POWER-LOOM WEAVING OF WOOLLEN AND WORSTED FABRICS

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THE history of spinning and weaving was discussed in an article published in the Autumn 1951 issue of WOOL KNOWLEDGE, and the concluding sentence of that article read: "Despite the invention of greatly elaborated machinery, housed in vast mills, the basic principles of the machinery for spinning and weaving remain the same now as when Neolithic man first drew out the raw wool and twisted it into yarn between his fingers, and with it wove the first primitive woollen fabric." Some qualification of that statement ought perhaps to be made, for in present day machinery the principles involved are the same only to the extent that the fundamentals of weaving are unalterable. A woven structure requires the interlacing of one series of threads called "weft", with another series of threads called "warp", the latter being set at right angles to the weft threads. Several hundred warp threads must be delivered together so that the weft threads can pass across one at a time to interlace with the warp threads and then be closed against the cloth already woven.

The means used on modern power-looms for delivering the warp threads to the point where weft picks[1] may be interlaced with them, for separating the warp threads to produce the space or "shed"[2] for the insertion of weft in a variety of interlacings, for projecting shuttles or otherwise inserting weft picks possibly in several colours and in various orders of colouring, for closing weft picks against cloth already woven, and for moving the cloth forward on to a roller or beam as it is made, are vastly different in detail and sometimes even in principle from one make of power-loom to another. In addition, the modern power-loom has many extra mechanisms which are designed to save the operative time and effort, to improve the quality of the cloth produced, and to prevent damage to the threads and to the various mechanisms if anything out of the normal occurs during weaving.

The object of this article is to discuss briefly the different mechanisms of the power-looms used at the present time for woollen and worsted weaving, and

1. See end of article for glossary of numbered terms.

the possibilities regarding the variety of structure, colour and design of the cloths which can be woven with these mechanisms.

PRIMARY AND SECONDARY MOTIONS OF POWER-LOOMS

Three motions of power-looms or weaving machines can be classed as primary. They are shedding, picking of shuttles or other means of weft insertion and beating-up,[3] the first two providing the means of interlacing weft with warp, and the last closing the interlaced pick of weft against the cloth already woven. They are primary in the sense that they perform the fundamental operations in the making of a woven cloth.

The secondary motions of a power-loom are the warp let-off, which is the means of delivering the warp to the point of weaving, and cloth take-up[4] which is the winding of the woven cloth away from the point of weaving. These are secondary in the sense that they are not required on a simple weaving frame. In the latter case, the operations of interlacing a pick of weft with the warp and closing it against the cloth already woven can move along the length of warp as the cloth is built, whereas in the power-loom the points at which these take place are fixed and the warp and cloth must, therefore, move forward pick by pick.

The weft thread and shuttle are shown passing through the shed created by the raising or lowering of the warp threads.

An example of an ordinary plain loom of about 1850, fitted for driving by power.

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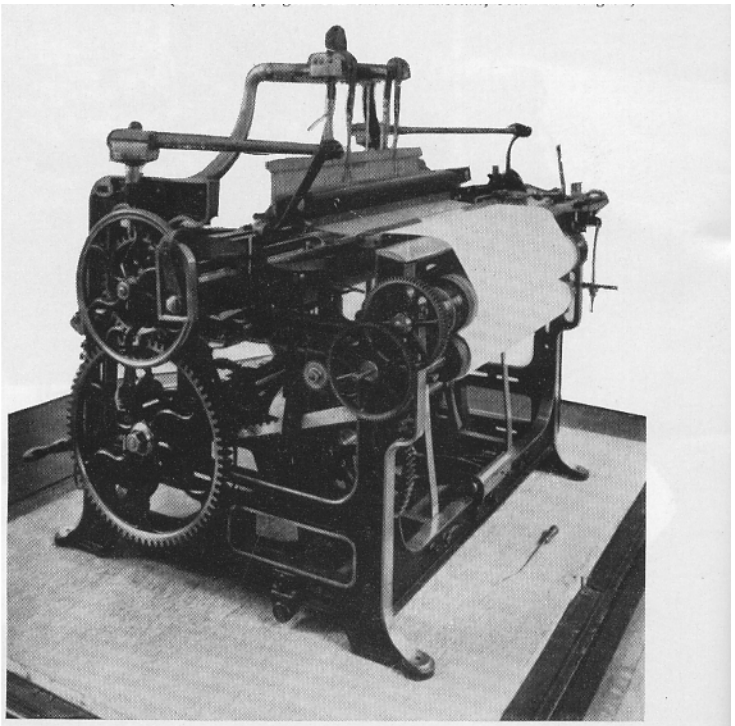
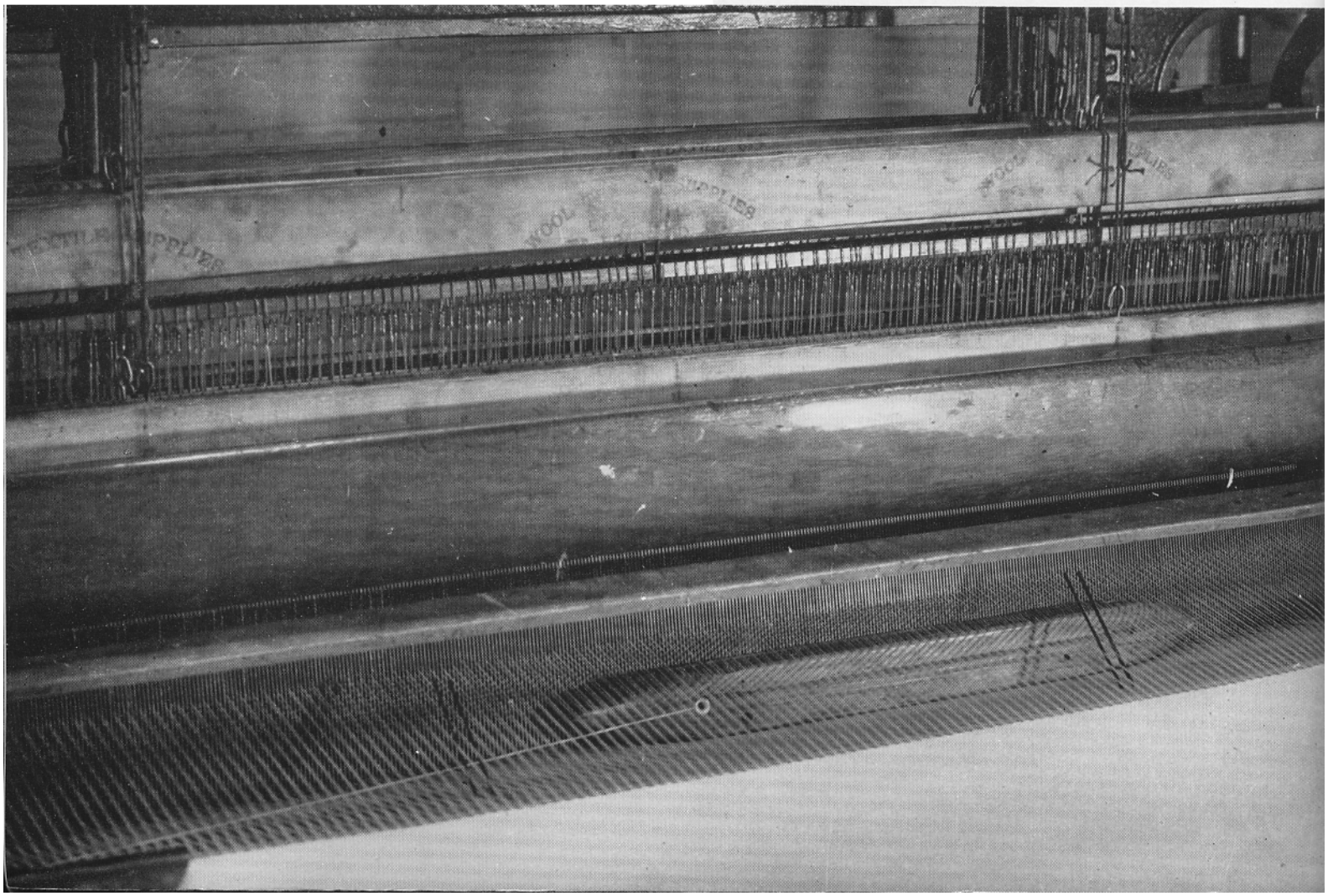




In a hand-loom, of course, the cloth can be built up for a considerable number of picks between stages of letting-off[5] the warp and taking the cloth forward, because the beating-up frame can be manipulated forward by hand to a decreasing degree as pick after pick is inserted. In hand-loom weaving, only when the space between the cloth fell[6] and the healds or harness has decreased to an extent which makes it difficult to pass a shuttle across between the separated warp threads is it necessary to slacken off the warp and wind the cloth forward.

The rest of the mechanisms of power-looms can be classed as auxiliary. Without them a power-loom could continue to produce cloth, but they are helpful in that they carry out a part of the operative's work, stop the loom to prevent damage to yarn, cloth or mechanism when there is breakage of material or a failure of the mechanism, and perform similar operations auxiliary to the interlacing of weft with warp and beating-up. Refinement of the primary and secondary motions may also be classed as auxiliary mechanisms of the power-loom.

Having described shedding and picking in their simplest forms and beating-up as the three primary motions of the loom, we can now consider the actual forms of the mechanisms for carrying out these operations in power-loom weaving and some of the possible refinements in detail and design.

Refinements in shedding include making it positive, that is converting mechanically the return of the warp threads to their neutral position as well as the separation of the threads, the provision of reversing devices for unweaving to correct a weft break, a wrong lift in shedding or some such fault, and the design of the mechanism so that a greater number of different warp thread interlacings can be woven.

TAPPET AND DOBBY MECHANISMS

The many types of mechanism for shedding on power-looms can be grouped into three classes – tappet, dobby and Jacquard. Tappet and dobby mechanisms operate heald shafts, that is, frames which carry the healds, through the eyes of which the warp threads are passed or drawn, and which are raised or lowered according to the interlacing required for the warp threads they control. The number of heald shafts which can be controlled by the mechanism decides the limiting number of different warp thread interlacings that can be arranged in the design. This is greater with dobby than with tappet shedding mechanisms.

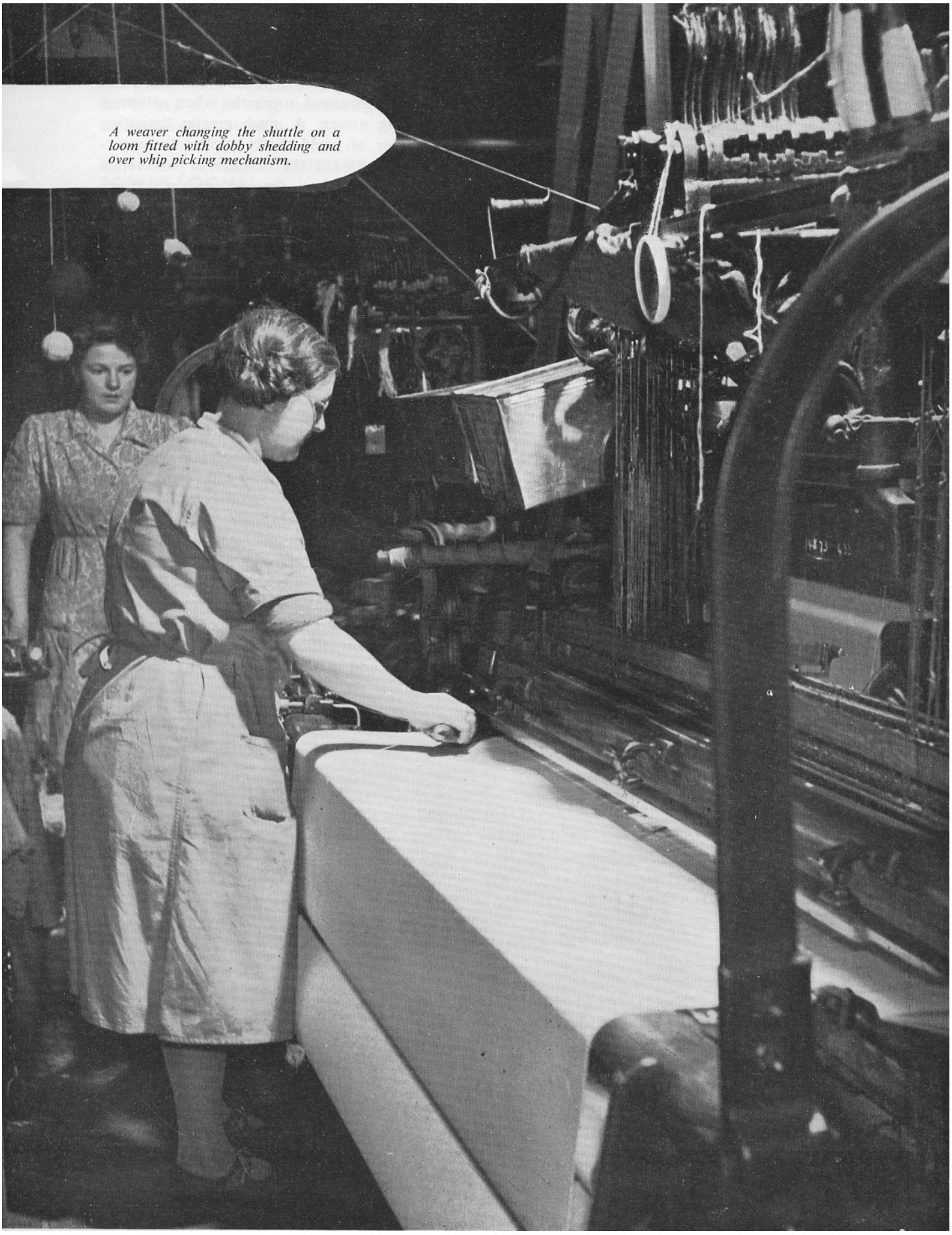
Dobbies are available for controlling up to thirty-six heald shafts, but twenty-four and sixteen are common limits. It should be noted, however, that by "drafting" or passing the threads through the heald shafts in various reversing, skipping and other orders, extension of the weave repeat well beyond the limit of the number of heald shafts is possible and this is, of course, very often arranged in practice when patterned fabrics are being woven. A much greater limitation than the number of heald shafts applies to tappet-shedding mechanisms. It is the "number of picks to the round", that is, the number of movements up or down of the heald shaft possible in one revolution of the tappet, which decides the number of picks covered by the weave interlacing. There is considerable difficulty in obtaining smooth movement of the heald shafts if too many picks to the round are attempted, so that eight picks is the common limit for tappets, although some types operate for twelve or even sixteen picks to the round. With dobby shedding, practically any number of picks to the warp interlacing can be arranged, limited only by the length of pegged lags that can be accommodated at the end of the loom. For large repeats weft-ways, it is useful to have a paper-roll controlled dobby because the paper-roll takes up much less space than pegged lags.

JACQUARD MECHANISMS

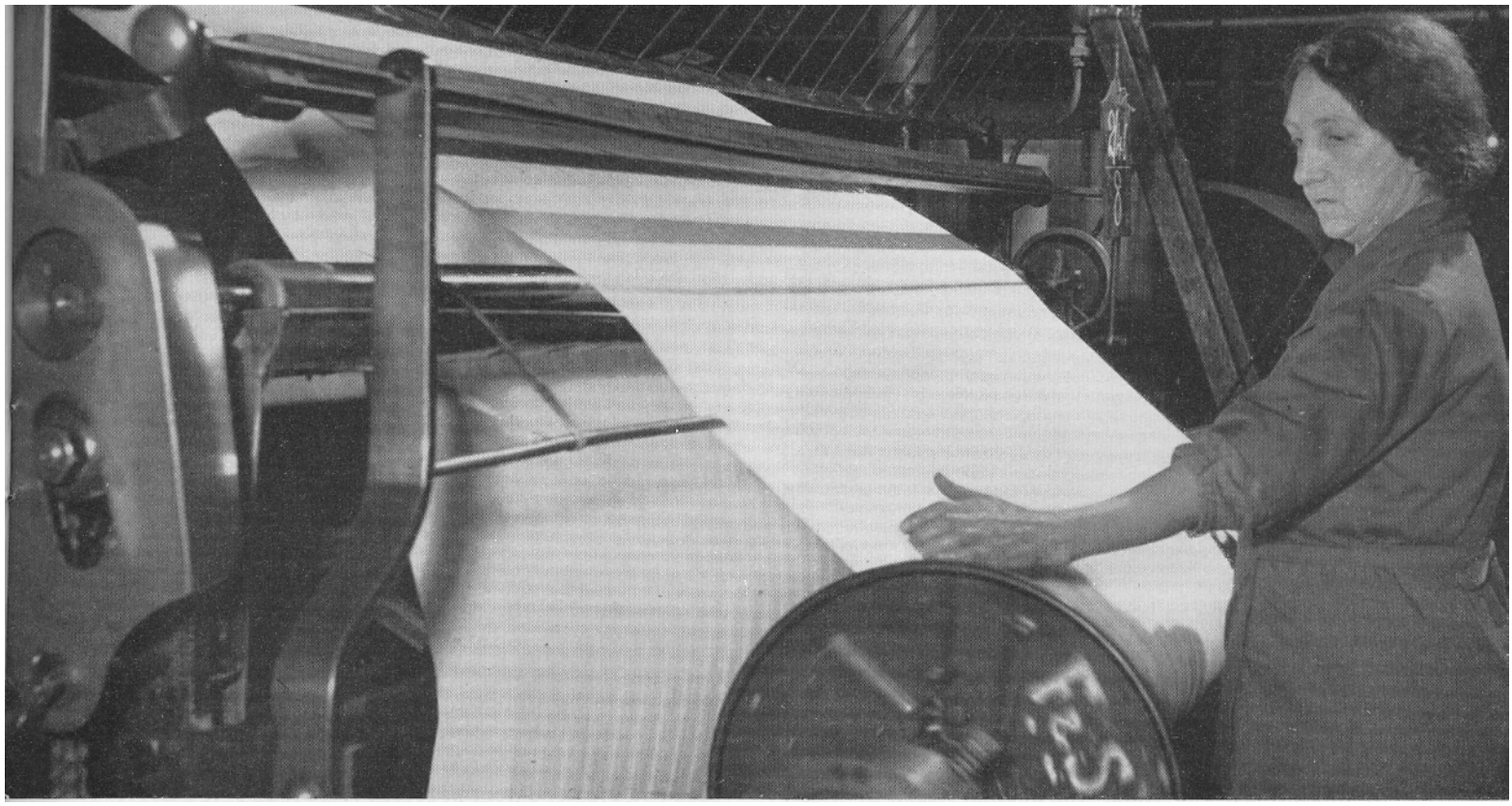
Jacquard shedding mechanisms have the great merit of extending the limit of patterning to allow hundreds of different warp thread interlacings, but there is a slight limitation to this type of mechanism in that fancy "ties" of the harness restrict patterning scope to the particular form dictated by the tie, such as reversed, border, and so on. In addition, the warp sett[7] cannot be varied so conveniently with Jacquard shedding as it can be with the heald shaft control of the warp threads in tappet and dobby shedding.

Shedding may be closed, open or semi-open, the last-mentioned being the natural feature of a double lift action in Jacquard shedding rather than a planned movement of the threads in forming the shed. After the weft has been inserted between the separated threads, closed shedding returns all the warp threads to a neutral position before the next shed is formed, whereas in open shedding only those threads move which are required to change position, up to down or vice versa. The other threads remain up or down for the successive picks. It is often claimed of open shedding that it allows greater loom speeds, but this is open to question. Compared with open shedding closed shedding has the advantage that it spreads the beating-up force over all the warp and reduces thread breakages.

There are so many designs and forms of mechanisms for picking or driving the shuttle through the shed that it is impossible to mention them all, and any mention would be of little value in a general article of this nature. However, the casual observer can easily note that the stick, straps, etc., which move to propel the shuttle through the shed, may be situated over or under the boxes, and that some mechanisms "whip"



A weaver changing the shuttle on a loom fitted with dobby shedding and over whip picking mechanism.



Beaming off from a warping mill on to a beam.

the shuttle whereas others "push" the shuttle. The important feature to note about picking is whether or not it can be arranged "at will", that is, from either side as required. The value of picking-at-will is that, in conjunction with multiple boxes at both sides of the loom, several shuttles can be used: (i) for mixing weft yarn – this is very important with irregular weft yarn which contrasts markedly in colour or shade with the warp yarn – and (ii) for the weaving of very fancy colour patterns.

OTHER METHODS OF INSERTING WEFT

It is of interest to mention briefly methods devised to displace the crude picking of shuttles as the means of inserting weft between separated warp threads. Rapiers, rigid or flexible, have been used to carry the weft across between the raised and lowered warp threads. One rapier may carry the weft all the way across and then return for insertion of the next pick. Alternatively two rapiers may be utilised, one taking the weft half-way across and "giving" it to the other which has moved to meet it and which completes the insertion of the pick as the two rapiers return to their original position. This method of weft insertion can operate with a smaller depth of shed, is less noisy, has greater colouring scope than that of ordinary picking and box looms, and is virtually automatic in weft supply because tip-to-tail link-up of cones from which the rapiers take the weft can be arranged to give an endless supply of weft. However, it may slow the loom a little and requires "tucked-in" or leno edges.

Another method, which also feeds the weft from cones situated at the side of the loom, is applied on the Sulzer weaving machine. Small carriers, which are torsion rod propelled, pick up the weft yarn and take it through the shed. They then release the yarn and are dropped on to an endless belt conveyor which takes them back to the side of the loom from which they came. Much greater speeds of weaving with increased widths of cloth are possible when the weft is inserted by this method but it, too, has the disadvantage of requiring a tucked-in or leno edge to take the place of the natural edge or selvedge obtained with weft insertion by the more usual shuttle method.

Yet another recently developed method of inserting weft from cone packages (placed at both sides of the loom in this case) utilises a single gripper shuttle which is much lighter in weight than the normal pirn-carrying shuttles but is heavier than the multiple gripper shuttles used on the Sulzer machine. This single gripper shuttle is torsion spring propelled from each side alternately and picks up the weft as it enters and releases it as it leaves the shed.

Other developments are air or water jet methods of weft insertion. In spite of the merits of all these newer methods of weft insertion in increasing loom speed, decrease of noise, etc., when compared with the crude mechanical picking of shuttles, the latter continues as the main method on present-day weaving machinery.

Beating-up on modern power-looms has not changed in principle and design of mechanism, other than to switch to the underswinging sley[8] as compared with the

overswinging sley which was common on earlier power-looms and which is still used on hand-looms and on some weaving frames.

In the secondary motions of power-looms, "negative" let-off, or the mere retardation of rotation of the warp beam by the friction of ropes, chains or brakes, is still used to a very large extent on power-looms for cotton and silk weaving. However, most of the looms for woollen and worsted weaving are fitted with gear let-off motions. In these, the control for the amount of warp let-off on successive picks and the compensation for the decreasing diameter of warp on beam as weaving progresses, is by means of a vibrating back rest which determines the sweep of pawls on a ratchet wheel.

Cloth take-up can be somewhat similarly controlled, but the more usual take-up on present-day looms is by a friction beam or roller. This is gear driven, has a constant surface speed, and is covered with crêpe rubber, emery or perforated tin so that it grips the cloth to pull it forward efficiently. The cloth then passes to another beam or roller, the angular speed of which is decreased as the diameter of the cloth on the beam increases. The decreasing angular speed of the cloth roller is produced either by having it contact-driven by the friction roller or by incorporating a slipping collar arrangement in a gear-drive from the friction roller to the cloth roller. The gear-drive to the friction beam in such positive cloth take-up mechanisms may incorporate either a pawl and ratchet or a worm and wheel as the main reduction which is necessary in the gears to obtain the very small movement of cloth per pick woven. The ratchet-type can "cram", that is, cease taking up for certain figuring picks, by merely lifting the pawl. When weaving extra weft spot effects and hungback check styles with worm take-up motions, however, a special "cramming attachment" must be fitted.

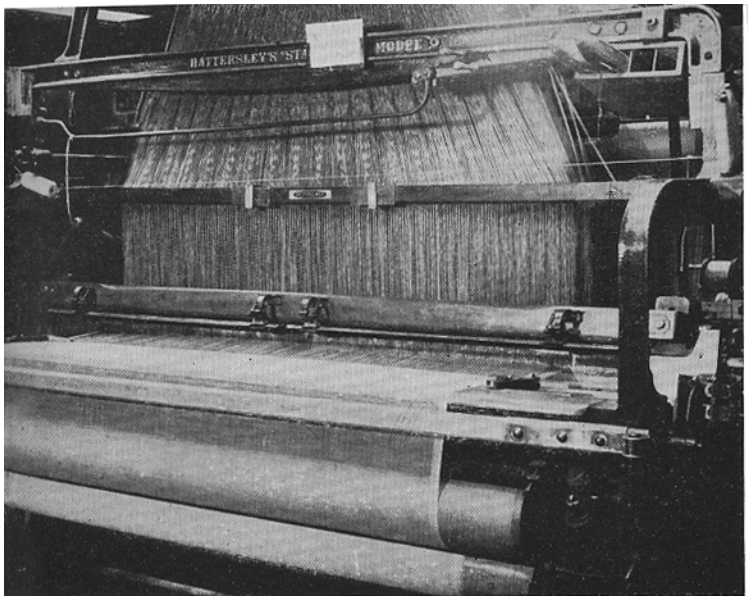
In comparatively recent years the Wool Industries Research Association has developed a roller let-off motion which is a considerable improvement on previous attempts to deliver warp in an absolutely positive manner by means of rollers. Naturally this motion introduces a slight degree of complication as regards deciding the amount of warp to be delivered per pick to suit the variety of counts, weave interlacings and picks per inch which may be required in the different structures to be woven. Nevertheless it is a valuable motion in that the crimp in the warp yarn at the weaving stage can be controlled and modified as desired. A change wheel is incorporated in the train of gears driving the pair of rubber-covered and fluted rollers which deliver the warp and the gears operate forward or in reverse, or stop for the cramming of weft, in synchronisation with the take-up gears.

AUTOMATIC STOP MECHANISMS

Auxiliary mechanisms are designed to save the weaver time and labour, and to assist in production as regards quantity or quality of product or as regards prevention of damage to the material or the machine. The value of escape features in the various mechanisms is so obvious that any detail regarding them is scarcely merited. One "escape" can be mentioned to give readers the general idea of where and how they apply, i.e., in dobby shedding the lag cylinder drive has an escape mechanism. If the pegging legs pile up or otherwise foul to prevent easy rotation of the lag cylinder, the damage to the lags and to the dobby mechanism if there were no escape in the gear drive would be very serious and the time spent in extricating the parts would be considerable. In addition, should the weaver be engaged on some job at the time the lags fouled, serious damage could be caused to warp and cloth before the loom could be stopped. The value of motions which stop the loom when a warp or a weft thread breaks is likewise very obvious. Warp stop motions have been used to a greater extent in recent years than ever before, because of the practice of having more and more looms under the care of one weaver. Briefly, warp stop motions consist of "droppers" or thin pieces of metal, one of which is placed on each warp thread. If a thread breaks, its dropper will fall and interfere with a reciprocating device or complete an electrical circuit. In either case a knock-off lever will move the starting handle of the loom to its "off" position.

Weft stop motions consist of a fork or feeler placed to sense the presence or absence of weft. When the weft is absent due to a break or to the pirn[9] running empty in a shuttle, the feeler senses this and operates a mechanism which moves the starting handle to the "off" position. On alternate picking looms the weft fork must be placed so that it feels for the weft pick between the cloth selvedge and the shuttle boxes, but it must be placed between the selvedges on looms fitted with picking-at-will. The latter positioning gives what is commonly known as the "centre" weft fork and is the more usual for woollen and worsted weaving, because so many of the looms in this section of cloth manufacture have multiple boxes and pickings-at-will so that they can cope with fancy colourings. A centre-weft fork feels for the weft as the reed moves forward to the beat-up, and it may be linked with the stop mechanism to stop the loom either on the pick following or before the reed reaches its beating-up position.

Yet another arrangement links the fork with an automatic reversing device. In the course of the few revolutions of the crank-shaft following the sensing of absence of weft, the picking is put out of action, and the dobby mechanism operates the pattern lags forward and in reverse, so that the heald shafts and box positions



A Jacquard loom, which is particularly useful for intricate patterns.

Drawing in. The operator pulls the warp ends through the healds and reed, so as to get the threads in the required order in the heald shafts.

at the stopping of the loom a few picks later are those of the pick on which the break in weft supply occurred. With ordinary stop motions the weaver has to "reverse" the shedding and box movements to find the broken pick and restart weaving so that no fault shows in the cloth. Some looms provide a hand-wheel for such reversing, while others are power manipulated. It is obvious that ordinary stop motions save a great deal of time and waste, because the absence of weft for possibly inches of cloth "woven" while the weaver is engaged on other duties is avoided. Stop-on-pick or automatic pick-finding are even better, however, as the weaver saves time in not having to reverse. All she has to do is to complete the broken pick which is in the shed, pick up the end of the weft from the shuttle, or replace with another shuttle if the pirn is empty, and re-start the loom.

Warp protector motions prevent damage to the warp if a shuttle is trapped in the shed instead of continuing to the box to which it has been picked. Fast-reed[10] types are more usual for woollen and worsted looms with drop boxes and they consist simply of a stop rod, the daggers of which strike against powerfully sprung parts to prevent the lay, or going part, moving forward to the beat-up position, at the same time knocking the starting handle to the "off" position. Loose-reed warp protector motions must be fitted to looms which have circular or rotary boxes, because these boxes cannot be fitted with the "swells" or levers which are necessary to control the position of the stop-rod of the fast-reed mechanisms. Loose-reed motions allow the reed to slip back when a shuttle is trapped, with the result that no beat-up takes place and damage to the warp is avoided. A lever is positioned to move the starting handle to the "off" position as the going part with its loosened reed moves to its furthest forward position.

One of the most important developments in auxiliary weaving mechanisms occurred over fifty years ago in the designing and fitting to looms of automatic means of weft supply. Instead of the weaver having to watch shuttles for the weft running nearly empty on the pirn and then stopping the loom and replenishing the weft, all that is required now is to maintain a battery or magazine supply of pirns or replenished shuttles. When the loom senses the need for replenishment of weft, it either inserts a full shuttle in place of a nearly empty one or presses a full pirn into the shuttle to take the place of the nearly empty pirn. Shuttle-changing automatic weft supply is not so common as pirn-changing on woollen and worsted looms. Both types nowadays may be single or multiple colour. Multiple colour automatic weft supply requires a fairly complex system of selection to ensure that the correct colour of weft pirn (or shuttle with the correct colour of weft) is placed in position for change

There are many different designs of mechanism to supply weft automatically during weaving but, as with the other mechanisms discussed, the detail is not important in an article such as this. It is useful to mention, however, that recent designs of mechanisms are considerably improved compared with earlier mechanisms, in respect of weft mixing and colouring, cutting of the weft ends, prevention of the ends of weft trailing into the cloth, etc. Automatic looms with two-twos and three-ones weft mixing are available and multi-colour automatics which will weave elaborate check patterns with up to four colours in any even-picking order have been perfected by all the leading loom-makers. Doubtless most loom-makers are working toward the production of the single and odd-pick colouring automatic loom and some, e.g., the Crompton and Knowles PAPA and the Schwabe have been available for some time but used only to a very limited extent.

TRENDS IN LOOM DESIGN

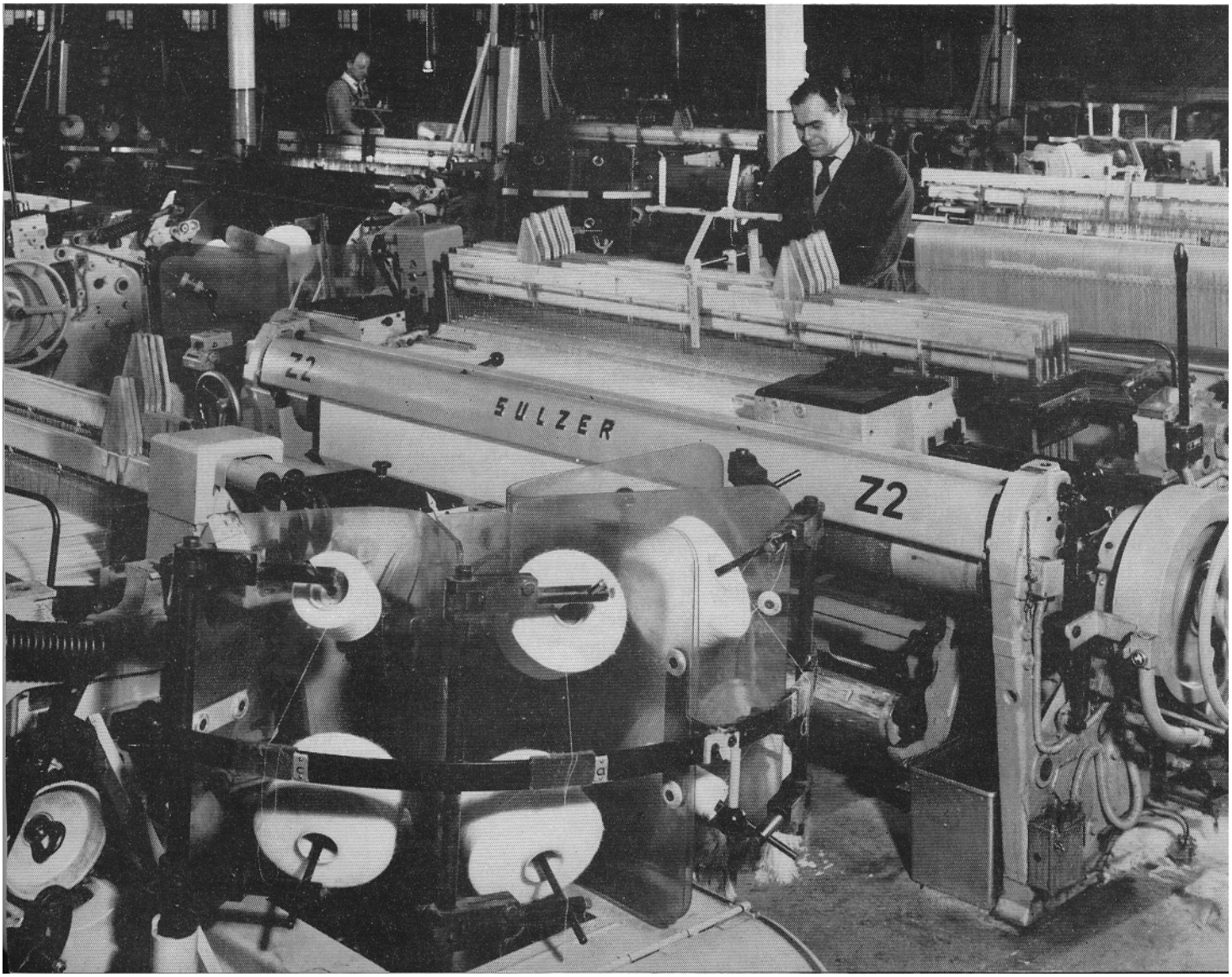
In conclusion, it may be interesting to make some comments on the possible trends in loom design in the next twenty years or so. It is unlikely that there will be any sweeping changes in the general form of looms for woollen and worsted weaving compared with present-day looms. Circular looms have again had a minor wave of publicity over the past few years, but this form of machine is not likely to supercede the orthodox loom, for woollens and worsteds at least, unless it can be designed to produce closely set fabrics and structures which are more elaborate both from the weave interlacing and weft colouring points of view.

Looms using the newer methods of weft insertion, particularly the Sulzer carrier principle, have a better chance of success, particularly as they are now being developed to give better edges to the cloth during weaving. Other likely changes in the fairly near future are the production of new and better automatic looms capable of introducing single or odd-pick groups of different weft colours, and the improving of the existing orthodox mechanisms to increase loom speed, and to render the loom even more efficient and independent of the operative than it already is.

GLOSSARY

1. Pick — the thread of weft carried across the warp in the loom by one passage of the shuttle.
2. Shed — the triangular opening formed for the passage of the loom shuttle by raising some warp threads and depressing the others.
3. Beating-up — the third primary movement of the loom when making cloth. It is the action of the reed as it drives each pick of weft to the fell of the cloth.
4. Take-up — the winding of the woven cloth forward pick by pick as weaving proceeds.
5. Let-off motion — the mechanism on a loom for regulating the delivery of the warp from the warp beam, and for maintaining the necessary tension on the warp.
6. Fell — the woven edge of the cloth against which the reed beats each weft thread.
7. Warp sett — the number of warp threads per inch or other standard of measurement. The sett systems vary according to the locality in which they are used.
8. Sley — the part of a loom mechanism in which the reed is fixed and which moves the reed forward to beat up the weft.
9. Pirn — a wooden or paper spool carrying the length of weft yarn ready for weaving. May also refer to the bare spool.
10. Reed — a metal comb fixed in a frame. The closeness of its wires determines the fineness of a cloth. It keeps the warp threads spaced evenly, forms a guide for the back of the shuttle, and beats up the weft to the fell of the cloth.

Cloth Weaving. *A modern automatic high speed weaving machine now being widely introduced into the worsted side of the industry. This is the stage where the warp and weft come together in the form envisaged by the cloth designer.* *(Photograph taken at Salt's Saltaire Ltd.)*



THE TEASELS OF SOMERSET

DONALD MULLINS

IN late summer, Somerset is the scene of one of Britain's rarer harvests – that of the teasel crop. It was the availability of teasels and of fuller's earth (the export of which was banned), together with proximity to the port of Bristol, which contributed largely to the West Country's early fame for woollens. John Billingsley, writer of a classic treatise on the agriculture of Somerset, remarked in 1795 that "teasels are much cultivated", the heads being "used in dressing of cloth". To-day this cultivation is confined entirely to the pleasant fertile countryside in the neighbourhood of Taunton, though it was formerly carried on also in the Mendip country round Blagdon.

Above
Crop of teasels at Fivehead, near Taunton.

Left
Harvesting teasels.

The wild teasel, a kind of scabious, with its prickly head and pairs of leaves opposed to form water container insect-traps (the water being regarded by gypsies as a tonic), is a fairly common wayside plant. The cultivated variety, known as the "fuller's teasel", is not unlike it, except that the head or "burr" has much stronger spines, with hooked points.

This natural comb has long been used for raising a nap on woollens (the word "teaseler" can be traced back to 1607) and it still remains, even in this age of mechanical invention, without effective rival for the purpose. Wire substitutes have been tried, but they lack the essential properties of elasticity and of gradual wear in use, which prevent damage to the cloth.

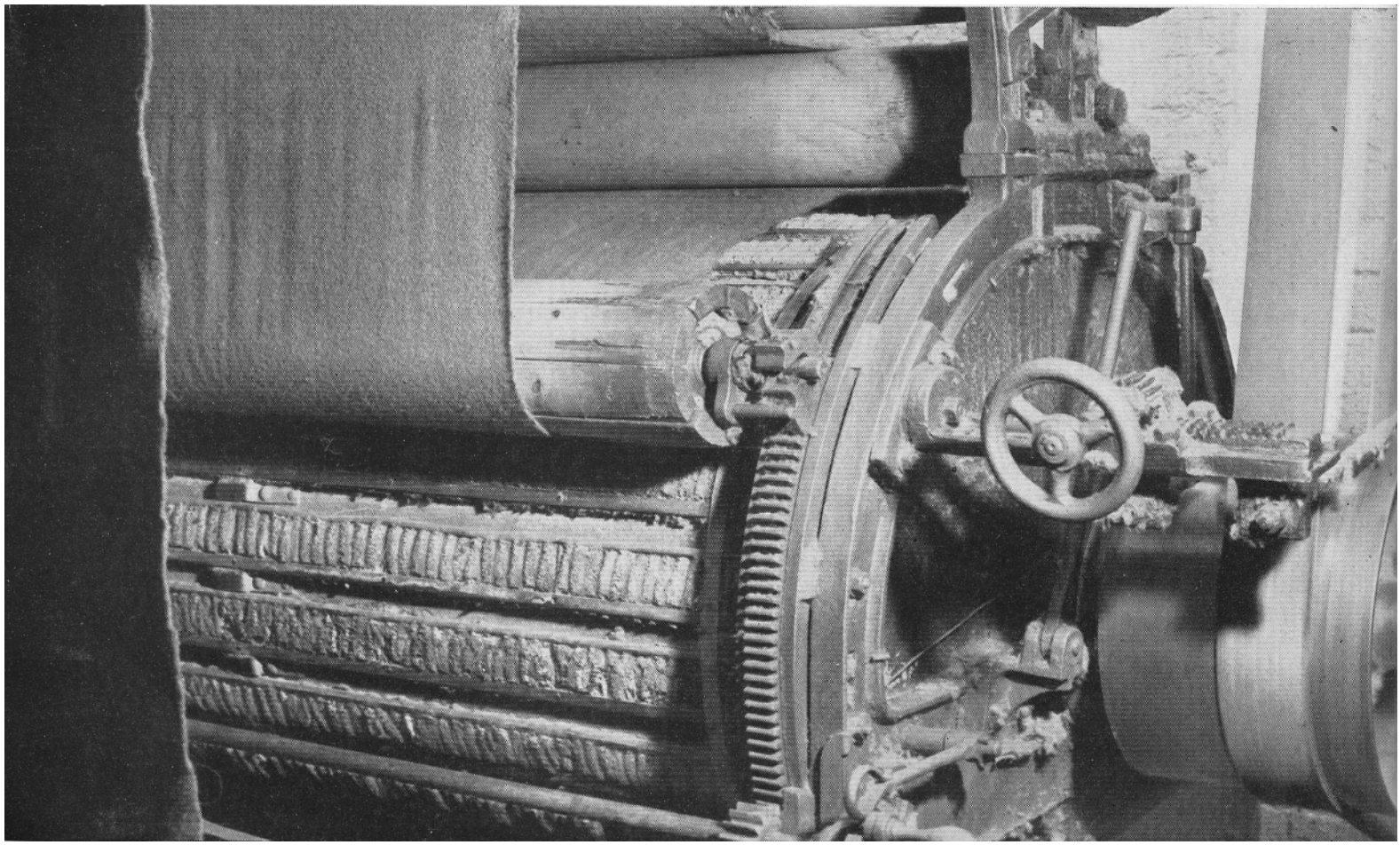
It is for this reason that the woollen mills of Great Britain still demand the burrs from Somerset, in addition to a considerable number which are imported from the Continent. A single mill may require as many as 600,000 in one year.

The seed (which, incidentally, may be used for feeding canaries) is saved from the better heads, and is sown in April. The young plants have roots resembling parsnips, so that they are difficult to remove for transplanting. The upper portion or "knot" is therefore cut off with a short chisel-like tool known as a "teasel-spitter". The prepared plants are set out in October with a short planting-stick or "dibber" – about 14,000 to the acre – and by the following spring they will have become established.

The heads break into pale blue flower in July, and harvesting commences when the burrs are sufficiently mature. They are cut with a short, curved knife, which is looped for convenience to the cutter's wrist. An average crop of 200,000 burrs to the acre will occupy a cutter for ten days. The spiny nature of the stems necessitates the wearing of protective gloves. The heads are bound in "handfuls" of fifty and attached to long poles, which are then stacked in the open to facilitate drying-off. They are ultimately despatched in packs of 20,000 to the mills.

The burrs are prepared for use by cutting off the calyx with scissors. Afterwards they are fitted into long, narrow frames, known as "rods", which are clamped into the cylindrical drums of the "gig-mills" assembled in the raising-room. The rolls of cloth are then unwound and brought into gentle contact with the drums, which revolve at 120 r.p.m., thus enabling the teasels to raise a nap or pile on the surface. New heads are inserted piecemeal, to obviate too violent a change in intensity of the pulling action.

Teasels are used to brush up the surface and to give a fluffy finish to woollen cloths such as blankets and overcoatings. The surface of the cloth passes in one direction over the drum and is brought into contact with the teasels which are revolving in the opposite direction at a greater speed.



COLOUR and Wool

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COLOUR is a phenomenon of light. We can have no colour without light. White light contains all colours and may be broken up with a prism into its component parts, producing a perfectly graded rainbow consisting of red, orange, yellow, green, blue and violet. Every spectral colour is elementary or primary, but in dealing with paints and dyes, red, yellow and blue may be accepted as the primaries. By mixing primaries in pairs, secondaries are formed. Thus red and yellow when mixed produce orange, yellow and blue produce green, blue and red produce violet. The hue of a secondary colour is determined by the proportionate quantities of the primaries combined in its production. For example, to obtain a yellowish green, yellow would be the predominating and blue the subordinate colour. If it is required to obtain a bluish or a reddish purple then this is done by increasing the blue or red components of this secondary colour. It is in this way that colours are modified and multiplied.

Tertiaries are obtained by combining secondaries or all three primaries. They are not real colours, but shades of the predominant colour in the mixture, that is, colours dulled by black or dull grey. Their number is infinite. For example, russet is composed of two parts red, one part yellow and one part blue. Citron is composed of two parts yellow, one part blue and one part red. Olive consists of two parts blue, one part red and one part yellow. It will be obvious that by varying these proportions the tertiary colour can be changed. If in the case of russet the proportion of the red constituent is increased, the warmth of the colour is intensified. By increasing the yellow the reddish tone is neutralised, while an increase of the blue would add to its depth and saturation. In all tertiaries there is a saddening of the colour when compared with the primaries and secondaries from which they are obtained. This is due to the fact that red, yellow and blue in equal parts produce grey, so that by adding one extra part of red, a red-grey or russet is produced. Where yellow is the predominant colour then the tertiary is a yellow-grey or citron. With blue predominating, the corresponding tertiary is slate.

Before dealing with the application of colour to wool, the term "complementary" needs a brief explanation. A colour is complementary to another colour when, together, they include all three primaries. Thus the complement of red is green (yellow plus blue); the complement of yellow is purple (red plus blue); the complement of blue is orange (yellow plus red). In the early days of colour investigation it was found that the greatest effect of brilliance was obtained where a colour was contrasted with its complement, but that when mixed with it the result was dull, and even grey could be made. The result of mixing such complementary colour pigments, paints, dyes or any kind of colours, was to produce a shade darker than the component parts. In fact, with a little care a dyer can produce a quite tolerable black on cloth, or a printer on paper, by the use of the complementary colours in combination.

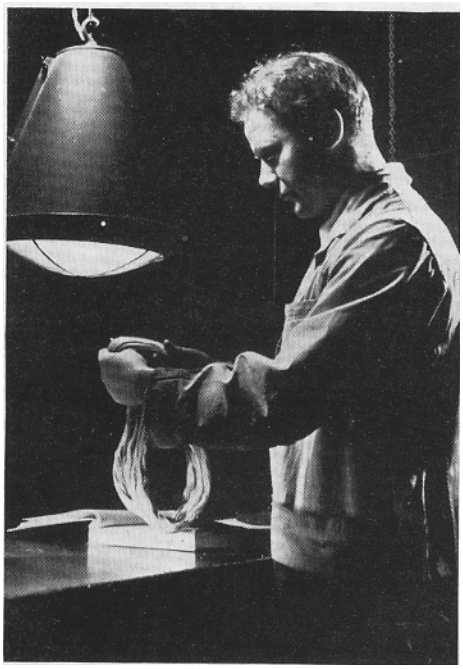
COLOUR MIXING IN THE WOOL

The actual colouring of the wool fabric may have its beginning in the initial stages of manufacture, that is, in the preparation of the material or blend for carding and spinning. Much attention has been given to the colouring of yarns for weaving by the admixture of dyed wools. From a prepared range of dyed wools the colourist proceeds to build up a range of colour mixtures by mixing together colours of different hues or tones in varying proportions. This provides one of the most interesting fields for the study of colour mixing, particularly when one considers that wools used in the manufacture of wool fabrics may vary in fibre-fineness from 1/400th of an inch to 1/2,000th of an

inch. To produce bright colour mixtures the original colours, of course, must be brilliant, but it is still more important that they must not be divided too minutely for the eye to see them separately, otherwise the result is simply dull, for one colour cancels out the other. Wools of medium fineness, that is, about 1/1,000th of an inch fibre diameter, are usually selected when the brightest of colour mixtures is required, as the fibres are not so fine that the eye cannot distinguish the individual colours near at hand.

COLOUR AND THE WEAVER

In addition to the colour mixtures made in the loose wool, the weaver and knitter has available an extensive range of self-colour yarns dyed in the slubbing or top, or in the yarn. Such a range may include primaries, secondaries, tertiaries and all variations introduced by the dyer in applying the colour to the wool in its different forms. Altogether this could supply an almost infinite range of colours, but generally in mill practice there is made a very carefully chosen range of colours, mixtures and self colours to suit the requirements of the trade and to meet the ever-changing fashion trends. Sometimes, as with Scottish clan tartans, the range of colours is comparatively limited, because most of these are obtained from the primary and secondary colours with a few tertiary colours, and, of course, black and white. Thus the wide assortment of Scottish clan tartans illustrates the skill of the weaver in manipulating this limited range of colours and producing distinctive checks or plaids. Wherever check pattern differentiation is required the range of tartans will supply the weaver with an almost endless range of check pattern schemes which can be modified and extended at will.



A yarn dyer examines dyed yarn under a special lamp to see if it is accurate in shade.
(Photo: Patons and Baldwins, Ltd.)

Another group of patterns, also of Scottish origin, which provide for the colouring of wool fabrics by the manipulation of coloured threads is the range of Scottish "district" checks, wherein the colours are combined in smaller groups of threads of each colour, and generally with coloured threads and white threads combined in about equal proportions. District checks include the shepherd's, the gun club and the glen checks.

As with tartans, where distinctiveness in the resultant pattern is obtained by the inclusion of a bright coloured over-check contrasting with the colours of the grounds, so in district checks great diversity is obtained by changing the colour of the overchecking threads in a set of patterns all made from the same ground colours.

COLOUR TWISTS

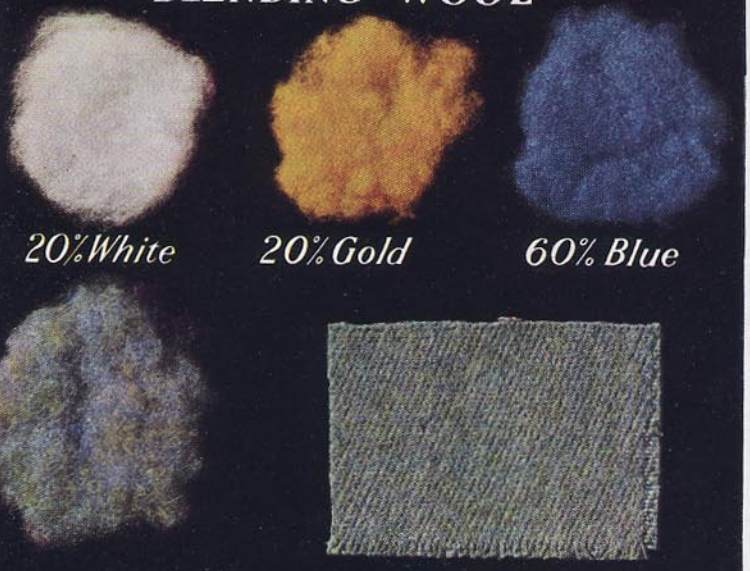
Although the designing of men's wear suitings may produce results which are less striking than those produced in other directions, this is due to the more subtle blending of the colours and to the use of smaller quantities of the pure colour hues. The basis of the colour range illustrates how carefully the colourist builds up his grades of mixtures, including greys, browns and blues, either by mixing the coloured fibres or by the twisting together of two or three threads of different colours or tones. Next to the mixing of fibres the combination of fine threads by twisting gives the closest association of the colours used in the resultant cloth. Where lively and sparkling twists are required it is not infrequent to find complementary hues combined, such as blue and orange, or red and green. Such twists, however, would not be used alone but in combination with white, grey, natural, black or brown threads; for example, one thread of white and one thread of colour twist, or one thread of black and one thread of colour twist. By this close association of the colour elements it is possible for the colourist to show how colours are applied to obtain such widely different results in the woven fabric.

DESIGNER AND COLOURIST

All of these preparations for colour mixtures and twists are only to bring us up to the stage where real designing and colouring at the loom begins. The designer and colourist appreciates the importance of laying a good foundation with regard to colour selection for the making of patterns for all types of fancy woven textures. It is still good practice to have colour ranges prepared, even with small sections of each colour in warp and weft, so that from the colours originally selected further combinations of colours by warp and weft crossings are obtained. The making of such ranges is a prolific source of colour mixture, almost beyond one's comprehension, and it is quite impossible to visualise exactly the resultant effects of these combinations

COLOUR *and* WOOL

BLENDING WOOL



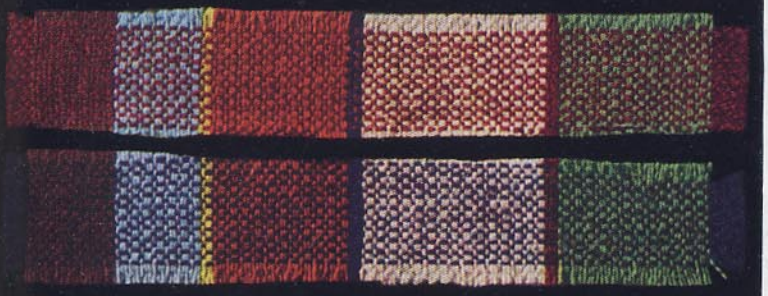
20% White *20% Gold* *60% Blue*

LOVAT MIXTURE

BLENDING YARNS

By manipulating a limited range of colours the weaver can produce a vast range of distinctive plaids and checks

(THE FERGUSON TARTAN IS ILLUSTRATED HERE)



Change of weft colour influences colour of warp

SCOTTISH DISTRICT CHECKS

Dogstooth effect in varying colours

A MAN'S WORSTED SUITING

A subtle blend of different coloured yarns

GREY

RUSSET

CITRON

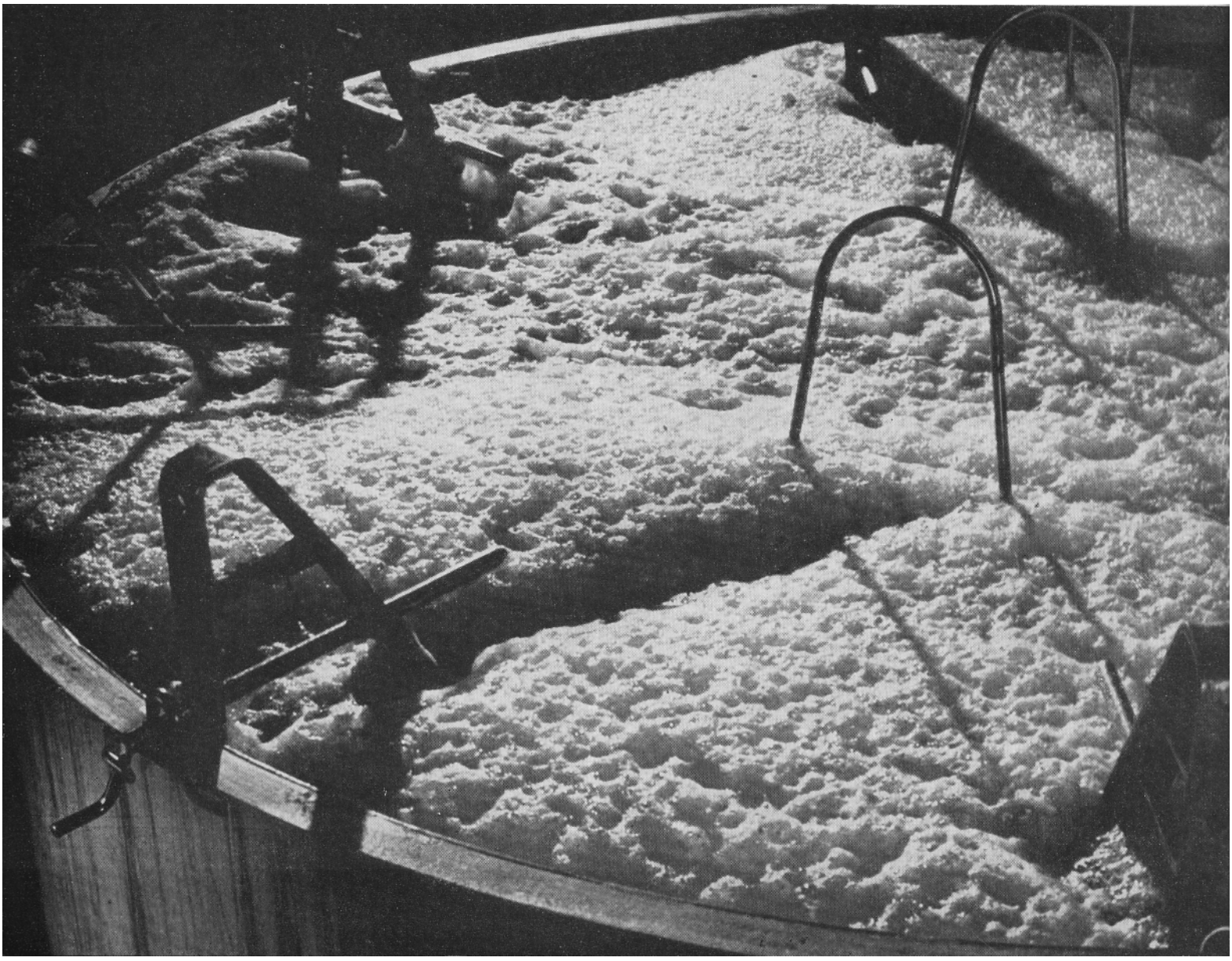
OLIVE

without actually making the samples. When dealing with colour patterns which have to combine the actual colour hues in their purest forms, and, especially, when these are combined in large checks, as in tartans, we can draw a better picture in our mind's eye of the yield in such combinations.

COLOUR CONTRASTS

Colour combinations are influenced by the law of contrasts, that things unlike each other look most unlike when placed side by side. The utmost brilliance of red is obtained by contrasting it with green. Contrast is the essence of colour styling in practically all types of woven fabrics, and in the application of colour the designer may employ three bases for colours in combination – (1) tone and tone – for example, dark grey and light grey, or navy and lavender; (2) contrast in hue – for example, crimson and navy, myrtle and brown; (3) contrast in both hue and tone – for example, maroon and lavender, navy and gold. In some of the more complex colour schemes we may find the colours combined so that both contrasting tones and contrasting hues are employed. For example, beige, fawn, brown; beige, cherry and turquoise. In fact, a careful study of colour combinations in woven fabrics for men's wear and women's wear will show that the greatest possible diversity is obtained by the skilled designer and colourist by the application of the limited number of simple colour elements. The colourist exercises the greatest ingenuity in the use of greys and naturals associated with bright, full-toned colours, appreciating the value of the neutral elements when combined with colour elements, thereby producing the most exquisite range of nicely-blended patterns.

Slubbing dyeing. The carded sliver is dyed in these huge vats which are 7 ft. 6 in. in diameter, and hold 500 lb. of wool and 700 gallons of water.
(*Photo: Patons and Baldwins Ltd.*)



THE WELSH WOOLLEN TEXTILE INDUSTRY

Cartheni, the traditional Welsh type of blanket.

Above
Detail of Cartheni.

(*Photographs for this article by courtesy of the Rural Industries Bureau*)

O. W. LIPTON, B.Com., M.Inst.M.S.M.,
Economist and Senior Marketing Officer, Rural Industries Bureau

WHEN the location of the British wool textile industry is described as concentrated in Yorkshire, Scotland and the West of England, the section of it in the Welsh dales is usually omitted. Yet this small part of the industry might well claim a considerable reputation for the quality of its traditional products.

HISTORY AND TRADITION

The Welsh textile industry is as old as the other branches of the wool textile industry in Britain. When fulling became mechanised and power machinery developed, spinners and weavers went in search of water power to the streams of Yorkshire, Scotland, the West of England and in Wales largely to Cardigan, Carmarthen and Pembrokeshire. There are mills in other parts of Wales. Usually the buildings are old, blend well with the countryside and do not spoil the

landscape, as is often the case in other textile districts. The size of the mills ranges from the one-man firm to sizeable mills.

The industry has been shrinking over the last few decades from about 250 mills in 1900 to rather less than 30 as is shown on the accompanying map. Increasing competition and the slump of the interwar period are largely to blame for this shrinkage, as is the trend of depopulation in Wales. The picture is, however, not on of unremitting gloom. Some owners have modernised their buildings and equipment and in a few cases new ventures have been started. Management and ownership of Welsh mills are usually identical and the fight for survival is a very personal battle. There are many natural handicaps, such as remoteness from the big centres of population, not necessarily in miles, but in difficulties of transport and communications. There is no natural training centre and too few Welshmen train in other wool textile centres, though some have done so and returned to build up and extend their mills.

THE PRODUCTS

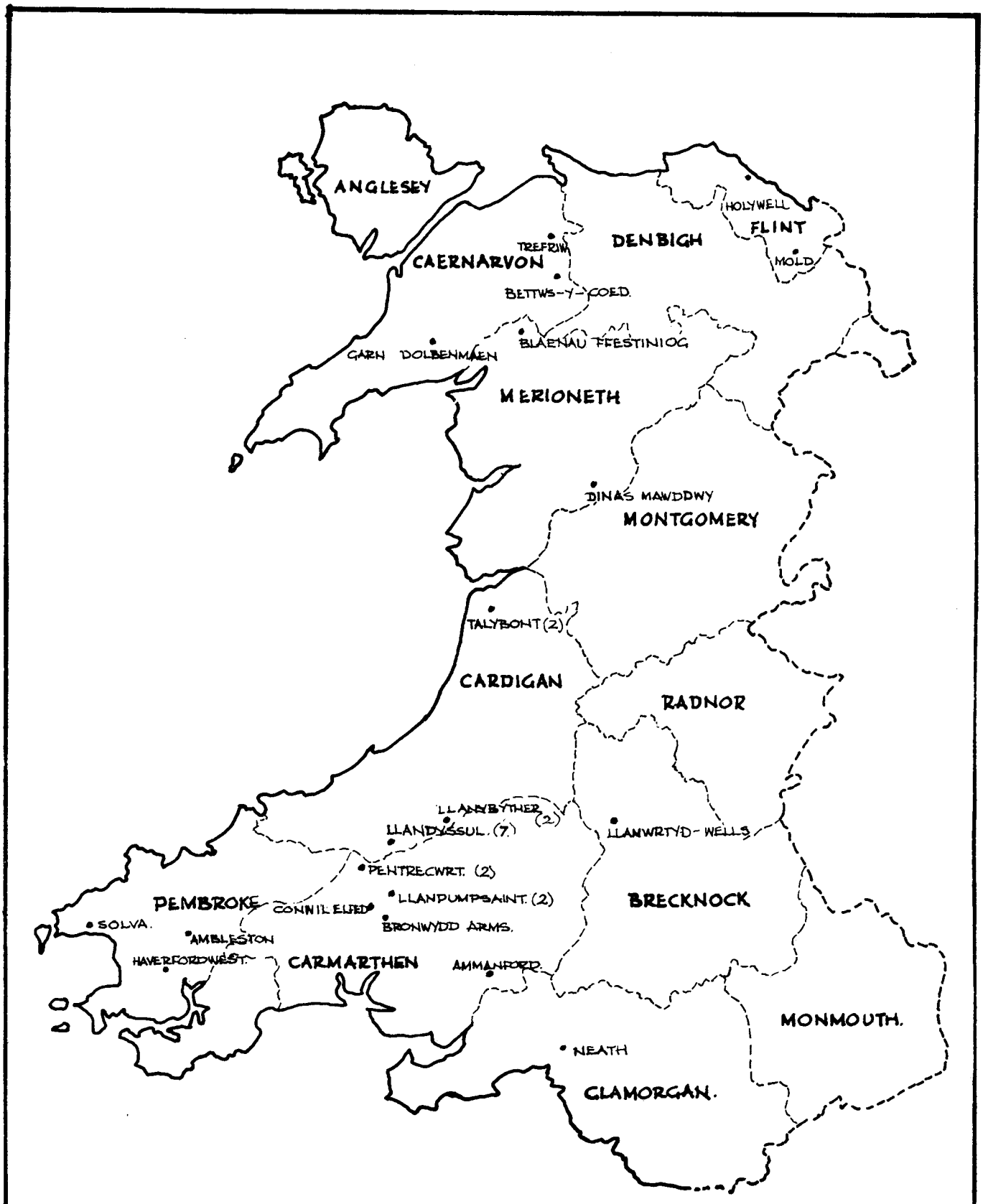
The Welsh textile industry is not backward and hidebound, but largely makes traditional products, such as flannel, quite often suitable for ladies' garments (few flannel shirts are worn by the miners now for the sweat absorbing qualities), and tweeds in all colours and weights of great durability (there are no better tweeds for stalking and fishing). Wales also produces lightweight tweeds without losing any of the excellent tweed qualities. In the next group of products which comprises blankets, there are plain blankets, check blankets in pastel shades, travelling rugs, and a bedspread-cum-blanket called cartheni. Carthenau (which is the plural will be gratefully remembered by many a traveller in Wales because they kept him warm and cosy during cold winter nights. The fringed cartheni is often a harmonious mixture of two or three bright colours and two or three pastel shades, and constitutes a very useful bedspread. An equally characteristic Welsh product is the honeycomb quilt, which can lend grace and attraction to a bedroom furnished in modern style. The double cloth (woven on two sides) that the Welsh mills produce can serve as wall hangings or floor coverings because of their almost indestructible character. Recently it has also been used for the making up of anoraks, après-ski clothing and similar garments. Wales also produces knitting yarns, though these are a challenge to the really skilled knitter, as fingering yarns from Wales do not necessarily comply with standard thicknesses. Furnishing fabrics have been increasingly made in recent years by the Welsh mills. All these products are pure woollens (practically no worsted yarns are used in Wales). The raw materials are a skilful blend of New Zealand and home produced wool.

OUTSIDE HELP

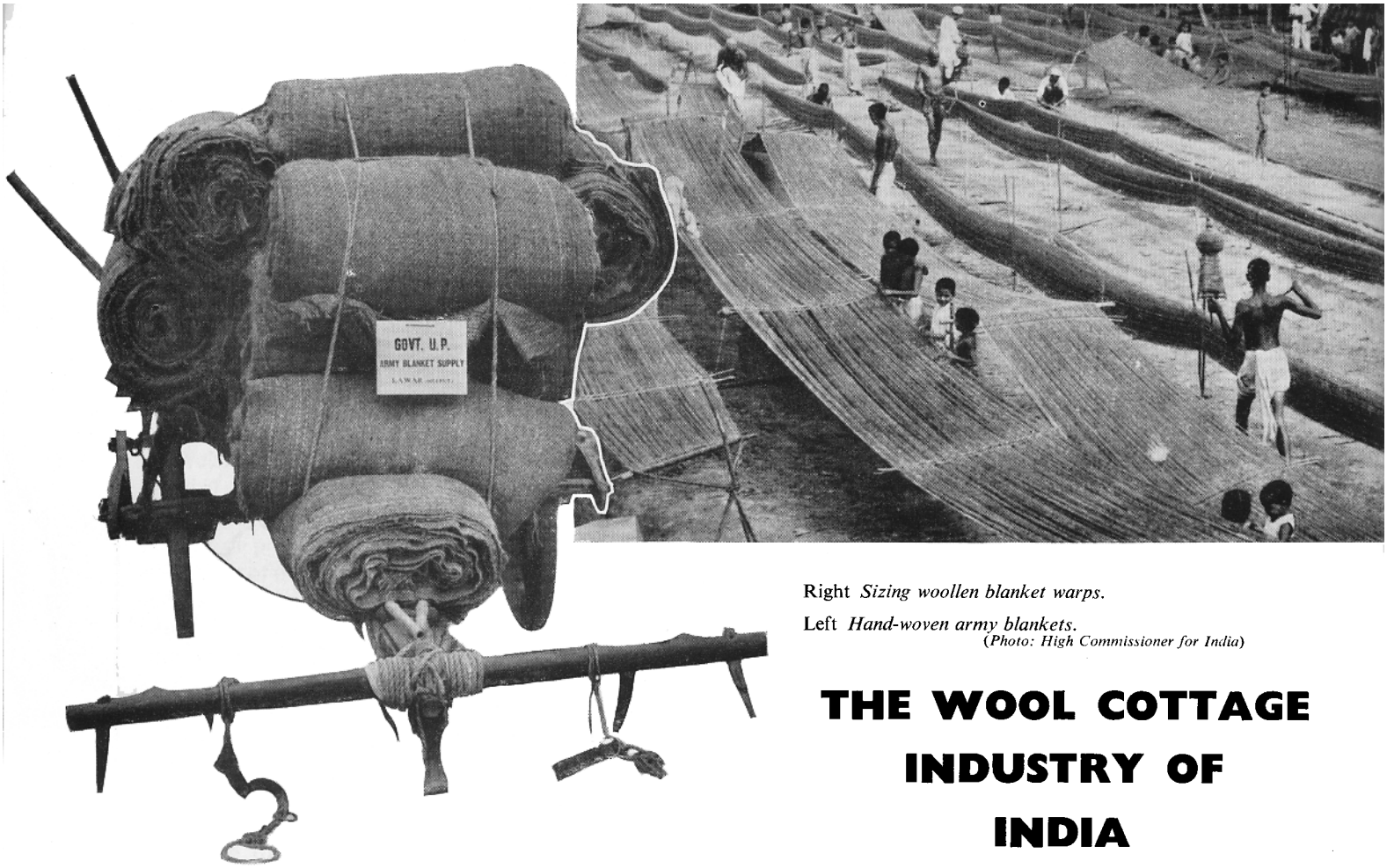
From this brief and incomplete recital of the products of the Welsh textile industry, it can be rightly deduced that there are possibilities of new developments hidden in the small mills in the Welsh dales. Though Llandyssul has, with some exaggeration, been called the Bradford of Wales, there is no natural centre of the Welsh textiles industry. The Rural Industries Bureau has taken on the role of stimulating and assisting the industry. At different times the Bureau has maintained a Technical Officer to advise the mills. Over the years there have been numerous designers and one is still in post; the Bureau has helped in the marketing field, including exhibitions abroad, and has given assistance in the formation of the Welsh Woollen Manufacturers' Association, which however did not last for more than a few years. Assistance is still available from the Bureau, including recent arrangements for training, the Rural Industries Loan Fund, the Rural Industries Organisers employed by the Rural Community Councils and last, but by no means least, the Mid Wales Development Association also stand ready to assist.

THE ECONOMIC PROBLEMS

It might well be asked why assistance should be given to the Welsh textile industry. Depopulation in the Welsh valleys is a serious problem and is surely one for the nation. If the Welsh mills can be assisted to maintain and expand output and employment, it would be a real contribution to solving the problems of Wales, quite apart from the considerations that the Welsh woollen products could and should be developed. At present the main outlets of the industry are in Wales and many mills own shops or have links with shops catering for the growing tourist traffic in Wales. There is a considerable challenge here.



MAP OF WALES SHOWING THE DISTRIBUTION OF THE WOOLLEN TEXTILE INDUSTRY.
FIGURES FOLLOWING PLACE NAMES INDICATE THE NUMBER OF MILLS IN THE AREA.



Right *Sizing woollen blanket warps.*

Left *Hand-woven army blankets.*
(Photo: High Commissioner for India)

THE WOOL COTTAGE INDUSTRY OF INDIA

FROM earliest times hand spinning and weaving of wool has been carried on in India and to-day it is still an integral part of the rural economy, producing blankets, carpets and low-grade woollens, and with an estimated output of eleven million pounds of cloth a year. Although in large centres like Muzaffarnagar and Panipat hand spinning and weaving is carried out almost entirely by full-time weavers and their families, in the villages it is done by peasants who, during the dry season when they are unable to work on the land, turn to spinning and weaving to provide clothes, blankets and rugs for their own use, and for sale on the market to supplement their small incomes. Before the war, cottages and small-scale factories consumed about half of India's total wool and it was estimated that there were 100,000 looms. The great bulk of the yarn used is hand spun, and, on an average, three spinners are required for every weaver. Since throughout the greater part of the sub-continent the demand for wool cloth is seasonal, skilled weavers are frequently compelled to find casual employment or remain idle from time to time.

CLIMATE, CUSTOM AND CLOTHING

By tradition the people of India are users of woollen materials, but their specific needs are determined by such factors as climate and custom. In the north, climate determines the need for woollen clothes and blankets, and 75 per cent of the woollen hand-loom industry is concentrated in this area in Uttar Pradesh, Punjab, Kashmir and Rajasthan. Wool is used all the year round in the extreme north, and for most of the year in the hill country of Assam and Bengal. Further south and in Central India wool is used mainly as a covering at night, although it replaces cotton for clothing during the colder parts of the year.

The actual type of clothing or covering is governed by custom, for each of the tribes or races has a distinctive dress both for men and women. One of the most common articles of dress is the woollen shawl which varies from the delicate Kashmiri type to the eighteen feet long shawl of the hill country shepherd.

TYPES OF CLOTH

The industry caters for the clothing requirements of the home market by producing tweeds, shawls, coatings, and scarves, and some knitted articles, such as socks and jerseys, are also produced, though on a small scale. Most of the tweeds are made of hand-spun yarn from local wools, but in the north there is a recent tendency to use mill-spun yarns which give a more regular structure to the cloth and which, owing to a more careful blending of the wool, can be given a better finish. The *pashmina* yarn* of Kashmir can be spun to very

* Made from the fine undercoat of the Kashmir goat.

high counts, but elsewhere most of the hand-spun yarn is coarse in quality and uneven.

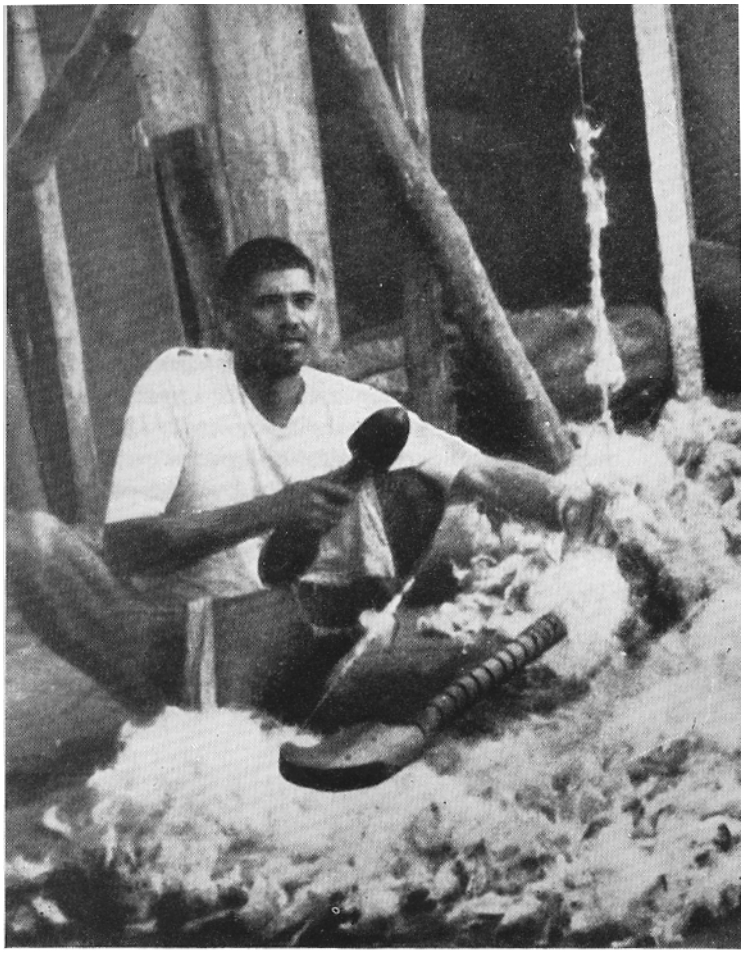
In the plains of the west, south and east, the local wool is mainly used in the manufacture of coarse blankets or *kumblies*. These blankets are frequently sold in the loom state, and, as they contain a certain amount of grease, they are used as waterproof capes in the rainy season. The quality varies with the wool; in Madras where the wool is coarse and hairy, the finished cloth resembles hessian, but in Uttar Pradesh, Punjab, Kashmir and parts of Mysore, where the wool is of a better quality, the blankets, when given a satisfactory finish, equal many of the types produced in the heavy woollen districts of England. During the last world war the industry supplied thousands of barrack blankets and blanketing cloth to clothe the armed forces.

The industry also has its place in the export trade. The shawls and carpets of Srinagar, Amritsar and Mirzapur, the druggets of Mysore and Bellary, the *namdas** from Kashmir, find their way as far as Britain and the United States, earning valuable foreign exchange. It is the hereditary skill displayed by artisans which enables this cottage industry to maintain its share in the export trade.

HAND PROCESSES

Since the hand manufacturing processes used in the cottage industry of India have been evolved independently of Western processes it is desirable to describe them briefly. The carding is done with

*Felt rugs with embroidered designs.



Carding indigenous wool with a bow.

Weaving at Palanpur, Rajputana.
(Photo: Paul Popper)

a bow made of bamboo or cane whose ends are connected with strings. The carder, usually a woman or child, squats on the ground and pulls the bow through the fleece and this is continued until the wool is suitable for spinning. Where large quantities of wool have to be carded, professional carders or *pinjaris* are employed.

In the village, spinning is sometimes still done with the *takwa* or *takli*, a simple type of hand spindle, but the *charkha* is widely used. This spinning wheel is usually worked by hand and has an endless cord passing over to a spindle. A handful of loose or carded wool is rolled into a sliver and attached to the point of the spindle, and the work of drawing and twisting is begun.

To prepare the warp yarn a board with a series of upright pegs arranged in a U-shape is frequently used. The yarn is wound on to selected pegs, according to the length required, and this is repeated until the desired number of warp ends is obtained. In the case of blankets there are usually ten to an inch. Then the yarn is removed from the pegs, the threads are arranged to give the required width and are then placed on a trestle. After they have been stretched tight they are brushed with size made from crushed Tamarind seed boiled in water.

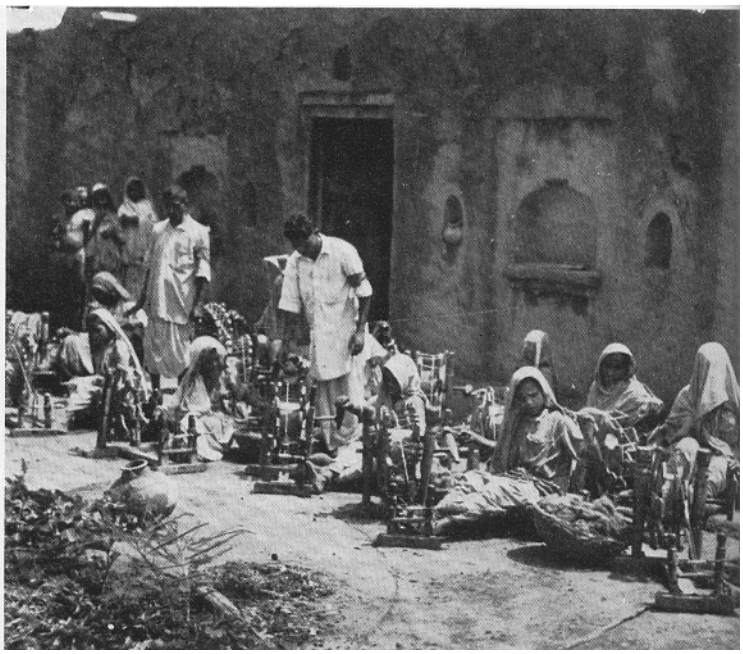
Once it is dry the yarn is ready for the hand loom. This is frequently a throw-shuttle type of "pit" loom, which has the advantage of being both simple and cheap. The weaver has an arrangement which takes the place of healds. For a shuttle he uses a hollow cane or bamboo in which is placed the weft yarn. The shuttle is thrown backwards and forwards, the shed being opened as required. "Beating up" takes place by means of a heavy stick shaped like a knife which is inserted into the shed. This serves a double purpose, and after 'beating up" the blade is turned edgeways to form a new shed.

Although many of the *kumblies* are marketed in the loom state, some villagers do carry out a form of finishing, especially where medium-type wool is used. The folded blanket is laid on a flat stone and soap solution is added. Then the "fuller" works the blanket with his feet until it attains the desired size. After being washed it is sun dried on a frame or merely laid on the ground.

CARPET WEAVING

For carpet weaving a vertical loom, usually built in a pit, is used. The weaver sits on a rough wooden bench with his legs in the pit. The balls of coloured yarn are suspended above his head within easy reach. Frequently a prompter reads or sings the pattern, which is taken from a sample carpet or design. A few plain rows are inserted, which ensure that the end of the carpet is held firm. The woollen yarn to be inserted is held in the left hand, it is twisted round the warp, crossed on itself forming a knot, and the yarn is then cut with a knife held in the weaver's right hand, the pile being towards the weaver. When the whole line has been completed, a weft-thread of cotton or jute is passed through the shed and beaten down firmly with an iron comb. When the carpet is finished it is removed from the loom and the pile is trimmed by placing the carpet over

Milling blankets.



Spinning with the Charkha.

a roller, or laying it on the ground, and using a sharp knife or scissors. Druggets are made on a similar loom, but in a plain weave without any pile.

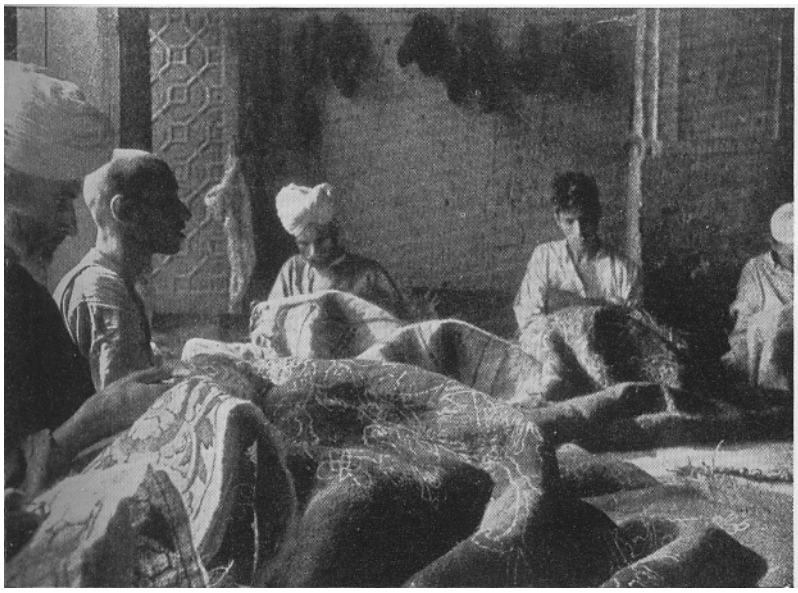
CHANGES AND IMPROVEMENTS

Although true cottage industry implies production by a family unit who use their own equipment, buy their wool and sell their goods, this system of work is declining under present economic conditions. In certain areas of Kashmir, however, the family unit still survives. In some areas the cottage worker has gradually been reduced to the status of a wage earner for a middleman, who provides the wool and markets the finished products. In the more developed areas of the Punjab and Uttar Pradesh small capitalists, frequently successful weavers, have set up small-scale factories or integrated the cottage workers into a single unit, while leaving them to carry out the work in their own cottages.

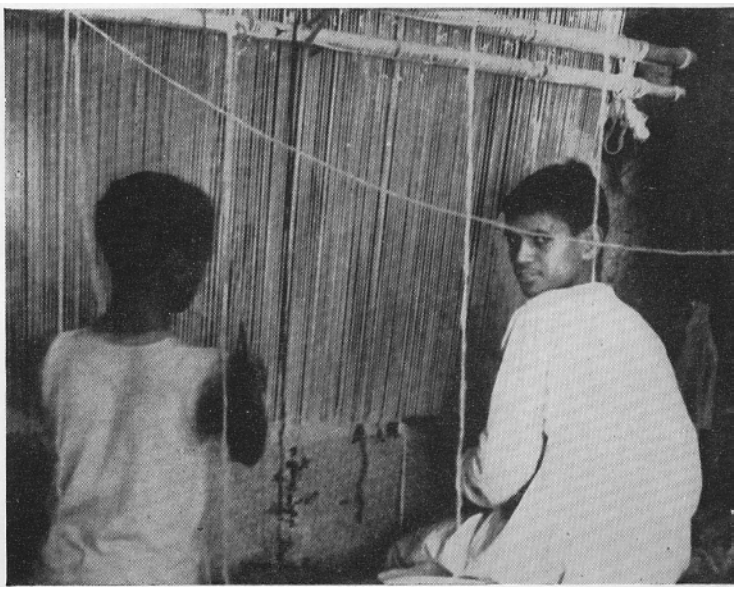
The villager is handicapped by his lack of capital. Having barely enough money to meet his daily needs, he cannot purchase more wool until he has marketed the finished product. Another difficulty is the lack of suitable wools. Often the weaver attempts to make cloth from unsuitable materials and not only is the spinning and weaving difficult, but the cloth is of a low quality and brings the weaver little financial return. To remedy these defects it would be necessary to provide cheaper credit facilities and a central organisation through which the right type of wool could be obtained. Moreover, to speed up the production of cloth certain improvements in equipment are essential. At the present time it takes five carders to prepare enough wool for one spinner, whereas one mechanical card would keep five hundred spinners busy. To improve the final product there could be established central finishing plants, such as already exist in the Punjab. Here the weavers bring their cloths and these are either finished at a nominal cost or bought outright. In this way the functions of cottage and factory can be complementary.

Many years ago the Government adopted plans to assist the industry. Grants were allotted to different states and provincial governments and many of these appointed Wool Development Officers. The main needs of the industry are for weavers' co-operative organisations, for technical guidance and better facilities for obtaining raw wool and marketing the finished products. In some provinces co-operative societies have already been formed, but there is need for many more. To provide better facilities for technical guidance a Wool Technological Institute and a Central Training and Research Institute of Cottage Industries have recently been established in Delhi. Meanwhile, provincial centres and demonstration parties are doing valuable work in the rural areas. A central organisation of the co-operative societies could profitably undertake the bulk buying of finer wool and yarn. A few years ago the Central Cottage Industries Emporium was established in Delhi to market and advertise the goods made in the provinces. As a result of these improvements the woollen cottage industry will continue to play an important role in the economy of India, not only producing goods for the home and overseas markets, but also by providing useful employment for thousands of workers.

Making namdas in Kashmir.
(Photo: Paul Popper)



Weaving a carpet.



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GROWING WOOL

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SHEEP HUSBANDRY AT HOME AND ABROAD

•

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WOOL IN HISTORY

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WOOL THROUGH THE AGES

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