16

Warp Pile Fabrics Produced on the Face-to-Face Principle

Face-to-face weaving represents an alternative method of manufacture of the cut warp pile fabrics in which two cloths are woven simultaneously and the pile is produced without the aid of wires. By comparison with the wire insertion system there is greatly increased production, while the mechanism required for cutting the pile threads does not necessitate any increase in the normal width of the loom, so that there is great economy of floor space. For the above reasons this system is preferred to the wire method for the production of most cut pile fabrics at present.

Two separate ground fabrics with a space between them, each with its own warp and weft, are woven on the unstitched double-cloth principle, while the pile warp threads interlace alternately with the picks of both fabrics and thus are common to both. The distance between the ground fabrics is regulated according to the required length of pile and as the textures pass forward the pile threads extending between them are cut by means of a transversely reciprocating knife during the weaving process. Two cloths are thus formed—the bottom cloth with the pile facing up, and the top cloth with a similar pile facing down. The cloths pass in contact with separate take-up rollers and are wound on two cloth rollers as shown schematically at C in *Figure 16.1.* The double texture may be woven either on the single-shuttle or the double-shuttle principle, both of which are illustrated in *Figure 16.1.* The single-shuttle method is represented at A in which the wefting is shown arranged in the order of two picks top fabric, two picks bottom fabric, and one shed is formed at a time while the weft is inserted in the ordinary manner. Only one shuttle-box is necessary at each side of the sley, but a box motion may be employed when, for special reasons, two different kinds of weft are used or weft mixing is required. If the picks alternate in even numbers, as shown at A in *Figure 16.1*, the weft joins the two fabrics together at the extreme edge at one side only, but the picks for the respective fabrics may alternate in odd numbers, in which case the selvedges are joined at both sides. A knife situated between the top and bottom selvedges comes in contact with and cuts the joining picks as the weaving proceeds. The picks in each fabric are shown separated in pairs at A in *Figure 16.1* for convenience of illustrating the single-shuttle method, but in actual weaving they are evenly spaced.

In the double-shuttle method represented at B in *Figure 16.1*, two sheds are formed, one above the other, and two shuttles are thrown across simultaneously,

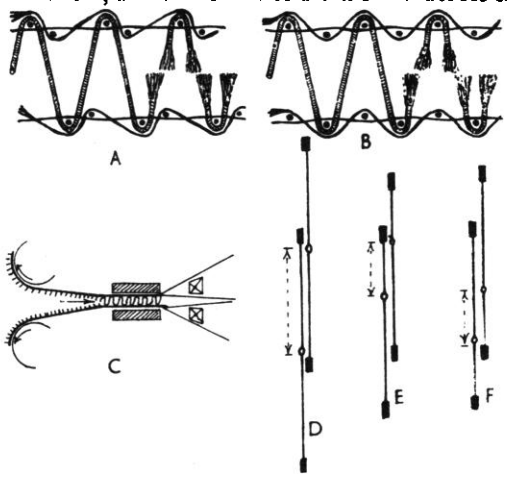

Figure 16.1

so that a pick is inserted in both the top and the bottom fabric at the same time. A shuttle-box is provided for each shuttle at both sides of the sley and the two shuttles are propelled by the same picking stick at each side. The lower shuttle runs on the warp on the race-board in the ordinary way, while the upper shuttle runs on the lower line of the top shed, which is usually higher than the upper line of the bottom shed. As each ground fabric is woven from its own shuttle there is no joining of the selvedges at either side. Double-shuttle weaving is much more productive than the single-shuttle system and is chiefly employed, but the latter method is sometimes preferred for certain makes of cloth as its use renders the production of defective cloth less liable. Most of the modern machines used for this class of structure instead of shuttles employ double or single rigid rapiers in a twinned (two-tier) arrangement, one set inserting weft at the top, and the other at the bottom cloth level. Apart from permitting higher speed of operation this system also offers the advantages of continuous weft supply from large stationary packages at the side of the machine and reduces frictional contact between the warp and the weft inserting element.

For single-shuttle work the healds are of the usual type. The pile shafts are placed centrally but the healds which operate the group warps are adjusted so that the ends for the cloth are rather higher than those for the bottom cloth in order to assist the shedding and to reduce friction. For double-shuttle weaving the mails of the pile healds are midway between the shafts, as the pile threads have to move between the top line of the upper shed and the bottom line of the lower shed or the full distance of both ground sheds as indicated at D in *Figure 16.1*. The ground warp threads have to move only half this distance and the healds are constructed with the mail eyes one-third of the distance between the top and bottom shaft. Thus, as shown at E and F in *Figure 16.1*, placed in position E the ground heald controls the ground ends of the top cloth, and placed in position F it controls the ground ends of the bottom cloth, an equal movement of the shedding mechanism being sufficient to move the ground ends of the respective fabrics to form the corresponding top and bottom sheds.

Special mechanisms required in face-to-face weaving

In weaving face-to-face pile fabrics by the single-shuttle method the only devices different from the normal are those connected with the cutting action, the take-up and the let-off of the pile warp. As the function of these mechanisms is identical with that of the corresponding devices in double-shuttle weaving the descriptions given in connection with the latter are equally applicable to the former.

There are several weaving machine makers both in this country and on the continent of Europe who specialise in the production of looms for the face-to-face double-shuttle weaving and although each version differs from another in some detail they are basically similar in principle.

Two shuttle boxes are provided at each side of the sley from which two shuttles are picked across simultaneously. On account of the shape of the two sheds the shuttles are specially bevelled and the boxes shaped accordingly. Fast reed warp protector motions are used and a weft fork is provided at each side of the loom, one acting for the top and the other for the bottom shuttle. In some instances the crankarm is constructed in two parts to provide sley dwell giving sufficient time in wide looms for the shuttles to cross before the forward movement commences.

In weaving continuous pile fabrics in double-shuttle machines a tappet shedding motion is usually employed and the tappets are most frequently of the positive type. Utilising the form of healds previously described the ground ends are moved the usual distance between the top and bottom of their respective sheds but the pile threads move about twice that distance oscillating between the top of the upper shed and the bottom of the lower shed and consequently require tappets with a bigger stroke or suitable leverage adjustment if normal stroke tappets are employed. In weaving certain construction three-position tappets are required the pile ends moving not only through the distance of the two sheds but also occasionally to the centre position. For figured pile fabrics three-position dobbies and jacquards are available.

Two cloths have to be taken up simultaneously and exactly at the same rate. The double take-up is of the positive type usually with pinion and worm gearing. Following the cutting of the pile threads the top cloth passes upward and the bottom cloth downward, each in contact with a pinned take-up roller. The two rollers are equal in size and turn in opposite directions, the cloths are suitably guided and are wound on to two cloth rollers in a stand in front of the loom.

A special stand for the ground and pile warp beams is provided at the rear of the loom. If all the ground ends in both fabrics are at the same tension one ground beam may be used which usually is placed low down and is controlled positively, but sometimes, for convenience, the ground ends of each fabric are placed on a separate beam. In weaving such fabrics as moquette, of which the odd and even ends are at different tensions, the tighter ends of both fabrics are run off one beam which is positively controlled, while the beam which contains the slacker ends of both fabrics is usually placed above the warp level and is sometimes provided with only a negative let-off. By means of dividing rollers the ends from the ground beam or beams are divided into two series to correspond with the top and bottom fabrics, the top series of ends passing over the

upper roller and the bottom series under the lower roller, so that the ends of each fabric are retained at the proper level.

The delivery of the pile yarn ranges from five to ten times or more the length of the ground yarn, and the pile warp is therefore specially controlled in order to ensure that the proper length is let off according to the depth of pile and number of tufts, etc., required. A train of wheels from the low shaft drives a yarn delivery roller A, *Figure 16.2*, on which presses a free roller B, and both rollers are coated with suitable material to prevent slipping of the pile yarn. The threads

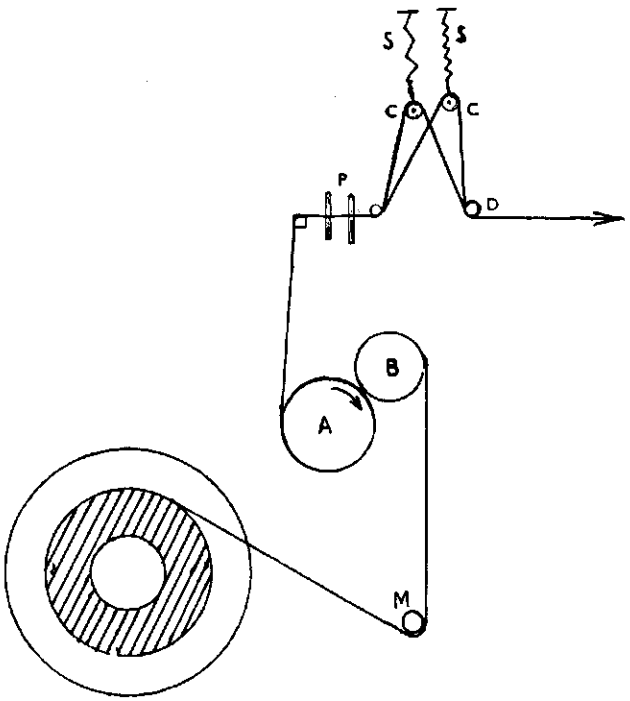

Figure 16.2

pass from the pile beam under a guide-roller M, over roller B, between the two rollers and under A, then over compensating rods C and under guide-rod D, and forward to the healds. The threads are gripped firmly by the rollers A and B and are given in at a predetermined rate at each pick, and this rate can be changed according to requirements by altering a change-wheel by which the surface movement of roller A is modified. The arrangement enables the proper length of pile to be fed-in to obtain the required depth of pile in both fabrics at the same time that no undue tension is put on the pile warp.

With certain weaves, although all the pile threads have the same degree of take up, they are in series which pass from one fabric to the other at different times. A separate pile beam and pile delivery roller may be employed for each series, but the use of compensating rods enables all the threads to be operated

from the same beam by means of one pile let-off motion. The threads pass together from the pile yarn delivery roller A, *Figure 16.2*, then the different series are distributed separately over the compensating rods, as shown at C. Each rod passes across the width of the loom above the top ground warp, and is suspended at each end by a spring, S. A considerable number of rods can be used if necessary in the space available. The pile warp passes from the pile roller at a constant rate, and any length that is given in of a series that is not immediately taken up by tufting is taken up by the corresponding compensation rod through the recovery action of the springs. From the rods the pile threads pass downwards through the top ground warp, then under guide-roller D, *Figure 16.2*, situated about midway between the top and bottom ground ends, and in a straight line to the centre of the healds. If a warp stop-motion is employed the pile threads pass through it before they reach the compensating rods C, as shown at P.

The pile threads are firmly interwoven in both ground fabrics which are held some distance apart, while between them the pile threads extend until they come into contact with the cutting knife which passes to and fro across the loom. The distance between the ground fabrics, i.e. the depth of the pile, can be regulated by means of two distance plates which extend across the width of the loom between the fell of the cloth and the path of the knife. Machined regulating screws are provided at each side by means of which the distance between the plates can be modified according to requirements. Once set for a given cloth the distance is maintained at a constant value by the direction of tension in the two sets of warp threads and in the cloths after they are separated. The tension in the top set of ends and in the top cloth acts in the upward direction thus forcing the upper fabric to sit tight against the top bar. The lower cloth is tensioned in the opposite direction and sits tight against the bottom plate.

The cutting motion is a principal feature of face-to-face weaving and considerable attention must be paid to the accuracy of running and the sharpness of the knife. The knife runs in a carriage upon a rail placed between the two fabrics near to the point at which they are separated. The plane of the rail can be adjusted according to requirements once the distance between the two cloths has been determined. Normally the knife is set midway between the two fabrics to produce equal length of pile in each, but if so desired, it could be adjusted to produce low pile in one cloth and high pile in the other. After each traverse the cutting edge comes into contact with a pair of hones and is honed twice before commencing the reverse traverse. The knife is also racked so that a different portion of the blade is presented to the threads for each run. The knife rail is very accurately planed and has a comparatively broad span, and the carriage and rail are so shaped that vibration is reduced to the minimum at the same time that a free sliding movement is secured. It is upon the steady movement of the carriage, the frequency of the cutting and the sharpness of the knife that the production of a level pile of uniform depth which requires little cropping largely depends.

Apart from increased production and reduced space requirements the face-to-face system of weaving permits considerable savings in the consumption of pile yarn in multi-frame structures as will be shown later. It also eliminates some of the defects of wire-produced pile fabrics such as wire marks due to bad cutting or wire over-heating and the distinct diagonal alignment of pile in the direction of wire withdrawal.

ALL-OVER OR CONTINUOUS PILE STRUCTURES

Moquettes

The structure illustrated in *Figure 16.3* is used for firm and hard wearing cloths of the upholstery type known as moquette. There is one series of pile threads which passes from the top to the bottom fabric and back again, and the ground ends in each fabric, which interweave in plain order with the weft, are often arranged 1 three-fold single, 1 two-fold three-ply. Two ground warp beams are employed at different tensions, the single ends being held very tight in order that they will lie almost straight in the cloth, while the three-ply ends are lightly tensioned so that they will bend and impart a ribbed appearance to the back of each ground fabric. The pile threads are bound on alternate picks, and the plain shedding of the ground ends is so arranged that the binding position of each pile thread is covered by the slack three-ply ends. The bend or knuckle of the pile is thus protected, and the liability of the tufts 'rolling' or moving out of position is avoided. Usually all the weft is alike, but in some fine qualities of moquette thick and fine wefts are inserted alternately in each fabric, the cloth then being woven in a loom provided with a cross-pick arrangement by means of which the top and bottom shuttles are interchanged. In the pick-and-pick structure the pile threads are bound by the fine picks, the thick picks forming the ground.

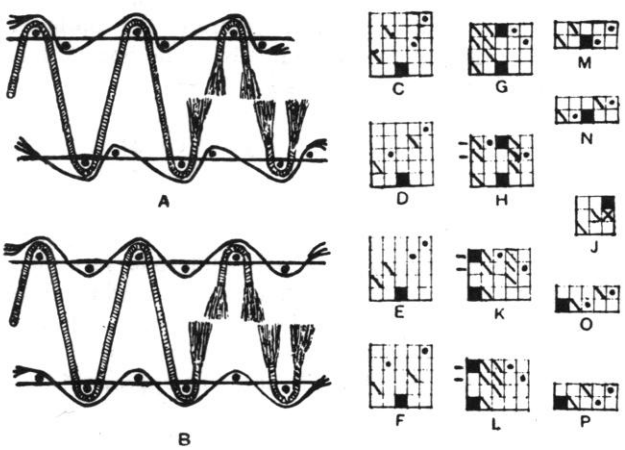

Figure 16.3

In face-to-face weaving the pile threads are invariably drawn on the heald or healds at the front, but considerable latitude is permissible as regards the arrangement of the ground ends and healds. Thus, four drafts that are suitable for the single-shuttle and double-shuttle structures illustrated at A and B in *Figure 16.3* are shown at C, D, E and F in which the solid marks represent the pile threads, the diagonal strokes the warp ends of the top fabric, and the dots the ends of the bottom fabric. In drafts C and D the ground healds are arranged top and bottom alternately, but in E and F the healds for the top fabric are in front of those for the bottom fabric. The ends for the respective fabrics are

arranged in 2-and-2 order in drafts C and E, and in alternate order in drafts D and F. Each group of ends is dented in one split of the reed, and in all the drafts the pile thread is shown in the centre, but it may also be arranged to precede or to follow the ground ends in each split. Draft F shows the principle of arrangement largely used in this country.

G shows the weave of the structure represented at A in *Figure 16.3* with the ground ends arranged 2 top and 2 bottom alternately, as indicated in drafts C and E, while H shows the weave if the ground ends are arranged top and bottom alternately, as shown in drafts D and F. For comparison the weave which will produce the same structure when the pile is produced by means of wires is given at J, the solid mark representing the lift of the pile thread on the wire shed. The lifting plan for diagram A in *Figure 16.3*, to correspond with drafts C and D, is given at K, and to correspond with drafts E and F, at L. The marks at the side of plans G, H, K and L indicate the picks of the bottom fabric.

For the double-shuttle structure shown at B in *Figure 16.3* the same drafts as for single-shuttle weaving can be employed, but as two sheds are formed and two picks are inserted at the same time each horizontal space of the weaves shown at M and N (to correspond with the single-shuttle weaves given at G and H) represents a pick of each fabric, and each weave therefore repeats on two horizontal spaces. The lifting plan for the double-shuttle structure, to correspond with drafts C and D, is given at O, and to correspond with drafts E and F at P. The solid marks show the lifts of the pile threads from the lower line of the bottom shed to the upper line of the top shed, the diagonal strokes the lifts of the ground ends of the top fabric from the centre to the top line of the upper shed, and the dots the lifts of the ground ends of the bottom fabric from the bottom line to the top line of the lower shed.

Yarns in the moquettes and similar fabrics vary considerably according to the purpose and quality of the cloth. Pile yarns consist of cotton, staple or filament rayon, mohair, worsted, and various synthetic materials. Ground yarns are mainly cotton or staple viscose rayon. Silk, either net or spun, which at one time was very widely used for pile in dress goods is at present employed very infrequently. Mohair, worsted, and polyamide pile yarns are largely used in the manufacture of different kinds of imitation fur, while acrylic and polypropylene yarns are particularly suitable for upholstery plushes because of their lustre, springy nature and resistance to wear. Cotton pile is liable to flatten under pressure and, therefore, is not very appropriate for upholstery cloths, but for curtainings and similar purposes and for dress goods cotton pile yarns, either mercerised or ordinary, produce very suitable and attractive textures. Combed yarns are desirable in order that there will be a minimum of short fibres which are liable to leave the surface of the cloth. Broken ground ends cause defects to show in the pile surface because the adjacent tufts lack support, and strong two-fold or three-fold good quality cotton yarn is therefore largely used for the ground warps, while a medium quality of cotton is employed for the weft, but with rather more twist than is usual for weft.

Pile yarns are sometimes sized in order to facilitate clean cutting which improves the lustre of the pile. Curled mohair and worsted pile yarns are used for mats and for the manufacture of imitation. Astrakhan fur, etc. As a rule pile yarns are rather soft twisted as there is no great strain on the threads, and with soft twist the tufts more readily open out. The pile generally has to be

dense enough to conceal the ground fabric, and to secure this condition fine setting is required if the pile is short, while in lower setting coarser yarns with longer tufts are necessary. In low set cloths the cover can be improved in the finishing process by laying the pile in the direction of the length, or sideways.

The following are average particulars of the moquette structure illustrated in *Figure 16.3*, for 100 m of cloth: pile warp, 74/2 tex lustre worsted, 700 to 1000 m; tight ground warp 98/3 tex cotton, 110 m; slack three-ply ground warp, 38/2 tex cotton, 160 m; weft 74 tex cotton, 14 picks per cm in each cloth, 72 splits per 10 cm with one pile, and two tight and two slack three-ply ground ends in each split. Tufts are formed in each cloth on alternate picks, hence there are approximately 7 tufts per cm in width and length giving 49 tufts per cm^2 (not allowing for contraction).

Velvet structures

In the moquette structure only one series of pile threads is used and the tufting in each cloth is complete on two picks, on one of which all the pile threads are interwoven, so that the tufts of pile are distributed in horizontal lines or ridges. In the examples shown in *Figure 16.4*, the tufting is again complete on two picks in each cloth, but in this case two series of pile threads are employed, one of which is interwoven on the odd picks and the other on the even picks. The alternate binding of the pile thread yields a more uniform distribution of the pile tufts so that a well-covered surface is produced and this type of structure has been found very useful for upholstery and hangings. The ground weave is plain but the foundation texture is different from that of the moquette structure as all the ground ends are alike and only one ground beam is essential. However, the ends for each ground fabric are brought from separate beams while the use of two compensating rods enables one pile beam and one pile let-off motion to be employed for both series of pile threads.

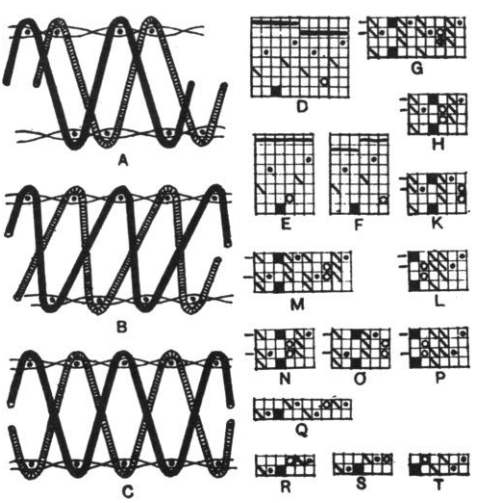

Figure 16.4

The single-shuttle system is illustrated at A in *Figure 16.4*, with the picks arranged two top fabric, two bottom fabric alternately, and three drafts with the orders of denting indicated above, are given at D, E and F. In drafts D and E two top and two bottom ground ends are dented in each split, but D has one and E has two pile threads in each split. In the same setting draft D would give the same number of tufts per cm^2 as the moquette structure illustrated in *Figure 16.3*, whereas draft E would yield twice as many tufts per cm^2. Draft F has the same proportion of pile threads to ground threads as E, but it is arranged for the threads to be dented three per split instead of six, giving one thread of each in each split. The weaves for the structure represented at A for the drafts D, E and F are given respectively at G, H and K, while the lifting plan shown at L is applicable to the three arrangements.

B in *Figure 16.4* is similar to diagram A except that for the purpose of illustration the structure is shown wefted one pick top fabric, one pick bottom fabric instead of 2-and-2. The corresponding weaves for drafts D, E and F are given at M, N and O respectively, while P shows the lifting plan. In the examples solid marks and circles are used to distinguish the two series of pile threads; diagonal marks and dots respectively represent the ends of the top and bottom fabrics, while the marks at the side of the plans indicate the picks of the bottom fabric.

C in *Figure 16.4* illustrates the double-shuttle structures to correspond with diagrams A and B. The weaves, which repeat on two picks in each fabric and two horizontal spaces, are given at Q, R and S for the respective drafts D, E and F, and T shows the lifting plan.

Average particulars for 100 m of cotton velvet curtaining fabric are as follows: Pile warp, 38/2 to 42/4 tex combed, gassed and mercerised cotton, 600 to 800 m; ground warp, 24/2 to 30/2 tex cotton, 107 m; weft 26 to 30 tex cotton, 26 to 32 picks per cm in each fabric, 14 to 18 ground ends per cm in each fabric, 14 to 18 pile ends per cm (for draft E or F). Each pile thread forms a tuft on alternate picks, or from 13 to 16 tufts per cm, giving from 182 to 288 tufts per cm^2 (not allowing for contraction).

The pile surface of a cloth is usually satisfactory when the pile is dense and the tufts stand vertically from the foundation. To obtain these conditions in a structure such as that represented in *Figure 16.4* the ground ends and picks require to be set close enough to nip the pile threads and hold the knuckles of the tufts firmly in position. In lower quality cloths, however, in which the density of the pile is deficient, sufficient cover can be obtained by laying the pile over in the finishing process, and the required firmness is secured by treating the ground fabric with resin or latex on the underside.

In *Figure 16.5*, A and B represent the single-shuttle and double-shuttle structures respectively of a style in which the ground weave is 2-and-2 warp rib; there are two series of pile threads which are bound in alternately in each cloth. The tufting in each cloth is complete on four picks, and each tuft is bound by one pick. The examples illustrate also the introduction of extra ends which work in 1-and-3 order alternately and are given in rather slacker than the ground ends from a separate beam. The object of the extra ends is to form a backing to each fabric and, by covering the knuckles of the tufts on the back, to reduce the possibility of the pile fraying out or becoming displaced.

The draft for A and B in *Figure 16.5* is given at C, and except for the backing ends is similar to draft F in *Figure 16.4*. In the same setting, however, the latter draft will produce twice as many tufts per area as draft C in *Figure 16.5* because each pile thread in *Figure 16.4* forms a tuft every two picks, and in *Figure 16.5* only every four picks.

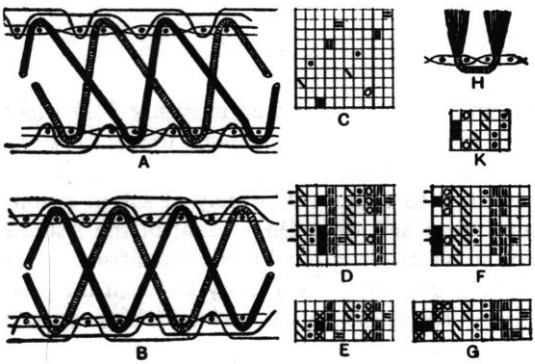

Figure 16.5

D and E, *Figure 16.5*, are the respective weaves for A and B, the first repeating on eight picks which are inserted singly, and the second on four double picks. The corresponding lifting plans are given at F and G. The diagonal marks and dots respectively represent the top and bottom ground ends, the vertical and horizontal marks the top and bottom backing ends, and the solid marks and circles the respective pile threads. In addition, in plans E and G crosses are shown which represent the lifts of the pile threads to the upper line of the bottom shed on the picks on which they have to be interwoven in neither fabric. Thus, in plan G which is arranged for a three-position dobby, two solid marks or two circles are indicated alongside each other to show the lifting of two jack levers in order that a pile heald will be raised the full depth of both sheds, while a cross represents that one jack lever will lift a pile heald the depth only of the bottom shed.

The warp-backed structure is largely woven with acrylic or lustre worsted pile threads, and in proper setting a very upright pile is formed which will resist pressure, so that the material is very suitable for upholstery work. The same order of interlacing of pile and ground threads, but without the backing ends, is also used with mercerised cotton for the pile, and the cloth has a softer handle and is suitable for table covers and curtaining fabrics. The following are suitable particulars for producing 100 m of upholstery velvet in the structure illustrated in *Figure 16.5*: Pile warp, 60/2 tex acrylic yarn or lustre worsted, 800 to 1000 m; ground and backing warps, 42/2 tex cotton, 106 m and 120 m respectively; weft, 60 to 74 tex cotton, 22 picks per cm in each fabric, 13 ground and 13 backing ends per cm in each fabric, 13 pile threads per cm. Each pile thread forms a tuft every four picks giving 72 tufts per cm^2 (not allowing for contraction).

The form of tuft previously illustrated, which is bound by one pick, is often referred to as 'V' pile, but in the 2-and-2 rib ground weave shown in *Figure 16.5* the 'U' form of tuft is sometimes formed, the shape of which is illustrated at H.

The pile thread is bound by two picks and each side of the knuckle of the tuft is gripped between two picks which are in the same shed, so that improved pile anchorage can be secured by wefting the cloth suitably. The lifting plan for diagram H on draft C for double-shuttle weaving is given at K, assuming that no backing ends are employed.

Fast pile structures

A system of pile interlacing is illustrated in *Figure 16.6* which gives very firm binding of the pile and the term 'W' is applied to the tufts on account of their shape. It is extensively used for light textures such as dress fabrics, hat trimmings, etc., which may be composed entirely of silk or rayon or of rayon pile and cotton ground warp and weft. On account of the fastness of the pile textures can be made in which the ground fabric is light and somewhat open, while a short pile may be produced above a fancy effect in the ground which shows more or less clearly through the fibrous surface. This order of pile interlacing is also very commonly used in figured velvet in which a pile figure is formed on plain voile crepe-de-chine, or georgette ground. The 'W' pile represented in *Figure 16.6* is similar to the fast pile structure shown at D in *Figure 15.4*.

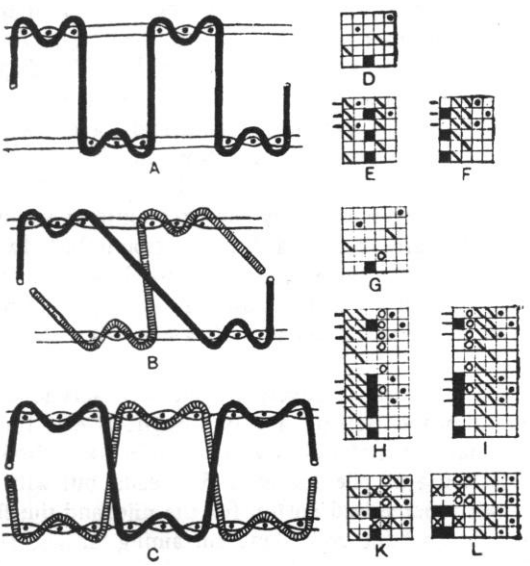

Figure 16.6

In the single-shuttle structure shown at A in *Figure 16.6*, the order of wefting is 3 picks top fabric, 3 picks bottom fabric, to correspond with the tuft formation. One series of pile threads is employed and the ground weave of each fabric is 2-and-1 warp rib, the last pick of each group of three picks, being in the same shed as the first pick of the next group of three picks, the weave thus repeating on three picks in each fabric. The arrangement is very suitable for the 'W' form of tuft as the two picks which are in the same shed readily approach

each other, so that the tendency of the picks to ground in three's is reduced at the same time that both sides of the 'W' tufts are gripped by these picks. Sometimes, in order to accentuate the 2-and-1 ribbed effect in the ground, odd and even ends in each fabric are woven with about 10 per cent difference in the let-off from separate warp beams.

The draft for A in *Figure 16.6* is given at D, the arrangement consisting of 1 pile thread to 2 ground ends in each fabric. The corresponding single-shuttle weave is given at E and the lifting plan at F. B in *Figure 16.1* represents a single-shuttle structure which is similar to that shown at A, as regards the ground weave and the shape of the tufts, but the example illustrates the use of two series of pile threads which interlace alternately in each fabric. In the draft G there are 1 pile thread, 2 top ground ends and 2 bottom ground ends in each group which, in the same setting, will give the same number of tufts per cm^2 as A and draft D. The corresponding weave is given at H and the lifting plan at I, the repeat in each case being on 12 picks or six picks in each fabric.

C in *Figure 16.6* represents the double-shuttle structure to correspond with A, but in this case the ground weave is plain and two series of pile threads are used so that the weave in each fabric repeats on six picks. Draft G is suitable for C, while K is the corresponding weave and L the lifting plan which repeat on six double picks. The double solid marks and circles in plan L show the full lifts and the crosses the half lifts of the pile threads.

In correctly set cloths an erect pile can be obtained in the structure, represented in *Figure 16.6*, but on account of the formation of horizontal lines of pile every three picks it is difficult to obtain good cover, and the pile may therefore be laid over in the finishing process in order to secure a better covered surface.

The examples illustrated in *Figure 16.7* also show the production of the 'W' form of fast pile tuft, but they are designed to get over the 3-pick grouping and to secure a more even distribution of the pile. A represents a single-shuttle structure which is wefted four picks top and four picks bottom fabric, and two series of pile threads are used, one of which is interwoven on the first three and the other on the last three of each group of four picks. The ground weave is plain, and the corresponding draft is given at C in *Figure 16.7*, the weave at D and the lifting plan at E.

The plain interlacing of the pile threads in the 'W' structure represented at A in *Figure 16.7*, cuts with the plain weave of the ground ends on one side only. By arranging the draft, however, so that a ground end on both sides of a pile thread is drawn on the same heald, as shown at F, the ground ends will form plain weave with the pile interlacing with the result that the tufts are more firmly secured, as they are held in position by the cutting of the ground ends at both sides. The style is used for light supple cloths composed of silk or rayon. The corresponding weave for diagram A and draft F for single-shuttle weaving is given at G in *Figure 16.7*, while H is the lifting plan.

The double-shuttle structure illustrated at B in *Figure 16.7* contains six series of pile threads, three of which work opposite to the other three, the idea being to distribute the pile to the greatest possible extent and thus secure a cloth with a surface that is most effectively covered. Three pile warp beams may be employed, but by making use of three compensating rods all the pile threads can be brought from one beam. The draft for diagram B is given at K,

the corresponding weave at L and the lifting plan at M. Different marks are used to distinguish the various pile threads, the half-lifts of which, in plans L and M, are indicated by the crosses.

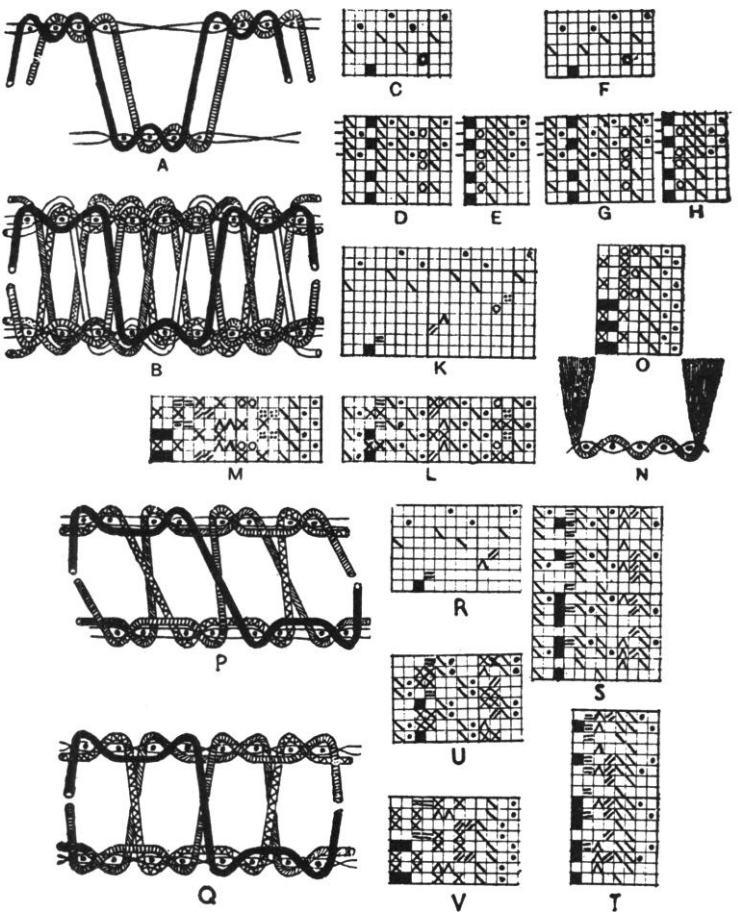

Figure 16.7

Particulars for 100 m of dress fabric suitable for draft G, *Figure 16.6*, or draft K, *Figure 16.7* are: Pile warp, 17 tex filament rayon, 400 m; ground warp, 20/2 tex cotton, 110m; weft, 20 tex cotton, 29 picks and 29 ground ends per cm in each fabric, 29 pile threads per cm. Each pile thread forms a tuft every six picks giving 140 tufts per cm^2 (not allowing for contraction).

A modification of the 'W' form of tuft is shown at N in *Figure 16.7*, which is used to obtain great firmness when a very long pile is formed or when the cloth is liable to be subjected to hard wear, as in the case of pile rugs and mats. In addition, the draft of the ground ends can be arranged, as shown at F, so that the plain ground weave cuts with the interlacing of the pile threads and the tufts are held in position at both sides. The lifting plan for double-shuttle weaving is shown at O.

The order of interlacing, illustrated in *Figure 16.7* at P and Q, produces very firm pile anchorage and is particularly appropriate for 2-and-2 warp rib and hopsack ground weaves, which, themselves, are specially suitable for the production of heavy pile fabrics. Each tuft is interwoven on four picks, and in order to distribute the pile four series of pile threads are used, two of which work opposite to the other two, so that they can be operated from two warp beams or from one beam if compensating rods are used. This pile structure may be compared with that shown at F in *Figure 15.4*.

P in *Figure 16.7* represents the single-shuttle structure wefted 2 picks top fabric, 2 picks bottom fabric. The draft is given at R, the complete weave at S, and the lifting plan at T. The double-shuttle structure, shown at Q corresponds to P except that the 2-and-2 warp rib ground weave is in a different relative position to the interlacing of the pile threads. The draft R is suitable and U and V show the weave and lifting plan respectively, the crosses representing the half-lifts of the pile threads.

The following are suitable particulars for an imitation fur woven in the structure, represented at P and Q. Pile warp, 64/2 tex mohair, 800 m or more of warp for 100 m of cloth; ground warp, 40/2 tex cotton 108 m; weft, 50 tex cotton, 28 picks per cm in each fabric, 14 ground ends per cm in each fabric, and 14 pile threads per cm. Each pile thread forms a tuft every 8 picks giving 49 tufts per cm^2 (not allowing for contraction).

Carpet structures

Double shuttle face-to-face weaving represents the principal method of producing self-colour, all-over cut pile carpets which after separation by the knife become structurally identical with those produced by the wire insertion method. Any constructions described in connection with the latter method can be used although the two-shot structure is mainly employed, as depicted in *Figure 16.8*. All the healds are tappet controlled; the chain or ground ends are operated alternately 2 up, 2 down in each cloth, the stuffer yarns 1 down, 1 up, whilst the pile threads oscillate between the two cloths and are anchored around alternate picks in each fabric.

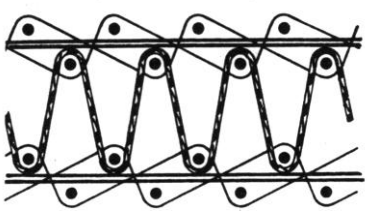

Figure 16.8

Similar qualities can be made to those described with regard to carpets produced by the wire insertion method. Frequently high twist yarns are employed for the pile which have the merit of yielding carpets which are not only hard wearing and resilient but also less prone to show furniture marks, etc.

Production rate of the face-to-face system compares very favourably with the wire loom. Weaving identical quality body width carpeting in a two-shot structure the face-to-face loom will produce 105 horizontal rows of tufts per min as

opposed to 55 by the wire loom. Similar proportional advantage is retained in broadloom weaving.

FIGURED PILE STRUCTURES

Face-to-face moquette textures, which are used for upholstery and similar purposes, are ornamented in diverse ways by means of colour and design. In the ordinary structure in which only one series of pile threads is used stripe patterns and marl effects are formed by combining yarns that are different in colour, material or dyeing property, etc., and figured styles are obtained by printing. Bulky threads similar to the pile yarn are substituted where required for the slack cotton ground ends (corresponding empty mails being left on the pile healds) so that stripes of pile are separated by sunken repp lines as shown in the fabric at A in *Figure 16.9*. The special surface effects obtained in finishing and described in connection with all-over pile structures produced with the aid of wires are, of course, equally applicable to similar face-to-face fabrics.

In dobby shedding more elaborate effects, ranging from combinations of hopsacks and horizontal cords to simple figured patterns, are produced by making use of the system of compensation and, instead of using only one series of pile threads, by employing two series which are differently coloured.

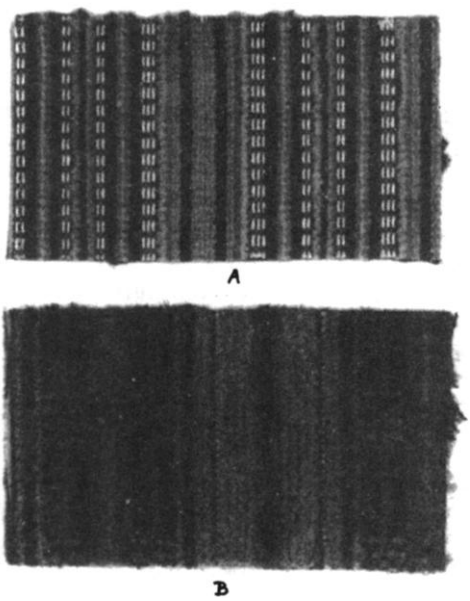

Figure 16.9

By planning a design so that an equal number of tufts is formed by each series of pile threads only one pile warp beam and one pile let-off motion are necessary, as one series is a duplicate of the other. A separate pile warp beam and pile let-off motion may, however, be used when greater freedom of design is desired as the pile ends used for forming the figure can then be considered

independently of those forming the ground pattern. Figured effects which require a jacquard machine for their production are also made, but for these separate bobbins are necessary for the pile threads. Multi-frame jacquard designs are produced mainly in upholstery moquettes and in carpet structures.

Production of loop and cut pile effects is possible with the aid of frieze wires and different height of pile can be formed by using special stitching weft which is removed after weaving but neither of the above two structures is utilised to a great extent. The results are not as good as in similar structures produced with wires and in employing the special devices the face-to-face system tends to jeopardise its main advantage over the wire method which is the high rate of production.

The use of duplicate series of pile threads

The principle by which two duplicate series of pile threads are used in forming a fancy effect is illustrated in *Figure 16.10*. A motif is shown on one vertical space at A in which the solid marks represent a dark pile thread and the circles a light pile thread, the plan thus indicating that in a longitudinal line three tufts of dark pile alternate with three tufts of light pile. The corresponding diagram, given at B, shows that when one series of threads is forming pile the other series is interweaving in the bottom fabric in the same way as the slack ground ends. The pile threads, when not forming pile, might be interwoven similarly in the top fabric, but the method illustrated is generally preferred, and to allow for the addition of the pile threads to the ground only one slack ground end instead of the usual three may be used in the bottom fabric. This causes the top and bottom fabrics to differ from each other in composition and handle, but the difference is not considered objectionable as long as the two fabrics are not combined in the same article.

As only one pile beam is used, the length of pile warp must be the same for both series of threads, and the yarn is let off regularly at the average rate required for tufting. The threads which are not forming pile, however, are taken up only at the same rate as the ground ends so that there is an accumulation of length of this series during the period that the other series is tufting. The accumulated slack, which each series forms in turn is taken up by means of compensating rods, the operation of which by means of stretched springs has been described previously. The length that can be taken up by the rods is limited, but as each series of pile threads forms only its own proportion of the tufts, in this case one-half, the rate of pay-off is very much less than when only one series of pile threads is employed.

The draft for the structure, represented at B in *Figure 16.10*, is shown at C; six healds are employed and each group of threads consists of 2 top and 2 bottom ground ends and 2 pile threads in each split of the reed. The complete lifting plan is given at D for double-shuttle weaving, the weave of each fabric repeating on 12 picks. It is assumed that a three-position dobby is used, hence two solid marks alongside each other, or two circles followed by blanks, represent the full movement of the pile threads for tufting, while the single crosses show the half-lifts of the pile threads during the period they are being interwoven in the bottom fabric. One vertical space is used for each ground heald and the lifts of

the top and bottom fabrics are represented by diagonal marks and dots respectively.

Design E in *Figure 16.10* shows an elaboration of the motif A in the form of a stripe, but the structure throughout corresponds to that represented at B, while G and D show the draft and lifting plan respectively. The change of pattern is

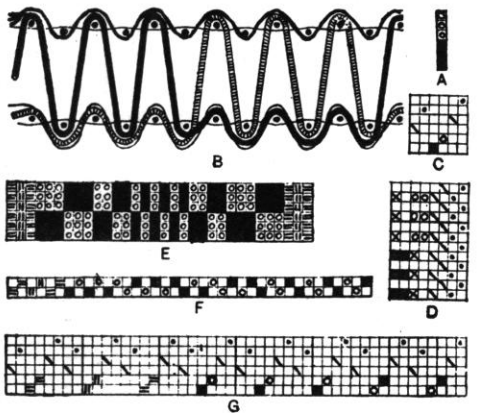

Figure 16.10

due to the arrangement of the pile threads as to colour. Each vertical space of design E represents two pile threads, while F shows how the colours of the first 19 vertical spaces of E are arranged and how the pile threads are drawn on the two pile healds. Where continuous lines of the same colour are formed, as represented by the horizontal and vertical marks in E, both pile threads of a pair are of the same colour. Where the pattern changes colour longitudinally in 3-and-3 order, as represented by the solid marks and circles, the two pile threads of each pair are differently coloured, and to alter the pattern in a horizontal direction two threads of the same colour are brought together at the change of effect. Thus, assuming that in design E the horizontal marks represent black, the vertical marks green, the solid marks blue, and the circles gold, the warp arrangement of the continuous lines is two black, two green, two black; in the 3-and-3 colour effect it is one blue, one gold three times, then one gold, one blue three times; in the 2-and-2 effect it is one blue, one gold twice and one gold, one blue twice, and in the 1-and-1 effect it is one blue, one gold and one gold, one blue three times. To further illustrate the arrangement of the warp pattern the complete draft is given at G of the first eight vertical spaces of design E.

In *Figure 16.10* each continuous line of colour in the plain stripe, indicated by the horizontal and vertical marks in design E, is taken as being formed by the working of two pile healds which combine the tufting of two pile threads of the same colour. The changing from one thread to the other in forming the pattern tends, however, to produce an irregularity in the continuity of each line of colour (which is not so apparent where the two threads are differently coloured), and to avoid this defect a separate pile heald, pile beam and let-off motion may be used for the threads which form the continuous lines. As these pile threads form pile all the time their take-up is greater than those that form the discontinuous stripe, while under the plain stripe in the bottom fabric

three-ply slack ground ends must be used. B in *Figure 16.9* illustrates the type of fabric described above.

Motif A and the corresponding design B in *Figure 16.11* show, on a small scale, a development of the preceding example which can be produced by the same mounting, viz. a duplicate set of pile threads drawn on two healds, one

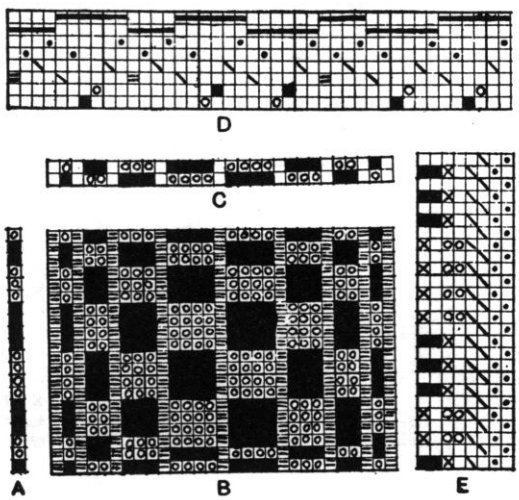

Figure 16.11

pile beam and pile let-off motion, and two compensating rods. The order as to colour in which the pile threads are drawn on the two healds is represented at C, the colour shown on the first heald preceding that indicated on the second heald. In this case, however, it is assumed that the continuous lines represented by the horizontal marks in design B are produced by threads which form a repp effect. These threads therefore are drawn on the same healds as, and in place of, corresponding slack ground ends, as shown in the draft given at D, and it is usual to weave the repp threads from a separate beam provided with a negative let-off. For convenience empty mails may be left on the pile healds to correspond with the repp threads, and there are no pile threads in the corresponding split. The arrangement of the pile threads in the check figure effect is as follows:

Dark	1 1 2 1 1 1 1 1 2 1 1 1 1 1 2 1 1	20
Light	2 1 1 1 2 1 1 1 1 1 1 2 1 1 1 2	20

D shows the complete draft to correspond with the first eight vertical spaces of design B, while E represents the lifting plan for the first 13 horizontal spaces, two vertical spaces in E being used to show the lifts of each pile heald.

B in *Figure 16.12* is the motif of the simple figured stripe design given at A in which there are three different orders of working, but the figure is so arranged that in each longitudinal line an equal number of figuring and ground tufts is formed, viz. 16 of each in the repeat of 32 tufts. Like the previous example the design requires two series of pile threads, one pile warp beam and one pile let-off motion, but each series of pile threads requires three healds. In addition to

the four ground healds, therefore, six pile healds are necessary, and as the threads operated by the latter form pile at different times, six compensating rods to correspond are necessary.

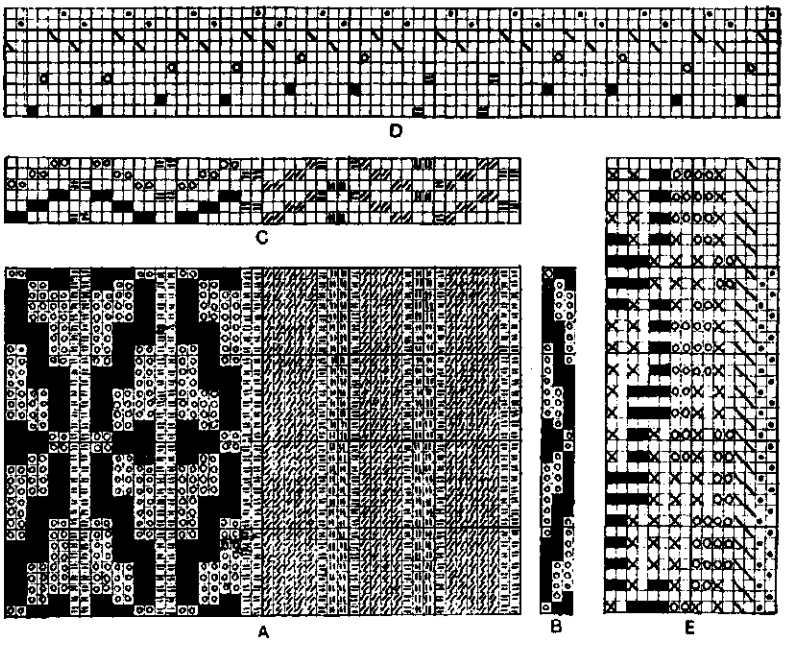

Figure 16.12

C in *Figure 16.12* shows the colour arrangement of the pile threads as they are distributed over the six pile healds, and to simplify the heald order the threads in the plain stripe which form continuous lines of colour are indicated on the healds in such a way that an equal number of threads is drawn on each heald. The change from one thread to the other in the plain stripe occurs at different times so that the possibility of cracks or irregularities showing in the continuity of the lines is reduced.

The complete draft of the first 12 groups of threads of design A is given at D, and the lifting plan of the lower portion of the design at E in which the method of marking is the same as in the previous example.

In the figure of design A in *Figure 16.12*, the pile threads are arranged one dark, one light throughout, but additional variety of effect would have resulted if, say, the middle strip had been changed to one light, one dark, as a counter-change pattern would have been formed. This method has been employed in the design given at A, *Figure 16.13*, the motif for which is shown at B with the result that the central line of figure appears different from the outer lines without an increase having been made in the number of different orders of working. In this example, in each vertical line of figure, more tufts of pile are formed by one colour than by the other in the proportion of 15 to 9 in the repeat of 24 tufts. Four series of pile threads drafted upon four healds and four compensation rods are needed, and as two of the series of threads require

a very much greater length of pile yarn than the other two, two pile warp beams and two pile let-off motions are necessary.

The colour arrangement of the pile threads and the order in which they are distributed upon the four pile healds are shown at C in *Figure 16.13*, and as

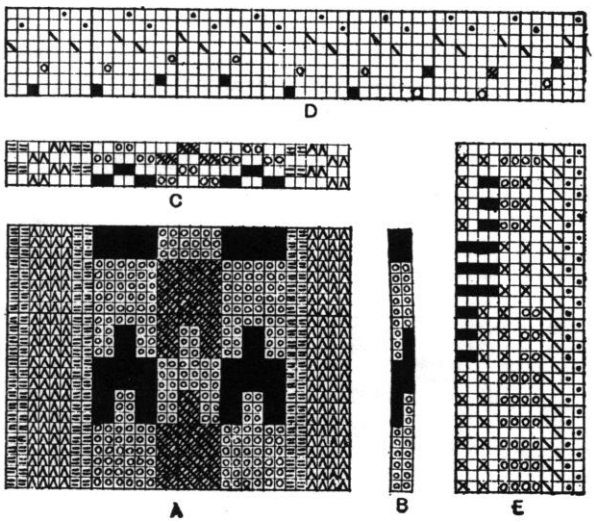

Figure 16.13

before each vertical space of A and C represents two pile threads. The complete draft of vertical spaces 9 to 17 of design A is given at D, while E shows a portion of the lifting plan.

Face-to-face looms are usually built to accommodate three pile beams and three pile let-off motions, and opportunities are thus provided for increasing the size and diversity of designs which require two series of pile threads in each line of the figure, while special colour effects can be introduced by employing where necessary a third series of pile threads. A multiplicity of pile beams, let-off motions, compensation rods and healds complicates the working of the loom, however, and care needs to be taken that the resulting pattern is worth the means employed in producing it.

The use of three series of pile threads, instead of two, in each line of the cloth greatly facilitates the production of variety of design and at A, in *Figure 16.4*, for which B is the motif, a style is illustrated on a small scale which can be woven with a comparatively simple mounting. Three colours are represented by the blanks, shaded squares and solid marks, and the spaces of the design are arranged both vertically and horizontally in the order of six, four, two, two, four repeated. An equal number of tufts of each colour, viz. 18, is formed in a vertical direction in the repeat of 54 tufts. There is only one order of working the three series of pile threads so that the required mounting consists of three pile healds, one pile warp beam and let-off motion, and three compensating rods. The change of pattern in a horizontal direction is due to changing the order in which the colours are arranged on the principle illustrated with two colours in *Figures 16.10* and *16.11*. Thus, assuming that the blanks represent

light, the shaded squares mid and the solid marks dark, in the first section the colour arrangement is one light, one mid, one dark for six times; in the second section one mid, one dark, one light for four times, and in the third section one dark, one light, one mid twice. This is indicated at C in *Figure 16.14*, which shows the order of colouring and the arrangement of the threads on the pile healds of the first 16 vertical spaces of design A, while D shows the complete draft of the ninth to the sixteenth space.

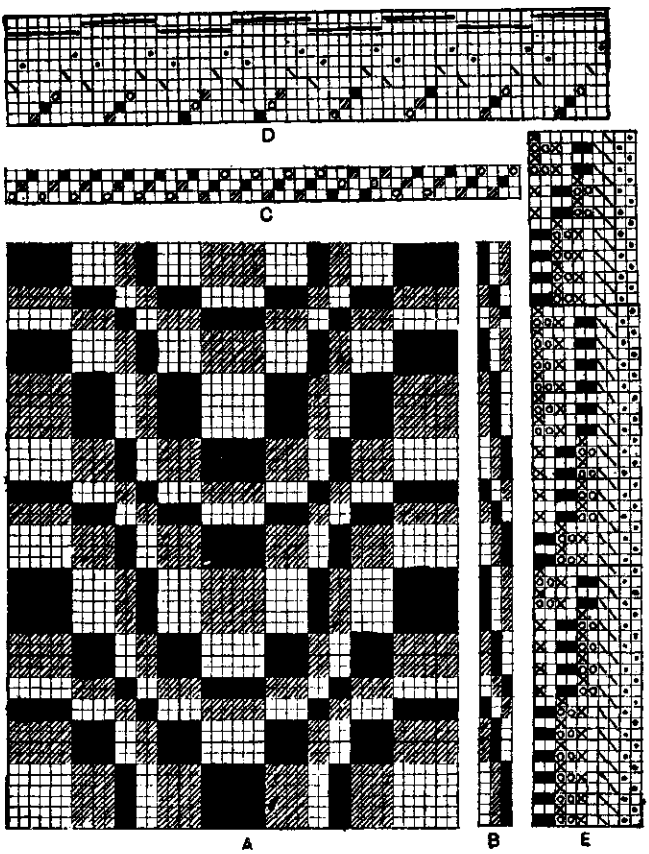

Figure 16.14

The lifting plan for the lower portion of design A in *Figure 16.14* is given at E and, as it is assumed that two dobby jacks are used for each pile heald, the lifts of each are indicated on two adjacent vertical spaces. Where two solid marks are followed by two blanks the corresponding pile heald moves the threads the full depth of both sheds for the purpose of tufting. The crosses show where the pile healds are moved, each by one jack, to the intermediate or centre position. Thus, when a cross on an odd pick is followed by two blanks the corresponding threads are interwoven in the bottom fabric when not forming pile, while where a cross on an even pick is preceded by two circles the pile threads are similarly interwoven in the top ground fabric. In this manner each series of

pile threads, after forming pile, interweaves in the bottom fabric and then in the top fabric so that both cloths appear the same, and a saving of two-thirds of the slack ground ends can be effected in both ground warps.

Jacquard figured constructions

Jacquard shedding is employed in producing many different kinds of figured pile fabrics by the face-to-face system, and the machine and harness are varied in construction and arrangement according to the class of pile texture required while the pile threads are brought from bobbins or cheeses carried in a creel. A variety of pile weaves may be used in the figure, but when the ground is a light texture, such as voile, or crepe-de-chine, the 'fast' or 'W' form of pile weave is used in order to bind the pile firmly. This type of structure may be conveniently woven on the single-shuttle principle, using an ordinary double-lift jacquard for the pile threads, and ordinary healds for the ground threads. Cloths in which the foundation is dense and compact may have the pile threads interwoven into the ground when they are not forming figure, and they may be woven equally into both the upper and lower fabrics. In some cases, however, it is more convenient for the pile threads to be interwoven only in the ground of the lower fabric.

Using single-shuttle, multi-frame constructions suitable for upholstery or velvet pile carpets are produced on the one-shot principle, i.e. a tuft is anchored around every pick. A two-frame structure of the above type is depicted by the weft section at A in *Figure 16.15* but any number of frames could be employed if desired, up to a maximum of five. A plain weave ground structure is used in both the top and the bottom cloth arranged so that all the odd picks form the upper and all the even picks, the lower fabric. The ground ends are controlled by healds and only the pile ends are jacquard operated. To produce the design selected pile ends from each longitudinal row of pile are raised over the odd picks. The unselected or dead pile ends float on the underside from which they are removed by mechanical means during finishing. It will be noted that on the even picks all the pile ends remain down. In consequence the jacquard needs to operate at only half the loom speed the cylinder presenting the cards on the even picks and the knives lifting the selected ends on the following odd picks. A jacquard of this type has been shown in *Figure 15.9*.

At B in *Figure 16.15* a small portion of a condensed design is shown in which each vertical row represents one longitudinal row of pile, i.e. two pile ends, and each horizontal row represents two picks. A fully worked-out weave for the first two vertical rows is given at C in which the first row corresponds to the section at A. In the condensed design the solid marks show the lifts of the pile ends from frame 1 and the circles the ends from frame 2. At C solid marks and circles represent the lifts of the pile ends from frames 1 and 2 respectively, whilst the dots and diagonal marks respectively indicate the lifts of the ground ends in the top and bottom cloths.

In a higher frame cloth each longitudinal row contains three, four, or five pile ends of which only one is lifted on any given odd pick and the design for such a cloth must be painted in an appropriate number of colours. Colour planting is often carried out and sunk or pile-less places can be easily created by deliberately missing out pile lifts where required. If figuring by means of

sunk places is undertaken then the portions at which it occurs must be indicated by a special colour or mark in the condensed design to denote that at such portions none of the pile ends are to be lifted.

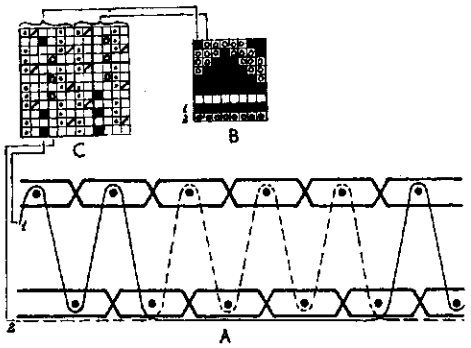

Figure 16.15

As the tuft anchorage in the structure described above is not very secure, especially in the bottom cloth, such fabrics are usually finished with a latex or other adhesive backing. Their main advantage lies in the fact that their rate of production is high, one horizontal row of tufts being produced on every pick as opposed to one for every two or three picks in other constructions, but being single shuttle they are confined to fabrics in which the pile height is limited to only about 5 mm. For this reason, and also due to a certain amount of lack of dimensional stability, the one-shot structures are infrequently used for carpets for which double-shuttle looms are preferred.

In the double-shuttle looms two to five frame designs are produced in two different major classes of structures. In the first one all the pile yarns are allocated to, and interwoven with, the bottom cloth, from which the selected pile ends are raised to the top cloth level only to form the tufts whereupon they immediately drop down. Thus, a difference in the weight of the two cloths exists which has to be compensated for by running in the top cloth additional stuffing or ground yarns but the construction permits the use of a simple jacquard system. In the second structural class the pile ends are equally distributed between the top and the bottom cloths and the ends allocated to the top cloth make the tufts by descending down to the bottom cloth level whilst those allocated to the bottom cloth ascend to make the tuft. Both fabrics are of equal weight but a more complex jacquard system is required. Each class of structure can be employed for both upholstery moquettes and carpets, and is produced in machines which operate in accordance with the same principle, irrespective of the end use of the cloth. It must be realised, however, that although the same in principle the machines differ in weight and size, much more robust constructions being required for carpetings than for upholstery cloths.

The first class of construction is shown by the weft sections A and C in *Figure 16.16* in which the former represents a 3-frame moquette and the latter a 3-frame Wilton carpet structure. It will be noted that although the ground weaves in the two sections, A and C, differ the pile yarns are operated in an identical fashion. On odd picks all the pile ends are down, on even picks the

selected pile ends are raised by the knives to the high level to form tufts whilst the unselected or dead pile ends are lifted by the working comber-board to the centre position to be interwoven with the picks of the bottom cloth. Consequently, the same type of jacquard can be used in both cases the operation of which has been given in *Figure 15.9* in the previous chapter. The method of designing is the same as explained with reference to multi-frame pile fabrics produced with the aid of wires (see pp 305 to 314).

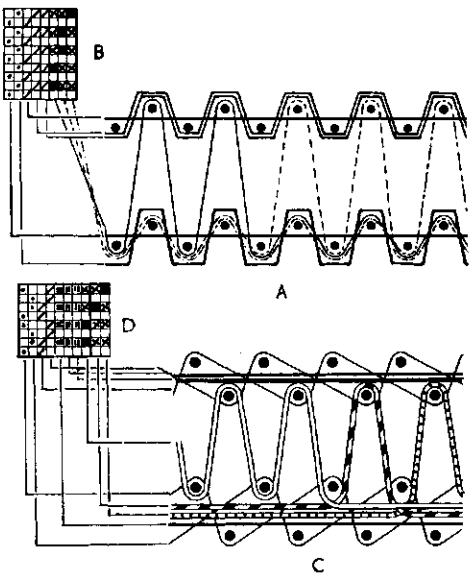

Figure 16.16

B in *Figure 16.16* represents the fully worked-out weave for the longitudinal row of pile given at A with which it is connected by fine lines. It will be noted that to compensate for the difference in weight between the top and the bottom cloths the top cloth contains two slack ground ends working as one. If greater degree of weight compensation is required, as it may be in 4 -frame or 5-frame structures, three or even four slack ground ends may be incorporated into each longitudinal row of the construction. In the carpet structure shown at C the weight compensation is achieved by introducing into the top cloth additional stuffer yarns as clearly indicated by the fully worked-out weave at D. In both B and D the solid squares represent the high lift of the selected pile ends, the crosses the comber-board lifts of the dead pile whilst the diagonal marks indicate the ground end lifts in the top cloth and the dots, the ground end lifts in the bottom cloth. At D the lifts of the stuffers are represented by the double vertical marks in the top, and by the double horizontal marks in the bottom cloth.

The second class of structures is represented in *Figure 16.17* by the weft sections A and C. Both sections depict 4-frame effects but whilst the former represents an arrangement suitable for upholstery moquettes the latter one shows a two-shot Wilton carpet structure. In this class of construction the pile yarns, as has been stated, are equally apportioned between the top and the

bottom fabrics. Therefore, as there is no need for the equalisation of weight the ground structures in the top and in the bottom cloths are identical. This is clearly shown in the sections and in the fully worked-out weaves at B and D in which the same marks have been used as those in *Figure 16.16*, except that for the top pile ends, which move down to make sheds, the circles indicate the full distance drop of the selected yarns whilst the shaded squares represent the half distance drop of the dead pile yarns. The jacquard which controls the pile yarns must have a sufficiently flexible action to provide various levels of lift

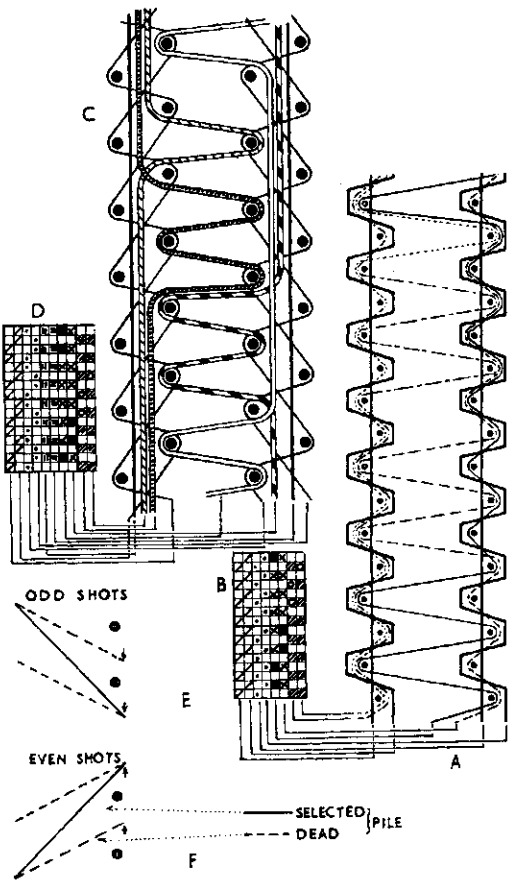

Figure 16.17

(or drop) simultaneously. Studying the sections, A and C, and the shed diagrams, E and F, in *Figure 16.17* it will be seen that the pile yarn allocated to the top cloth—in this instance frame 1 or 2—makes a figuring tuft by moving from the top to the bottom position through two shed heights, and by converse, the bottom pile yarn—frame 3 or 4—produces a figuring tuft on the following shot by moving from the bottom to the top cloth level. Each yarn returns to its normal allocated position after the figuring movement. On odd shots, the jacquard will have to provide the following movements: Top selected pile to drop right down; top dead pile to drop half-way down; all bottom pile to stay

or return right down. On even shots the movements are: All top pile to remain or to return right up; bottom selected pile to lift right up; bottom dead pile to lift half-way up.

A schematic diagram of one type of jacquard which is used for the production of multi-frame face-to-face cloths is given in *Figure 16.18*. The jacquard is arranged on the inverted hook principle with the hooks which control the top cloth pile yarn facing the cylinder and the bottom cloth hooks inverted. For convenience only two hooks per short row are shown in each—the top and the bottom cloth machine although normally there are eight. Every hook is operated by its own needle and selection of the pile ends is given by a blank in the card. Thus, the cards are perforated except for the tuft forming pile ends. Any pile ends not selected by the blanks to form tufts are automatically treated as dead pile yarns. The operation of this machine is explained with reference to A and B in *Figure 16.18* which show the movement of the shed forming elements of the jacquard on the odd and the even shots respectively. On odd shots when the ends allocated to the top cloth make the figuring movement the griffe and the bottom boards descend. The selected hooks, TS, are pushed clear off the knives and fall upon the bottom board and are taken by it right down. At the same time the unselected hooks, TD, remain over the knives (because the needles which control them are opposed by holes in the card) and are taken only half-way down. On the same shot the pile ends allocated to the bottom cloth are all in the bottom shed line irrespective of whether on the previous shot they were fully up or half-way up. This arises out of the fact that on the odd shots, the bottom board and the knives, which between them control the bottom pile, are both at the lowermost positions in respect of the bottom pile yarns. On the even shots, when the ends assigned to the bottom cloth make the figuring movement, the griffe and the bottom boards ascend, as shown at B. The selected hooks, BS,

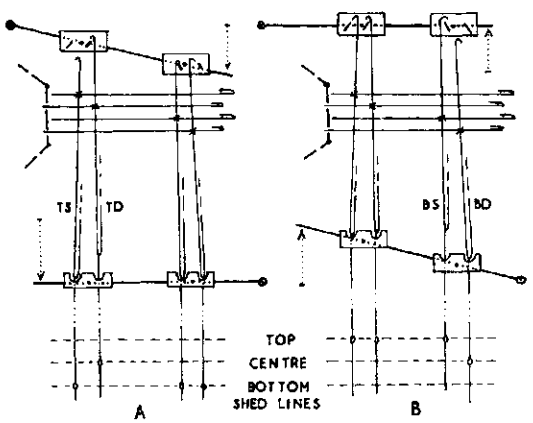

Figure 16.18

in the inverted hook section of the jacquard are pushed over the knives and are taken by them right up whilst the unselected hooks, BD, remain clear of the knives and are taken half-way up by the bottom board. On the same shot the top cloth pile ends are all taken right up irrespective of whether on the previous shot they were fully down or half-way down. This occurs because on the even shots

the knives and the bottom board which control the top pile are both at their uppermost positions in respect of the top pile ends. Thus, it will be seen that the movement of the pile ends on each shot of the figuring sequence conforms exactly to the requirements stipulated in respect of the shed diagrams E and F in *Figure 16.17*. The original positioning of the griffes and the bottom boards and their movements are such that a uniform and correctly angled shed line is achieved for all the pile yarns between the front and the back harness rows in all the three shed positions. This is valuable in reducing the friction to which some ends would be subjected if the angle to which they were raised or lowered differed from that of other ends. It will be appreciated that the jacquard controls only the figuring or pile ends. The ground or chain ends and the stuffers, if any, are controlled by healds which are operated by suitably contoured positive tappets.

An equal apportionment of pile ends between the top and the bottom cloths presents no problems in 2-frame or 4-frame structures. However, in 3-frame or 5-frame effects equality of distribution in each longitudinal row of pile is impossible, therefore, to maintain the same weight and quality between both fabrics equalisation is achieved by reversing the number of frames allocated to the top and the bottom cloth over two adjacent longitudinal rows. Thus, in a 5-frame structure in odd rows two pile ends may be allocated to the top cloth and three to the bottom cloth. In even rows this allocation is reversed, i.e. there are three pile ends in the top and two in the bottom cloth.

A short row in the jacquard described in the foregoing consists of 15 needles and 16 hooks, eight in the normal section and eight in the inverted section. The one hook which is in excess of the number of needles is left out in each short row alternately from the normal and the inverted section on alternate short rows as shown at A and B in *Figure 16.19*. *Figure 16.19* shows the order in which the needles control the hooks and the tie of the harness on odd and even short rows. It will be noted that the needles, for ease of card cutting, control the pile ends from the different frames in a consecutive order, i.e. in each short row needles 1 to 5 control ends from frames 1 to 5 in the first longitudinal row or course of pile, needles 6 to 10 frames 1 to 5 in the second row, and needles 11 to 15 frames 1 to 5 in the third row of pile. Thus, each short row of needles is used to select the tuft forming ends in three adjacent longitudinal rows. If a fewer number of frames is employed in a design then the jacquard is simply cast out in long rows and the excess needles in each group of five are not utilised. For example, in a 2-frame design in each short row only the needles 1 and 2, 6 and 7, and 10 and 11 would be in use. The method of designing is the same as described in the previous chapter in connection with wire-produced multi-frame pile fabrics. To show the order of card cutting for the face-to-face jacquard a small portion of one horizontal row of a 5-frame design with a gamut is given at C in *Figure 16.19* and this is connected to a corresponding portion of a card at D.

In addition to the structures described above the same form of jacquard, with a slight change in the order of movement of the shedding mechanisms, can be used to produce carpets in which the selected pile yarns are woven through to the back. The design is fully visible on the underside which in certain markets is preferred as it resembles more closely the effect produced in hand-knotted carpets. A section of a 4-frame structure in which the design is visible on the back is given at E in *Figure 16.19*. It will be seen that the structure is similar to

the one given at C in *Figure 16.17* except that prior to and upon each figuring movement the selected pile end is placed around the back shot of weft. The dead pile yarns are retained in the same position as in the standard construction.

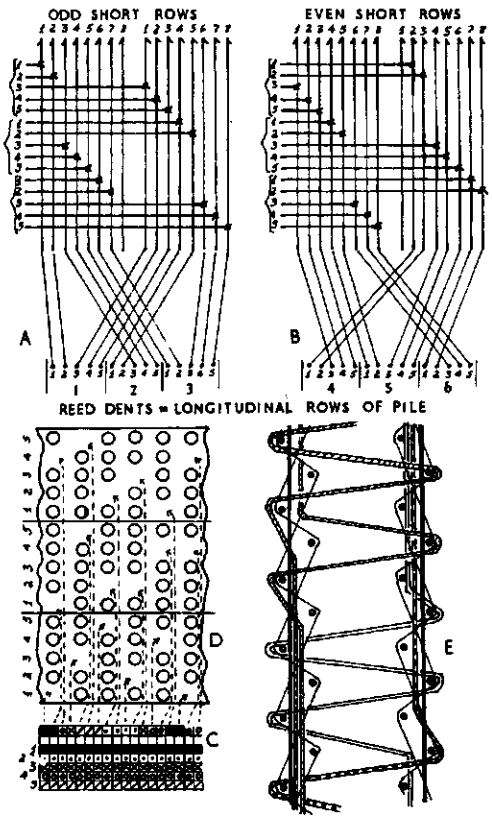

Figure 16.19

In all the multi-frame structures described in this chapter auxiliary ornamentation by using the sunk places can be easily carried out. It consists simply of not operating any pile ends in selected areas which must be distinctly marked in the design so that the card cutter leaves them unselected. To enable manufacturers to diversify their production even further, face-to-face machines may be built as convertible looms which can be used either for face-to-face weaving or, if necessary, for wire-woven pile effects with looping or cutting wires. The conversion involves removal of the knife mechanisms and the twin jacquard and substitution of the wire motion and a single jacquard and it is claimed that the complete change-over in either direction can be accomplished within a day and a half. The main advantage of this system lies in the fact that a manufacturer may follow any changes in the fashion without keeping a proportion of specialised machinery under-utilised when for a given time the demand is for one type of cloth rather than another.

In multi-frame face-to-face weaving, using the structures described in the foregoing, a considerable saving in the pile yarn can be effected compared with

similar wire-produced fabrics. This is due to the fact that the pile yarns in face-to-face weaving are shared between two carpets whilst in the structures made with the aid of wires all the pile yarns are contained within one carpet. Thus, in a 5-frame structure produced by the latter method under each tuft there are four dead pile ends but in a similar structure woven face-to-face there are, on average, only two dead pile ends. The saving is of considerable importance because the pile yarns are the most expensive item in the make-up of a carpet and in a high quality structure the cost of materials may represent as much as 75 per cent of the total factory cost of an article. If required exact replicas of cut pile constructions achieved by the wire method can be produced on the face-to-face system as shown at A in *Figure 16.20* in which duplicate threads, simultaneously alternating between the two cloths, are used. However, such structures are rarely made as their manufacture results in the loss of an advantage inherent in the face-to-face method.

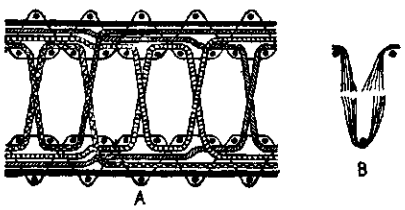

Figure 16.20

It will be noted from the study of the standard multi-coloured effects produced by the face-to-face system of weaving that although the design between the top and the bottom cloth is identical in respect of colour it differs in respect of construction. The difference is due to a slight displacement of the tuft anchorage point between the two cloths and is shown at B in *Figure 16.20*. Normally this variation is of no significance but to avoid difficulties matching of strips of the top to the bottom piece is not recommended.

The range of materials and yarn settings in this system is as wide as that described in respect of pile fabrics produced with the aid of wires and the details of construction given in Chapter 15 can be equally well applied to fabrics for similar end uses woven face-to-face.