Pattern and selection devices

11.1 Weft knitted patterns

Generally, patterns are produced in weft knitted structures either in the form of selected colours for face stitches or surface relief patterns based on a choice of different types of stitch. As illustrated in Fig. 3.4, the height to which a latch needle is lifted in its trick determines which stitch will be knitted. If all needle butts are in the same position on the needle stems and they pass over the same cam profile, a plain fabric will be knitted, with all stitches having the same intermeshed loop structure. Patterning is therefore determined by selection of needle butts – for example, either to pass onto a raising cam to knit or to miss the cam profile and not be lifted.

The width of the pattern in wales is determined by how many needles can be selected separately, independently of each other. The pattern depth in courses is dependent upon the number of feeds with selection facilities and whether the selection can be changed during knitting.

Simple patterning and quick rib changes (during garment-length knitting) can be achieved in a limited width repeat when element butts are at one of a range of lengths or positions associated with particular raising cam arrangements.

The cam arrangement and element butt repeat set-out will determine the pattern area. Popular simple methods employ different butt lengths and cam thicknesses and/or different butt positions and cam tracks.

11.2 Different lengths of butt

Whereas butts of normal length extend into the track formed between cams and guide their elements by contact with the profiled edges, a butt of shorter length may not reach into the track and will thus pass across the face of the cam and be unaffected by its profile (Fig. 11.1).

The same principle is employed when cams are withdrawn into their cam-plate

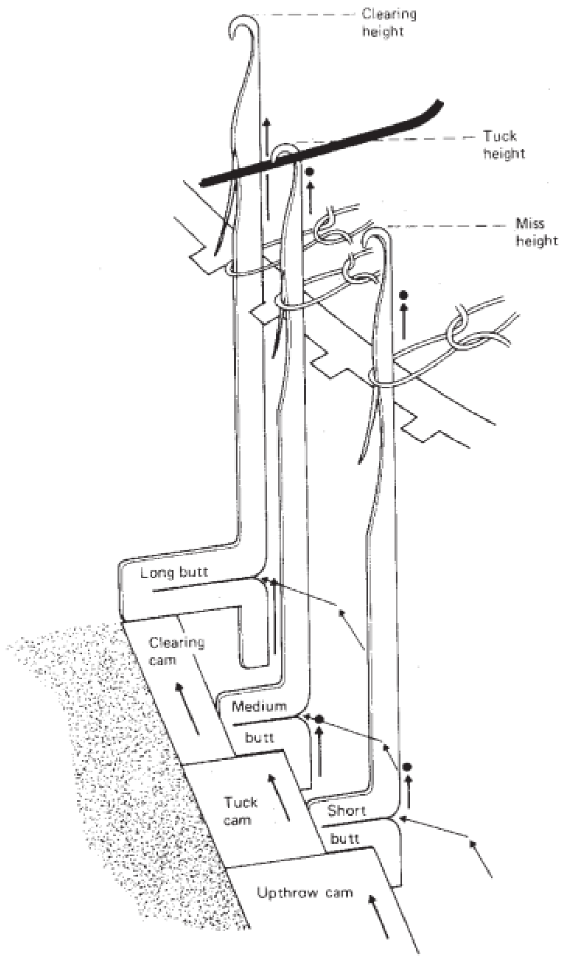


Fig. 11.1 Miss, knit and tuck using different butt lengths.

or the elements are depressed into their tricks, thus reducing the effective length of their butts.

The principle of butt lengths is that the element with the longest butt is always contacted first as a cam is brought into operation and the shortest butt is affected only when the cam is fully in action.

For example, a tuck cam might be partly in action, raising long and medium butt needles but allowing short butt needles to pass across at miss height, whilst the succeeding clearing cam is set to raise only long butt needles, leaving medium butt needles at tuck height. If short, instead of long, butt needles are required to be lifted, it is necessary to contact and lower the long butt needles before they reach the raising cam that is placed fully in action to lift the short butt needles remaining in line with it.

Separately butted and cam-controlled elements known as *push-jacks* may be placed below the needles in their tricks. As their butt set-out need not correspond to that of the needles, a greater selection potential is available than through the set-out of the needle butts alone. Long butt jacks can thus be used to positively lift short butt needles. Jack butt set-outs are particularly suitable for obtaining predetermined rib set-outs in garment length sequences.

11.3 Different butt positions

The principle of different butt positions is employed in the interlock cam system, where two cam tracks are used (Section 7.4.2). In *single-jersey multi-camtrack (raceway)* machines, needle butts may be positioned in one of between 2 and 5 cam tracks that, at every feed position, have fixed but exchangeable knitting, tucking or missing cams. In some machines (e.g. jacquard machines), a common top butt is controlled by a stitch cam-track, whereas in high-speed machines the exchangeable cams also incorporate the stitch and guard cam shape and are located on a common slide for stitch length adjustment (Fig. 11.2).

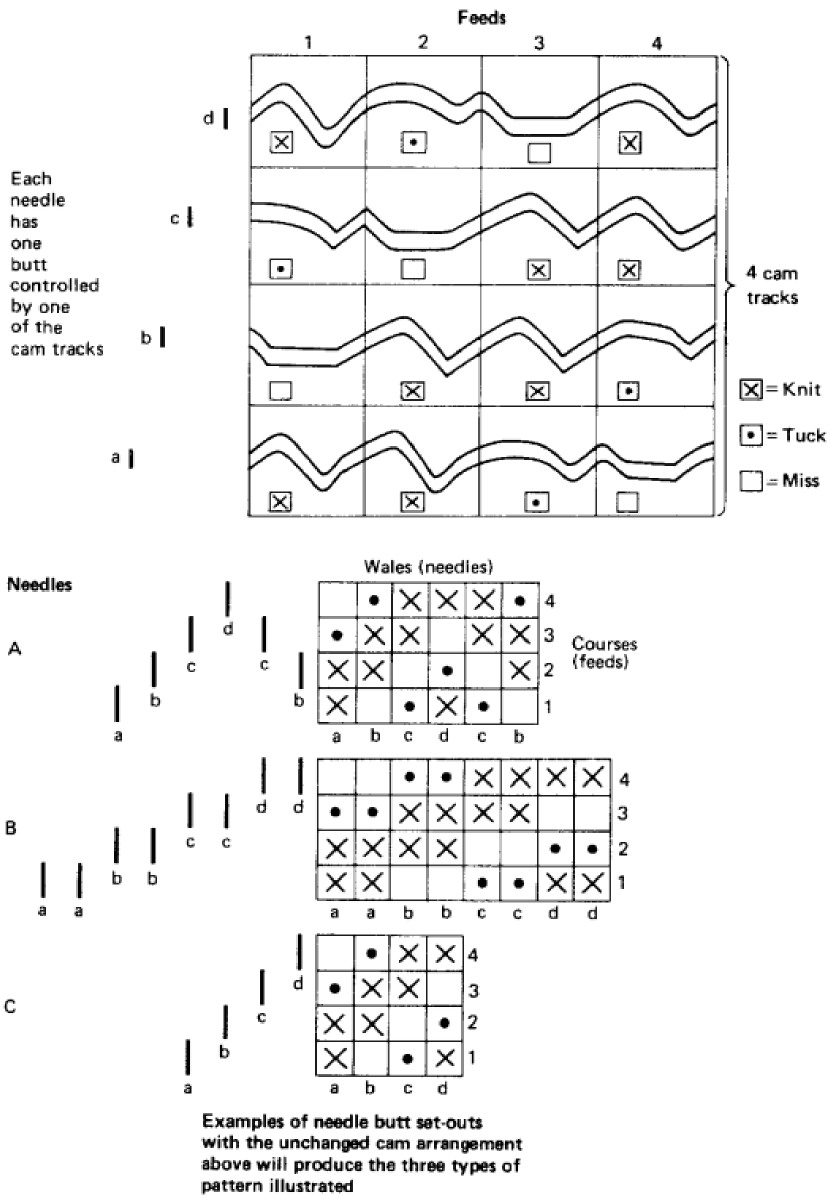


Fig. 11.2 Multi-cam track needle butt control.

11.4 Multi-step butt set-outs

Although some selection devices, including pattern wheels, operate onto element butts of one height position, many patterning arrangements involve the use of a single selection butt for each element, placed at one of a choice of height positions. The total number of different heights often directly influences the width repeat in wales. It is generally most convenient to arrange and retain a butt set-out that is a factor of the needle bed, so that the pattern widths exactly repeat into it.

The two most common geometrical butt set-outs are straight and mirror repeats, although combinations of the two are possible.

A *straight* (*diagonal*, *echelon*, or *up-and-up*) *butt set-out* is arranged in an ascending order in the direction of knitting (Fig. 11.2). Each butt position is used once only in the set-out repeat, so the pattern width is equal to the number of available pattern butt positions.

A *mirror repeat* (*reflex chevron*, *up-and-down*, or *geometric*) *butt set-out* is a mirrored continuation of the straight set-out, with the butts descending in sequence after the highest position (see Fig. 11.3). The top and bottom butts are not used in the descending sequence as the former would produce two identical adjacent wales in the same repeat and the latter would produce two identical adjacent wales with the first wale of the next repeat. This set-out thus produces a symmetrical design width about a common centre wale, with the right side identically mirroring the left side.

With geometric selection, the top butt position is used only in mirror repeats so that these are exactly twice the width of straight set-outs and both mirror repeats and straight set-outs are a factor of the number of cylinder needles.

For example, an E 18, 30-inch diameter machine with 1728 cylinder needles, using a small-area fixed selection, might have 24 butt positions (and pattern comb teeth) for a straight set-out repeating 72 times around the cylinder, and an extra top butt and tooth used only for mirror repeat set-outs, making 25 up and 23 down, giving a width of 48 butts that repeats 36 times around the cylinder.

11.5 Selection devices

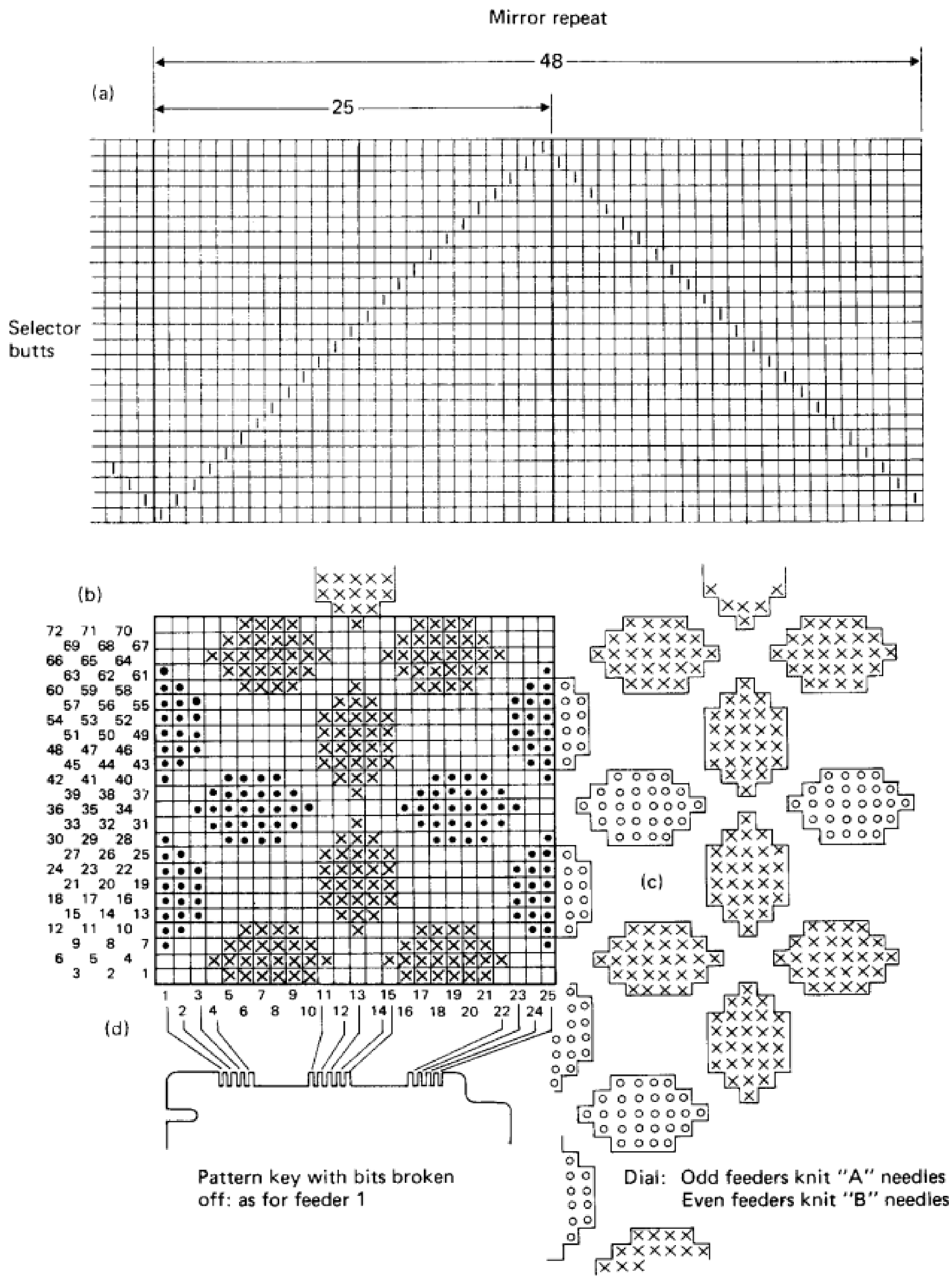
Selection devices vary considerably in their facilities and their pattern-changing and pattern-area capabilities.

A *selection device* is positioned to operate in advance of a raising cam system (usually associated with a knitting feed position) to select the path that the element operating butts will follow as they pass through that system. Each possible path will cause the element to be moved in a different manner, resulting in the knitting of a different type of stitch. Usually, a selection decision determines the choice of two butt paths.

11.6 Element selection

Element selection involves three aspects:

1 The *initiation and presentation* of the selection decision, usually as a *YES* or *NO*, by the presence or absence of a tooth, a peg, a punched hole or an electronic



Feeders: 1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58 61 64 67 70 Bits off at ☒

Feeders: 2 5 8 11 14 17 20 23 26 29 32 35 38 41 44 47 50 53 56 59 62 65 68 71 Bits off at ⊡

Feeders: 3 6 9 12 15 18 21 24 27 30 33 36 39 42 45 48 51 54 57 60 63 66 69 72 Bits off at ☐

Fig. 11.3 Mirror repeat needle selection.

impulse. Normally, there is a selection in advance of a raising cam, with each feeder course being associated with a particular selection device.

2 The *transmission of the selection decisions* from the device and their reception by elements in each trick of the needle bed. One of three methods is normally employed for this task:
   (a) Employing *individual raising cams*, when required, for each element raising butt (pattern wheel selection).
   (b) *Selectively pushing* the elements upwards in their stationary tricks to align their raising butts into action with the path of the traversing or rotating cam systems (full mechanical jacquard selection).
   (c) *Selectively retracting* the elements into the interior of their tricks so that their raising butts no longer project out into the path of the cams. This method is widely used for mechanically- and electronically-initiated selection on circular and flat machines, especially when employing geometric multi-butt set-outs of selection butts. Raising butts may be selected to miss a complete raising cam or only the final upper section (e.g. between tucking and clearing height).

3 The *translation of the selection decision into a knitting movement*. With the exception of linear-motor drive of needles, this is still a completely mechanical action of a raising butt following, or failing to follow, the profile of a raising cam and thus causing an element to be lifted, or not lifted, in its trick during a stitch formation cycle.

Normally, all selection devices of one circular machine will hold an equal number of width selections and an equal number of depth selections. When each device is aligned to commence selection at the same starting trick (wale), equal widths of selection will occur at each feeder course and will be aligned into rectangular selection areas exactly framed by the courses and wales of the fabric (Fig. 11.4).

11.7 Selection area arrangement

Dependent upon the type of device, four arrangements of the selection areas around the fabric tube are possible:

1 *Full jacquard selection* can produce a selection area of theoretically unlimited depth and a width equal to the number of needles in the cylinder, so that the design exactly surrounds the fabric tube without repeating.

2 *Pattern wheels* have a circumference selection that is not an exact factor of the number of cylinder needles, so that their selection areas follow the spiral path of the feeder courses around the fabric tube. In the starting wale of each machine revolution, the base of the areas will thus have risen by the number of feeder courses knitted in one machine revolution compared with its position in the same starting wale at the previous machine revolution (X in Fig. 11.4a).

3 *Fixed geometric selection devices* (step jack devices) provide only one selection width at each device, which is unchanged from one machine selection to the next (Fig. 11.4b). Machines employing this type of device are termed *small-area* or *intermediate jacquards*; although their pattern area potential is limited, they have

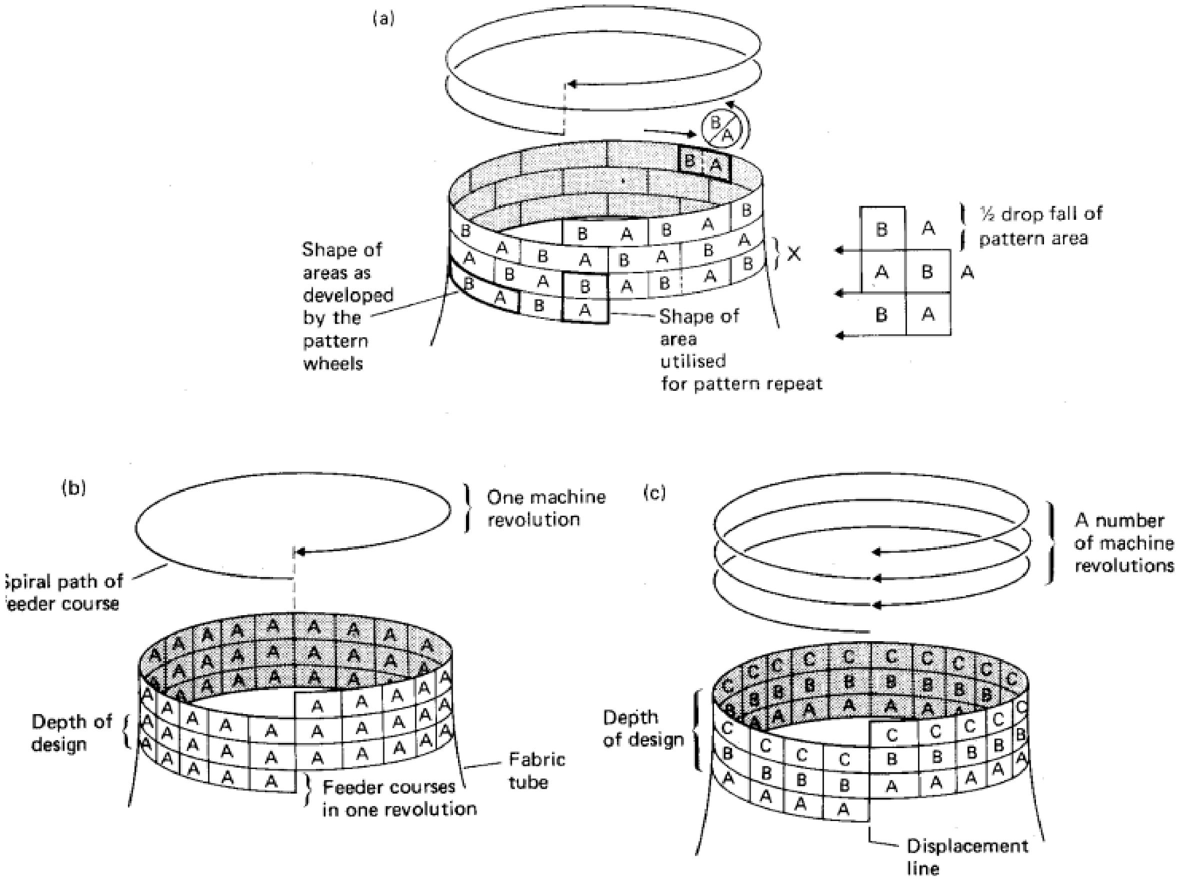


Fig. 11.4 The development of design areas using selection devices.

sufficient feeders and speed to be employed in the production of single colour and plain structures as well as jacquards.

A complete design depth is thus produced at each machine revolution, composed of the number of active feeder courses, so that the base of the design will have risen by that number of courses each time it is recommenced in the starting wale, but no displacement of design is noticeable between the adjacent finishing and starting wales of the fabric tube.

4 *Non-fixed geometric selection devices* hold a limited number of different selection widths so that a new selection width may be presented, commencing in the starting wale of each machine revolution (Fig. 11.4c). Single-jersey and rib machines using non-fixed selection are termed *large-area jacquards*. A design depth is thus developed that is a multiple of the number of machine revolutions in the sequence of selection presentations. These devices produce a displacement line between the starting and finishing wales of the tube in the form of a rise by the number of feeder courses in one revolution. Usually, the tube is split open along this line during finishing.

The potential depth of non-fixed selection devices is increased by the ability to dwell (retain) a selection for a number of machine revolutions, and to rack the selection sequence forwards or backwards by one or two steps.

Only in the case of full jacquard selection on machines with stationary needle bed tricks (certain flat machines and revolving cam-box circular machines) can a successive row of selection decisions be kept in permanent alignment with each trick. On other revolving cam-box machines and flat machines, the selection devices pass across the tricks with their associated cam-sections or, in the case of revolving cylinder machines, they remain with their cam-sections as the cylinder revolves past them.

Pattern wheels or discs turn in continuous alignment but in the opposite direction to the cylinder, so that each trick in turn receives a decision from the selection sequence around the wheel periphery. The element butts being selected may be set-out at the same height. Although the selection is in a fixed set-out in a pattern wheel, the pattern depth is spirally developed over a number of machine revolutions. On machines with selector wheels, a tape may rearrange the selection set-out for the next machine revolution, or a different disc selection may be switched into operation.

With multi-butt selection, the selection butt at each trick can be placed at one of a number of different heights, usually in a geometric set-out, which together will determine the pattern width (Fig. 11.4). As either the selection device or the needle cylinder is revolving, the selection is transferred from the device by a bank of spring-loaded plates or electronically-controlled selectors that pivot across to contact any selection butts at that height as they pass (Fig. 11.5).

Instead of one pattern key (comb) at each selection, it is possible to have four different selection keys on a spindle so that, when the machine has a pattern

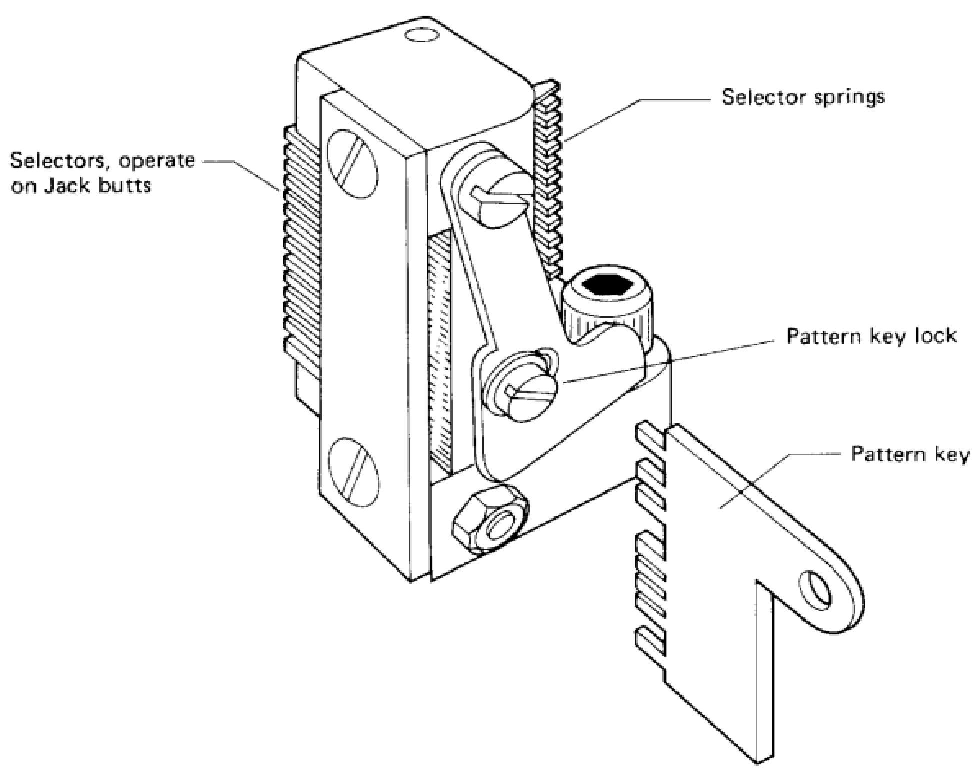


Fig. 11.5 Fixed pattern key selection.

change, the spindle is turned at each feed to introduce a new pattern-selection key.

On mechanical selection devices, a vertical row of selection teeth or pegs at each station pushes the respective height plates towards the needle bed. With non-fixed selection, a different selection row may be aligned at the start of each machine revolution at each device in turn.

11.8 Full jacquard mechanical needle selection

Full jacquard mechanical needle selection provides the possibility of independent selection over the full width of the stationary needle bed in a simultaneous movement for all needles on flat machines or onto blocks of adjacent needles on revolving cam-box circulars. Theoretically, it offers unlimited depth in traverses or revolutions dependent upon the number of jacquard steels or the length of the jacquard rolls. Each column of holes is allocated to a particular needle, with a new selection being presented by each part turn of the prism or roller.

The arrangement was widely applied to flat machines. It has also been employed on rib jacquard and garment-length purl machines produced by the *Wildman Jacquard Company* (see previous editions of this book). Pattern changing was time-consuming and expensive (just one design row of two-colour jacquard around the machine involved 2×1344 separate punched hole positions). In addition, low production speeds, a limited number of feeders, and coarse gauge restricted its use. Full mechanical jacquard selection has now been replaced by electronic jacquard selection on both V-bed flats and on circular machines.

11.9 Multi-step geometric needle selection

Multi-step geometric selection has developed from the *Brinton* trick wheel of 1926, which first employed single butted depressible selectors beneath the cylinder needles rather than in an intermediate drum. Figure 11.6 illustrates a device, used on *Wildt Mellor Bromley* machines of the RTR range, for either rib jacquard or rib loop transfer selection on circular garment-length machines with revolving cam systems. The pattern drums move with their associated cam sections and have a circumference of 40 vertical rows of selection. As each drum passes the garment control mechanism, it may be caused to single or double rack forwards, or single rack backwards, or be bluffed to dwell and retain the same selection for the next machine revolution. Thus, within the pattern depth, 40 different feeder courses are possible for each pattern drum.

Each vertical column around the drum has a height of either 24 or 36 selection positions, depending upon the model. This depth corresponds to the pattern width repeat. The drums are either drilled with holes to receive push-in metal pegs or are equipped with grooved tricks for the insertion of pattern jacks whose butts are snipped off according to the pattern. The latter arrangement is generally preferred as the jacks can be prepared in a less laborious operation whilst the machine is knitting another design.

A bank of spring-loaded selector plates, corresponding in height to the possible selection heights, works with each drum to transmit the selection to the cylinder.

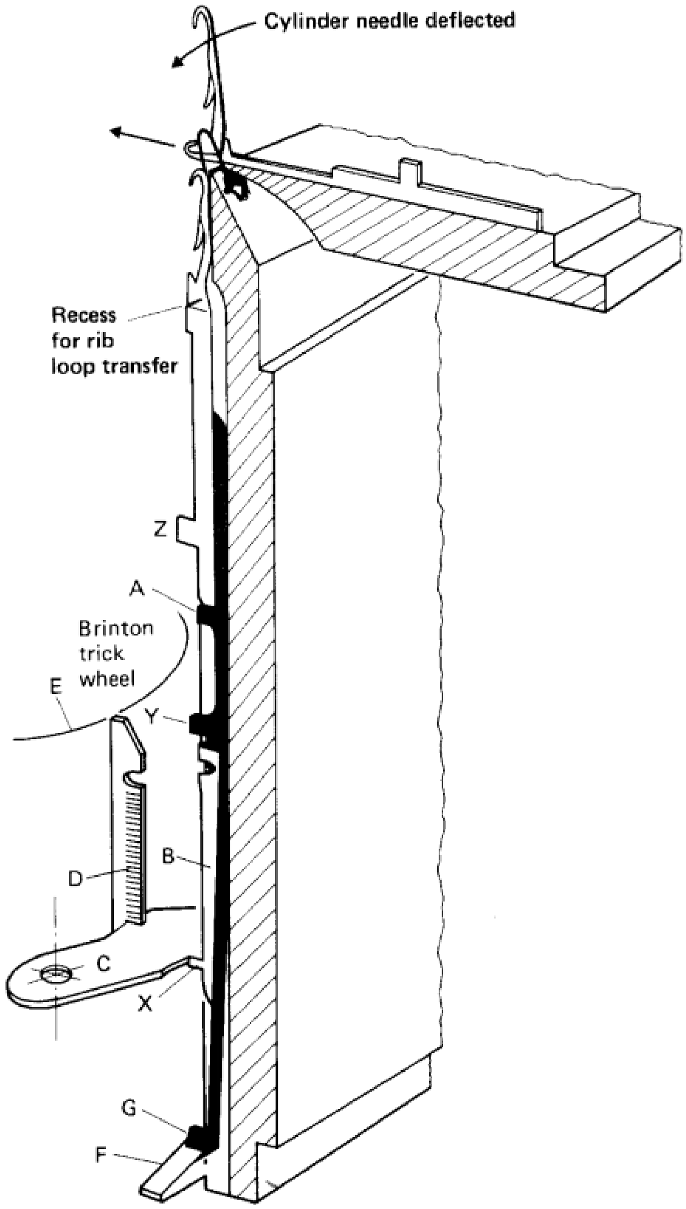


Fig. 11.6 Geometric selection using Brinton trick wheels.

The tail of each cylinder needle is supported by the upper edge (A) of a spring-tailed lifting jack. A selector presser (B) is placed in front of each jack in a trick. The presser has a complement of 24 or 36 pattern butts corresponding to the width repeat; all except one butt (X) are removed so that a chevron or echelon pattern butt set-out is arranged around the needle cylinder.

The tail of the lifting jack is sprung outwards, so that its raising butt (G) is in line with the raising cam (F) (F may be either a clearing cam or a rib loop transfer cam). If butt (G) follows the profile of cam (F), the jack will lift its cylinder needle to either knit or transfer its loop, depending on the cam position and shape.

The selection is indirect, requiring a decision for non-movement of the needle.

When a pattern bit (D) is placed in the vertical row of the drum directly facing the cylinder at the same height as the pattern butt (X) of a needle jack presser, the spring-loaded plate (C) at that height will be pivoted towards the cylinder so that it presses against butt (X) as it passes by. This causes the tail of the jack to be depressed into the cylinder so that its butt (G) goes behind the raising cam (F) and the needle is not lifted.

Needle butt (Z) is used to lower the needle and this, in turn, lowers the jack ready for selection at the next cam system. The effect of the selection may be cancelled (for example, in the rib border of a garment length) by introducing a raising cam to lift all jacks by means of butts (Y).

11.10 Needle selection by disc

The *Mellor-Bromley* rib jacquard (RJ) system uses revolving stacks of discs at each feed selection position. The replaceable disc stacks are rotated in unison with the machine drive. On 72-feeder machines, the stacks are accommodated at two alternately staged heights. When a disc tooth contacts the bottom half-butt of a presser (X in Fig. 11.7), it causes the jack tail (Y) which supports it to be retracted into the cylinder so that its tail butt misses the raising cam (Z) and the needle which is supported by the jack is not lifted to knit.

Presser half-butts are of two types: those with an upper half-butt (X in Fig. 11.7) are placed in odd cylinder tricks, and those with a lower half-butt are placed in even tricks.

A selection disc is actually composed of a pair of discs, the teeth of the upper one selecting odd needles by means of the upper half-butt and the teeth of the lower one selecting even needles by means of the lower half-butt (O in Fig. 11.8). As each only selects alternate needles, their teeth are cut twice as coarse as the machine gauge and are centred for these needles. The total number of teeth in a selection disc determines the pattern width, which may be 144 wales in 28 gauge.

At any cylinder revolution, a disc at the same height at each stack will be selecting. After each revolution, the pressers may be raised or lowered to a different height so that their half-butts are aligned with a different disc selection. In this way, as many as 18 discs, each for a selection at a different cylinder revolution, may be accommodated at each stack.

The height control of the pressers is achieved through their identically arranged and carefully-spaced guide butts, of which each may have as many as 10, depending upon the height of the disc stacks. During each cylinder revolution, two of these butts are in contact with a guide channel that surrounds the cylinder so that the pressers are held at a constant height. Three bolt cams, situated at a short break in the channel, provide the choice of serially lifting, lowering or retaining (bluffing or dwelling) the pressers at the same height for the next cylinder revolution. Introduction or withdrawal of each cam is controlled by separate tracks on a punched-hole film that racks once per cylinder revolution and thus has a major effect on the pattern depth.

Fig. 11.8 illustrates the change of presser height (S) at each of eighteen cylinder revolutions so that its half-butt obtains the selection from every disc (D) in the stack. Notice that, during the revolutions whilst the presser is being lifted, its guide butts occupy position (A) in the guide.

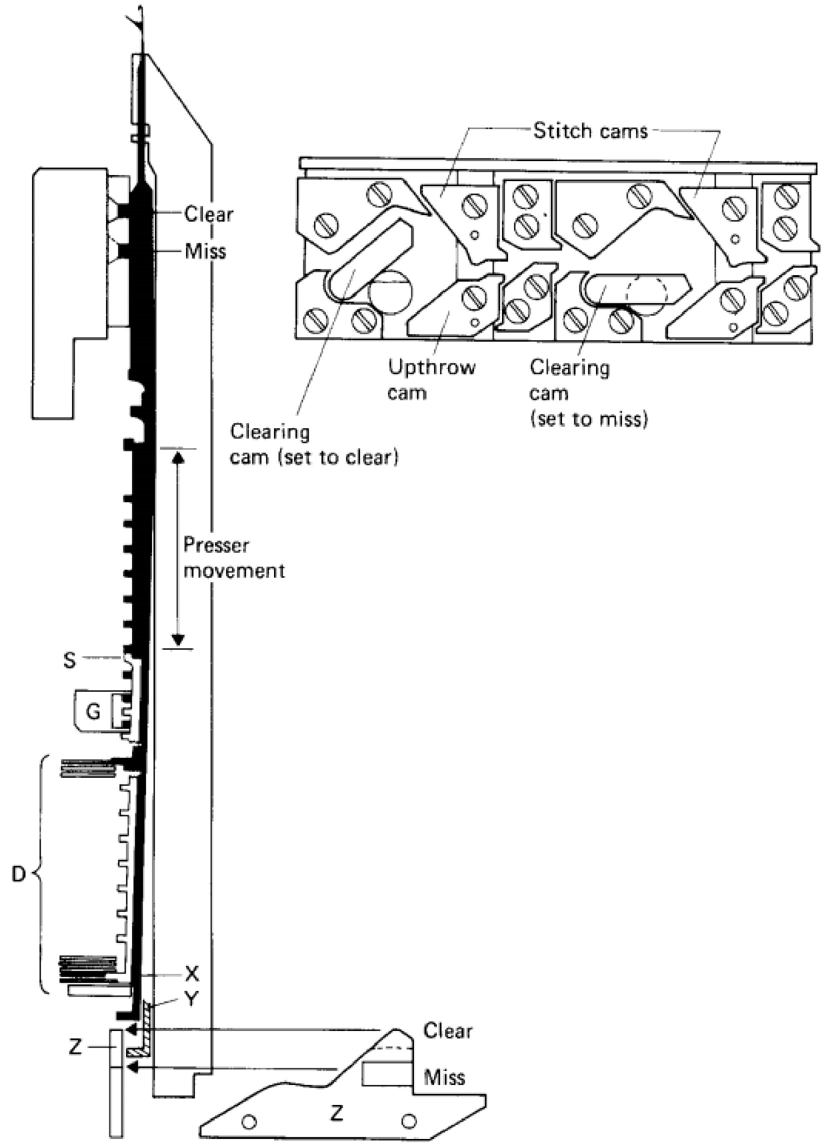


Fig. 11.7 Disc selection.

11.11 The pattern wheel

The pattern wheel is a cheap, simple device occupying little space, and is unique in employing separate raising cams, in the form of pattern bits, to select and move individual elements, if necessary, to three different positions in their tricks (Fig. 11.9). It is most popular in single-jersey machines, either as an inclined wheel for needle or point selection, or as a horizontal wheel for plush sinker selection. The pattern set-out, which is unchanged during knitting, uses bits which are either re-usable and are inserted into the tricks, or are break-off teeth on pre-prepared discs.

The wheels, tricked to the same gauge as the revolving cylinder needles, are driven continuously in the opposite direction, either by the needle butts meshing with their tricks or by gearing from the cylinder.

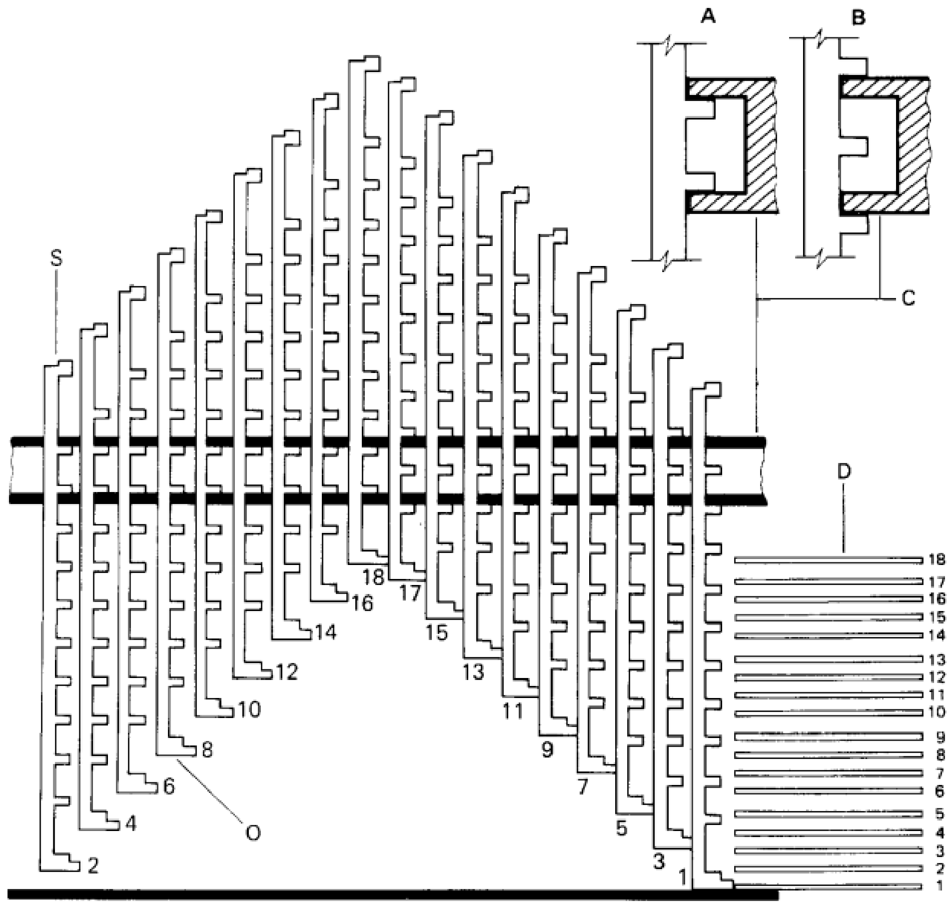


Fig. 11.8 Change of presser position from one revolution to the next.

The wheels are of the gain or loss type so they do not produce an exact number of complete turns in one machine revolution. The design areas can have a depth greater than the number of feeds, but are built up in a spiral manner, compared with the courses around the fabric tube.

The inclined pattern wheel, like all selection devices, is normally placed at each feeder. It is set at an angle of 20–40 degrees in place of the solid raising cam so that, as it turns, it lifts any element whose butt rests on a pattern bit. The needles will all have a butt of the same size in the same position.

With a three-position wheel (Fig. 11.9), a needle entering an empty trick will remain at miss height (3), a needle supported by a low bit will be lifted to tuck (2), and a needle supported by a high bit will be lifted to clear (1). Needles left at miss height are lowered by a wing cam (X) to ensure that they do not inadvertently receive yarn.

Some machines have four-finger striping selection available at each feeder wheel, which considerably increases the pattern depth and scope. Another mechanism often used in conjunction with striping is a pattern placer, tuck bar, or pattern-cancellation device, which is a moveable raising cam, usually acting onto a butt at a level lower than the pattern wheel. When the cam is raised into action, it causes

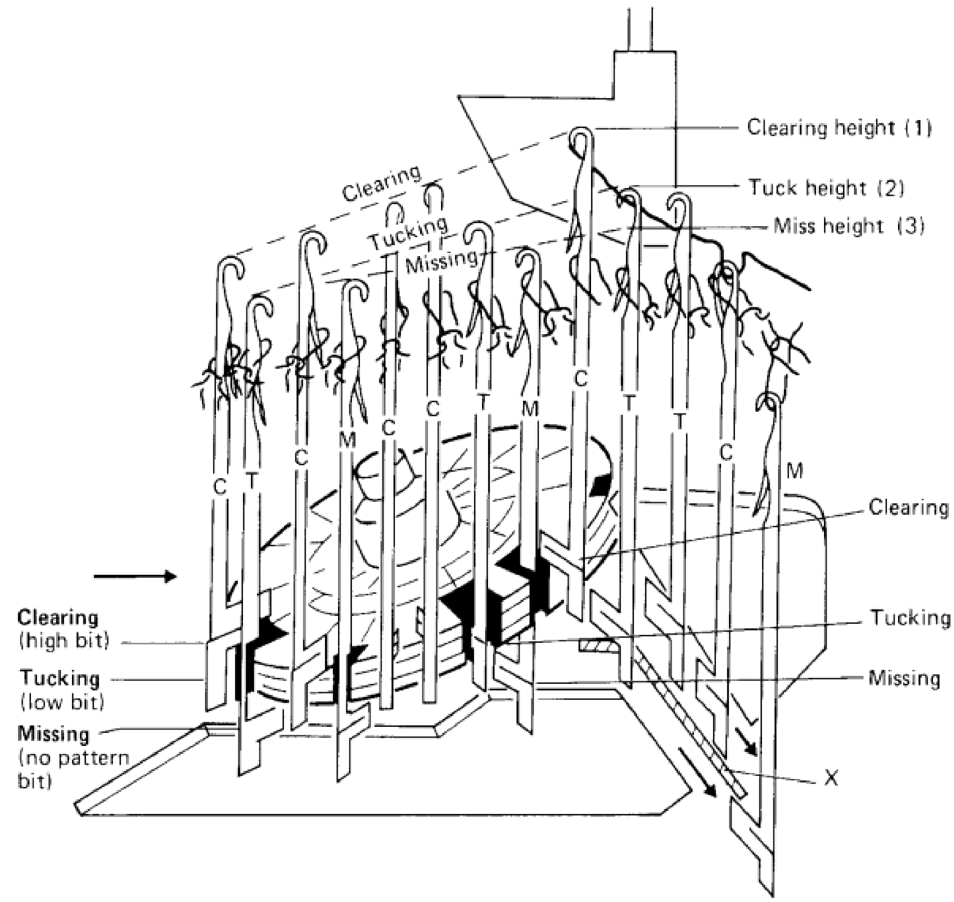


Fig. 11.9 Three-step needle selection using a pattern wheel.

all needles to be lifted to knit and thus cancels the selection for a number of courses so that alternating bands of design and plain single colour may be produced.

Alternative methods of needle selection with higher productivity, less restrictive pattern areas, and quicker pattern-changing facilities have replaced the pattern wheel as the most popular method of pattern selection.

11.12 Pattern wheel design areas

The principles governing design areas apply to all wheel selections, including sinker-wheels with plush and plain plating sinkers, provided that their set-out remains unchanged during knitting (Fig. 11.10). The wheels are generally of the same size and gauge on the same machine. The needle producing the starting wale of the design is marked and, as the cylinder turns during the first revolution, it will align with the marked starting trick of each wheel in turn, to ensure that their selections commence above each other in the same wale. As the widths will be of the same size and similarly arranged in each wheel, they will be built-up into a pattern depth, each exactly aligned with the previous one, commencing with the first feeder selection. They will therefore be arranged as columns of pattern widths around the fabric tube.

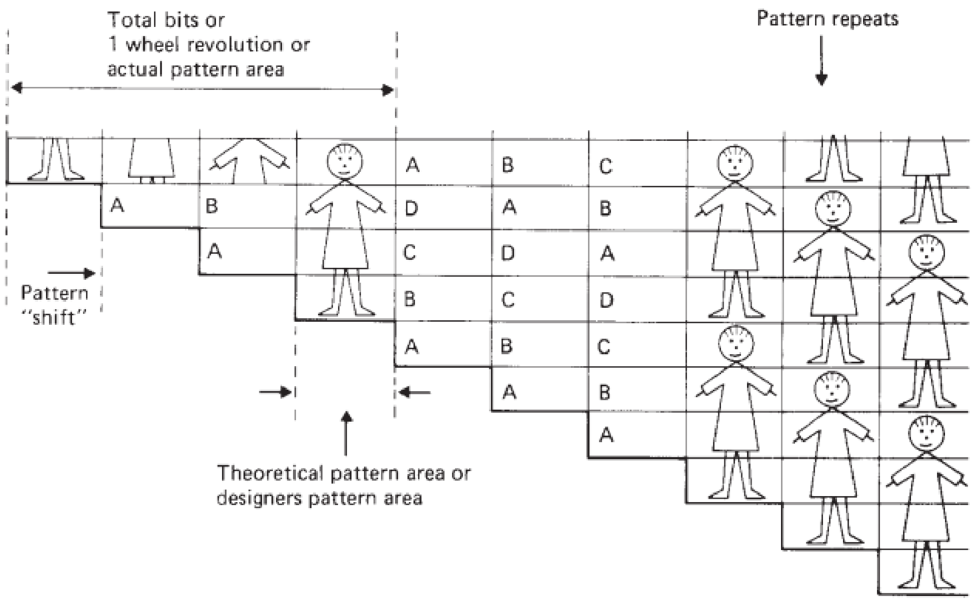


Fig. 11.10 The building of pattern areas over a number of machine revolutions using pattern wheel selection.

A rectangular design area is developed if the chosen width (W) is the highest common factor (hcf) of the cylinder needles (wales in the fabric tube) (N) and the tricks in one wheel (T).

A non-spiral design area, showing no fall (f) in courses from one pattern width to the next across the fabric, is produced when T is an exact factor of N, so that $W = T$. In one machine revolution, the wheels will make an exact number of turns and their starting tricks will re-align with the starting needle in the cylinder, thus completing the pattern depth.

The number of pattern width columns around the fabric tube (P) = N/W. The pattern depth (D) in feeder courses = Feeders (F) × depth per feed or number of pattern widths in one wheel (d).

To convert the number of courses to pattern rows, it is necessary to divide them by the number of colours (C) in the design.

Example: If $N = 1400$, $T = 140$, $F = 36$, $C = 2$.

Calculation: $W = 140$ (hcf of N and T)

$P = N/W = 10$

$d = T/W = 1$

$D = F \times d = 36$ Therefore depth in pattern rows $= 36/C = 18$.

With a design area of 140 wales by 18 pattern rows, it is too wide and too shallow for most designs.

Spirally-developed designs are used because they provide a greater pattern depth but, as a consequence, they also produce a fall between one pattern area and the next one adjacent to it. They are produced when T is not an exact factor of N (i.e. $N = nT + RT$) where n = a number of whole turns of the wheel and R is a fraction of a turn.

At the second revolution, the starting tricks in the wheels will not re-align with the starting needle in the cylinder, and the continuous selection of the wheels will have 'shifted' or 'moved on' compared to the cylinder needles. Each wheel can be set-out with more than one width ($d > 1$) and W will be a factor of R, so that a different width selection will be produced in the first column of design and in all the others in turn at the next machine revolution, as a result of the shift of the wheels.

The pattern depth will therefore be increased by a multiple of d and it will be built up during d revolutions of the machine, after which the starting tricks of the wheels will again re-align with the starting needle in the cylinder because, by then, they, as well as the cylinder, will have completed an exact number of turns.

The disadvantage of spirally-developed designs is that each wheel is producing a number of different pattern width selections in adjacent columns along the same feeder course and, as these are for different courses in the pattern depth, the pattern areas will appear to fall from one column to the next.

The fall (f) is expressed by the difference between the two adjacent widths in courses in the direction of knitting, which is towards the right in fabric produced on machines with clockwise revolving cylinders. It must be understood that each wheel has shifted sideways by the same amount, so that its width selections are placed exactly above those of the first wheel and are in the correct sequence for the depth. Therefore, although the areas show a fall or drop, the courses are always correctly placed within the pattern depths.

Half-drop design areas occur when $N = nT + 1/2T$ so that $W = 1/2T$ and $d = 2$. It will take two machine revolutions to develop the pattern depth in the starting pattern column but the wheels will, as they turn, place the selection for their second width in the adjacent column and thus produce a half-drop of the pattern area. Using the previous machine data as guide, $N = 1400 + \frac{1}{2}T = 1470$; $W =$ hcf of N and $T = 70$; $N/T = 10\frac{1}{2}$; $P = 21$, $D = F \times 2 = 72$. The wheel of the first feeder will make course width 1 and ($F + 1$). As the two widths will occur in adjacent columns, the fall will be 36 courses in a total depth of 72 courses.

(Calculations for other types of pattern drops are included in previous editions of this book but are no longer in general use.)

11.13 Electronic needle selection

Electro-magnetic needle selection is now available on many types of knitting machines; this was first commercially used on circular rib jacquard machines (Fig. 11.11). The electronic impulse that energises an electromagnet is usually assisted by the field of a permanent magnet, and the minute selection movement is then magnified by mechanical means.

If all the needles, or a block of needles, were to be simultaneously selected, each would require its own actuator. It is much cheaper to select the needles at a single selection position in serial formation, using between one and six actuators, although the time interval between each selection impulse is shorter.

Many of the modern electronic selection units are now *mono-system*, i.e. the selection butt position for each needle is at the same height, so the time interval between each selection impulse is the time between one needle and the next passing the selection position. The selection speed can be as fast as 6000 needles per second. These selection units are very compact and can now be fitted into the dials of

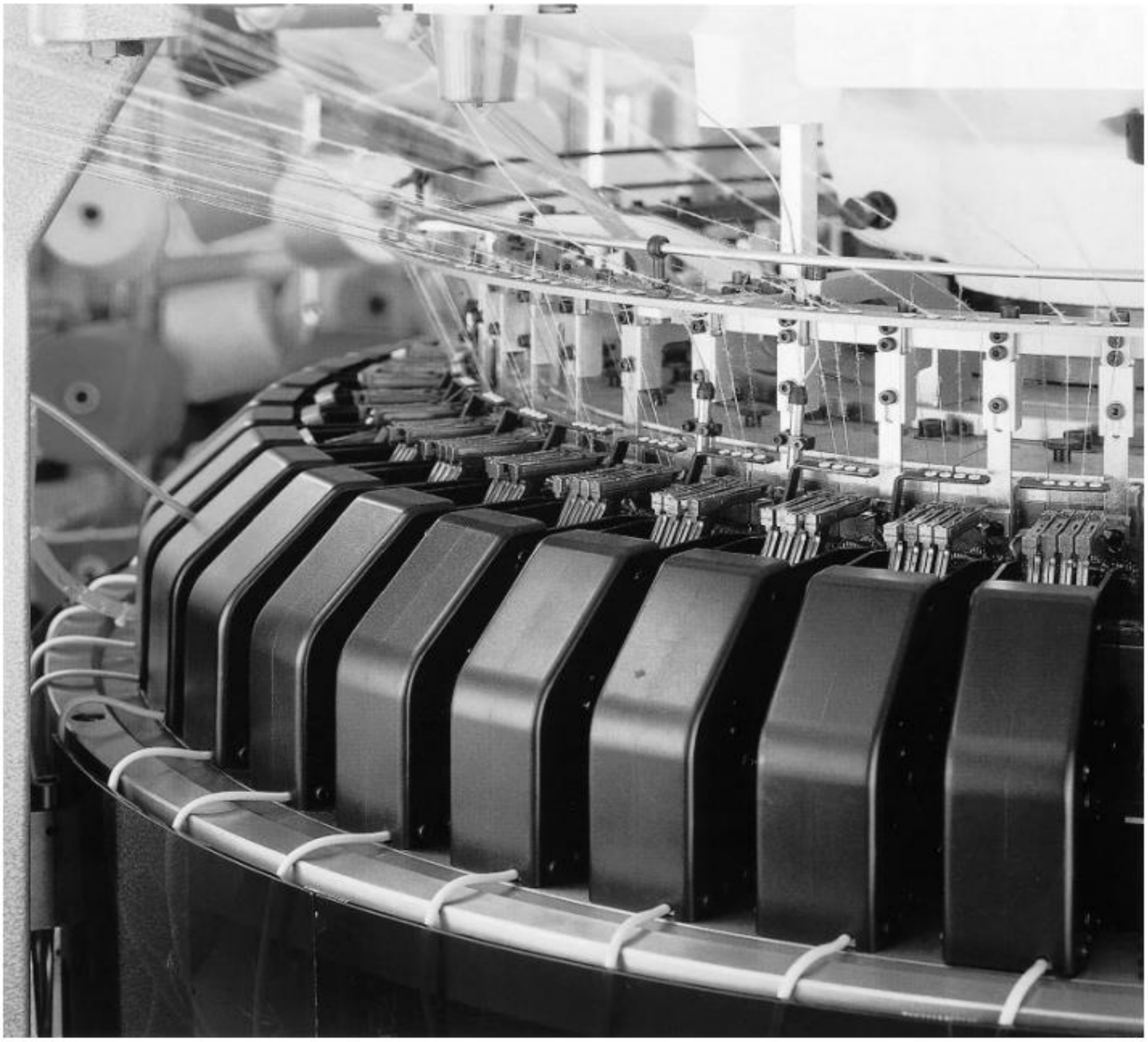


Fig. 11.11 Piezo-electronic rib jacquard machine with three-way selection and four-colour stripers

large-diameter circular machines for dial needle selection in addition to cylinder needle selection [1].

The *Moratronic* was one of the earliest machines and was first exhibited in 1963 (Fig. 11.12). For each feeder, a photo transistor scans its own track of an endless 35-mm film, giving a selection for each jack control spring as it passes the control position of the feeder. If the position on the film has a transparent spot, light is transmitted to generate an impulse. If the position on the film is opaque, no impulse is generated for that control spring. The impulse is magnified to energise a coil and thus neutralise its permanent magnet at the control position at the precise moment when the jack control spring is guided onto it. The spring is thus not held by the magnet and stands vertically to pass on the far side of a wedge-shaped control cam.

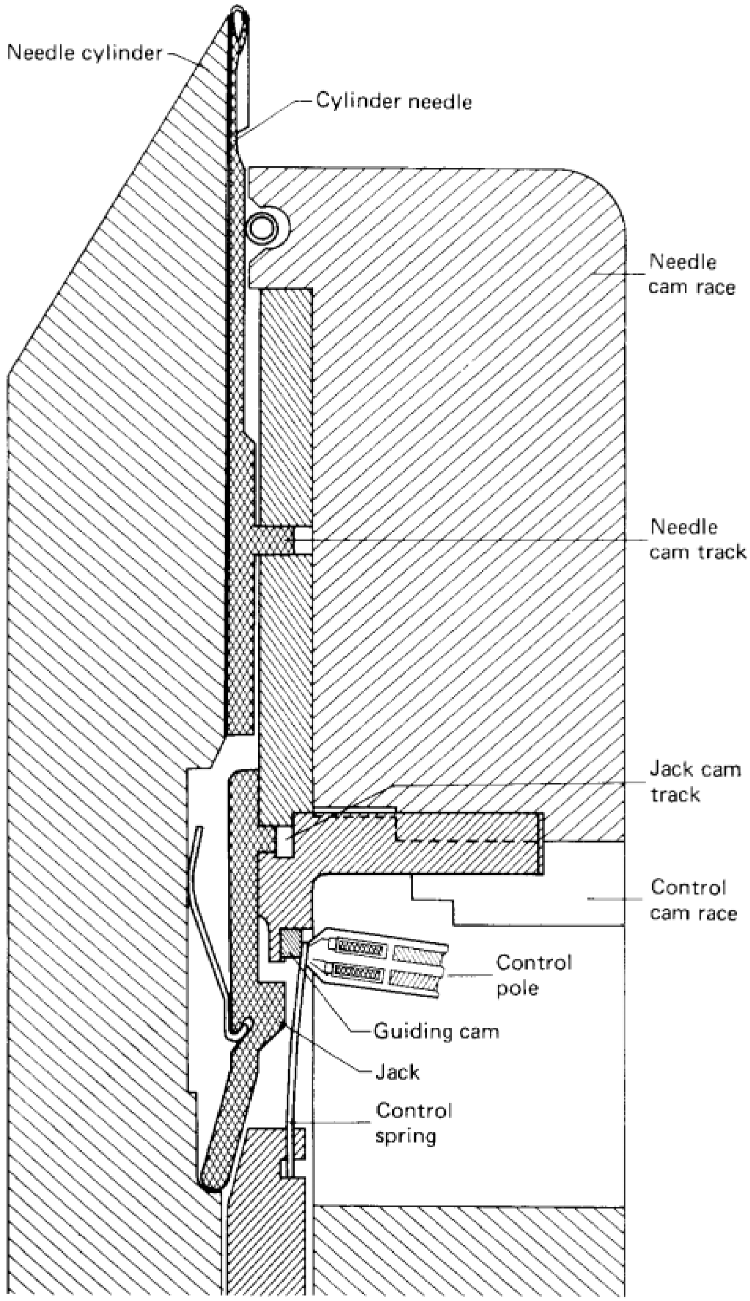


Fig. 11.12 Moratronic needle selection.

As the cam presses onto the spring, it depresses the jack into a deep recess of the trick so that the jack butt is pushed away from the cylinder raising cam and the needle supported by the jack is not lifted to knit. If no impulse is generated, the control magnet can hold the spring so that it passes in a bent position on the near side of the control cam and is held away from its jack, which stays out of its recess with its butt remaining on the raising cam to lift the needle above to knit.

The film is driven in phase with the needle cylinder to make a selection in

0.5 milli-seconds. Twelve million selections are possible – enough for a full-width selection 1564 pattern rows of three-colour design deep.