Rapier Weaving

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Weft Insertion by Means of Rapiers

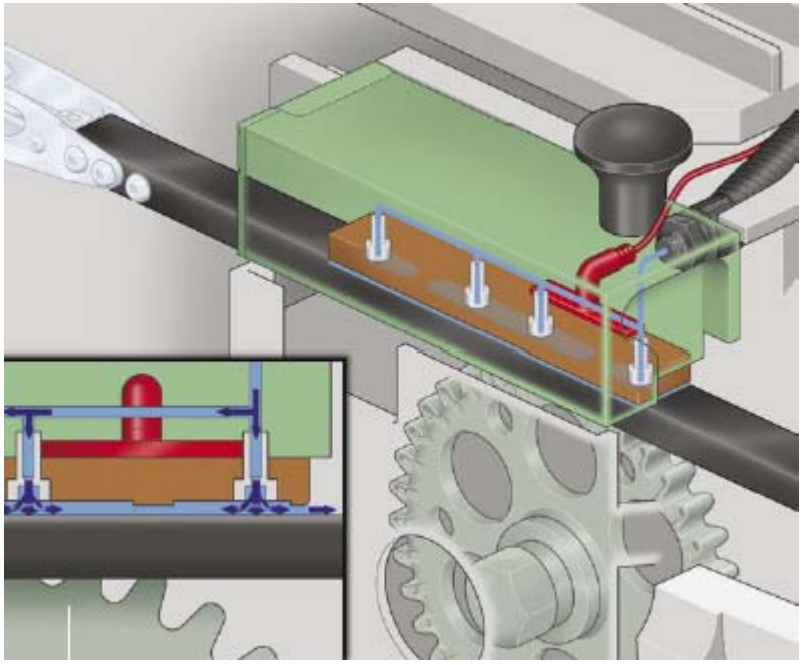
- Rapier weaving machines are known for their reliability, performance and versatility, i.e., ability to weave a wide range of fabrics.
- In the field of rapier weaving, the number of manufacturers is unbelievably high.
- It is therefore realistic to consider only the principles involved.
- Although all rapier machines can be classified as a single group for convenience, they can be sub-classified in several ways.
- Classification of the rapier picking:
  - Type of rapier: rigid, flexible, telescopic
  - No. of rapiers: single, double or twin
  - Method of weft insertion. Gabler, Dewas
  - Positioning of the picking mechanism

Type of rapiers: Rigid rapiers

- Thin-wall tubes, ~ 10 to 15 mm ϕ, or hollow bars of rectangular cross section.
- Advantages:
  - They do not require guiding across the warp sheet; the rapier head slides on the warp, or on the raceboard.
  - High mass and rigid construction ensures straight movement of rapier heads.
  - A great diversity for both warp and weft threads in yarn count and character.

Rigid rapiers

Hollow bars of rectangular cross section are attached to the rapier heads



Rigid rapiers

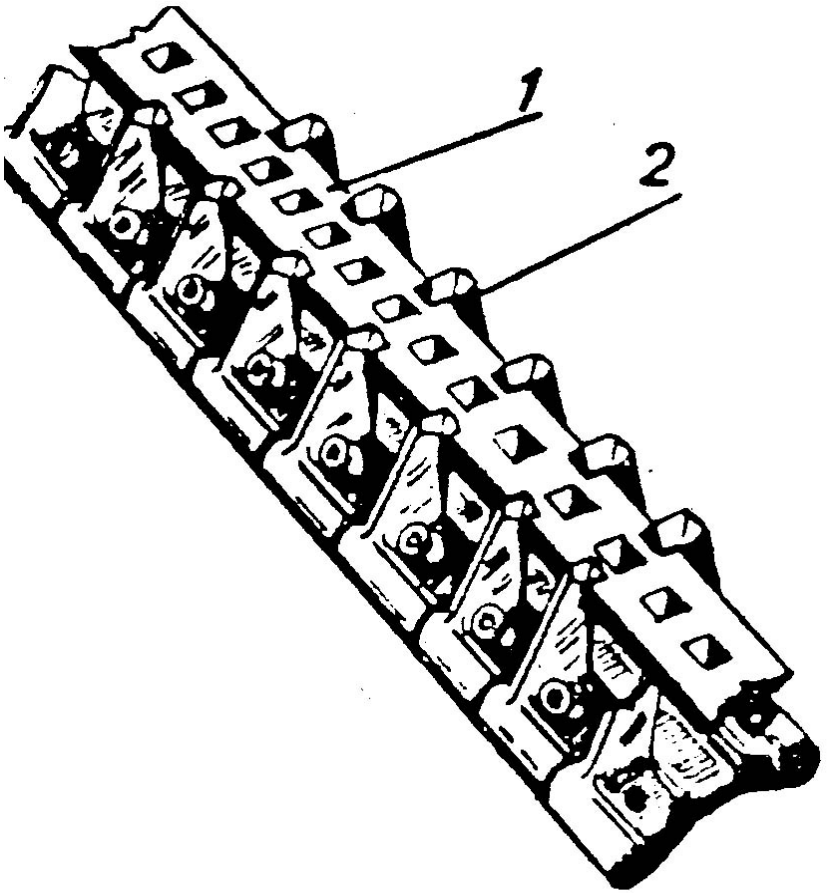
Disadvantages:

- Their large floor space requirement, at least twice the fabric width
- Half of their movement is wasted (common to all types).

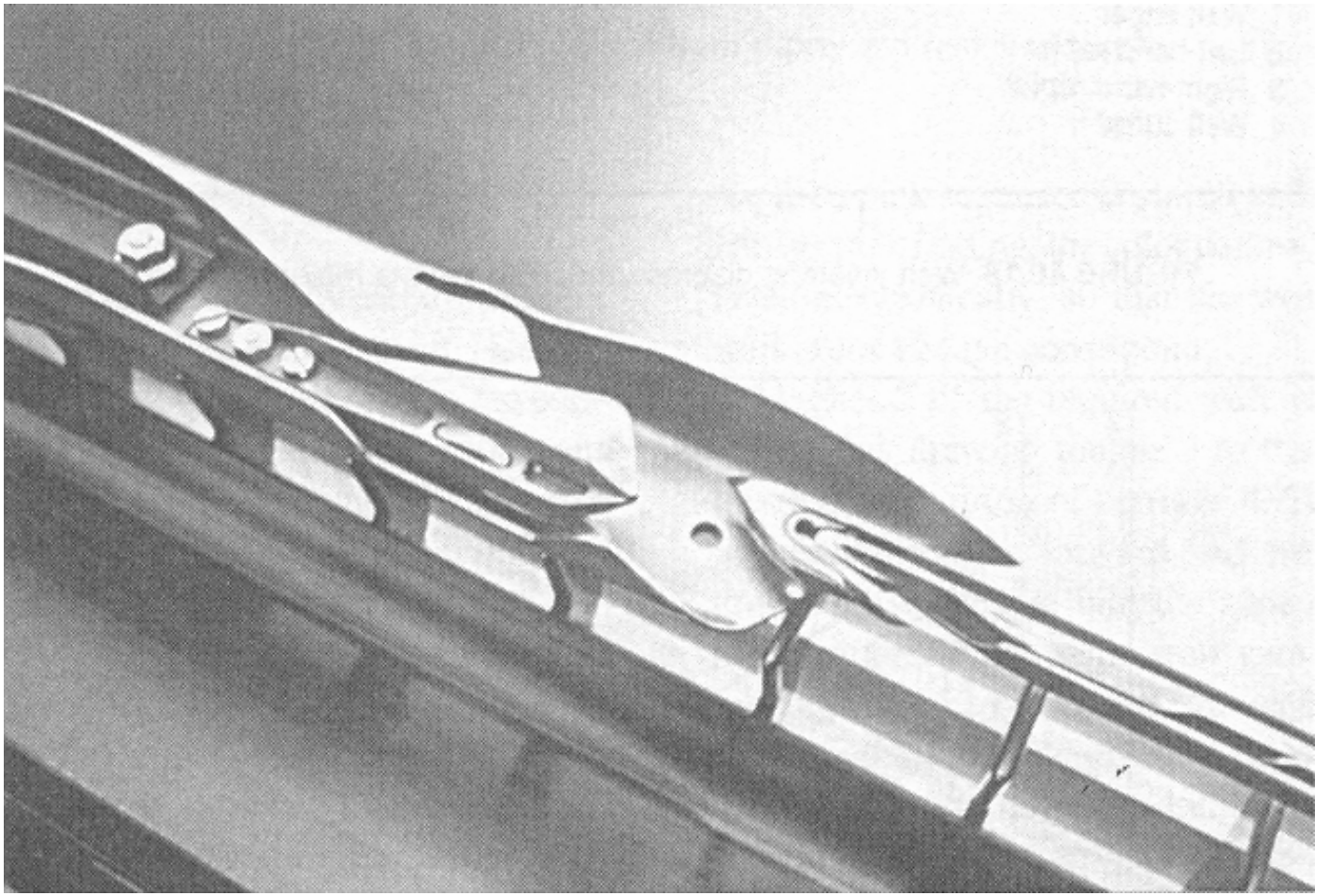
Type of rapiers: Flexible rapiers

- Tapes of rectangular cross section, 25 x 10 mm, made of spring steel or plastic.
- They require guiding across the shed especially for larger working widths.
  - The ribbed guide is similar to that used with the gripper projectile weaving machines
  - Directing the flexible-rapier band through a fixed housing on the loom frame just outside the reed (no guide mounted in the sley)

Flexible rapier guide

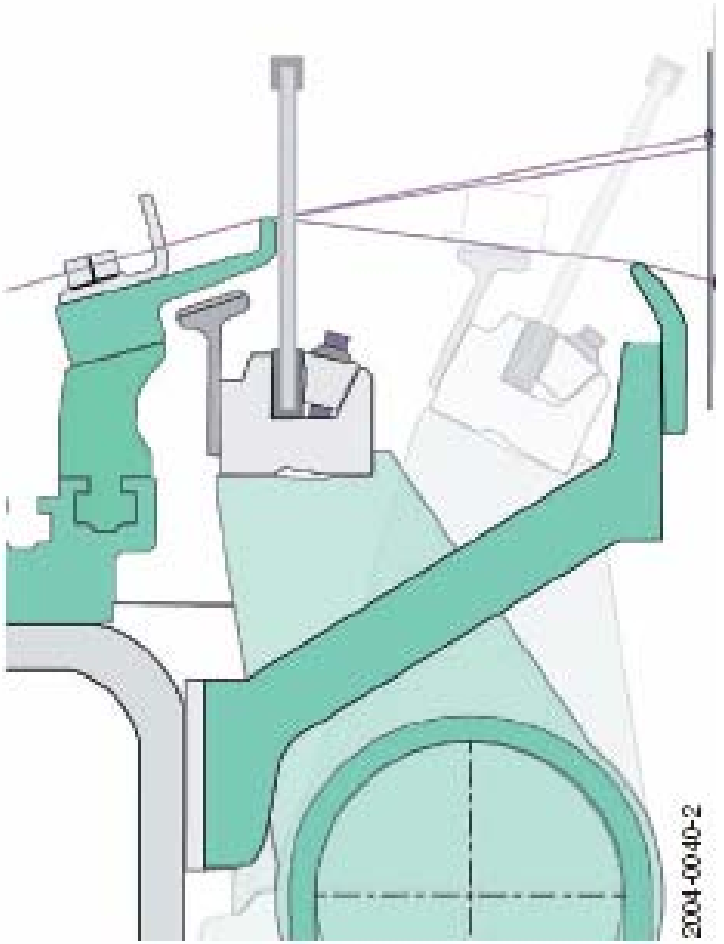


Flexible rapier heads



Flexible rapier guide

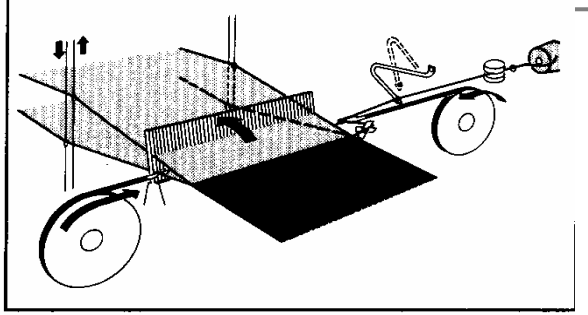
- Ribbed guides lie between warp ends when the shed is open.
- The guides pass under the cloth fell when the sley approaches its most forward position.

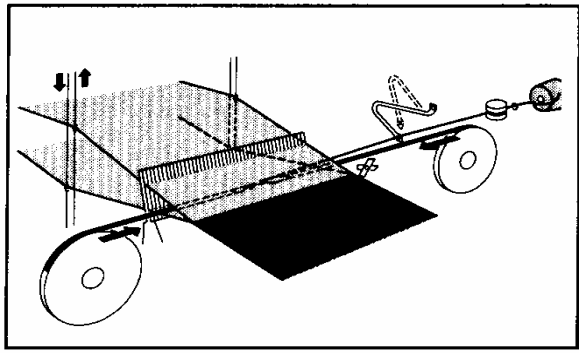


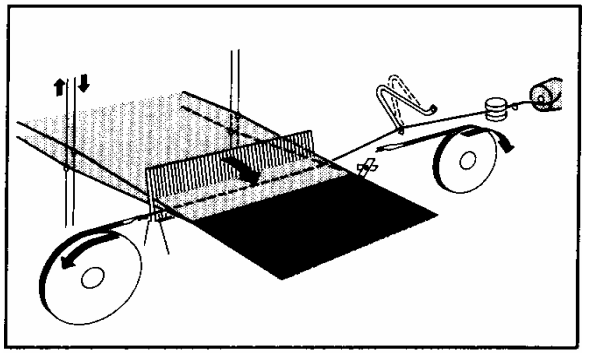
Close but contactless: high-precision positioning of the rapier head close to the reed results in clean shed separation, even with clinging warp ends and a small shed opening angle.

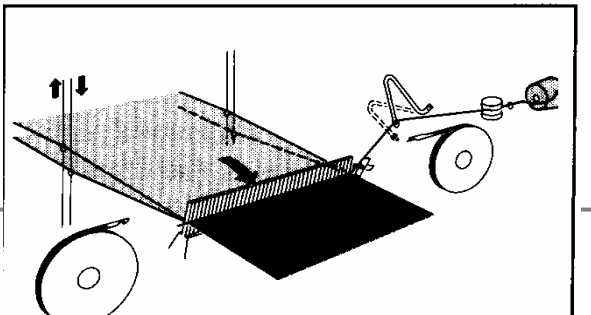
Flexible rapiers

- Advantages:
  - Less floor space requirement, spatial productivity is higher.
  - Flexible rapier band are wound on wheels or placed in n semi-circular channels when they are withdrawn outside the shed, and the result is wide working widths up to 5 m.
- Disadvantages:
  - The warp threads should not be damaged by the ribbed guides.
  - Guiding system may lead to the end breakages due to knot failure.
  - Using fancy yarns in warp direction is almost impossible.
  - By eliminating guides, there is the advantage of reducing end-breaks due to knot failure, and the weaving of fancy yarns becomes much easier because the obstructions are removed from the warp shed.
  - Wasted movement



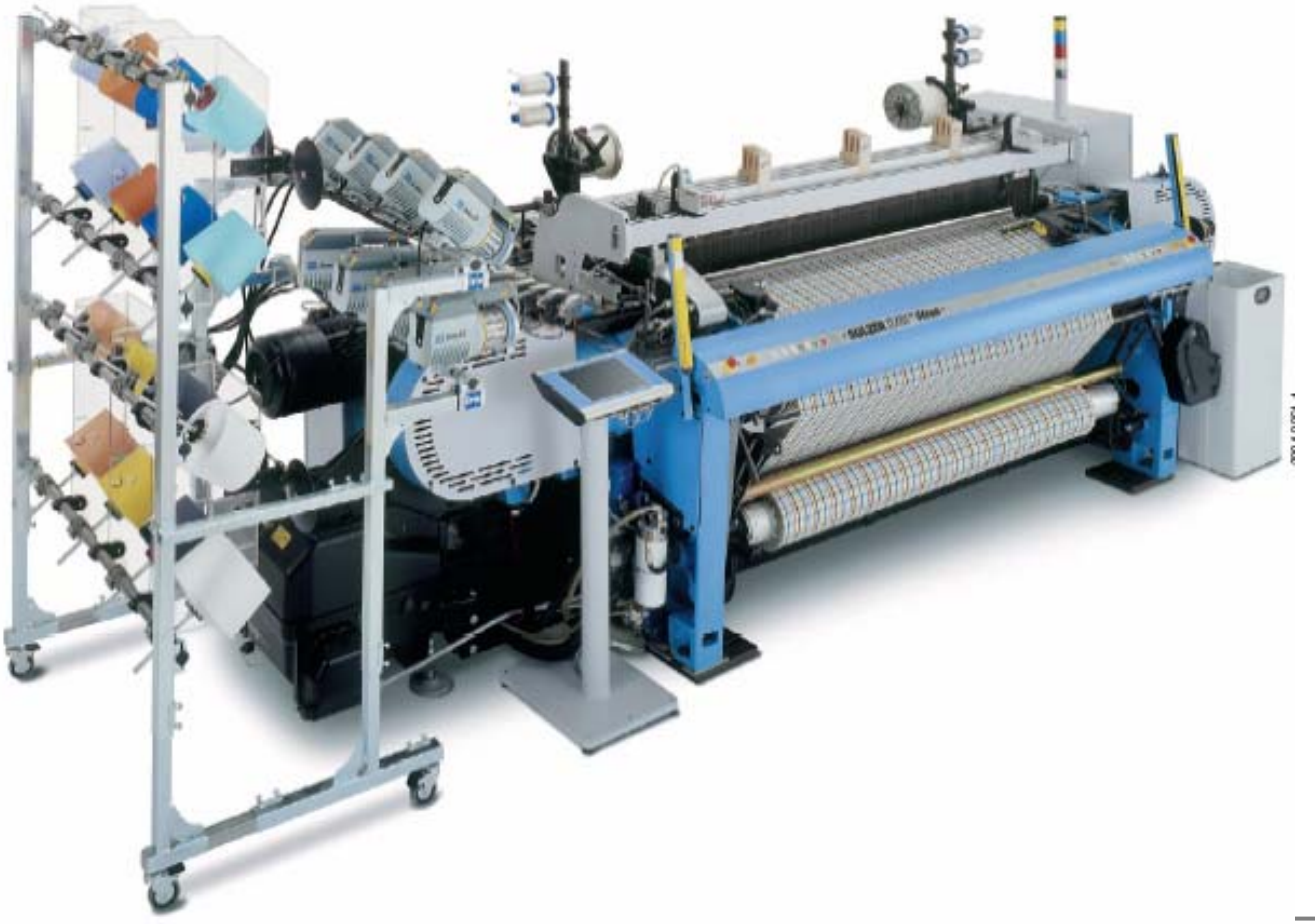






Flexible rapier weaving machine

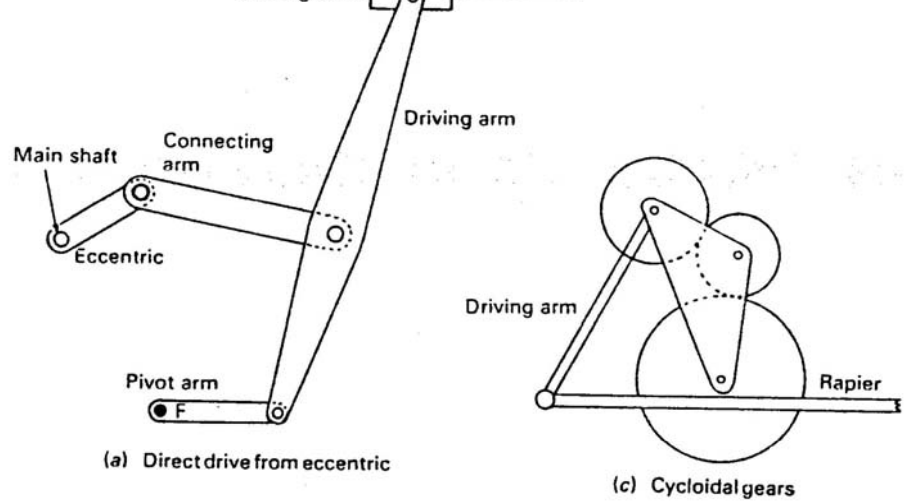
Large weft
patterning options
up to 12 colors

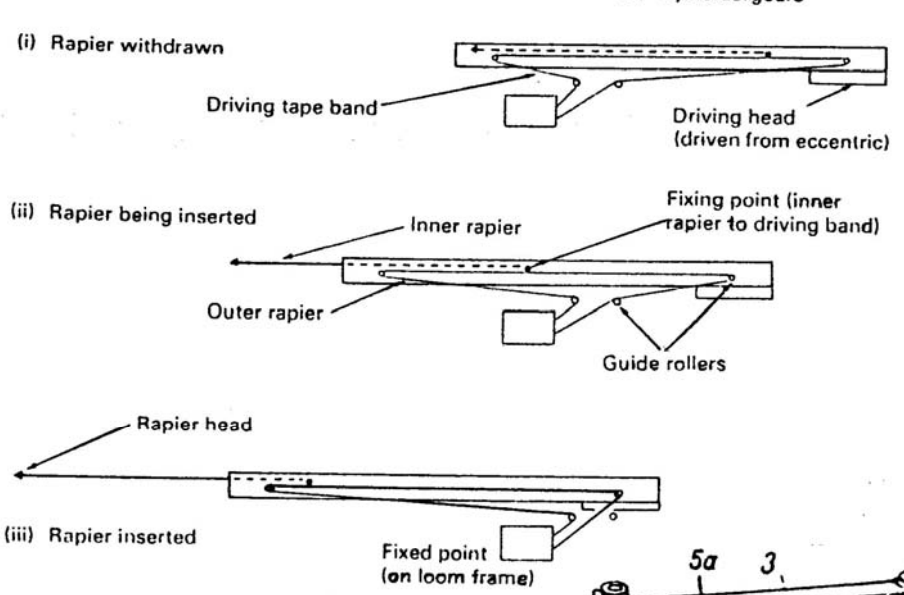


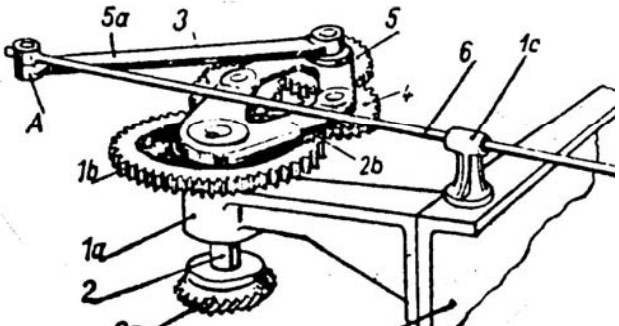
Type of rapiers: Telescopic rapiers

- The disadvantage of the large floor space requirements of rigid rapiers is removed on weaving machines equipped with telescopic rapiers.
- Space can be saved on this type of rapier drive if a compound rapier operating on the principle of **telescopic** expansion is used.
- This system is used on the Vamatex Versamat loom.
- The main outer body of the rapier is driven by the eccentric, but the inner body is fastened to a tape at its outer end. The tape is attached to a fixed point on the loom, and it passes round four pulleys.
- When the rapier is out of the shed, the inner rapier is withdrawn inside the outer rapier but, as the outer rapier is driven towards the center of the loom, the tape slides round the rollers so that the inner rapier moves in the same direction at an even faster rate.

Telescopic rapiers

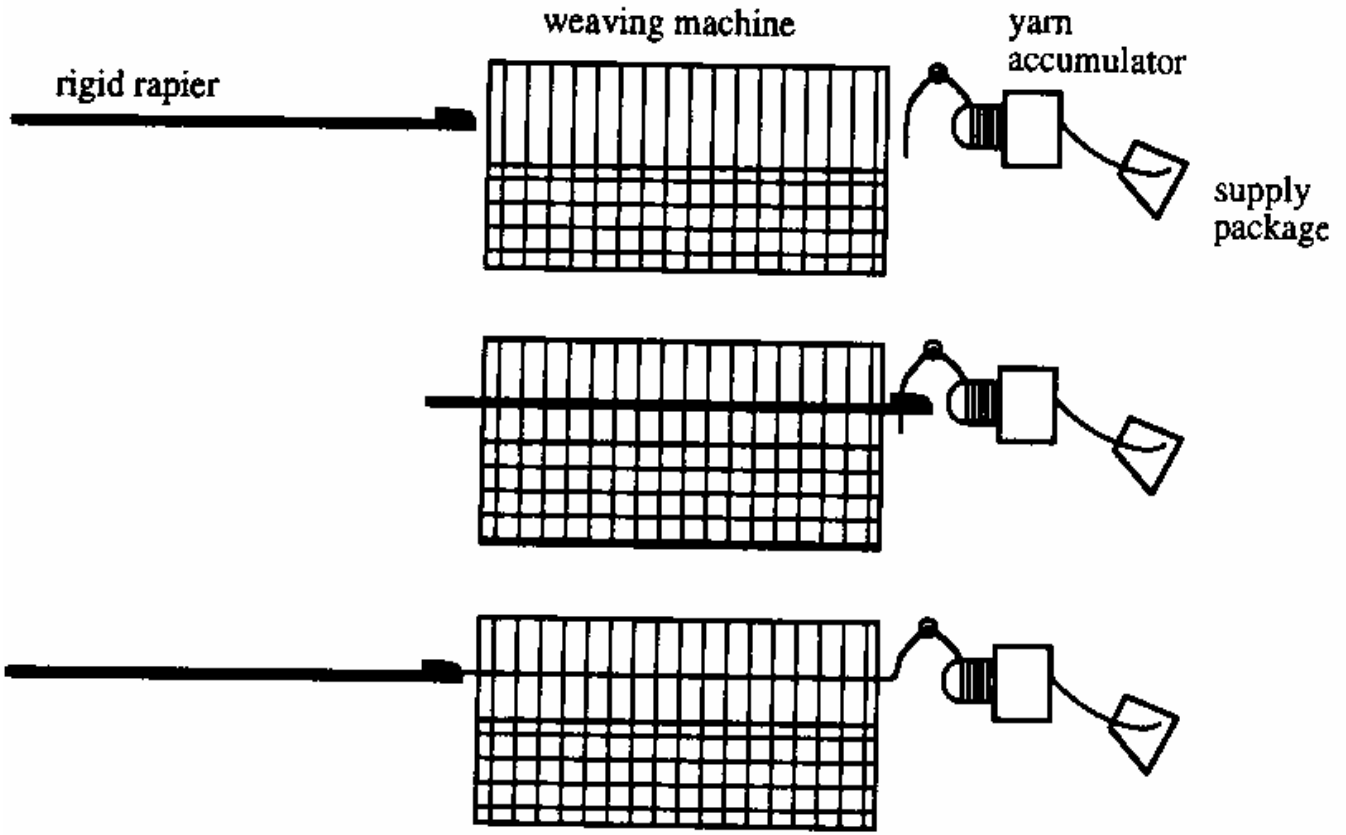






Single Rapier

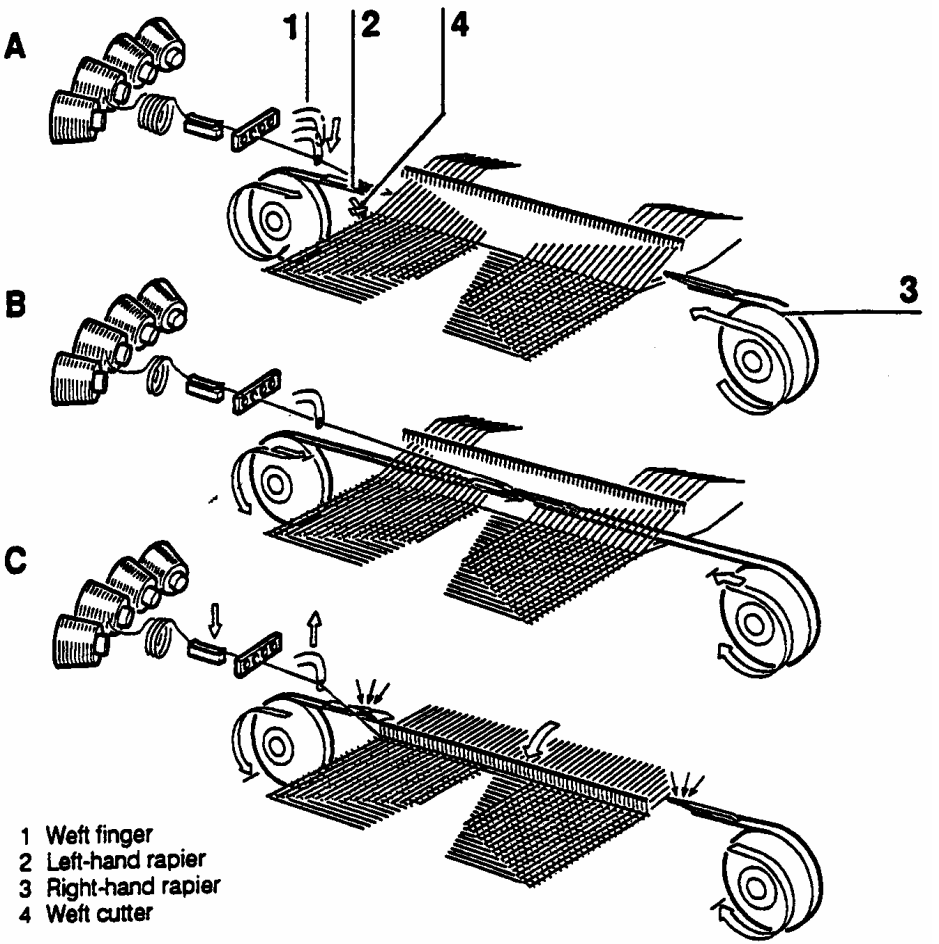
- Rigid
- a great deal of wasted movement
- slow operation
- no need to transfer the weft yarn at the center of the loom



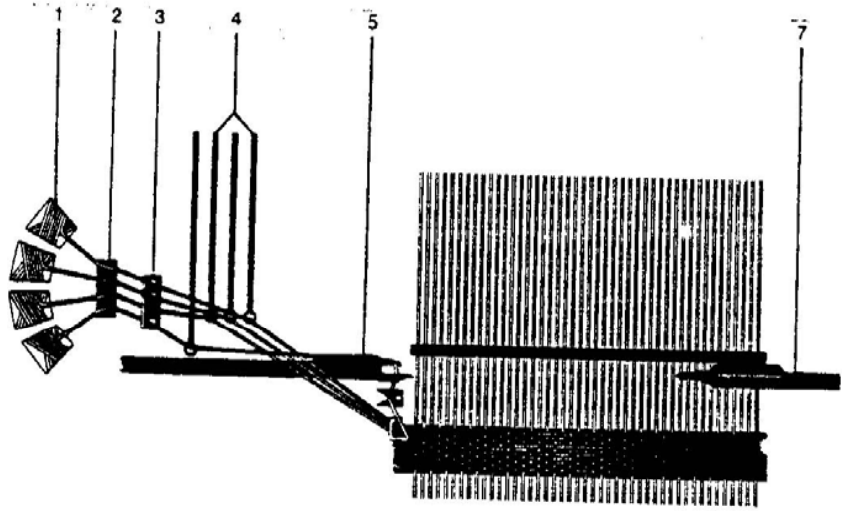
Double Rapiers

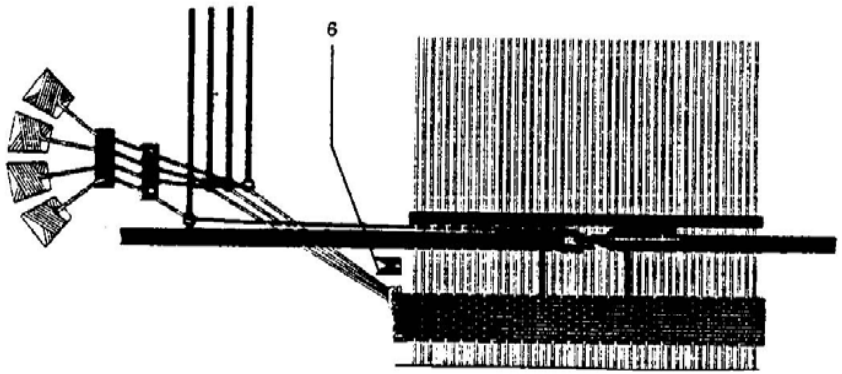
- They may be rigid or flexible.
- Two rapiers enter the shed from the opposite sides and meet at the center.
- The double rapier weaving machines are subdivided into:
  - One-sided weft insertion. One rapier is the transmitting rapier the other is the taker rapier.
  - Double-sided weft insertion. Each rapier acts alternately as the giver and the taker.
- The giver picks up the yarn from the accumulator at one side, brings it to the center of the shed, transfers it to the second rapier (taker).
- As the taker retracts, carries the yarn to the other side.
- In a twin-rapier system, two rapiers move together from the same driving source, as is necessary in face-to-face (i.e., double-plush) weaving.

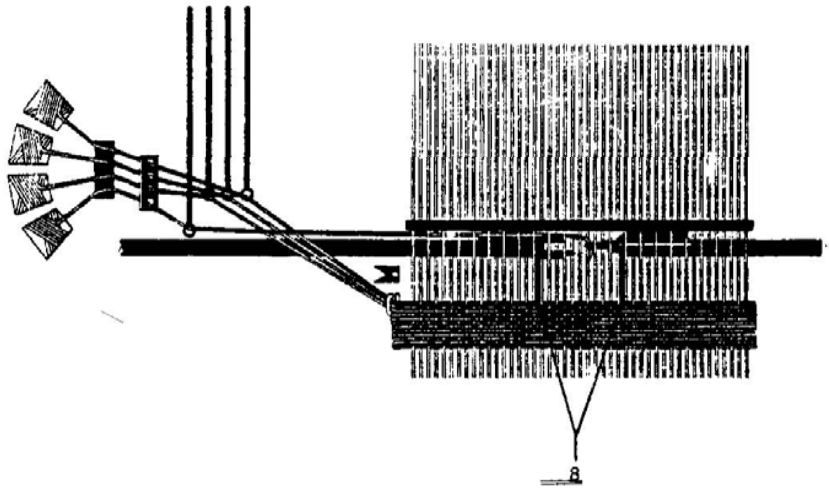
Double Flexible Rapier



Dornier rigid rapier







1-weft supply

2-weft brake

3-weft stop motion

4-weft feeders

5-left hand rapier head

6-weft cutter

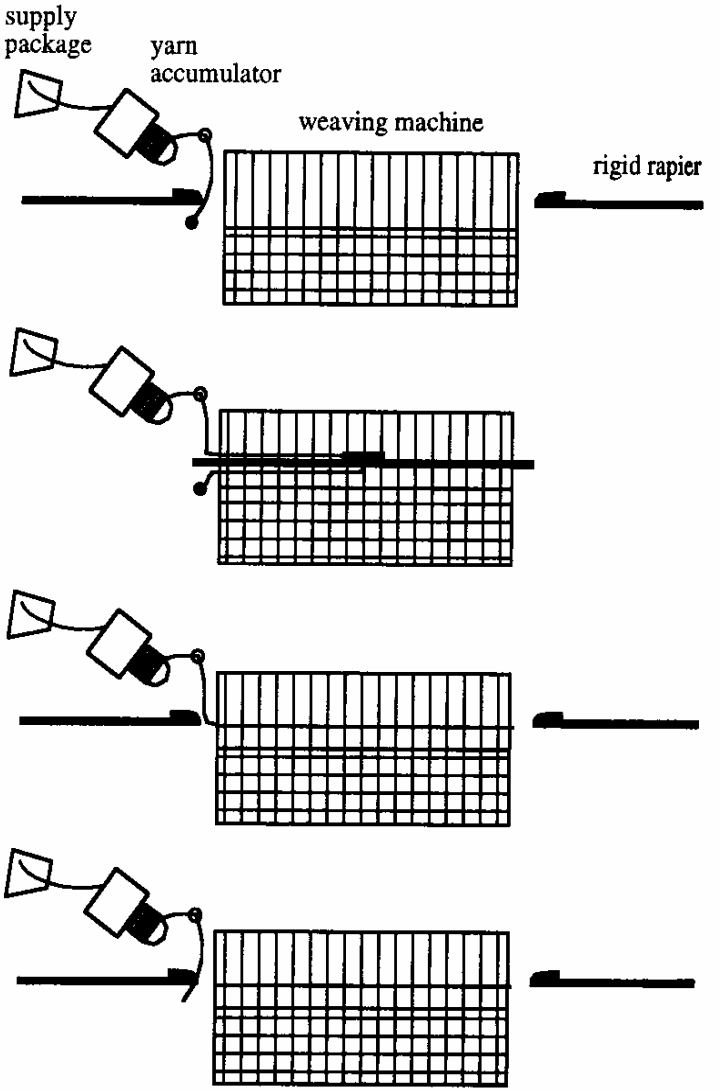
7-right hand rapier head

The method of weft insertion

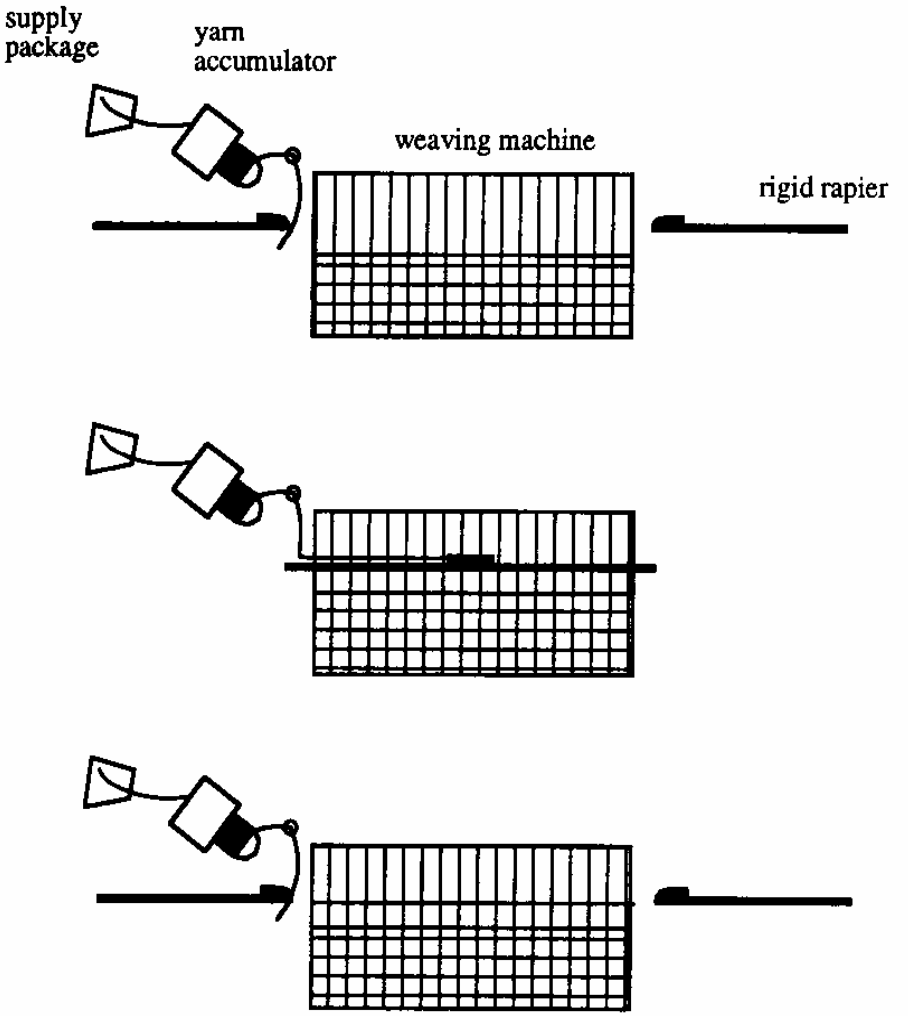
- **Gabler**
  - Weft insertion in the form of hairpin
  - The weft yarn is not firmly gripped, merely threaded round the rapier head.
  - After its transfer at the center, it is straightened as the taker retracts the shed.

- **Dewas**
  - Tip to tip weft insertion
  - The tip of the weft yarn is firmly gripped by the rapier heads during the entire period of weft insertion
  - **Type of weft transfer at the center**
    - **negative transfer:** all flexible rapiers
    - **positive transfer:** Dornier rigid rapier (gentle treatment)

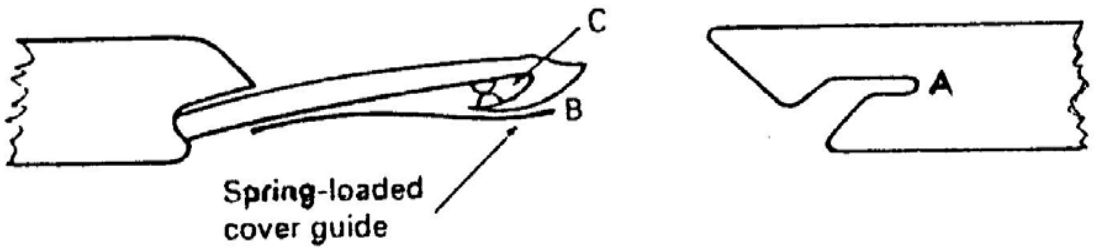
Gabler System



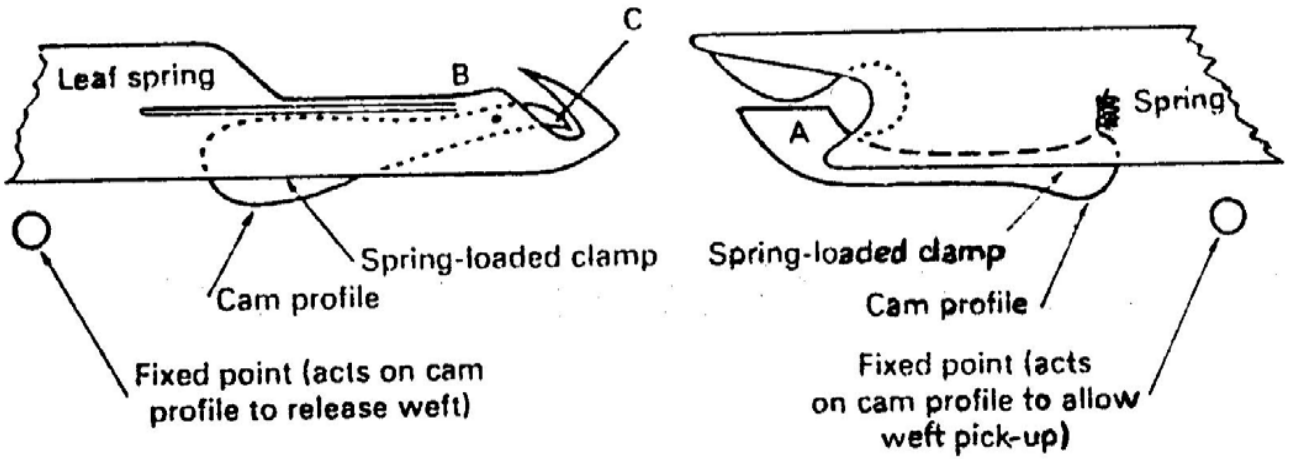
Dewas System



Rapier Heads



(A) Gabler type (Versamat)

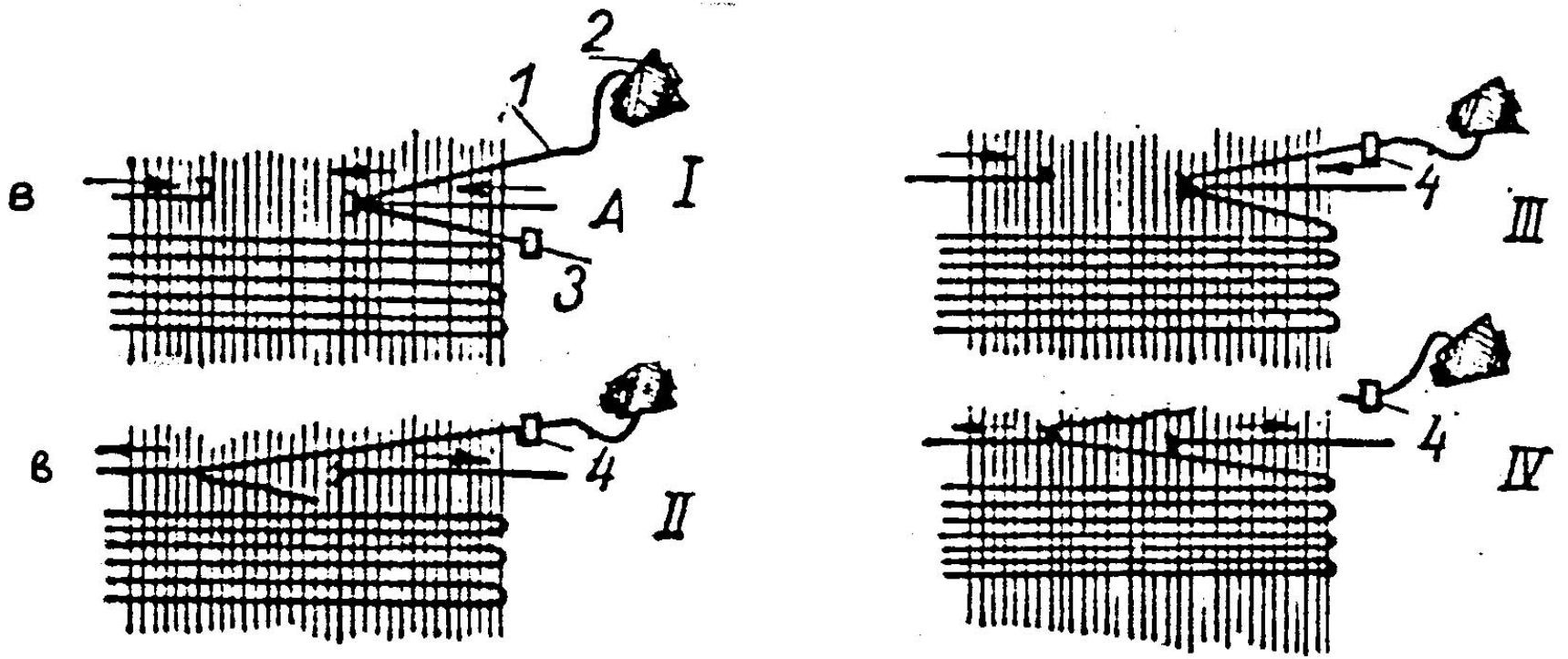


(B) Dewas type (MAV)

Rapier heads in Gabler system

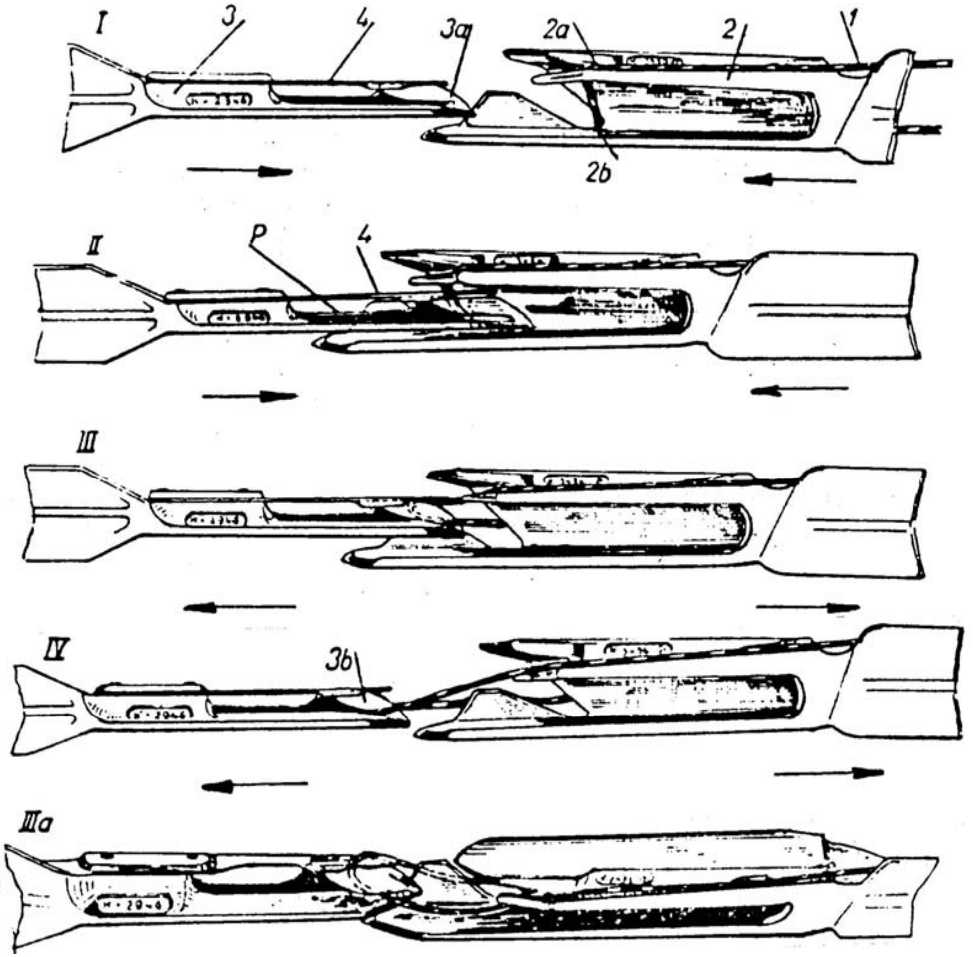
- The weft is never gripped.
- It is threaded round the cut-out *A* in the right-hand rapier head.
- As the rapier advances towards the center of the loom, the yarn is introduced in the form of a hairpin.
- When the two rapier heads meet at the center of the loom, the smaller left-hand rapier head enters the yarn-carrying right-hand head.
- The thread at A is passed under the spring-loaded cover guide at B, and, as the left-hand rapier is withdrawn, it repositions the weft at C.
- The yarn can then slide through the left-hand rapier head as it is withdrawn so that the hairpin is straightened out.

Draper system (Loop form)

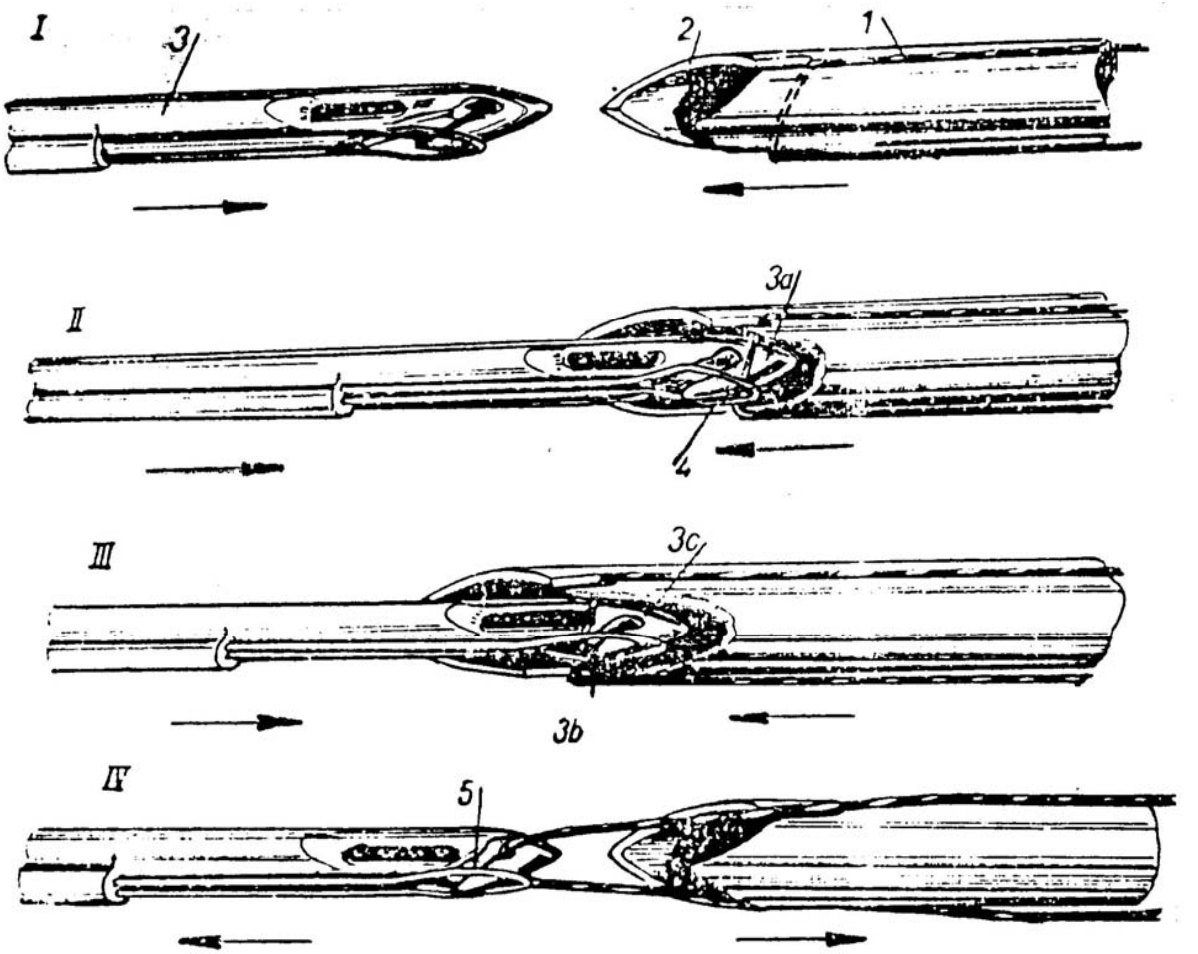


The unwinding speed of the weft thread from the supply package is twice as high as the rapier speed

Draper system (Loop form)



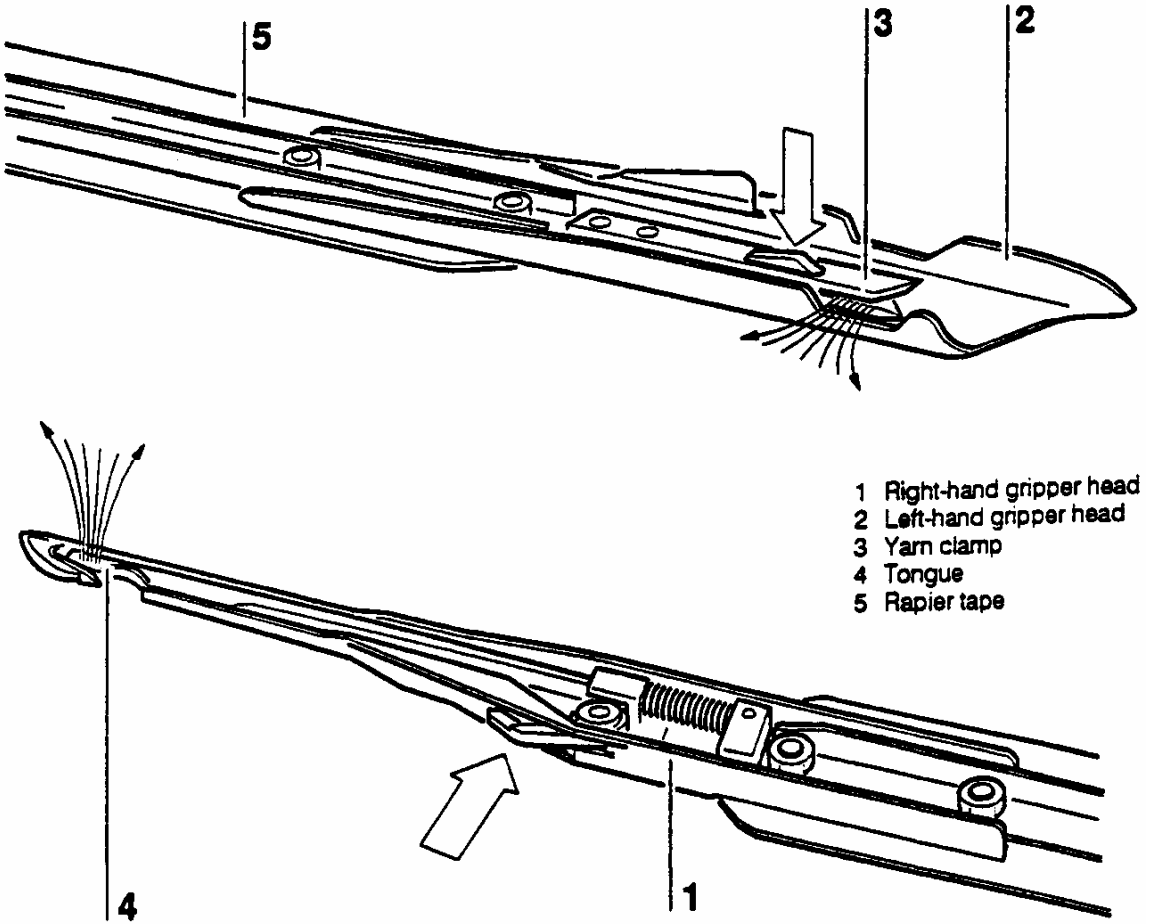
Güsken system (Loop form)



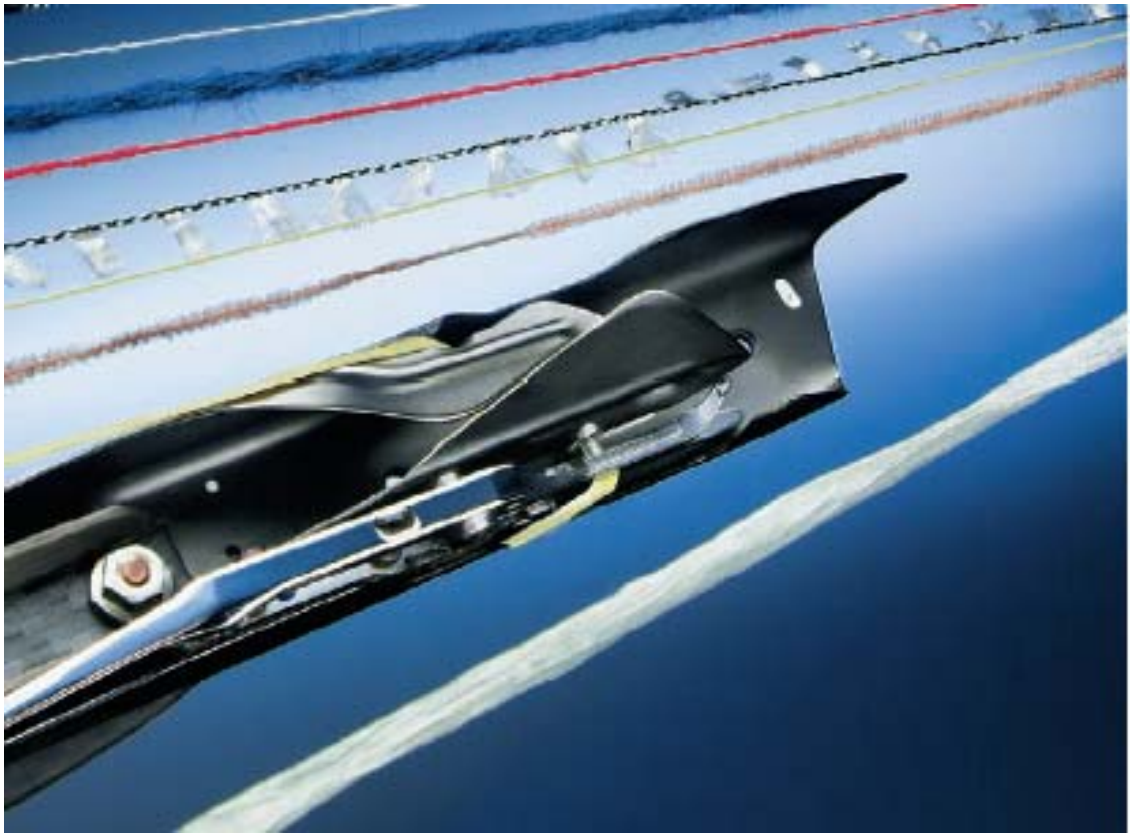
Rapier heads in Dewas system

- The yarn is gripped in each rapier head.
- The gripping unit: a fixed point against a spring-loaded clamp presses to trap the weft.
- The spring-loaded clamp has a cam profile that meets a fixed point on the loom or sley-mounting. These points open the clamps when the weft is to be picked up or released outside the selvedge.
- The right-hand head thus traps the weft at A and pulls it through the shed until the rapiers meet. The thread is then guided round point B and, as the left-hand head withdraws, the thread is trapped at C and pulled across the loom to complete insertion.
- In some looms, at time of transfer clamping points in the rapier heads are positively controlled and opened. The possibility of weft breaks at transfer is minimized. Furthermore, there is no chance of the weft's being pulled out of the receiving spring.

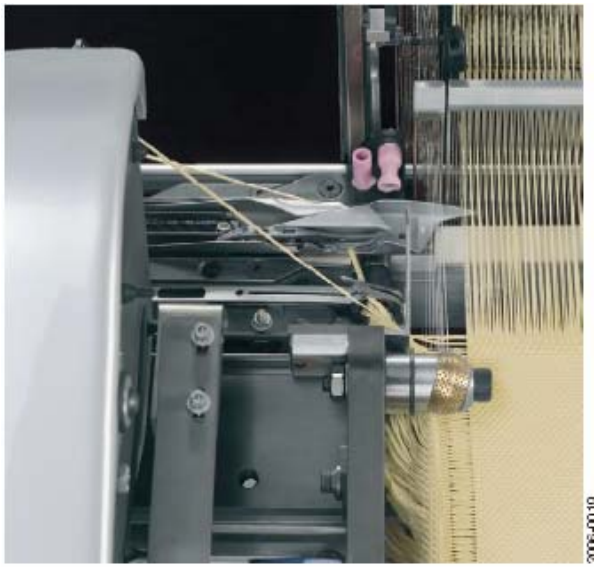
Grippers


5
3
2
1 Right-hand gripper head
2 Left-hand gripper head
3 Yarn clamp
4 Tongue
5 Rapier tape
4
1

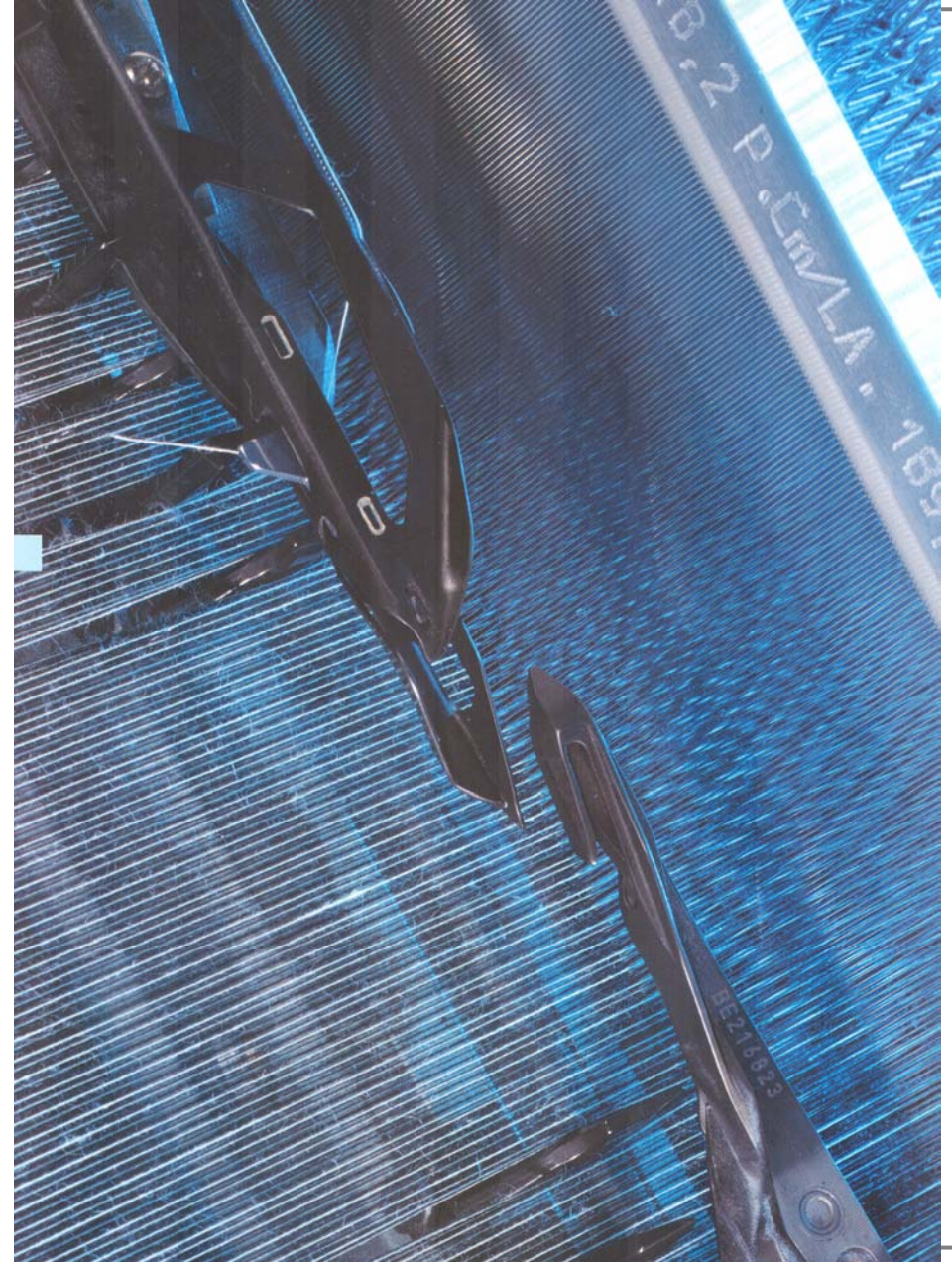
Tip to tip, negative transfer

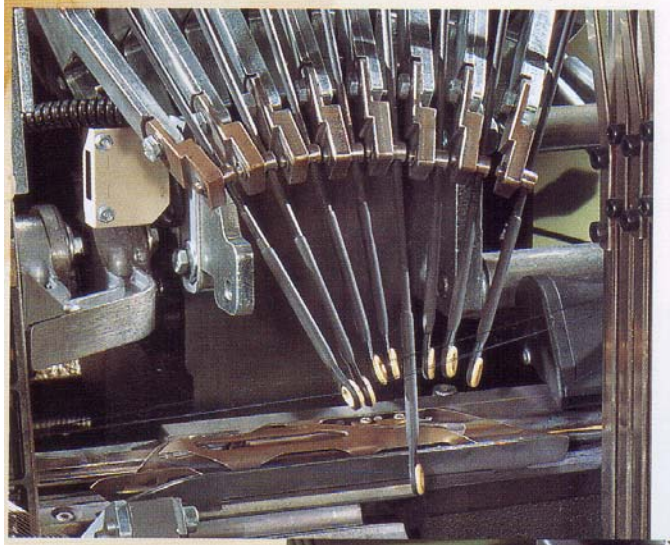


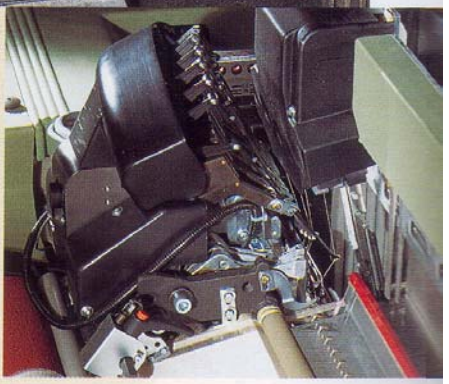
One of the G6500's major strengths: the rapier head inserts any kind of weft reliably. The compact dimensions and the small cross-section guarantee optimal running characteristics at high speeds, and thus excellent fabric quality.



the "RotoCut" electric weft cutter always cuts the weft at the best possible moment, irrespective of yarn type and material. Therefore, manual setting of the cutting time is not necessary.







Drawing on the wealth of exclusive experience that Somet has acquired in this specific field of technology and in that of linear motors, the new electronic weft selector on the SuperExcel HTP can truly be said to be at the cutting edge. The weft selector consists of modular sections, with 2, 4, 6 or 8 colours and special guiding slides for positioning the fingers at a converging point when in the "lowered/presentation" position.
This system offers an even deviation angle that improves the gripping of the weft.
Particular benefits are to be had when weaving wefts of different natures or very hairy wefts: in any case, the overall textile efficiency is improved thanks to the possibility of programming the different movement

Tip to tip, negative transfer

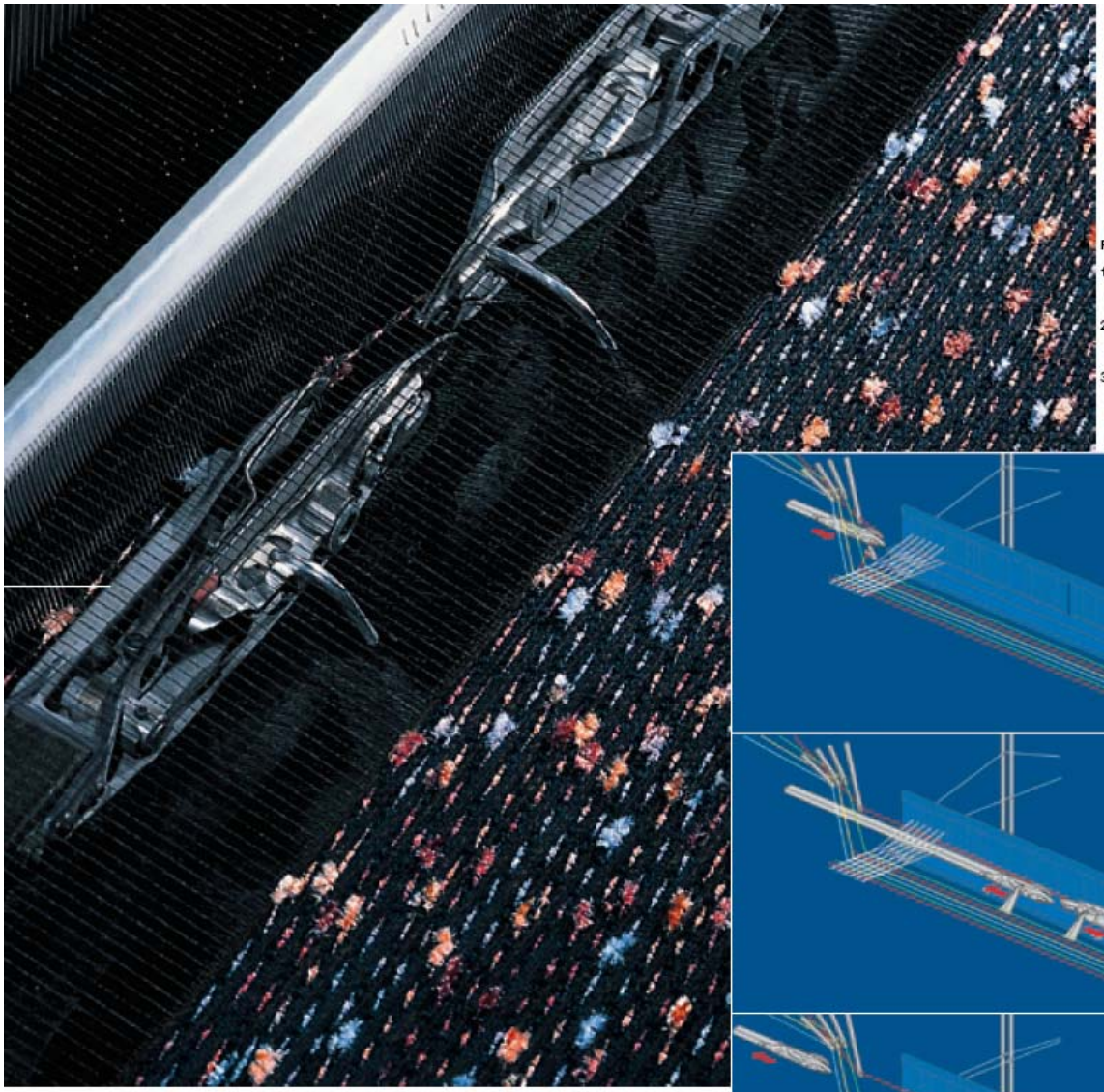
At the center the weft yarn is taken over by the right hand rapier head, gripped and pulled in the reversed direction. The pulling force is effective to transfer the pick.

Dornier Rigid Rapiers :Feeding the weft yarn to the rapier head

The filling insertion system, with positive control in every phase, facilitates the processing of the widest range of yarn types and counts – from fine silk yarns through glass rovings to the coarsest effect yarns. The count range lies between 0.77 tex and 3333 tex.

Dornier Rigid Rapiers :Positive weft transfer at the center

During the weft transfer the gripping points of the rapier heads are positively controlled and opened by the clamp openers sequentially.



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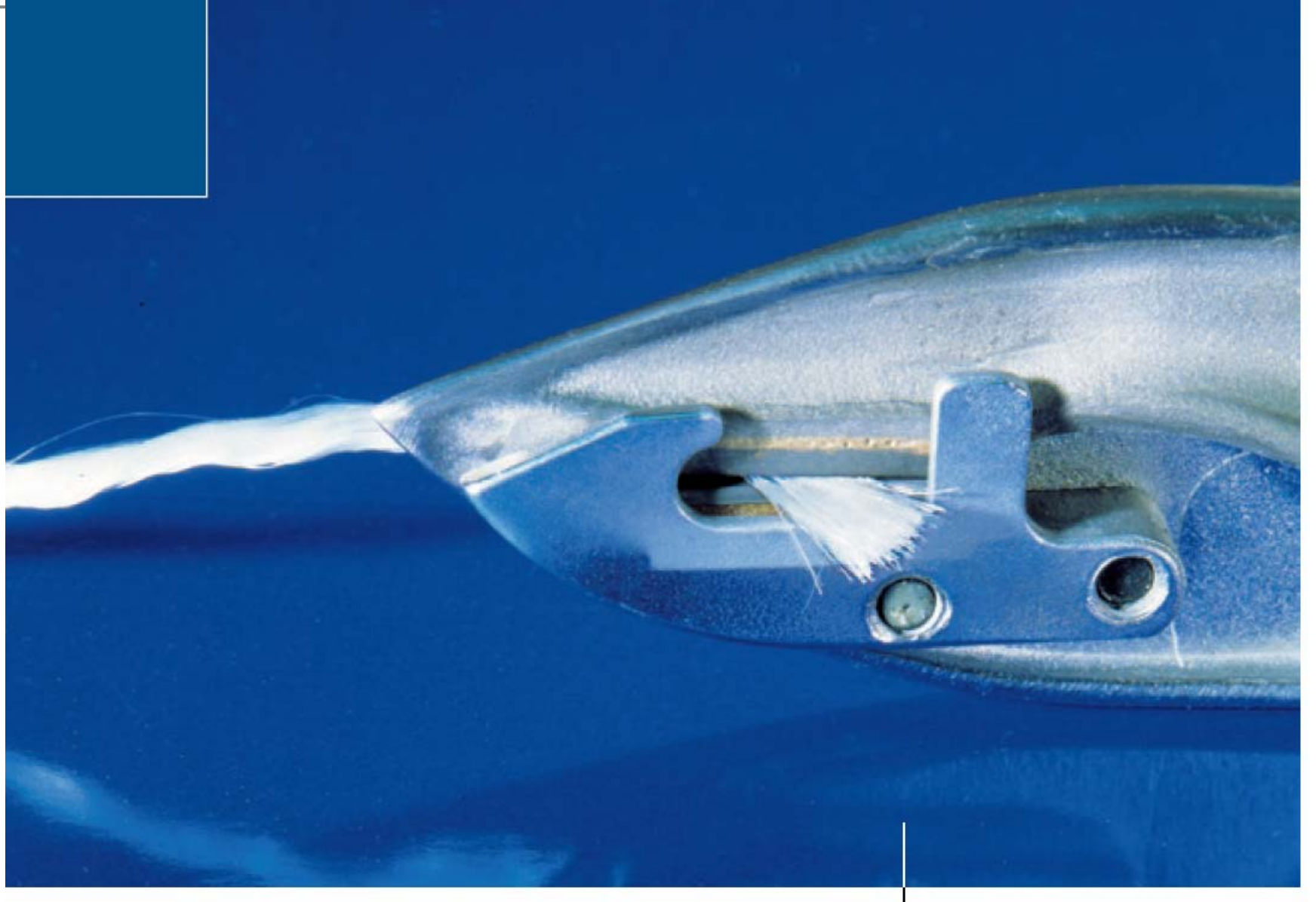
Double and multiple filling insertion, pick and pick as well, are possible with no extra setting effort. This increases the level of productivity and creates a wider range of possibilities for special patterning effects.



ison, the peak thread

Soft thread clamps with hard metal inserts and precision-controlled transfer enable even coarse filament yarns of 2200 dtex with 450 filaments to be securely clamped and inserted.

Due to the open shed filling insertion, independent of shed closing, the friction of the filling on the warp ends is decisively reduced. This results in fewer broken picks, no over tensioning, no jump-back picks, clean left and righthand selvedges and a consistent inserted pick length, all contributing to best fabric quality.

- To avoid weft contraction the upper part of the shed is closed earlier so that the weft is retained by the warp, or
- The end of the weft thread is retained by the fabric selvedge.

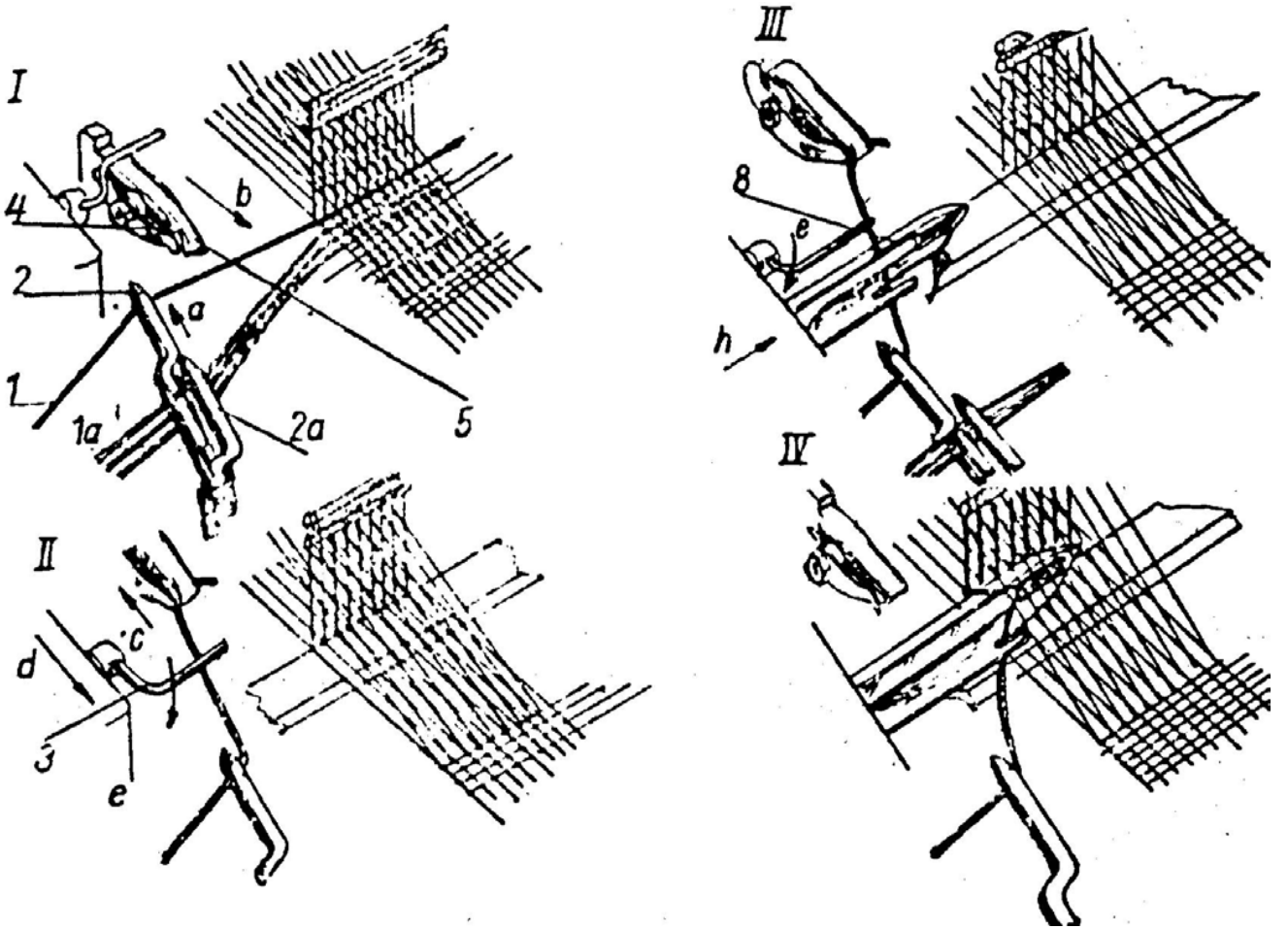
The positioning of the picking mechanism

- Machines with a stationary picking mechanism mounted on the machine frame. This requires a precise sley dwell at the rear extreme position for the whole duration of the pick.
- Machines with swing type picking mechanism moving with the sley.

Sequence of Insertion

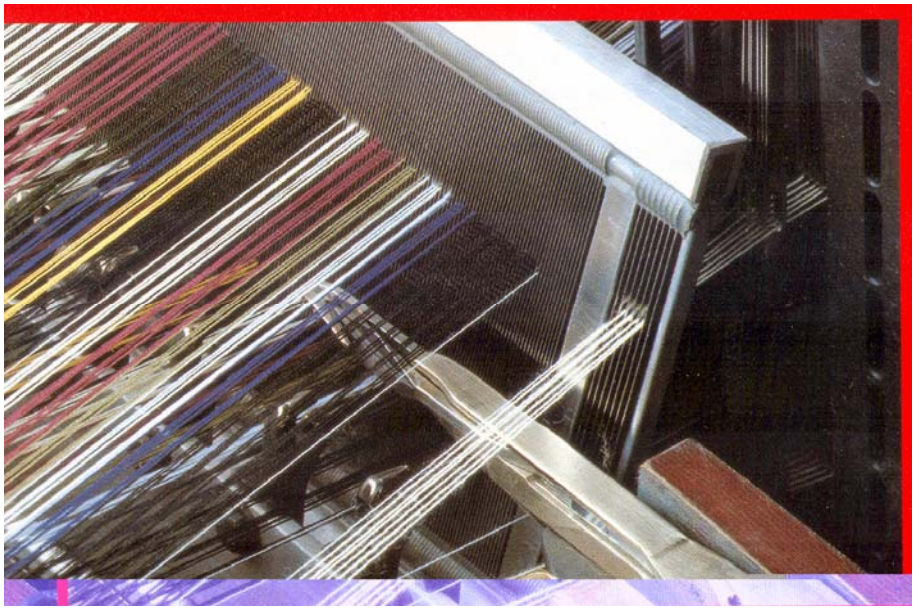
- A great advantage of the rapier weaving machines is an easy and reliable weft transmission to the giver rapier at the beginning of weft insertion.
- On the Sulzer projectile weaving machine, due to the high initial speed of the weft carrier at the beginning of its free flight, the weft must be transmitted to the carrier before its acceleration. This requires precision made mechanisms.
- As distinct from this, the initial speed of the giver rapier is very low so that enough time is available for the weft to be engaged the rapier head.
- As the weft is merely placed in the way of the rapier the weft feeder motion need not be absolutely precise.
- This also explains why the weft color change is so easy and simple on the rapier weaving machines.

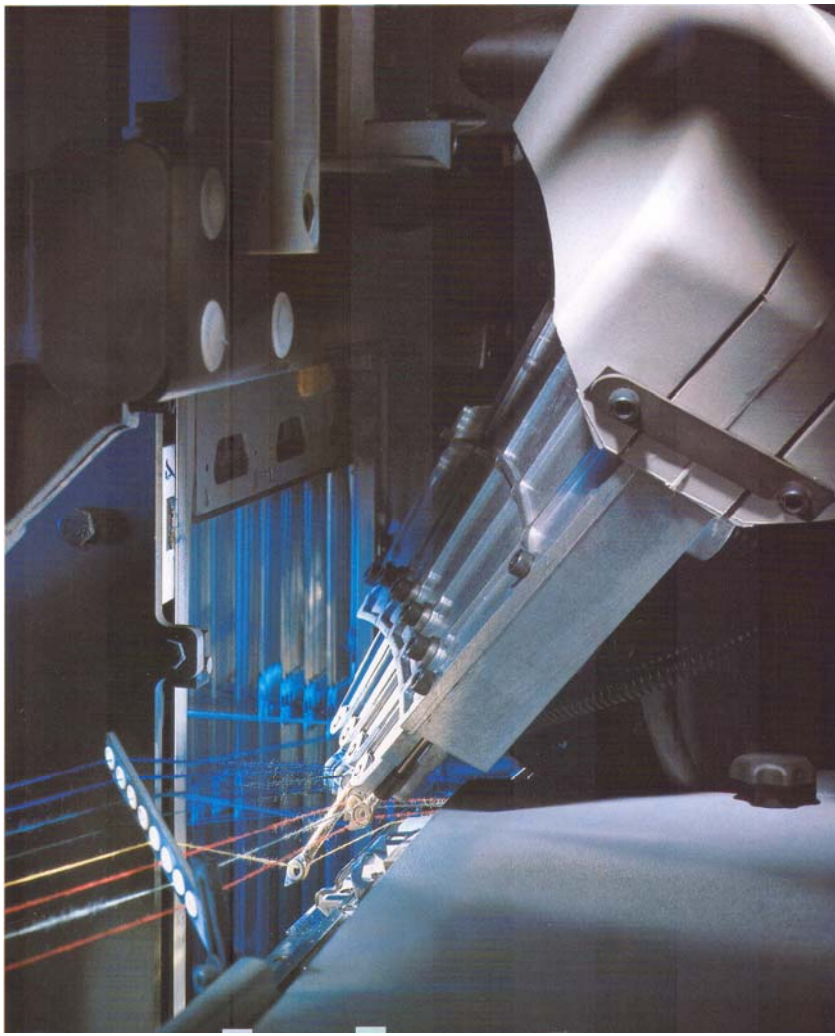
Sequence of Insertion



Picanol Gamma

Weft change is so simple.





Weft feeder displaces over a distance of mm.

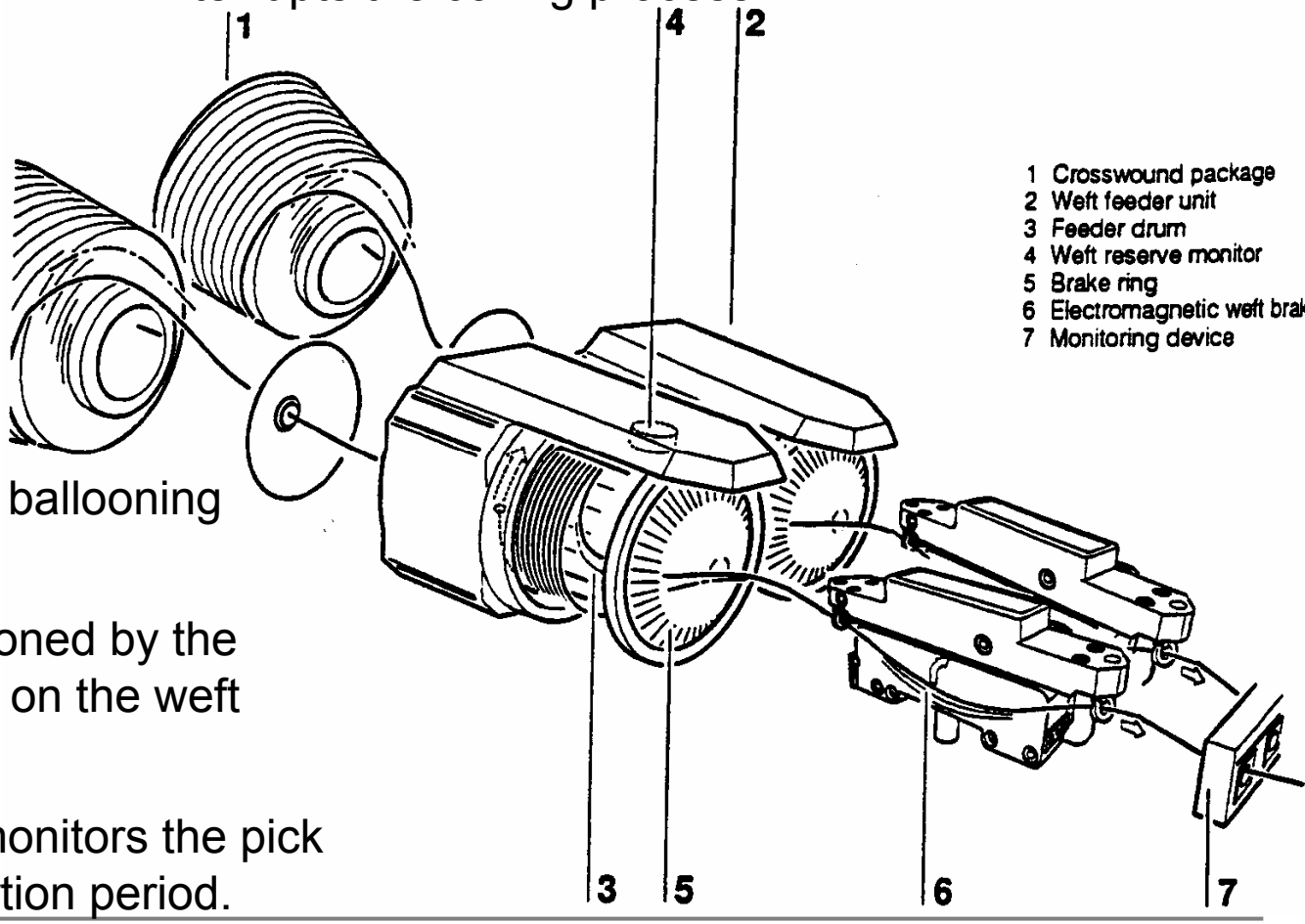
The mass of the feeder is low, a few grams.

The use of weft yarn of different color and character is easy.

Weft Feeder

Weft feeder draws the weft yarn off cross-wound package 1 and coils it onto accumulator drum at a preset speed. When a sufficiently large weft yarn supply has been wound on, weft reserve monitor 4 interrupts the coiling process

The weft yarn is always unwound from the same drum diameter at the weft insertion and thus maintains a defined weft tension.



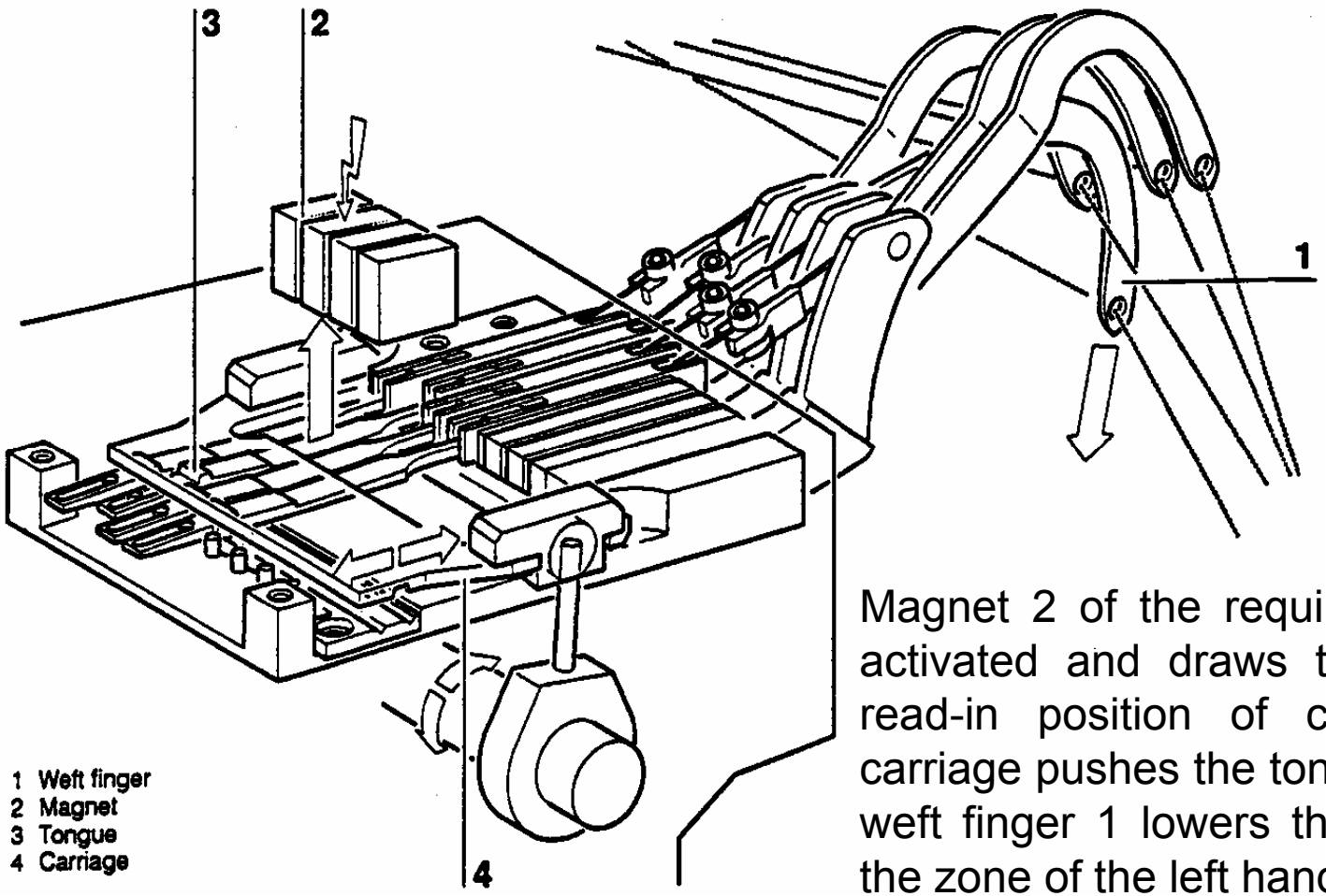
Brake ring 5 prevents ballooning during drawing –off.

The weft yarn is tensioned by the weft brake depending on the weft insertion conditions.

Monitoring device 7 monitors the pick during a defined insertion period.

Color Control

The pick sequence is determined by the fabric style and is controlled electronically.

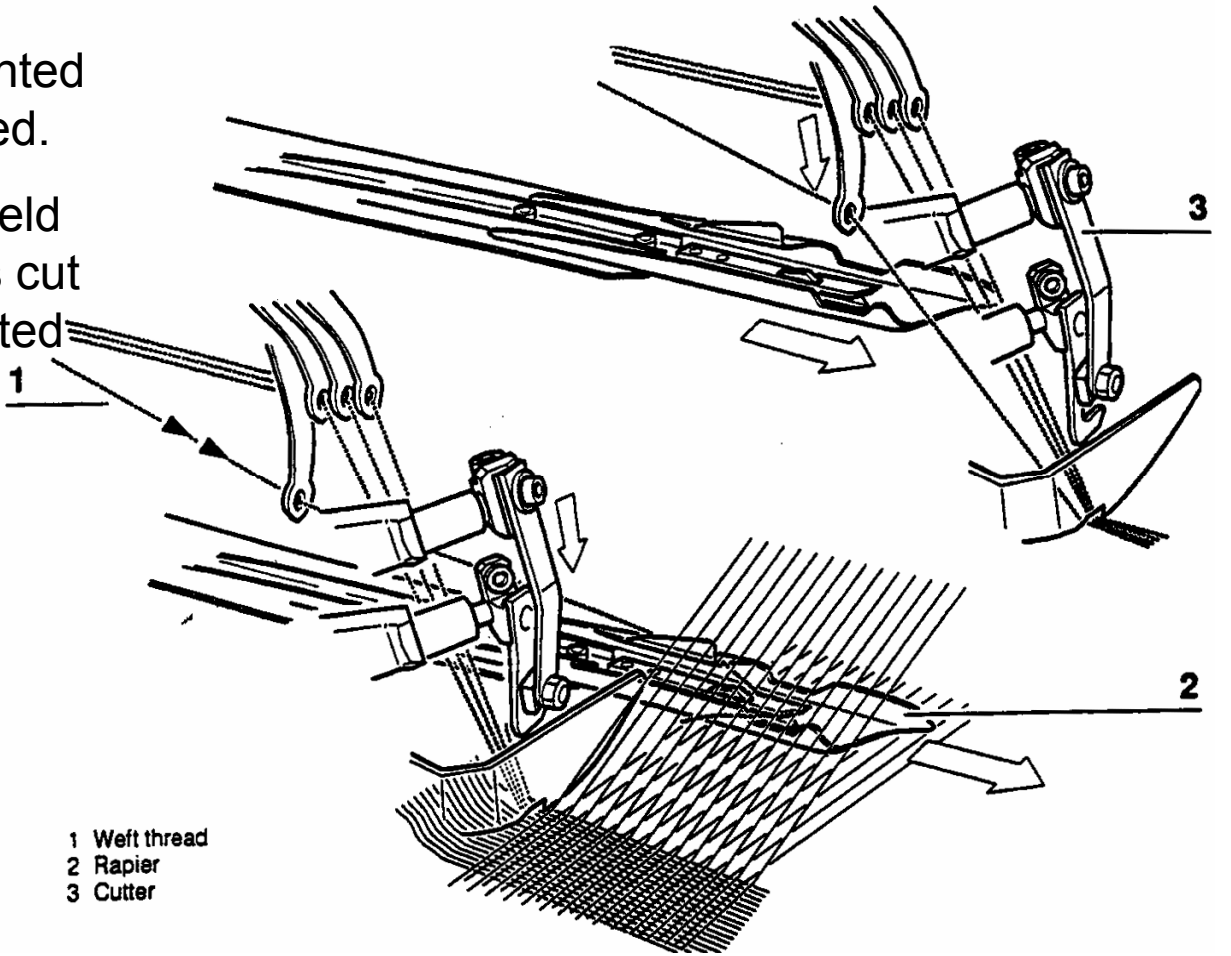


Magnet 2 of the required weft yarn is activated and draws tongue 3 to the read-in position of carriage 4. The carriage pushes the tongue forward and weft finger 1 lowers the weft yarn into the zone of the left hand rapier.

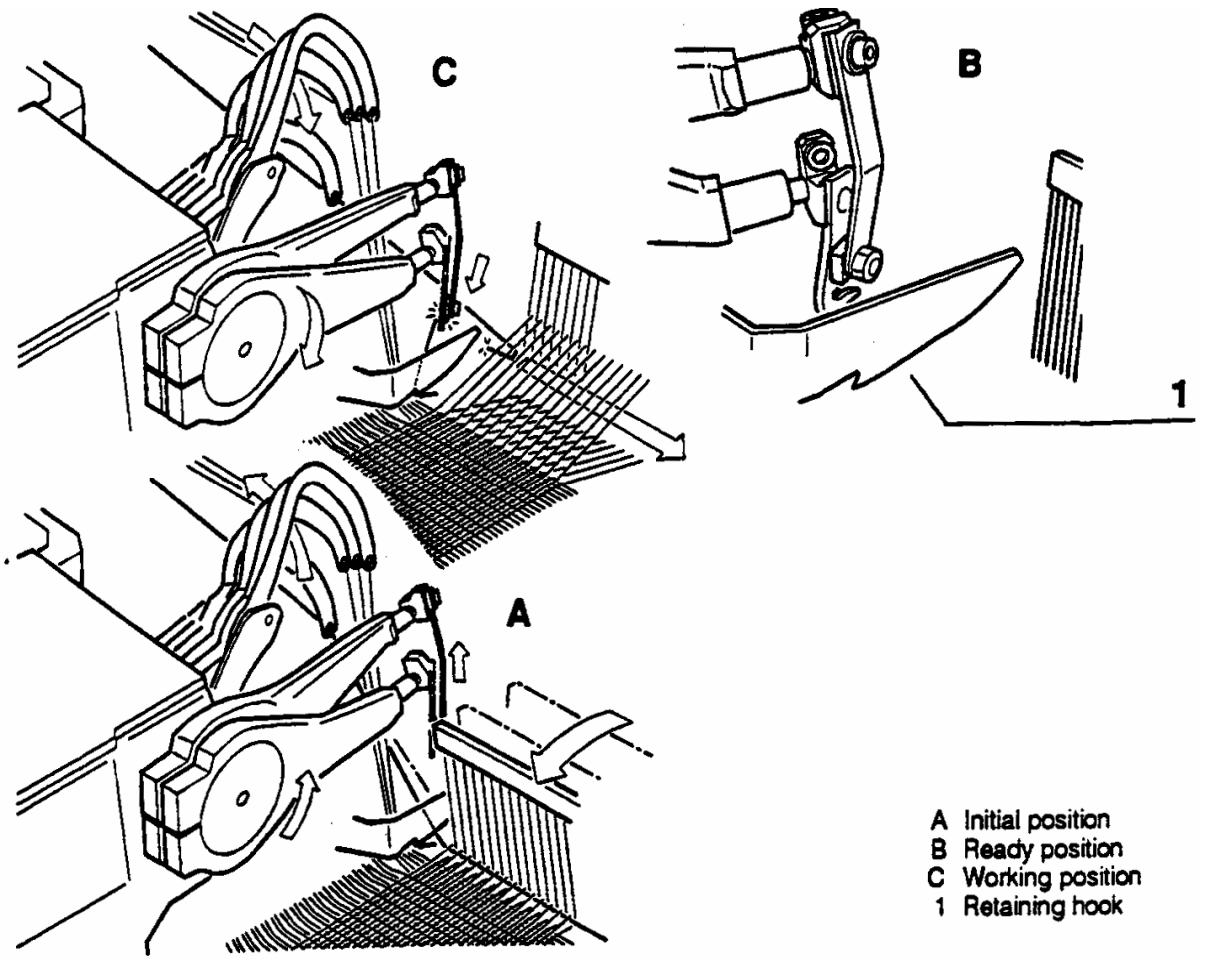
Feeding the weft yarn to the rapier head

Filling yarn 1 is represented to the rapier 2 and seized.

When the weft yarn is held in the gripper clamp it is cut off by cutter 3 and inserted by the rapier.



Filling Cutter



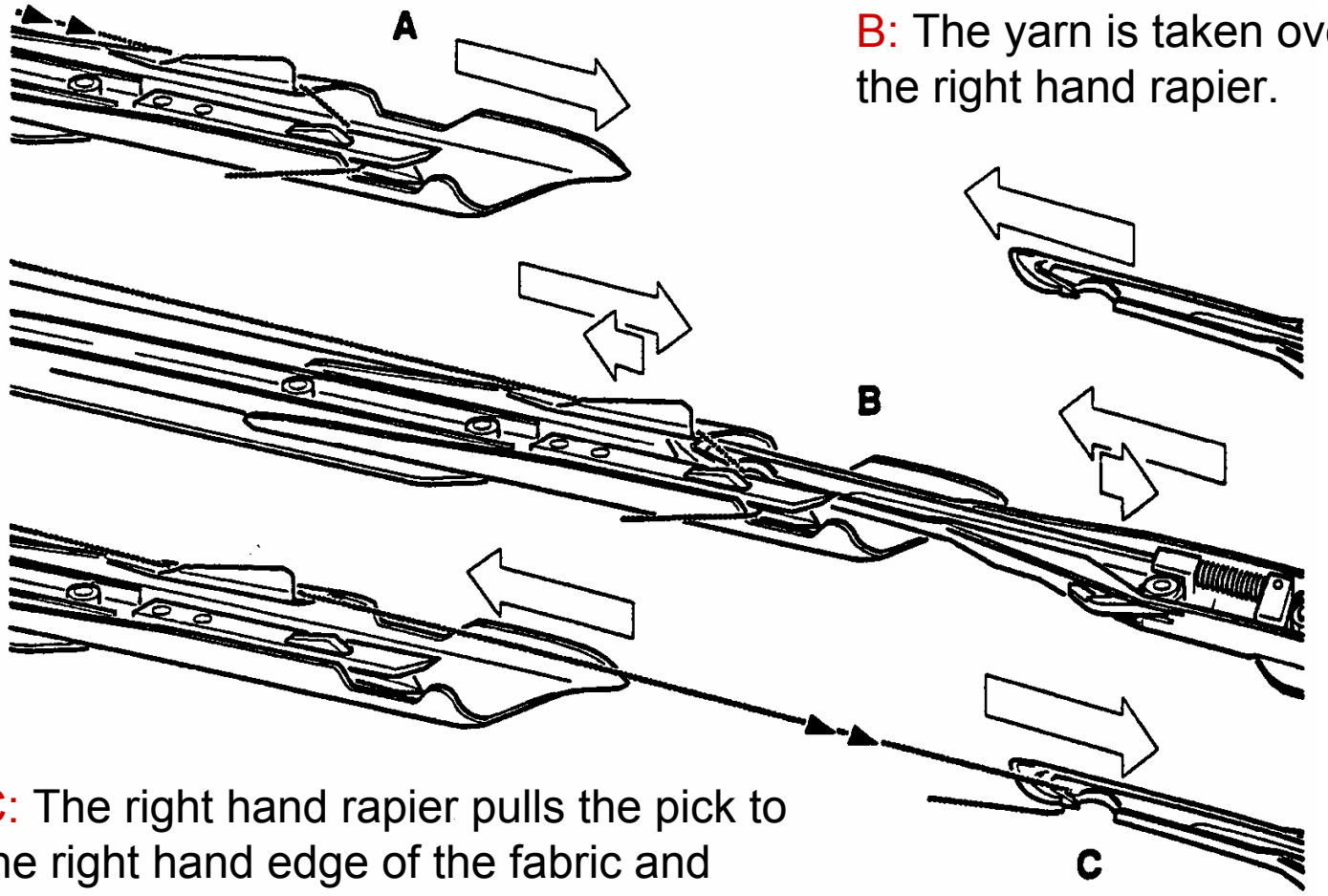
Filling yarn in waiting position is held by the retaining hook 1.

The weft yarn being inserted moves into the opening of the cutter blades and is cut as soon as the left hand rapier enters the shed.

Filling Yarn Transfer

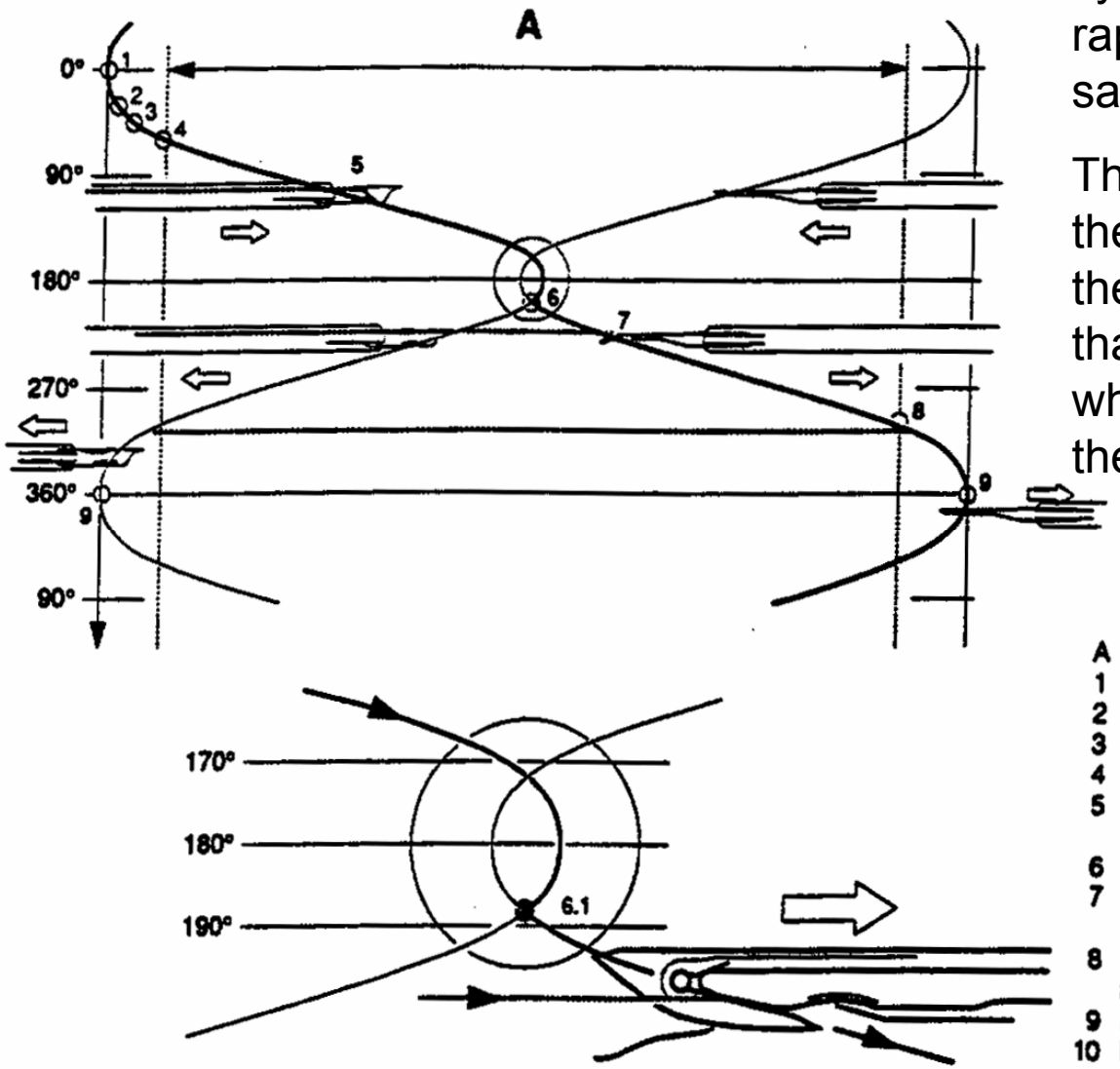
A: Left hand rapier takes the pick with the accelerated and decelerated speed into the middle of the weaving machine

B: The yarn is taken over and gripped by the right hand rapier.



C: The right hand rapier pulls the pick to the right hand edge of the fabric and releases it.

Rapier Movements

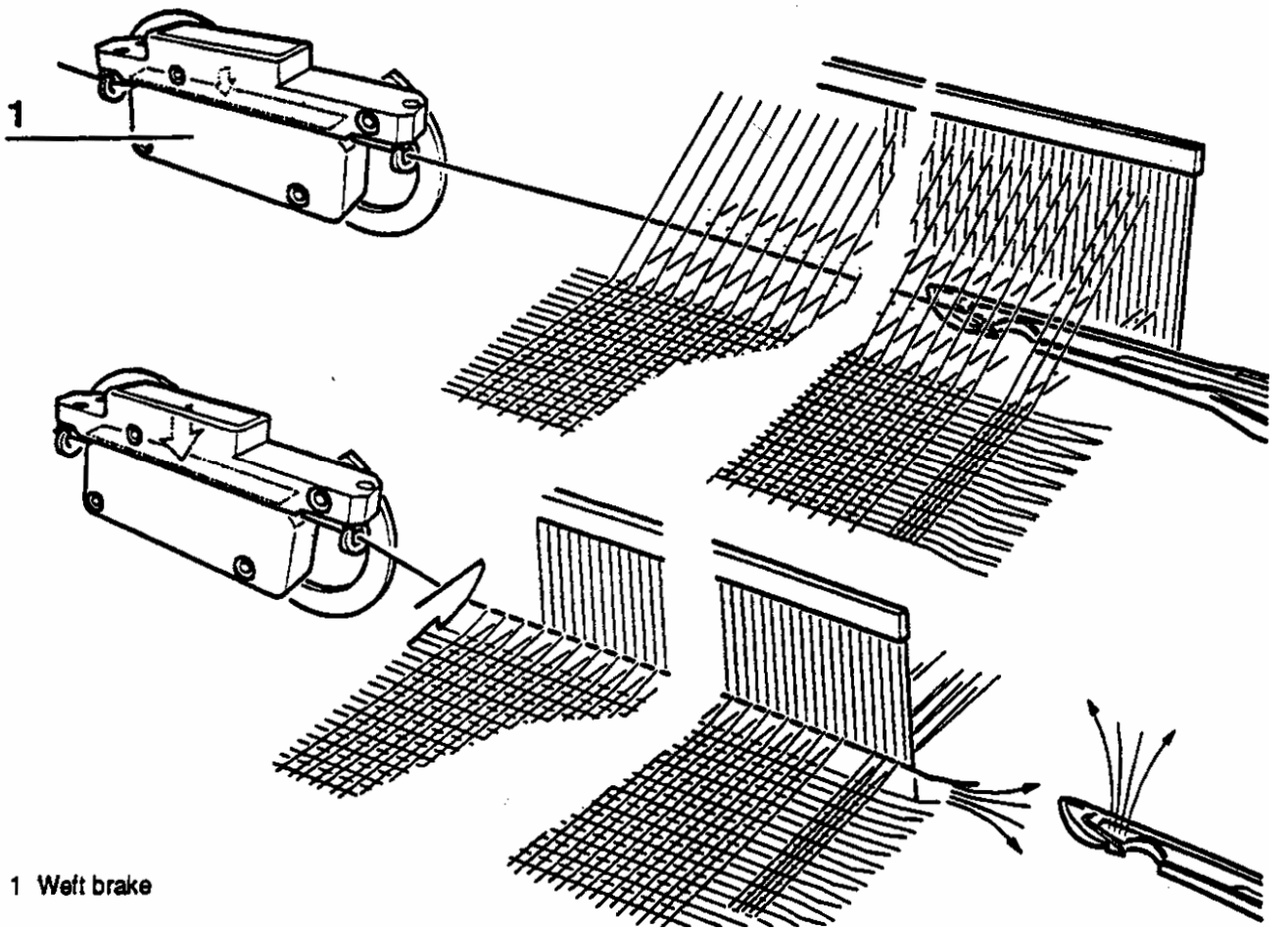


A Cloth width
1 Start of rapier motion
2 Presenting the pick
3 Seizing the pick
4 Cutting the pick
5 Maximum speed of the left-hand rapier
6 Pick transfer
7 Detailed diagram of pick transfer
8 Maximum speed of the right-hand rapier
9 Releasing the pick
10 End of rapier motions

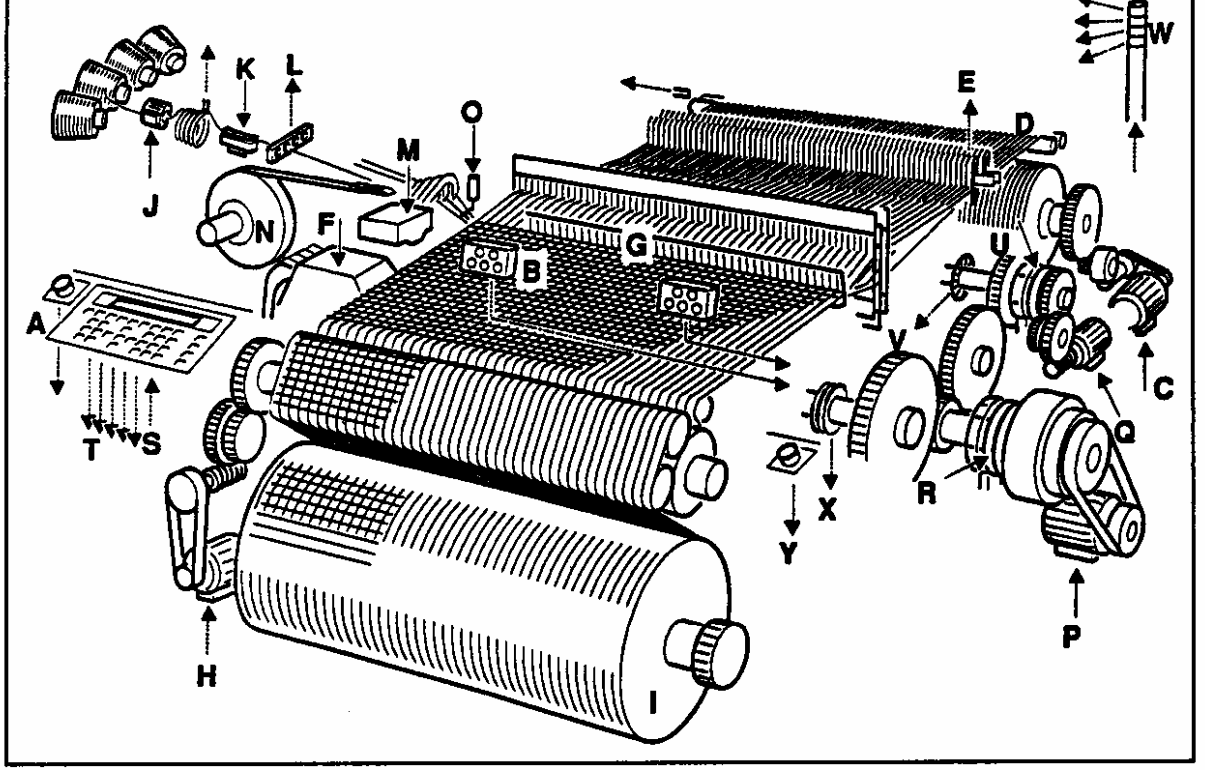
The rapier movements are synchronous, i.e., both rapiers start to move at the same crank position.

They meet in the middle of the weaving machine and their movements overlap so that pick is transferred when both rapiers are on their way back.

Weft Brake



1 Weft brake



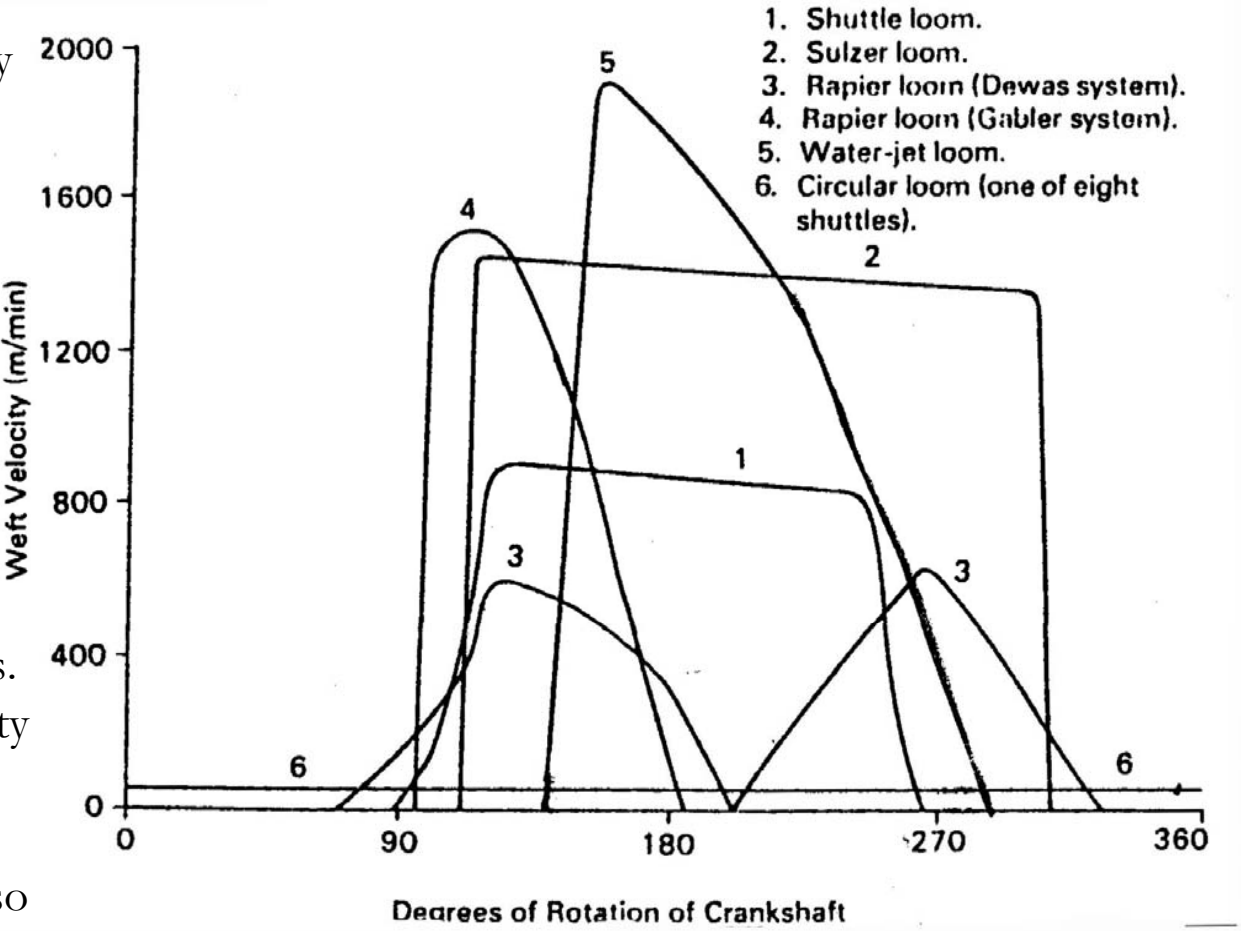
Overview of subunits

A	Operator and display terminal
B	Operating keyboard
C	Warp let-off
D	Warp tensioner
E	Warp stop motion
F	Shedding mechanism
G	Sley drive and reed
H	Cloth take-up
I	Cloth wind-up
J	Weft feeder
K	Weft brake
L	Weft monitoring
M	Pick sequence control
N	Tape wheel with rapier tape
O	Weft yarn lifter
P	Main motor
Q	Creep speed motor
R	Clutch and brake
S	Input of fabric and machine-specific information
T	Communication between terminal and weaving machine
U	Pick finder clutch
V	Crank angle transmitter
W	Signal column
X	Synchronization monitoring
Y	Emergency stop button

Weft velocities

Rapier movement is basically SHM, but in many instances this is modified to achieve a higher rapier velocity in the early and late parts of the movement and thus a lower maximum velocity halfway through the movement.

In the Dewas system, weft withdrawal from the supply package occurs in two stages. In Gabler system, the velocity of the weft during the first half of the pick rises rapidly from zero to a value that is so high that weft breaks are likely to occur more frequently.



The rapier drive

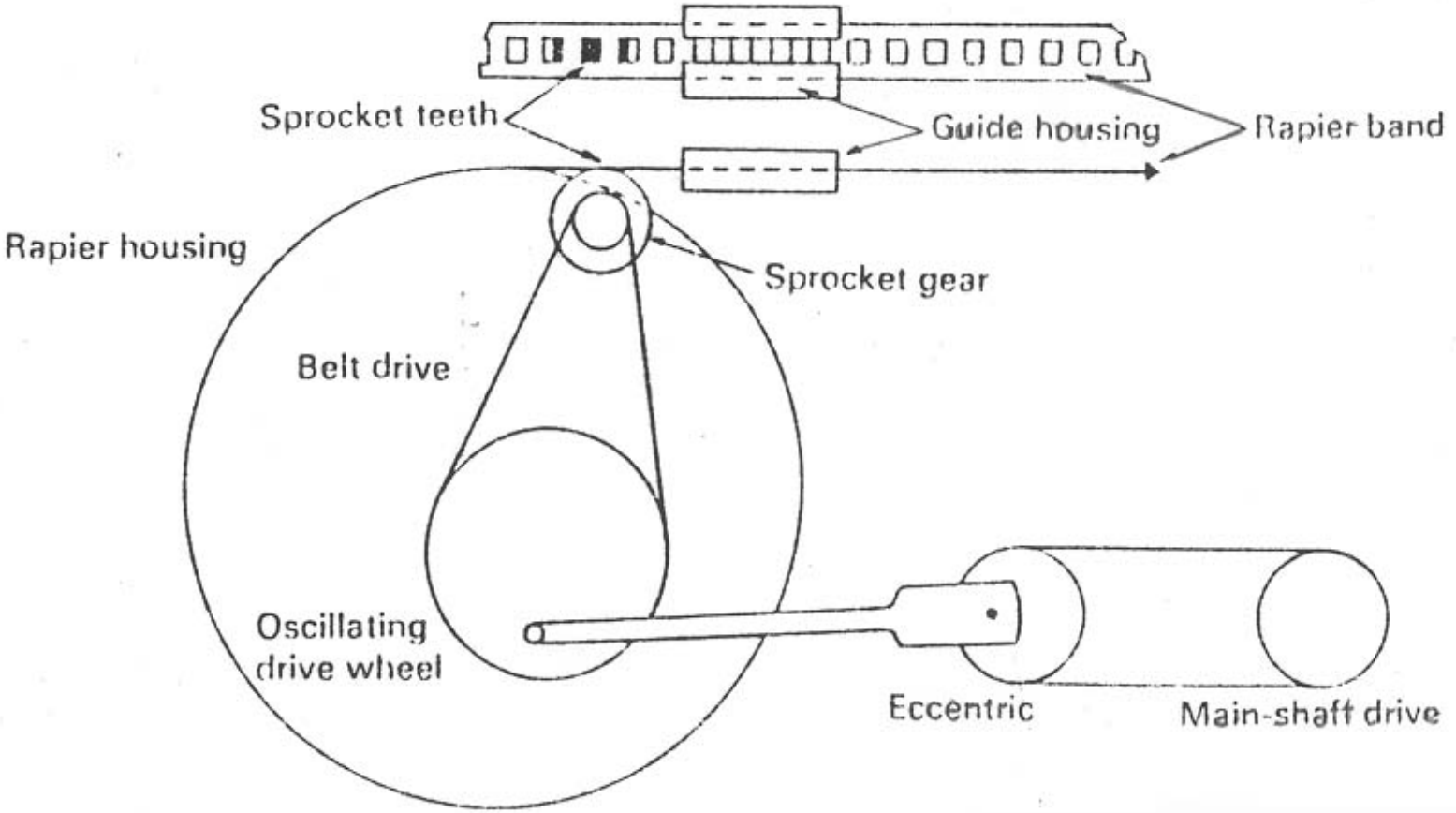
- The rapier motion is mechanically linked with the machine motion,
- The rapier motion is completely under control, thus the position of the weft yarn at any instant during picking is exact.
- There are various attempts and alternatives to drive the rapier.
- Systems are still changing to obtain a smooth picking operation at high loom speeds.

The rapier drive

- The rapier drive should ensure a gentle treatment to the weft yarn while it is being picked up by the giver rapier or while it is being transferred between rapier heads.
- The rapier head acceleration and its speed are important since the type of motion results in high forces acting in the body of the yarn.
- If the forces exceed acceptable limits, the weft yarn breaks off.
- The unwinding speed of the weft yarn is determined by the rapier movement.

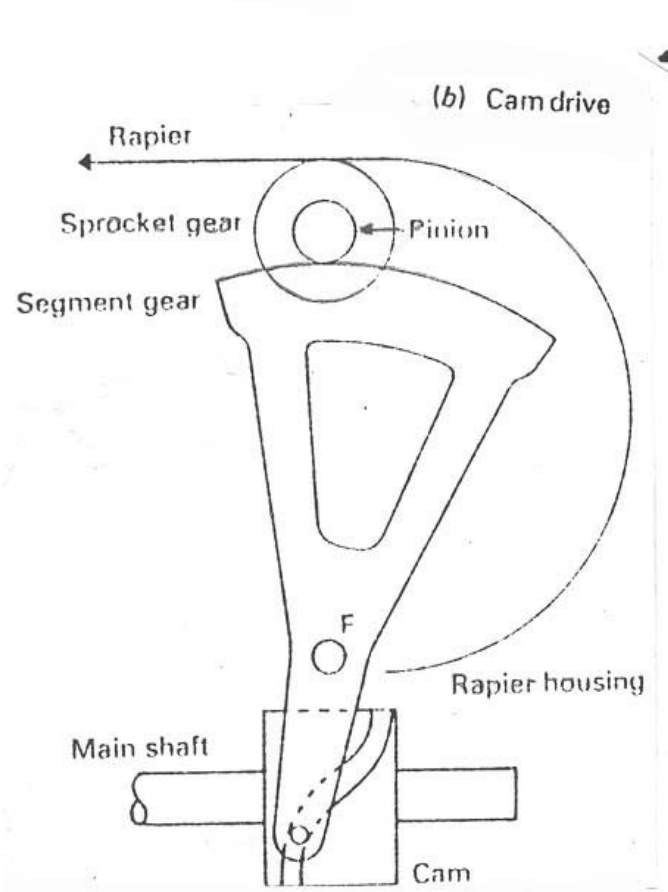
The flexible rapier drive from oscillating sprocket

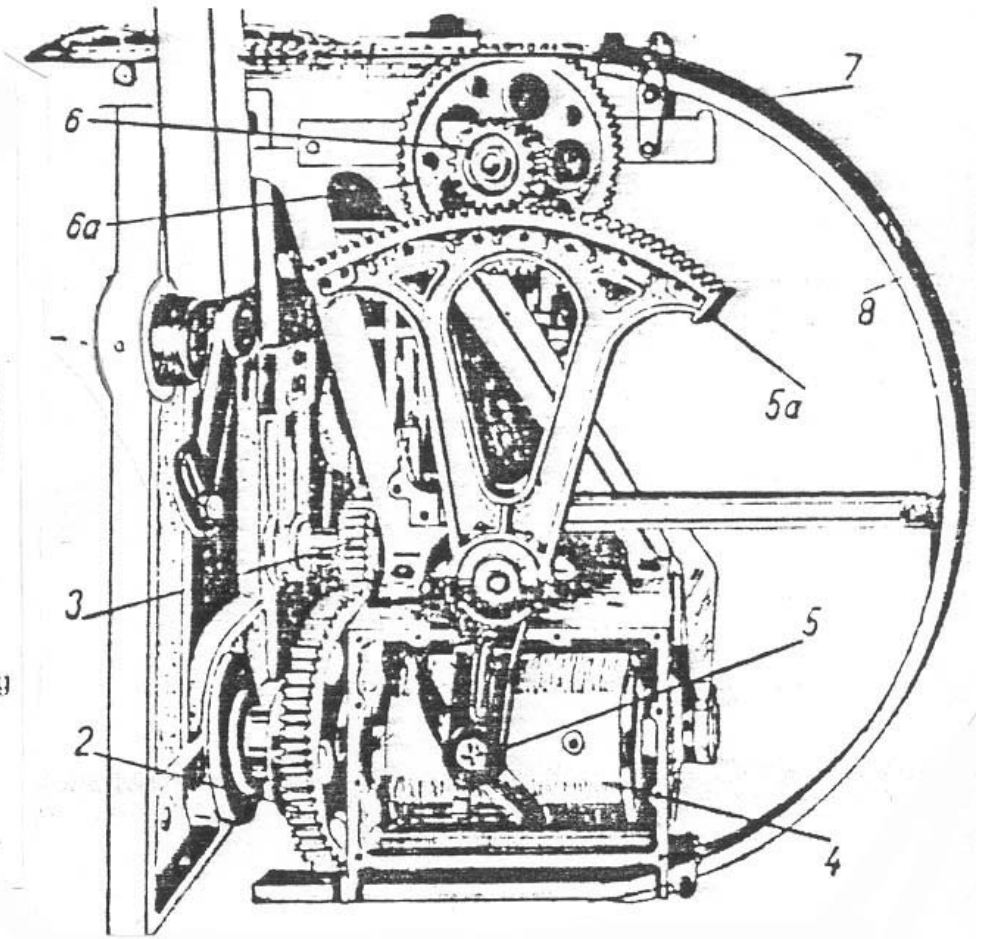
The teeth of the sprocket pass through holes in a driving band. The reciprocating movement may be given to the sprocket by a crank arrangement



(a) Eccentric drive

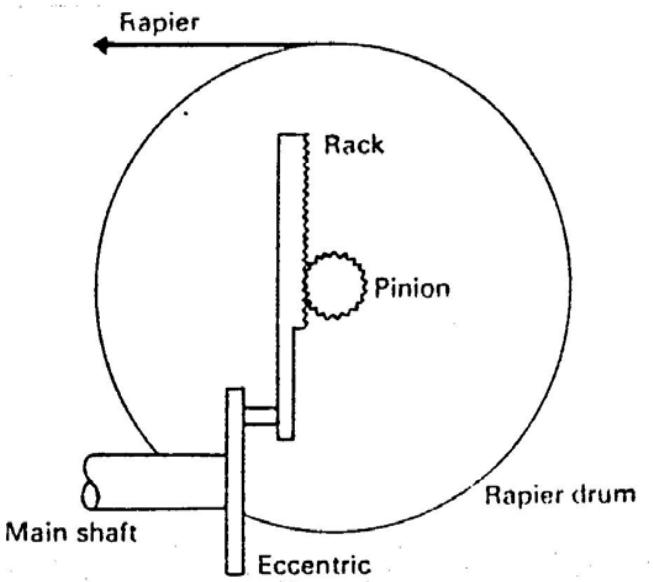
The flexible rapier drive from sprocket: grooved cam operated motion

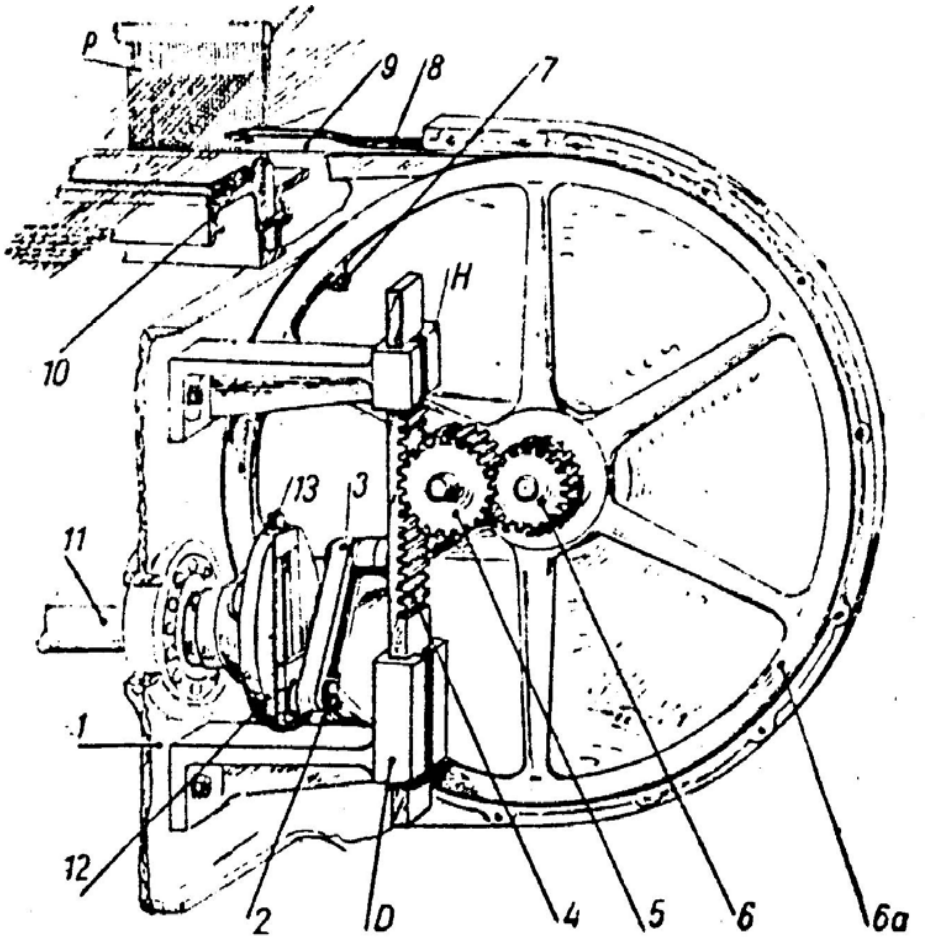




Snoeck and Nuovo Pignone rapier weaving machines

The flexible rapier drive: crank & rack operated motion





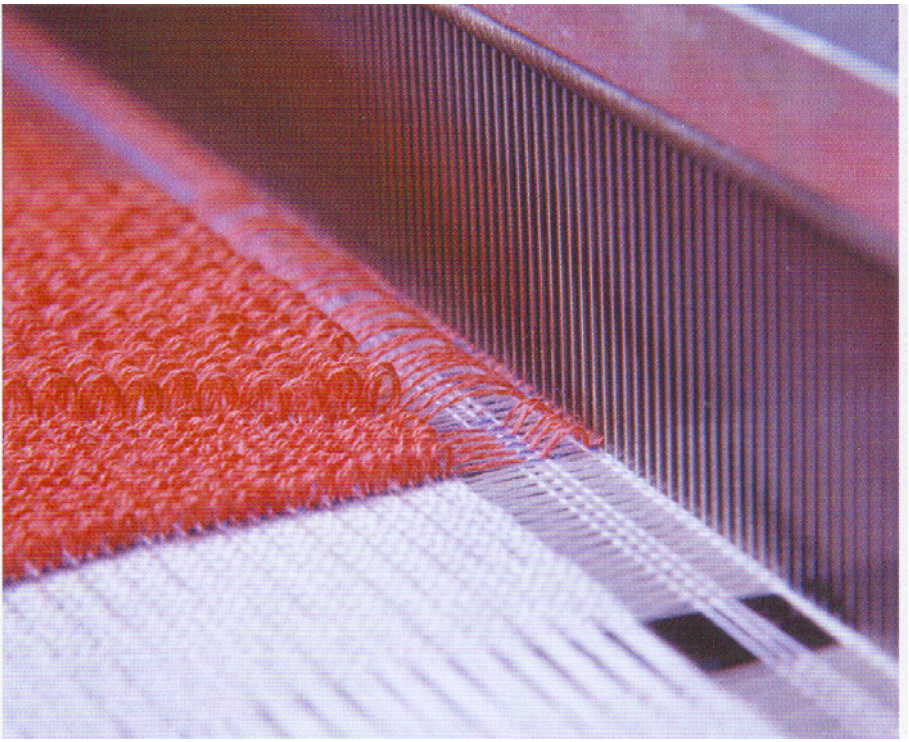
Draper Type DSL rapier weaving machine

Flexible Rapiers

Leonardo Dyna Terry:

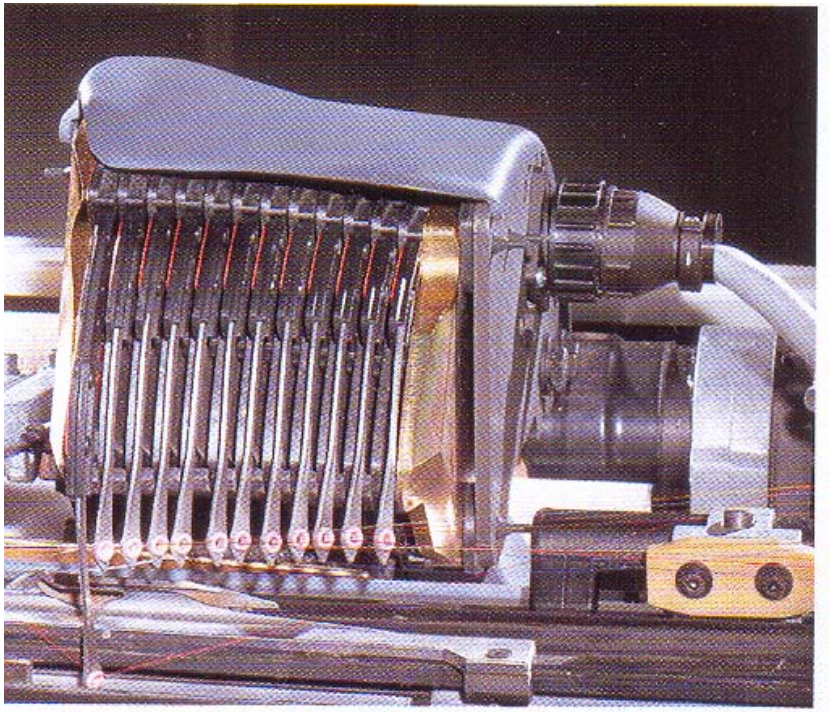
Lightweight and small-sized, yet very rugged and reliable, the rapiers allow to weave the most diverse and difficult yarns

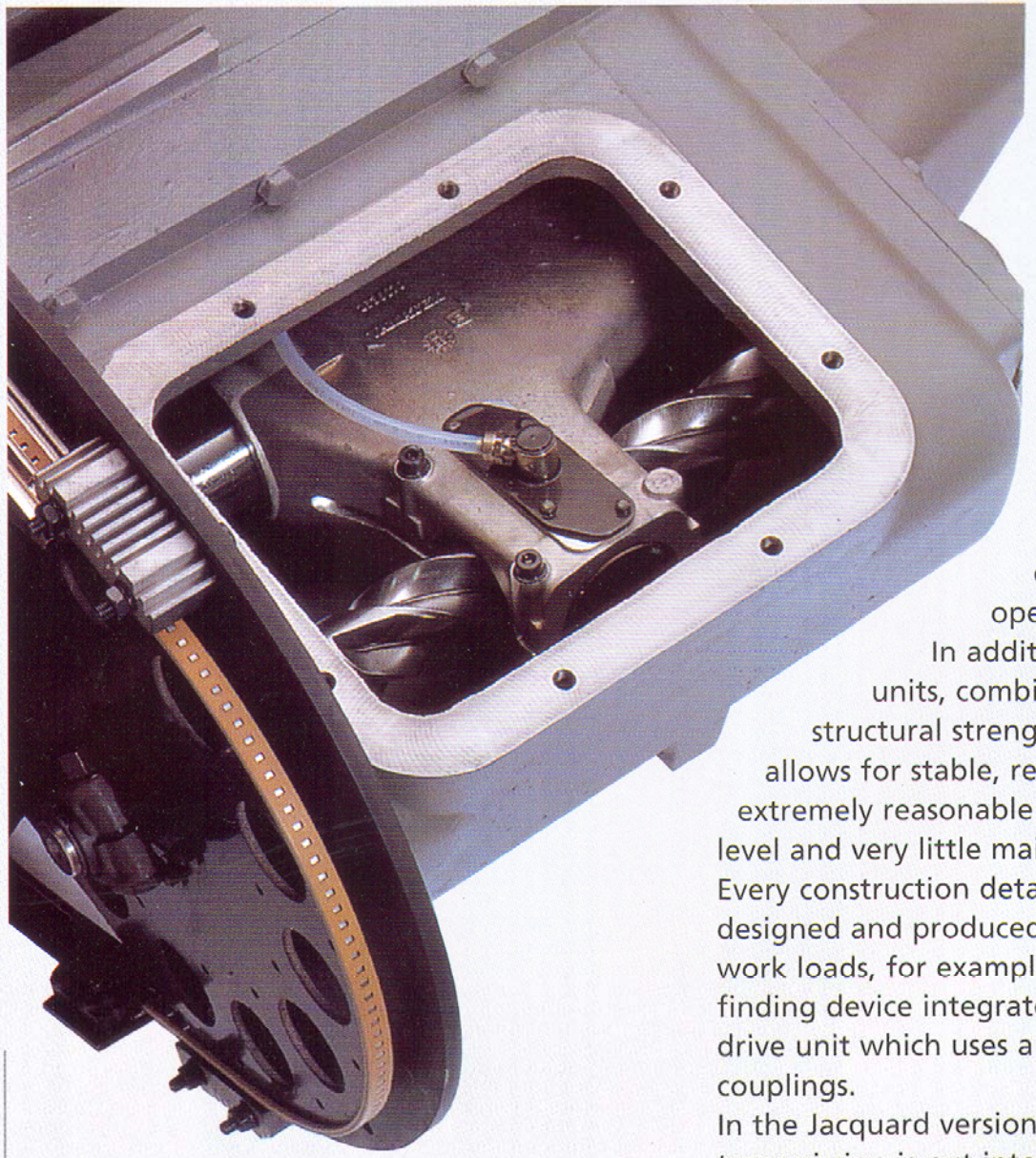
Flexible Rapiers



Leonardo Dyna Terry

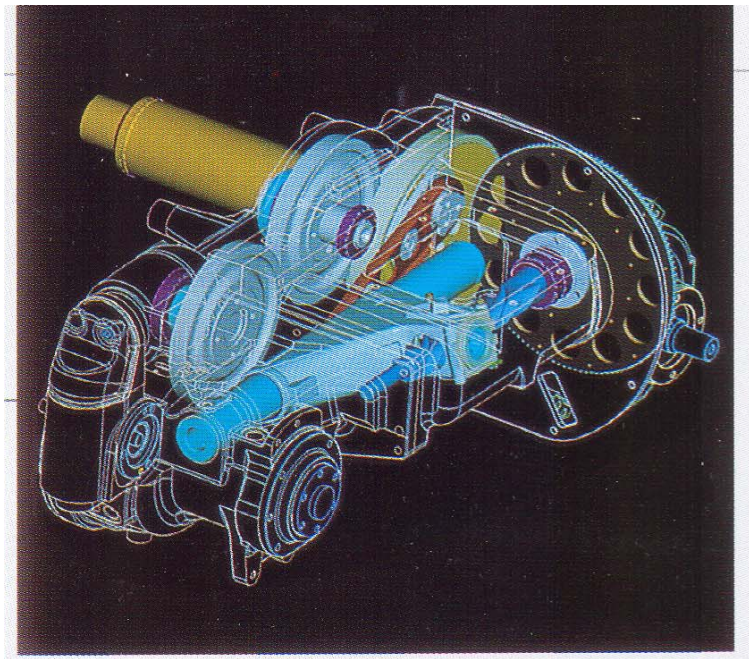
Electronically controlled color selector is available in three versions: 4, 8 and 12 colors.

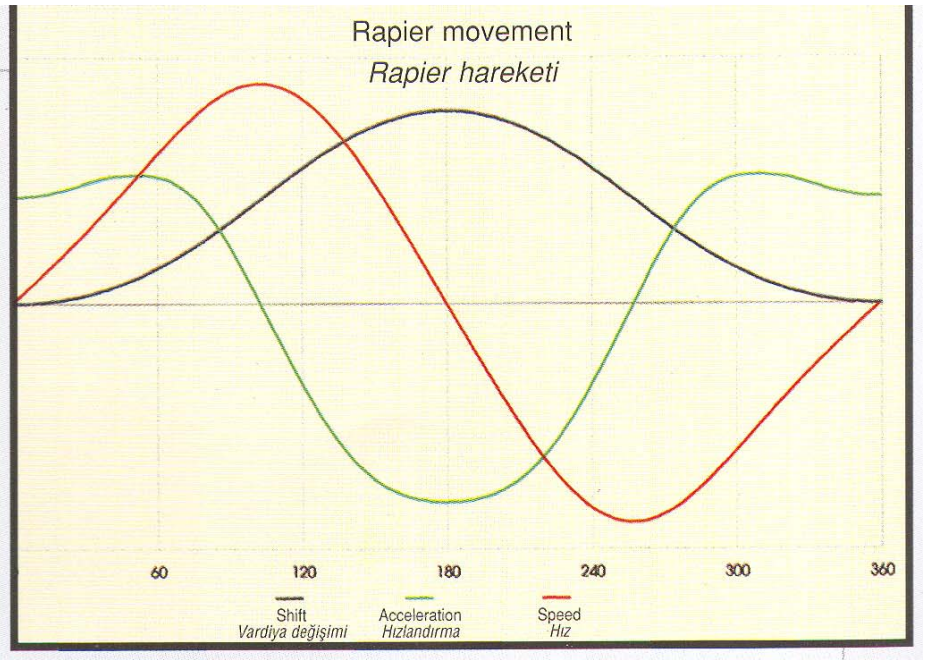




Among the most distinctive elements of Promatech's know-how is the Propeller ribbon and rapier drive system: it is the real dynamic heart of the Leonardo DynaTerry. Offering state-of-the-art performance and reliability, the Propeller consists of two coupled devices: the connecting rod-crank unit and the variable pitch screw-nutscrew unit.
It dominates the laws of motion, ensuring optimal rapier speed and acceleration, and thus enabling maximum operating performance.
In addition, the structural simplicity of the units, combined with high structural strength and reduced dynamic mass, allows for stable, reliable motion even at high speeds, extremely reasonable energy consumption, a low noise level and very little maintenance.
Every construction detail of the Leonardo DynaTerry is designed and produced to withstand even the heaviest work loads, for example, the slow motion and pick finding device integrated into the rear of the left-hand drive unit which uses a pair of electromagnetic drive couplings.
In the Jacquard version, the cardan drive bevel transmission is put into motion directly by a drive unit without a transmission belt; the system ensures perfect transmission under any load conditions.

Leonardo Dyna Terry: Flexible Rapier Drive

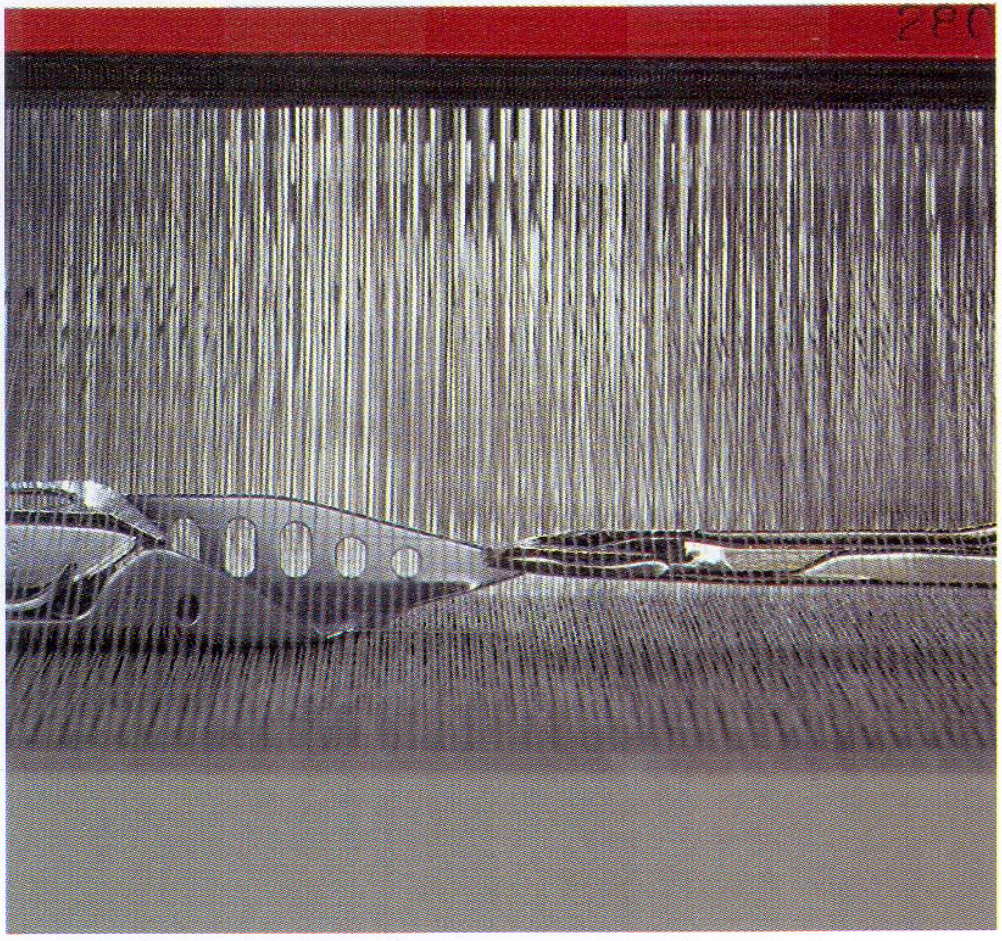




SMITH TEXTILE G6300

9099-0491

↑ The direct tape drive moves the rapier tapes at speeds which ensure extremely low yarn loading.



9099-0356

↑ Special gripper clamps grip even widely differing types of yarn reliably and securely.

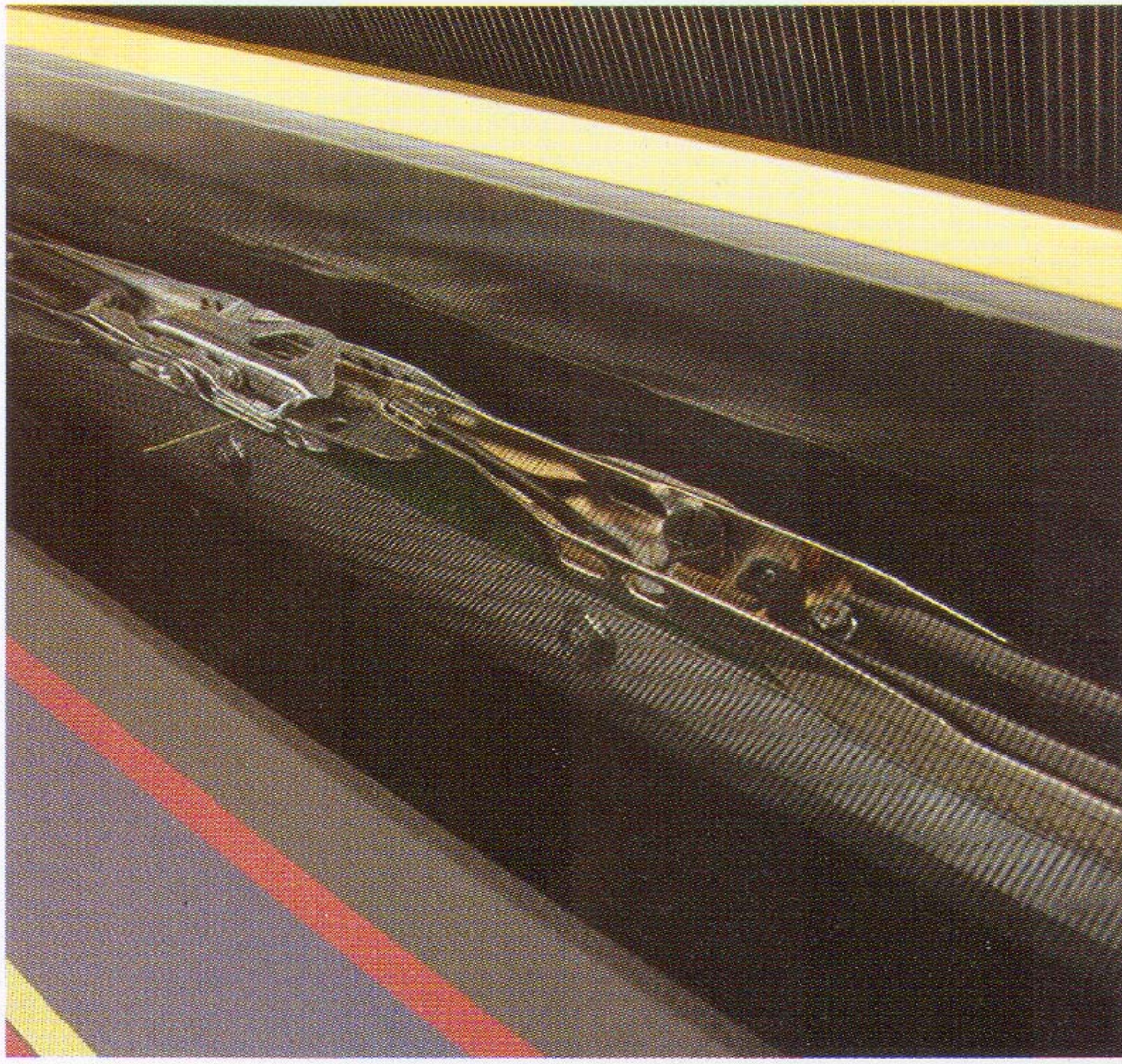
The grippers fly in the shed sliding on race-boards. Supporting teeth are optional for special or thick fabrics.

SMITH TEXTILE

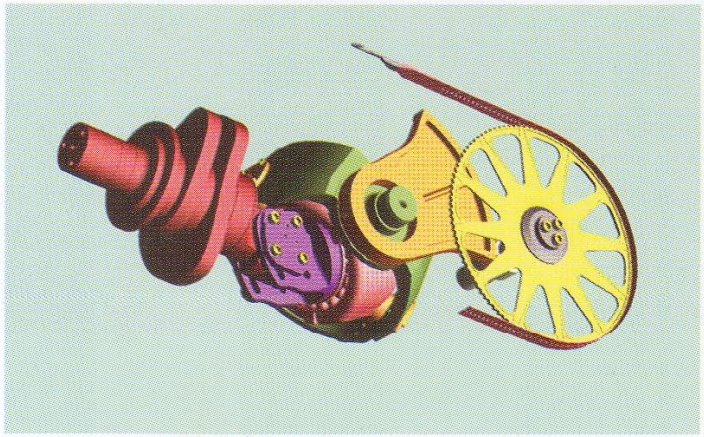
WSC rapiers:

Warp Save Contour: reduced section shaped in accordance with the geometry of the warp shed.

Great versatility for every type of yarn and application: fabrics for fashion, for upholstery, technical fabrics and home fabrics.



SMITH TEXTILE:
Flexible Rapier Drive



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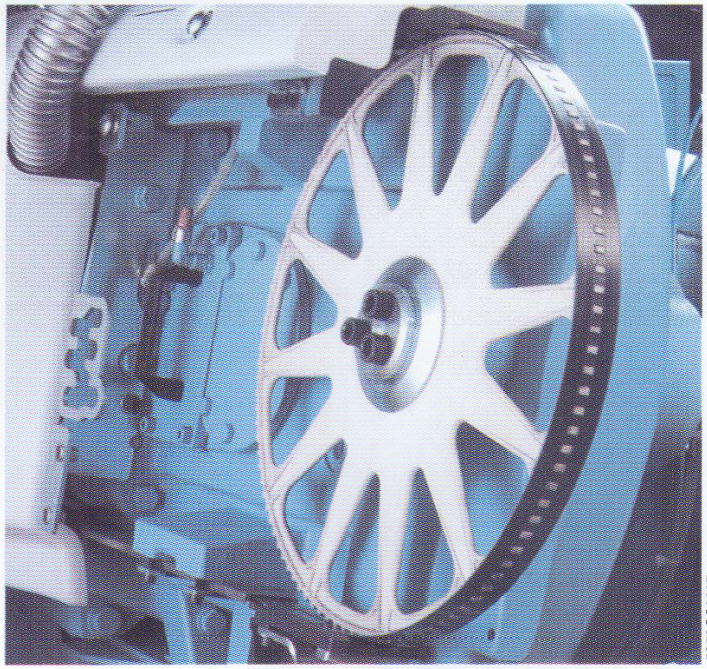

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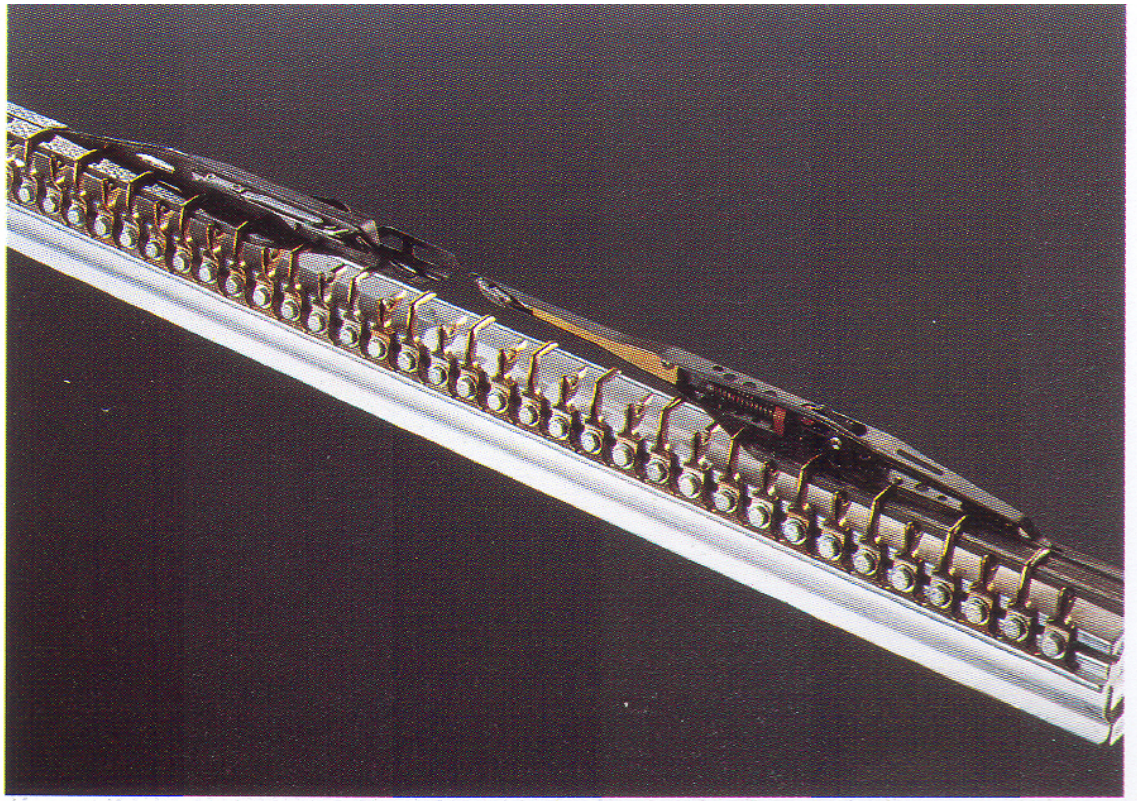
The rapier control

Carried out with a "spherica
crankshaft", it is characterise
by optimum acceleration an
speed profiles, which result
in:

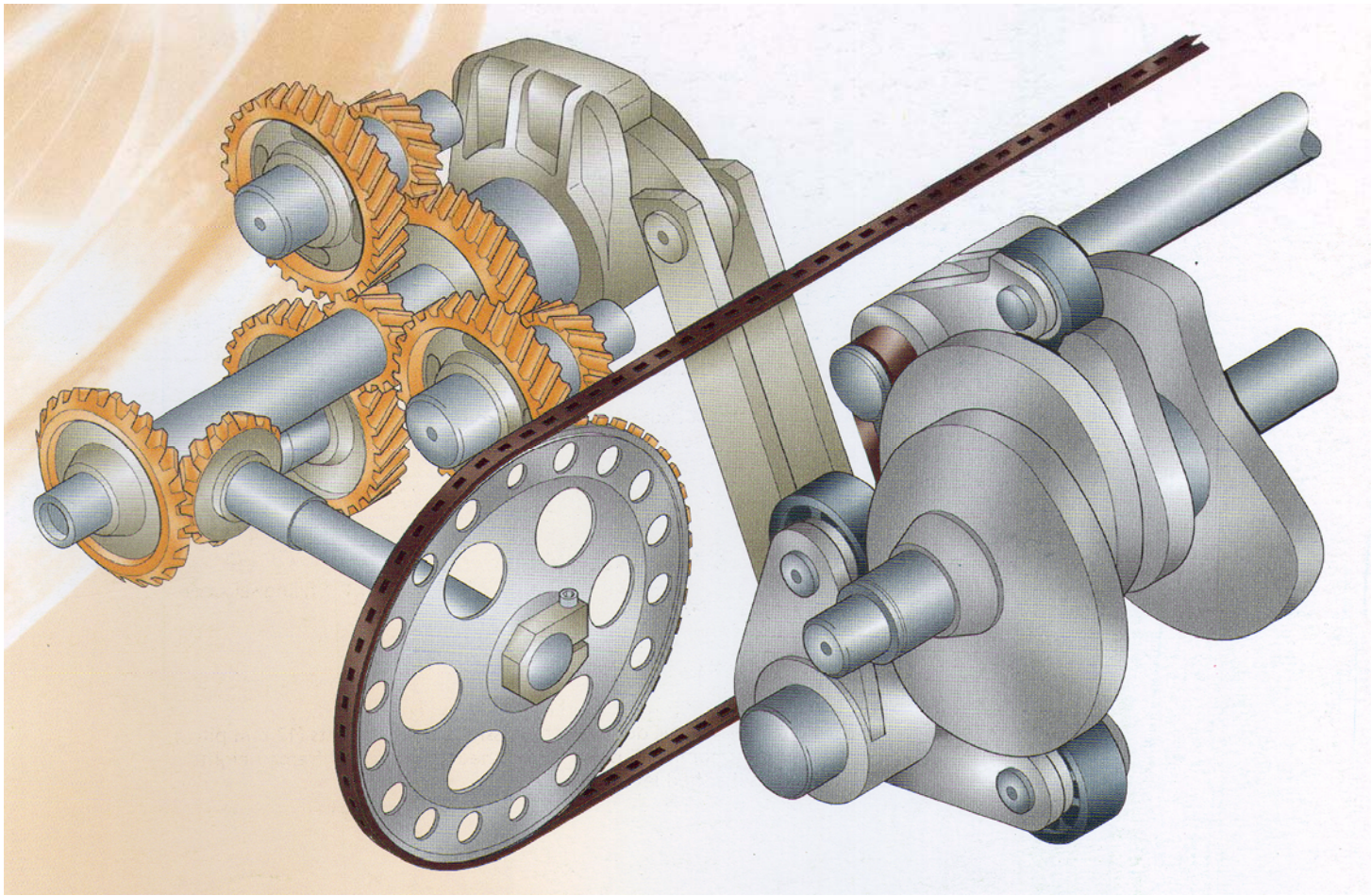
- minimum rapier extrastroke
- minimum weft cutting, changing and release spee
- high regularity in weft insertion and maximum efficiency.



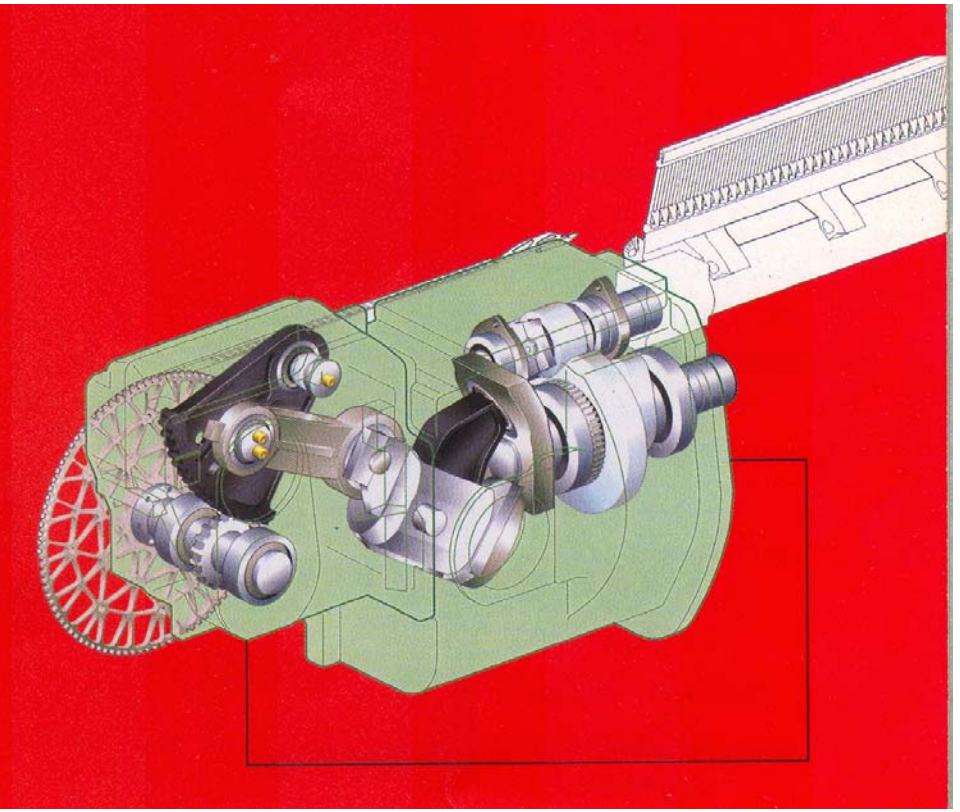
MFG race and grippers

The painstaking care given to these delicate and strategic parts of the loom has contributed to improving the textile performance of the SuperExcel HTP, which can be fitted with either a MFG race and relevant grippers or a GFG race with standard grippers or those used on the Excel and SuperExcel versions.

Somet Super Excel Rapier drive system derived from positive cams with optimized profiles



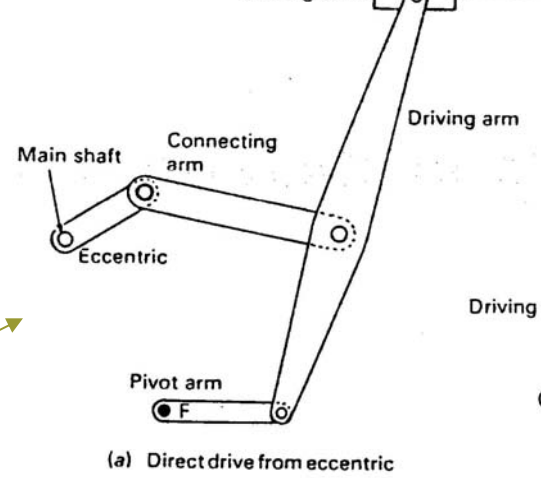
Picanol Gamma: Flexible Rapier Drive



- At the position where the left gripper clamps the presented filling yarn, the rapier acceleration is low.
- The initial low tension of the filling yarn can thus also be retained during the insertion cycle.
- At the end of the insertion, the rapier speed is reduced before the right gripper head opens and releases the inserted pick.
- This optimized rapier motion results in fewer filling breaks, and hence higher fabric quality.

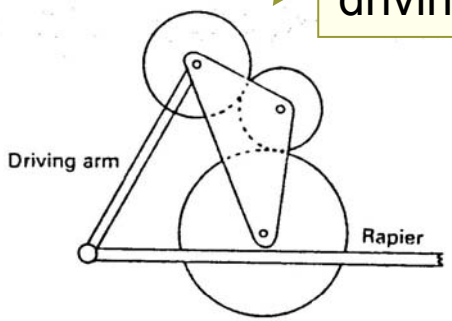
The rigid rapier drive

The direct eccentric arrangement

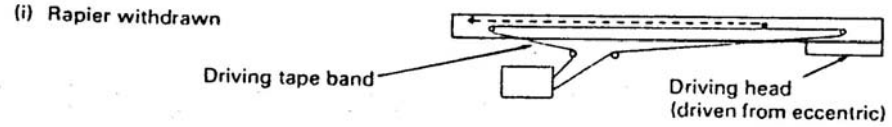


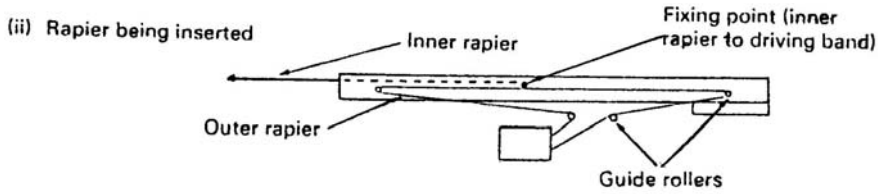
(a) Direct drive from eccentric

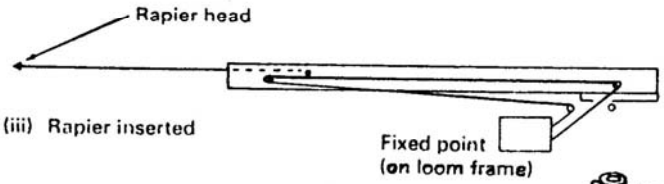
the cycloidal-gear driving arm.



(c) Cycloidal gears

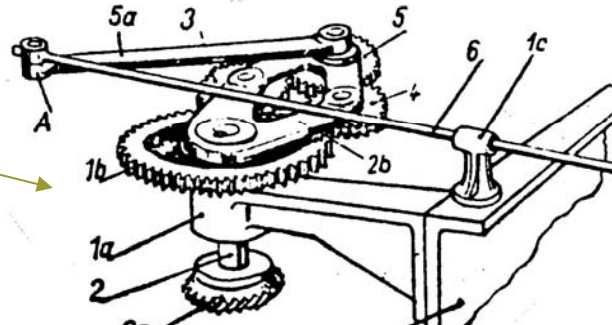




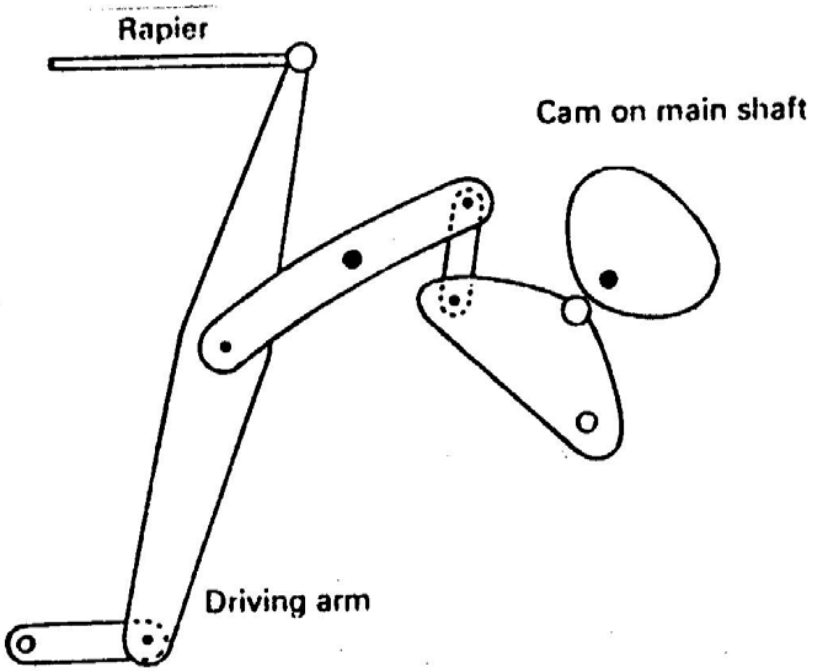


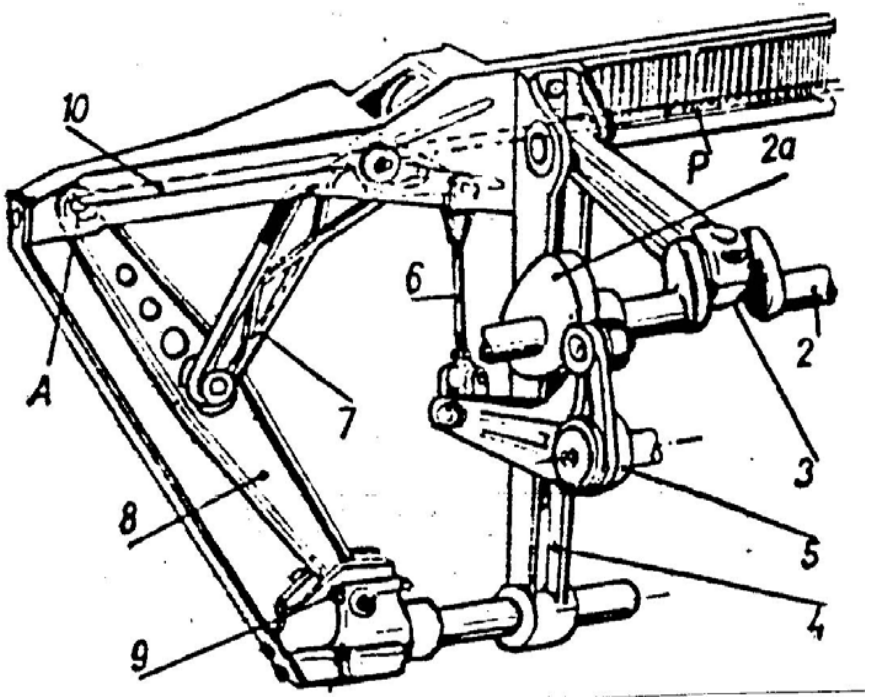
(b) Telescopic rapier drive

the planetary straight-line motion

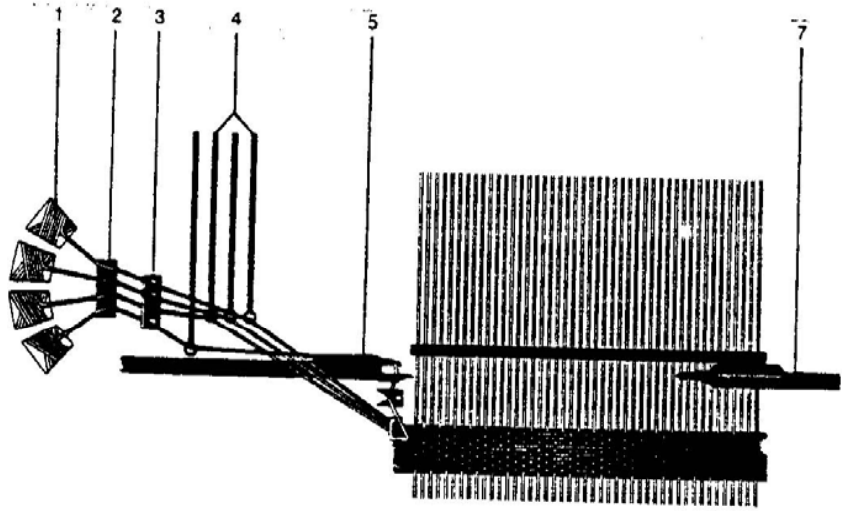


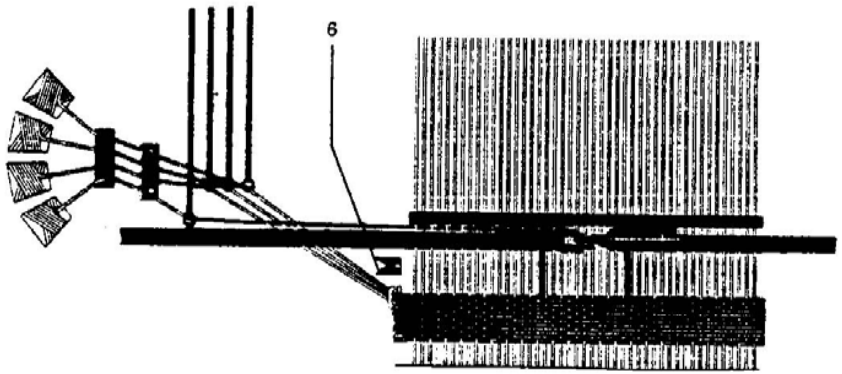
The rigid rapier drive: Radial cam operated motion

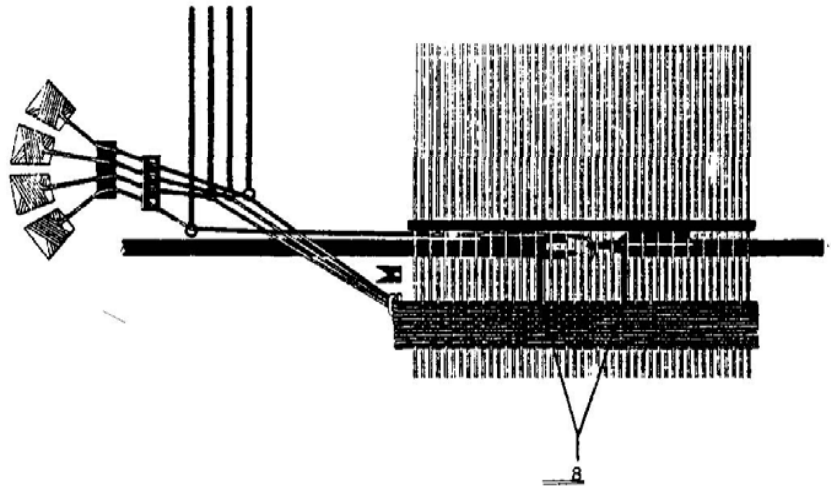




Dornier rigid rapier







1-weft supply

2-weft brake

3-weft stop motion

4-weft feeders

5-left hand rapier head

6-weft cutter

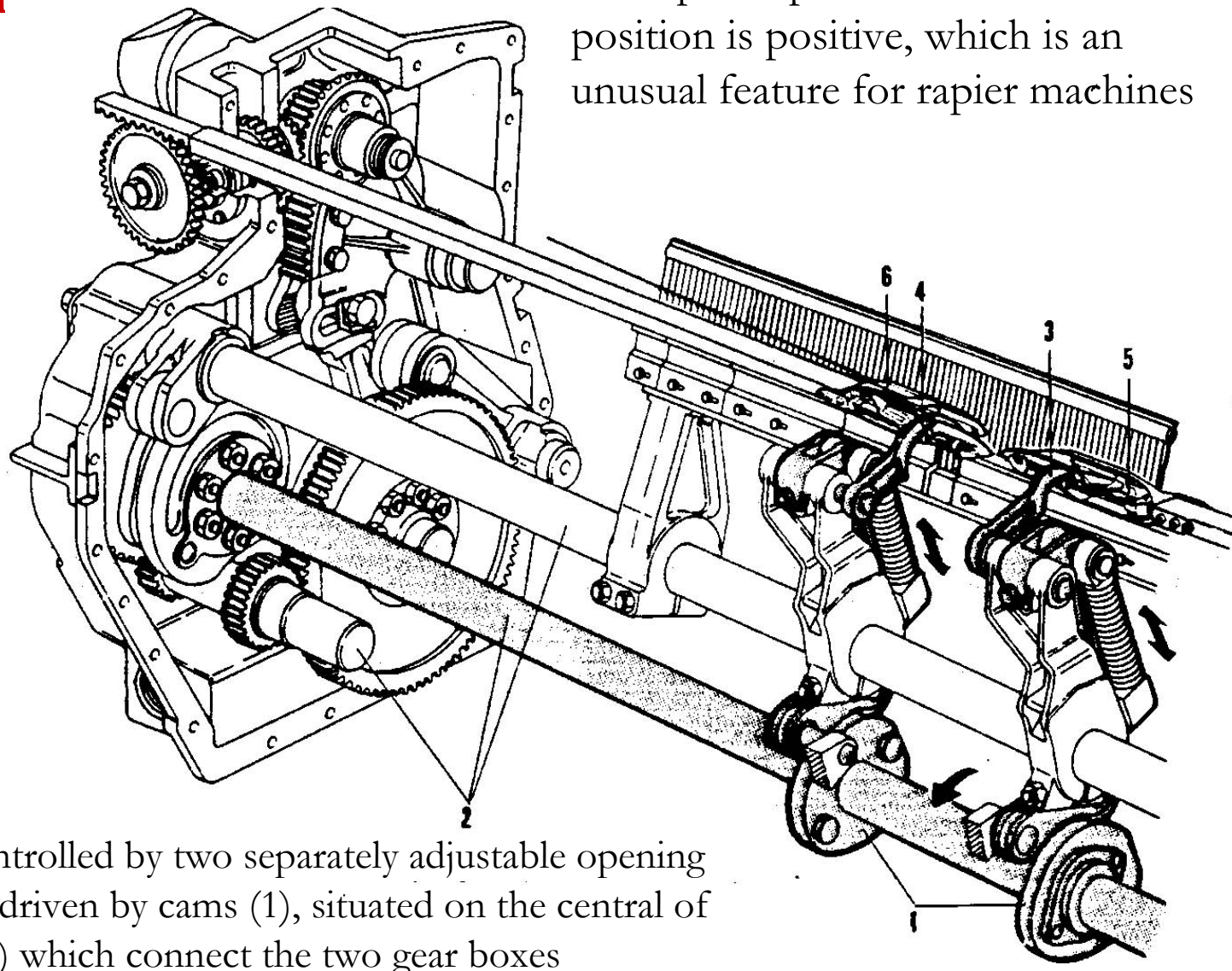
7-right hand rapier head

Dornier tip to tip transfer

- The weft insertion system is shown in Fig. 7.16. The weft is drawn-off weft-packages (1), through thread-brakes (2), the electronic weft stop motion (3), and the thread selector levers (4), which present the selected thread to the open feeder a rapier (5). The rapier commences its insertion stroke and grips the weft prior to entering the warp-shed. The cutting device (6) severs the weft from the cloth selvedge. The transfer to the receiver-side rapier (7) from the feeder rapier(5) takes place at the center of the reed space. The receiver rapier (7) completes the insertion of the pick at the same time as the rapier(5) withdraws from the shed, so that the reed can complete the insertion by forcing the pick to the fell of the cloth.

Dornier

The tip-to-tip transfer at mid-shed position is positive, which is an unusual feature for rapier machines

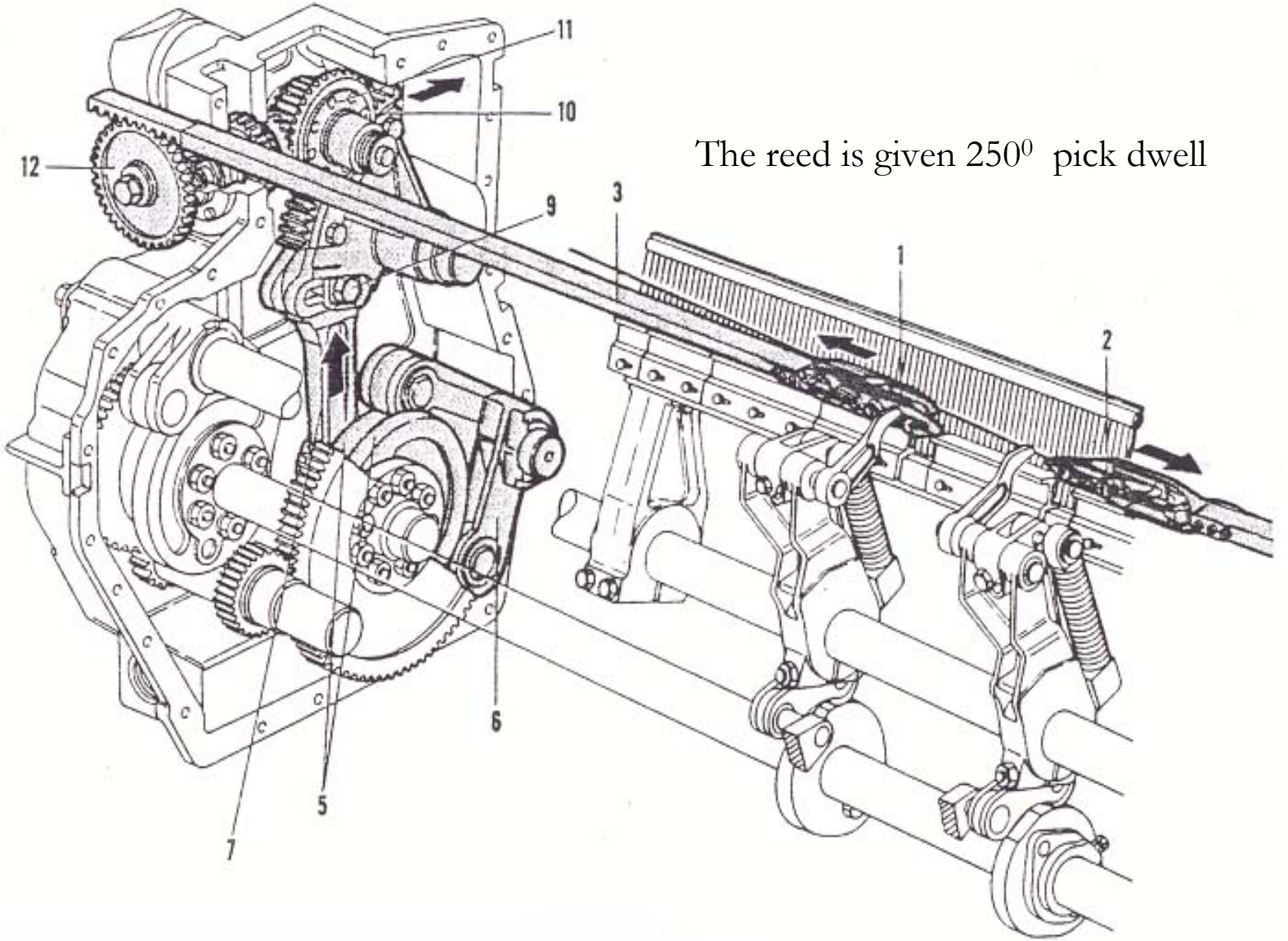


The transfer is controlled by two separately adjustable opening levers (3) and (4), driven by cams (1), situated on the central of the three shafts (2) which connect the two gear boxes

Dornier tip to tip transfer

- The receiver-side rapier (5) reaches the center a little earlier than the feeder rapier and is opened by the opener lever (3).
- The insertion-side rapier then presents the weft into the open receiver-rapier which is then closed by opener lever (3).
- The opener lever (4) then opens the insertion-side rapier and the weft is released.
- The receiver-rapier (5) then completes the pick insertion and the insertion-side rapier simultaneously withdraws from the shed.
- The clamp on the receiver-side rapier is again opened positively by a cam and opener plate and releases the weft when the reed moves forward to beat-up and the weft is securely constrained by the closing shed.
- Throughout the insertion phase the shed remains fully open and no contact takes place between the weft and the two warp sheets.

Dornier rigid rapier drive

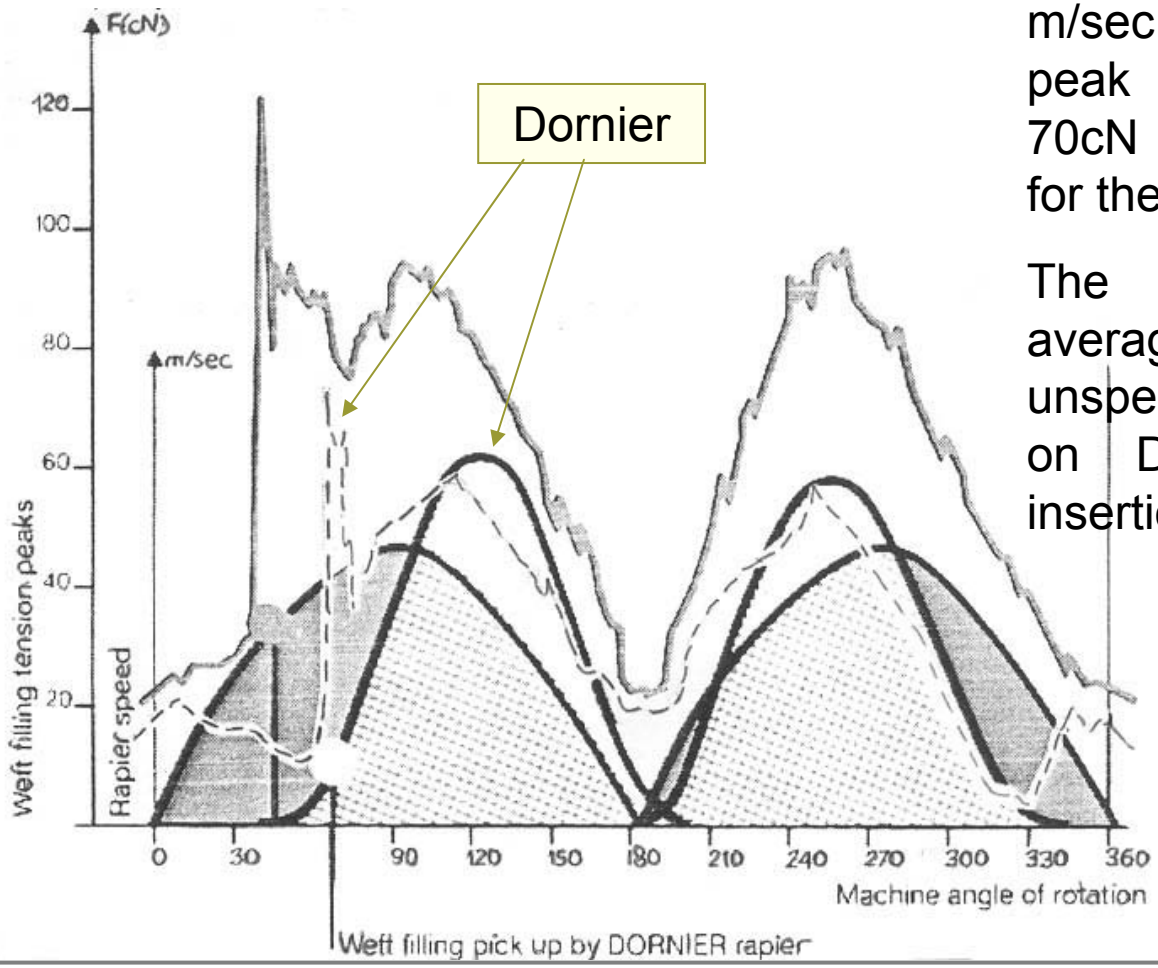


The reed is given 250^0 pick dwell

Dornier tip to tip transfer

- The insertion-side rapier head (1) and the receiver-side rapier head (2) are attached to rigid rods of a rectangular cross section with a machined rack on the lower face of its outer end.
- The required acceleration characteristics are achieved by a complementary cam (5) working in conjunction with a rocking double lever (6).
- The oscillating motion of (6) is transferred to the connecting rod (7) and its toothed segment (10) which drives a pinion and co-axial bevel gear (11).
- The bevel gear drives the rack-wheel (12) which controls the insertion-side rapier
- The adjustment of the rapier for fabric width only requires the adjustment of the connecting rod (7) by a single bolt (9), and no adjustment of the central rapier clamp control is required.
- The gear boxes are provided with a reverse motion which facilitates removal of the broken pick at the press of a push button. The rapier drive is disengaged and cloth take-up and warp let-off, shedding motion and color selection mechanism all reverse one pick, so that the broken pick can be removed.

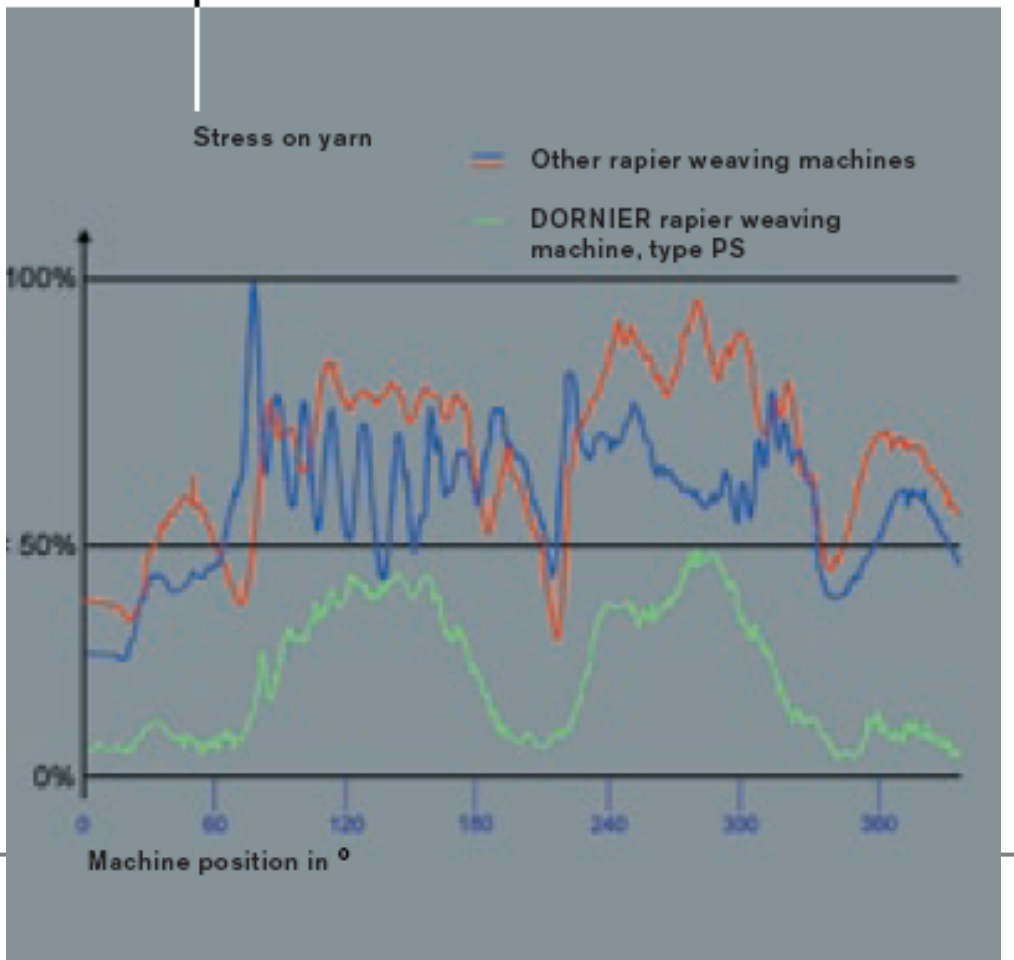
Filling yarn stresses



The rapier velocity and weft tension plotted against machine angle of rotation. The rapier speed reaches a maximum of 60 m/sec and the weft reaches a peak of very short duration of 70cN and averages about 38cN for the complete insertion cycle.

The much higher peak and average tensions for an unspecified machine operating on Dewas system of weft insertion.

In a competitive comparison, the peak thread tension level of the DORNIER rapier weaving machine, type PS, remained below even the basic tension level of all known negative tape rapier weaving machines. Therefore broken picks are a rarity.



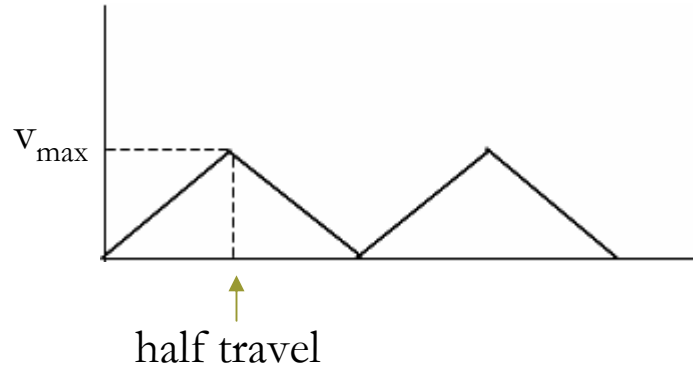
Example: The weft velocity

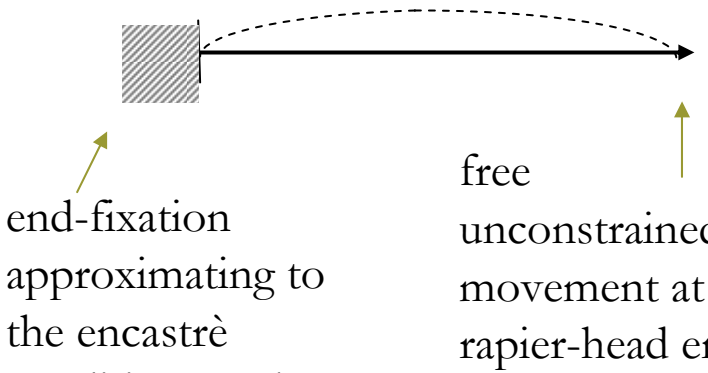
- A rapier loom having a reed space of 180 cm and running at 225 picks/min will not have excessive velocities if the rapier can be made to enter the shed at 60^0 and leave at 300^0. These figures are typical for a range of looms, and the average velocity will be:

$$\text{average} \quad v = \frac{\frac{180}{100}}{\frac{60}{225}\times\left(\frac{300-60}{360}\right)} = \frac{180}{100}\times\frac{225}{60}\times\frac{360}{240} = 10.125 \qquad \text{m/s}$$

The rapier speed

- All unguided rapier looms, irrespective of type, are subjected to the buckling forces during weft insertion.
- Double rapiers are accelerated to maximum velocity at about half travel, about quarter reed space, and then decelerated to zero at the transfer position.
- During the first half of the traverse the rapier is under compression, tendency for buckling takes place.
- In the second half of its travel the rapier is in tension and there is no tendency for buckling to take place.
- Under these end-conditions and with a high slenderness ratio the rapier will buckle when an accelerating force exceeds the buckling load.

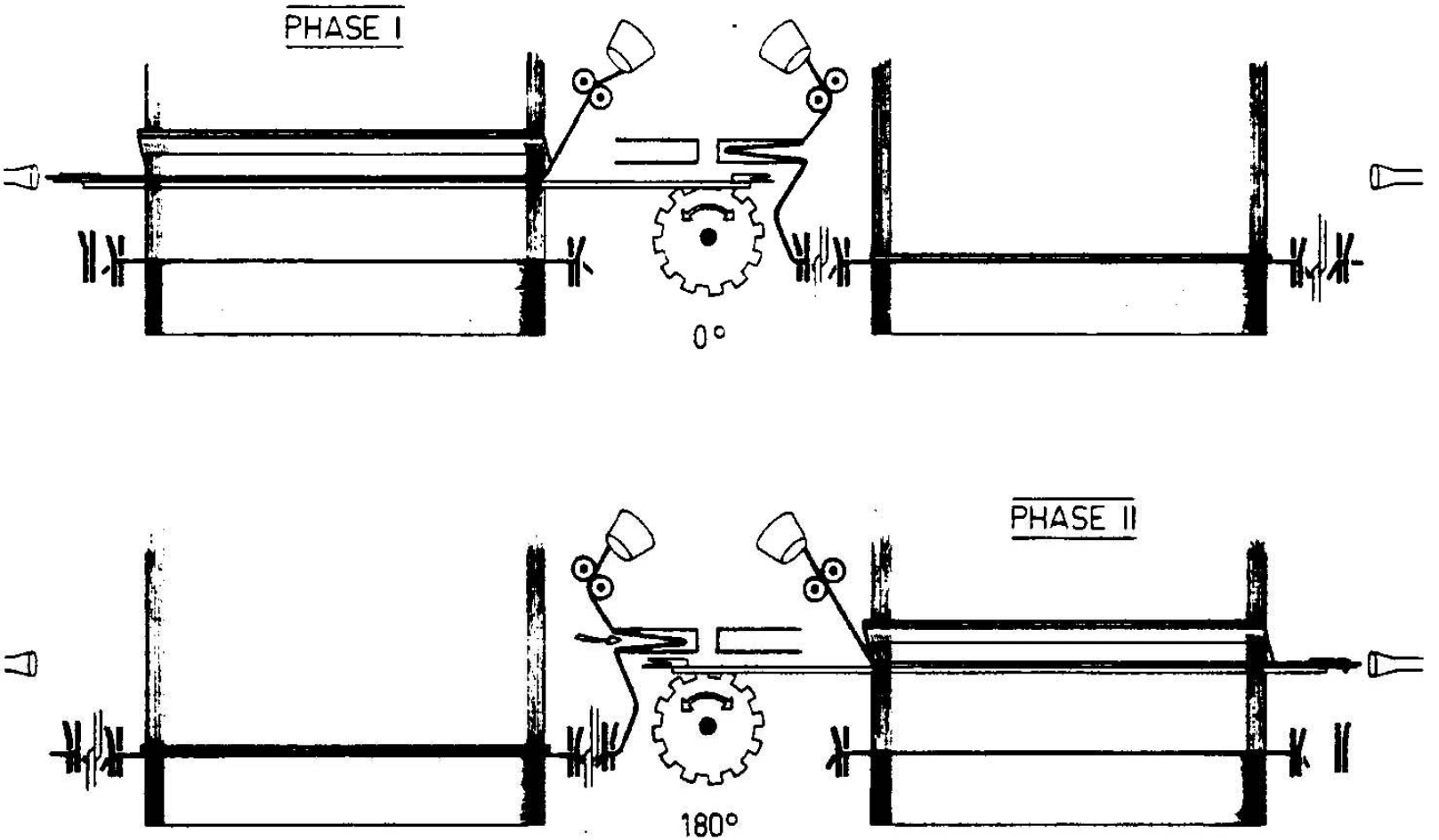




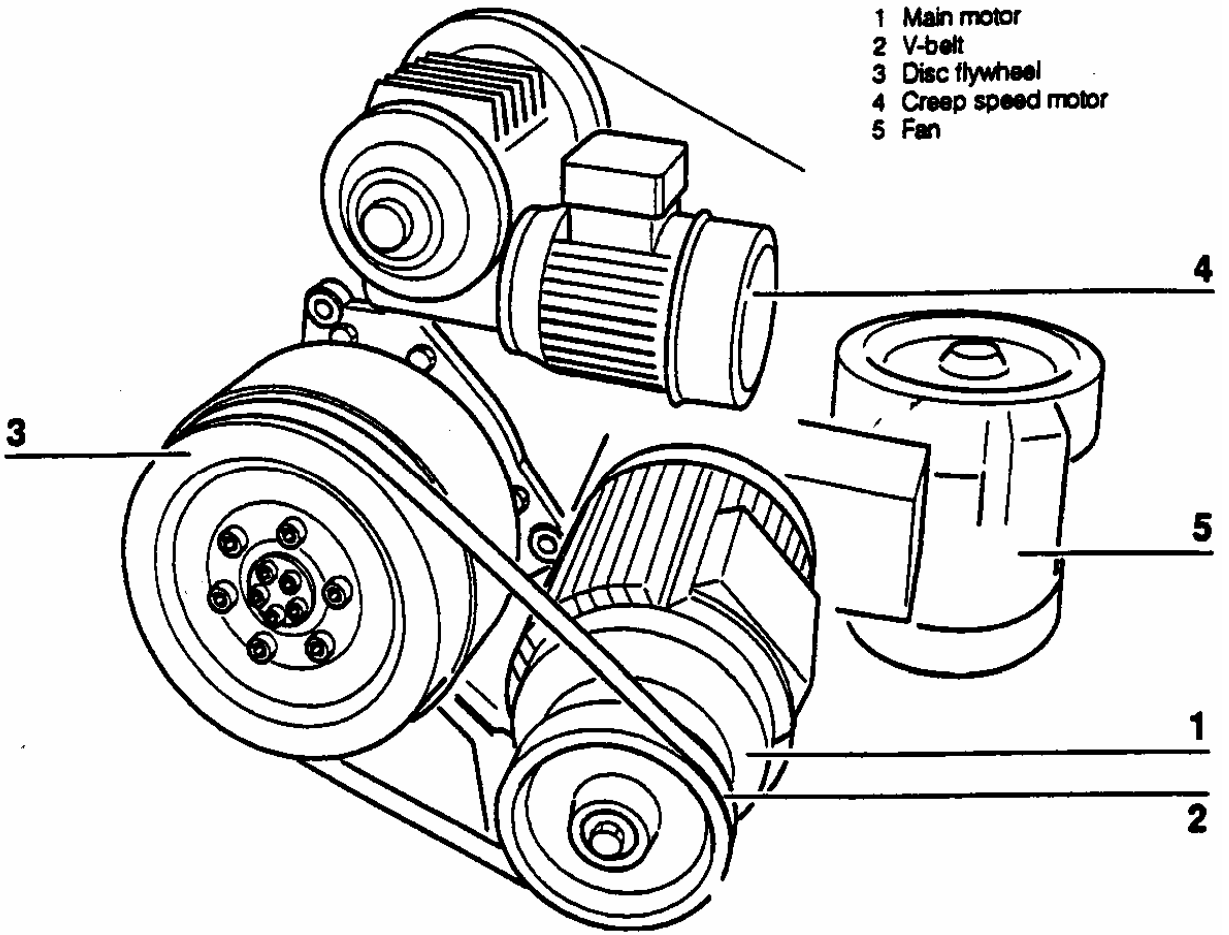
The rapier speed

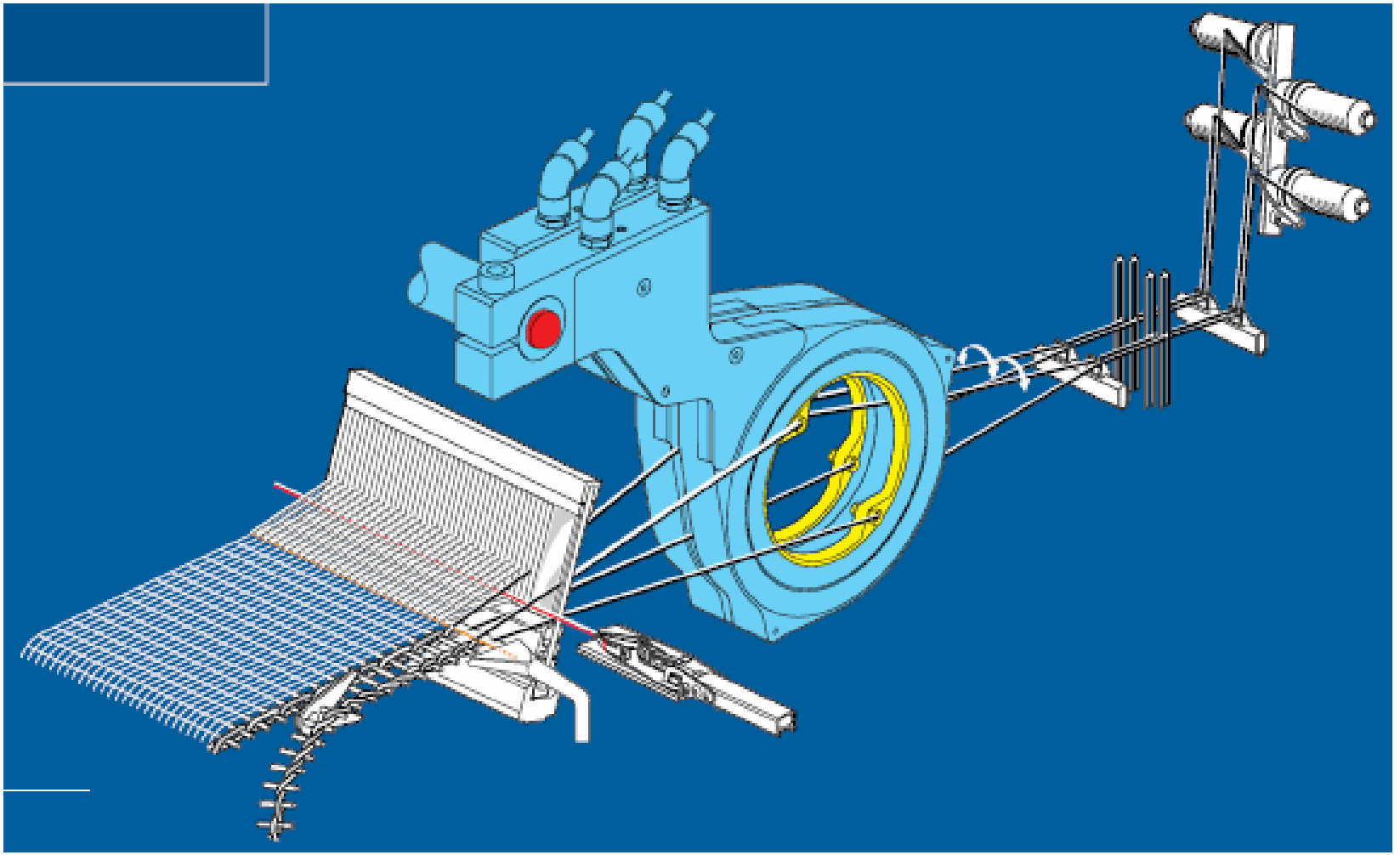
- A very substantial increase in the WIR capability of flexible rapier machines in the last few years has largely been achieved as a result of the use of special materials such as carbon fiber reinforced rapier drive tapes and the use of light materials to reduce the mass of the rapier head and the associated inertia forces.
- If the accelerating masses can be minimized, the buckling forces are proportionately reduced.
- Some rapier heads have been spectacularly reduced in mass. The Saurer 400 rapier head, for example, only weighed 40g.
- As looms increase in width the problem of buckling increases, as the permissible buckling load varies inversely as the square of the accelerating length. In consequence most of the rapier looms in service of about 340cm and over tend to use either guided rapiers

Double acting single phase



Weaving Machine Drive





Leno creates the fabric selvedge.

Versatility in fabric production