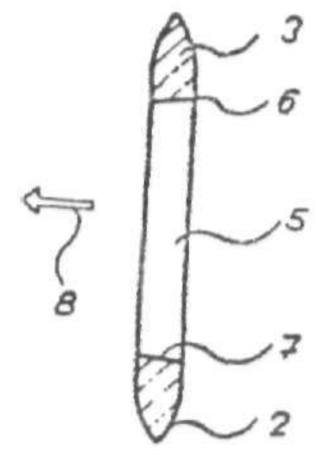


Figure 1B

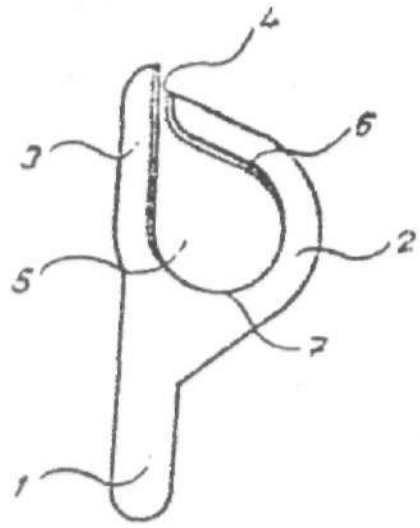


Figure 2A

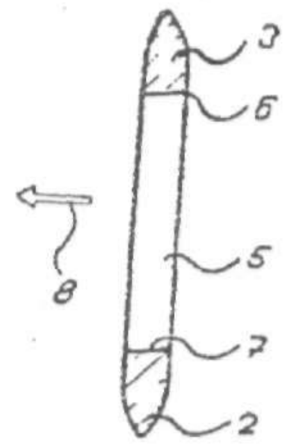


Figure 2B

Jiri Cernocky, Miloslave Hiha and Josef Martinec[8] in their patent claimed that where the individual teeth provided with openings are so arranged to pass through warp threads into an open shed the probability arises, during the course of the passage of air, that the air escapes through the gaps between individual teeth into the ambient space and the surrounding air is simultaneously sucked in. These gaps were created to enable the comb to enter the warp thread, but could otherwise cause a reduction in speed of the air jet and thus its capability to reliably pick through the weft. Furthermore, another proposed arrangements was to cover the open shed during picking with a special cover plate which, together with one side of the reed, form a closed space of triangular cross-section. The warp threads in this arrangement vibrate thus breaking the picking jet and might lead to entanglement with picked weft. In this present invention, the inventors used a number of ring-shaped teeth arranged in a row and simultaneously and uniformly angularly displaced. When the teeth are in the picking position, that is A as shown in Figure 3, all the adjacent teeth are in contact and form an uninterrupted channel 6 for directing and guiding the jet of air. In this position the radial plane of each tooth is at an acute angle to the axis of the channel so that in the tilted, closed, position the channel is smooth. Prior to moving the sley with the reed to the beating-up position, the teeth are pivoted from the position A to position B (Figure 4) in which gaps are created between the individual teeth. This establishes an interrupted channel and enables the confusor to pass through the warp threads into the shed and also to be removed from the shed after the weft has been inserted.

The radial planes of the teeth are preferably parallel to the warp threads and the exit slot, perpendicular to the radial plane of the teeth, are in alignment, thus easing the slipping out of the weft thread. In position A (Figure 3) the slots are mutually off-set so that any slipping of the weft thread out of the channel during picking is prevented.

Karel Kakac claimed some drawbacks on an invention whereby the straight and arcuate parts are constructed to have a wedge-shaped external circumference with a flat spring to cover the exit slot.

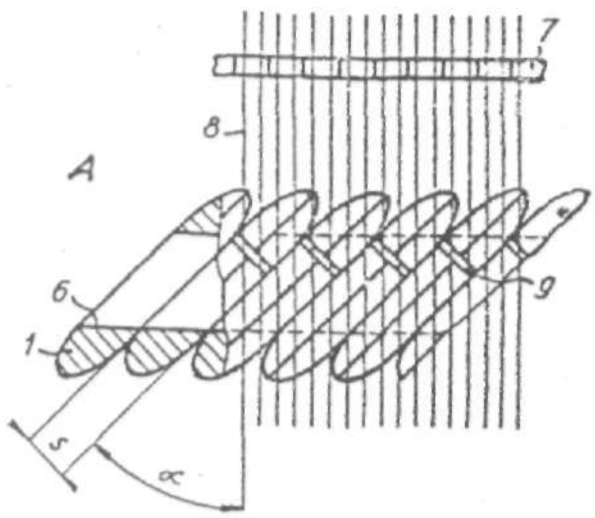


Figure 3

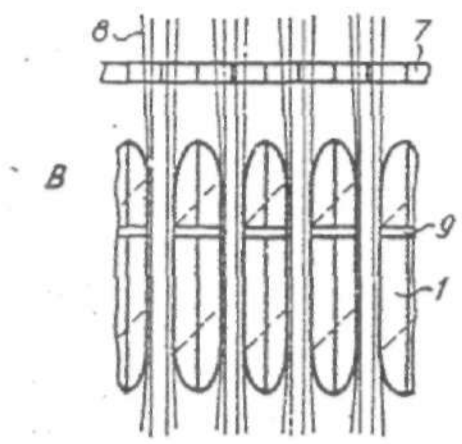


Figure 4

According to Kakac, the confusor was arranged to enter the warp threads, not by its wedge-shaped part, but through its flat part having the width of the flat spring, and could possibly cause frequent damages and breakages of individual warp threads. This patent, therefore, provides the exit slot with flat spring 7, which fully contacts the longitudinally straight part of the confusor. The frusto-conical internal surface is disposed at an angle /2 with respect to the plane of the confusor in order to concentrate the airstream passing in the direction of the arrow "S" as shown in Figure 5. In Figure 6, due to the relative movement of the confusor with respect to the weft thread 12, the flat spring is deformed in the direction towards the exit slot, thereby enabling the removal of the weft from the previously closed picking aperture.

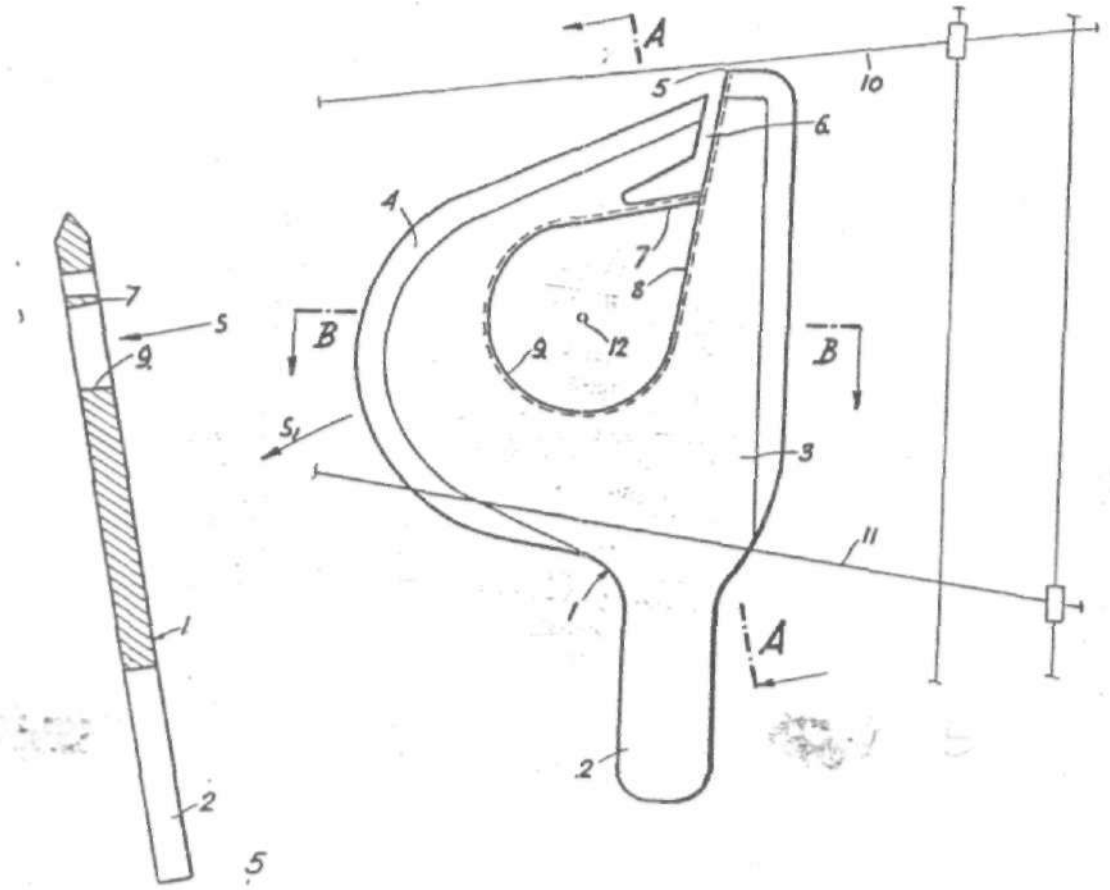


Figure 5

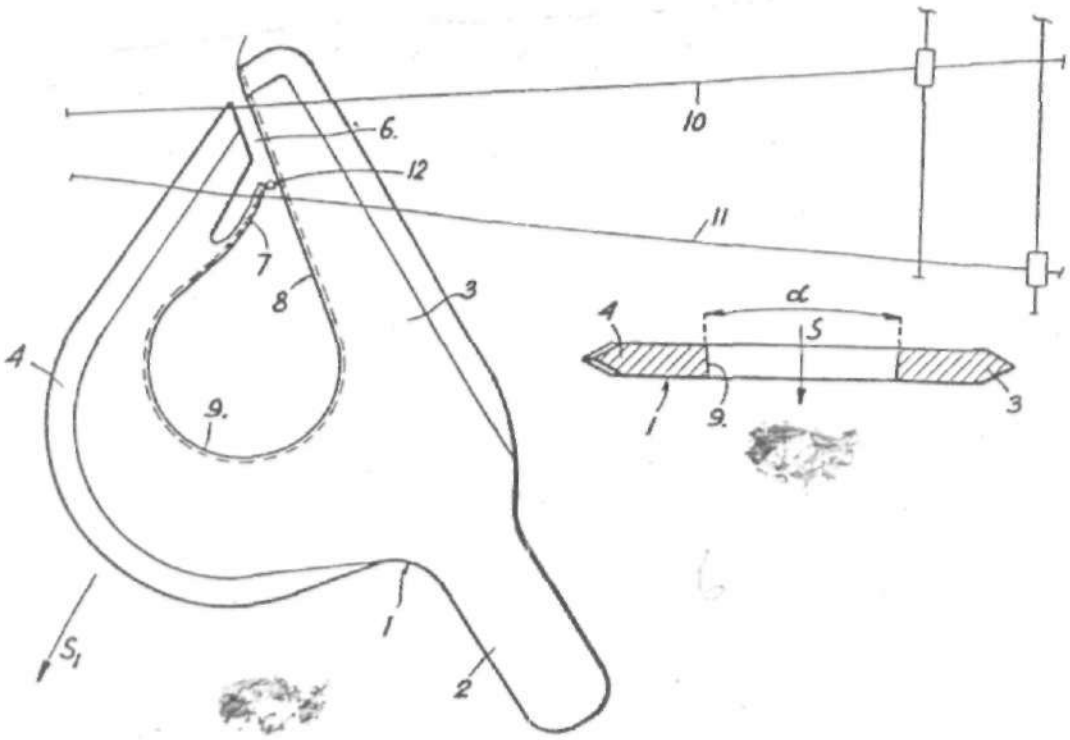


Figure 6

In 1979, Nissan Motor Company[10] detected some drawbacks in the above patent as the air stream leaks through a clearance between the arcuate part and flat spring and therefore in this invention provided a screen sealing device 24B as shown in Figure 7 to prevent air-flow leakage. The sealing mechanism is constructed with a resilient material and arranged to project towards the exit slot and functions to almost close the exit slot while the weft is being inserted through the aperture to completely open the slot upon exodus of the weft thread from the aperture. In another arrangement, Nissan used a flexible sponge 26B (Figure 8) bonded to the inner surface of the flat spring portion and a rib, 26C, integrally formed with and projecting from the inner surface of the leading end of the arcuate part. This device also successfully prevents the unwanted air leakage.

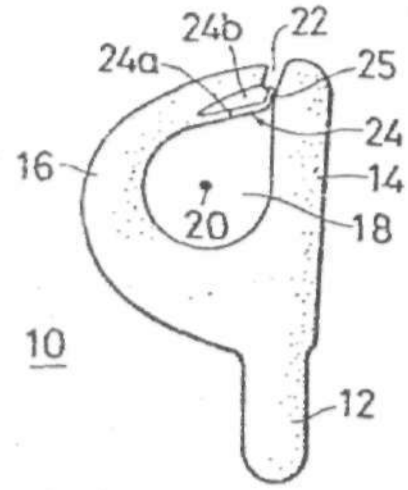


Figure 7

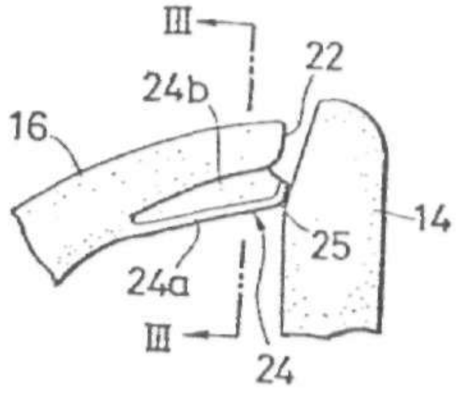


Figure 8

Milos Jansa and Karel Vystral in 1971[11] approached their invention rather differently from the earlier patents, though with similar objectives. The applicants gave the drawbacks of a "known" confusor composed of a number of guide blades, each of which is provided with one opening. In this arrangement, the weft yarn can only be inserted in one direction and, therefore, requires complicated mechanisms or additional material for making even the simplest selvedge. The applicants, therefore, used a number of flat guide blades 15 (Figure 9) provided with two substantially circular openings 20 and 21, and narrow exit slots, 22 and 23 respectively, but disposed one above the other. The interior surfaces of the openings are formed by conically shaped guides

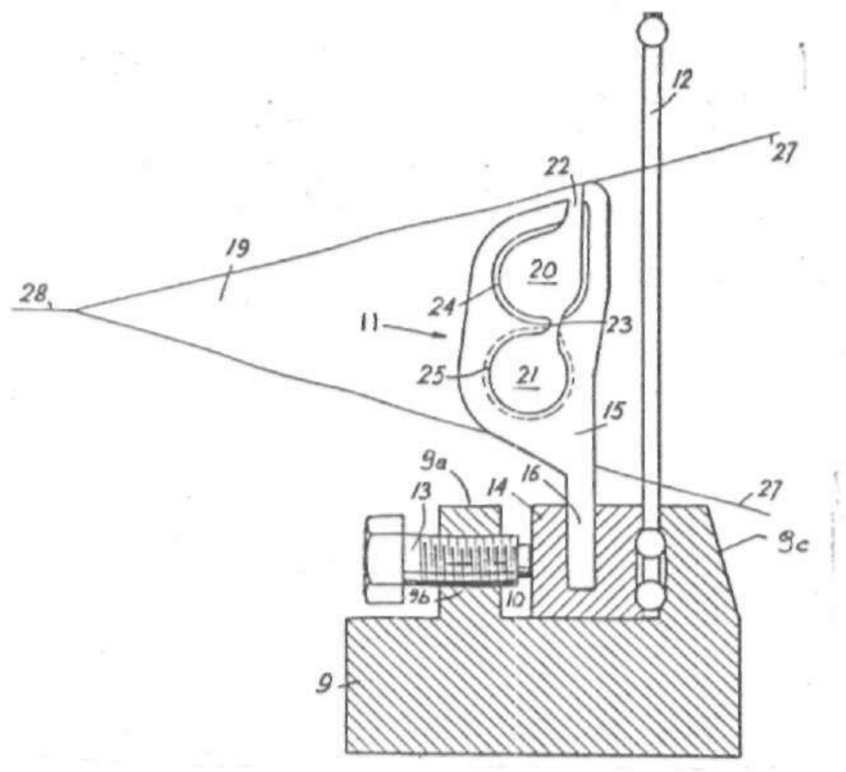


Figure 9

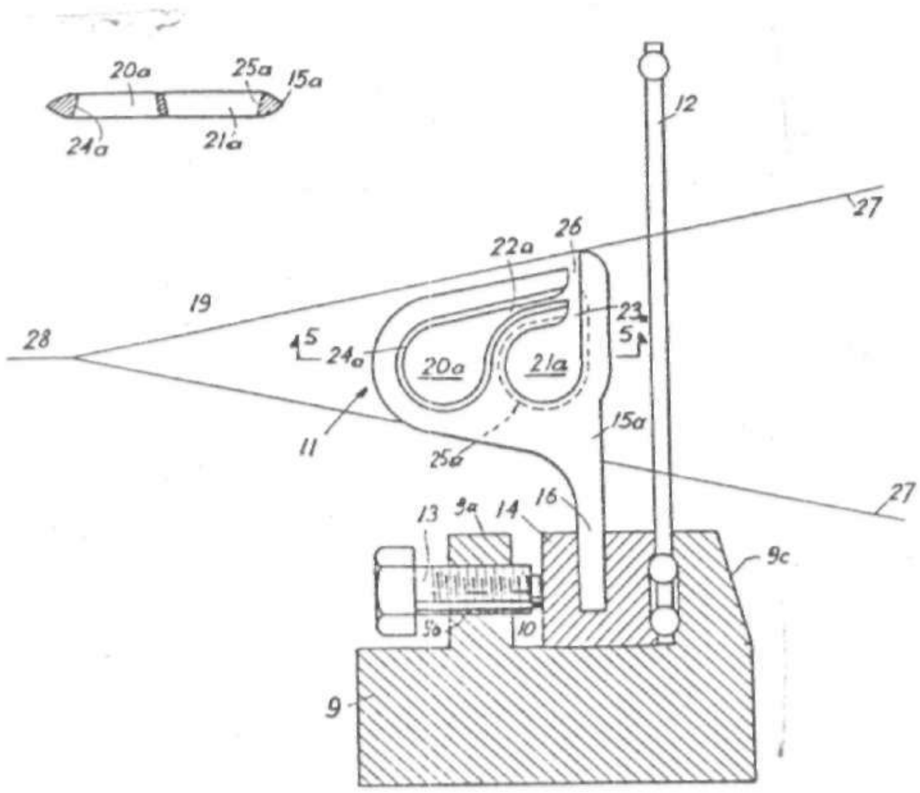


Figure 10

which are tapered in the direction in which the weft thread is to be inserted. They are, therefore, arranged in alignment with respect to each other forming two oppositely tapered passages for directing the movement of the weft in opposite weft insertion directions. With this arrangement, a natural selvedge can be formed in the woven fabric by using only the basic weaving material and not requiring additional threads and without employing any additional mechanism. Also by the use of alternate feed directions, the loom revolutions may be increased and the breakages of weft threads are simultaneously reduced. An additional advantage resides in the possibility of using a double quantity of weft thread material while employing the same supply packages.

As can be seen from the diagram, the exit slot 22 communicates the opening 20 with the exterior of the guide while slot 23 communicates the opening 21 with opening 20. Figure 10 shows another arrangement having a different shape and configuration. Each comprises a pair of openings, 20A and 21A, which are disposed side by side and respectively provided with exit slots 22A and 23A, leading into a common exit passage 26.

During the forward movement of the sley, the passage formed by the openings 20 and 20A, moves forward and downwards so as to emerge from the shed, and the weft thread is then urged by the warp threads 27 to move through the exit slots 22, 22A and 26 respectively. A second blowing device directs an air jet stream in the opposite weft direction and through the passage formed by the openings 21 and 21A. During the forward movement of the sley, the warp threads 27 urged the weft to move through the exit slot 23A out into the open shed via the exit slot 26.

Vladimir Svaty and Jiri Libansky[12] patented a device relating to a "known" air jet loom using a guide recess opened on one side to permit the removal of the picked weft thread from the guide structure. As the air stream is not fully confined in the guide structure, the flow velocity reduces after a certain picking length and when the open sides are in alignment, the weft thread is sometimes blown out of the aligned outlet. With these observations, therefore, the applicants provide a guide passage in the warp shed from which no air can laterally escape and thus increasing the length of picked weft thread across the shed. Two rows of guides were provided with each guide alternately arranged. In the picking position, the guide portions 12 and 13 (Figure 11) are aligned so that the axes of the guide openings 12A and 13A coincide forming a guide passage, while the outlet gap is crossed by portions of the respective adjacent guides. As a result, the passage through which the weft is picked is substantially closed about the periphery due to the angular staggering of the outlet gaps 14 and 15 and, therefore, an escape of the picked weft thread is prevented. When the guides are successively moved out of the warp shed, the warp threads passing between alternate guides retain the weft thread ready for beating-up action of the reed. Figures 12A and 12B show the modified guides having wedge-shaped cross-sections disposed in opposite directions, so that gaps having uniform width S_1 are formed. In the position (Figure 12B) corresponding to that of Figure 11, the space between the adjacent arms is increased to larger distance S_2.

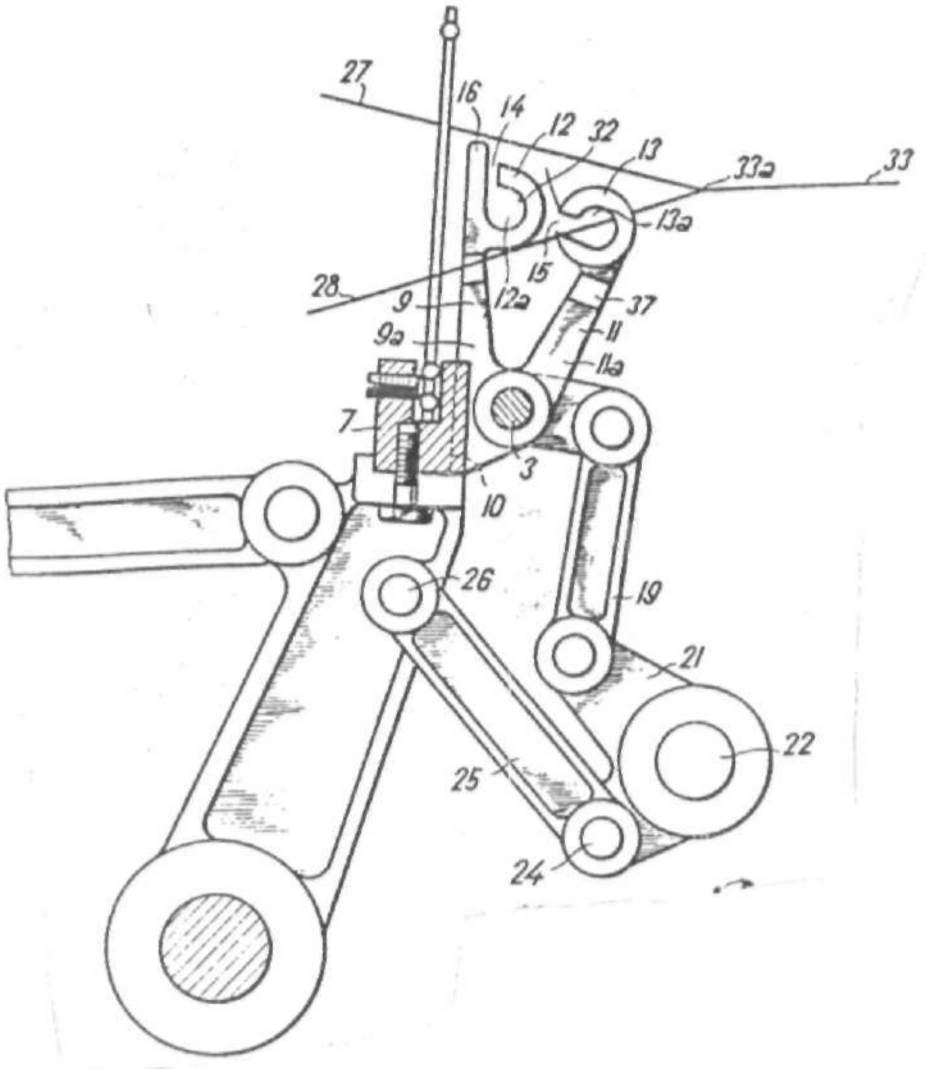
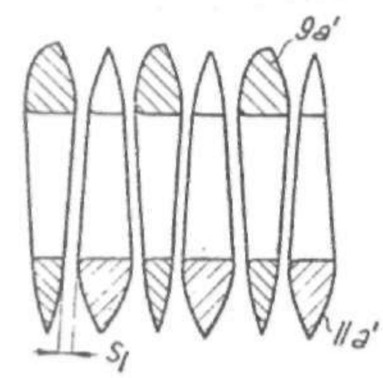


Figure 11



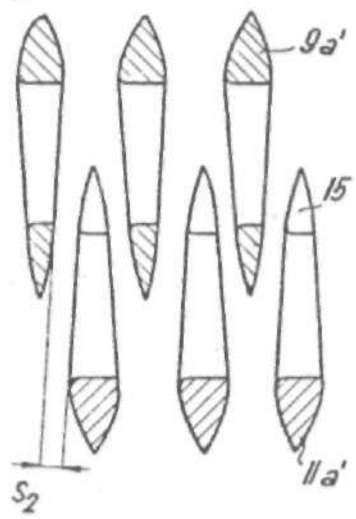


Figure 12A

Figure 12B

CHAPTER 3

Reed Blade and Air Guide

Reed Blade and Air Guide

As a further development to the confusor, Ruti Machinery Works[13] in Switzerland, declared an invention relating to the use of blade recesses together with the reed to form a guide channel for the stream of air serving for the insertion of the weft thread. The blades according to the applicant and as published in U.S. Patent No. 4,127,148, are firmly connected to the loom sleys in such a manner that they can emerge from and enter into the warp shed. With this arrangement, the firm claimed the possibility of the warp threads being caught by the blades or entering into the recesses during this movement. Ruti again cited a similar invention whereby the dents of the reed are developed as channel blades, having respective recesses. The recesses are so developed and arranged that the weft yarn which has been inserted remains in the channel during the beating up, and emerges from the guide channel only upon the following return stroke of the sley. Although it seems to avoid the disadvantage described in the first illustration, it was noted that the reed dents in their beating-up positions have portions which extend forward beyond the fell which defines the recesses that receive the weft. According to the applicant, it was attempted to adapt the temples and the recesses of the blades to each other such that at the beat-up position of the reed, the temples are received in the guide channel. This patent detected a drawback to this arrangement as it requires an unfavourably large cross-section of the guide channel with the use of specially designed temples. The inventors, therefore, arranged the blades 25 (Figures 13A and 13B) with their respective outlet openings 27 facing the fell and being situated between dents 13 of the reed. The blades are held independently of the reed on two rails 31 and 32 sufficient distance apart for the warp yarns to pass through between them. Further arrangement was provided to oscillate the blades and reed in such a manner that at the beat-up stroke (Figure 13B), the recesses 26 move a smaller distance towards the fell than do the dents of the reed. During weft insertion, as shown in Figure 13A, the blades project from between the teeth of the reed to such an extent that the entire recesses are located at the side of the reed facing the fell. The outlet openings of the nozzle 28 are so directed that a stream of air is produced in the guide channel formed by the recesses transversely through the shed when the nozzles are put into operation. With this invention, the blades are not in front of the dents in the beating position; therefore the temples can be arranged without difficulty at a sufficiently small distance from the fell. Also suitable shape and size of the guide channel can, therefore, be selected without regard to the construction of temples.

Similar to an invention cited by Ruti was an earlier one invented by Michel Volland, Pierre Remond and Roland Boyer[14] described in French Patent No. 81 18565. In patent BP 2,146,040 they detected a drawback, especially when weaving threads made up of untwisted filament which are not interlaced, as it has the risk of being separated at the tips of the slit (Figure 14). In order to eliminate the sharp points which might catch the weft, another device (Figure 15) was made by the inventors in which the edge of each dent facing the nozzles has two triangular projecting parts between which a U-shaped recess is formed. With this alteration

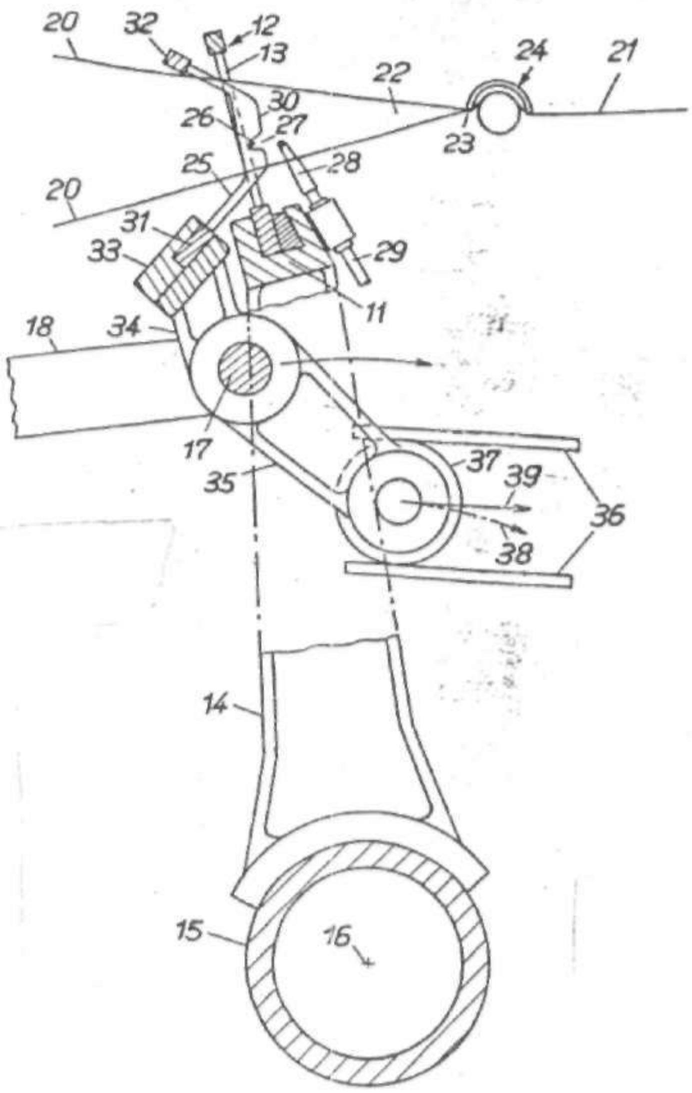

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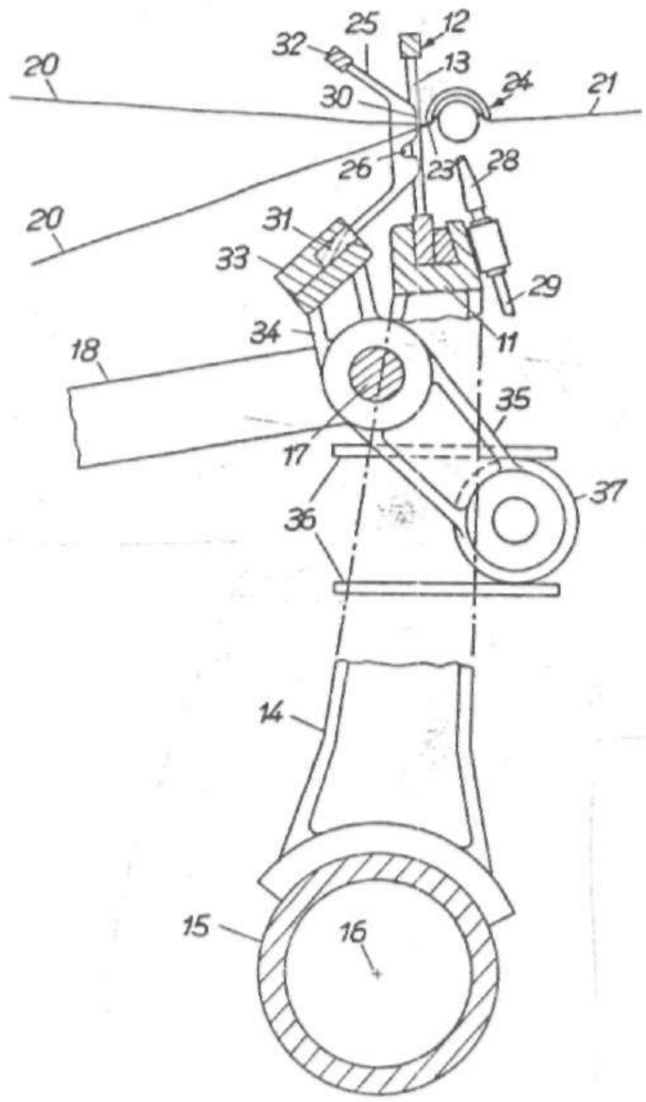
Figure 13B

of design, the insertion channel has a wider opening at the top resulting in a high consumption of compressed air. The inventors, in the modification of their previous invention, provided a reed (Figure 16) with each dent having a single approximately triangular projecting forward part formed with a recess opening and an escape edge at a slight inclination relative to the longitudinal direction of the dent, which avoids the problem encountered in Figure 14. Further, to their invention the projecting part of each dent has a recess widely open towards the top and bounded by a bottom edge perpendicular to the longitudinal direction of the dent (Figure 17). The inventors found that despite the less advantageous position with regard to air consumption, the latter completely retains the advantage of extracting the weft thread before beat-up action. With critical observation of the inventions, it seems that Ruti and this patent agreed on a similar problem, but the approach differs. I therefore feel that with the inclination or "off-set" of the projecting part of the reed, it could possibly eliminate or reduce the chances of the temple being obstructed at the beat-up position. Either solution could eliminate the additional production costs which might arise when designing a special temple.

A further development was made by Kazunori Yosha[15] relating to the use of semi-opened blades arranged in alignment at a predetermined space through which the warp threads are penetrated. However, this arrangement results in the instability of weft insertion due to the air escaping through this space. The applicant, therefore, provided each blade with curved groove 12 (Figure 18A) described as cavity elongated along each of the openings 4, and an apparatus 15



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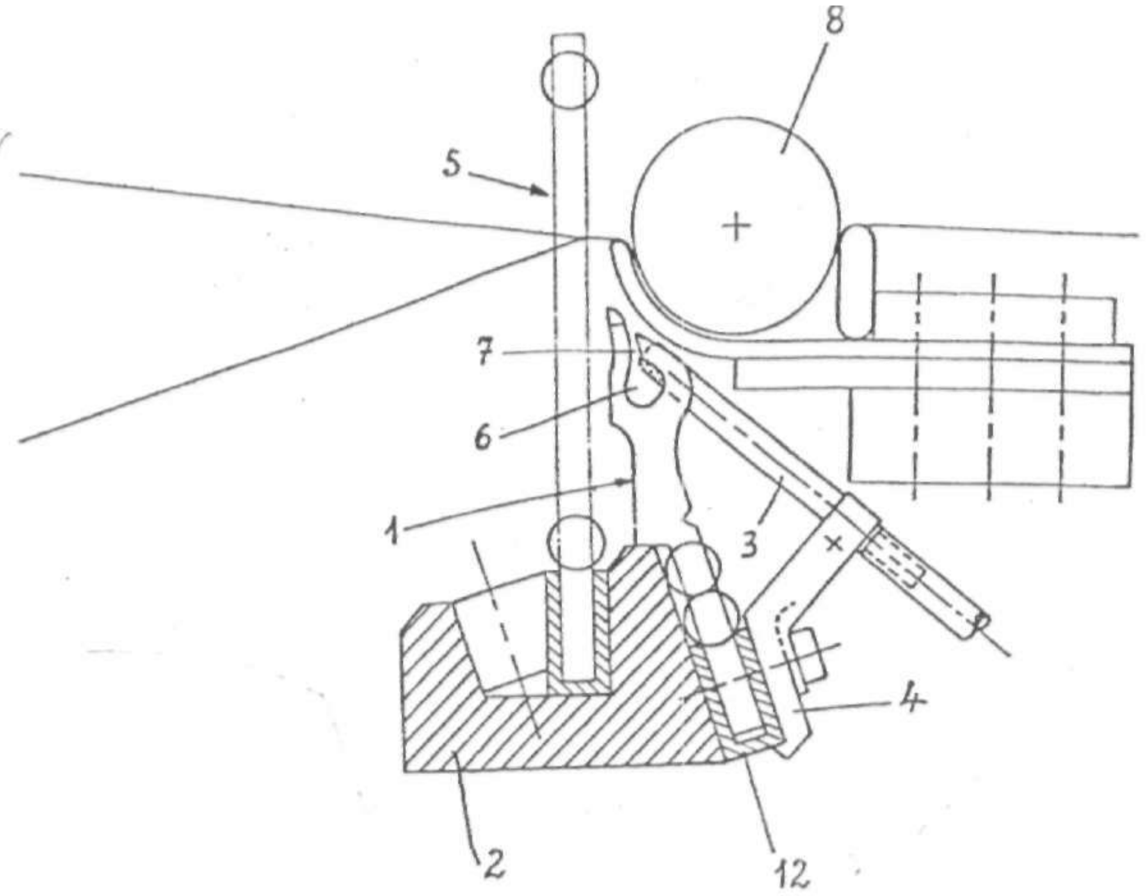


Figure 14

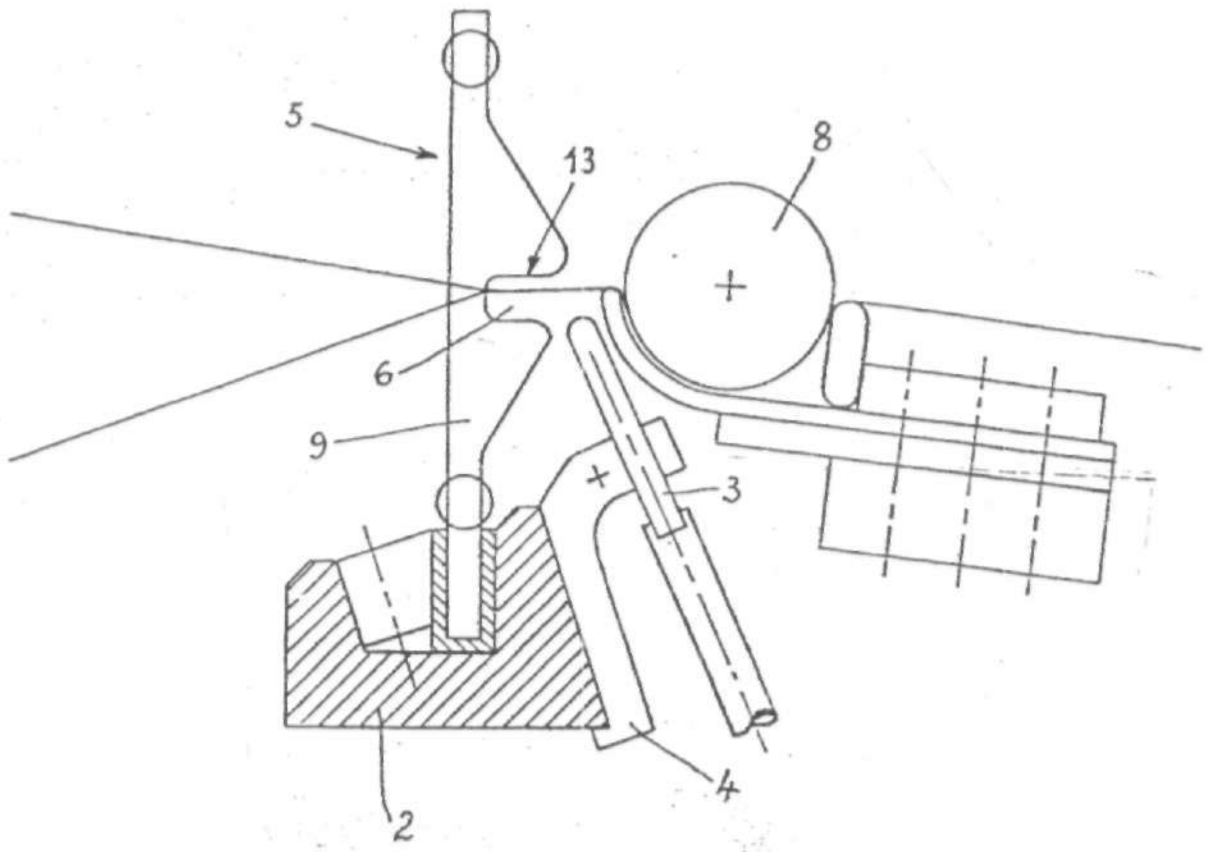


Figure 15

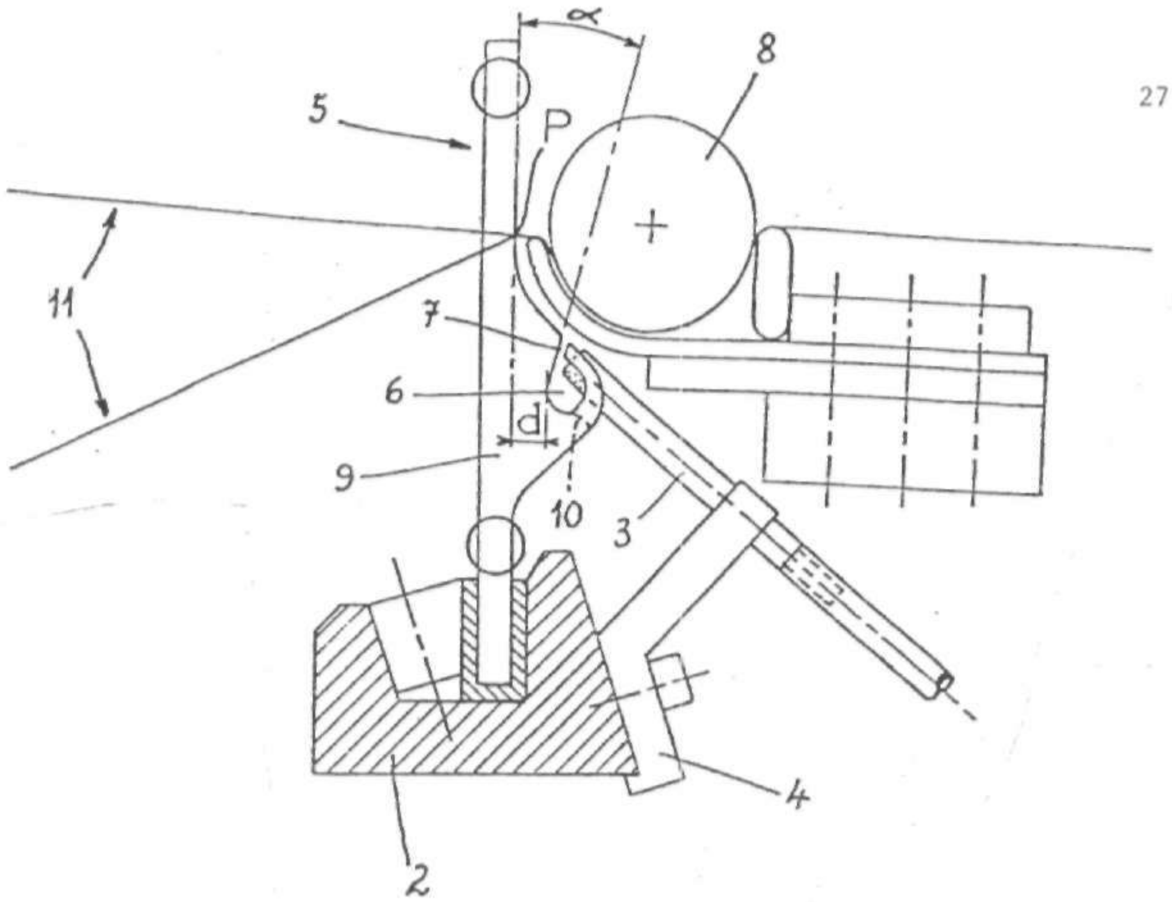


Figure 16

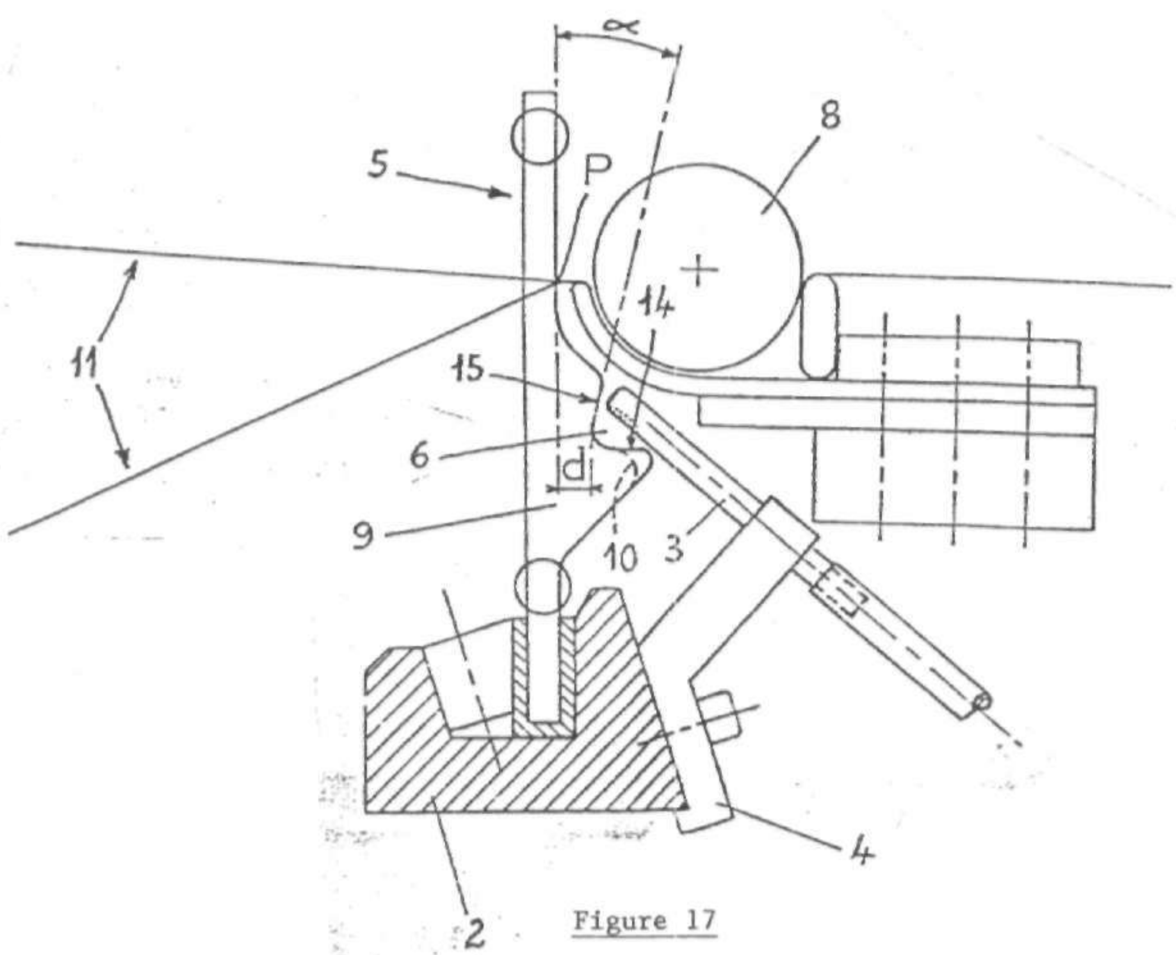


Figure 17

(Figure 18B) in between this space to reduce the loss of compressed air. With this arrangement, Figure 18B represents the diagrammatical flow of air ejected from auxiliary nozzle 6 through a number of reed blades. Most of the air, as shown by a line "M", flows in the longitudinal direction of the guiding channel at the innermost portion while parts, as shown by a one-dot broken line "n", escapes through the space between each two adjacent reed blades outisde the guide channel. With the formation of the curved groove as shown, a line q is positively produced so that the air flow escaping through the space between each two adjacent reed blades is drawn near to the downstream side wall in the direction of weft insertion. The vortex 15 is enlarged and strengthened to stabilise the position and thereby narrowing the cross-sectional area effectively for the escape of air flow.

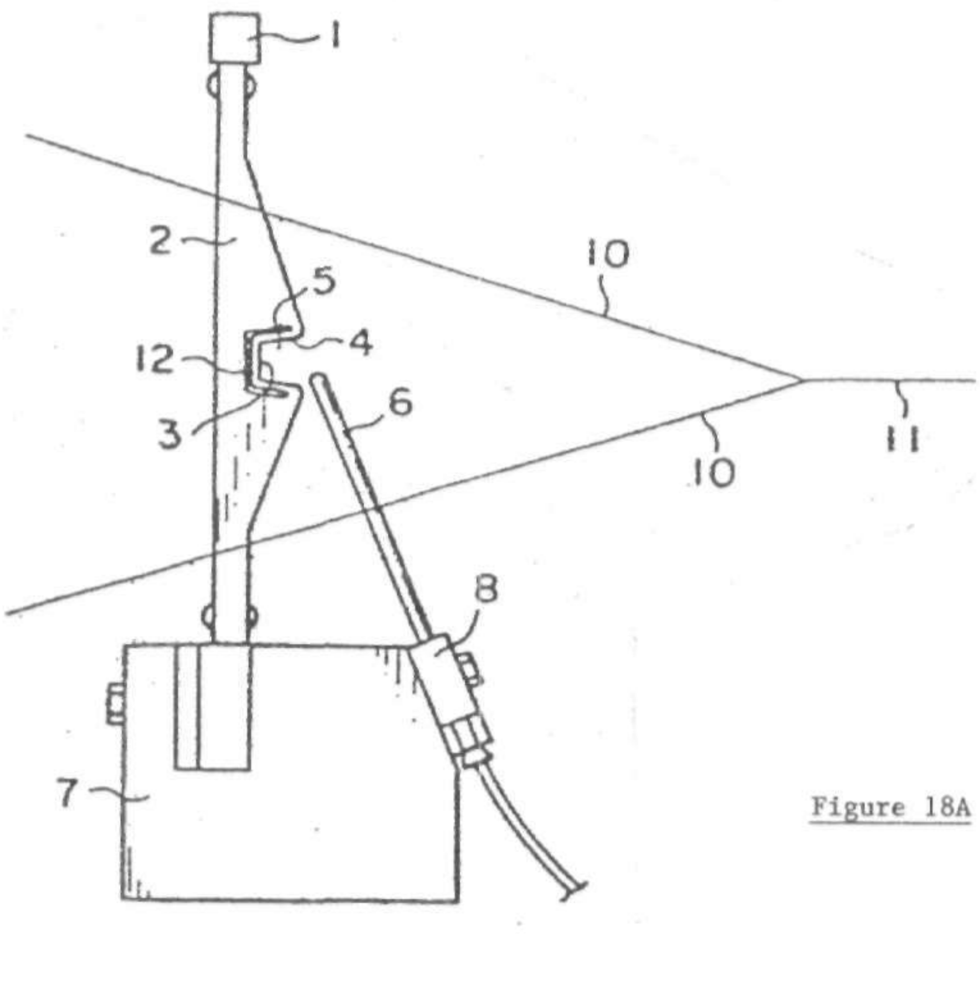


Figure 18A

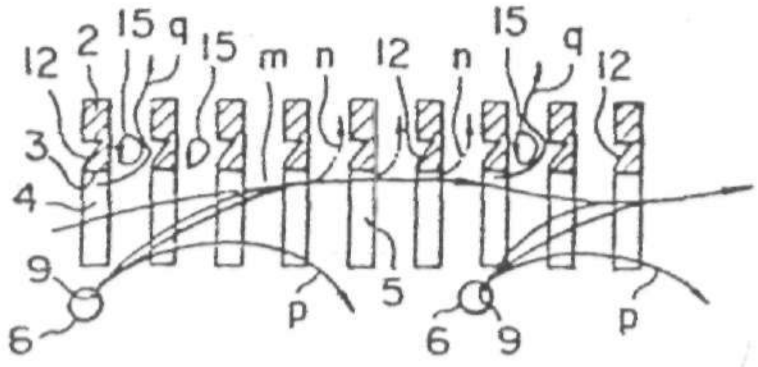


Figure 18B

The patent U.S. 4,422,484[16] relates to the design and arrangement of the open and closed types of weft guide device referring to the publication in Japanese laid, open patent specification No. 55 - 128 047. The inventor claimed that the design as shown in Figure 19, the straight surface 3d, cannot cause the air discharged from the nozzle to be satisfactorily converged for effective carriage of the weft thread as the airflow is apt to branch away to the escape openings 6. In his design, therefore, as shown in Figure 20, the rear wall surface 15d is in communication with its upper portion $15d^1$ being curved forward, which serves to smoothly guide the airflow and provide a relatively narrow opening 22. With the special design of the upper portion, the efficiency of air utilisation increases as the amount of air flowing out through the exit slot is reduced, resulting in a decrease in power consumption. Figure 21 shows the arrangement on a reed carrier.

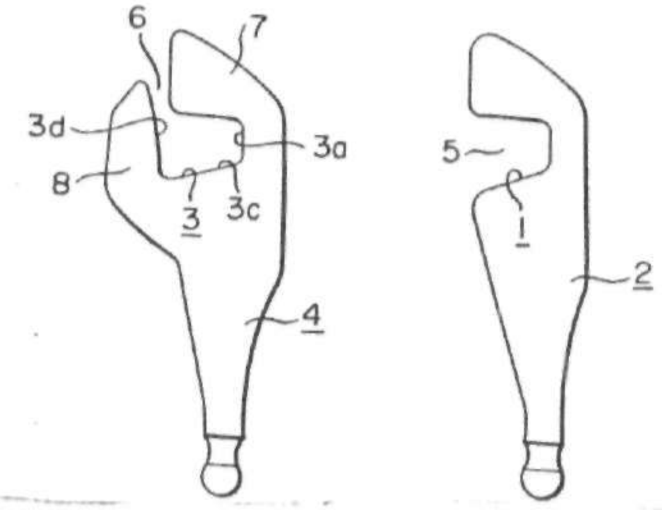


Figure 19

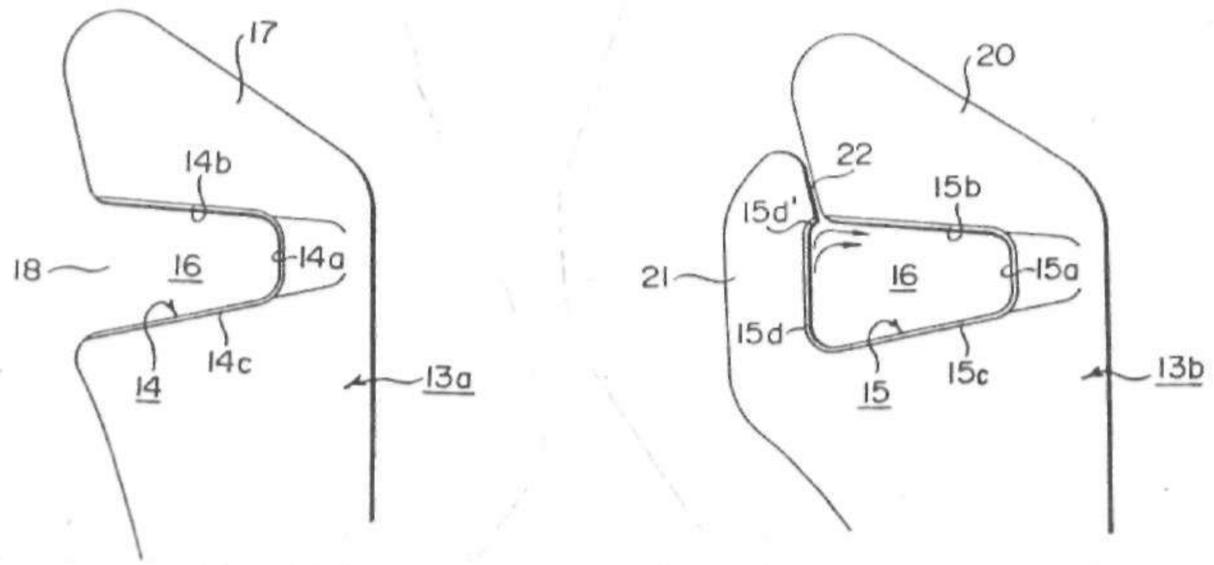
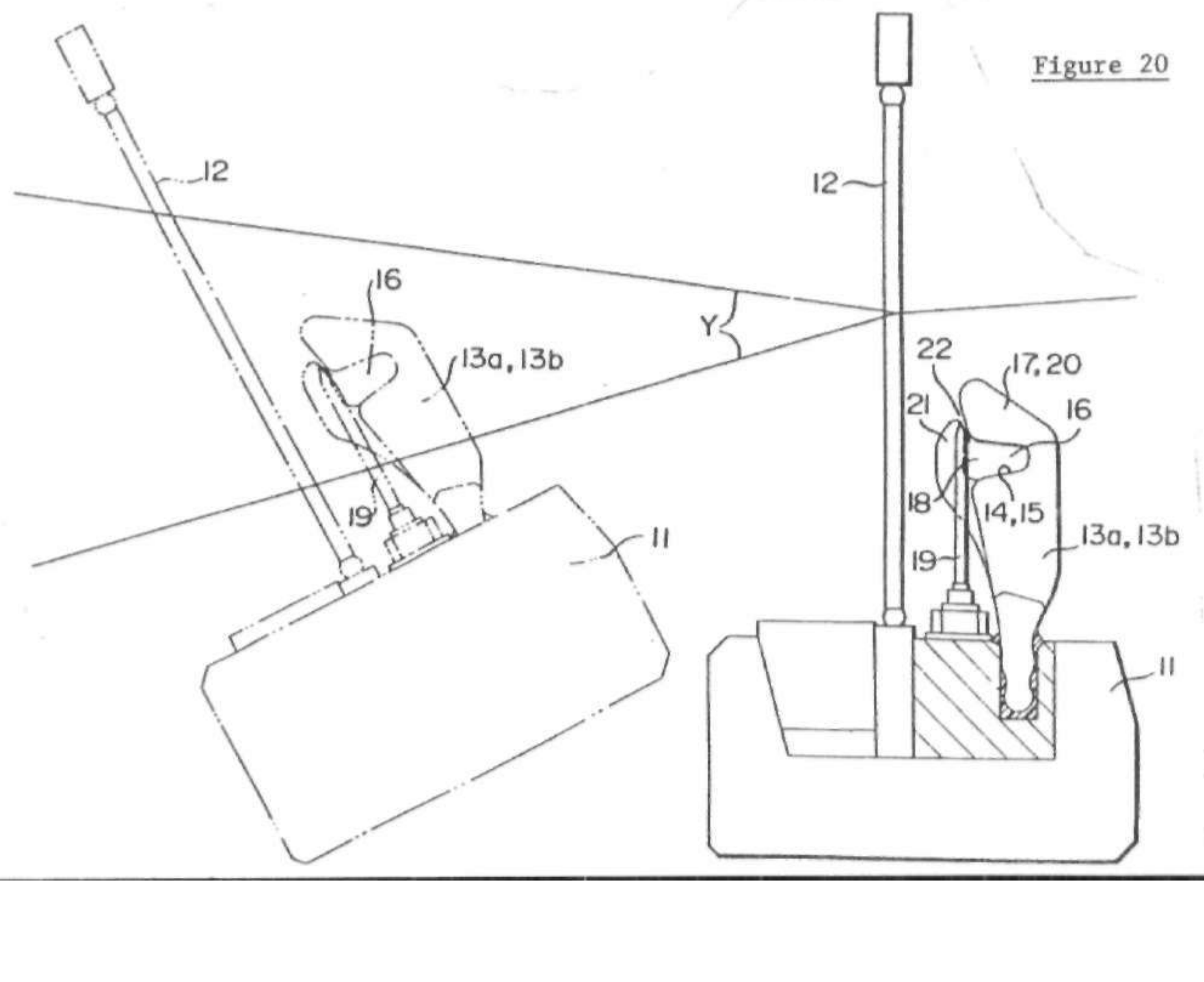
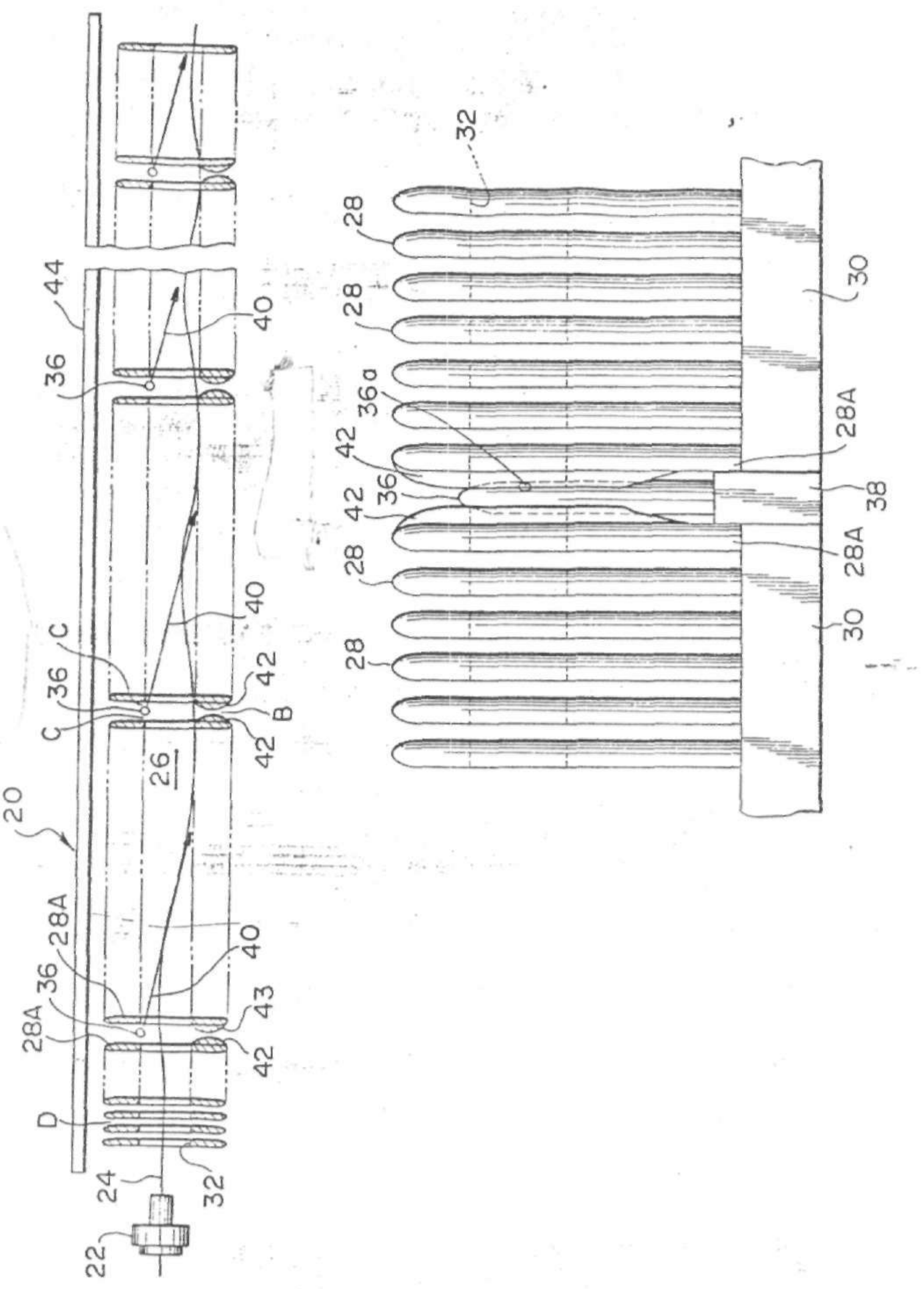


Figure 20




20
22
24
32
D
28A
36
28A
40
43
42
26
C
36
C
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B
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36
40
44
32
28
28
28
28
28
42
36
36a
42
28A
38
28A
30
30

During weft insertion, when the leading end of the weft as well as the main airflow go across the auxiliary airflow, there is a force positively forcing the weft towards the fore wall surfaces which increases the flight of the inserted weft.

Patent G.B.2,073,790[17] relates to the invention of air guide and the arrangement of an auxiliary nozzle with the provision of a device 42 to reduce the amount of air leaking through the clearance between two adjacent air guides. Each auxiliary nozzle 36 with the air ejection opening 36a is constructed and arranged to angularly eject an air jet, 40, (Figure 22) and positioned between two suitable adjacent air guides 28A. The auxiliary nozzle initiates ejection immediately before the leading end of the weft yarn reaches the vicinity of the auxiliary nozzle, so that the weft is pushed against the inner surface of the air guide channel 26. The device is so arranged that the distance between the facing projection is approximately twice the distance between the auxiliary nozzle and the air guide straight section, so that the warp threads can smoothly pass through the clearance.

Despite the above development, Onishi Kimimasa[18] claimed the arrangement encountered some problems, that is, rubbing contact of the warp yarns with the auxiliary nozzle, thereby forming longitudinal streaks on the woven fabrics. The patent, therefore, proposed a solution by constructing the auxiliary nozzle with an outer diameter smaller than the thickness of the adjacent air guide. Figures 24 and 25 give the descriptive diagram of the invention showing a number of air guides 22 and 22^1 of the closed type. Each auxiliary nozzle 42, with an ejection opening 44, is located between the opposite surface 22a and 22b, and thus preventing the warp yarns 28 from rubbing contact with the auxiliary nozzle.

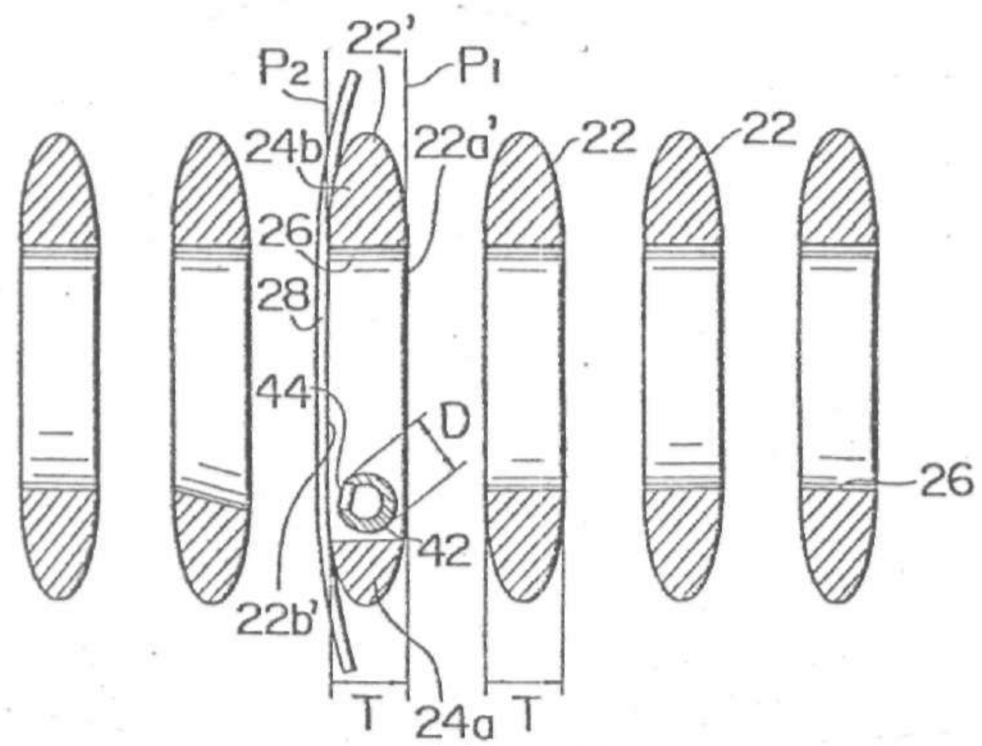

Figure 24

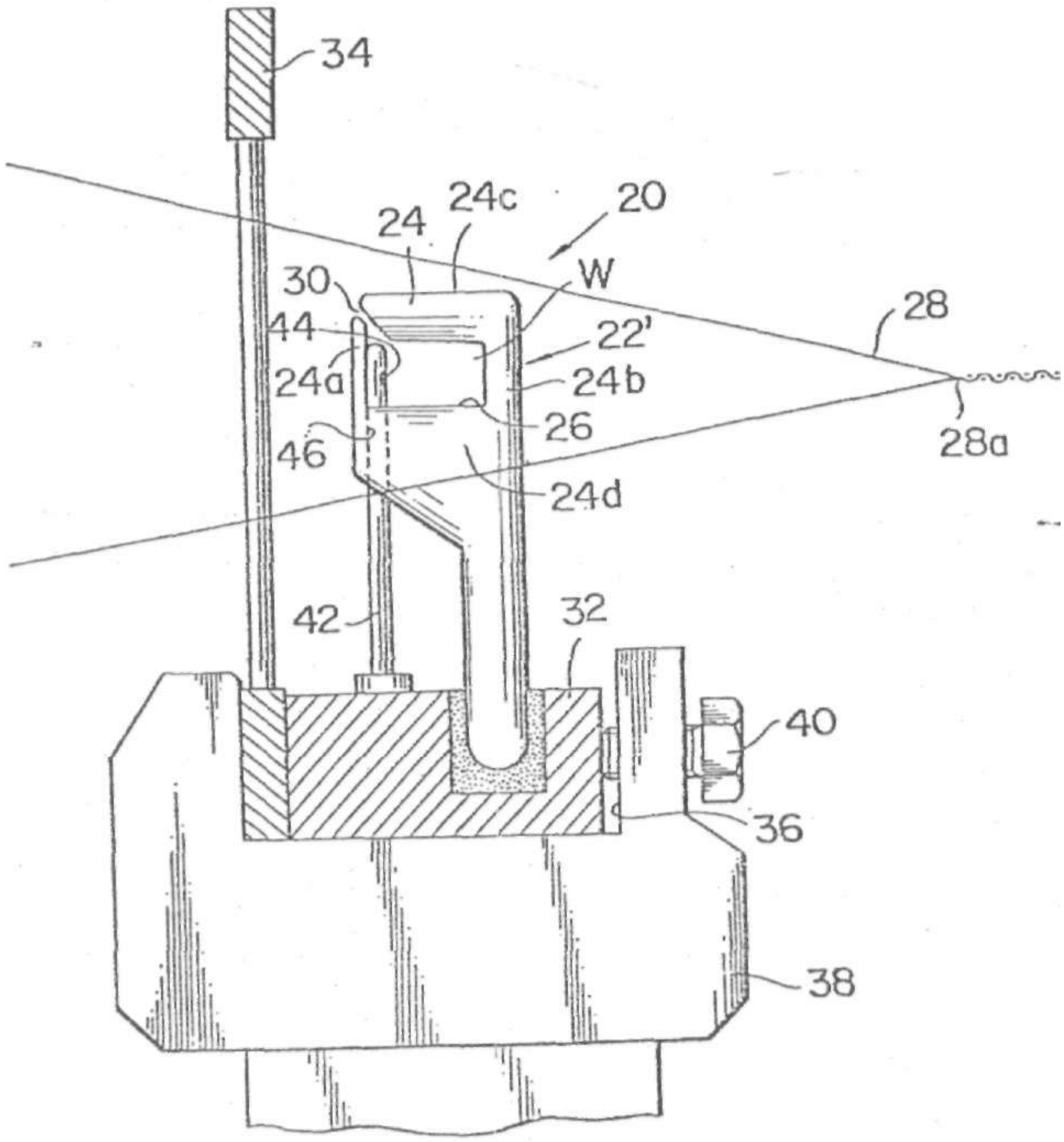

Figure 25

Active Confusor

The disadvantage of confusor weft insertion arrangement resides in that, with an increasing width of the weaving machine, the range of air flow is inadequate, which causes a weft insertion of inferior quality at more distant points from the nozzle. Consequently, this method of weft insertion is suitable only for weaving machines of narrow and medium widths. Furthermore, various active weft insertion methods and apparatus are, therefore, proposed in which the active teeth are interposed between the passive teeth. However, it has been observed that the negative influence of the additive air flow from the active teeth causes the weft yarn to oscillate across the whole cross-section of the weft inserting opening, thereby entering the exit slot. In 1979[19] and 1980[20] Vladimir Kuda, Vladimir Vasicek and Borivoj Suchanek in their patents gave some essential characteristic features shown in Figures 26 and 27 which could be applied to direct the auxiliary air flow from the active teeth to achieve weft yarn acceleration. One of the features is to position the outlet opening on the circumference of the active teeth such that the axis of the auxiliary air, when rectangularly projected onto a plane, makes an angle with the axis of the inserting channel falling in the range from 5 to 30 degrees, and preferably 15 degrees as shown in Figure 26. Another feature is to make the axes intersect each other in the space disposed below a plane parallel to the axis of the weft inserting channel and intersecting the axis of a pair of auxiliary outlets which are most distantly spaced from the unthreading gaps (Figure 27).

The auxiliary outlets are located only close to but always beside

CHAPTER 4

Active Confusor

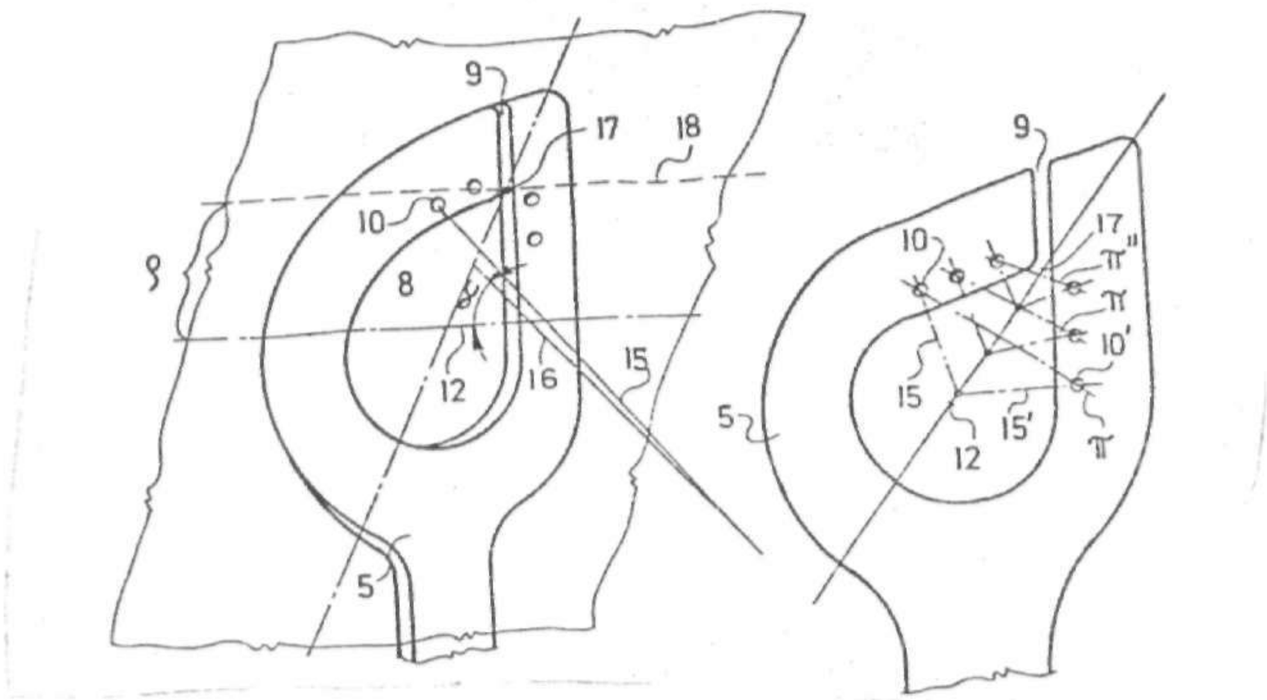

Figure 26

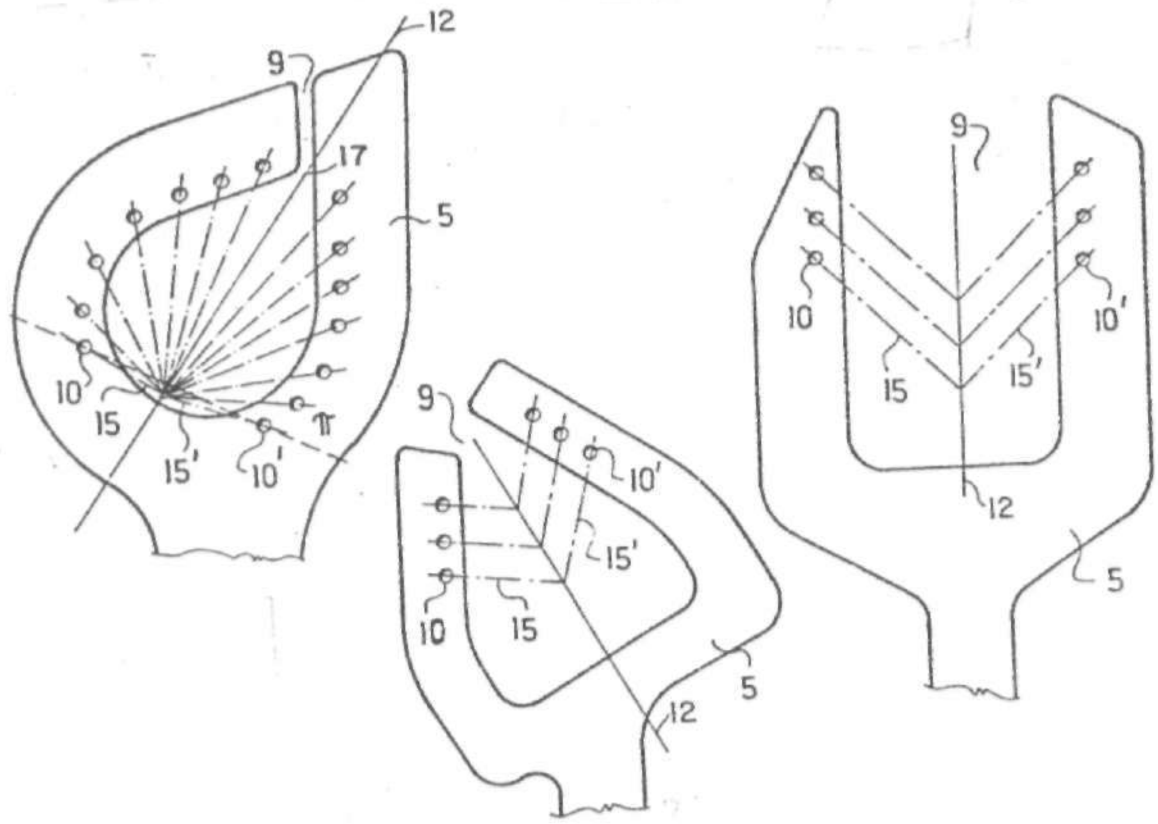

Figure 27

the exit slot and directed away from the exit slot. The secondary airflow produces a suitable distribution of the velocity field of the combined air, particularly in the zone remote from the unthreading gaps. When a loop is formed on the front part of the inserted weft thread, the secondary airflow opens such a loop and propels the weft thread forward. This new arrangement ensures a stable and balanced flight of the weft thread through the inserting channel making the weft to occupy, in the course of insertion, such a position which does not allow its penetration either into the exit slot or the gap between the teeth.

Vyzkumy[21] in his patent pointed out the drawback on a device where the axis of the outlet openings is made to cross that of the confusor at an angle between 0 and 90 degrees. The inventor noted the possibility of achieving the transmission of only small quantities of kinetic energy of the pressurised air and inconstant airflow velocity due to lack of continuity of the separate paths of the air jet which attains a maximum value at the point of intersection of the paths of one active confusor. The weft thread, therefore, tends to unthread through the exit slot as its movement is rather fluttery due to its variable velocity. The applicant then arranged the outflow openings such that the axis as shown in Figure 28A intersects a respective plane which is parallel to a wall of the active confusor and their point of intersection located on a single straight line. The outflow opening, as shown in Figure 28B, is formed on different radii RR' in such a manner that the axis intersects at the same angle while in Figure 28C, the openings are formed on the same radii but intersect at different angles. This device requires less active confusor and hence reduces the air consumption which ensures constant and reliable weft insertion.

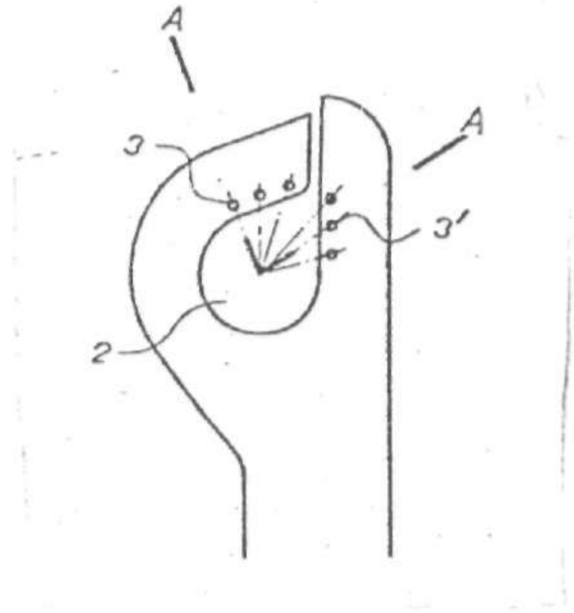

Figure 28A

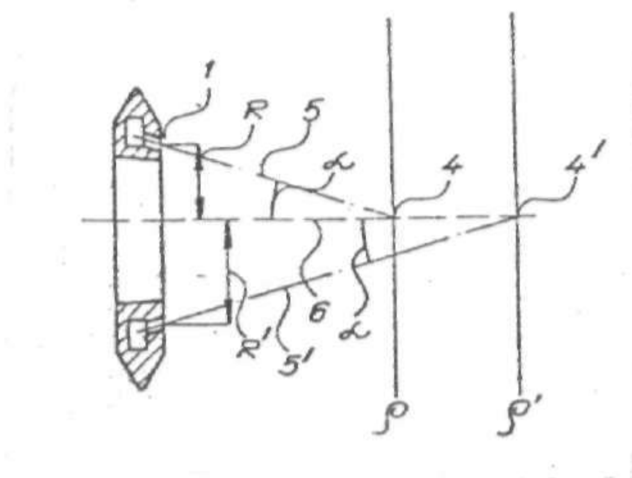

Figure 28B

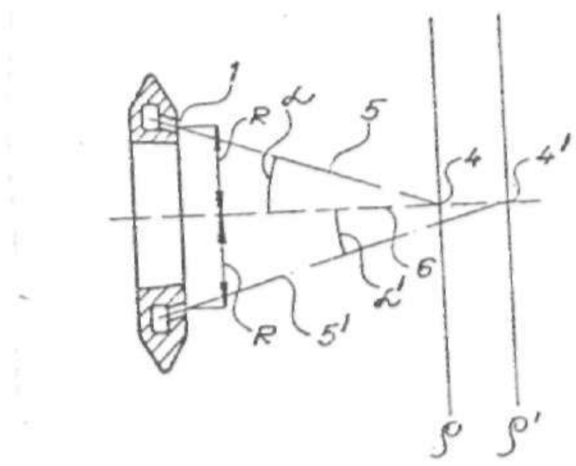

Figure 28C

CHAPTER 5

Booster Jet

Booster Jet

The use of a confusor is effective only on narrow and medium weaving looms and where a wider fabric is to be produced on an air jet loom, another weft controlling device has to be devised. Provision of a number of jet nozzles arranged in front of the reed to eject compressed air within the shed has been proposed, and many works done by various inventors to improve the new device described as a Booster Jet.

Hubert Peter Van Mullekom[22] in his patent, illustrated a similar arrangement in which the nozzles are mounted above and below the upper and lower warp sheets respectively, and arranged to press groups of warp threads into the shed, so that the air jets streaming out of the jet nozzles can enter the shed. Another device, according to the applicant, is the provision of curved jet nozzles which are not entirely closed so that the inserted pick can be laterally removed from the channel before the beat-up action of the reed. The nozzles are so arranged that they can move between the warp threads into and out of the shed. The weft inserted, therefore, tends to move into the path of the jets leaving the nozzles, thereby localising the weft position resulting in entanglement with the warp threads. The applicant, in his invention, arranged some of the nozzles in the corner of the shed such that each nozzle lies outside a circle inscribed within a triangle formed by the warp sheets and the blade of the reed. This triangle is perpendicular to the conveying direction of weft which is preferably conveyed through the centre of the inscribed circle. The jet nozzles are incorporated in projections 9 as shown in Figure 29 carried by a common support below the lower warp threads into the shed, and each projection having a single lateral discharge opening. The projections 9a and 9'a are arranged respectively to project a weft from the right side and from the left side of the shed for the proper formation of the selvedges. When a weft is to be inserted from the right side of the shed, the air is supplied to a duct 11 and through this duct to the opening 10. When new weft is to be inserted from the left side of the shed, the air supply to the duct 11 is interrupted and therefore admitted to the duct 12 to be linked to the projection 9'a.

Instead of two projections 9a and 9'a, a single projection 9b can be provided having two openings 10' and 10" connected to the ducts 11 and 12 respectively. The jets leaving these openings are not entirely parallel in the direction of the weft, but have a laterally directed component in the direction of the warp threads.

In another arrangement of the nozzles as shown in Figure 29B, the nozzles 14 and 15 are situated in the upper and lower corners of the shed and between the jet nozzles 9 and arranged in a repeating series as shown in Figure 29C. The provision of the jet nozzles in all corners of the shed according to the inventor, is advantageous, more particularly if the jets discharged by them are disposed so that they deviate from the weft direction towards the bisectors of the angles at the respective corners of the shed.

Three ideas were patented in G.B.2060 720[23] and the first illustrates the use of hollow needles 3 with discharge apertures arranged in an angular position such that the axes of the issuing conical air jets form an angle with the direction of weft insertion as shown in Figure 30A. By moving the rack 6 in the

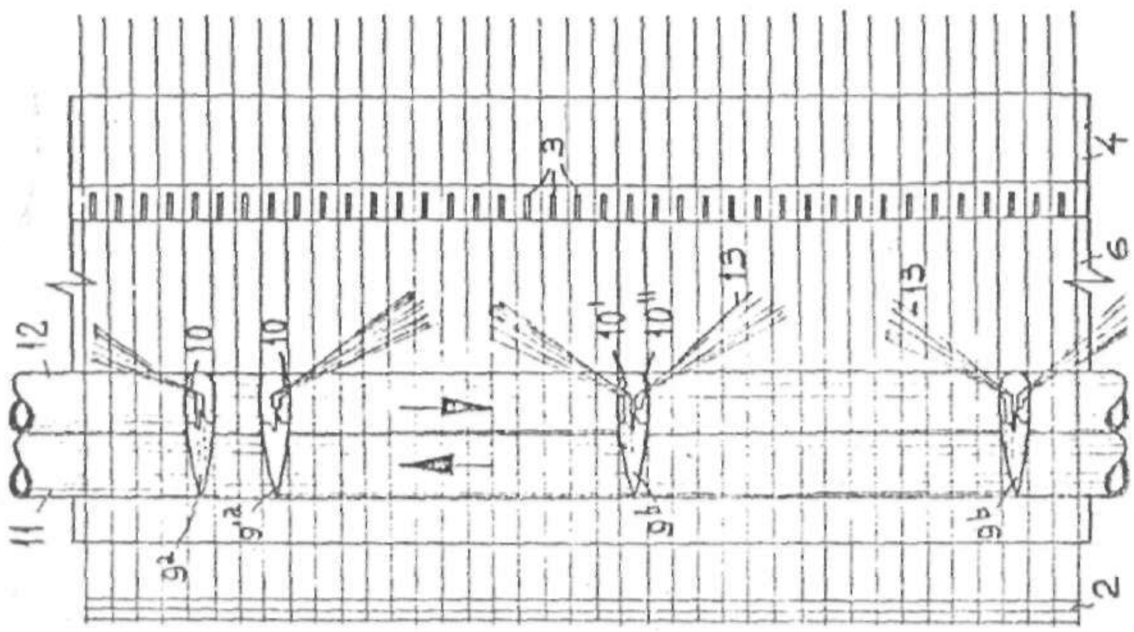

Figure 29A

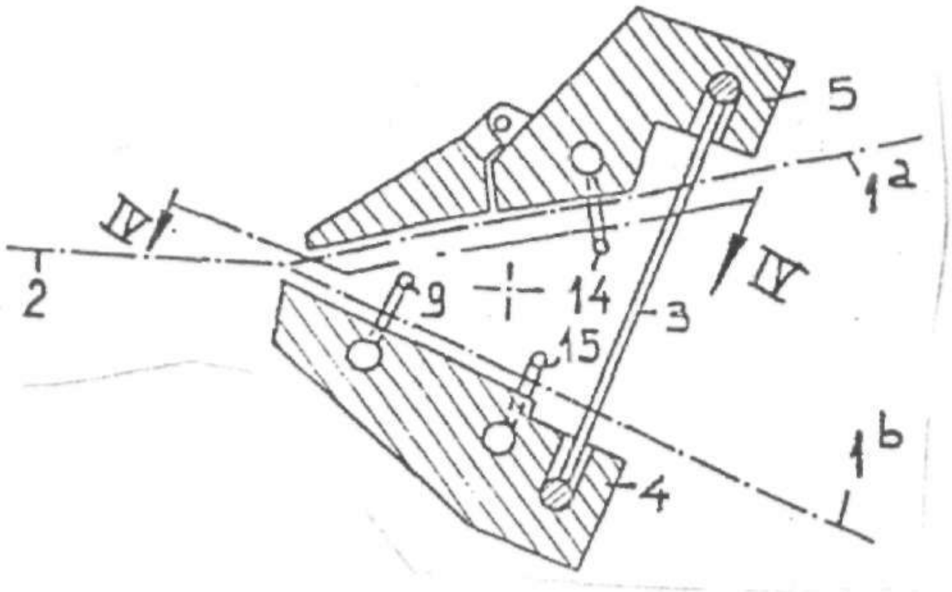

Figure 29B

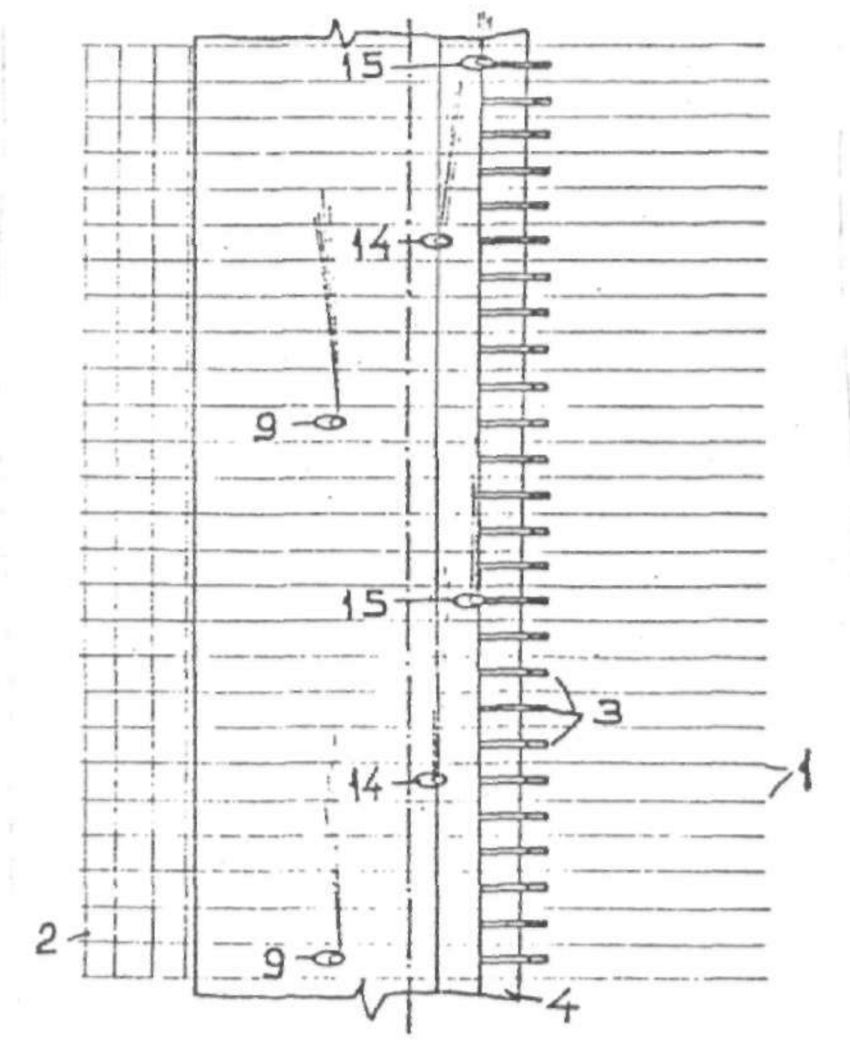

Figure 29C

direction of the arrow X the blowing nozzles are pivoted around the axis and the angle will increase or decrease respectively, therefore influencing the frictional contact of the weft thread and the close side of the guide channel. Secondly, the applicant provided a selectively controlled additional nozzle arranged between two other auxiliary nozzles oriented in a fixed position as shown in Figure 30B. The additional nozzles indicated 8 are only supplied with air when processing smooth yarns to further frictional contact. In his last illustration, the inventor provided a disc-shaped plate (Figure 30C) arranged adjacent to at least one of the auxiliary blowing nozzles which is moveable between an inoperative and an operative position. In the inoperative position, the disc plate is completely outside the conical air jet of the relative blowing nozzle, whereas in the operative position, it enters the path of the issuing air jet and tends to deflect the jet in a direction traverse to the path of movement of the weft thread. But Geert Jan Vermeulen[24,25] claimed some drawbacks in the above arrangement as there is a tendency of the weft to lodge itself in the boundary layer surrounding each jet cone issued by each separate jet nozzle. This invention, therefore, is directed to an improvement in the energy transmission from the transport airflow to the thread moving through the shed. The applicant then proposes to energise the jet nozzles successively in time with the advancement of the leading end of the weft thread. The supply of transport air to a jet nozzle is opened before that of the preceding one is terminated or reduced in order to obtain a certain overlap to compensate for any possible variations that might occur. It appears that the energy transmission is improved in such

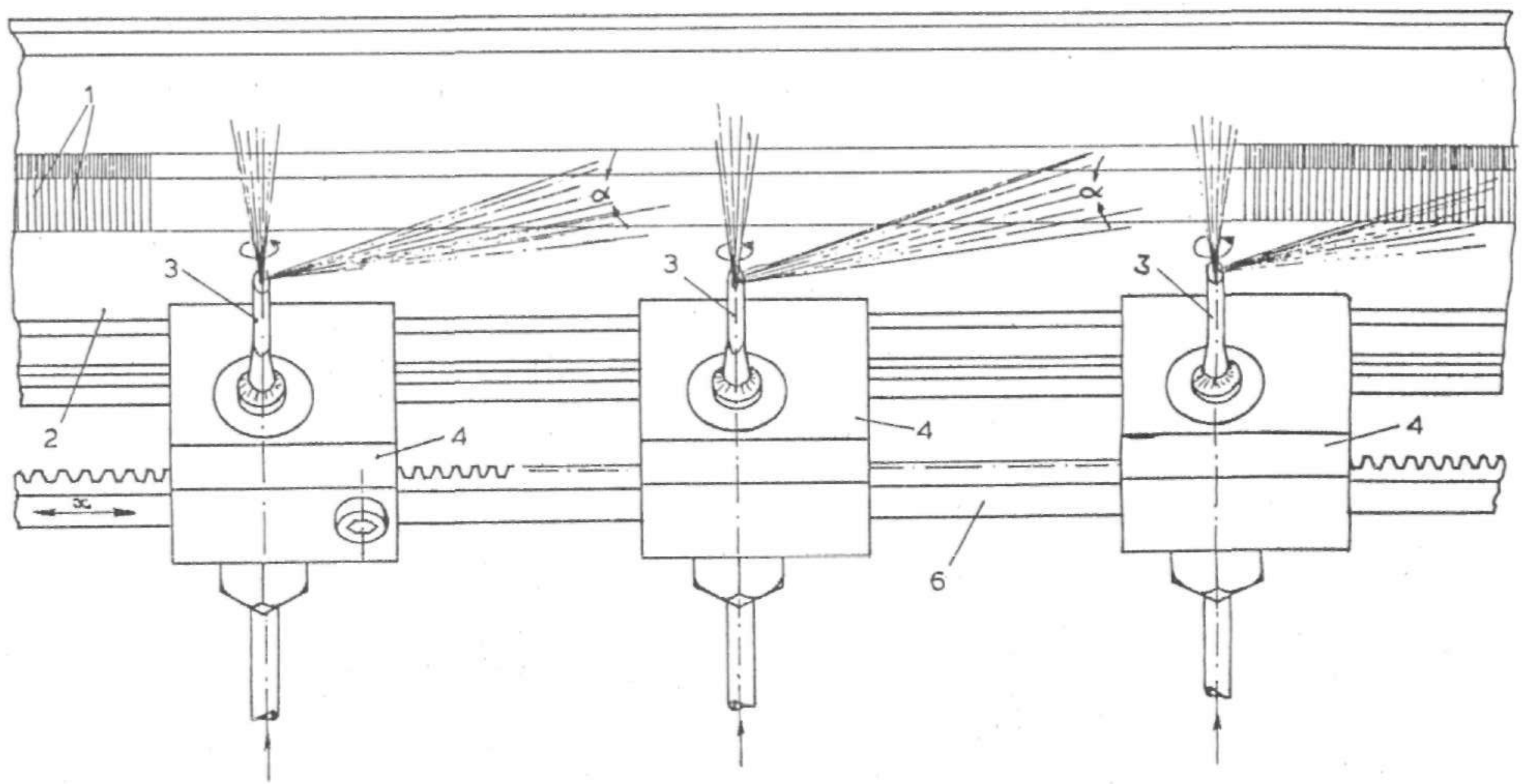

Figure 30A

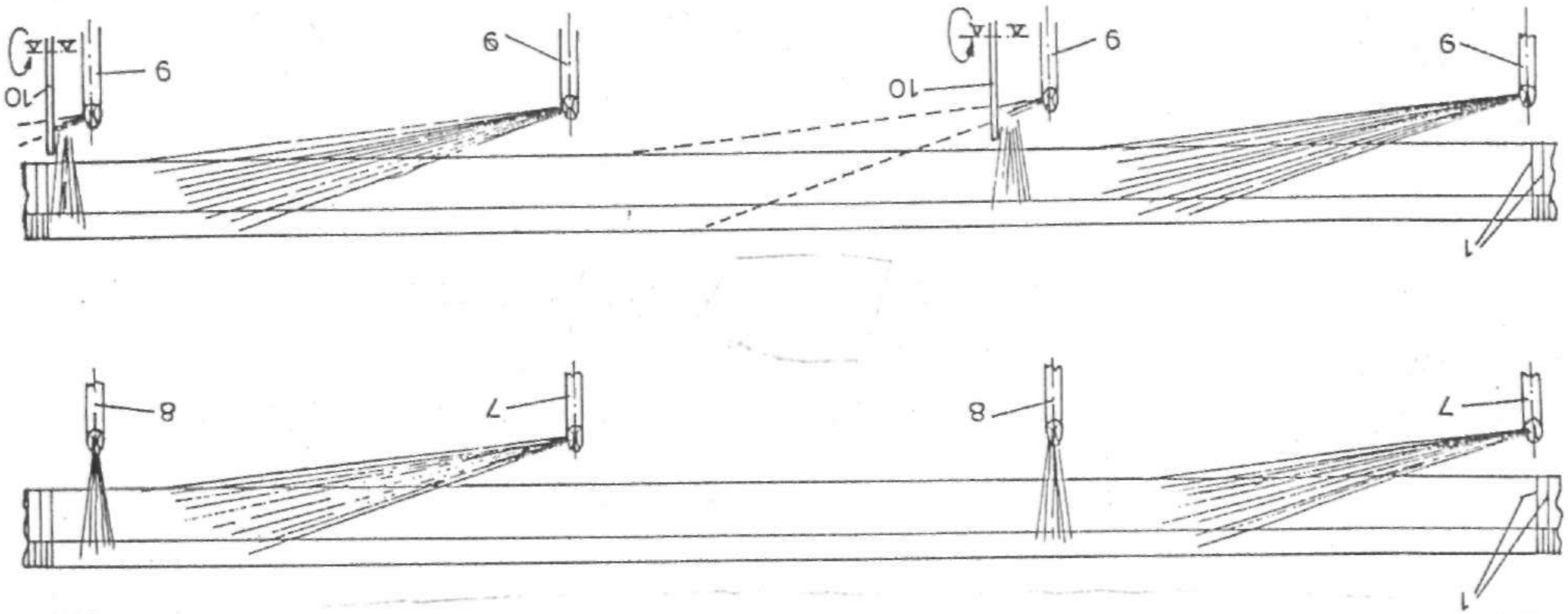

Figure 30B

a way that the increased force acting continuously upon the weft is able by itself to cause the weft to be transported through the shed at the desired high velocity. Figure 31A shows schematically an arrangement of a number of jet nozzles 1 - 6 aligned and arranged to discharge air in the same direction to that of the weft thread. During weft insertion, the supply of the air to the first nozzle is opened to eject a conical jet of air for the transportation of the weft thread towards the next nozzle. The supply is continued just beyond the point at which the supply to the second nozzle is opened and the weft being taken over by the second nozzle towards the third. The jet issuing from the first nozzle has at this time been interrupted. This method of issuing and interrupting the jet flow from the nozzles continues sequentially until the weft yarn is picked across the weaving shed. This avoids the possibility of the weft yarn being entangled with the warp threads and there could be the corresponding reduction of shed height.

The diagram in Figure 31B shows the air consumption with this invention in comparison with that of the conventional method. It can be seen from the diagram that the energising of the jet nozzle 1 starts at 0 degrees and ends at 33 degrees, whereas that of the second nozzle starts at 30 degrees and ends at 63 degrees and so on. An overlap of 3 degrees occurs between each successive transport of jets. The last jet nozzle 6 stays energised during 40 degrees in the second half of the weaving cycle in order to keep the inserted weft taut during the beat-up action of the reed.

Control mechanisms are used to achieve higher weaving velocities and these mechanisms, as illustrated in Figure 31C, cause each of the valves to be energised for the proper interval and in the proper sequence. A single control cam 15 is used to open a valve 16 in order to shift a control slide 18 against the action of a return spring 19 to a position in which the jet nozzle 1 is in communication with an air source 20. At the same time, the control slide 18 connects the source with a control 21 belonging to the second jet nozzle. The pressure signal transmitted by the conduit 22 reaches the control slide 21 with a retardation corresponding to the desired time interval between the start of operations of the control slides The control slide 21 will, therefore, connect the source with the second jet nozzle only at a moment at which the first control slide 18 under the influence of the return spring is about to return to its de-energised closed position.

Takahashi[26] positioned the auxiliary nozzle between suitable air guides in which the upper tip section is closed with smooth and curved shape to easily push the warp yarns aside when each auxiliary nozzle advances between the warp yarns. The air distributors 12a to 12c, as shown in Figure 32A, are positioned under the woven fabric and provided with three air discharge holes which communicate with the respective group of auxiliary nozzles. The cam followers 28a to 28c are biased to contact the surfaces of cams 30a to 30c which are constructed with low 32 and high 31 lobe sections. Before 120 degrees of crank shaft rotation, as shown in Figure 33B, the cam followers remain contacted with the surfaces of the low lobe section of the cam so that the valves 14 remain closed. At exactly 120 degrees, all the cam followers contact the surfaces of the high lobe sections and consequently all the valves are opened. As a result,

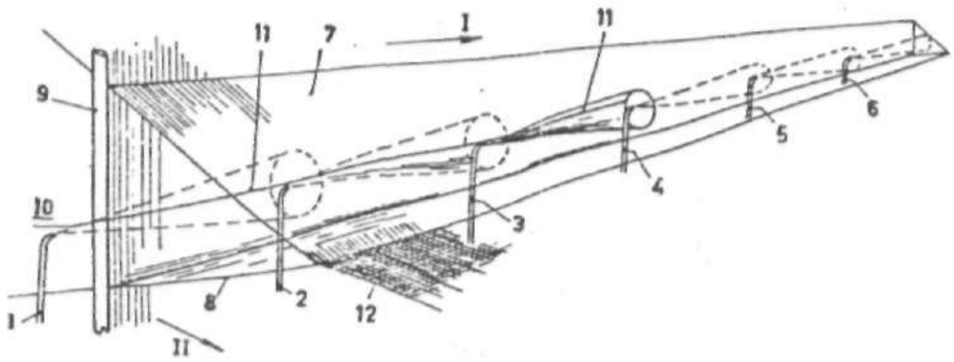

Figure 31A

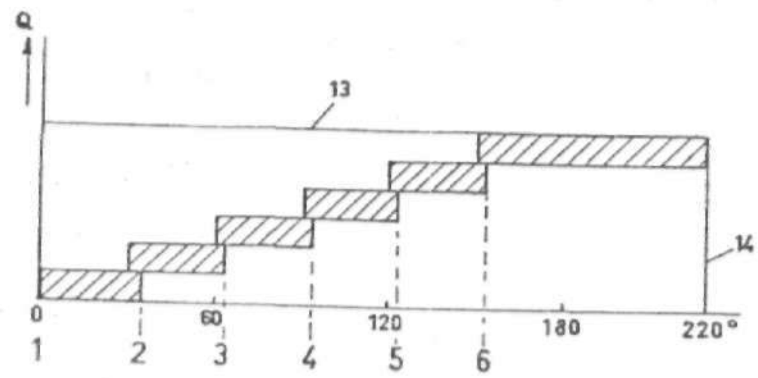

Figure 31B

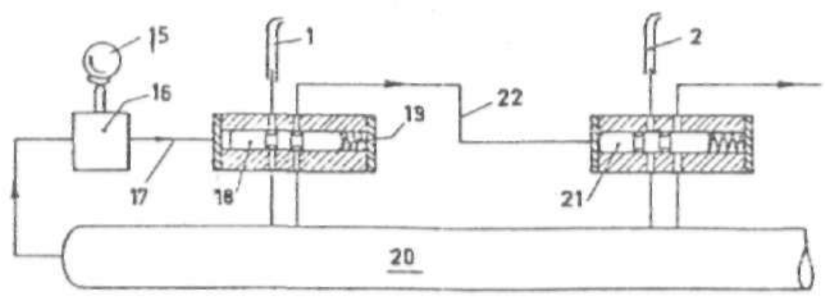

Figure 31C

the pressure air is supplied to all the auxiliary nozzles and almost at the same time the main nozzle ejected air to blow forward the leading end of the weft yarn. The grasping device 2 is made to release the weft yarn to be pulled by the air jet from the main nozzle at about 125 degrees of the crank shaft rotation; and at 160 degrees the leading end of the weft yarn passes by the first group of auxiliary nozzles 10a to 10c and reaches the vicinity of the second group 10d to 10f. At this time, the cam follower 28a of the valve 14a starts to connect the low lobe section to close the valve, thus stopping the air jet ejection from the first group of auxiliary nozzles. At about 200 degrees the leading end of the weft yarn passes by the second group 10d to 10f and reaches the vicinity of the third group 10g to 10i, and at this time the cam follower 28b of the valve 14b starts to contact the low lobe section of the cam to close the valve. AT 210 degrees the air jet ejection from the main nozzle is stopped and at about 230 degrees the weft yarn passes by the third group 10g to 10i to complete the weft picking action. According to the applicant, at the initial stage of the weft picking, a turbulence of air stream temporarily occurred in the weft guide channel for the reason that the air jets from the auxiliary nozzles strike still air and interfere with each other. But this temporary turbulence is abruptly cancelled and a steady state air stream is effectively produced within the guide channel.

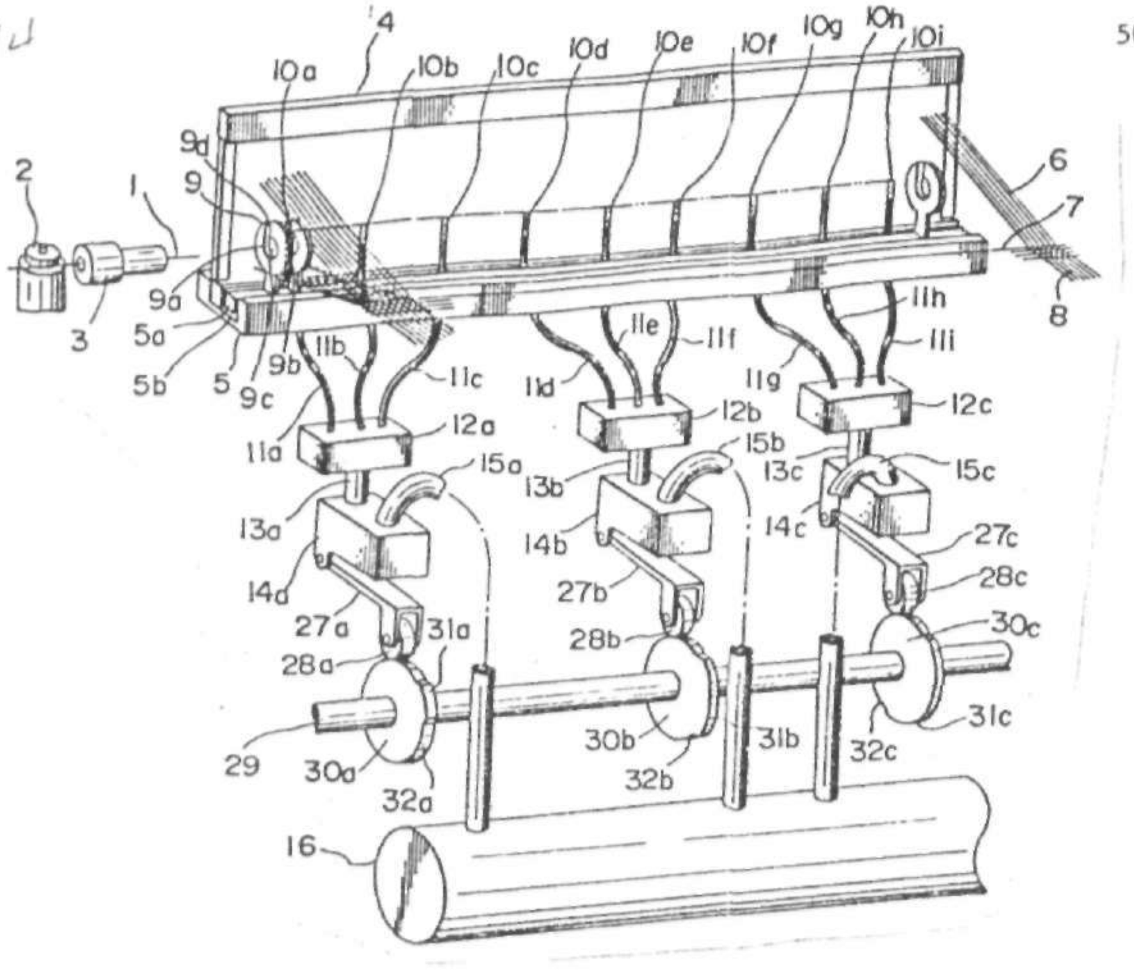

Figure 32A

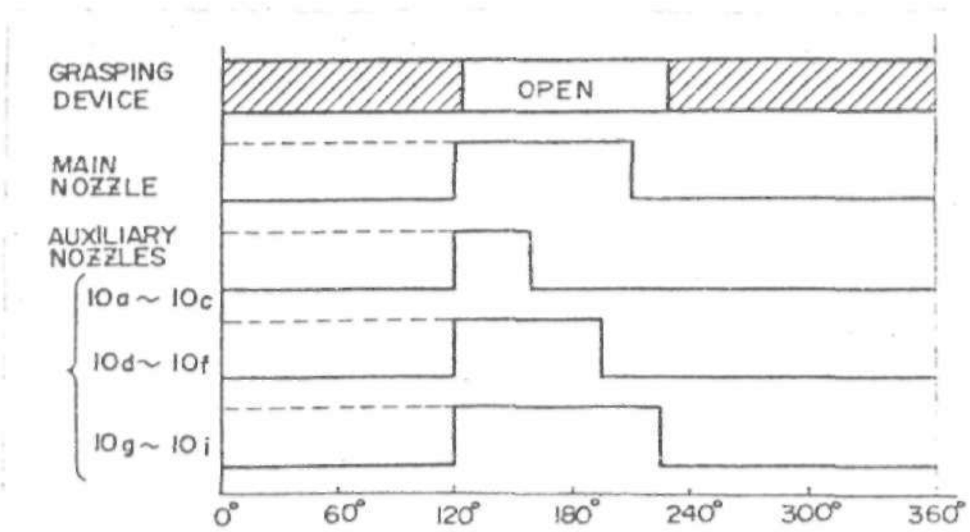

Figure 32B

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