

Merino Fabric.

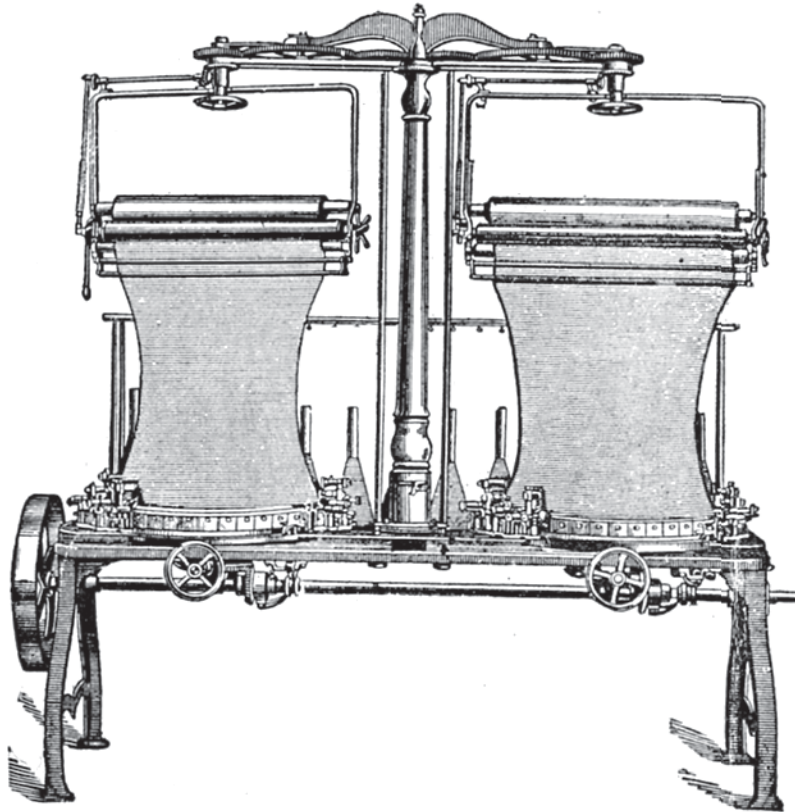


VIEW IN ONE OF THE KNITTING ROOMS OF THE AKEN KNITTING COMPANY, SHOWING KNITTING FRAMES MAKING 20- AND 22-GAUGE FLEECE LINED CLOTH

a bobbin of the yarn to be used, place it on its rack directly under the screw eye nearest the sinker stand, pass the yarn up through this eye, then through the outer end of the guide and finally through the inner end. The yarn should be delivered as near to the bur as possible, and a little above the nibs. This necessitates placing the inner end of the guide close to the bur and the needles, but care should be taken that it is not so close that a slight pull on the yarn or a bunch on the needles will pull the guide against the bur, causing it to drag and break needles. After threading the guide, draw the sinker bur back, pass the end of the yarn around it, and let the bur come back into its position. If the edge of the fabric is ragged it should be trimmed with shears, otherwise the sinker will pick up these ragged edges and break needles. In any case, the machine should be turned gradually to avoid pick-ups. Turn until more exposed needles are available, and continue putting on the fabric. If the first feed is properly set, the old fabric will be clear of the needles after leaving the cast-off, but will be held to them by a new loop on each needle. When these new stitches approach the new sinker, thread it as with the first, and so on around.

Evils to Look for and Remedy. When the fabric is on all the needles, turn the cylinder once or twice by hand and then examine the new stitches. It will generally be found that in some cases one stitch straddles two needles, making a drop stitch effect. Hold down the fabric at this place, press down the beard of one of the needles and let the stitch off of that one. At the next bur the stitch will form properly. If the sinkers are not set deep enough the stitches will be too tight and will break. If the pressers are not pressing enough the needles will load up, that is to say, two or more stitches will be left on the needle. This will occur even when the pressers are deep enough, if some of the needles are bent inward. If the cast-off is too high it will break the stitch in casting off. If it is too low, it will not even the stitch in casting off and the fabric will not look well. Remedy all these defects and see that everything is running free and the take-up is working properly, before putting on the power; and in putting on the power, let it be for half a turn at a time, and keep ear and eye alert for trouble. A bent needle or a bent blade, a rough

bearing, a misplaced guide, a bobbin kicked out of place--· any one of many little things may let the fabric off the needles or break a lot of needles if caution is not used in starting. If half a turn with power discloses no trouble, try a whole turn or more, feeling the fabric frequently to make sure that it is being taken up properly. If the tension is too severe it will finally pull the fabric right off the needles, and if it is not enough, the push-downs

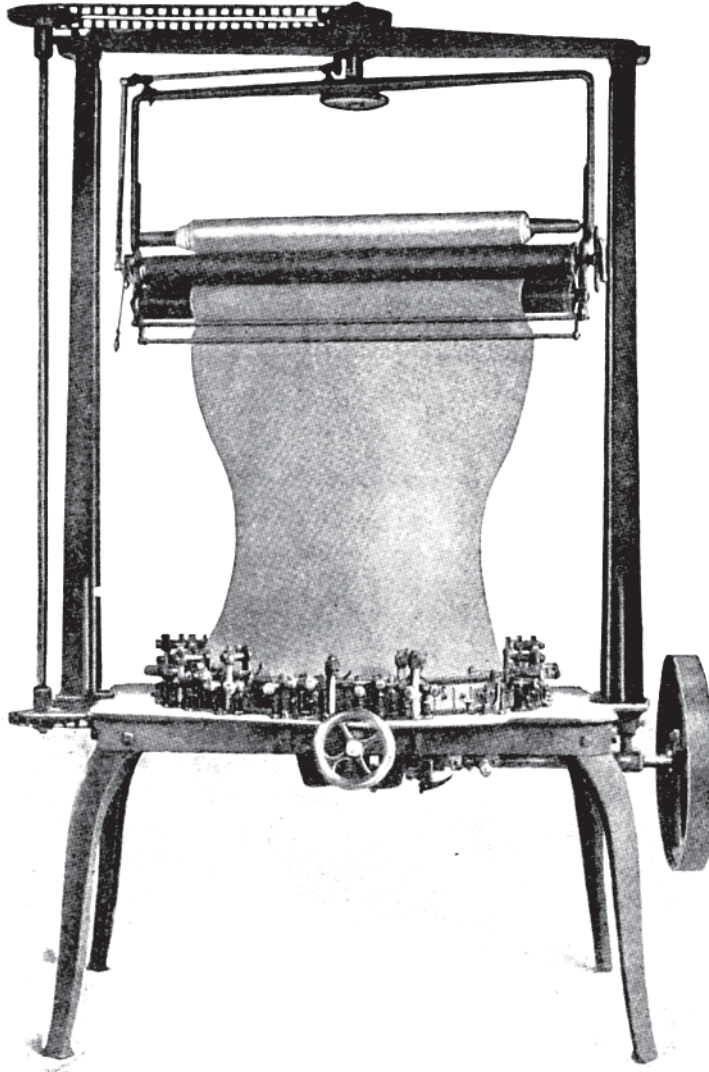


Trick Needle Frame.

cannot keep it clear of the sinkers and a smash will result.

After running up a little fabric, stop the cylinder and look for defects. A high beard will make a long stitch, or a tuck. A bent needle will make a line. Needles out of line will make a vertical streak of tight or loose stitches according as the displace-

ment is inward or outward. A short needle will make a line. Plyer or remove defective needles.



Trick Needle Stockinette Frame, Chain Take-Up Drive.

Evening the Stitch. The stitch should be evened by marking each yarn one foot from the guide, turning the cylinder

slowly, noting which marks reach the guide first, and shortening the corresponding stitches or lengthening the others according to the weight of fabric desired. Continue this until all the yarn feeds alike.

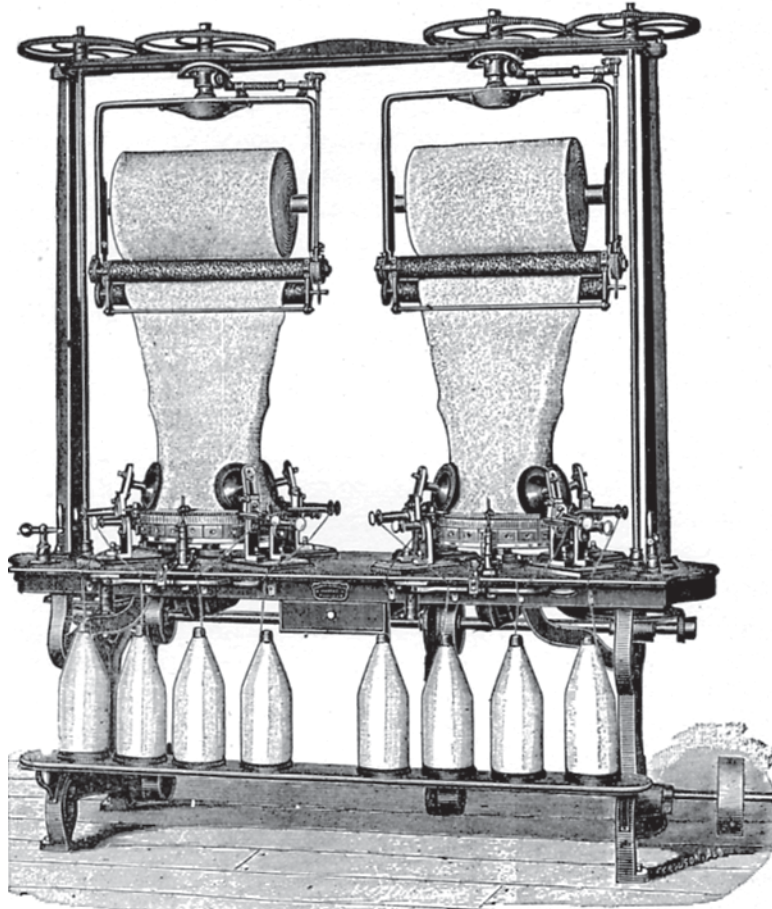
Adjusting the Stop Motion. Before letting the machine run without watching, the stop motion should be adjusted so that the feeler will enter a hole and stop the machine. Some stop motions have a waste claw. This should be adjusted near to the needles to catch bunches or thread that stay on the outside of the needles. The stop motion spring should be adjusted as lightly as possible without making it stop the cylinder unnecessarily. If the spring is set hard it will enlarge the holes and sometimes bend the needles at the same time.

Plating. Plated work has one kind of yarn on the face (the inside when on the machine) and another kind of yarn on the back. It may be made by using a guide with two sets of holes to accommodate two different yarns, the face yarn being the upper one as delivered to the bur. Of course when two threads are used each should be equivalent to about half the weight of the single thread used for fabric of the same weight and gauge.

A better way of plating is to use two sinker burs to each feed and deliver the face thread to the first sinker in order of rotation, making the stitch of this bur longer than that of the following one. The difference in stitch depends on circumstances, but from 1" to the foot to 1½" to the foot is usual. Plated work with two burs has some marked advantages over single thread work. A nice appearing garment may be made with expensive stock in the face and cheap stock on the back. The sinker burs divide the work between them and make an evener stitch and are less likely to overreach than when one bur puts in the yarn. The fabric is generally stronger, having two threads; it is durable and it runs well, and if a yarn breaks the fabric does not leave the needles as in single thread work.

Cut Presser Work. Designing for the knitting machine is analagous to designing for the loom. It is obvious from the foregoing that if four feeds and four different colored yarns are used, the fabric will be striped horizontally in a pattern containing the four different colors, and this pattern will repeat itself at every

revolution of the cylinder. By increasing the number of feeds, the width of the pattern and the number of colors may be increased. From this and from the construction of the machine it is evident that changes in the yarn effect the fabric horizontally or across its



Another Type of Leaded Spring Needle Machine. Overhead Take-Up Drive. Stands Fastened to Bed of Table.

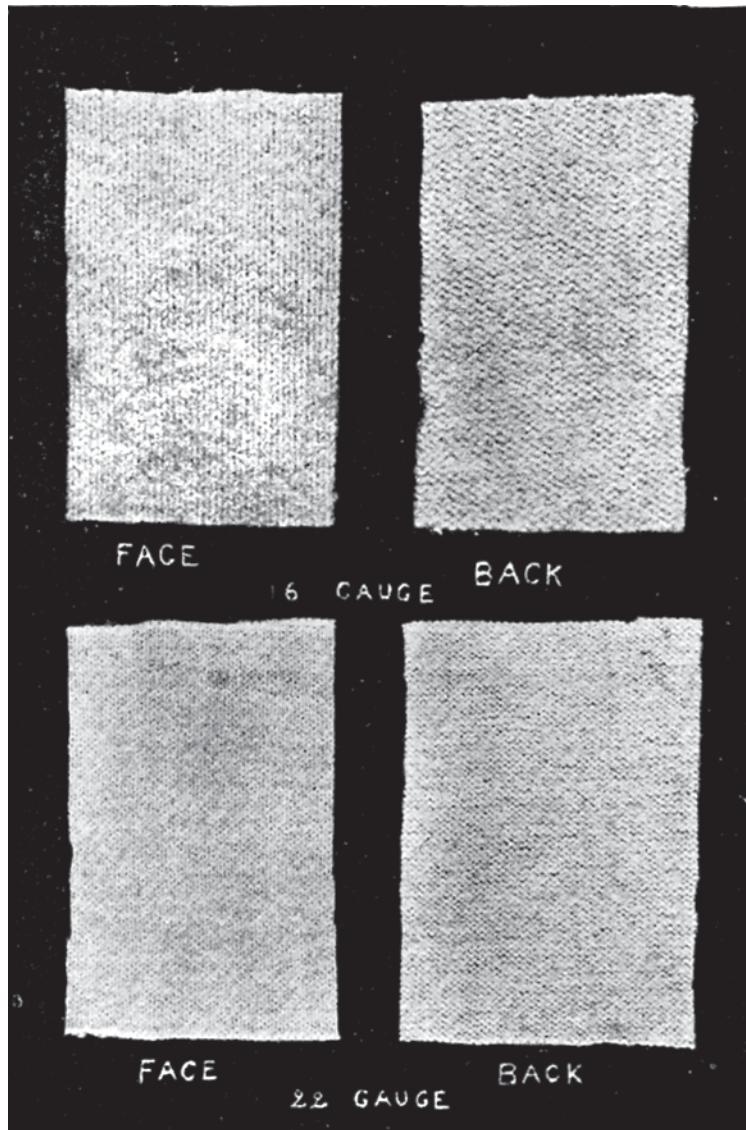
length, and that vertical or lengthwise effects must be caused on individual needles, for the fabric rises vertically from the needles.

Now, suppose that the cylinder is set up with but one feed, this feed having a round presser, and suppose the presser has been

nicked on a milling machine so that the nicks correspond to the needles and so that each succeeding needle comes to each succeeding nick. The result will be plain fabric just as if the presser were not nicked, but the presser will make a certain number of revolutions to each revolution of the cylinder. Suppose that the cylinder has 600 needles and the presser has 100 nicks; then the presser will revolve 6 times to one revolution of the cylinder. Now suppose one nick is filed deeper than the others so that the needle which enters it is not pressed. Then every hundredth needle will not be pressed, and at every turn of the cylinder a tuck stitch will be left on each of these six needles. If this were allowed to continue each of these six needles would load up and break, for a new stitch would be placed under the beard at every turn, and not being pressed off, would be retained there. The tuck stitch is desired in order to get a vertical effect in the cloth. Possibly one tuck is required, or two or three, as the case may be, but it is not desirable to injure the needle, so at intervals this must be pressed off. It may be done in two ways, either by adding another feed with a plain presser, or by removing or adding a needle. Suppose that another feed with a plain presser is added. Then every hundredth needle will have a tuck stitch as it passes the cut presser and all the needles will be pressed at the next feed. The result will be a fabric in which every hundredth stitch in every other course is tucked. These tuck stitches will occur in a vertical line at every hundredth needle. The width of this pattern is 100 and its height is 2.

The pattern is $\left\{ \begin{array}{lll} \text{Press 99} & \text{Skip 1} & \text{Cut Presser.} \\ \text{Press} & 100 & \text{Plain Presser.} \end{array} \right\}$

If the plain feed is removed and the original cut presser feed is used, this will load up every sixth needle. If one needle, however, is removed, then at every turn of the cylinder the skip-cut will step one needle ahead, that is to say, one needle farther around the cylinder in the direction of rotation. The needles that were skipped at one revolution will be pressed the next revolution and the tuck stitches will take a diagonal course of approximately 45° , inclined to the left, upward, as the fabric is viewed on a machine that turns from left to right (anti-clockwise). If one needle had been added instead of removed, the diagonal would have been



Merino Fabric, Slightly Brushed.

inclined to the right, as the presser would then step back at each revolution of the cylinder. At every hundredth revolution the skip space would be back to the needle where it started.

A similar result would be obtained by leaving the needles as at first, 600, and making one more nick in the presser, or taking one out. The effect of this would be to step forward or back one needle at every hundredth needle, one needle at the first hundred, two needles at the next, etc.

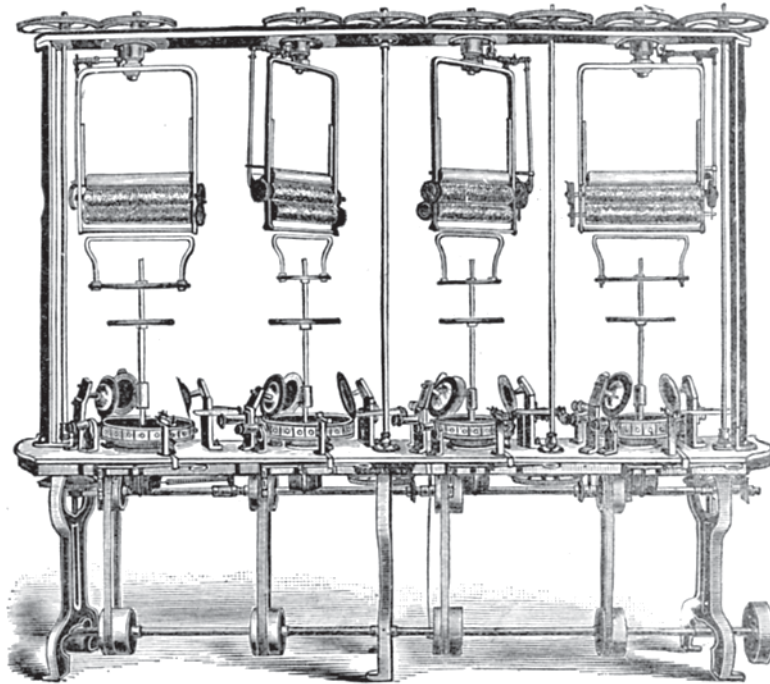
The above are the fundamental principles of tuck presser work. It is customary to run a plain presser after each cut presser for the ordinary forms of work, but of course, any combination may be used. To show how the pressers should be cut for any desired pattern, take a piece of cross-section paper having as many vertical spaces as there are needles in the pattern and as many horizontal spaces as there are courses. Number the horizontal rows of spaces to correspond to the pressers. For instance, if there are four pressers, number the horizontal rows, 1, 2, 3, 4, and then repeat 1, 2, 3, 4, to the end of the allotted space. Then mark the squares to be tucked. When all are marked the pattern for any one presser may be read on the lines numbered to correspond to it, that is to say, read for No. 1 presser the first No. 1 line; then the next, and so on stringing them together. If pressers 2 and 4 are plain their pattern will be press-all.

Collarette. When a considerable amount of plain work is required between the tuck work, as for collarette, an automatic device is used to substitute plain pressers for cut pressers without stopping the cylinder. A popular collarette combination is three tuck pressers in unison (3 tucks on the same needles) followed by two plain pressers. The pattern is generally "press one, skip one."

Backing Cloth. Backing cloth, including single plush and double plush is plain knit fabric with a thread or yarn caught in the stitches but not forming stitches itself. Backing cloth may be made with a sewing needle by taking the common or "flat" fabric, and running a heavy basting thread across it, making the courses close together. If this basting thread were then napped into a fleece, the fabric would be "fleece lined," and it would be single or double plush according as the original fabric was single

thread or two thread. The word single or double applies to the face and not to the backing. If the backing thread were a material that would kink and curl after knitting, the material would be astrachan, or bouclé cloth.

On the knitting machine the backing is put into the fabric by lacing it among the needles before the face thread or threads, if two are used, are looped under the beards. The backing is not placed under the beards and does not go there. Suppose the ma-

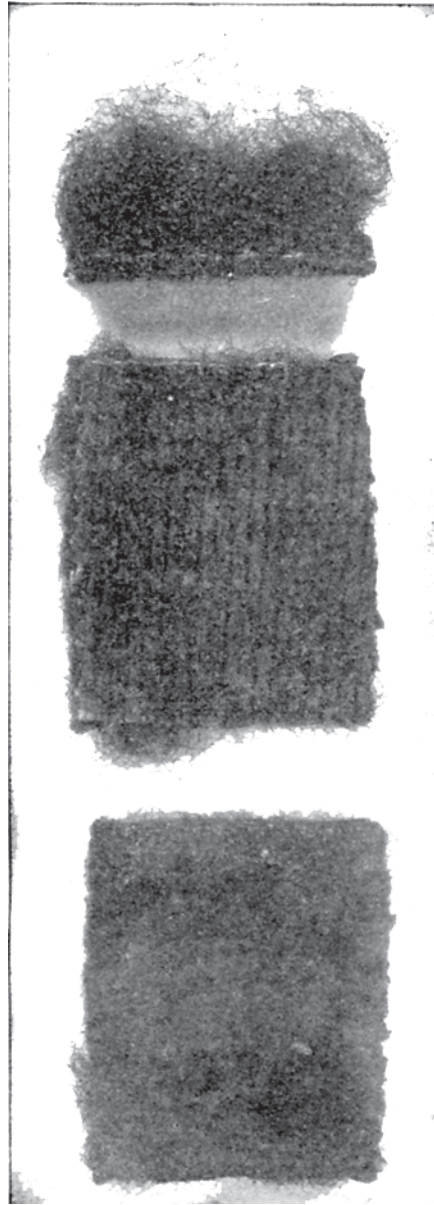


Four Cylinder Sleever.

chine is set up for flat work and with only one feed, for simplicity. Also, suppose that the one feed has been running and making cloth. Now suppose that a comparatively heavy but loose spun yarn is taken, and beginning just ahead of the sinker, where the fabric is held down, is laced in front of one needle and in back of the next two and so on, working from the sinker bur. Suppose that this yarn is pressed down to the base of the needles, so that

the sinker will not pick it up, and that the cylinder is slowly turned in order to get more needle space in which to lace the backing. If this is done the flat fabric will be transformed to single plush.

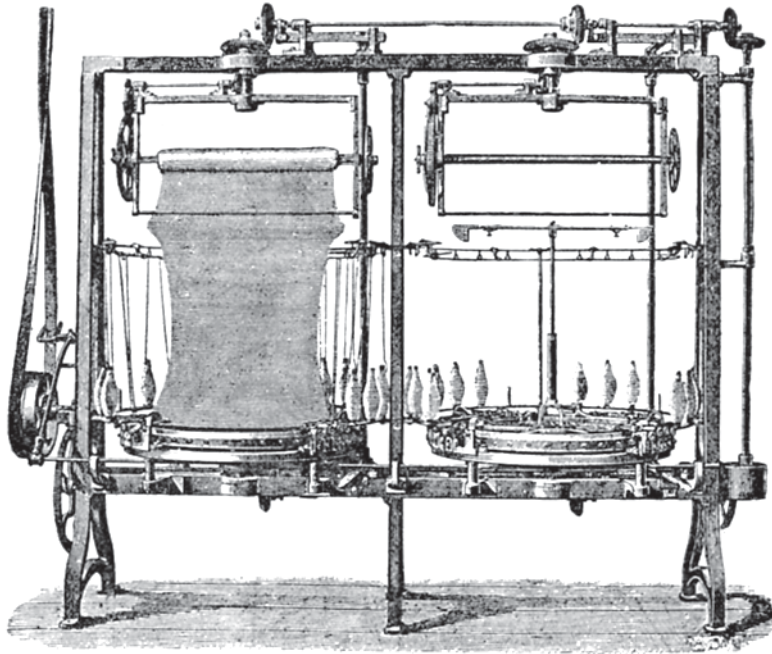
It will be noticed that the three requisites to make the changes were space in which to lace the backing on the needles (for the fabric must be held down before the backing can be placed in) means of lacing the backing thread, and means to carry the backing thread down clear of the sinker. To get the space the push-down must be long enough or of sufficient diameter to give the space, and the sinker and presser should be set pretty well back in respect to the push-down. To lace the backing in the needles a bur similar in shape to a sinker is used, but larger and with a deeper nib and the reverse angle. This bur is blocked so the needle will be pushed



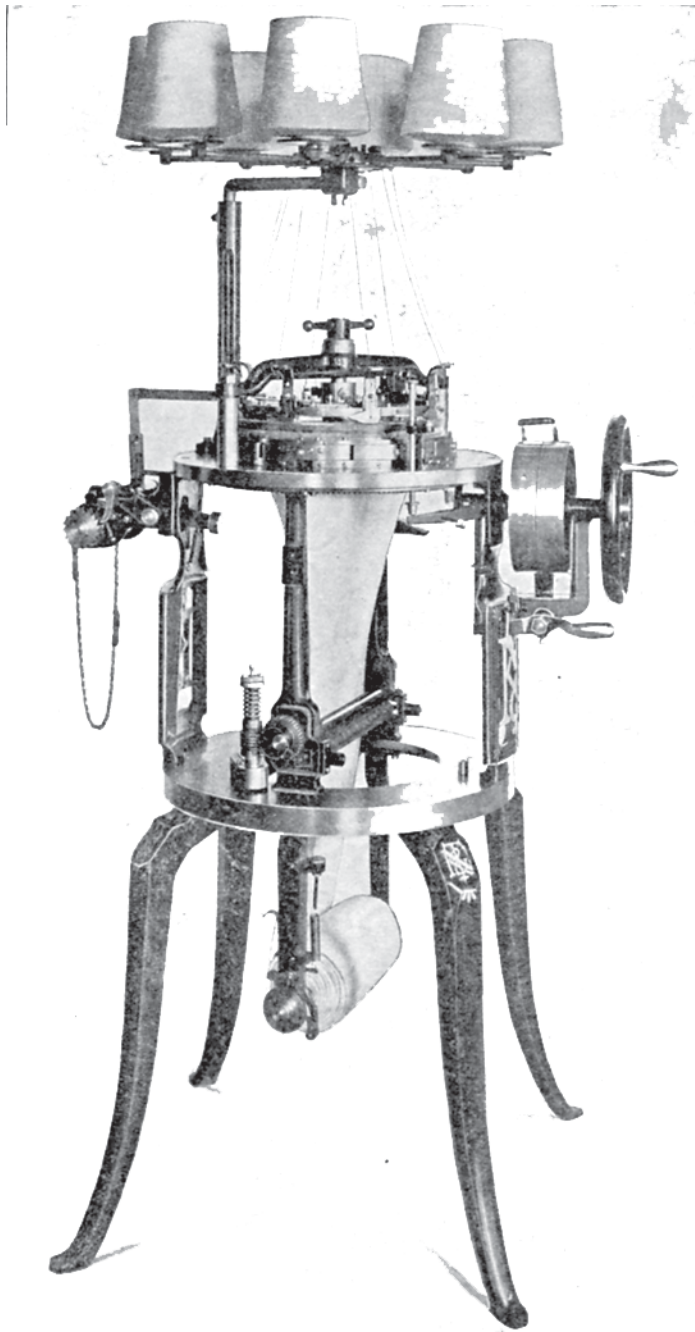
Cloth: Wool Backing, Buffalo Robe.

back at intervals and the backing will be placed in front of the needle so pushed back and back of the other needles. This bur will not carry the backing down far enough to clear the sinker, so a clearing-bur is put between the backing-bur and the sinker. The clearing-bur is like the cast-off, only being on the outside of the cylinder it works downward instead of upward. A combination of this kind—a backing and clearing-bur preceding a plain feed—makes a single plush feed. Of course, as many such feeds may be used as the cylinder space will allow.

To make a double plush feed, remove the cast-off from the single plush feed, and bring another complete flat feed up close to the single plush feed. With this arrangement the backing thread is brought up to the heads of the needles between the two feeds and is held there by the first face thread which is called the binder, because it binds the backing. In double plush the backing does not show on the face as in single plush.



Type of English Frame.



LATCH NEEDLE RIB KNITTING MACHINE WITH REVOLVING CYLINDER
AND AUTOMATIC CHANGE FROM PLAIN TO TUCKED STITCHES .
Nye & Tredick Company

KNITTING.

PART II.

LATCH NEEDLE KNITTING.

Latch-Needle Knitting has been exploited to a much greater extent than has Spring-Needle Knitting. It enters into the manufacture of almost every line of knitted goods, is a leader in the stocking industry, and nearly, if not quite so, in the underwear mills.

Since the time of Walter Aiken, latch needles have been used in various positions to make fabrics of a great variety of stitches; and in different systems, as the Lamb, Heginbotham, and Leighton. Since the invention of the dial plate for supporting a series of needles, horizontal to and in conjunction with the vertical needles in the cylinder, latch-needle circular frames have been utilized to a great extent in the production of all kinds of knitted wearing apparel, outer as well as under garments. For knitting fabrics for underwear, or more specifically shirts and drawers, latch-needle machines may be classified as *Flat* or *Straight*, and *Circular*.

LATCH NEEDLE CIRCULAR MACHINES.

The circular machines may be divided into three classes.

1. **The Revolving Needle Cylinder** in which the needle cylinder, needle dial, take-up, and fabric revolve (or strictly speaking, rotate); the cam ring, cam dial plate, and bobbin rack remaining stationary.

2. **The Stationary Needle Cylinder** in which the cam ring (to which are fixed the vertical needle actuating cams), cam dial plate (to which are fixed the cams for actuating the horizontal or radial needles), bobbin rack, and cross bar revolve; the needle cylinder, needle dial, take-up, and fabric remaining stationary.

3. **The Flat Head Circular Machine** in which the needle plate or dial is located *outside* of the needle cylinder.

Each type of machine may be subdivided into *Plain* and *Automatic*.

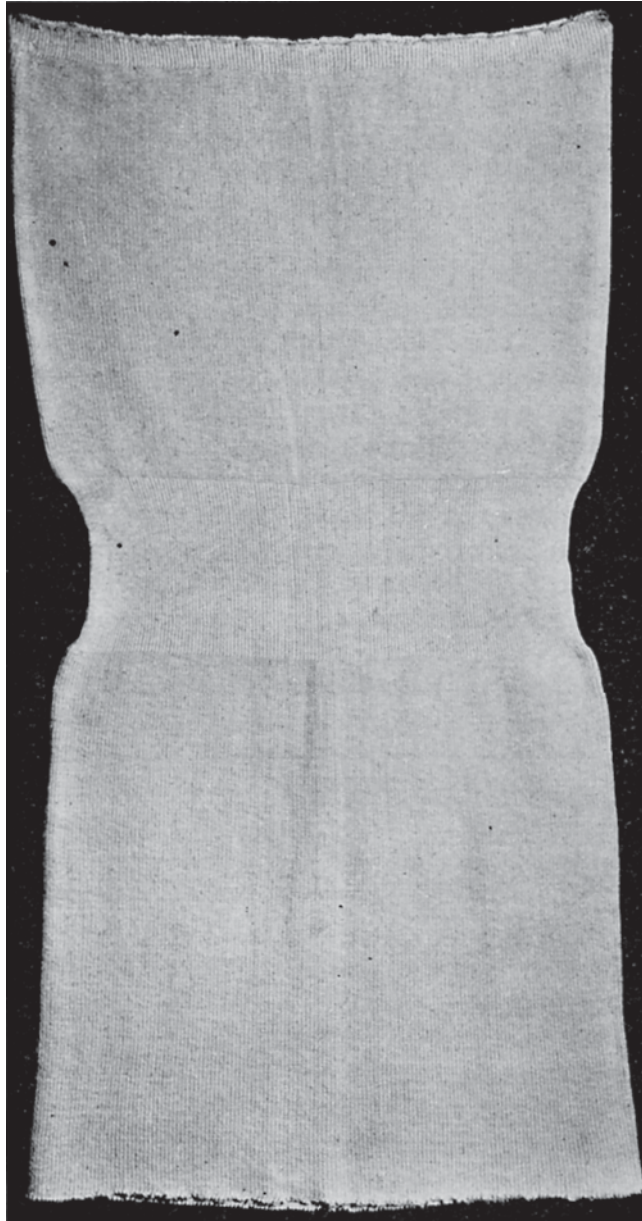


Fig. 25. Fabric for Shaped Goods. Knit on Automatic Machines.

The *Plain Machines* produce but one class of fabric, a straight, tubular web of either a plain or a tuck stitch, the fabric being used in making what are known as straight goods.

The *Automatic Machines* make a tubular web of either a plain or a tuck stitch, or a combination of both; in the latter, the stitch is changed automatically from one to the other. The fabric made with the combination stitch is used in making shaped goods. (See Fig. 25.) In these knitting machines the needles of the horizontal needle dial are controlled by movable needle-directing cams operated automatically. These cams move the needles farther out, or draw them in, as required to obtain the characteristic stitches for the plain or tuck fabric for the shaped garment.

In making shaped goods, the 1 and 1 stitch (Fig. 26), is usually employed, viz.: All the needles in both cylinder and dial. For making straight goods, it is common practice to use the 2 and 2 stitch (Fig. 27) with every third needle out of both cylinder and dial. This, the Swiss double-ribbed stitch, produces what is known as the *Richelieu* fabric. Various other combinations of stitches may be made, as 2 and 1, 3 and 1, 6 and 2, 4 and 4, etc., and also fancy tuck lace stitches, making fabrics of various effects for a variety of styles.

Machines up to 10 inches in diameter are commonly used for making children's goods. For fleece-lined underwear, sizes may be employed up to 10 inches for children's, 11, 12, and 13 inches for ladies' shaped goods, and 14, 15, 16 and 17 inches for men's (straight) goods.

Measurement of Knitting Machines. Fig. 28. The old method of measuring is from back to back of the needles, but this system often occasions misunderstandings; as each different gauge needle gives a different needle diameter. Diametrical needle measurement may mean any one of three things; from the outside of the hook of the needle on one side to the outside of the hook of the needle on the other side; from the center of the needle on one side to the center of the needle on the other side; and from inside of the needle on one side to inside of the needle on the other.

Cam-surface measurement has been adopted by many knitting machine builders. This measurement is taken from the outside diameter of the cam surface of the needle cylinder and not from the needles; that is to say, the cylinder for a 10-inch machine will measure

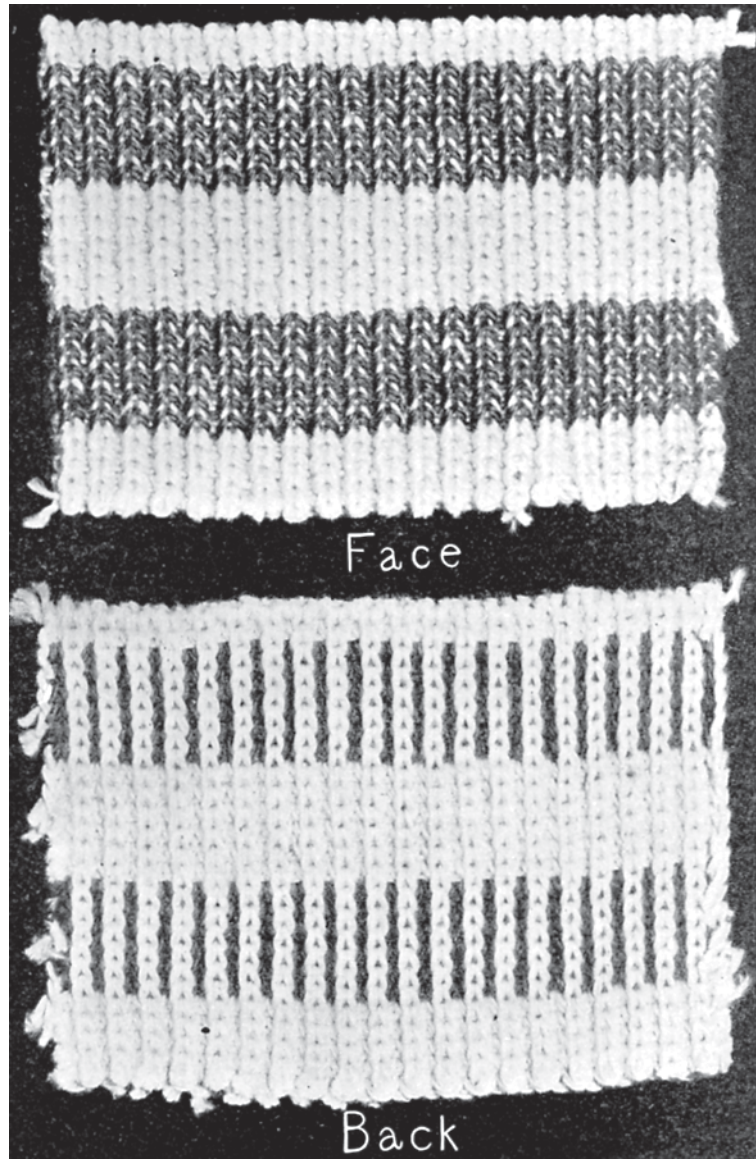


Fig. 26. One-and-One Plain Stitch. Fabric slightly stretched. All the Needles in both Cylinder and Dial.

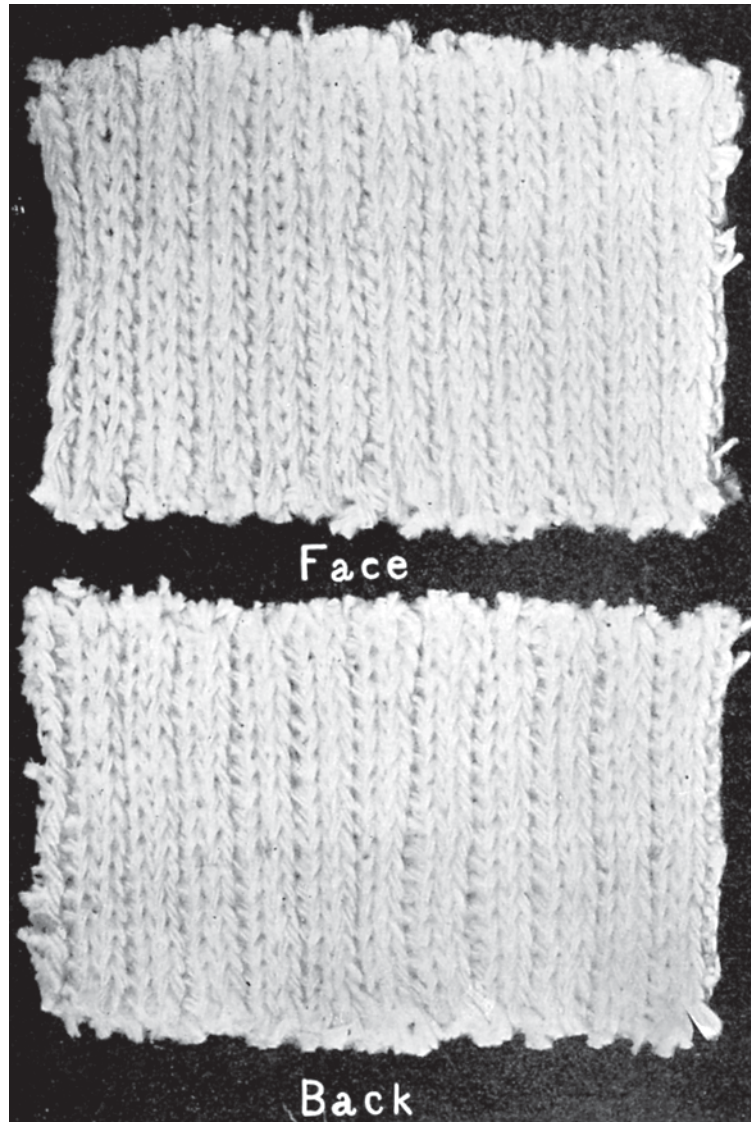


Fig. 27. Two-and-Two Stitch. Every Third Needle out of both Cylinder and Dial.

10 inches at its greatest or outside diameter. In most cases, the cam-surface measurement will give a reading one-quarter inch larger than the old system, thus, a $4\frac{1}{4}$ -inch machine (modern method) would correspond to a 4-inch machine by the old measurement.

Rib Knitting is done on a machine having two sets of needles, one forming the back of the fabric, the other forming the face. When the two sets of needles form, and cast off completed loops at every feed on the machine, the fabric is called a *plain rib*, each needle showing a distinct longitudinal wale or rib, both on the inside and on the outside of the fabric.

The *formation of the stitch* in rib-knitted goods differs from that of flat goods in its principle, the effect being produced by revers-

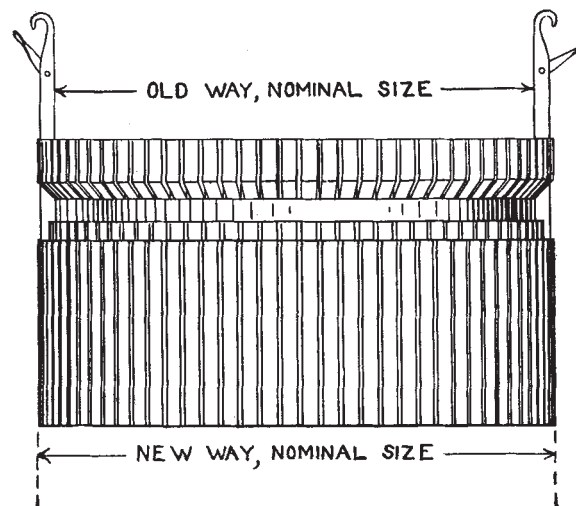


Fig. 28. Measurement of Knitting Machines.

ing the stitch. The needles are so arranged that every alternate row in plain-rib work is reversed (Fig. 29), thus making both sides alike. Ribbed work requires two banks of needles; the function of the second bank being to pull and loop the yarn in an opposite direction, thereby producing a thicker and more elastic web.

Useful modifications of plain-rib fabric are often obtained by varying the movement over the cams; of one or both sets of needles by leaving out certain needles in one or both sets; and by a combination of these expedients, as shown in Fig. 30.





Fig. 30. Six-and-Two Plain Rib.

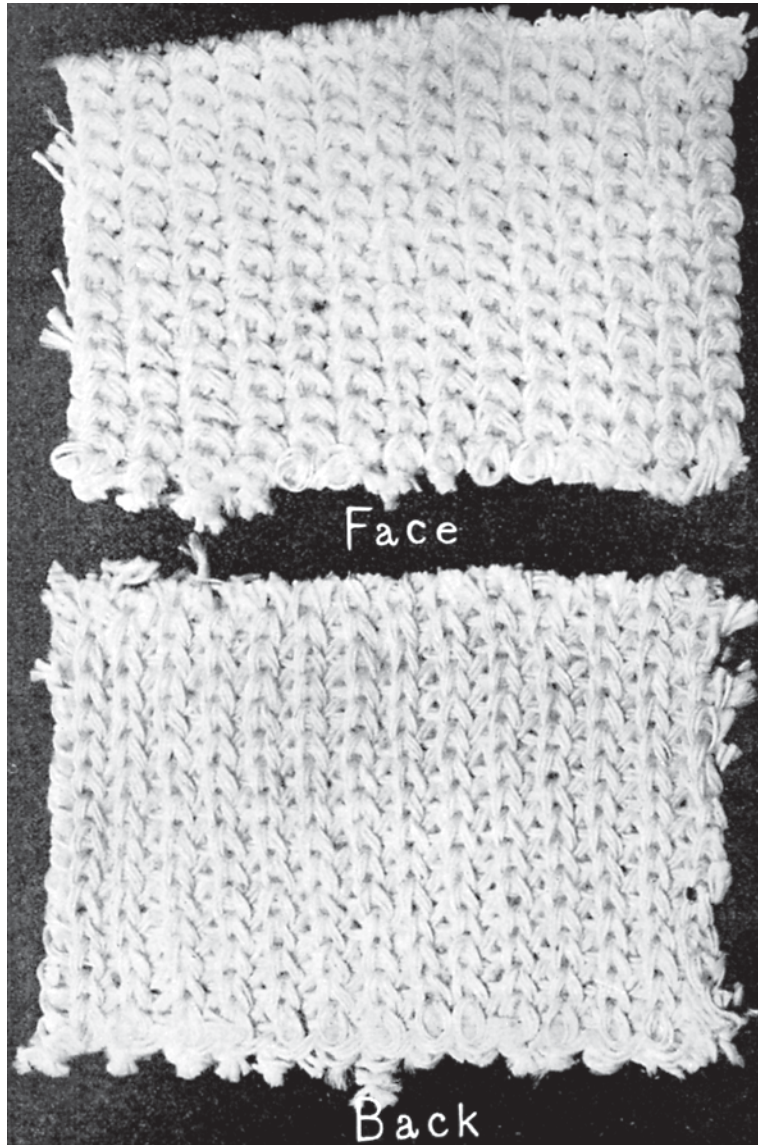


Fig. 31. One-and-One Tuck Stitch.

In knitting by hand, a latch needle will knit, tuck or purl the stitch. When *knitting* the stitch, the needle takes a new loop of thread and casts off a loop onto it, forming a completed stitch. When *tucking* the stitch, the needle takes the new thread into the hook but does not cast off the partly formed stitch. When *purling*, the needle neither takes the new yarn nor casts off the old loop, but retains the stitch previously made by it.

The most commonly used of these modifications of the plain-rib stitch are the tuck stitch, variously called half-cardigan, royal rib or sweater stitch, and the tuck stitch known as the cardigan stitch.

The Half-Cardigan, or Royal Rib Stitch (Fig. 31), is usually made by projecting the needles of the inside set not quite far

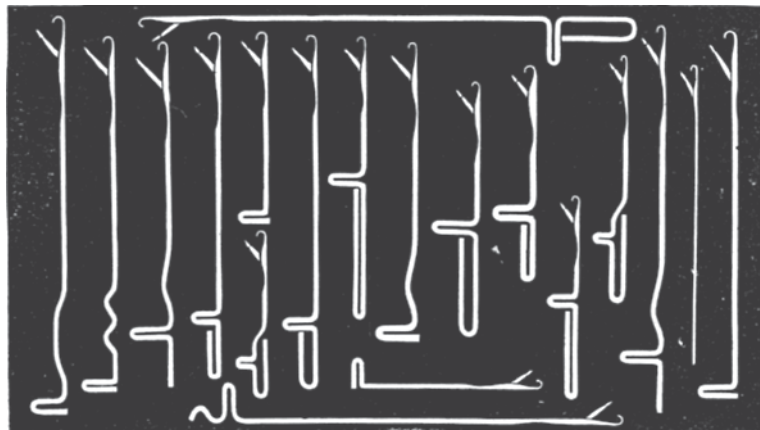


Fig. 32. Latch Needles.

enough on alternate feeds (or if a single-feed machine, on alternate revolutions) to cast off the partly formed stitch or loop in the latch over the end of the latch. As the latch cannot close with the stitch on it, the loop, instead of passing off when the needle is drawn in by the stitch cam, slides back into the hook of the needle and is retained with the new loop which is taken by the needle. The other feeds are knitting plain, and of course cast off the tucked loop with the other, making one complete stitch for each *two* feeds. The needles of the outside set are knitting plain, but two of the loops made by them are tied together by one double loop of the inside needles, widening and

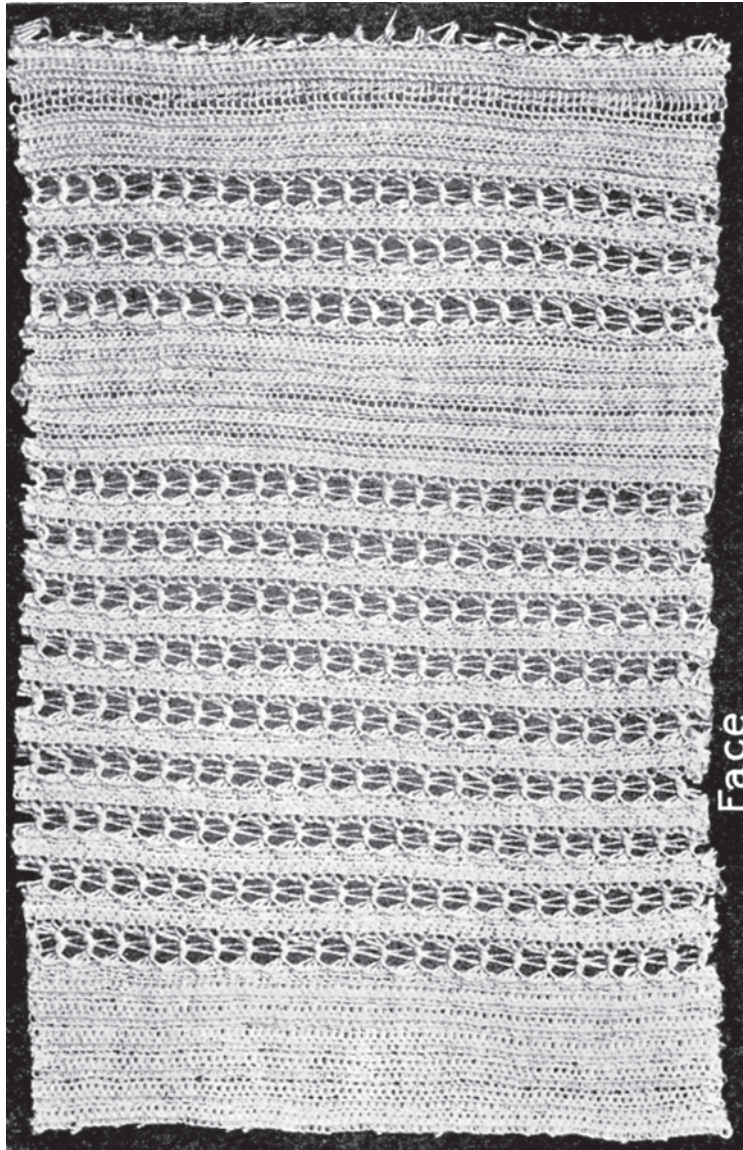


Fig. 33. Lace or Open Work Effect.

thickening the fabric without destroying the characteristic elasticity of rib goods.

This is the method commonly used for shaping ladies' underwear, the machines being made to automatically change the position of cams to make the bust and skirt on the royal rib, while the waist, band and cuffs are on the plain stitch. (See Fig. 25.) Sweaters, also, are made with the body a half-cardigan stitch; and neck, tail, cuffs, etc., a plain rib, or some fancy stitch.

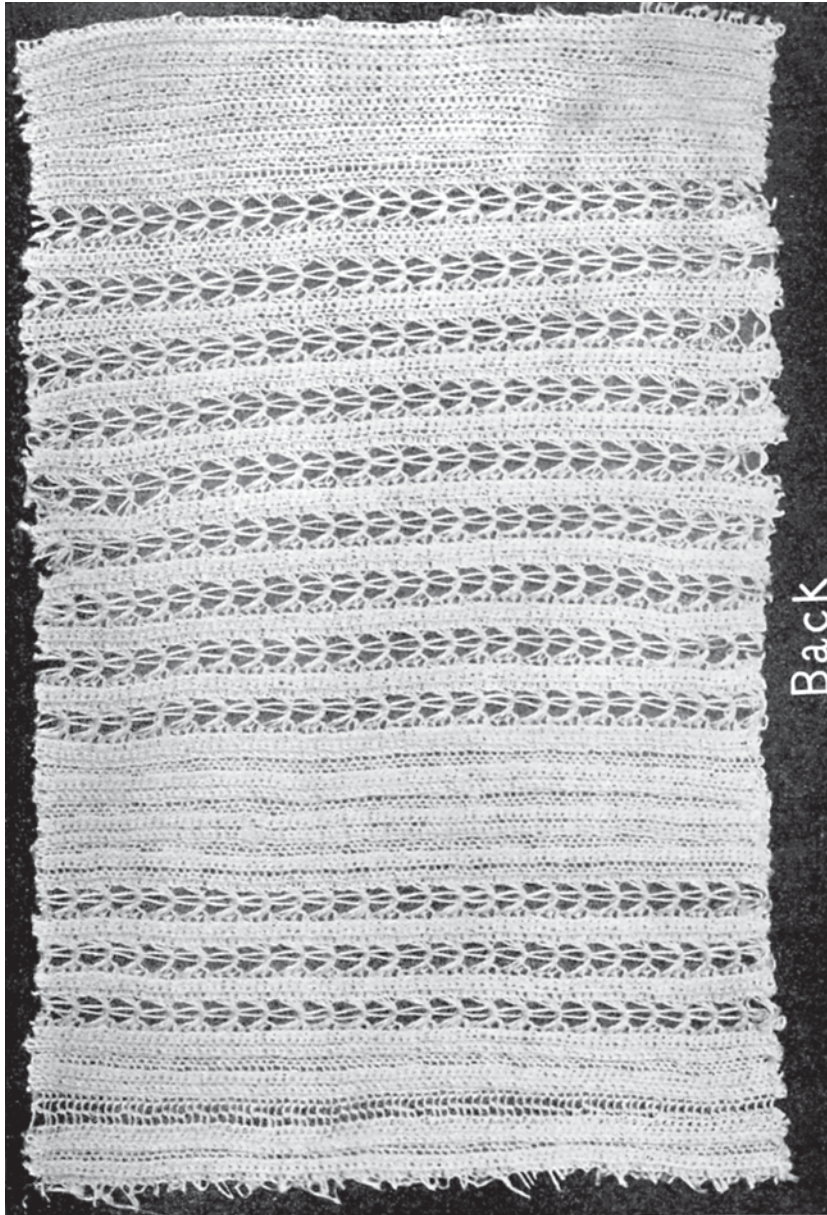
The Full Cardigan is made like the half-cardigan, on the inside needles; but in addition, the outside needles are also tucked on each alternate feed. The two sets of cams are arranged so that on the feeds, when the inside needles are tucking, the outside needles will cast off, and *vice versa*. This gives a larger, looser fabric than even the half cardigan, and is used extensively for cardigan jackets, etc.

It is customary to speak of the tuck stitch, but the needles do not form a complete stitch when tucking, and a tuck stitch is in reality *one or more tucks combined with a plain stitch*.

As will be seen from the above, the number of tucks which can be put in a needle without clearing is limited, and though for fancy effects, two, three, four, or sometimes even more tucks are placed in the needle hook at a time, the cams should be watched carefully to note that the clearing cams are working perfectly, otherwise the result will be disastrous.

Another use of purling is to make a fancy effect in the color design, or some special stitch similar to the pineapple stitch.

In Knitting Rib Fabric, needles are frequently left out of one or both sets at certain intervals around the machine, especially on ladies' underwear and hosiery. This gives a different appearance to the fabric, and to distinguish these different fabrics, they are known as 1 and 1 rib, 2 and 2 rib, 3 and 2 rib, 6 and 2, etc. The plain-rib fabric with every needle in both cylinder and dial, makes the 1 and 1 rib. Where there are two needles in the dial, then two in the cylinder, with an interval of two left out between each pair, it is known as a 2 and 2 rib. Where two are in the dial and two in the cylinder, with an interval of one between each pair, it is also called a 2 and 2 rib; in some localities it is known as two-needle line work. A fabric made with three needles in each plate, with an interval of one needle, is called three-needle line work, etc. Frequently the dial needles are



Back of Fig. 33.

set two in and one out, with all the needles in the cylinder; the effect produced being called a 2 and 1 rib.

Sometimes, on underwear especially, the needles are set, say for a 2 and 2 rib part way around the machine, and perhaps a 5 and 3 with the remaining needles. In many underwear mills, these "needle-out" effects are all referred to as *Richelieu* ribs, while in others, the name *Richelieu* designates a particular variety of needle-out work, oftentimes 5 and 3. As suggested before, these "needle-out" effects are often combined with the tuck stitch for producing the elegant lace effects, as illustrated in Fig. 33.

Double work in knitting consists merely in running two threads where one is ordinarily used. Coarser and heavier needles are required and a wider gauge for the needle cylinder. Fancy effects are obtained in double work by running two colors instead of one, the tendency being for one thread to twist around the other, thus making fancy double and twist work.

CONE WINDING.

The proper presentation of yarn to the knitting machine is one of the most important factors in the production of knit goods, and is, in a measure, more important in connection with the latch-needle machines than with spring needles. In the case of spring needle machines, where the bobbins rest on racks below the cylinders and near the floor, they may be made very large without other difficulty; but with latch-needle circular machines, where the yarn is placed on a rack above the cylinder, it is desirable to have as much yarn as possible in a small, light package.

The use of the paper tube to wind on, instead of the heavy winder bobbin, permits of the greatest quantity of yarn with the least weight, and winding machines have reached such a degree of perfection that the yarn is built into cones of uniform taper and tension, which give a free delivery to the knitting machines.

Universal Winder. It is customary for the yarn manufacturers to furnish yarn on the cop, although they sometimes re-wind it and furnish it in cones. When shipped to the knitting mill on cops, it must be wound on bobbins, or into cones; preferably the latter. The following is a description of a cone winder for this purpose: Fig. 34 represents the Universal Winder, ready for use in the knitting

mill for winding from the mule cop; and Fig. 35 illustrates the character of the wind and the shape of the cone. The yarn is laid in a regular succession of coils and layers; the same number of coils in

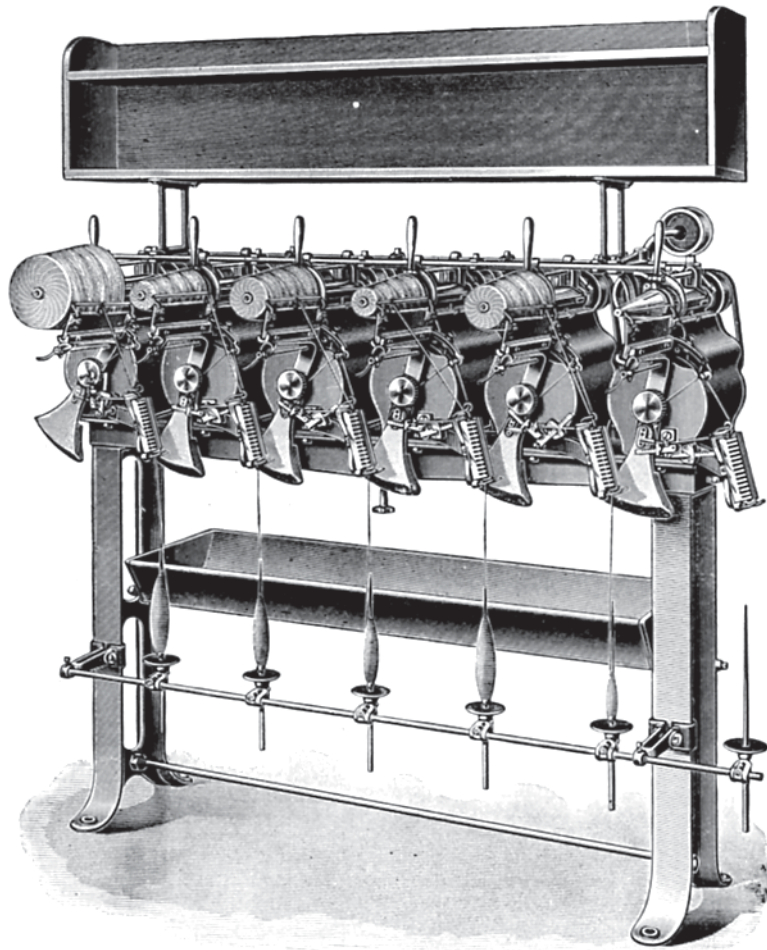


Fig. 34. Universal Cone Winder.

each layer. The successive coils are laid evenly, without crushing, or displacing the twist. Every coil is reversed at each end of the cone, passing back at a uniform angle, crossing every other previously laid coil, and binding it into place.

Guide. The guide delivering the yarn close to the surface of the cone, prevents any coils from passing beyond the point of reversal and slipping across the end of the cone to produce "cobwebs." The spindle is rotated at uniform speed; the yarn guide rests lightly against the surface of the yarn, and the number of coils in each layer about the cone is uniform. The same thickness of yarn is built up at each end, forming a cone with uniform taper, from start to finish.

Tension. The tension on the yarn in this process of winding is applied by passing the yarn between a number of polished steel blades, the pressure of which is graduated to produce uniform stress

on the yarn. Fig. 36 shows the yarn controller, which is adapted to all sizes and qualities of yarn. The interlocking fingers, between which the yarn passes, are made of thin steel with polished oval surfaces, bearing on the yarn alternately to deflect it from a straight line, and causing it to be delivered uniformly to the winding spindle. The position of the steel fingers can be adjusted to properly control the different grades and sizes of yarn.

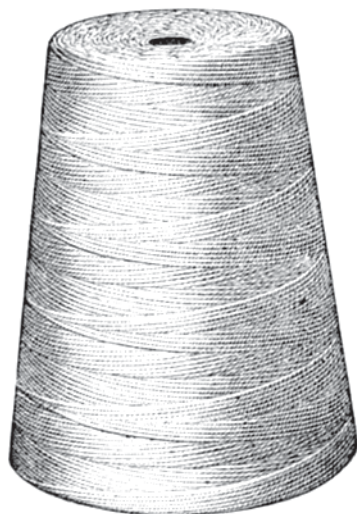


Fig. 35. Universal Cone.

The rapid traverse of the yarn through the controller causes it to act as a yarn cleaner, throwing off the specks, dirt and loose slubs, and thereby improving it. As the speed

of the yarn increases in proportion to the size of the cone the pressure of the tension blades against the yarn is *automatically reduced*, thus building the cone with a uniform density. When the winding spindle stops, the tension blades are automatically thrown apart, and the tension remains open until the spindle is again started.

Gainer Mechanism (Fig. 37). *The upper, or winding spindle*, being driven at a certain speed, is connected by means of a belt *o* with a small pulley on the end of the spindle, which carries the pinion *W* meshed with the gear *u* which is attached to the lower shaft *l* driving the cam. The speed relation is six to one, so that while the yarn

guide is moving from one end of the cone to the other and returning to its original position, the top shaft revolves exactly six times, when the diameter of the two pulleys is exactly the same.

A *micrometer adjustment* is provided by means of a split ring *r* on the top pulley *m*. This split ring is supported on the three arms *s* projecting from the hub of the pulley. These pins rest against the bevelled end of the threaded nut *t*. By turning this threaded nut to the left, the pins *s* move down the bevel, so that the ring *r* contracts

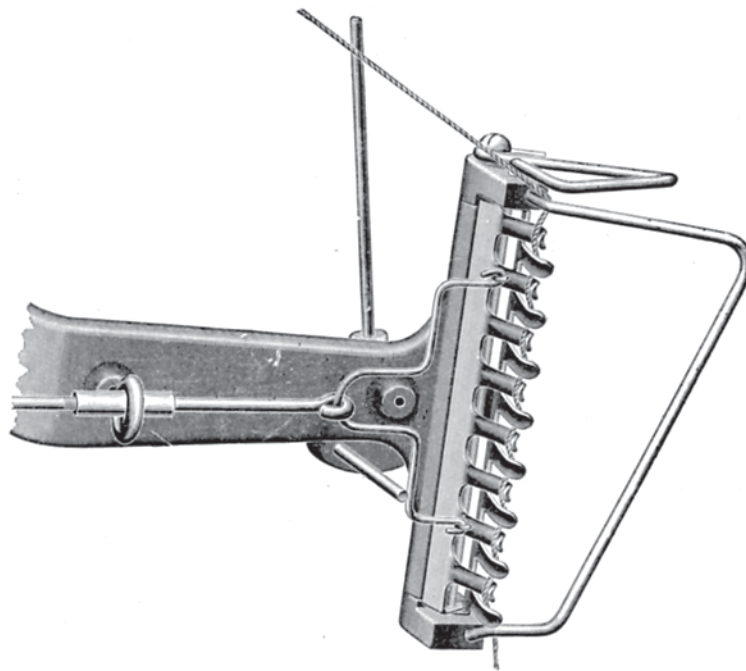


Fig. 36. Yarn Controller.

slightly, thus reducing the diameter of the upper pulley and changing the speed relationship. With this adjustment, the top shaft completes the sixth revolution, and has started upon the seventh before the guide has made a complete reciprocation and reached its starting point. The effect of this is to cause the yarn to cross over the preceding coils at the end, and form a regular succession of spirals, building up the entire cone.

To close the wind for finer yarn, the nut should be turned to the right. This adjustment by means of the threaded nut *t* is so delicate as to admit of winding the very finest yarns without "over-

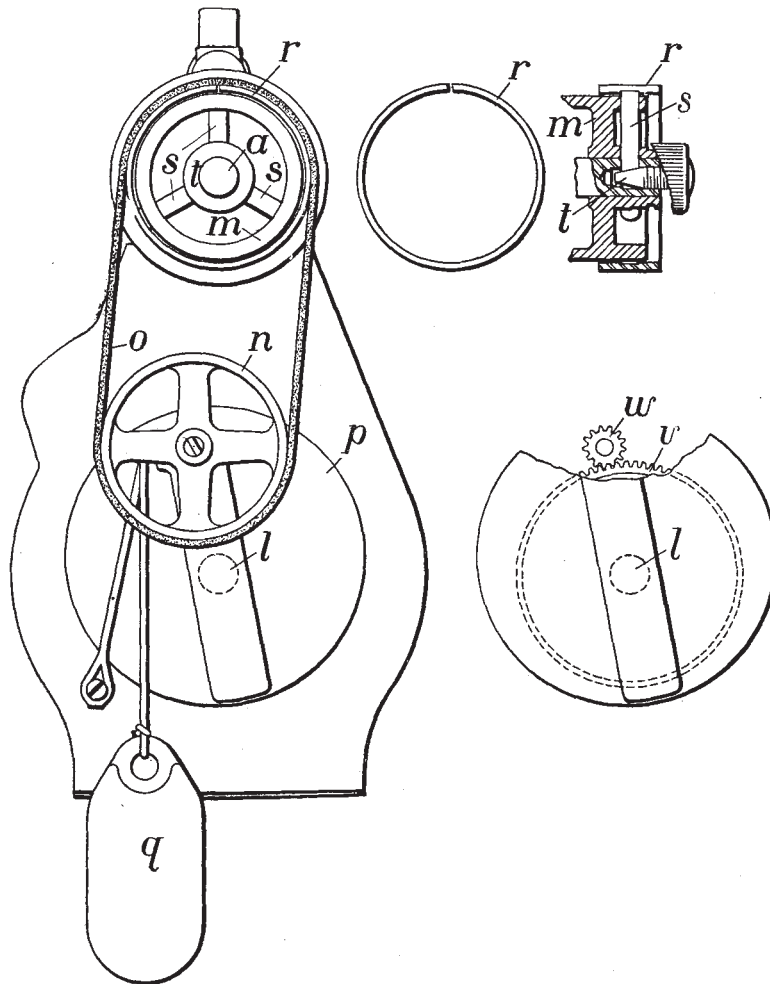
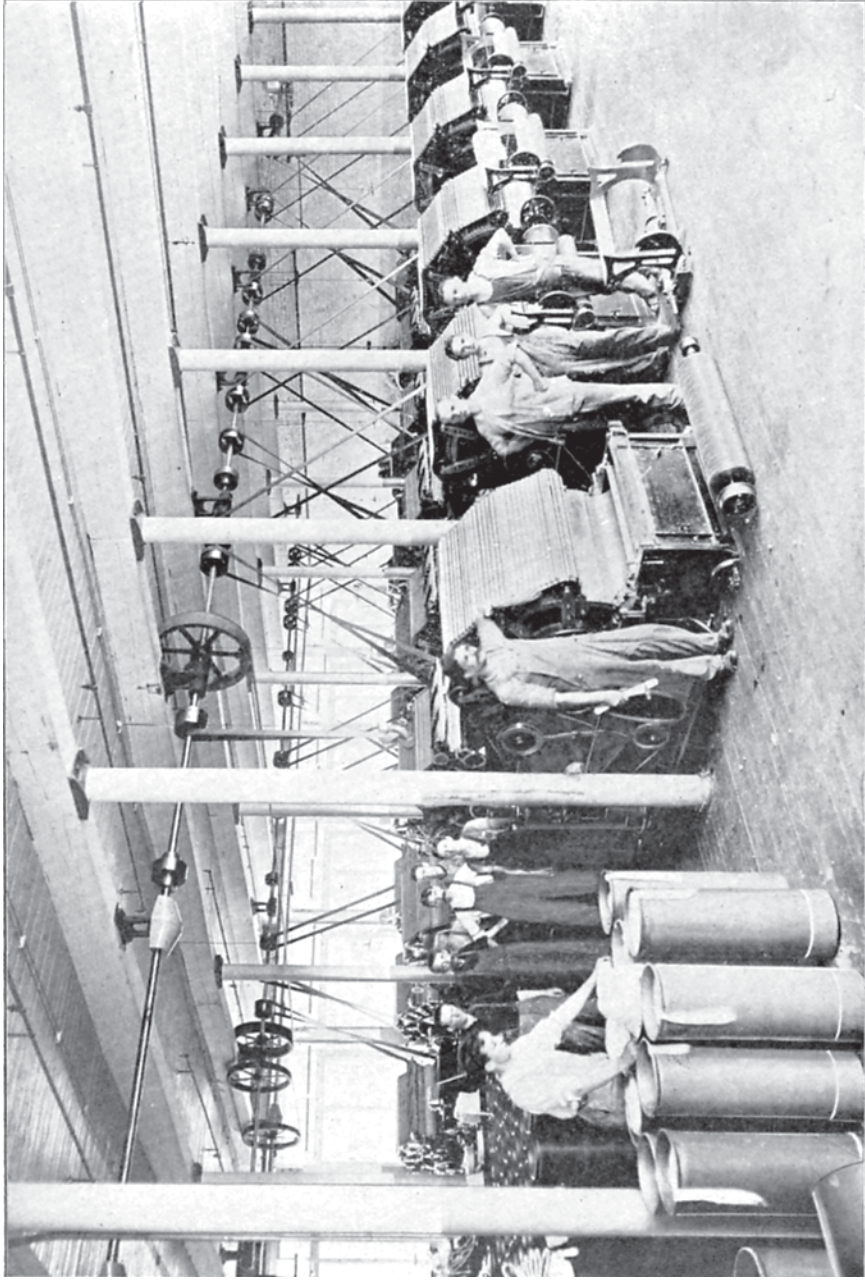


Fig. 37. Universal Gainer Mechanism.

rides," or leaving spaces between, forming one compact, uniform package from start to finish. The weight *q* holds the belt under uniform strain to insure accuracy at all times. The gear pinion *w* and the gear *u* are enclosed in a casing and run in oil, thus assuring



VIEW IN CARD ROOM SHOWING REVOLVING FLAT CARDS
Shaw Stocking Co.

durability and requiring less power. The top shaft *a* is oiled by means of the reservoir in the top of the frame, which automatically carries the oil through the bearings and returns it to the reservoir.

The threading of the machine and the arrangement of the tension is shown at Fig. 38, which is a sketch of a section of the front of the machine.

When starting the machine in operation, place the paper cone upon the spindle and draw the lever *x* forward towards the end of the spindle. This expands the holder and holds the cone tube firmly in place. The yarn is then drawn from the supply spindle at the base of the machine, and passed between the tension blades *d*, *d'*, over the pick-up bail *y*, and passed once or twice around the paper cone on the spindle. The guide *b*, supported by the swinging frame *c*, should be moved forward against the surface of the paper cone, as shown by the dotted lines in the cut, and the machine started into operation by pressing the lever *x* to the right.

It is essential that the guide rest against the surface of the cone, as otherwise the winding will be defective. It is not necessary to place the yarn in the groove of the guide, as the guide coming in contact with the yarn when the machine starts, will push it up the incline at either end of the pick-up bail and automatically thread itself.

Adjusting the Pressure. The frame *c* is pivoted on the cam shaft, and the lower end *c'* is counterweighted so as to bring the guide against the surface of the cone, while it is being wound with a slight pressure. This pressure can be varied for different classes of material by shifting the bent arm of the lever *f* in the holes *g*. The greatest pressure is obtained by placing the bent end of the arm in the lowest hole. For soft hosiery yarn, it is desirable to use the top hole, this giving the lightest pressure. Connected with the rod *f* is the lever *e* and a movable weight *j* on the lever. To increase the pressure of the guide against the cone, move the weight *j* toward the outer end of the lever. The softer and finer the yarn, the less pressure is required, and for knitting yarn, the pressure should be reduced to the least quantity.

Adjusting the Tension. The tension upon the yarn is regulated in two ways: The yarn passing between the series of blades *d-d'*, is deflected from a straight line by a slight pressure of the blades,

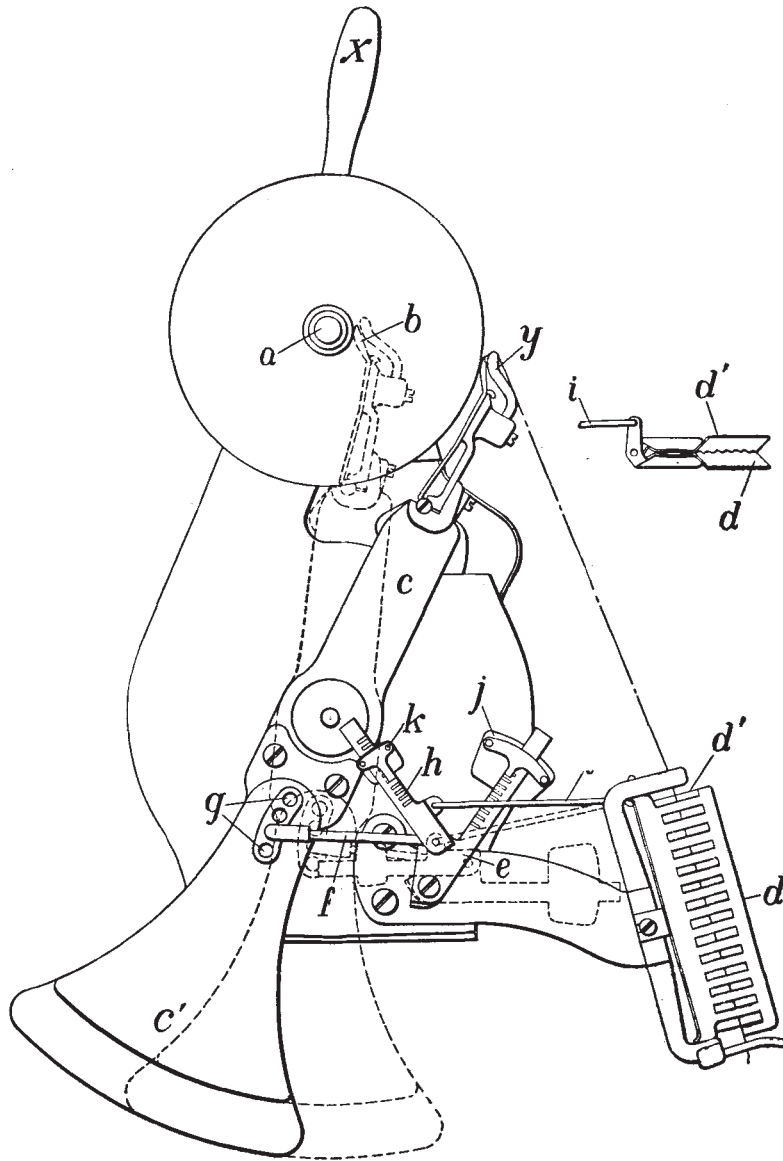


Fig. 38. Universal Differential Tension Mechanism.

and sufficient tension placed upon it to keep it in line for uniform delivery to the cone. On the lever h , which is connected to the movable tension blade d by means of the link i , is a weight k , which can be shifted to increase or diminish the pressure of the blades against the yarn. With the weight at its lowest position on the lever, there is a very light pressure of the blades against the yarn, on its passage from the supply cop, or bobbin, to the winding spindle. When it is desirable to break out soft spots in the yarn, the tension should be increased.

The Effect. When the machine is first started in operation with the paper cone bare, the frame c is in the position shown by the dotted lines, and the tension arms h , and e lie in nearly a horizontal position, thus giving the greatest pressure and tension at this point. As the cone increases in size, the guide is pushed back gradually, finally reaching the position shown in the sketch with the two levers raised nearer to a vertical position. The spindle speed of the machine being constant, there will be more and more yarn drawn on at each revolution until a full-sized cone is wound. The increase in speed in drawing the yarn through the tension blades increases the strain upon the yarn, if the pressure of the blades were to remain the same; but the change in leverage, as the guide moves back, automatically reduces the pressure of the blades to compensate for the increased rate of speed of the yarn, thus winding the outer coils of yarn under no more tension at high speed than inner coils are wound at a slow speed. By means of this differential tension, the machine can be adjusted to wind very soft twisted knitting or backing yarn with absolute uniformity.

The winding spindles should be run at a speed not to exceed 1,200 revolutions per minute, in winding soft spun yarn.

CIRCULAR RIB KNITTING MACHINES.

REVOLVING NEEDLE CYLINDER.

The type of this style of machine (Stafford & Holt) illustrated in Fig. 39, has the outlines usually followed by builders of these machines. It rests on four legs, secured to the bedplate A , which supports the housings Y and Z on opposite sides of the machine. These housing plates support the cam ring B in which the needle cylinder revolves, and on which the cam system for vertical needles

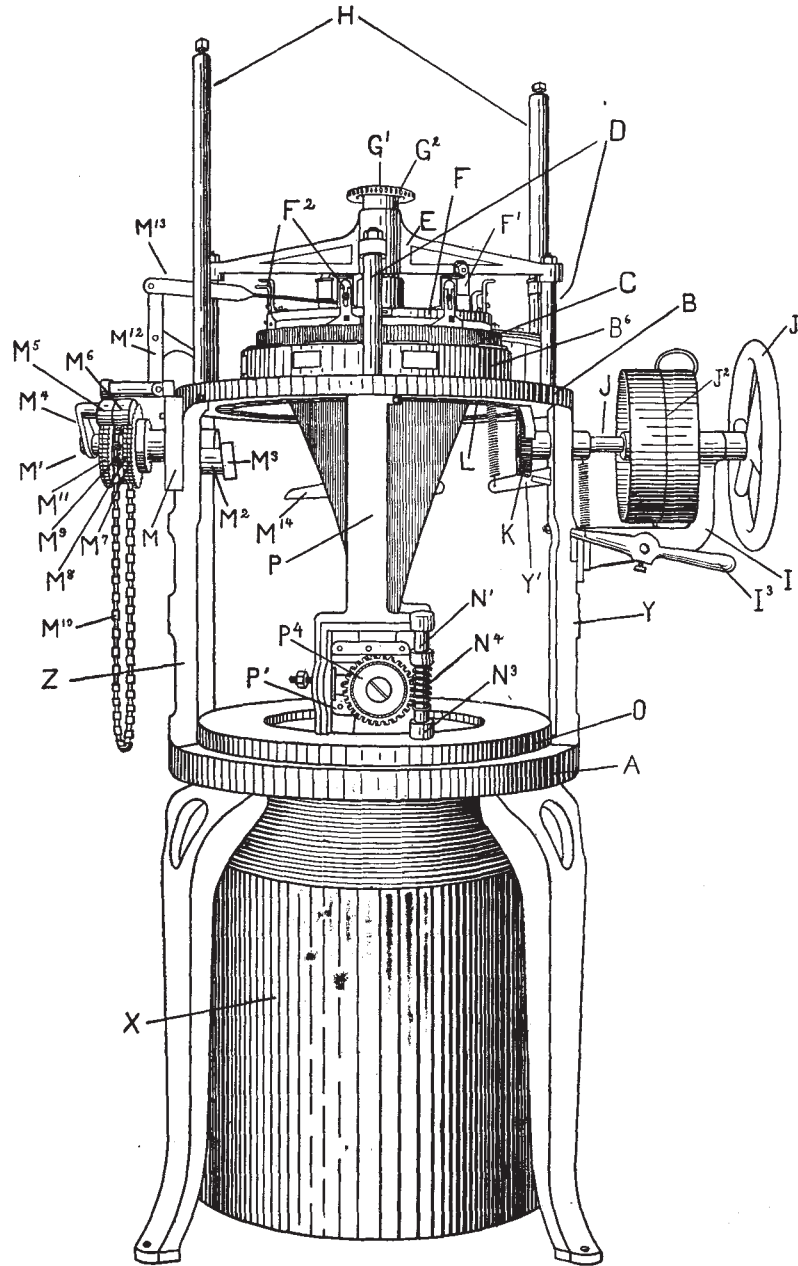


Fig. 39. Latch Needle Circular Knitting Machine.
Revolving Needle Cylinder.

is arranged. On this cam ring are secured four studs D, to support the dial arch E for holding up the cap, on which is arranged the cam system for the radial needles, and the dial. The bobbins are held on a frame, the supports H of which are secured to the cam ring also,

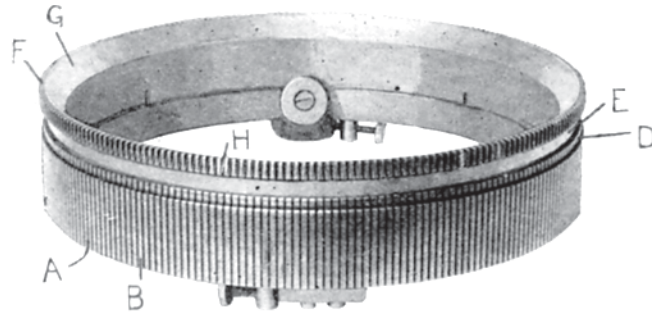


Fig. 40. Needle Cylinder.

To the right housing plate Y is secured the driving shaft bracket I, which makes the outer bearing for the driving shaft, and on the shaft J are tight and loose pulleys between the bearings. Outside the

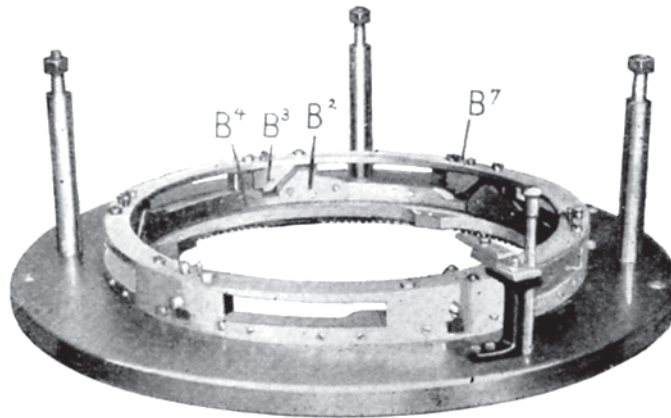


Fig. 41. Cam Ring.

shaft bracket bearing is a hand wheel J', for turning the machine by hand when occasion requires. Attached to the shaft arm is a belt shipper with belt and handle. On the shaft, inside the housing, is a bevel pinion K, which, meshing into the needle cylinder gear L, rotates the cylinder.

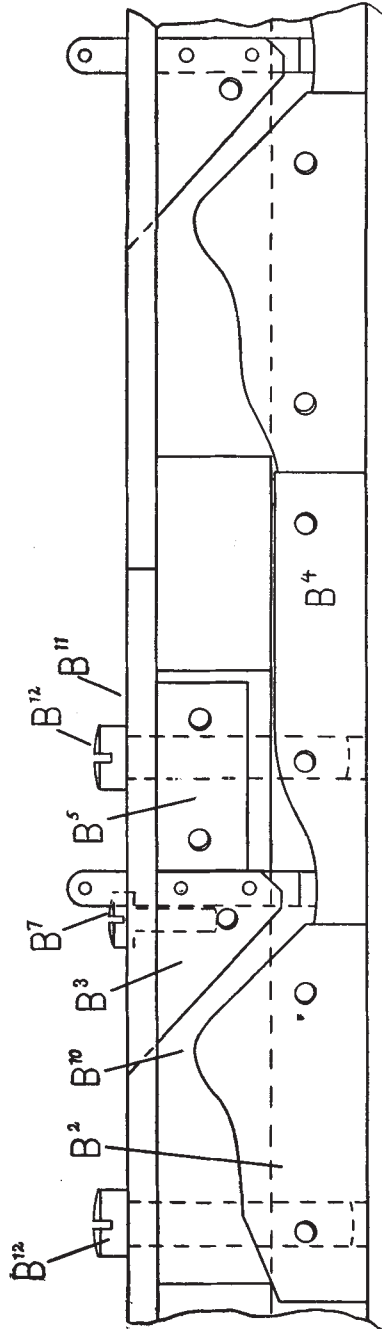


Fig. 42. Projection of Cam Ring Showing Disposition of Cams.

Needle Cylinder. (Fig. 40).

The cylinder needles are reciprocated vertically in slots in the periphery of the needle cylinders, as shown in the illustration. Needle cylinders are usually constructed from steel forgings of good quality, as the requirements are very severe; the needle walls or lands should be hard enough not to jam too easily, and yet not hard enough to break. The cut across the face of the cylinder for the needle, as at A, is generally called the needle slot; the part B, between the slots, is called the land, or sometimes, the needle wall. The slot is widened at the top, as at H, to clear the yarn when drawn into the slot by the needle. This widened part is often called the *sinker cut*. The grooves at D and E are called the gib, and clearance counterbores. The narrow radial face at F is called the top, and the adjacent face G, the bevel of the cylinder.

It is important that the cylinder be *perfectly concentric*, that the needle slots are exactly the same depth, accurately spaced, smoothly cut, and of such width that the needle slides freely back and forth without side play. The counterbore should be of such a depth that when the gib sets against it, the

needle just passes freely under it. The sinker cut should be smooth, of exactly the same depth as the slot, with the top edges of the cylinder and lands carefully rounded so not to cut the yarn when drawn through.

Cam Ring and Cams. Fig. 41 shows the cam ring and the arrangement of cams on its inner surface, but is more clearly illustrated in the projection of cam ring, Fig. 42. The cam B^2 is the rise cam;

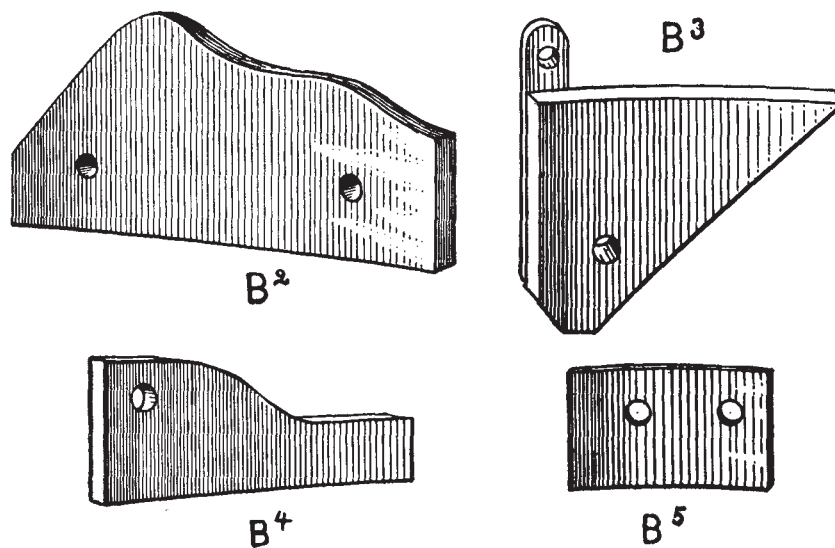


Fig. 43. Cylinder Cams.

B^3 the stitch cam; B^4 , the fill-in cam, and B^5 , the guard cam, all shown in detail in Fig. 43. These are all stationary except the stitch cam, which can be adjusted for slackening or tightening the stitch by means of adjusting screw B^7 . The stitch cam extends up into the gib, which is slotted to receive it, so that when it is pushed up or down, the extreme point is covered by the gib, and a needle that should happen to be drawn beyond its normal limit, will be forced into its proper position on striking this cam.

These cams are usually made of the best quality of tool steel and tempered very hard. Their working faces should be very smooth, and should come in contact with the needle close to the cylinder, which should be a nice running fit to the circle formed by the cams.

The first rise on the rise cam opens the needle latch, and should be long enough to get all the latches opened before reaching the yarn guide, but comparatively shorter than the rise cam on the dial. The stitch cam should be as steep as practicable, especially that part which actuates the needles from the time the yarn draws through the dial needles. One end of the fill-in or connecting cam is made low enough for the needle to pass around the stitch cam, and the other end high enough to return the hook of the needle about $\frac{1}{8}$ -inch above the cylinder top, for convenience in starting the machine, and also to assist holding the work in position on the dial needle when it starts to advance.

Needle Dial. Fig. 44 represents the needle dial. It is practically a duplicate of the needle cylinder, except the shape, which

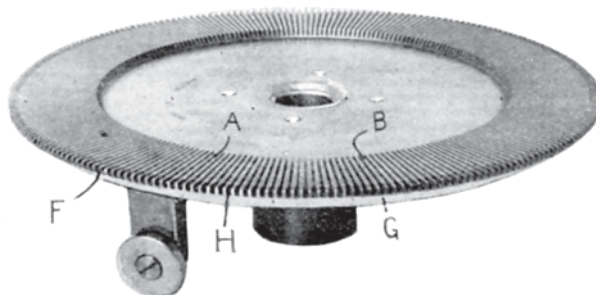


Fig. 44. Needle Dial.

is made to accommodate the radial needles, and the method of holding it in position. The corresponding parts of the needle plate are known by the same names as those of the cylinder. It is essential that the bore should be perfect, and be a nice fit on the dial shaft, in order that the upper surface with the needle slots will revolve perfectly true on the shaft.

Drivers. On the under surface of the dial are the drivers, usually placed diametrically opposite, abutting against a similar pair fastened to the inner surface of the cylinder. As the fabric is being knitted, it passes between a pair of these drivers, placed on each side of the machine, and as the whole strain of driving the dial needles against their cams is transmitted through them, it is essential that these drivers be very smooth, or preferably, that one or both be provided with rollers like those shown in Fig. 44. It is also necessary

that the needles in the dial and those in the cylinder, work in the center of space between the needles of the opposite plate, and as the fabric on the machine is varied in thickness, either the dial or cylinder drivers are made adjustable, especially in large machines. Fig. 40 represents a cylinder with adjustable drivers.

Dial Cap and Cams. The cams on the dial cap correspond closely to those in the cam ring, the shape being changed to suit their position. In Fig. 45, F^3 shows the rise cam; F^4 , the work cam; F^5 ,

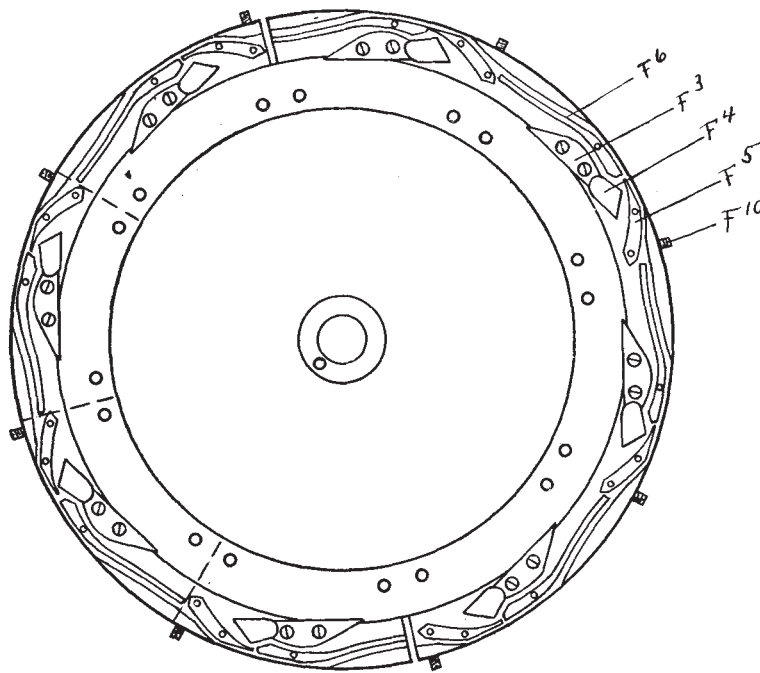


Fig. 45. Dial Cap.

the stitch cam, and F^6 , the guard cam, and their locations. Fig. 46 shows each cam in detail. On plain machines, cams F^3 and F^4 are often made in one piece corresponding to cam B^2 in the cam ring; but in automatic machines, the tuck stitch which widens the fabric is made by moving the outer point of the rise cam back to prevent the loop in the hook from slipping off the latch. The needle retains this loop in the hook, and on the next feed takes another loop, both

passing over the latch together, thus combining two cylinder stitches with one dial stitch.

The *dial* rise cam should start to push out the needle slightly in advance of the *cylinder* rise cam, as the cylinder needles are in a better position to assist in holding the stitch in position. The dial stitch cam is made adjustable to tighten or loosen the stitch, and should be of a shape that will not close the latches too quickly on the yarn that the cylinder needles are taking, but will complete the stitch as soon after as possible.

The *guard cams on both cylinder and dial* are used solely to prevent the needles getting misplaced. The yarn is fed into the cylinder needles, which draw it into the hooks of the dial needles, and the position of the two sets of cams in respect to each other is very important, as results can be varied widely by changing them. The above remarks in regard to cams have reference to underwear as generally made.

To vary the respective adjustment of the cam ring and the cap plate, the dial stop F^1 (Fig. 39) is provided, which is fastened to the top of the dial cap and has a set screw abutting against one of the arms of the dial arch. The dial shaft G^1 fastened in the arch, supports the cap and dial. This cap is fixed to the shaft by means of set screws in the hub and a stop on the dial cap resting against an arm of the arch. The dial is supported on the shaft by a collar secured to the shaft on which it revolves. The dial shaft with the cap and dial is adjusted vertically by means of the dial nut G^2 . The dial is rotated by means of two lugs in contact with lugs on the cylinder. The thread guides are fixed to the thread carriers which are fastened to the dial cap F .

On the under surface of the dial cap are arranged the cams for actuating the radial needles. These consist of the rise cams F^3 ; the work cams F^4 ; the stitch cams F^5 , and the guard cams F^6 . (See Fig. 45.) A set of these cams constitutes a feed for each thread used in the machine, excepting the stitch cams, which are adjustable for different stitches.

The Cap Plate, Fig. 47, represents the top side of the cap plate F and is the reverse side of Fig. 45. F^7 is the cap plate ring, to which are secured the cap plate straps F^8 , which move the cams, to which they are connected, in and out for the purpose described above.

In the ring F^7 is fixed a stud F^{10} to which is fastened the strap or connecting rod M^{13} (Fig. 39), which transmits motion from the automatic mechanism to the cams for changing the character of the stitch. The ring F^7 is fitted loosely around the hub F^{11} of the cap, and the plate straps are connected to the ring by means of the studs F^{12} .

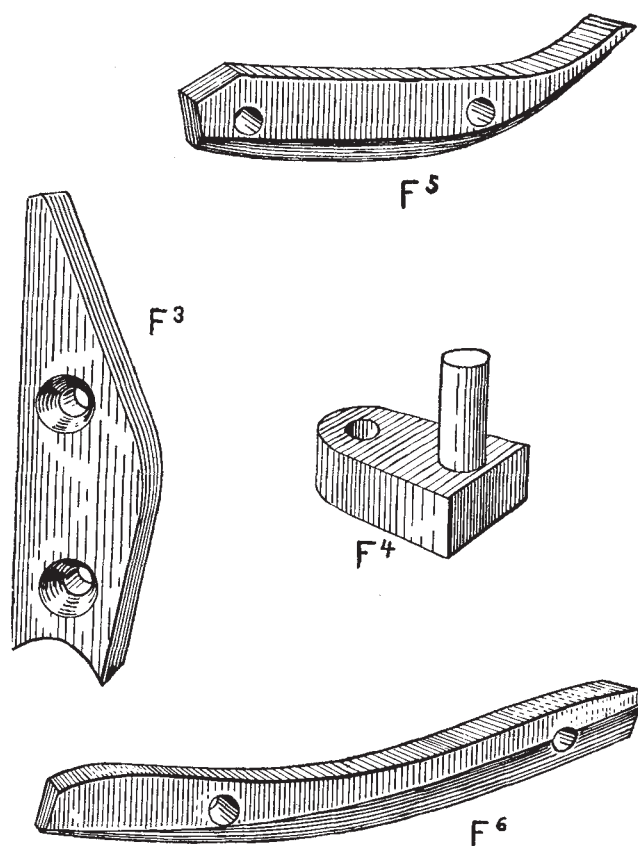


Fig. 46. Dial Needle Cams.

The several screws, heads and holes show the means employed to secure the cams on the reverse side. The cap is fastened to the dial shaft G^1 by means of set screws through the hub F^{11} .

Automatic Knitting Mechanism. On the automatic machine, the work cams are connected by a mechanism as follows: (See Fig. 39.) On the left housing plate Z is fixed the bracket M ,

in which is journaled the shaft. On the inner end of the shaft is the chain drive lever M^2 , with a stud roller M^3 , and on the outer end of the shaft is the pawl lever M^4 , carrying pawls M^5 and M^6 . The bracket M has a projection in which is the bearing of the shaft M^1 , and on the outside of which is journaled the idler ratchet M^7 nearest the machine. Outside of the idler ratchet is the chain ratchet M^8 ,

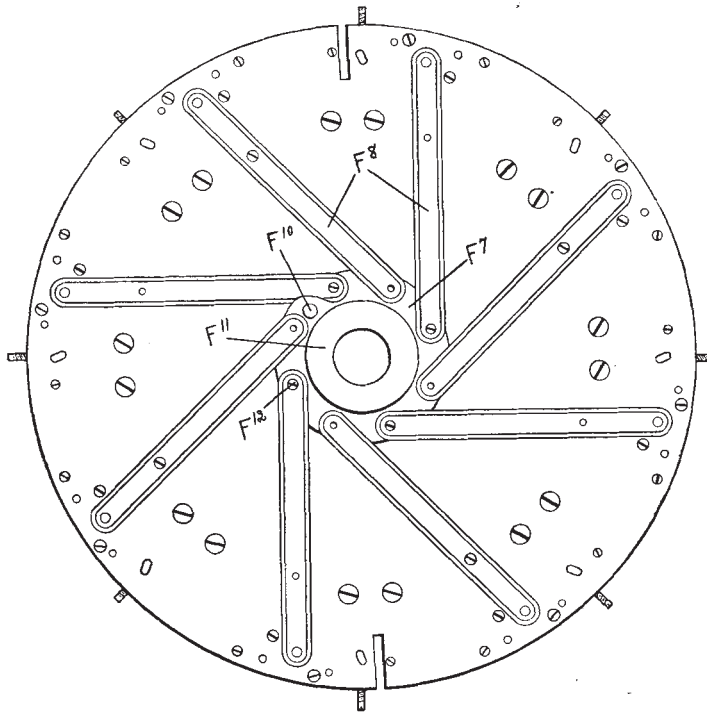


Fig. 47. Top Side of Cap Plate.

to which is fixed the sprocket wheel M^9 that carries the pattern chain M^{10} . Next to the chain ratchet is the cam wheel M^{11} , on the periphery of which rests the chain lever M^{12} , which is pivoted in the top of the chain bracket M . To the upper end of this bracket is connected a lever M^{13} that actuates the work cams in the dial cap by moving the cap plate ring F^7 , the motion being transmitted by the cap plate straps F^8 , which are connected by pins to the work cams, thus moving them in and out, as predetermined by the lugs on the pattern chain. The pattern chain is operated by the cam M^{11} on

the take-up arm, which raises the chain driver lever each revolution, and by means of a pawl lever, moves the chain ratchet and sprocket ahead one tooth, unless prevented by the idler ratchet, which permits the pawl to engage the chain ratchet only as predetermined.

The Take-up. (Fig. 48.) To the bedplate A is fixed the bedplate gear N, enclosed by the gear case O, which revolves on the bed-

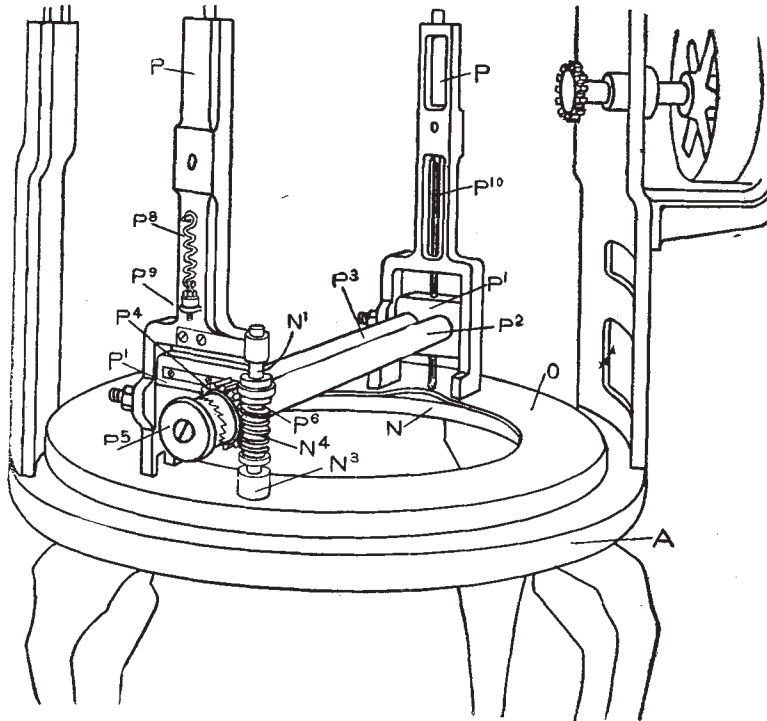


Fig. 48. Frame and Take-up.

plate, which carries a bearing for the pinion shaft N^1 , on the lower end of which is a pinion N^2 , meshing with the bedplate gear N . On the pinion shaft is fixed a single-toothed clutch N^3 , and a worm N^4 , journaled on the same shaft. The take-up arms P are supported on top of the gear case, the upper ends being in the cylinder gear L , by means of which the take-up mechanism is rotated. In the take-up arms are loosely fitted the bearing blocks P^1 in which are journaled

the take-up rolls P^2 and P^3 . The rolls, which are fluted, are geared together at one end, and are held in yielding contact with each other by means of coil springs in adjustable blocks with set screws on both ends. At the opposite end of the drive roll P^2 is journaled a worm gear P^4 , provided with a clutch P^5 feathered on the shaft and driven by the worm N^1 on the worm shaft, Fig. 49. The worm is supported by the arm P^6 , fixed to the take-up bearing P^1 . At the lower end of the worm is a projection to engage clutch N^3 .

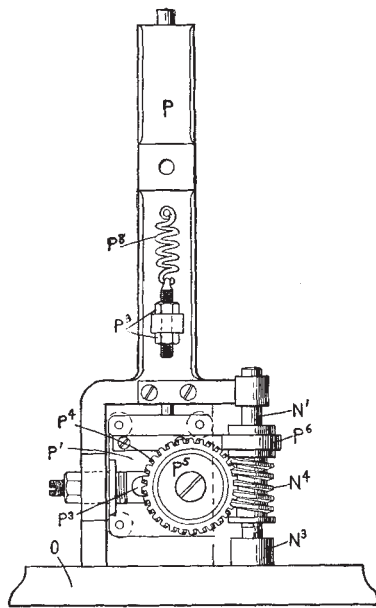


Fig. 49. Detail of Take-up.

The bearings P^1 have a certain amount of vertical movement, and by means of the arm P^6 , carry the worm N^1 up or down. This movement is sufficient to disengage the worm from the clutch N^3 and when the shaft N^1 turns freely in the worm, no movement is transmitted to the take-up rolls; but when the bearings are lowered, so that the worm engages the clutch, motion is transmitted through the worm and worm gear, by means of clutch P^5 , to the take-up rolls, and the fabric introduced between them is drawn away from the needles. It will be seen from the description that the motion of the take-up rolls tends to raise them and that they must have sufficient weight to keep the required

tension on the goods. The coil spring P^8 and adjusting nuts P^9 are provided to regulate this. They can be attached to the rods P^{10} and made to increase the tension on the fabric, or turned around and attached to the take-up blocks directly, and adjusted to diminish the tension.

Bobbin Rack. Fig. 50 represents the bobbin rack. H is a casting with a hub, in the bore of which is held, by means of a set screw, a rod H^1 extending upward two or three feet and downward a few inches. At a distance from the center sufficient to give the required amount of room, a number of pins H^2 are set concentric

with the hub, and outside these another circle of the same number are similarly arranged. The bobbins are placed on these pins. On the upper end of the rod H^1 is fastened a hub H^6 in which are drilled as many radial holes as there are bobbin pins, and extending from each of these holes is a yarn hook H^3 of sufficient length to bring the center of each hook directly over its corresponding pin and bobbin. Also on the rod H^1 , one above and one below rack H , are two guide discs H^4 and H^5 , each drilled near its edge with as many holes as there are bobbin pins.

Automatic Stop Motion. Drive-bracket I , as shown in Fig. 51, is an angle casting, having at one face a foot which is secured to housing Y . On the other face is a boss, through which is a bearing registering with the bearing in the boss on the housing. Through this bearing extends the shaft J , having at one end the bevel pinion K and at the other the hand wheel J^1 . Between the bearings are the drive pulleys J^2 . In the bottom of the bracket is provided a bearing transversely to the drive shaft, through which is the small shaft I^1 , on one end of which is the belt fork I^2 , and on the other end, the handle I^3 . The casting which forms the

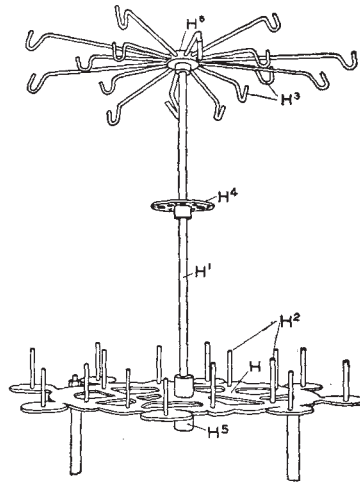


Fig. 50. Bobbin Rack.

handle extends on the opposite side of the shaft far enough to reach through the housing Y and engage the trip Y^1 . A coil spring Y^2 is adjusted to raise this projection of handle I^3 , and a coil spring Y^3 is attached to trip Y^1 , tending to hold it in contact with I^3 . The shifter fork and handle are fastened to shaft I^1 in such a position that the normal action of the coil spring Y^2 is to hold the belt on the loose pulley, but by raising the handle the belt fork shifts the belt onto the tight pulley, and the extended portion of the handle catches under the end of the trip by action of spring Y^3 and is held in this position until the trip is depressed far enough to clear the handle,

when spring Y^2 returns the belt fork and shifts the belt to the loose pulley.

Hole and Bunch Detector. Fastened on top of the cam ring, directly over the end of trip Y^1 (Fig. 51), is the needle protector bracket Y^6 , provided with latch Y^7 and finger Y^8 . Through the top of the bracket is a bearing which is also carried through the bedplate. In this bearing slides the plunger Y^9 , having on top a small handle or knob, and near its top, a channel or cross cut. This plunger is provided with a coil spring tending to force it downward, in which posi-

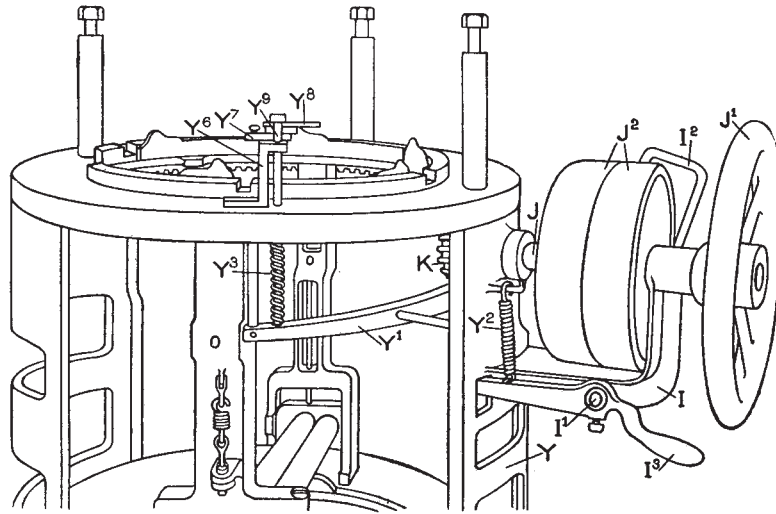


Fig. 51. Top Frame and Driving.

tion it rests on top of trip Y^1 . The finger is fastened to the latch so that when its inner end stands between the paths of the ends of the cylinder and dial needles, just beyond the point where the stitches are formed, the channel in the plunger can be rested on the latch, the plunger having been drawn up beyond the trip. In this position, it does not interfere with the running of the machine in any way, but should a lump gather on the needles, or some other imperfection cause a needle to rise slightly above its normal position, the finger is caught, swung around and away (carrying the latch) from the plunger resting on it, and the spring causes it to descend, striking the trip and stopping the machine.

In Fig. 52, B represents the cam ring of the knitting frame, C the cylinder and F the dial. Y⁶ is the cast-iron bracket fastened to the cam ring by screws through the angle post; Y⁹ is the plunger in which is cut the recess or channel Y^{9x}, into which one end of the swivel bar Y⁷ rests in its normal position. The pivot of the swivel bar is on the stud screw Y¹⁰. On the top side of the swivel bar is the hole and bunch detector Y³ made of thin spring steel, and fastened thereon by means of screws Y¹¹ and Y¹². Y¹¹ screws down tight and secures the detector in position. The offset in the feeder or detector Y⁸ provides an arrangement whereby a vertical adjustment in relation to the work

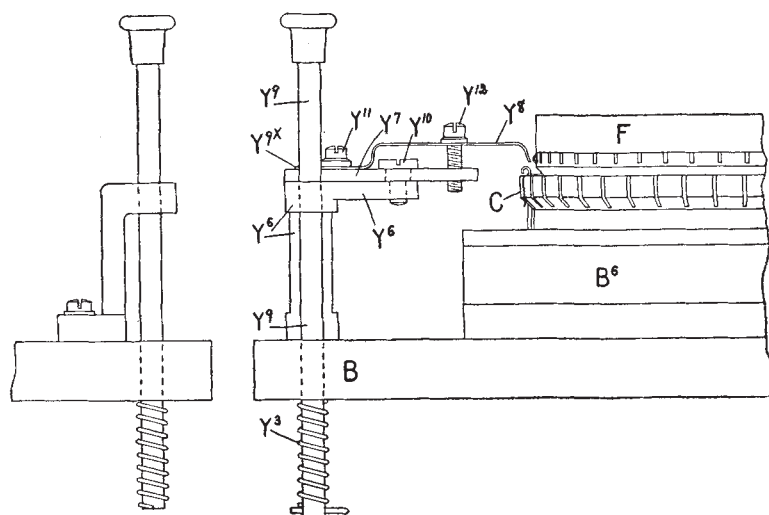
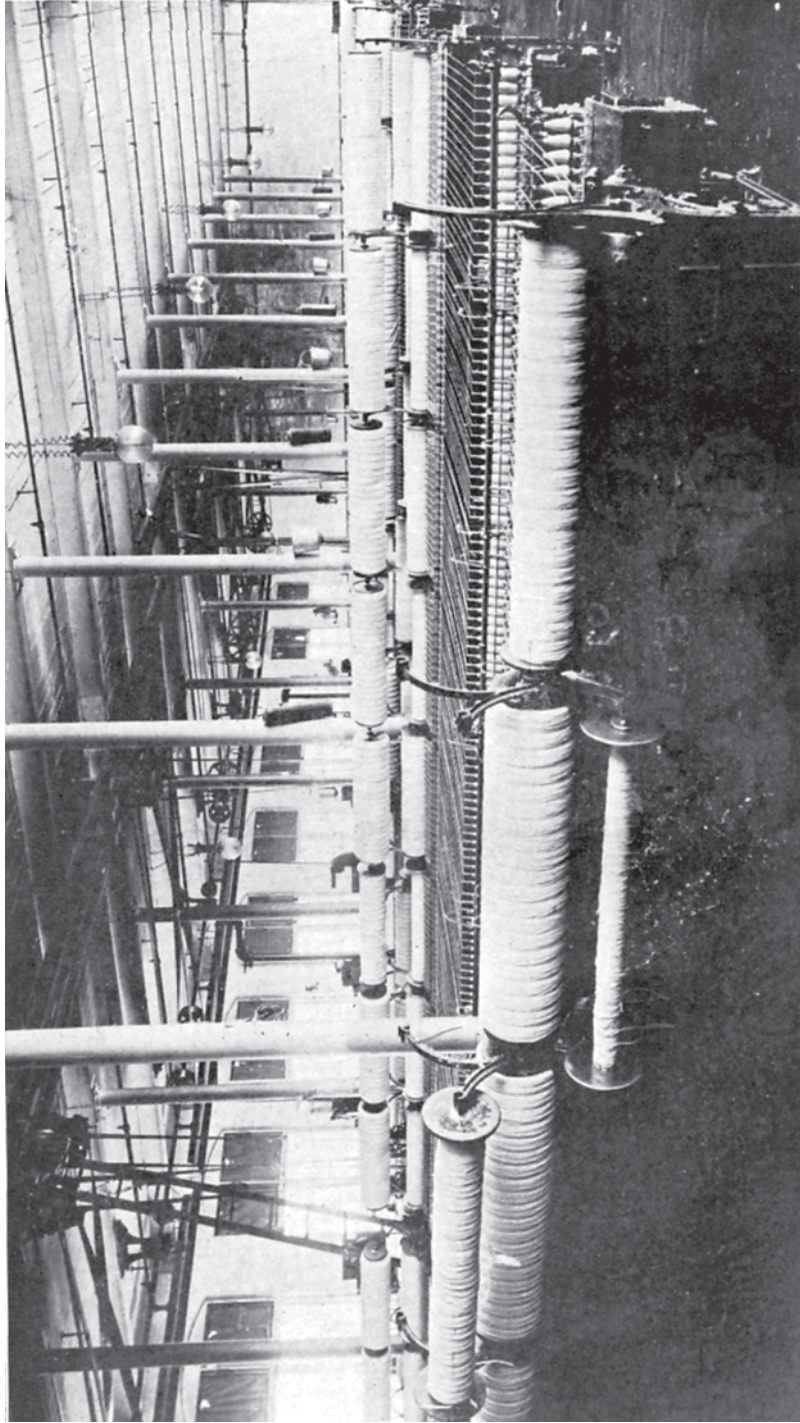


Fig. 52. Hole and Bunch Detector.

may be obtained by means of the adjusting screw Y¹². Normally, the detector rests with one end in the recess Y^{9x} and the other between the paths of the ends of the needles at the point where both sets of needles have just completed their stitch. If, however, a needle is misplaced, by reason of a bunch or hole, it will strike the inner end of the detector, and turning it on its pivot Y¹⁰, throw the other end out of the recess in the plunger Y⁹, releasing the plunger. This permits the spring Y³ to force down the plunger to strike the trip Y¹ (Fig. 51) with sufficient force to release the belt shifter and stop the machine.



WOOL SPINNING ROOM SHOWING MULES
Utica Knitting Co.

The Yarn Guide. Fig. 53 represents a yarn guide. A represents the shank in which is a slot to fasten it to the guide carrier C, which is fastened to carrier plate D, which, in turn, is fastened to the dial cap by means of screws through slots D. The part a^1 is known as the point, and part a^2 , as the heel of the guide. This should be of such shape and so set that the point will prevent the open latches from closing until the stitch is safely enclosed in the hook, the point being bevelled so that a partly opened latch will be forced open without bending it. The heel also is usually bevelled, principally to avoid interfering with the hook of the dial needles.

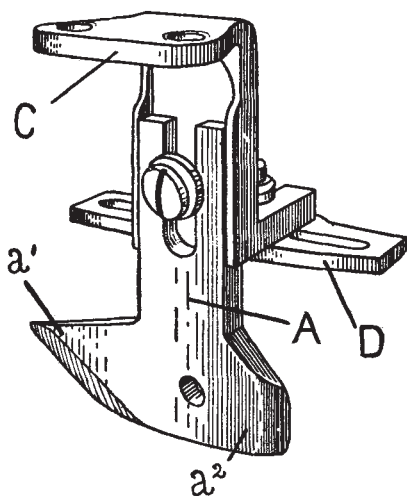


Fig. 53. Yarn Guide or Carrier.

The Needles. The cylinder needle, Fig. 54, is longer in the stem than the dial needle, being longer to admit of the various stitches made on it. In Fig. 54 are given the names of the parts of both cylinder and dial needles, though the names differ slightly with different makes, and the style or shape varies according to the position of the cams in the various other types of these machines.

Formation of Stitch. It is the function of the cams to actuate the needles in proper time to form the stitch. Their action and that of the attendant mechanism

must be closely studied to acquire ability to run as tender yarn as possible, and obtain a maximum of perfect web with a minimum of needle breakage and other expenses. The formation of the loop should be thoroughly understood, and is described as follows: As the needles advance on the rise cams, the loops in the hooks open the latches, slipping over them into the throats, and the cylinder needles, on striking the stitch cams, take the thread from the thread guide. On drawing the needles back, the loops in the throats sliding under the latches, close them, thereby holding the thread in the hooks, and pass over them, clearing the needles and casting off onto the thread held in the hooks, in this way forming the new loops.

This method of stitch forming is shown in the diagrams I, II., III., and IV. in Figs. 55 and 55"; C representing a section of the cylinder and G a section of the dial, each with needles in about their relative

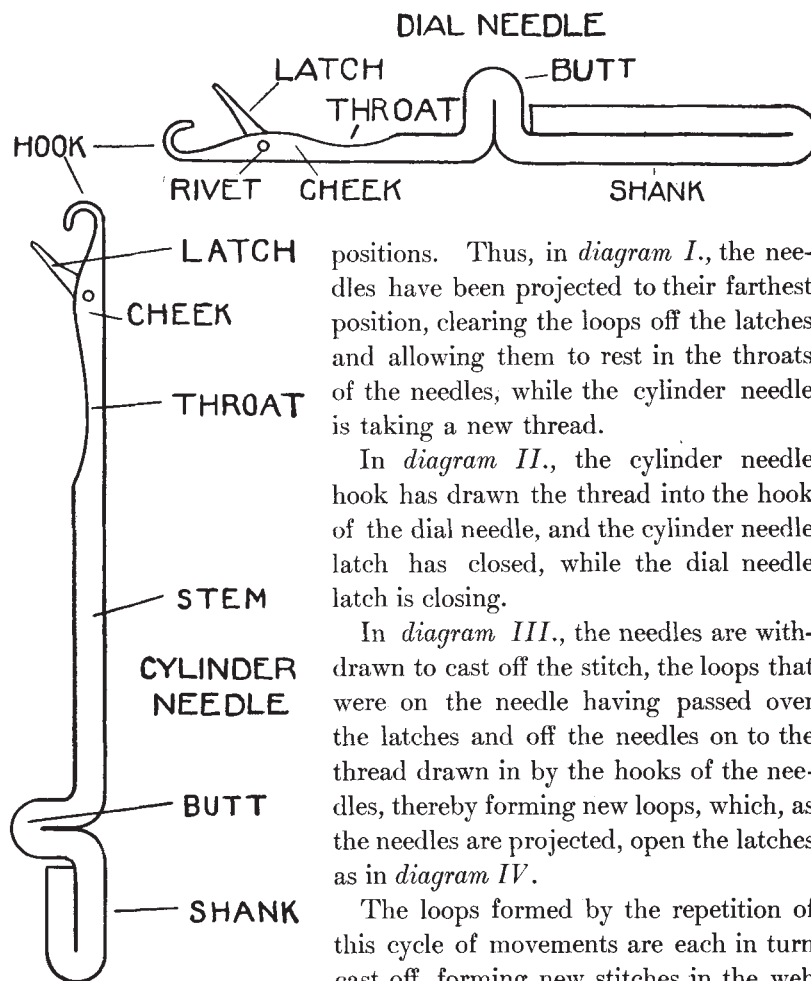


Fig. 54. Stafford and Holt Needles.

positions. Thus, in *diagram I.*, the needles have been projected to their farthest position, clearing the loops off the latches and allowing them to rest in the throats of the needles, while the cylinder needle is taking a new thread.

In *diagram II.*, the cylinder needle hook has drawn the thread into the hook of the dial needle, and the cylinder needle latch has closed, while the dial needle latch is closing.

In *diagram III.*, the needles are withdrawn to cast off the stitch, the loops that were on the needle having passed over the latches and off the needles on to the thread drawn in by the hooks of the needles, thereby forming new loops, which, as the needles are projected, open the latches as in *diagram IV.*

The loops formed by the repetition of this cycle of movements are each in turn cast off, forming new stitches in the web as long as the machine is in motion and yarn properly supplied to the needles.

Starting up the Machine. Before starting up the machine, turn it slowly by hand with the hand wheel, and see that the needles are working freely in the slots; that none of them are bent or broken,

or have stiff or defective latches; that the mesh of the needles is good, *i.e.*, with the dial needles coming out a trifle behind the center of the spaces between the cylinder needles; that the cylinder and dial are turning freely and true; that the two sets of cams are timed correctly (on most work so that the hook of the cylinder needle would just grasp the rivet in the dial needle latch, were it extended sufficiently); that there is sufficient room for the fabric to pass between dial and cylinder, and that the stitch cams of each feed are set to cast off the stitch perfectly.

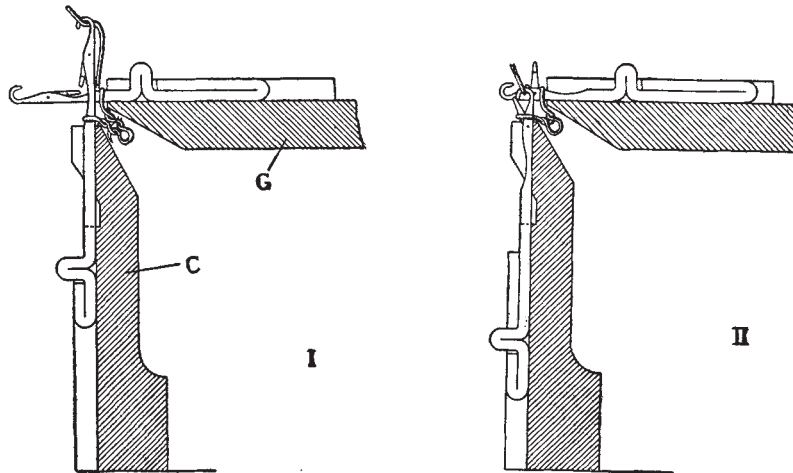


Fig. 55. Diagrams of Stitch Formation, I and II.

The *guides* should be carefully examined to see that they are perfectly smooth and set to deliver the yarn into the hooks of the needles, and yet not touch the needles. The heel should be set close to the point where the cylinder latches close, but must not interfere with them. The point must be close enough to the needles so that a cylinder needle latch, flying out horizontally, will not go behind it, and wedging in, become bent. The guide must be low enough so that the free end of the dial latch cannot clear it in its outward movement, and, flying up, lose the stitch. This trouble is also liable to occur if the two sets of cams are not properly timed.

The *take-up* should be examined to make sure that there is sufficient tension to take the goods from the needles nicely, and that there

is sufficient recoil in the contact of the rolls to allow the bunch where the fabric is started, or similar imperfections, to pass without clogging.

The machine may now be threaded up by placing the spools of yarn on their respective yarn hooks h^3 (Fig. 50), thence through holes in guide discs h^4 and h^5 to a hole in the top of the carrier. When this is completed for each thread, turn the machine so that the cylinder and dial drivers come opposite where the cylinder needles are resting on the fill-in cam, and insert the upper end of fabric between them. Hold it there with the left hand, and with a hook or needle held in the right, catch hold of the fabric as near the end as possible, and draw it up through the space between the cylinder and the dial, slipping it

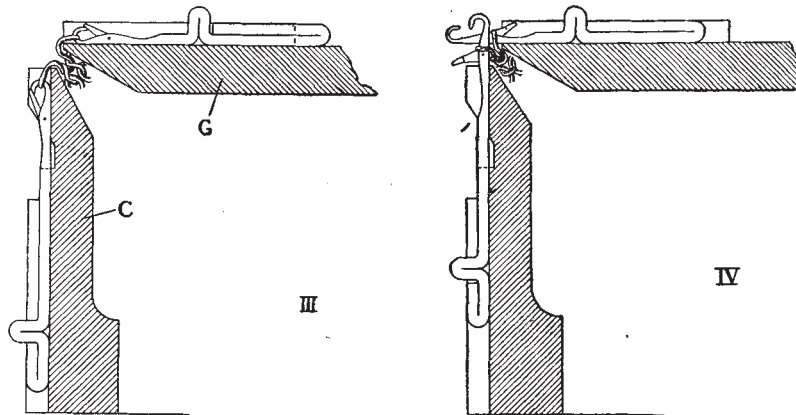
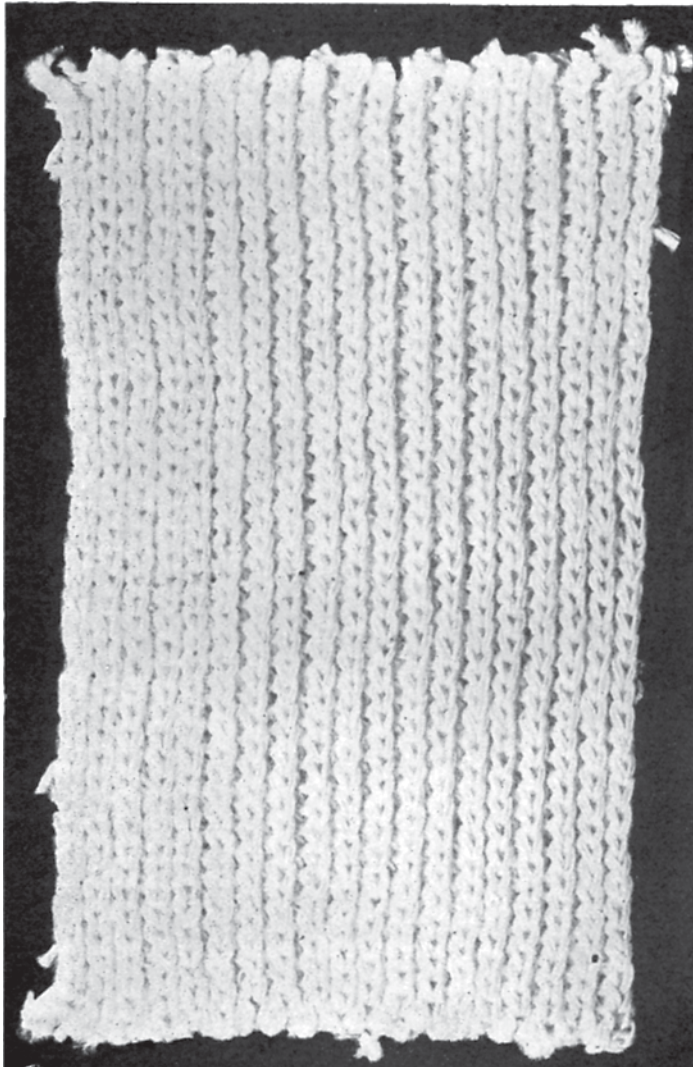


Fig. 55A. Diagrams of Stitch Formation, III. and IV.

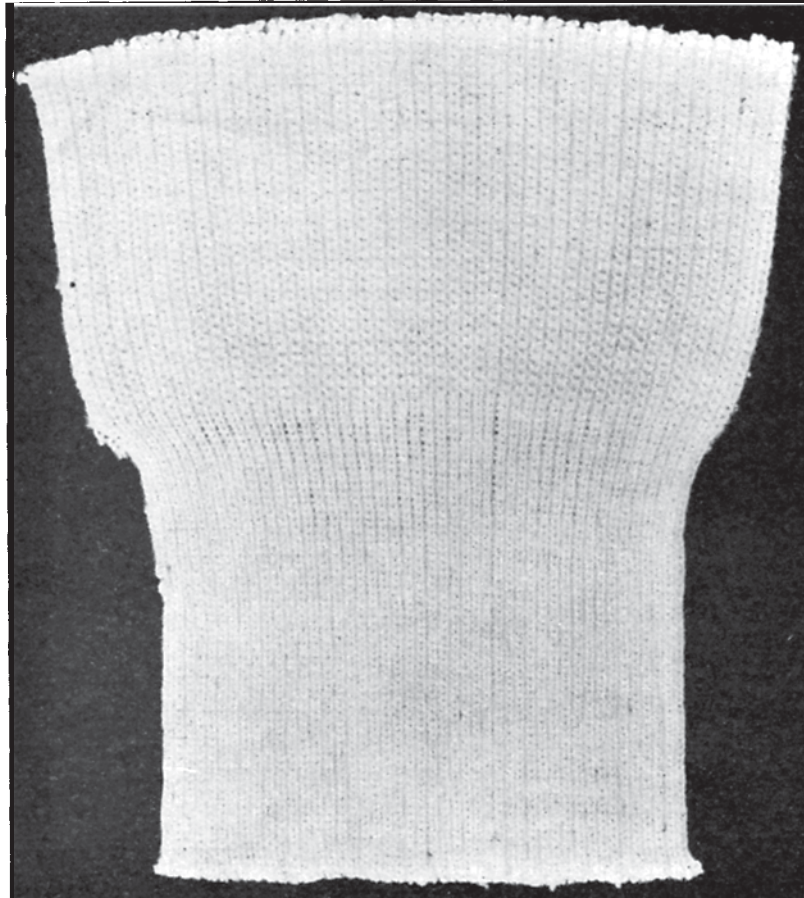
over and on to the hooks of the cylinder needles. Turning the machine slowly and at intervals, by the hand wheel, draw the end of the fabric onto all the needles as they come into position, until the needles with the fabric hooked on come to a yarn guide, then pass the end of the yarn through the hole in the yarn guide and into the hooks of the needles.

The loops are formed at this point, and knitting begins as the operation of turning and hooking on the fabric is continued. Be careful to start each thread as soon as the fabric hooked in the needles reaches a yarn guide, and to draw the fabric through the second pair of drivers as they are reached; continue hooking on and threading up until the fabric is hooked on the needles all around the machine.



One-and-One Plain Ribbed Goods Slightly Stretched. Coarse Gauge.

Now introduce the other end of the fabric between the take-up rolls, and put on sufficient tension to hold the fabric on the needles and prevent a pull-off.



Cuff of Ladies' Vest.

When turning the machine during the hooking-up process, use the left hand to exert a tension on the fabric similar to that which the take-up exerts when in action. This "run on" portion is cast off by the needles with more or less difficulty, according to how closely, loop for loop, the fabric has been picked on. The machine should be

turned slowly until all latches are carefully opened, dropped stitches picked up, and damaged needles replaced.

When this has been accomplished, look over the adjustment of the yarn guides; the adjustment and timing of cams, and the adjustment of take-up, as at this stage of operation adjustments can be more carefully made. Then start the machine by power, watching carefully to see that all the parts are doing their work properly.

On an automatic machine, it is perhaps best to start on the plain stitch, then start the chain, and when it changes to tuck stitch, stop the machine, looking over each dial tuck feed carefully to see that the cams are advancing the needles far enough to catch the stitches, but not far enough to allow any to slip over the latch and thus out of the hook. Then proceed to even the stitch, which is usually done when the machine is on the plain stitch, by carefully looking over the dial cams and setting them to draw the needles into the dial the same

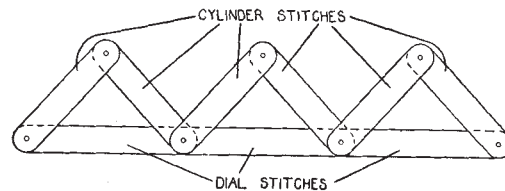


Fig. 56. Link Chain, Simile of Tuck Stitch.

distance or as nearly as possible; then mark each thread at an equal distance from its respective guide, and turn the machine by hand. Note which threads arrive at the guide first; make the required changes of cylinder stitch cams, so that all the marks will arrive at the guide at the *same time*, which will sometimes require several changes. If using white yarn, it can readily be marked by placing one end of a scale at the hole in the guide, and grasping the yarn at the other end of the scale, slightly twisting it between the thumb and forefinger of the other hand, somewhat soiled with the oil oozing from some bearing. If dark yarn, use powdered chalk for marking. Care should be used that the length of yarn measured off should be as long as convenient, and the length accurate at the same tension.

To Shorten or Lengthen the Stitch. A small set screw B^7 , Figs. 41 and 42, bears against the stud which holds the stitch cam in the cam ring. By means of this set screw, the stitch cam may be

adjusted up or down. The stitch cam B^3 is riveted to a spline, for which there is a key seat in the cam ring. This serves as a guide for the cam. Turn the set screw B^7 *in* to slacken or lengthen the stitch,

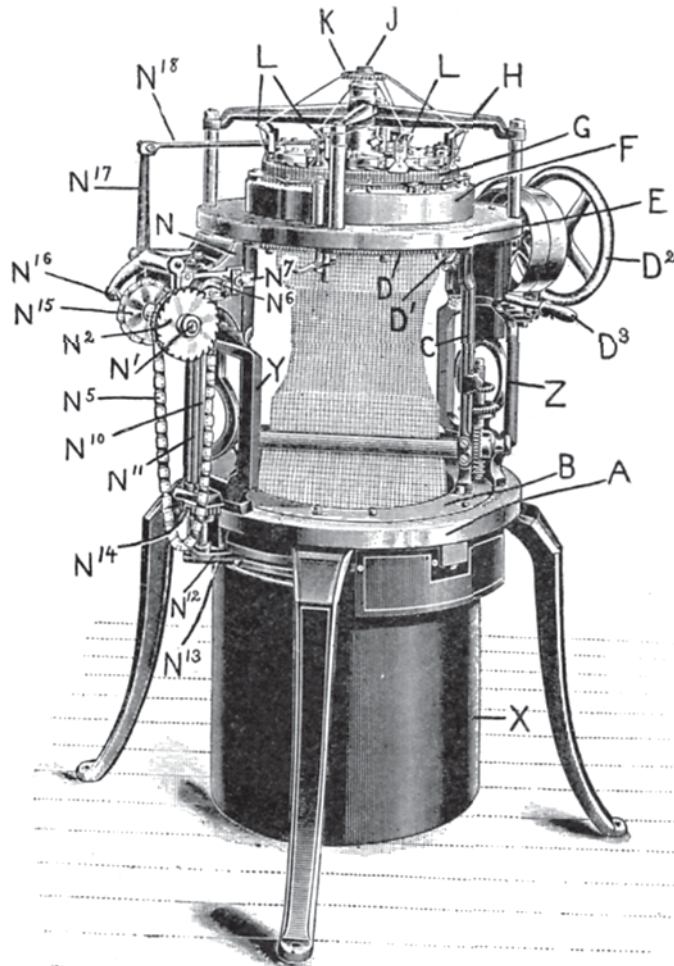


Fig. 57. McMichael and Wildman Machine. Revolving Needle Cylinder.

and turn it *out* to tighten or shorten. The dial cam is adjusted in a similar manner, by means of the set screw F^{10} , shown in Fig. 45. Turn the set screw *in* to lengthen, and *out* to shorten or tighten the stitch.

The stitch is also adjusted by raising or lowering the dial and cap by means of the dial arch nut G^2 . (Fig. 39.) Raising the dial slackens or lengthens the stitch, and lowering the dial tightens or shortens the stitch. This is similar in effect with that obtained by adjusting the cylinder cam B^3 .

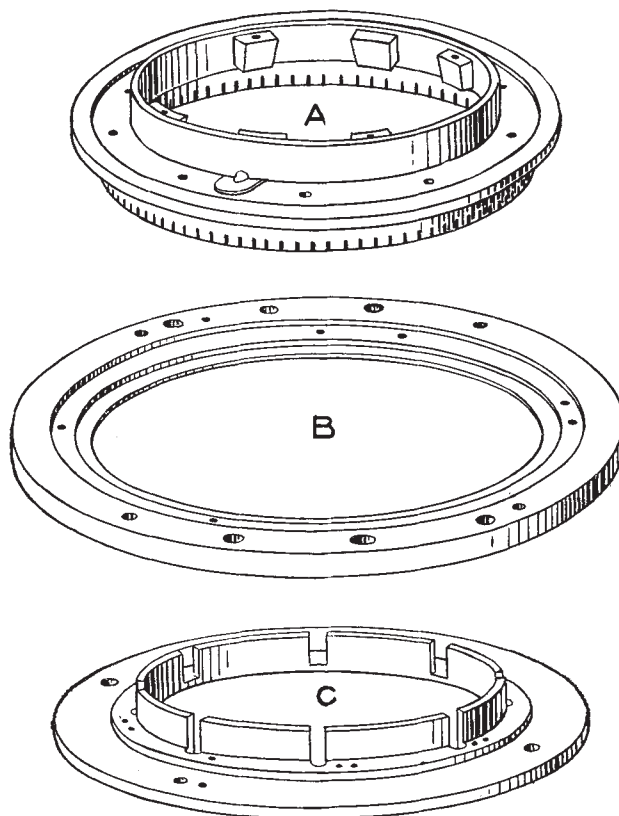


Fig. 58. A, Gear Ring. B, Head Ring. C, Cam Ring.

To Remove a Section of Cylinder or Dial. The upper part of the cam ring, or what is generally termed the section ring, Figs. 39 and 41, and also the cylinder gib, is divided into as many sections as there are feeds on the machine, and each section is held in place by two screws, B^{12} , shown in Figs. 41 and 42. A cylinder section may be removed by loosening these screws. On the dial cap,

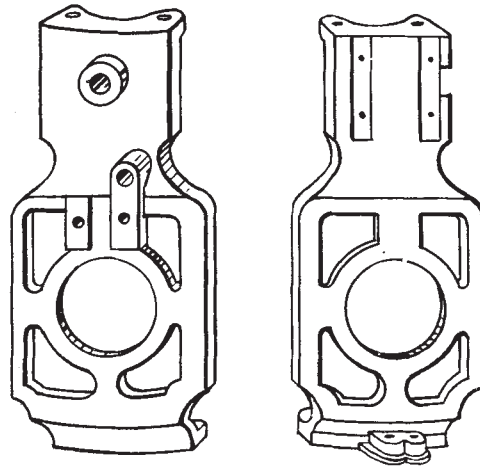


Fig. 59. Housing Plates.

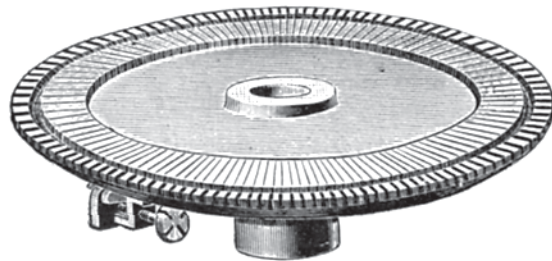
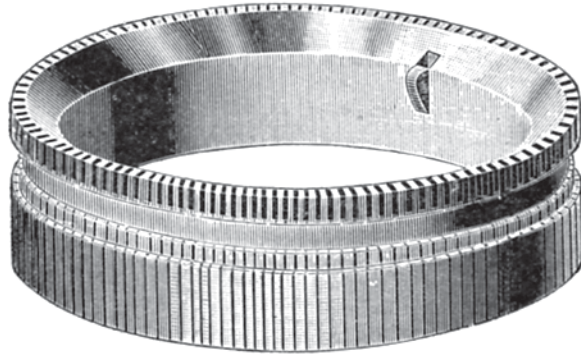


Fig. 60. Dial and Cylinder.

the top ring can be divided as indicated by the three broken lines in Fig. 45, and each section will be held by two screws, the bottom of which also show in Fig. 45.

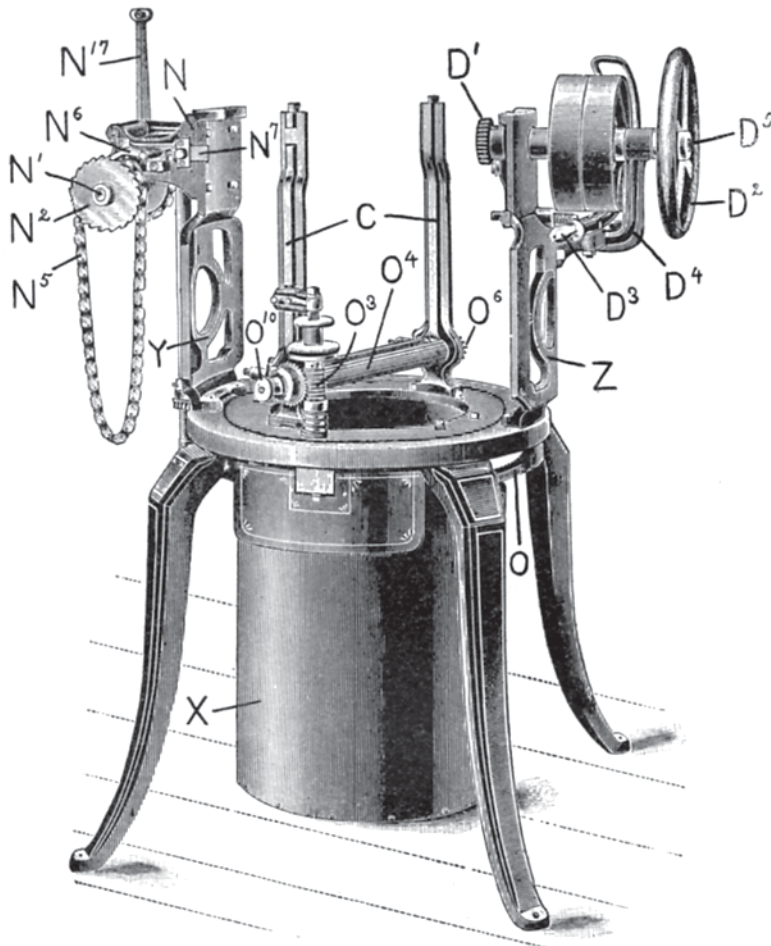


Fig. 61. Frame and Take-up.

Loading up the Needles. If anything goes wrong when the machine is running, the yarn begins to load up near the top of the needles. If a hook or a latch bends, or a butt cuts off, or lumps or other imperfections occur on the needles, it can, as a rule, be detected almost instantly by the load on the needle, which causes the stop

motion to act immediately. About the only imperfection that does not cause a load is an occasional dropped stitch or the head of a needle cut clean off. As these have no stitch on to hold them in place, they usually jump up and are caught by the stop motion. If the butt of the needle is entirely broken, the needle remains stationary and will not throw off its loop, but the needles on either side will accumulate yarn, and if not discovered, will soon cause two or more needles to be broken at either the hook or the latch. Twits in the yarn coming into needles running at high speed, break, causing the needles to jump, and, falling back, become wedged under the cams.

A **Tuck Stitch** makes a wider web, because more yarn is employed in making the stitch. The tuck stitch and plain stitch may be

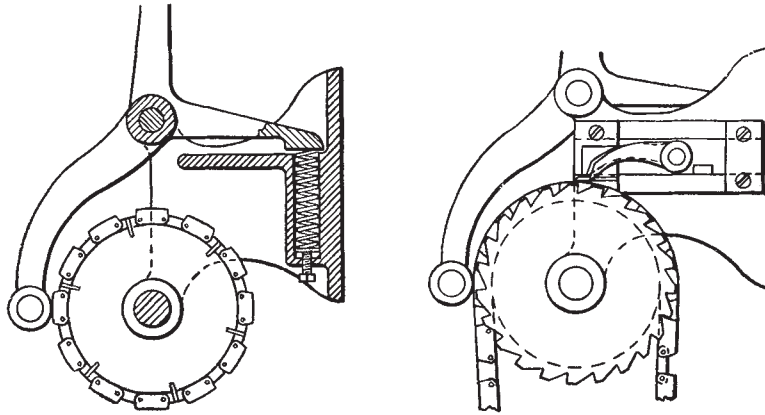


Fig. 62, Detail of Cam Controlling Mechanism.

likened to link chains, the plain stitch resembling the chains drawn out parallel or straight. The tuck is formed like fastening two links of one chain into each link of the other, as per Fig. 56. Unlike the chain, the yarn is not rigid, and seems not only to draw up and thicken the fabric, but also, because of the nature of the stitch formation, to spread it out wider.

To Make a Loose Course. A loose course is a single stitch of more than normal length, extending completely around the web or fabric. It is employed at certain points in the web or fabric where the rib fabric is looped on to another fabric, as a cuff or border on a balbriggan shirt, or rib top on a stocking or sock, and is usually made

by depressing one of the cylinder stitch cams for exactly one revolution of the machine.

To Make a Welt. A welt is a hem in the fabric and is used for a finish similar to a selvedge edge that will not ravel. It is made

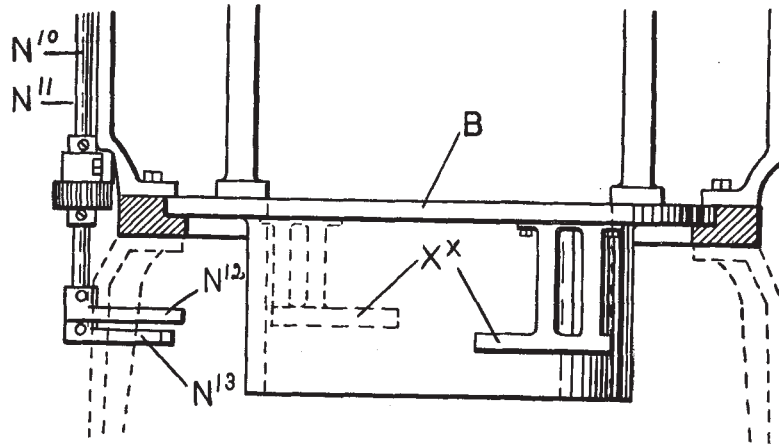


Fig. 63. Cam System for Actuating Automatic Mechanism.

by preventing one set of needles (usually the dial needles) from taking the yarn or casting off their loops for a certain number of courses, while the other set continues to knit a flat fabric. When the

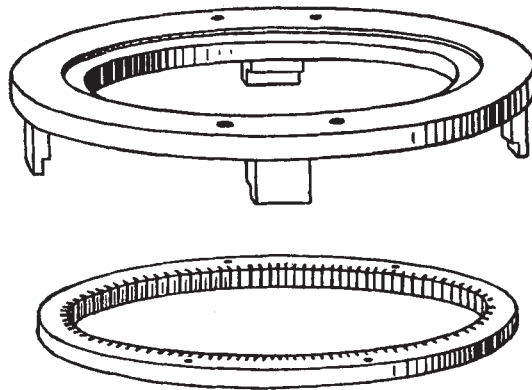


Fig. 64. Base and Gear.

first set is thrown into action, having retained the stitch from where the other set began to make single fabric, this loop is cast over with

the last loop made by the cylinder needles, joining both ends of the single fabric and making a perfect hem.

A welt is usually limited to *four or six courses*, unless special provision is made to hold down the fabric made by the single set of needles, as the stitch on the dial needle prevents the take-up from exerting its normal tension, while the single fabric is being knit. The more courses, the more bulky will the welt become, making it pass with difficulty between the cylinder and dial, unless provision is especially made to facilitate it.

Some of the variations in the style of this type of machine (Revolving Needle Cylinder) are herewith explained.

The frame illustrated in Fig. 57 (McMichael & Wildman Machine) has the same general outlines common to all circular rib

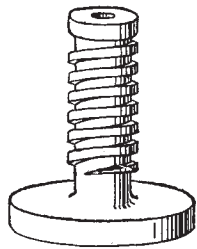


Fig. 65. Worm.

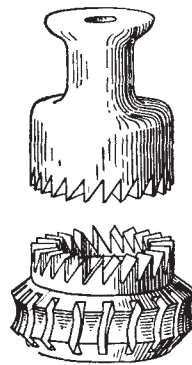


Fig. 66. Clutch and Worm Gear.

knitting machines. Four legs support the annular base frame A, which is machined to guide the take-up plate B, and connected by the take-up standards C C to the rotating bevel gear ring D (See A, in Fig. 58). This is seated in the stationary *bedplate* or head ring E (B in Fig. 58), supporting the stationary cam ring F (C in Fig. 58), and in this cam ring the vertical needle cylinder G is mounted in condition to rotate. On the base A is mounted the housing plates Y and Z (Fig. 59), which support the bedplate E. From the cross-tree H, supported on the bed ring E, depends the rotary needle dial I on the center stud J, on which it rotates, held up in position by a collar fastened to the lower end of the stud. Above the needle dial

(See Fig. 60) a stationary cam dial is suspended, fixed to the center stud by set screws. These dials may be raised or lowered, when adjusting the plane of the horizontal or dial needles in relation to the plane of the vertical needles in the cylinder by turning the hand wheel

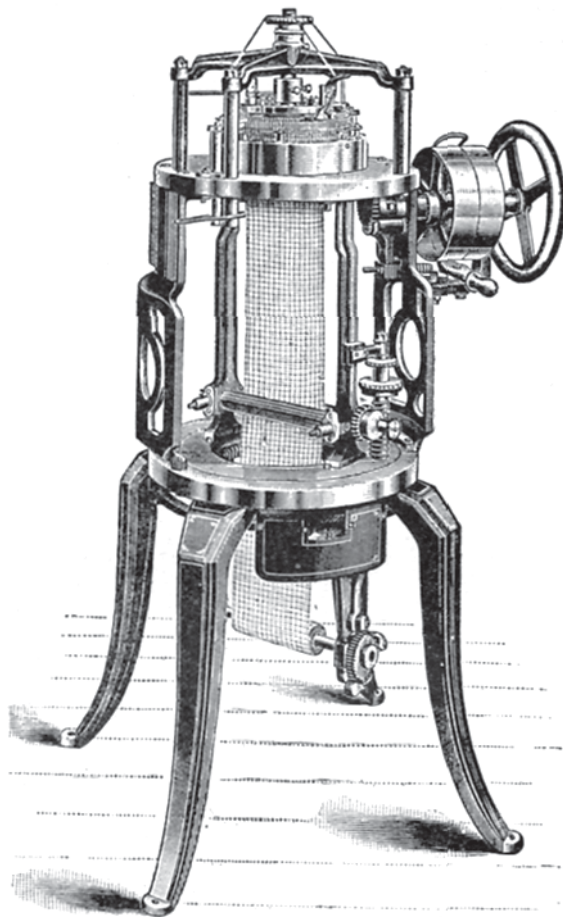


Fig. 67. Plain Machine with Fabric Roll in Place of Can.

K. The thread guides L are fixed to the stationary cam dial in a manner to properly present the thread to the needles at points where the dial needles are operated by the cams.

The bevel gear ring D receives its motion from the spur gear D¹, which is fixed to the driving shaft D⁵ (See Fig. 61) and on which are tight and loose pulleys. The shaft D⁵ is mounted at the inside end in a bearing in the right housing plate, and at the outer end in a bearing in the bracket D⁴ fixed to the same housing. The power is transmitted by a belt, which may be shipped from one pulley to the other by means of the shipper D³. The hand wheel D² is fixed to the driving shaft for use when the needle cylinder is required to be turned slowly for replacing needles, repairing, cleaning, etc.

The Chain Actuating Mechanism. This mechanism on the left of the frame (See Fig. 57) is for the purpose of automatically

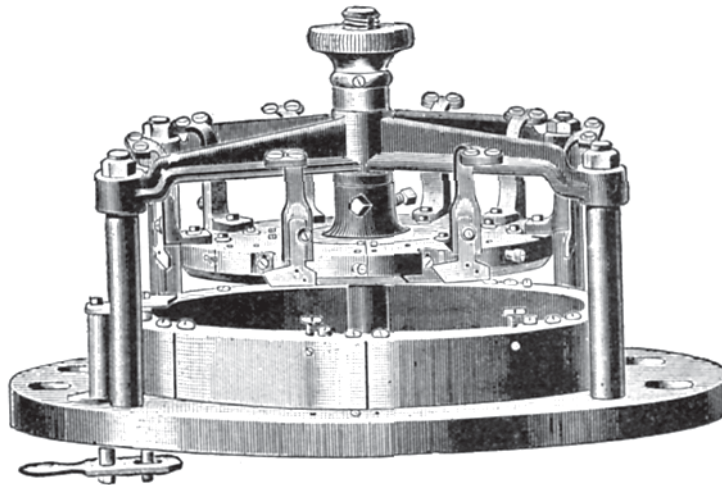


Fig. 68. Body Machine Head.

operating the movable cams of the cam dial plates, to move the needles farther out, or to draw them in, to narrow or widen the fabric for shaped goods. In the bracket N, fixed to the left housing, is a shaft N¹ on one end of which is fixed a ratchet wheel N² and back of this wheel is a sprocket wheel, or pattern chain wheel, secured to another ratchet wheel, both free to revolve on the shaft. The sprocket carries the pattern chain N⁵ and receives its motion by means of the pawl N⁶ connected to the slide N⁷. A larger view of this is given at Fig. 62. This slide is moved back and forth in its guide by the levers fixed on the upper ends of the upright shafts N¹⁰, N¹¹ (Fig. 63). At the lower



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ends of these shafts are secured arms N^{12} and N^{13} , which are acted upon by the cams X, secured to the rotating take-up plate B. These upright shafts are geared together at N^{14} (Fig. 57), so that when one is acted upon by its cam, the other turns in an opposite direction, and *vice versa*; this short reciprocating motion imparts to the pawl, through its connections, the required movement to actuate the ratchet wheel and move the shaft N' .

On the left end of the shaft is fixed a toothed disc N^{15} on the periphery of which rides a roll N^{16} , secured to the lower arm of the elbow lever N^{17} (See also Fig. 62). By this means, motion is imparted through the connecting rod N^{18} , to the pivoted dial cam, when the pattern chain permits the pawl to engage the ratchet wheel which is fixed on the opposite end of the shaft.

Operation. As the needles are carried round by the rotary needle dial and cylinder, they are operated by the respective cams to take the thread and form the fabric in the usual manner. The character of the fabric produced is governed by the pattern chain, which is carried on the sprocket wheel, operated in the manner described. The operation of the needles continues in a uniform manner as in plain knitting, or otherwise, until a notch in the pattern chain comes under the pawl, when the latter immediately operates the ratchet and shaft with its wheels, and in the manner described, moves the cams, and thus draws the needles in or out, as the case may be, and correspondingly changes the character of the fabric produced. When the cams have been so changed, the needles continue to operate in the same manner until the next notch in the pattern chain passes under the pawl, when they are moved back, and correspondingly change the extent of the movement of the needles and the character of the fabric produced.

Worm Gear Take-up. The take-up or tension rolls are driven by a worm gear arrangement. Fixed to the projection on the under side of the annular base is a stationary internal gear O (Fig. 61). The take-up mechanism is fixed on the rotating take-up plate B and as it turns, the pinion gear fixed to the lower end of the worm shaft and meshing into the stationary internal gear (Parts shown in Fig. 64), causes the worm O^3 , Fig. 61 (also shown at Fig. 65), to revolve and impart motion to the fluted take-up rolls O^4 and O^5 . These are journaled in the take-up standards C C and the knitted fabric passing

between them is held firmly enough to maintain the required tension on the fabric, between the take-up rolls and the needles. The driven

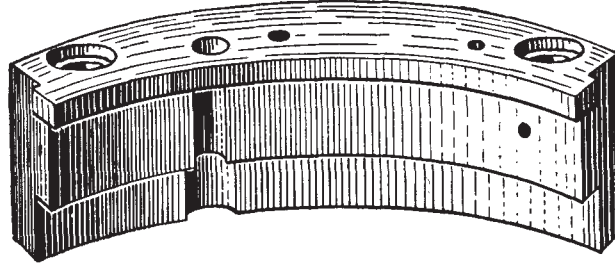


Fig. 69. Cam Ring Section.

take-up roll O^5 is geared at O^6 to the driver roll O^4 at the opposite end from the worm gear, Fig. 66, and is journaled at each end in sliding blocks, guides being provided for that purpose in the take-up stand-

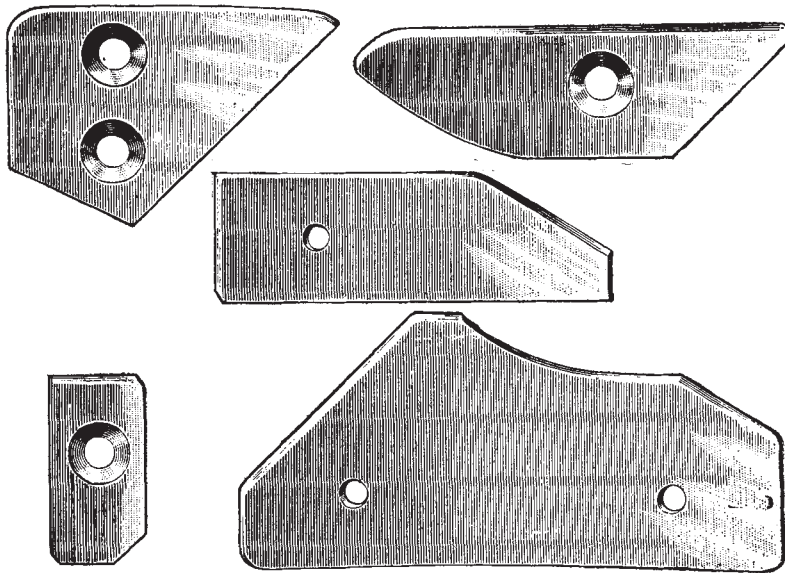


Fig. 70. Cylinder Cams. Full Size.

ards. These blocks and guides are so arranged that a yielding pressure is maintained on the frame by means of coil springs confined in sleeves fixed on the side of the take-up standards and against each block.

The worm gear is loose on the driving roll and is provided with a clutch, Fig. 66, feathered on the driving roll in such a manner that when the clutch is pulled away and disconnected from the worm gear, the rolls are at rest, leaving the worm gear free to revolve on the shaft. The worm shaft pinion gears vary in size according to size or diameter of the frame. Underneath the frame is can X, which receives the fabric during the knitting, and which is attached to and revolves with

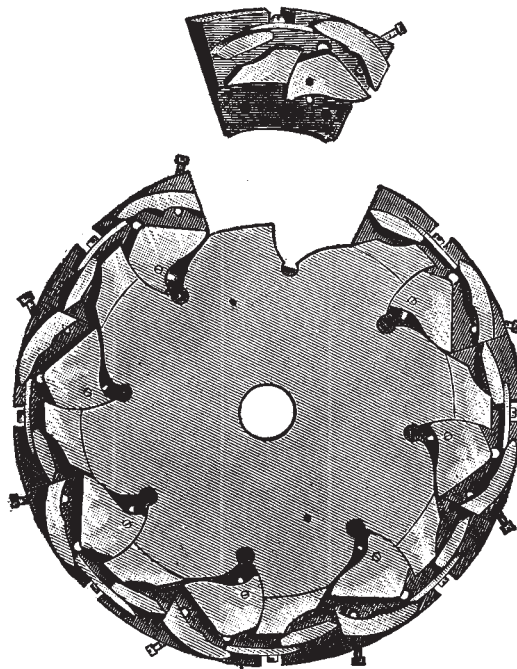


Fig. 71. Cam Dial with Section Removed.

the take-up plate. A fabric roll is often used in place of the can, and the fabric rolled up as shown in Fig. 67.

Head and Cam Ring and Cam Dial Plate. Fig 68 represents a plain body machine head, without the needle cylinder and needle dial, and more clearly represents the position of the sectional cam ring, the cam dial cap, the cross-bar, the thread guides and the manner of holding and adjusting the cam dial cap in position. These parts are all stationary. The sectional cam ring consists of an arrangement of the cam ring in a number of sections, corresponding to

the number of feeds on the machine, so that each section may be removed, exposing all the needles covered by that section when necessary for repairs, cleaning, etc. Fig. 69 shows a section of the cam ring, inside view, and Fig. 70 shows the cylinder cams, full size, those attached to the cam ring and actuating the cylinder needles.

Fig. 71 represents the under side of the sectional cam dial and a section removed. The sectional dial cap is divided in a similar way

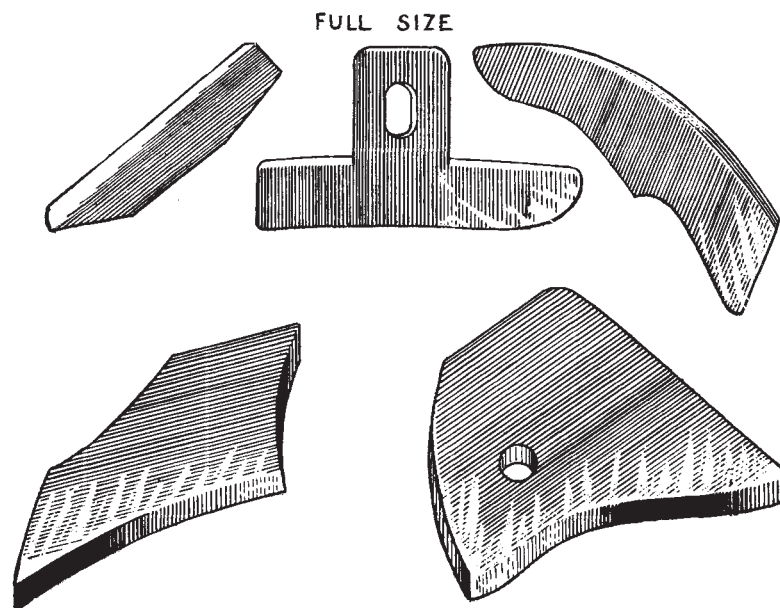


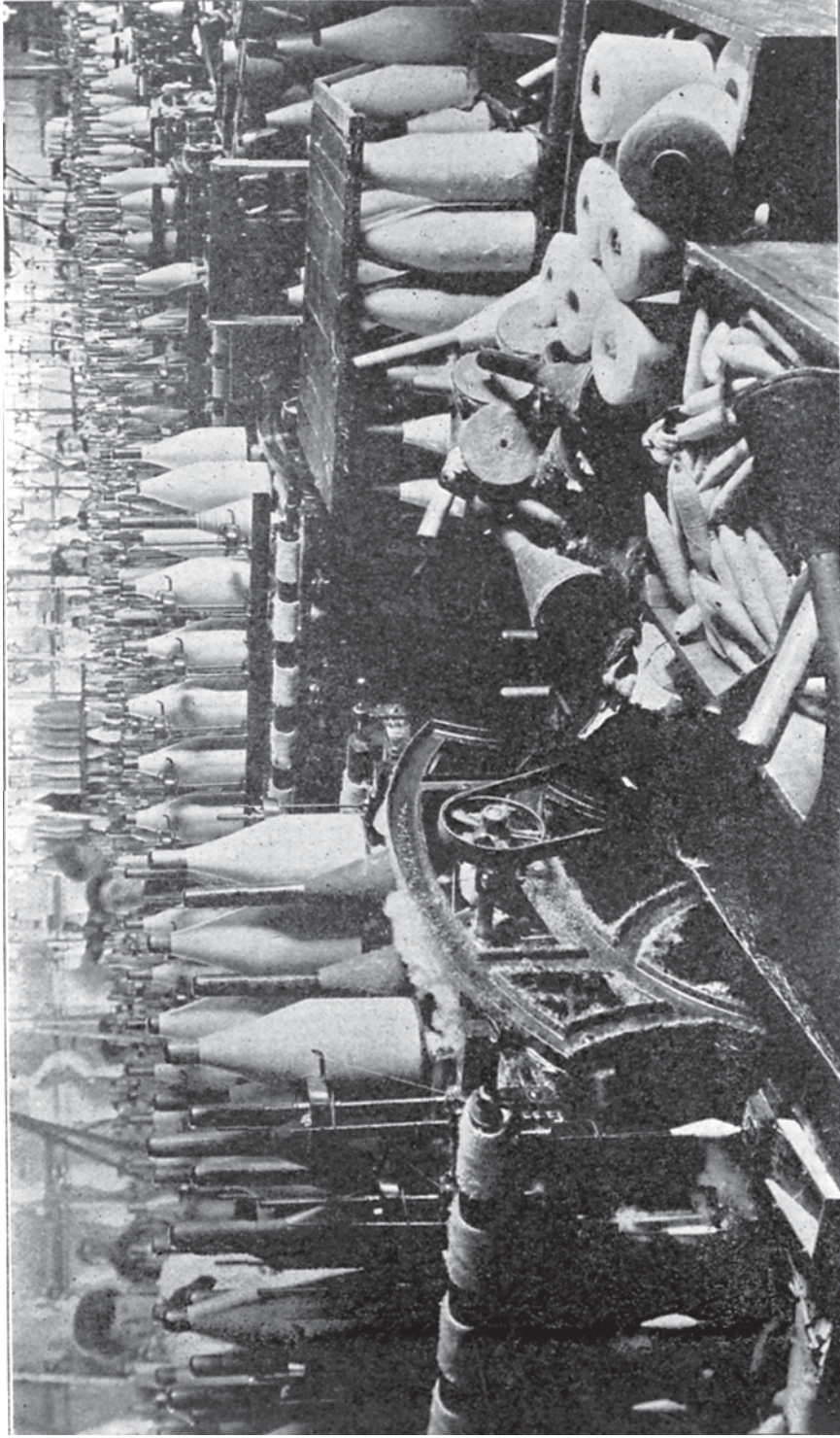
Fig. 72. Dial Cap Cams.

to the cam ring, each section containing in addition, the dial cams of the feed for actuating the dial needles, and the yarn carriers, or guides for delivering the yarn to the needles. Any or all of the sections may be removed, without running the fabric off the needles, by loosening the take-up.

The dial cap cams (Fig. 72) are disposed in positions to cause the needles to be reciprocated in a proper manner to co-operate with the cylinder needles to form the stitches, the cylinder needles first taking the yarn, after which the radial or dial needles operate with it to form the stitches. The "Automatic" cam dial is provided with movable cams so pivoted that they act on the butts of the dial needles and

move them in or out as the character of the knitting may require. The needle dial is provided with lugs (See Fig. 60) which are engaged by lugs on the needle cylinder and serve to transmit motion from the cylinder to the dial.

Other variations in latch needle circular machines may be noted in the mechanisms for taking up and rolling up the fabric and manner of applying or creating the tension on the fabric as it is being knitted; in the shape of both the stationary and movable cams to act on the heels of the needles to move them in or out, as the character of the knitting may require, together with the consequent changes in the form and location of the butts of the needles; in the stop motion mechanism; in the manner of actuating the movable cams, and in other mechanisms and the consequent changes in construction, so that the yarn is fed by the guides to the needles carried by the rotary needle cylinder and dial, and actuated by their respective cams, to take the thread and form the fabric in the customary manner.



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PART III.

STATIONARY NEEDLE CYLINDER MACHINES.

A type of Circular Latch Needle Machine, which is somewhat different from those taken up in Part II, is the Stationary Needle Cylinder in which the *cam ring*, *cam dial plate*, *bobbin rack*, and *cross-bar* revolve. As the needle cylinder and the cloth are stationary, the take-up is fixed to the frame, but the feeds and the bobbins as well as the cross-bar must revolve. These parts, with the *cam ring* and *dial plate*, compose the head.

Fig 73, the Scott and Williams Circular Latch Needle Automatic Machine, is a representative of the above type of machine with a revolving head. The most notable difference that may be observed in this illustration is the manner of applying the take-up to the frame, as the cloth is not revolved.

The Cam Ring, carrying the cylinder needle actuating cams, revolves around the stationary needle cylinder and thereby acts on the butts of the needles, moving them up and down with the required amount of travel to effect the formation of the stitch, instead of the needle cylinder carrying the needles around to the stationary cams to be acted upon.

The cam ring contains all the cams for operating the needles in the needle cylinder, and also the main stitch cams which control the yarn. The projection, Fig. 74, and the section as illustrated in Fig. 75, show the disposition of the cams in this machine, and their relation to each other.

The Ring Cams, or Cylinder Cams. The *cover cam* A, Fig. 76, is merely to guard the needles and prevent them from "firting," or jumping while the machine is running. It has no function to perform in making the stitch. The *landing or clearing cam* B lands the needles to a tuck point, so that all the latches are safely opened before the yarn guide covers the needles to feed them new yarn. The highest

point of the cam is the clearing point for placing the old loop under the latch in order that it may be cast off the needle over the new yarn, thus making a new loop.

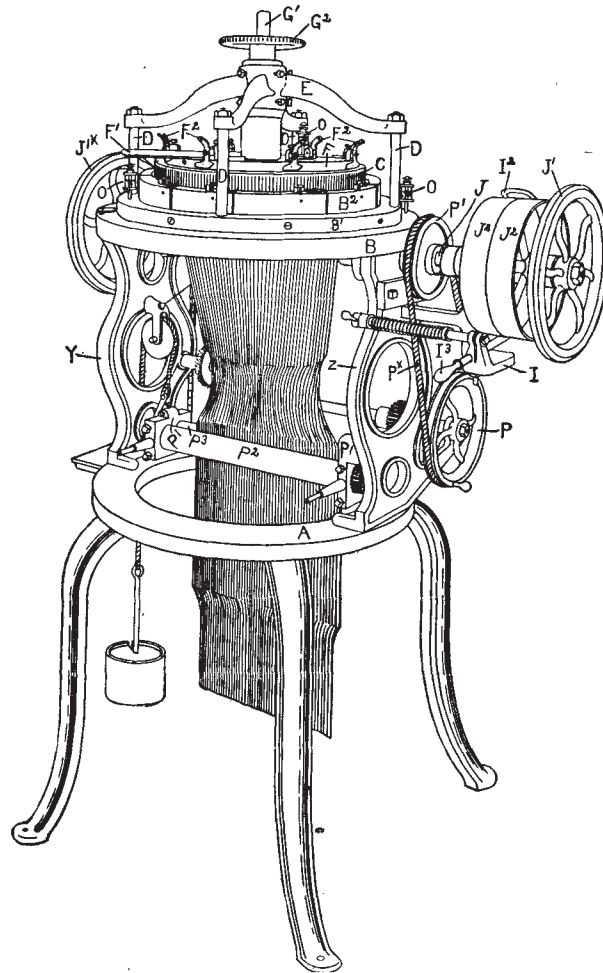


Fig. 73. Scott & Williams Machine
Stationary Needle Cylinder.

The *stitch cam* C controls and regulates the length of the stitch for both sets of needles. In Swiss knitting, the top and the bottom cam draw their yarn separately, which makes a much more elastic

fabric. The foreign machine manufacturers build their rib machines on this principle at the sacrifice of speed.

The *rest cam* D returns all the needles to one common level after the stitch has been formed, the main object being to even the length

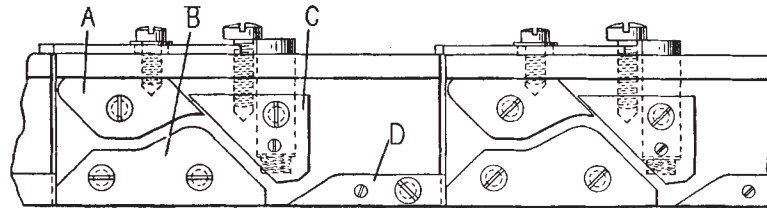


Fig. 74. Projection of Cam Ring.

of the stitches. Without this cam, a tight or stiff needle would make a slack line in the fabric.

The *land or tuck cam* B lands the needles to a tuck so that all the latches are safely opened before the guide covers the needles for pla-

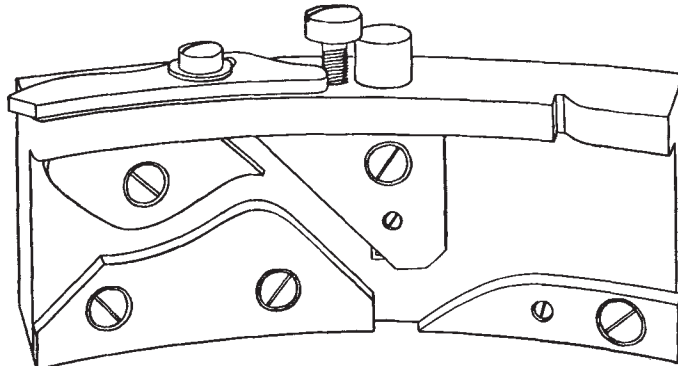


Fig. 75. Cam Ring Section.

cing a new stitch on them; while the *landing or clearing cam* C has the same functions to perform in the dial as the B cam in the ring.

The *rest cam* D performs the same function as does the D cam in the ring; the draw-in cam casts off the old stitch placed on the top needles by the cylinder needles; this cam also acts as a dividing cam for the top loops; it has nothing to do with the stiffness of the fabric. The *cover cam* F does the same work in the dial as cam A in the ring.

The Cap or Dial Plate (Fig. 77) contains all the cams for operating the needles in the dial, and also the movable clearing cams for making plain and tuck stitches for producing plain and royal fabrics used in making ladies' shaped vests and union suits.

The Cap Cams or Dial Cams (Fig. 78). The slide cam A is used for making regular royal fabric, or for making fancy stitches in lace work. When used in connection with a movable cam in the ring of two or more feeds, a full cardigan stitch can be formed.

STARTING UP AND ADJUSTING STATIONARY NEEDLE CYLINDER MACHINES.

The following instructions apply in most part to revolving head machines, though more particularly to the Scott & Williams frame, which is so commonly used in this class; and include directions for adjusting a frame that has never been run, or has been out of commission for some time.

Clean off the machine thoroughly and see that the working parts are well oiled, taking care to oil the cylinder and dial only slightly with a light, stainless oil. Belts of nearly the full width of the receiving pulley should be used, and run at an angle that will not interfere with the belt-shifting-fork. Fill both cylinder and dial with the necessary needles, after having removed all those broken, bent, or otherwise disabled, and see that the latches work freely and cover the hook perfectly.

Adjust all the *dial draw-in cams* to draw the needles about $\frac{1}{32}$ of an inch inside the diameter of the dial.

Adjust all the *cylinder draw-down* cams to draw the needles about $\frac{1}{16}$ of an inch below the top of the cylinder.

Adjust the *cap* circumferentially until the hooks of the cylinder needles meet the rivet of the dial needles.

Set the *height of the dial* so that a needle will pass freely between the edges of the cylinder and dial, or leave a space between the cylinder and dial wide enough so that the old fabric to be used in setting up the machine will pass freely between the cylinder and dial at the place where it will be joined to the new fabric. This adjustment must be made by the threaded wheel and center spindle at the top of the machine.

Fit all the yarn guides to the machine. The yarn guides, Fig. 79, should not touch the needles at any time, but should be set $\frac{1}{16}$ of