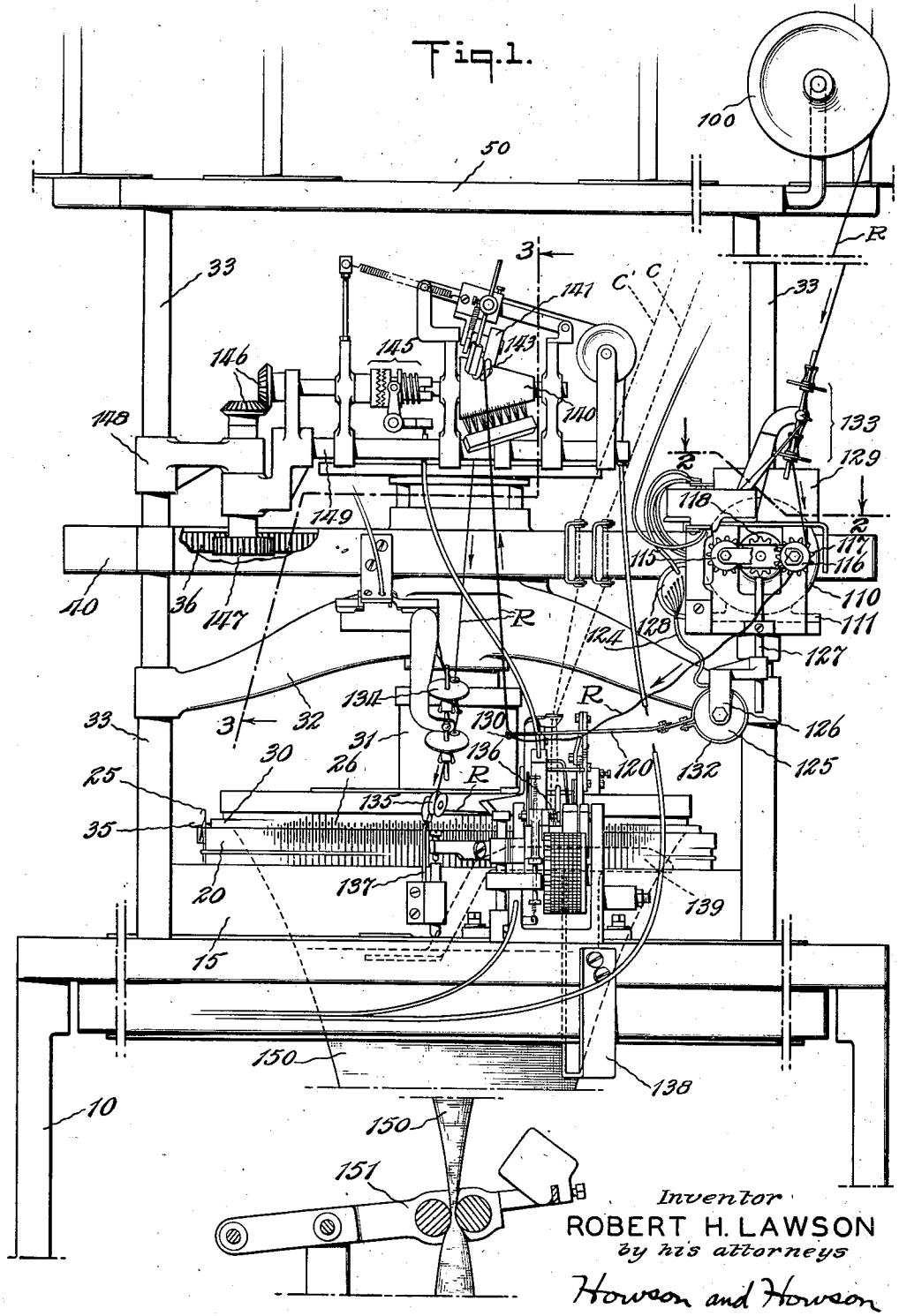
July 8, 1941. R. H. LAWSON 2,248,880

CIRCULAR KNITTING MACHINE AND METHOD OF OPERATING SAME

Filed April 2, 1940 4 Sheets-Sheet 1

Fig. 1.




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CIRCULAR KNITTING MACHINE AND METHOD OF OPERATING SAME

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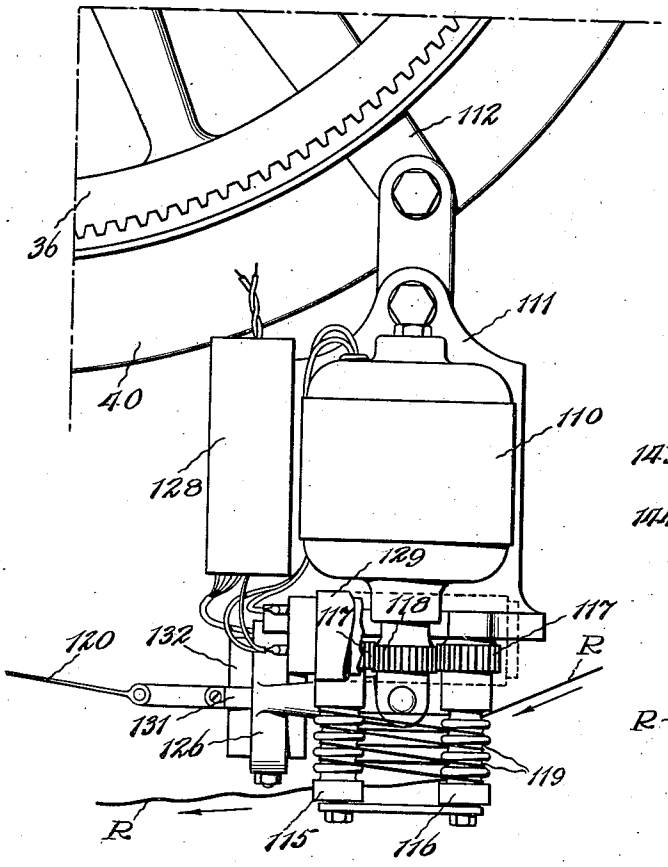



Fig. 2.

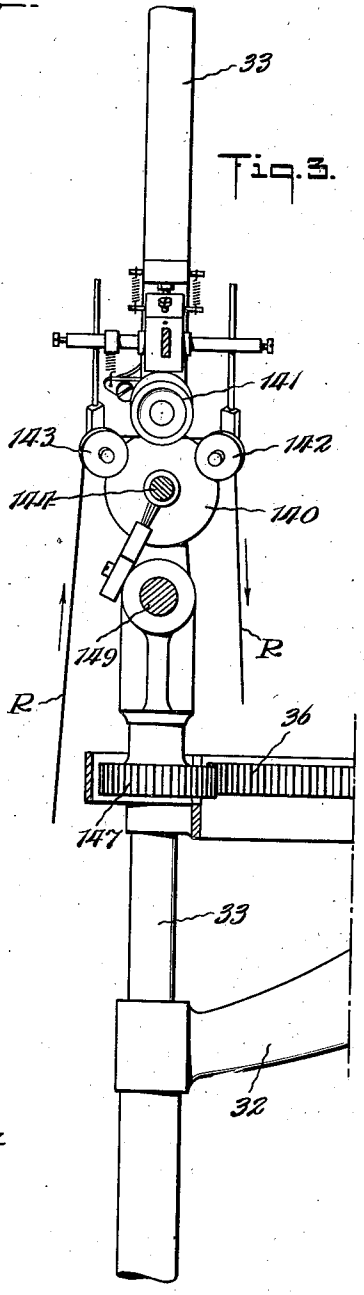



Fig. 3.

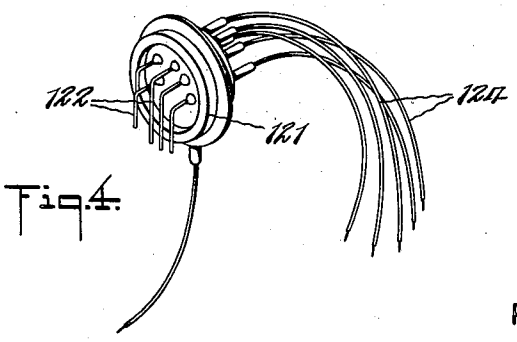



Fig. 4.

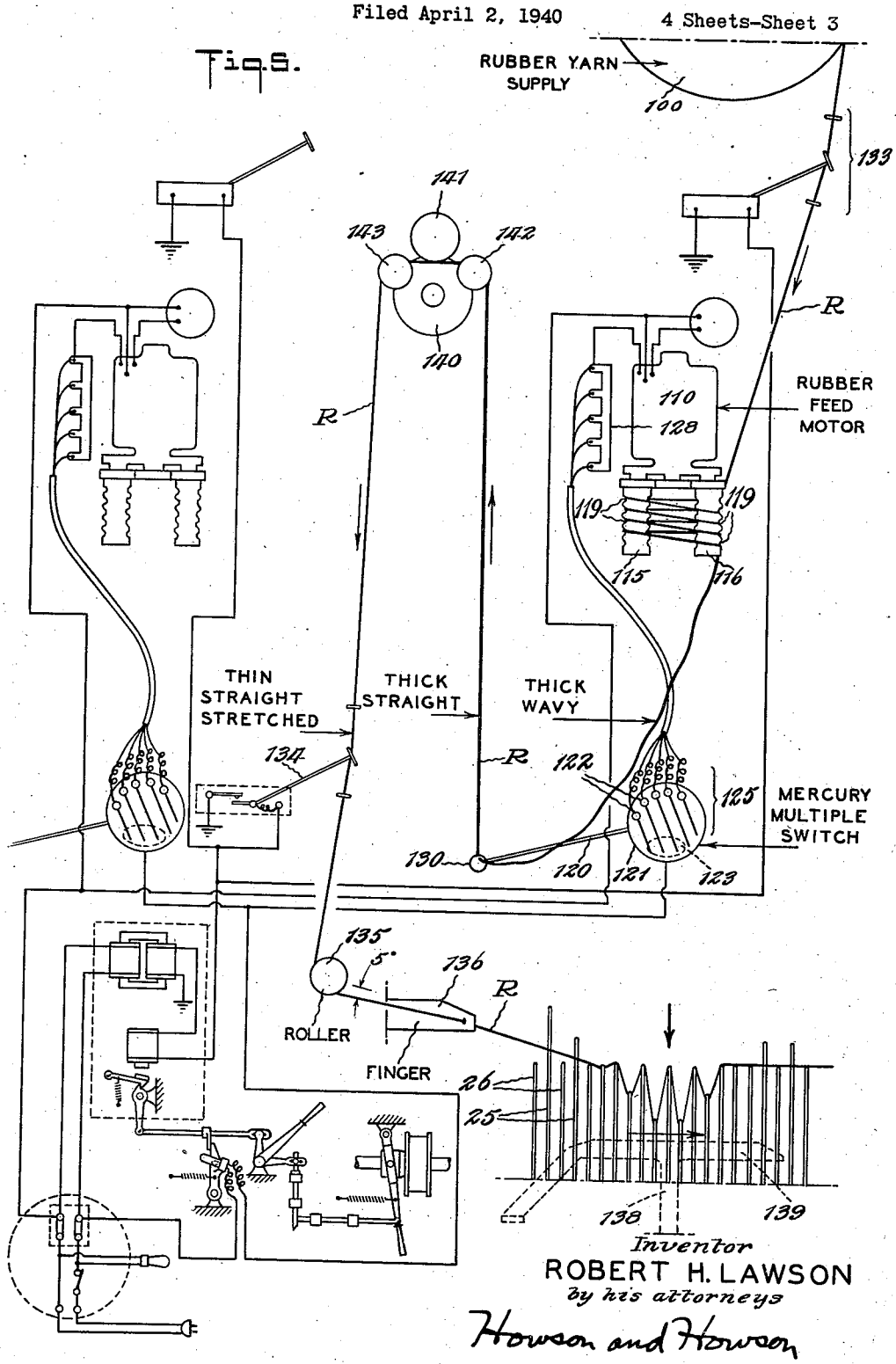
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CIRCULAR KNITTING MACHINE AND METHOD OF OPERATING SAME

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Fig. 8.




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CIRCULAR KNITTING MACHINE AND METHOD OF OPERATING SAME

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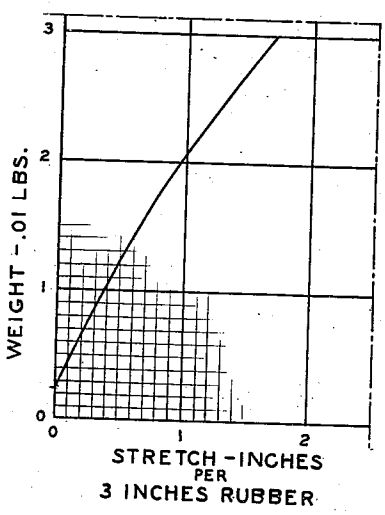



Fig. 2.




Fig. 6.

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Patented July 8, 1941

2,248,880

# UNITED STATES PATENT OFFICE

2,248,880

## CIRCULAR KNITTING MACHINE AND METHOD OF OPERATING SAME

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Application April 2, 1940, Serial No. 327,495

9 Claims. (Cl. 66—132)

This invention relates to rubber yarn feeding means for knitting machines and the method of operating same. One object of the invention is to provide mechanism and method which will feed bare rubber yarn to the machine in a uniform condition. It is characteristic of the invention that the mechanism first removes all tension from the rubber yarn and then presents the yarn to a positive feeding means in a tensed but unstretched condition.

In the drawings:

Fig. 1 is a view in front elevation of the central portion of a Scott & Williams revolving needle cylinder underwear machine embodying this invention;

Fig. 2 is a plan view, taken on the line 2—2 of Fig. 1, of the furnishing means which form part of the rubber feeding means;

Fig. 3 is a view in side elevation, broken away on the line 3—3 of Fig. 1, of the positive feeding means for the rubber yarn;

Fig. 4 is a view in perspective of the contact plate of the multi-point mercury switch for controlling the yarn furnishing means of Fig. 2;

Fig. 5 is a diagrammatic view of the condition of the rubber yarn at the various points as it passes through the machine, sufficient of the associated electrical and mechanical elements being shown to make the changes in its condition intelligible;

Fig. 6 is a stretch-tension graph of a typical rubber yarn suitable for use in the machine of Figs. 1 to 5, showing the main part of the curve; while

Fig. 7 is a graph on an enlarged scale of the low tension end of a graph test on a similar yarn.

The great difficulty in using rubber yarn in circular knitting machinery where yarn is fed in under tension is the elastic nature of the yarn. This is particularly true in the case of bare rubber, where the amount of stretch is greater than with covered rubber yarn and where surface friction problems arise between the rubber and anything against which it rubs. Many efforts have been made to eliminate the non-uniformity and they have been based on the theory that the way to achieve this end is to feed the yarn under uniform tension. I have discovered that uniformity in the finished garment is best obtained by feeding the bare rubber yarn under uniform stretch, and I have devised mechanism which feeds the yarn under uniform stretch.

There are a number of reasons why uniform tension on bare rubber yarn may not produce uniform stretch. One reason is imperfection in the tensioning mechanism, and, another, variation in the yarn. It is almost impossible to feed bare rubber yarn under substantial uniform tension because bare rubber has a high coefficient of friction and tends to catch on anything against which it rubs. If such a yarn is "dusted" to reduce the friction, this "dusting" is sure to be slightly irregular and there will be trouble if a disk tension mechanism is used to give the tensioning. With certain other types of tensioning mechanism there is a tendency for the parts to "bounce," thus producing irregularity.

Variations in the yarn may be of many different kinds. Rubber yarn always has inequalities in size, and any variation in size will give a considerable difference in stretch under uniform tension. Again the composition of the rubber may vary and result in variation in stretch when applying uniform tension. In fact yarns of the same diameter but with different compositions are made especially to have different capacities to stretch under the same amount of tension. Thus certain yarns are known as "long stretch" yarns. The applicant has noticed another important fact with regard to stretching bare rubber yarn. It appears that tension over a certain minimum is required before bare rubber is stretched appreciably, but that until stretched approximately 400% a slight increase in tension causes a considerable increase in stretch. The graph of Figure 6 illustrates this flat or knitting range and is taken from a test on size 50 yarn. The tensions which applicant seeks to use in knitting bare rubber fall in this "flat" range where a little difference in tension causes a large change in length of the yarn.

All these considerations show that it is impossible to expect bare rubber yarn to be incorporated in weft knitted fabric in a uniform manner if the rubber yarn feeding—as distinguished from the feeding of the ordinary yarn—is based on supplying the bare rubber yarn under uniform tension. My novel mechanism and method eliminate all irregularities due to the manipulation of the yarn and minimize the irregularities due to imperfections in the yarn itself. My invention is based on feeding of the yarn under uniform stretch, and not uniform tension. In order to obtain uniform stretch, I propose to draw the rubber from its original source of supply and deliver it in a slack loop, thereafter taking the rubber from this free loop on a surface

which travels at a slower linear speed than the speed at which the yarn is being knitted. The rubber yarn comes to this surface in a substantially unstretched condition and straight line, by virtue of my mechanism. The uniform stretch thus imparted is maintained to the needles.

My mechanism comprises several elements which cooperate in a knitting machine to give a high grade commercial product in which bare rubber is knitted while stretched uniformly. First, there is a supply or source 100 of rubber yarn, as for instance, a spool of bare rubber yarn. Next comes a yarn furnishing means, that is to say, means which will pull the yarn from the spool and present or furnish it constantly free of all tension and stretch, in adequate quantity for the knitting. The most convenient way to keep this unstretched yarn is in a loop. After the furnishing means come a floating or feeler arm and a positive yarn stretching device. The stretching device delivers the rubber yarn at a rate slower than the knitting, thus causing stretch. The interrelation between the furnishing means, the feeler arm and the positive stretching device is important and will be described in detail.

Attention should first be called to the fact that rubber yarn, if hanging free in a loop and subjected only to its own weight, is generally of a wavy character, i. e., has a stiffness or "set" which causes the rubber to assume various waved shapes. This results in increased and irregular feeding or stretching of the yarn as it passes through stretching means. One function of the feeler arm element of the combination is to eliminate this waviness without introducing stretch into the yarn. The free end of the feeler arm is hooked or hung on the loop of rubber yarn between the furnishing and the stretching means. For this purpose there is an eye 130 in the end of the arm. The eye 130 is preferably nearly under the stretching device, and the movements and arrangements are such that only the rubber between the eye and the stretching means is straightened. The yarn being presented to the stretching device in a tensed but unstretched condition, and the latter device being positively driven in timed relation to the knitting elements, it therefore follows that the rubber yarn is fed to the needles with uniform stretch. The feeler arm functions as a control and it has so little inertia and is so balanced that it floats on the rubber without exerting stretching tension on the yarn going to the positive stretching device. It electrically controls the speed of the furnishing means so as to keep a sufficient length of loop of yarn between the furnishing means and the stretching device at all times.

Referring now to the drawings, the invention is shown and will be described embodied in a Scott & Williams revolving needle cylinder underwear machine with a multiplicity of feeds, but only sufficient of the machine will be described to make plain the manner in which the rubber yarn is fed and controlled. The machine has a base 10 in which is supported a revolving needle cylinder 20 and revolving dial 30 carrying independent cylinder needles 25 and dial needles 35 respectively, the knitted fabric 150 passing downwardly through the center of the machine through drawing rolls into a can, in the usual manner. The dial 30 is carried by a central dial post 31 from a dial bracket 32 held on supports 33. These supports are mounted in the base 10 of the machine and extend upwardly beyond the dial bracket 32. Running vertically through the central post 31 is a shaft (not shown) for driving the dial, the shaft being turned by a dial driving gear 36 mounted above the dial bracket. The dial driving gear can be driven by pinions and shafts from the same gear ring which drives the needle cylinder. A guard 40 surrounds the dial driving gear 36.

There is an original supply 100 of bare rubber yarn R mounted on a yarn spool bracket 50 on the upper ends of the supports 33, some little distance above the guard. From the spool 100 the rubber yarn R is drawn by a yarn furnishing means. This furnishing means consists of a small, motor-driven device for drawing or pulling the bare rubber from the supply at a rate varied in accordance with the demands of the knitting machine. The device includes a small electric motor 110 mounted on a plate 111 adjacent the periphery of the guard 40 by means of an arm 112 associated with the dial bracket 32. The motor has two yarn advancing spindles 115, 116, arranged parallel to each other in spaced relation in a horizontal plane and both are driven in a clockwise direction as viewed in Fig. 1, by means of small gear wheels 117 which mesh with a small gear wheel 118 on the end of the shaft of the electric motor 110. Each of the spindles 115, 116 has a plurality of circumferential grooves 119 which can best be seen in Fig. 2. The rubber yarn is wrapped around the spindles in large open loops, each embracing both spindles. The yarn progresses from one groove 119 to the next in succession and from the motor end of the spindles toward the outer or free ends where the yarn drops off by gravity. It will be obvious that the rotation of these spindles under the drive of the motor will cause the yarn to be drawn from the yarn supply 100 and released in a free or unstretched condition at the outer end of the two spindles.

From the furnishing means the yarn proceeds downwardly and laterally to the outer end of a feeler or control arm 120 which is pivotally carried as an extension of an operating contact plate 121 of a multiple contact mercury switch 125. This mercury switch is carried on a bracket 126 supported from the plate 111 which carries the electric motor 110. For adjustability the bracket 126 has a vertical rod 127 interposed between it and the plate 111. This mercury switch 125 is adapted to control the operation of the electric motor 110 by means shown diagrammatically in Fig. 5. The switch has a plurality of points 122 carried by a contact plate 121 shown in Fig. 4. This multiplicity of points is so located with regard to the mercury 123 in the lower portion of the switch that as the circular contact plate 121 is rotated the number of points which are in contact with the mercury is varied. From each contact point there is a wire 124 running to a different point on a resistor 128. The amount of current which flows through the circuit formed by the mercury contacts, the resistor and the remainder of the electrical circuit varies with the changes in the number of contact points in the mercury. The resistor 128 is electrically connected to one side of the electric motor 110 operating the spindles 115 and 116 which draw the rubber yarn from the supply 100. The other side of the circuit to the electric motor is connected to the source of current and back to the mercury through various auxiliary devices which

need not be described here. A condenser 129 can also be provided at the terminal points of the motor, if needed.

The contact plate 121 is adapted to rotate about its center in a vertical plane, thereby swinging the points into and out of the mercury in succession, the plate receiving its rotary movement from a cylindrical casing 132 which encloses the trough containing the mercury. This casing is fast on the contact plate and is adapted to rotate on its longitudinal axis with that plate. Encircling the casing at its middle is a strap 131 which carries the feeler arm 120 previously referred to. The angle of the feeler arm with relation to the points in the contact plate can be adjusted by loosening the strap 131 on the casing 132, turning it with relation to the casing and tightening it again. The relation of the points and the feeler arm is such that when the feeler arm is raised, the number of points in contact with the mercury is increased. The electrical circuit including the motor is such that when the inertia arm is raised the speed of the motor is increased progressively.

From the eye 130 in the end of the arm the rubber yarn passes upwardly to a positive feeding mechanism comprising the positively driven bevelled or conical wheel 140 with a pressure roll 141 squeezing the yarn against the wheel 140. There are guide rollers 142 and 143 respectively located in leading and following positions with regard to pressure roller 141, and the rubber yarn passing over these guide rollers is led between the feed roll 140 and the pressure roll 141. The feed roll 140 is positively driven from the dial driving gear 36 by means of a small gear 147 engaging the periphery of the dial driving gear 36 and in turn driving two bevel gears 146 carried by a bracket 148 on the support 33 above the dial driving gear 36. The bevel gears 146 acting through a clutch 145 and which along with the conical feed wheel 140 are supported by a bar bracket 149 on the bracket 148, drive the feed wheel 140 so that it is positively driven with relation to the needles. The gearing relation is such that the linear speed of the yarn passing between feed wheel 140 and the pressure roll 141 is less than the amount of yarn drawn by the needles and may be less than the peripheral speed of the needle cylinder 20, which results in stretch being given to the rubber yarn. It will be seen that by this positive driving arrangement of the wheel 140, a uniform amount of the rubber yarn as presented to the wheel 140 will be fed to the needles and the yarn will be stretched uniformly. The conical shape of the feed wheel 140 permits variation of the stretch to shape the garment.

As already explained, the rubber yarn R coming off the spindles 115, 116 of the rubber furnishing mechanism is completely relaxed and free of tension and stretch. It generally takes a "set" and therefore is in a somewhat wavy condition when it leaves the spindles 115, 116 for the eye 130 in the end of the feeler arm. From the feeler arm the rubber goes upwardly to the positive feeding means 140, 141. The weight of the feeler arm is so slight and it is so freely mounted that it will straighten this length of rubber between the eye in the end of the arm and the positive feeding means, but will not stretch it to any appreciable extent. In other words, the pull of gravity on the feeler arm is such that the arm can be lifted by an upward pull on the rubber yarn from the positive feeding means substantially without stretching the yarn. Stated another way, the weight of the feeler arm can be said to be of the order of the unstretched pull of the rubber yarn. Since the weight of the arm will straighten but not stretch the rubber to any appreciable extent it follows that the rubber comes to the feed roll 140 in a straight but unstretched condition, and being thus presented to the feed wheel in an absolutely uniform manner, it is stretched a uniform amount as it leaves the feed wheel. One example of a feeler arm has weight such that gravity exerts a pull of say .002 lb. Part of this pull being taken by the rubber between the furnishing means and the eye 130, the pull on the rubber going to the feeding means is less then .002 lb. I find that with #50 rubber it takes about .0025 lb. to start the yarn stretching. It should be pointed out that in Fig. 1 the waviness of the rubber between the wheel 116 and the eye 130 is exaggerated. The angle between this portion of the rubber and the portion leading from the eye to the feeding means need not be constant in all construction, and the angle of each portion from the vertical may also be varied, so long as the pull of the arm on the rubber to the feeding means is less than the maximum pull for zero stretch. The existence of this maximum pull zero stretch point is shown in Fig. 7, where it will be observed that increase in tension does not result in stretch until the pull goes above approximately .0025 lb. (The vertical scale of Fig. 7 is ten times larger than that of Fig. 6.) This figure was the result of a test of size 50 elastic yarn. The figure would vary somewhat with yarns of other sizes.

In order that the uniformity may not be lost before the yarn reaches the needles, it is preferable to provide means at every point where the rubber yarn has to turn through any substantial angle to avoid frictional or sliding resistance to the yarn. Also friction on stretched bare rubber chafes and weakens it. Thus where the yarn turns to go through the yarn finger 136, a roller 135 is provided which avoids any sliding contact with the yarn in turning that angle. This roller 135 is carried by a support 137 mounted on the outer surface of the stationary cam cylinder 15. If desired, stop motions 133 and 134 operated on an electrical circuit can be provided between the rubber yarn supply 100 and the spindles 115, 116 of the yarn furnishing means and betwen the positive feed wheel 140 and the roller 135 respectively. These are adapted to stop the knitting machine and the motor 110 any time the rubber yarn breaks.

In the lower right hand corner of Fig. 5 has been indicated another phase of feeding the yarn. Here is illustrated a series of cylinder needles 25 and sinkers 26 moving from left to right in the direction of the horizontal arrow as they pass the knocking-over point which is indicated by the downwardly pointing arrow. When knitting with bare rubber, the yarn does not "rob" from one loop to another, and as soon as the yarn has been contacted by the sinkers 26 and the needles 25, the bare rubber yarn cannot "creep." Thereafter, as the needles are drawn down to knock over the loops, each loop of rubber must stretch still further without any compensation from its neighbors. If the stretch of the yarn is irregular, "break-outs" will then occur at this point. This serves to illustrate the importance of uniform stretch of the rubber when knitting with bare rubber. Precautions must be taken to see that

the stitch is pulled away from the needle. To achieve this a cam, horn or presser 139 may be provided, carried by a bracket 138 on the main frame 10 of the machine. The bracket 138 extends from the outside of the frame underneath the cam and needle cylinders, holding the presser or cam 139 itself inside of the needle cylinder but outside of the fabric 150 as it extends downwardly toward the regular fabric takeup 151 and the can in which the fabric is being collected. This cam 139 is directed radially inward and exerts extra pressure against the fabric opposite the knocking-over point and for a short distance on either side thereof. This extra pressure exerted by cam 139 is accomplished by concentrating at this point more of the tension from the regular fabric take-up 151, than would be normal were this cam not present. In this way it cooperates with the regular knitting elements and the take-up in taking the stitches from the needles and completing the knocking-over operation. It might be noted that the knocking-over referred to is the knocking of the inelastic yarn over the rubber yarn. It also assists in preventing the stitches or loops left on the needles from following the needles out as they are raised following the knocking-over point.

The rubber yarn may be fed at any number of feeds desired, and if preferred, inelastic yarn can also be fed at the feeds where rubber is present, as indicated for instance by the dotted inelastic yarns C and C' in Fig. 1. It has heretofore often been thought necessary to feed inelastic yarn in with the rubber so that if the rubber does break there will be no runs in the fabric. However, owing to the accurate control of the stretch of the rubber in accordance with this invention, the rubber stitches will not "break out" and the inelastic thread knit with it can be eliminated. The new means operates so accurately as to permit shaping of the garments by varying the stretch given the rubber by the cone wheel 140. This results in a cleaner fabric due to the absence of this extra thread, which tends ot make pile loops and also makes a greater narrowing of the fabric possible. The elimination of the thread also saves the cost of the extra yarn. Whether inelastic yarn is fed in with the rubber yarn or only at other feeds, inelastic yarn loops lie on both sides of the fabric and cover the rubber yarn, thus preventing the rubber yarn from coming into contact with the wearer. Still another advantage of the use of bare rubber when fed in accordance with the present invention is the possibility of spacing the rubber yarn further apart in the fabric than is practical with covered rubber.

While the invention has been shown and described in connection with bare rubber,—and it is peculiarly useful for that purpose—the invention may in certain cases be useful for the feeding of covered rubber.

It will be obvious that many modifications which do not depart from the scope of my invention will occur to those skilled in the art.

What I claim is:

1. In a circular knitting machine, rubber feeding means comprising a yarn supply, means taking yarn from the supply and furnishing same free of tension, in combination with a feeler arm whose weight will straighten but not stretch the rubber, said arm controlling the operation of the furnishing means, and a positive yarn feeding means adapted to take yarn from the feeler arm and feed it to the needles under uniform stretch.

2. In a method of feeding rubber yarn to the needles of a circular knitting machine in uniformly stretched condition by the use of a positive yarn feeding means, the steps of obtaining the rubber from the supply, allowing it to lie free and unstretched and then holding it tensed but without stretch by means of a gravity pull less than the zero stretch maximum pull, as it goes into the feeding means.

3. In a method of feeding bare rubber yarn to the needles of a circular knitting machine by the use of a positive feeding means adapted to put stretch into the yarn, the steps of allowing the rubber to lie free and unstretched as it goes into the feeding means while holding it straight by means of a feeler element, and obtaining the necessary rubber in its unstretched condition from yarn furnishing means controlled by the said feeler element.

4. In a method of feeding rubber yarn to the needles of a circular knitting machine by the use of a positive feeding means, the steps of pulling the rubber from the supply, allowing it to hang free but applying sufficient weight as it goes into the feeding means to hold it straight without stretching it.

5. In a circular knitting machine, rubber yarn feeding means comprising means adapted to furnish yarn in unstretched condition, and a positive yarn feeding means taking the yarn from the furnishing means and feeding it to the needles under uniform stretch, in combination with a feeler arm whose weight hangs on the yarn entering the positive feeding means with a gravity pull of the order of the unstretched pull of the yarn, said feeler arm being adapted to cause operation of the yarn furnishing means to provide a free loop of yarn between the furnishing means and the feeding means.

6. In a circular knitting machine, yarn feeding means comprising a rubber yarn supply, means taking yarn from the supply and furnishing same free of tension, positive yarn feeding means receiving yarn from the furnishing means, in combination with means located between the furnishing and feeding means adapted to provide a free loop of yarn therebetween, said means comprising a feeler arm hanging on the yarn going to the feeding means with a weight sufficient to straighten but not stretch the rubber, said feeler arm controlling the operation of the furnishing means to maintain a slack loop between the furnishing and feeding means.

7. In a circular knitting machine, yarn feeding means comprising a bare rubber yarn supply, means taking yarn from the supply and furnishing same free of stretch, in combination with two stretching devices and a fabric takeup to incorporate the rubber yarn in the fabric in uniform stretched condition, the first stretching device comprising positive yarn feeding means taking the yarn from the furnishing means and feeding same to the needles with uniform stretch, the fabric takeup pulling on the fabric coming from the needles, and said second stretching means comprising a device bearing against the fabric locally near the knocking-over point and cooperating with the fabric takeup to insure knocking-over of the rubber stitch.

8. In a circular knitting machine, yarn feeding means comprising a bare rubber yarn supply, means taking yarn from the supply and furnishing same free of stretch, in combination with a stretching device for said yarn, a fabric take-up and means for concentrating the fabric

tension caused by the take-up to incorporate the rubber yarn in the fabric in uniform stretched condition, the stretching device comprising positive yarn feeding means taking the yarn from the furnishing means and feeding same to the needles with uniform stretch, the fabric concentrating device operating in combination with the take-up to put more tension than the take-up would normally apply at or near the knocking-over point to insure casting off of the rubber stitch.

9. In a circular knitting machine, yarn feeding means comprising a bare rubber yarn supply, means taking the yarn from the supply and furnishing same free of stretch, in combination with a stretching device comprising positive yarn feeding means to take the yarn from the furnishing means and to feed same to the needles in uniform stretched condition, together with means for applying extra tension on the fabric in the neighborhood of the knocking over point where the rubber stitch is cast off, to insure knocking over of the rubber stitch.

ROBERT H. LAWSON.