17

Spool and Gripper Axminster Carpets

It has been shown in previous chapters that excellent figured effects can be produced in carpets in which the tufts are formed from continuous lengths of pile yarn controlled by a jacquard. Unfortunately, such carpets, whether produced with the aid of wires or on the face-to-face principle, suffer from a limitation in the number of colours which can be employed in each longitudinal row of pile, and their production involves a wastage of the expensive figuring material in the form of dead pile yarns. It is this wastage, inherent in the construction, which for reasons of practical economics limits the maximum number of colours per row of pile to five. Admittedly, the total number of colours in a carpet can be increased appreciably by planting but excessive or unskilled colour planting may result in the formation of stripes which detract from the excellence of a design. There is, therefore, a limit to the extent of planting and when it is realised that carpet designers, especially in connection with floral designs, often speak in terms of, say, eight shades of brown and six shades of green for the background even before the main colours are considered, it is obvious that the limits of planting are soon reached.

No such limitations existed in the fore-runner of all pile carpets, the hand-knotted carpet, where every tuft could be of a different colour without creating any wastage in respect of the dead pile yarn content, with the additional benefit of a very firm tuft anchorage. The two chief systems of hand-knotting are illustrated in *Figure 17.1*, in which A shows the Ghiordes or Turkish knot which is mainly used in Turkish and Caucasian carpets. Each knot is formed on two adjacent warp threads and both ends of each tuft come between the two threads. B in *Figure 17.1* represents the Sehna or Persian knot chiefly used in Persian, Central Asiatic, and Chinese carpets. The pile yarn encircles one warp thread while the two ends of each tuft pass separately between the two threads, so that a thread and single tuft alternate. This method produces a more uniform surface of pile and enables a closer texture to be made than with the Turkish knot. Thus, while in Turkish carpets the knots range from 4 to about 16 per cm^2, Persian carpets are made with up to 80 tufts per cm^2.

Although the hand-knotted carpets are still produced their share of the market is very small and is likely to decline even further in view of the rapidly increasing labour costs. Due to the structural advantages of the hand-knotted carpets efforts were made to produce machines which could imitate the knotting action and thus improve the rate of production of such carpets. Eventually, machinery capable of reproducing faithfully either Turkish or Persian knots was devised and is still used in a number of European countries. Mechanisation of the knotting action has resulted in a severe limitation of the colour range and although it

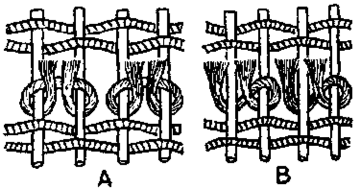

Figure 17.1

represents an improvement in the rate of production compared with hand-knotting the operation is too slow to compete on equal terms with spool or gripper systems of carpet weaving. Consequently, it is confined mainly to the production of high quality, luxury articles, usually in designs which reproduce the traditional Eastern styles of ornamentation. The inventions of the spool and, later, of the gripper Axminster systems have overtaken the machine-knotting looms and between them they now represent the major means of production of multi-coloured woven carpets with no dead pile yarns in the ground structure.

In spool and gripper carpets a horizontal row of pile tufts is formed, usually at intervals of three double picks, by passing the tufts around one of the double picks, as illustrated in *Figure 17.2*. In the warp each group of threads consists of two chain ends and a stuffer end, the length of the former being alike in the structure shown at A so that, in addition to the stuffer warp beam, only one chain beam is necessary. In the structures B, C and D, however, the chain ends vary in length so that the two chain beams are necessary. The double pick arrangement

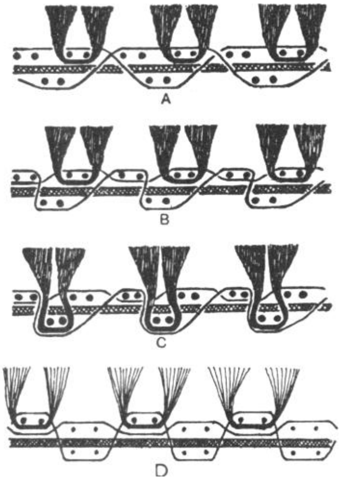

Figure 17.2

of the weft occurs because, instead of a shuttle, a rigid rapier or needle carries the weft across the full width of the warp. The weft, which is usually jute, is taken from a large cone placed near the floor, the method of supply having the advantage that a large amount of fabric can be woven without the weft being replenished.

Diagram A in *Figure 17.2* shows the three-shot structure, known as *Imperial*, which is generally woven by the spool method. The fine chain ends interweave over and under three double picks and a slightly sloping tuft, which gives good cover, is produced by the pressure of the double pick that is in the corresponding shed to that of the double pick that holds the tufts. B in *Figure 17.2* differs from A as regards the interweaving of the chain ends. This structure was first woven on a Crompton spool loom and the term *Crompton* was applied to it, but it is now produced on the gripper system and is known as the *Corinthian* structure.

Structures A, B and D in *Figure 17.2* give the most economical use of the pile yarn in the woven fabric, as each tuft forms part of the surface design and none of the pile material is concealed in the body of the fabric, except what is used for attachment to the binding threads. The structure D, however, results in a rather poor tuft anchorage and is only suitable for very densely tufted cloths.

In the structure represented at C in *Figure 17.2* the chain and stuffer ends interweave the same as in B, but the tufts are inserted round a different double pick on which the stuffer ends are raised. The pile tufts are held more firmly than in the other structures and they show on the back of the fabric somewhat the same as in a hand-knotted texture, which is an advantage. The gripper system can be adapted to weave the structure, but the pile material is not used so economically as in structures A, B, and D and the style is employed to a lesser extent. The construction C is known as the wool-back or Kardax weave.

Most of the machines are built to produce carpets in a standard pitch of 28 per 10 cm (7 per in.) i.e. 28 longitudinal rows of pile per 10 cm width. For very fine carpets looms are constructed in a higher pitch of 31 or 35 per 10 cm (8 or 9 per in.). On the other hand, for so called Berber rugs, in which very coarse pile yarns are used, special machines are employed with a pitch of only 12 or 16 per 10 cm. As the looms are built to a pre-determined warp setting the quality is changed by varying the density of weft spacing, i.e. in effect, the number of horizontal rows of pile tufts per unit length. Usually, the horizontal rows of pile per 10 cm vary between 18 to 48. Normally, the length of yarn required to form one tuft varies from 18 to 30 mm but for high pile rugs, known variously as shag pile, rya or Berber, machines are available to provide twice the above length of yarn per tuft. Modifications have also been made in the gripper system to permit production of carpets with two different heights of pile.

The ground warp yarns are usually cotton or staple viscose rayon in linear densities ranging from 180/3 tex to 250/3 tex, although other materials, such as hemp, are also used and recently some manufacturers employed polypropylene filament yarns for chain warps. The pile yarns are normally woollen spun and may be all wool, or wool in varying blends with man-made fibres or entirely synthetic and range in linear density from 500/2 text to 620/2 tex for standard qualities of carpets. For gripper Axminster carpets three-fold instead of two-fold pile yarns are sometimes used. The weft is almost invariably jute of about 520/2 tex but sometimes the bottom shot consists of low quality woollen yarn to improve the resiliency of the construction.

THE SPOOL AXMINSTER SYSTEM

A design for spool Axminster carpets is painted in the usual manner on squared paper ruled to correspond with the pitch of the machine and the number of horizontal rows of tufts per unit length. Thus, each square corresponds to one tuft. Normally the colours used in the design are the same as the actual colours of tufts in the carpet. Apart from aesthetic considerations and difficulties of dyeing and matching a huge range of colours there are no limitations as to the number of colours used in a design and some contain 40 or more different shades and hues. No colour gamut is necessary.

The system is a two-stage process comprising:

(1) Spool setting, which consists of winding pile yarn on to spools and during which the design formation and colour sequence is determined.

(2) Carpet weaving, where tuft insertion takes place in an order already determined by the previous operation.

Spool setting

A general view of a machine used for spool setting and of the associated flat table creel is given in *Figure 17.3* and an empty and a full spool are represented in *Figure 17.4*. The design is pinned on to a drum above the machine and the first horizontal space is set to a straight edge, the surface of which is divided into spaces of the same pitch as the vertical ruling of the design. The straight edge enables the order in which the colours are indicated on the horizontal space against which it rests, to be readily followed. The bobbins of coloured yarn are then creeled to pattern in the same order as the colours are shown on the first horizontal space, and the threads are drawn forward, passed in the desired order through an open reed which is the same sett as the weaving reed, and are wound under suitable tension on to the first spool, as illustrated in

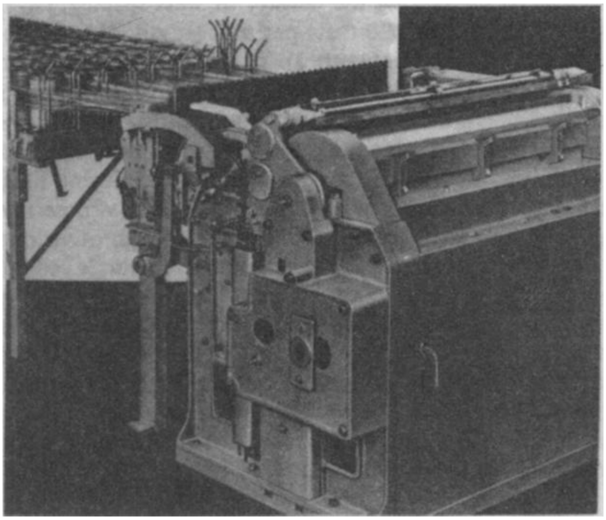

Figure 17.3

Figure 17.3. A separate spool is wound for each horizontal space of the design, that is for each horizontal row of tufts, and as many pile threads are wound on each spool as there are tufts of pile to be formed in the width. Thus, a design

1 m long for a 1 m wide carpet with 25 horizontal rows of tufts per 10 cm and 28 tufts in width per 10 cm, requires 10 x 25 = 250 spools and 10 x 28 = 280 pile threads on each spool. The number of spools is, of course, influenced by the form of the design; thus, a figure that reverses at the centre requires only as many spools to be wound as there are horizontal spaces in the half-repeat, the second half of the design being woven by running the spools in the opposite direction. The spools are numbered from one upwards to coincide with the horizontal spaces of the design, and for each succeeding spool the bobbins of pile yarn are rearranged as to colour in the creel in the same order as the colours are indicated in the corresponding horizontal space, in which order they are wound on to the spool. At each creeling the length wound on is regulated according to what it is estimated will be required for the length of fabric to be woven, and if the length is considerable, two or more spools may be wound from each creeling of the bobbins. When the desired length has been run on to each spool the threads are cut and secured in position.

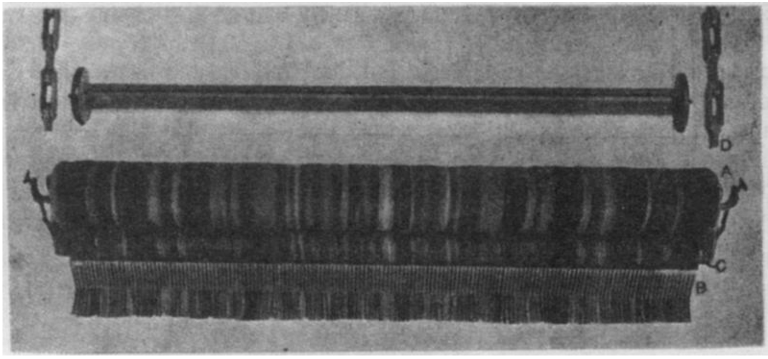

Figure 17.4

Each spool is capable of accommodating a sheet of between 10 to 15 m of pile yarn depending on the thickness of the yarns used and on the flange diameter. If it is assumed that, for a carpet requiring 2 cm of pile yarn per tuft, each spool contains 12.3 m of yarn of which 0.3 m represents waste (end wrap, trimmings, etc) then the spool will yield 1200 ÷ 2 = 600 tufts. As each spool is representative of one horizontal row of tufts in a repeat it is clear that 600 design repeats will be produced from one spool and, of course, if the length of the repeat is equal to the length of a carpet square then, effectively, one set of spools will yield 600 identical carpets. In fact, it is not normally economic to wind just one spool after each creeling and usually at least two or three spools are wound which duplicates or triplicates the number of identical repeats or carpets which need to be produced before the point of economic viability is reached. The main reason why it is necessary to wind more than one spool, and the more the better, for each creeling lies in the fact that it is the creeling operation which is time consuming; winding on is very rapid and modern spool setting frames are capable of winding the sheet of yarn on at 15 to 25 m per min. It is, therefore, undesirable to expend an appreciable length of time upon creeling for the purpose of just one minute's running on time.

After winding the threads from each spool are drawn through a series of tubes which are shown with the pile yarn protruding through them at B in *Figure 17.4*. The tubes are situated alongside each other and are secured to a tufting frame or carriage C. This is shown in *Figure 17.4* together with end bearings that support the journals of the spool in such a manner that the spool is free to rotate. The number of tubes attached to each frame coincides with the number of pile threads on each spool, and they occupy the same width, the pitch of the tubes thus corresponding with the sett of the fabric. When each spool A, with the pile threads extending through the tubes B– as shown in *Figure 17.4*–has been attached to a tufting frame C, the pile yarn is ready for the second stage of the process–that of tuft insertion.

Spool presentation

A spool Axminster loom, of the Platt split-shot type is illustrated in *Figure 17.5*, in which a prominent feature is a gantry and endless chains that support the tufting frames at each side. *Figure 17.4* shows at D the form of the chains which are made with alternate single and double links, and it also shows at the sides of the frame C the end brackets and the flat springs by which the frame is retained in the chains. The spools and frames are placed in correct order according to the design upon the chains, which are mounted on sprocket wheels supported by the gantry, and are driven either from the main shaft of the loom or by means of a separate motor. The movement of the chains brings each frame

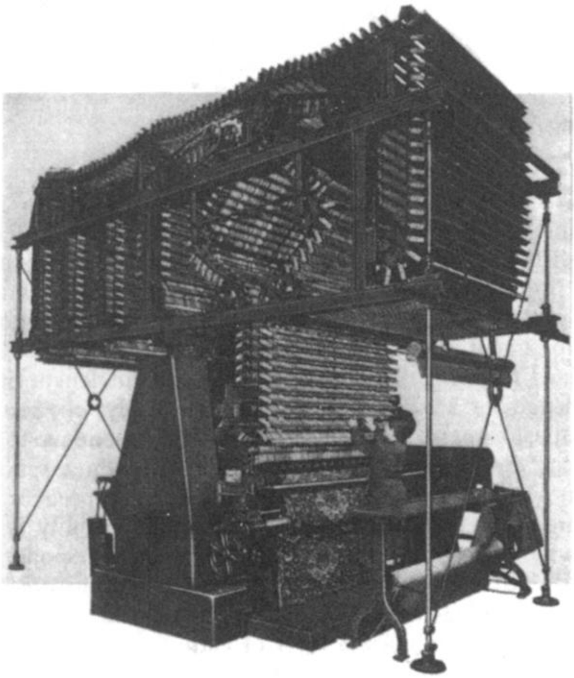

Figure 17.5

in turn, with its spool and tubes, a short distance above the fell of the cloth, and the chains then remain at rest while the frame is lowered, the pile threads are entered into the fabric and cut off, and the frame is returned to the chains.

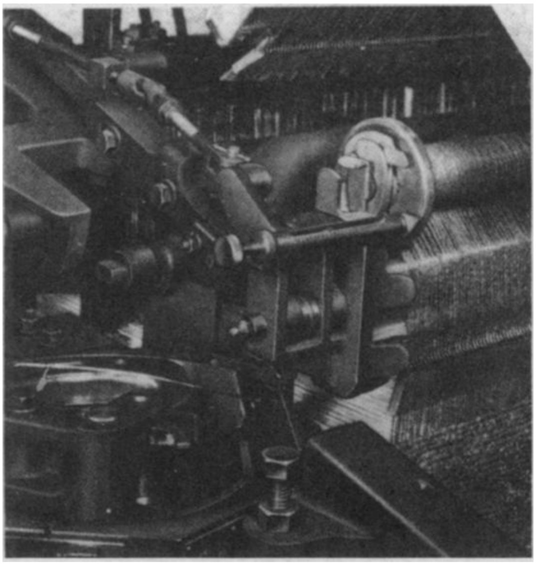

Figure 17.6

Only a portion of the chains is stopped intermittently, as the rear sprocket wheels are driven continuously in order to secure easy movement. In *Figure 17.5* a spool with its tubes is shown in its lower position, and the same is represented in *Figure 17.6* which shows the parts after the free ends of the tuft yarn have been entered between the warp threads and before the attached ends have been severed.

Loom operation

Figure 17.5 illustrates a typical, medium-width, split-shot loom, the distinguishing features of which are the formation of a double shed and the simultaneous insertion of three double picks of weft by means of two rigid rapiers or needles as shown at A in *Figure 17.7*. An enlarged view of the Imperial structure which the loom is built to produce is given at B in *Figure 17.7*, and shows that the order of shedding remains the same while each group of three double picks is put in. In C, *Figure 17.7* the two needles are shown at N in their respective sheds, the extreme top and bottom lines of which are formed by the chain ends. These are brought from the chain warp beam and change position after the insertion of each group of three double picks, while the middle line is formed by the stuffer ends which remain permanently in the centre of the shed. No heald is required for the stuffer ends.

The heavy jute weft which is usually precision wound on large cones is placed in three cans at the side of the loom. One end of weft is threaded through an eye of the bottom needle whilst the top needle is threaded with two ends of weft. As the rapiers (or needles) move forwards the weft is drawn from the can and is deposited in the form of a double strand—one double strand for each of three ends of weft—in the two sheds as shown at A in *Figure 17.7*. Immediately

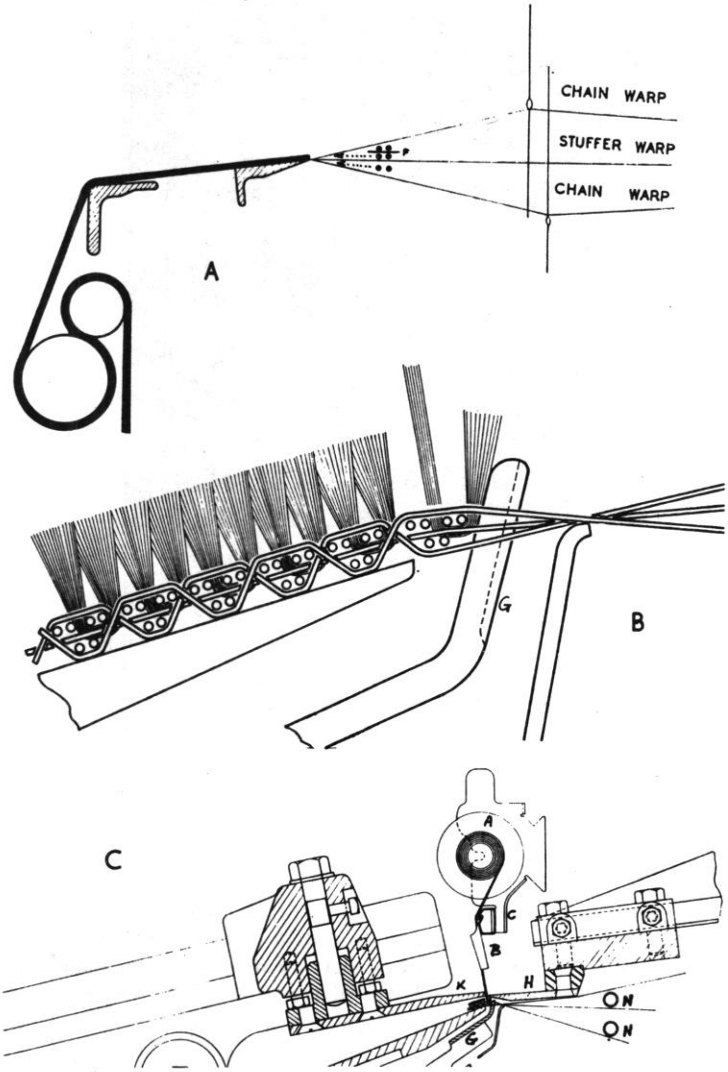

Figure 17.7

after the rapiers reach the end of their stroke a separator finger, designated F in diagram A, enters the top shed and separates—splits—the two top strands into two levels. The loops or strands of weft are held by a selvedge shuttle motion at the far end of the loom, the rapiers withdraw and an auxiliary reed comes up through the warp and beats up the two lower strands of weft to the fell as indicated by the arrows and dotted lines at A in *Figure 17.7*. The uppermost strand of weft is left isolated in the middle of the top shed in a position in which a pile tuft can be manipulated around it.

Owing to the weft being inserted two picks in a shed by means of needles, a special selvedge motion is required in order to secure the picks in the selvedge and hold them at proper tension as the needles are withdrawn. The method employed in the double-needle loom is illustrated in *Figure 17.8,* where the top needle is shown entering the top selvedge shuttle race the bottom needle

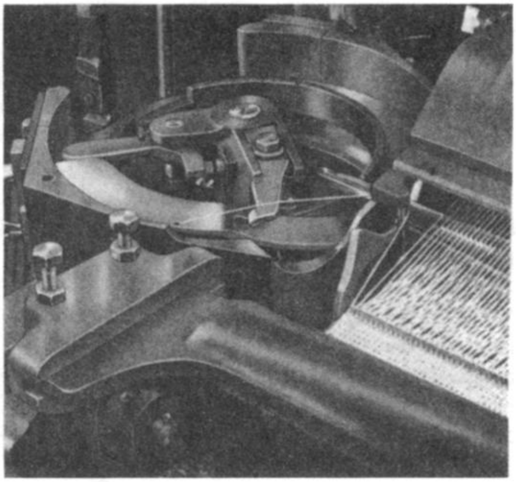

Figure 17.8

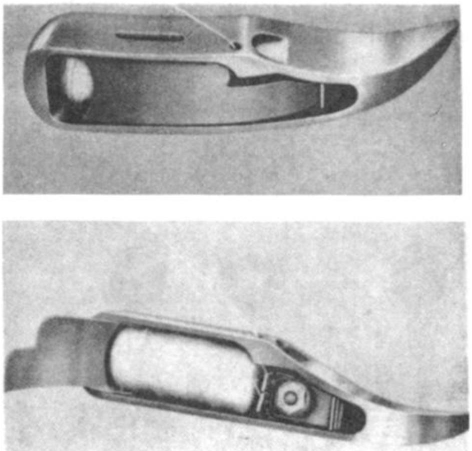

Figure 17.9

operating in an identical manner in respect of the lower shuttle. The shuttles containing strong linen or polyester catch cord move through the loops of the double picks and hold them as the needles commence to withdraw: The cords are suitably tensioned to prevent them being pulled into the body of the cloth as the needles withdraw further so that a straight and firm edge is formed.

Two views of a small selvedge shuttle containing a polyester cop are given in *Figure 17.9.* Larger shuttles which give longer uninterrupted runs have been developed for the modern broad looms whilst for narrow looms, due to high speed of operation, a stationary form of selvedge shuttle has been devised.

Tuft insertion

The operations involved in tuft insertion are illustrated in six consecutively numbered stages in *Figure 17.10.* The chain healds change position at the commencement of each cycle of operations, and the two needles insert the three double-picks of weft in the top and bottom sheds, as shown previously in *Figure 17.7* and also at 6 in *Figure 17.10.* The auxiliary reed beats up the two lower double picks and then retires. In the meantime, two arms of a transferring motion, one of which is seen in *Figure 17.6*, grip the frame C at the sides, remove it from the chains and move it downwards so that the spool A is lowered and the tubes B pass down between the groups of ends and take the tuft threads below the warp in front of the two double picks that have been beaten up, as shown at 1 in *Figure 17.10.* The insertion of the tubes B between the groups of ends is facilitated by the dents of the reed which divide them. The parts are then moved by the transferring mechanism so that the tubes are in a vertical position, as shown at 2 in *Figure 17.10*. The tubes continue to be raised, so that the upper portion of the tuft threads is brought above the level of the warp, while leaving the remainder of the threads passing vertically down between and below the ends of the warp a sufficient distance to form the right side of the tufts, in which position the main reed E beats up the third double pick against the tuft threads, as shown at 3 in *Figure 17.10.* The pressure of the reed then holds the tufts firmly, while the transferring mechanism raises the frame, spool,

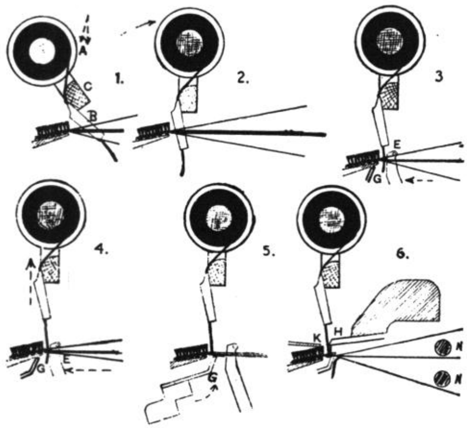

Figure 17.10

and tubes a sufficient distance to draw off the spool the required length of pile yarn to form the next row of tufts, as shown at 4 in *Figure 17.10*. During the draw-off of the pile yarn the shed commences to close and becomes fully closed as the sley moves back, while an under comb G below the fabric moves upwards, as shown at 5 and also, more clearly, in the enlarged view given at B in *Figure 17.7.* The tips of the under comb G pass through the goups of ends when the shed is closed (i.e., when the chain ends are midway of their movement as the shed changes), and they turn or double the lower portion of the tuft threads vertically round the third double pick as shown at 6 and also at B in *Figure 17.7.* As the new shed opens for the next group of picks the comb supports the tufts firmly while the attached side is cut by the knife motion shown at 6 and also at C in *Figure 17.7.* This consists of a fixed straight or ledger blade H that is parallel to the fell of the fabric, with which an inclined knife K operates on the guillotine principle at the required height to give the required depth of pile in the fabric, and at the same time sufficient length of thread is left projecting below the ends of the tubes B to form the next row of tufts. The transferring mechanism then replaces the frame with the spool and tubes in the chains which move forward and bring the succeeding spool and tubes into position in readiness for the next operation of tufting. As these movements are taking place the shed is opened and the two needles are inserted carrying the three double picks of the next group as shown at 6 in *Figure 17.10*, and the under comb continues to support the tufts until the auxiliary reed, in beating up the two lower double picks, is almost at the fell of the fabric; otherwise the tufts would fall towards the back of the loom. The under comb then moves below the fabric, and the parts assume the position shown at 1 in *Figure 17.10.*

General features

The split-shot spool Axminster looms are built in twelve different widths ranging from 46 cm to 366 cm and cannot be conveniently adapted to weave any width of cloth other than the one for which they were specifically constructed. The narrowest machines are capable of inserting 30 horizontal rows of tufts per min and the widest 14 horizontal rows of tufts per min. In favourable circumstances these speeds can be increased but when two or more looms are operated by one weaver it is advisable to reduce the rapidity of operation for the sake of better overall efficiencies. The wide looms can be made to use either sectional or single-span tube frames, and most looms are constructed to give the cloth with the standard pitch of 28 per 10 cm.

Looms can be fitted with a variety of electrical stop motions which ensure safe and faultless operation. When one weaver operates several looms stop motions are essential and frequently a full range is installed which can stop the loom for the following causes: Breakage or exhaustion of weft; breakage or exhaustion of the selvedge shuttle catch cord; breakage of chain warp end; breakage of selvedge cord; failure of warp let-off motions; failure of tube frame to leave the chains; missing tube frame; tube frame falling due to faulty replacement action; uncut pile threads. Due to the large number of stop motions they are usually connected to a central indicator panel which lights up to show the cause of any stoppage thus saving the weaver's time.

The spool system is capable of operating at very high efficiency but it is suitable only for long runs. As has been explained, the preparation processes are so time consuming that in a short run it may be impossible to recover the cost involved. The system is particularly advantageous for the production of continuous length cloth as opposed to carpet squares, especially if a short length, repetitive form of design is used. In such circumstances it is possible to achieve considerable savings in preparatory costs by running say, six or eight spools from a single creeling during spool setting.

THE GRIPPER AXMINSTER SYSTEM

A general view of the narrow gripper Axminster loom from the front and side is given in *Figure 17.11*, while the common gripper Corinthian structure is illustrated on an enlarged scale in *Figure 17.12*. (The thread interlacing corresponds with that shown in the section B in *Figure 17.2.*) The fine ends are of unequal length and require two warp beams, while a third beam is required for the stuffer ends, and the three ends which constitute a group of ground threads are operated by three healds. The reed, shown at H in *Figures 17.12* and *17.13* consists of arched dents attached to the sley which are open at the top.

On the edge of the breast plate a slotted, horizontal bar or comb L, *Figures 17.12* and *17.3*, is mounted, the slots of which correspond with the sett of the reed and admit the dents of the latter when they are in the forward position. The slots are formed to the line P in *Figure 17.12*, and are widened at the top inside the dotted line R to provide room for the warp threads which are thus prevented from being cut when the reed beats up. Incorporated with each section of the breast comb is a lip M, *Figures 17.12* and *17.13*, over which the weft is driven by the reed when beating up. The lips M serve to prevent the weft from rebounding after it has been beaten up, and they also assist in turning up the tufts after the grippers have opened.

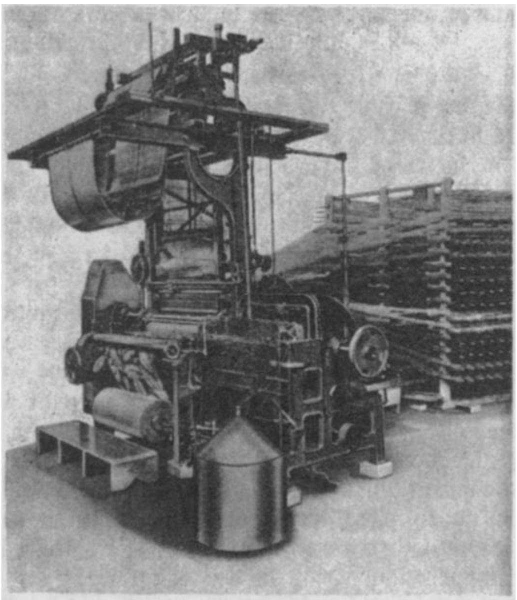

Figure 17.11

In the gripper system the preparation of the pile yarn is the same in principle as in Wilton or Brussels carpet weaving, the different coloured pile threads being wound separately upon bobbins which are placed in creel frames behind the loom, as illustrated on the right of *Figure 17.11*. Fourteen horizontal frames or rows of bobbins are shown and each frame consists of a set of bobbins of the same colour except when modifications are made by 'planting'. The number of colours in each longitudinal line of the fabric is limited to the number of frames used, but the restriction is not so great, as in Wilton and Brussels structures, for it is possible for as many as 16 frames to be employed. Generally however, not more than about 10 frames are used, but as each frame can be planted the diversity of colour effect obtainable is very considerable. The pile yarns are selected for presentation to the grippers by a special form of jacquard.

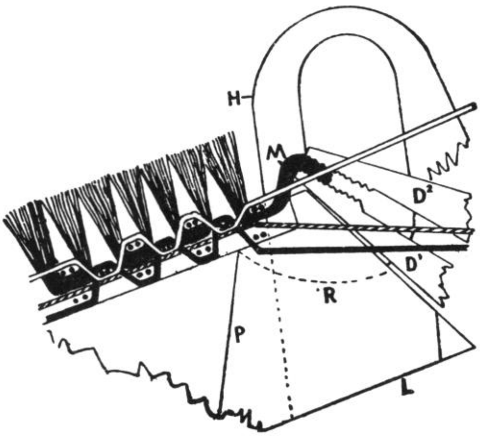

Figure 17.12

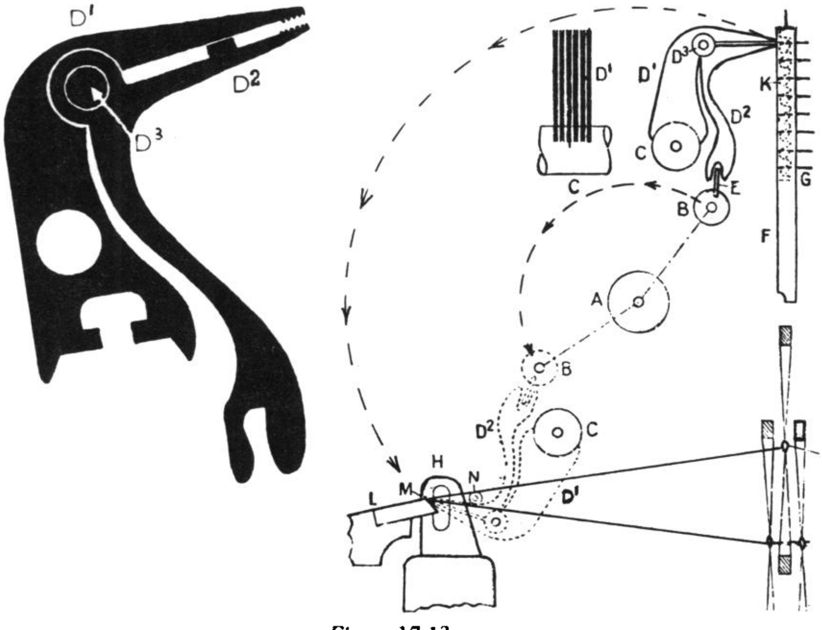

Figure 17.13

From the bobbins in the creel frames, shown in *Figure 17.11*, the pile threads pass between horizontal guide bars and through holes in a guide board to slots in yarn carriers, shown at F in *Figure 17.13*. As many yarn carriers F are provided as there are longitudinal tufts of pile formed in the width, i.e., one to each longitudinal row of pile and to each split of the reed. Each carrier consists of a narrow vertical strip of metal, grooved back and front, and contains as many slots as frames used, one above the other, through which the pile threads G pass. Suitable tensioning holds the threads in position and steadies them while they are being drawn forward and then cut to form the tuft lengths. The threads are passed through the slots in the order of the frames, those from the top frame passing through the highest slots, and those from the bottom frame through the lowest slots.

Selection of pile colours

The jacquard in this system does not operate as a shedding mechanism but simply as a pile colour selector. Design is painted on squared paper ruled in accordance with the number of vertical and horizontal rows of pile per unit space. Each square thus represents one tuft. As the pile yarns are arranged in frames it is necessary to show under the design a colour gamut to indicate to the card cutter what colours are placed on which frames—a procedure similar to the one used in Brussels and Wilton carpet designing. A gamut for eight frames, with a portion of the first horizontal row of design above it, is given in *Figure 17.14*. It will be noted that frames 1 to 3 are planted with various additional colours but by referring the design colours down to the gamut it can be easily established to which frame a given colour belongs.

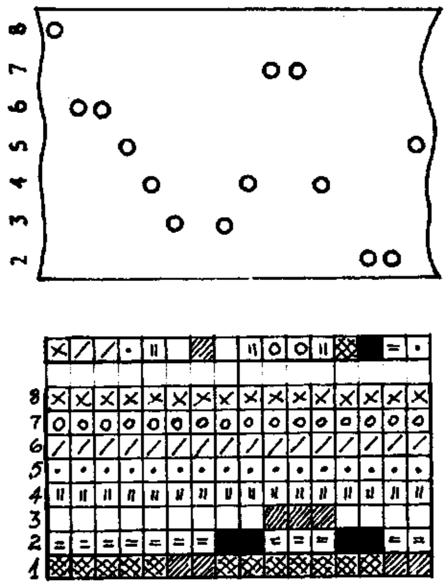

Figure 17.14

Jacquards can be built in various sizes to provide selection for 8, 10, 12, 14 or 16 frame designs. The function of the jacquard is to move the pile yarn carrier (F in *Figures 17.13* and *17.15*) to the level of the gripper which operates at a fixed height and will draw off such colour as is presented to it. A schematic diagram of an 8-frame jacquard in which a hole in the card provides selection is shown in *Figure 17.15*. It will be noted that it has only seven needles—this is so because the gripper operates at the level of frame 1 when the yarn carrier is at rest and, therefore, pile yarns from frame 1 are presented to the gripper automatically without any need for jacquard selection. This is clearly indicated by the portion of card in *Figure 17.14* where against the seventh and thirteenth tufts in the design, both of which are obtained from frame 1, no holes are cut. Obviously in the bigger jacquards there will be also one needle less than the number of frames which it can operate, thus a 10-frame machine has 9 needles, a 14 frame, 13 needles, and so on. Either coarse pitch machines with cards or fine pitch machines of the Verdol type are in use and they can be constructed to provide selection by means of either a blank or a hole. In the machine shown in *Figure 17.15* selection is obtained through the agency of a hole in the card.

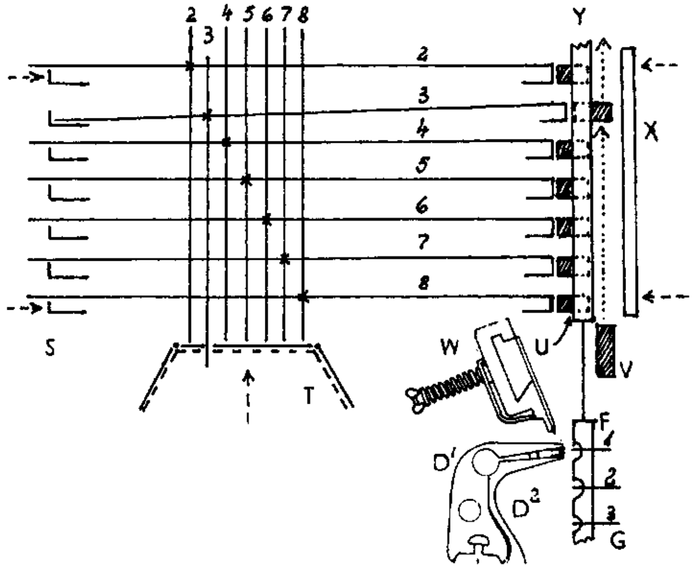

Figure 17.15

Upward pressure of the card cylinder, T, causes contact between the vertical feelers, numbered 2 to 8, and the card. Feelers opposed by blanks in the card are pushed up thus lifting the tails of the corresponding needles clear of the advancing pusher plates, S, and, therefore remain inoperative. Feelers opposed by holes penetrate into cylinder apertures and their corresponding needles remain in the path of the pusher plates and are, therefore, moved to the right—note feeler and needle numbered 3 in *Figure 17.15*. The needle pushes a corresponding lifting peg, U, carried in a slot of the selector, Y, out into the path of the ascending lifting bar, V, which has a fixed stroke. The selector is thus raised to varying heights depending upon which lifting peg is engaged. As the yarn carriers, F, are connected by wire to the selectors, *Figure 17.15*, they follow the movement of the selectors and present the selected yarns to the level at which the grippers, D, operate. In the example illustrated in *Figure 17.15* the lifting bar will engage the peg pushed out by needle 3 thus lifting the selector and the associated yarn carrier to the second height level which results in the presentation to the gripper of pile yarn from frame 3.

Tuft insertion

Carried in one casting there is a central shaft A, *Figure 17.13*, a moveable shaft B, and a fixed shaft C. Shaft A is operated from a camshaft that runs at one-third the speed of the loom so that tuft insertion takes place every three double picks. The feature of the tuft motion consists of the grippers D, *Figure 17.13*, which in side view appear very similar to the neck and beak of a bird as shown by the enlarged view on the left. As many grippers as there are longitudinal lines of pile in the fabric are arranged in a horizontal row (a front view of six is shown on the left of the top portion of *Figure 17.13*) and each consists of a fixed jaw D^1, and a moveable jaw D^2 which are privoted together at D^3. Each fixed jaw D^1 is mounted on the fixed shaft C, while each moveable jaw D^2 is forked and straddles a flat joint or blade E which is connected to moveable shaft D. By means of cams, shaft B is rocked so that at the correct time the jaws D^2 are moved privoted together at D^3. Each fixed jaw D^1 is mounted on the fixed shaft C, while each moveable jaw D^2 is forked and straddles a flat joint or blade E which is connected to moveable shaft D. By means of cams, shaft B is rocked so that at the correct time the jaws D^2 are moved privotally at D^3, and the jaws of the grippers are caused to open and close as required.

Central shaft A and shafts B and C revolve in about a semi-circle round the centre of shaft A and cause the grippers D to move between their top and bottom position. In their upward movement the grippers are open and on reaching the top position the beaks are inserted just into the grooves of the carriers F and close upon the projecting ends of the pile threads. Then a sufficient length of thread is formed in front of the carriers to give the required height of pile by moving the grippers the necessary distance away from the carriers. A vandyked bar comb, of the same pitch as the gripper shown at W in *Figure 17.15*, descends with its points between the threads and holds the latter steady whilst a travelling knife traverses the comb and cuts off the tuft lengths. The position of the grippers immediately after cutting is shown in *Figure 17.16*. In wide looms several sliding cutters are provided, one for every 45 cm width of carpet. This ensures that the grippers do not need to stand waiting for all the selected pile ends to be cut which would be the case if only one knife was used.

Shaft A then rotates and the grippers D move forwards and downwards until they pass below the upper line of the warp shed, as shown by the dotted lines in the lower portion of *Figure 17.13*, and at the same time lay the free ends of the pile tufts against the fell of the carpet. The rigid rapier or needle is inserted and passes over the grippers through the shed, as shown at N, and inserts a double binding pick which is then beaten up, the open dents of the reed passing between the grippers as they lie in the warp. The grippers then move backwards and upwards and draw the secured end of the tuft threads round the double pick, and as the grippers rise above the surface of the fabric the beaks open and release the threads. In *Figure 17.12* part of an open dent of the reed H is shown in its forward position in the next slot of the comb L to that in which

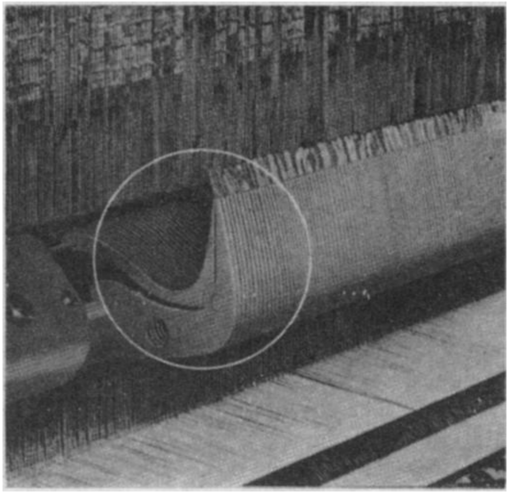

Figure 17.16

a group of three warp threads is indicated. The grippers commence their backward and upward movement as the reed completes the beating up of the weft, and *Figure 17.12* shows the serrated working points of the jaws D^1 and D^2 of a gripper about to release a tuft of pile. As the reed moves back, a rake, which normally is in front of the fell, moves over the row of tufts on to the warp and draws them into a vertical position. Two more double picks are inserted and beaten up, and the grippers move in their semi-circular path upwards to seize the next row of pile threads which have been in the meantime selected and are projecting from the yarn carriers.

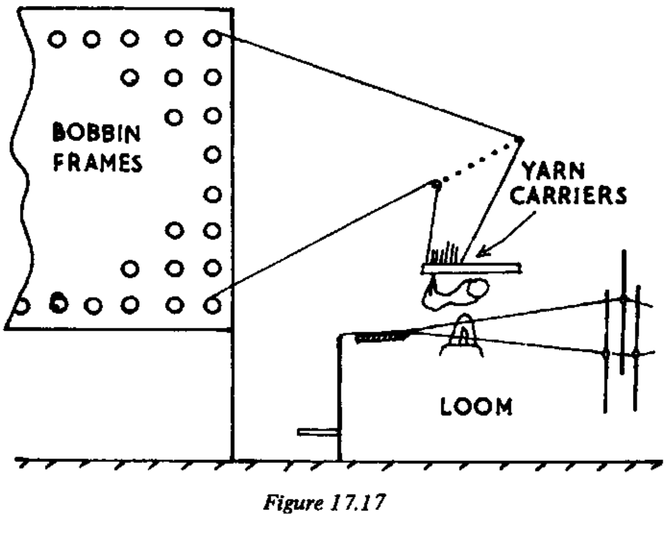

Figure 17.17

Figure 17.13 illustrates the basic principle of tuft insertion, however, the very considerable arc of travel (about 150°) of the grippers represents a very serious impediment to any improvement in the speed of operation. In modern gripper looms, although the basis of tuft insertion remains the same, the arc of travel of the gripper assembly is substantially reduced with a resultant improvement in the tuft insertion rate. In one version, yarn carriers are placed horizontally above the cloth fell and slide backwards and forwards to present selected yarns to the grippers which have only a very short distance to move to insert the tufts. This is shown schematically in *Figure 17.17* in which, it will be noted, that the pile yarn frames are placed in front of the loom, immediately behind the weaver's platform which facilitates the mending of breaks in pile yarn, etc.

General features

The take-up motion is arranged to coincide with the structure of the cloth, the take-up roller being caused to dwell while the bottom shot and the tuft shot are inserted and beaten up. The advantage of this is that the cloth is stationary whilst the pile tufts are being inserted, and the ground ends remain at the same tension. The weft, precision wound on to large cones and often magazined, is inserted in double strands by a single rigid rapier (or needle). A selvedge shuttle and catch cord, similar to the one described with reference to the spool system, holds the weft on the side opposite to the insertion side. High speed of operation is facilitated by the use of weft accumulator drums which markedly reduce the frequency of weft breaks. Accumulator drums also permit the use of lower qualities of weft yarn.

Due to the manner of tuft insertion the gripper carpet is remarkably rigid and dimensionally stable and requires little back finishing. The system is suitable for both, short and long runs and sometimes one design is produced in several different colour versions, without expensive changes and long machine down time, by partial re-creeling in the frames. As the pile yarn is wound on individual packages, either bobbins or cheeses, no excessive waste is created.

Looms are built in varying widths up to 366 cm and can operate efficiently at very high speeds. A modern 366 cm wide loom is capable of producing cloth at the rate of 18 to 20 horizontal rows of tufts per min.

THE SPOOL-GRIPPER SYSTEM

Spool-gripper looms combine some merits of the spool and the gripper system. The weaving of the cloth and the insertion of the tufts are the same as in the gripper loom, while the differently coloured pile threads are wound on spools which are supported in frames, that are carried in chains in the same way as in the spool method. The spool frames, however, are not taken out of the chains during the process of weaving, and they are specially constructed to accommodate the seizing and drawing-off of the pile yarn by the grippers. As each frame in turn is brought to the draw-off position it is held clamped to locating blocks while the required length of yarn is drawn forward and the tufts are cut off by the knife. The above situation is illustrated in *Figure 17.18;*

the gripper, D indicated in dotted lines, is shown commencing to draw a yarn from the clamped spool, S, whilst the comb and knife unit, K, is ready to come forward and sever the drawn-off length of tuft. The tuft insertion position of the gripper is indicated at D^1 which shows clearly the very short arc of movement of the gripper assembly in this system. This helps to achieve a high speed of operation which is comparable with that of the most modern of the gripper looms.

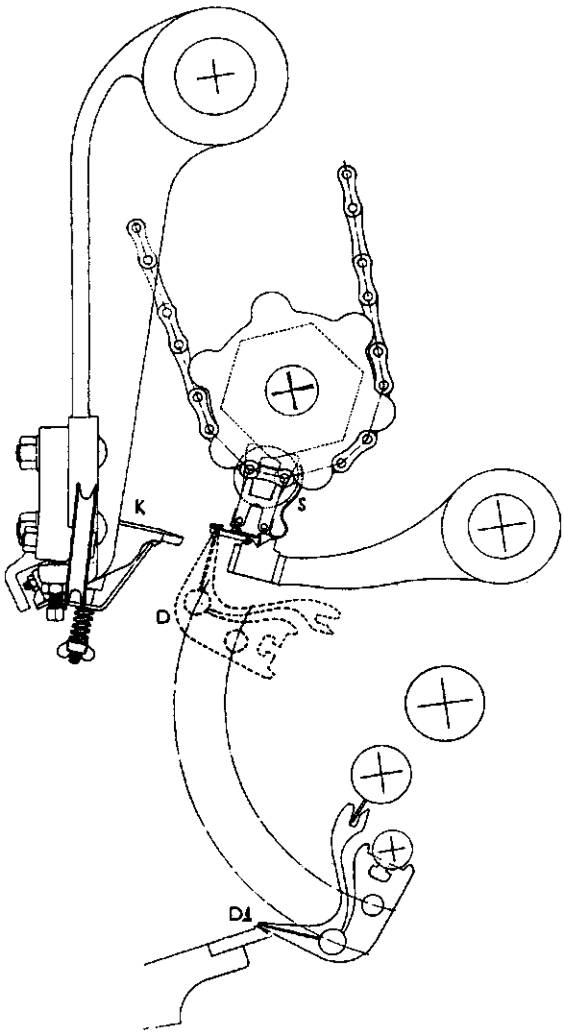

Figure 17.18

The main advantage of employing spools as the design forming unit lies in obtaining an unlimited colour scope. Some simplification of designing procedures also occurs, as no colour gamut is required, and there is no fear of stripiness which in limited colour jacquard controlled systems results from misjudged or unskilled colour planting. However, the use of spools inevitably results in some disadvantages inherently associated with the spool systems. The most important of these are the need for the time and space consuming process of spool setting and the unavoidable creation of waste in pile yarns.

The spool setting, as explained in connection with the ordinary spool system, makes it necessary to recognise the fact that only long design runs will be economically acceptable. However, as the spools in the combination systems are not the instruments of tuft insertion, the overall effort of design preparation is easier because the process of tube threading is cut out. Instead of the tubes the spool frames are made with self-threading yarn slots shown at A and B in *Figure 17.19* which represent the end and the front elevations of the frames respectively.

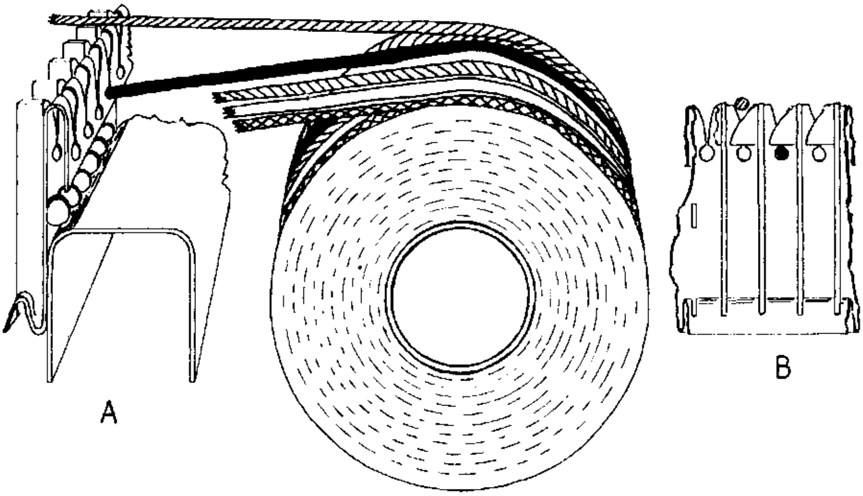

Figure 17.19

In respect of pile yarn waste, which represents an appreciable loss in ordinary spool Axminster weaving, considerable savings are achieved in the combined system. Apart from spool setting and final cropping, waste is created in the ordinary spool system at several points during weaving. The first source occurs as a slight overcut of the upturned leg of the tuft during the cutting action after tuft insertion as shown at 6 in *Figure 17.10*. The overcut is very small but it takes place at every tuft insertion and the resultant fluff which gathers at the knife edge has to be cleaned periodically as shown in *Figure 17.20*. This source of waste is eliminated completely in spool-gripper weaving as the tuft is inserted in its entirety by the gripper action. The second reason for unavoidable waste in the spool system is due to the combined effect of differences in yarn diameter in some pile yarns across the spool length and the impossibility of applying high tension to the yarns. The diameter differences are due mainly to varying dye percentages between the light-coloured and the dark-coloured yarns. As such yarns are wound on side by side the larger diameter yarns form larger diameter rings and as the yarn unwinds the spool is turned, in effect, by the thinner yarns thus creating an excess of length in the thicker ones. This excess eventually would cause entanglements and, therefore, has to be trimmed periodically. The trimming consists of pulling the extra length available through the tubes and cutting it off. Nothing can be done to eliminate the diameter differences but the excess occurs because the spool is comparatively weakly

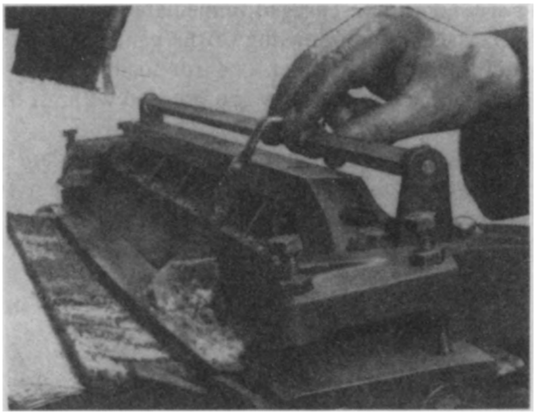

Figure 17.20

tensioned so that it can be turned easily. The brake acting upon the flange of the spool is clearly shown in the centre of *Figure 17.6* and the reason for the weak braking action is that when the frame moves up to measure out the tuft length (stage 4, *Figure 17.10*), the inserted portion of the tuft is held in the ground structure only by the pressure of the reed and if the tension on the spool were too high then instead of unwinding yarn from the spool the upward movement would tend to pull the tuft from the ground. In the spool-gripper method the grippers are used to pull the yarn off the spool, therefore the spool tension can be higher so that a combined pull of all the ends on the spool is necessary before it turns. Thus, the length released is the same for all ends and no build up of an excessive length results on the spool. Admittedly, before the spool turns some of the thinner yarns may be stretched which means that, upon relaxation following cutting, the tufts formed from them are marginally shorter. However, this difference is so small that it is normally easily equalised during the final cropping operation. The final source of waste in spool weaving is in the form of yarn remnant wraps upon the barrel of the spool. These cannot be eliminated in the spool-gripper system but as the spools are not detachable they can be made to hold a greater length of pile yarn which means that the remaining wraps represent a smaller proportion of the total than in ordinary spool weaving. Thus, the employment of the grippers for tuft insertion permits them to achieve worthwhile reduction in the amount of waste associated with the use of spools.

The gripper also enables the formation of a rigid and dimensionally stable construction, usually in the Corinthian weave, which helps to reduce the cost of back finishing.

In the spool-gripper machine considerable attention has been paid to the chain drive for the spools and the gantry arrangements. This was necessary because of the great weight of a full spool complement which may reach 10 tonnes.

The chain is driven by its own independent motor with electromagnetic clutches controlled by automatic compensator devices. Provision is made for driving the spool frames forwards or in reverse direction and also in skip fashion to present alternate spools. This permits the loading of the gantry with two different designs, one on odd spools, the other on even ones. After the first complement is exhausted the second can be engaged immediately without any loom downtime otherwise necessary for the loading of the gantry. Often two gantries are used—one in operation and the other one for loading away from the loom. In this manner the loading of the gantry can proceed without the loom standing idle.

Most of the spool-gripper looms are built in the standard pitch of 28 per 10 cm, some are, however, constructed in the pitch of 24 per 10 cm for coarser work and some in 35 per 10 cm for contract quality carpets.