Feb. 16, 1954 J. W. PHILLIPS ET AL 2,669,107

FLAW DETECTOR FOR KNITTING MACHINES

Filed Sept. 16, 1947 3 Sheets-Sheet 1

Fig. 1.

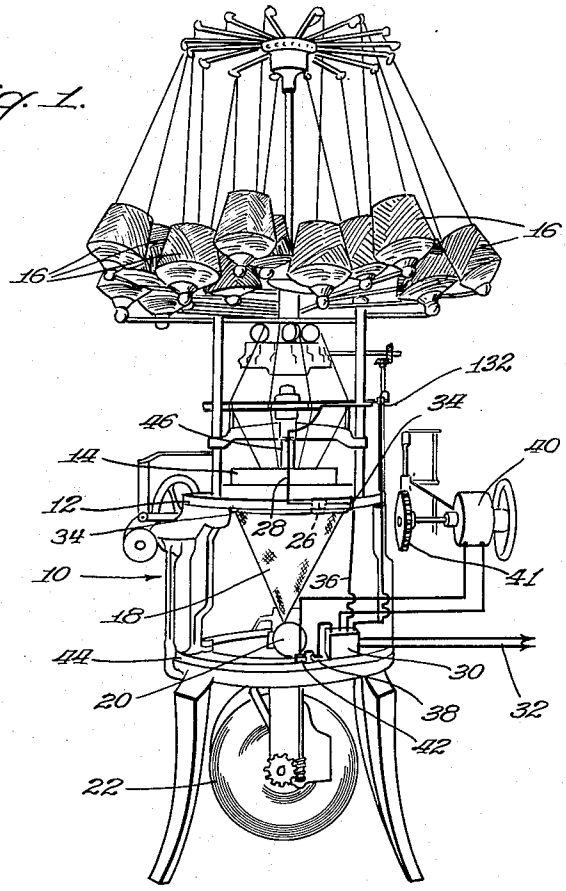
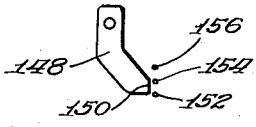


Fig. 5.



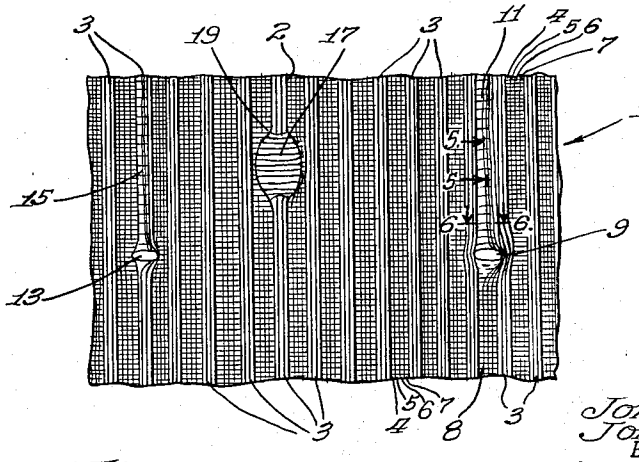
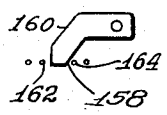


Fig. 4.

Fig. 6.



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FLAW DETECTOR FOR KNITTING MACHINES

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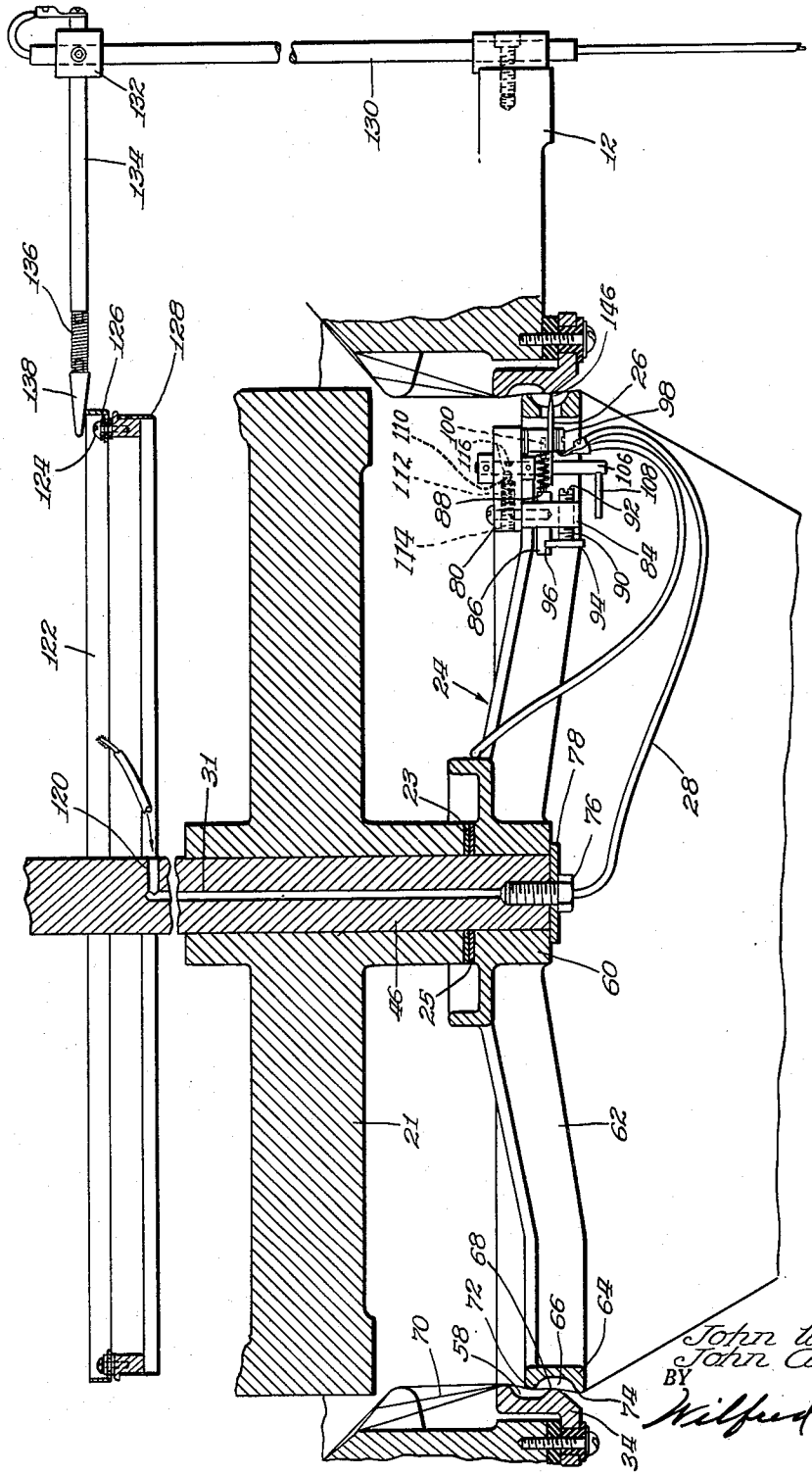


Fig. 2.

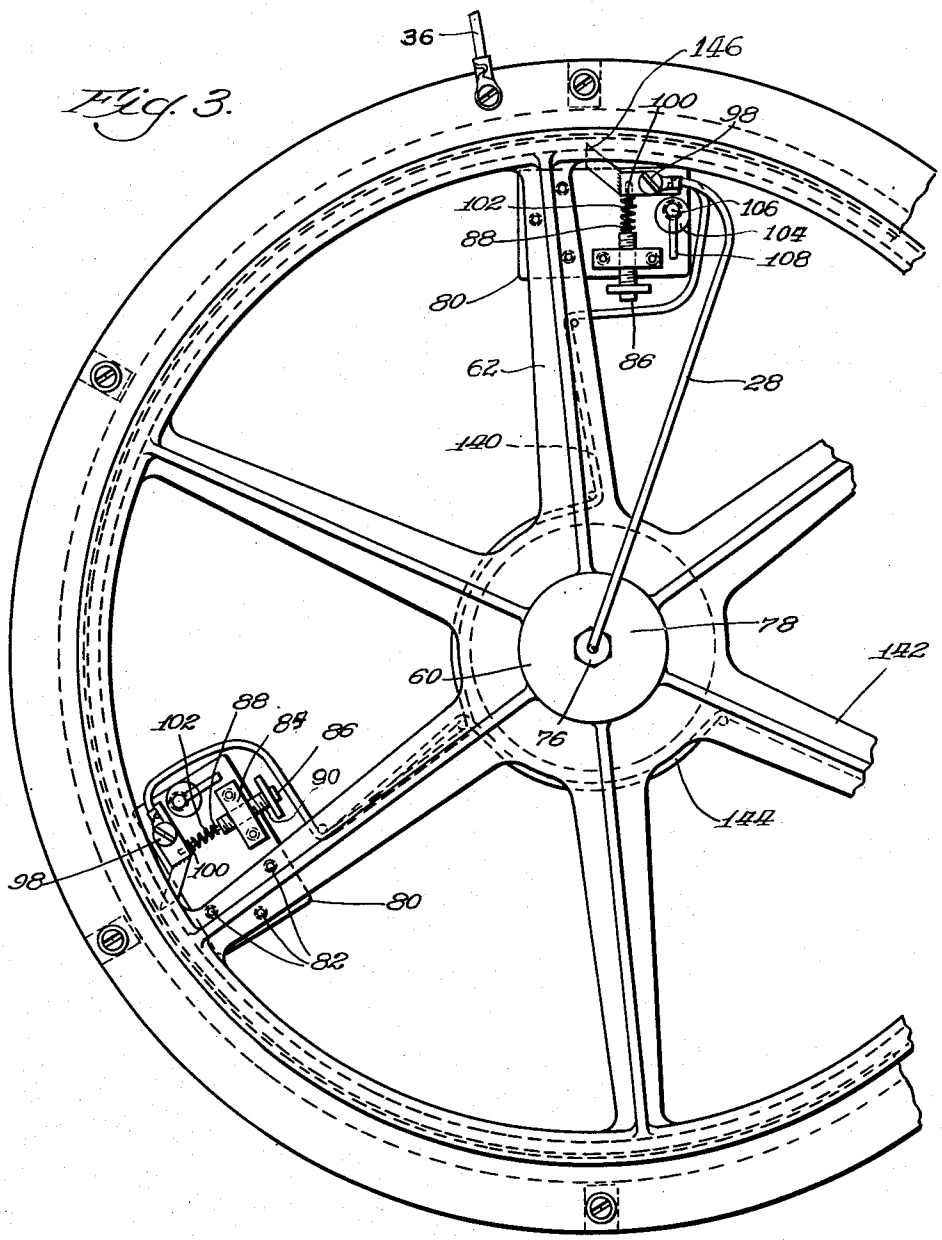
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FLAW DETECTOR FOR KNITTING MACHINES

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Fig. 3.



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FLAW DETECTOR FOR KNITTING MACHINES

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10 Claims. (Cl. 66—166)

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This invention relates to a flaw detector and counter for a knitting machine, and to a method of detecting flaws in a knitted fabric. More particularly it relates to a flaw detector and counter for a fabric knitting machine adapted to knit a continuous tube of fabric.

The principal object of this invention is to provide a flaw detector that will locate every flaw which justifies a garment cutter rejecting cloth as unsuitable for "firsts" garments. There have been both mechanical flaw detectors and photoelectric cell detectors but the applicant Phillips is not acquainted with any which will reliably detect a run. They, particularly the mechanical detectors, are designed to detect big holes and therefore do not function efficiently in detecting small holes or runs.

Another object of applicants' invention is to provide a flaw detector finger which is moving parallel to the line of stitching, that is at right angles to a run, and to shape the fabric-engaging surface of the finger so that the moment there is no vertical support for the finger, it will cleave two horizontal supports, (that is the rungs of a ladder), make contact with the electrode over which the tube of fabric is moving, and stop the machine and record a flaw.

A further second object of this invention is to relate the number of scanning fingers to the number of stitching stations on the revolving cylinder. This will be explained after the machine has been described.

Another object of the invention is to mount the testing finger so that there will be relative motion between it and the tube of knitted fabric. This keeps the testing finger moving relative to the tube of fabric in a plane parallel to the plane of the movement of the stitching stations, and along a spiral with respect to the knitted tube. Expressed differently, the knitting proceeds along a spiral having a given pitch with respect to the axis of the fabric tube, and its relative motion such that the testing finger moves along the same spiral having a pitch with respect to the tube.

Applicants' invention contains several features. Firstly, the testing finger assembly is a removable unit for testing one valley between two rows, and these units can be conveniently added to the flaw detector assembly as knitting stations are added to the cylinder. The testing finger contains a delicate but simply operated control for varying the pressure of the testing finger on the fabric. Each testing finger assembly contains a cam control for locking the finger out of engagement with the fabric. Also, the newly knit fabric is drawn to a fine and uniform tightness between four shoulders which is responsible in no small degree for the successful operation of the device.

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Applicants are considering placing a washable mark on the outside tube wall by a stamping device operated by the flaw detector. The purpose of this is to assist the garment cutter in avoiding errors. Some flaws are quite small and occasionally a garment maker misses them. Had he spotted the flaw at the time he made the garment, he could have cut it out as an arm or neck hole. This type of garment becomes a "second" and is sold as a "second."

These and such other objects as may hereinafter appear are attained in the embodiment of the invention hereinafter described and shown in the accompanying drawings comprising three sheets wherein:

Fig. 1 is a view of a knitting machine illustrating the relationship of the flaw detector and counter to the machine with the wiring schematically shown;

Fig. 2 is a view in elevation and partly in cross-section of the flaw detector wheel and associated parts with all of the knitting elements omitted, however;

Fig. 3 is a fragmentary bottom view of the flaw detector wheel;

Fig. 4 is an enlarged view of a piece of knitted fabric having typical holes therein; and,

Figs. 5 and 6 are somewhat diagrammatic views taken on the lines 5—5 and 6—6 of Fig. 4 respectively and showing the manner in which a vertically disposed testing finger 148 would operate at that point, and the manner in which a horizontally disposed testing finger 160 would operate at that point.

Referring now to the drawings, and particularly to Figure 4, a piece of fabric 1, three times normal, unstretched size, is there shown, having small defects therein of the type which are most difficult to detect. The piece of fabric 1 is a portion of a knitted tube or sleeve produced by a machine, having several knitting stations which successively knit along a line parallel to the line 2. Imperfections in the fabric are caused by a stuck latch on a needle, or a broken needle, or a heavy piece of yarn, and the defect may continue in the fabric until the machine operator discovers it and repairs the needle, or the machine may correct itself.

Again referring to Figure 4, the fabric shown consists of ribs such as 3, each formed of what appears to be four vertical lines of thread, and spaced from each other by four parallel ladders, 4, 5, 6, and 7. If one turns the fabric inside out, the ladders 4, 5, 6 and 7 appear to be a rib like 3, while 3 appears to be four parallel ladders on the inside. When a needle which is handling the stitch at 8 sticks, the knitting machine does not jam, but simply skips the needle and continues to knit. At the point where this first occurs there is usually a rather pronounced hole 9.

This hole is greater in width by reason of the disappearance of the stitching along the line 8, and it usually has a geater height. In the illustration shown, the particular needle along the line 8 did not re-pickup with the result that there is a double width ladder 11, which constitutes a fine run.

The hole 13 occurs in an outside rib, but inasmuch as the rib results from a simple reversal of needles, the opening 13 is exactly the same as the opening 9, with this important distinction, for applicants' flaw detector, that a mechanical scanning finger rides at a greater distance from its electric contact point when it is riding a rib that is projecting upwardly or outwardly toward it than when it is riding a ladder.

It will be observed that the runs 11 and 15 did not correct themselves, indicating a broken needle or a permanently stuck latch, and the machine will turn out imperfect cloth at the rate of several inches a minute until the operator notes the defect. An operator handles several machines, and a run arising from the failure of a single needle is difficult to observe when you are standing four or five feet away from the cloth.

Continuing to refer to Figure 4, 17 identifies a comparatively large opening caused by the failure of four or five needles on perhaps one or two revolutions of the cylinder. The latches momentarily stuck and then freed themselves. When the latches freed themselves, perfect knitting was resumed at point 19.

The defects illustrated in Figure 4 are the ones that applicants seek to detect. Big holes in the fabric are easily detected. A quarter or half inch opening in the fabric will be seen by the operator. Flaw detectors have been able to catch these openings in the past, but they are not appreciably more effective than the operator and the applicant Phillips' own mill does not use them.

Referring now to Fig. 1, the numeral 10 generally identifies a circular fabric knitting machine which has a fixed table 12, a shaft 46 (see Fig. 2), a cylinder carrying knitting equipment 14, a stationary dial member 21 (see Fig. 2), holders for spools of yarn 16, and various drive mechanisms and controls. Thus the numeral 40 refers to the prime mover, to which is rotatably secured the gear 41. The cylinder and the shaft 46 are mounted for relative rotation therebetween. A tube of knitted fabric 18 is drawn downwardly from the cylinder by pressure rolls 20 and is fed onto a bolt 22. The machine thus far described is standard mechanism and is available in a large number of specific forms. Generally, what applicants have done is to mount a wheel called the flaw detector wheel 24 on the bottom of the shaft 46 so that the periphery of the wheel engages the inside surface of the fabric tube. On the periphery of the wheel is mounted an electrically conductive finger 26 which finger is pressed against the inside of the fabric tube. A conductor 28 is connected through an electronic relay 30 to a source of power 32.

On the outside of the fabric tube is an electrically conductive annulus 34 which is connected by the conductor 36 through the electronic relay 30 to a source of power 32 when the circuit is closed by the finger 26 engaging the annulus 34. The said relay 30 is thus adapted to be activated by the said engagement of the finger 26 with the annulus 34 to open the power circuit from the line 32 to the said motor 40 so as to stop the said motor. The annulus 34 carries an inwardly directed circular channel 58.

The flaw detector wheel 24 comprises a hub 60 from which radiate spokes 62 which support at their ends a rim 64. The rim 64 carries an outwardly directed circular channel 66 and the spacing is such that the testing finger rub line 68 is inside the channel 66 so that when the fabric 70 is passed between the annulus 34 and the rim 64 the fabric will bear against the shoulders 72 and 74 which stretches the fabric tightly across the fabric rub line 68.

The wheel is drawn up tightly against the bottom of the shaft 46 by a sleeve bolt 76 pressing a washer 78 against the bottom of the hub 60. The dial member 21 does not rotate and suitable bearings 23 and 25 are provided between member 21 and hub 60. It will be appreciated that the diameter of the wheel, the diameter of the hub journal, and the relationship of the rim to the hub may be varied to suit the particular machine to be equipped. On the knitting machine shown in these drawings, there is a cap having a shape very similar to the hub 60 mounted on the bottom of the shaft 46. Applicants replace this cap with the wheel.

The detector or switch comprises a fiber base 80 which is mounted on the top of one of the wheel spokes 62 by bolts such as 82. Depending from the base 80 is a finger adjustment bracket comprising a block 84 having a pair of vertically aligned transverse holes therethrough. In the upper hole is mounted an axially movable plunger 86 which carries on its inner end a short stud 88. In the lower hole is threadedly mounted a bolt 90 having a screw driver slot 92 and a disc head 94 which rides in the slot 96 in the plunger 86. By turning the bolt 90, the plunger 86 may be moved in either direction axially, and the plunger 86 need not itself rotate. The finger 26 is pivotally mounted on a shoulder screw 98 which is vertically positioned in the base 80. The finger carries an inwardly directed dowel 100 in alignment with the stud 88. An expansion spring 102 is disposed between the plunger 86 and the finger 26 and is held in position by the stud 88 and the dowel 100. A cam 104 is mounted on a cam shaft 106 which carries on its bottom a lever 108. The base 80 is drilled to receive a ball 110 pressed inwardly by a spring 112 which in turn is positioned by a set screw 114. Oppositely disposed sockets 116 are cut in the shaft 106 to receive ball 110 whereby cam 104 may be selectively held in a position in which it holds finger 26 completely out of engagement with the fabric or in a position in which finger 26 is permitted to fully engage the fabric.

Being able to hold the testing fingers away from the rub line 68 is important not only in setting up the machine, but after each time that a testing finger has stopped the machine. Referring to Fig. 1, a testing finger is at approximately the point indicated by the lead line 34 while the knitting stations are at approximately a vertical distance thereabove of about four inches on this particular type of machine. If the machine has been stopped by the beginning of a run, the run extends on up to the needles and it will be necessary to operate the machine until four inches of clear fabric have been knitted so as to reach the level of the testing fingers. During this time the testing fingers must be kept out of engagement. An alternative method is to connect up the circuit so that the reset button can be held closed when it is desired that

the testing fingers fail to function even though they engage the rub line 68.

Electricity is carried to the finger 26 through screw 98 to which is fastened the conductor 28, which is carried up axial hole 31 in the shaft 46 to a point above the knitting mechanism where it is carried out through passageway 120 to a slip ring 122. This slip ring is mounted by a screw 124 and insulator 126 upon a ring 128, which latter ring is standard equipment on the particular machine applicants are using. Mounted on the table 12, at its edge, is a tubular post 130, on the upper end of which is a bracket 132 mounted on a horizontal pivot. The bracket supports a horizontally directed arm 134 carrying by means of a spring 136 a brush 138. Depending upon the angle of the bracket 132 with respect to the post, the brush 138 may engage the slip ring 122 firmly or lightly.

In Fig. 3, two flaw detector units are shown, current reaching the second by means of the conductor 140 and reaching a like finger unit on the spoke 142 but not shown, by the conductor 144. A finger testing unit is desirable for each three or four knitting stations on the machine. Ordinarily when a hole occurs, it is not confined to just one row but extends through several rows as a runner or even a large opening. The testing finger is following a spiral path around the inside of the tube and it is important that the spacing between the loops in that path be not so great that occasionally an appreciable hole might be missed. Consequently, if on each rotation of the machine, the tube is being formed at the rate of about one-quarter of an inch of fabric, it is desirable that more than one testing finger be used. It will be appreciated that the testing fingers will not overlap each other, that is, will not describe exactly the same path, because all of them are mounted in a common plane parallel to the plane of the knitting stations. In theory, by providing a testing finger for each knitting station, the testing finger would move around parallel with one knitted row, and would always be riding in the valley between two knitted rows. This accuracy is not possible because the downward pull on the tube from below is not quite uniform. Each testing finger irregularly climbs over rows depending upon the regularity of the downward pull of the tubular fabric. At no time, however, is the pitch angle between the motion of a testing finger and the direction of a knitted row great enough to prevent the finger from dropping into an elongated opening such as 9 in Fig. 4.

Referring to Figs. 2 and 3, the tip 146 of the testing finger is very thin and very short so that it will drop into an opening smaller than hole 9 in Fig. 4. The relay 30 is very sensitive and while applicants use a low voltage and a low current, the slightest contact between the finger 26 and the rub line 68 will actuate the relay. Applicants expect that the movement of the fabric tightly drawn over the rub line 68 will maintain the surface clean of insulating matter. In operation, the relay 30 will, upon actuation by contact between the finger 26 and the rub line 68 as aforesaid, open the power circuit from the power line 32 to the motor 40 so as to stop the said motor.

It will be understood that the knitting proceeds along a line parallel to the line 2 in Fig. 4, and that rows of knitting are parallel to that line. The knitting machine has several knitting stations on the cylinder so that the knitted rows are substantially horizontal although if examined in detail they would be spiral.

Figure 5 illustrates why moving a testing finger at right angles to the rows (or parallel to the ribs) will not pick up a run while Figure 6 illustrates that moving the testing finger parallel to the rows (or at right angles to the ribs) will pick up a run. A run is caused by one or more needles not functioning and consequently a run extends at right angles to the knitted rows. There is no break in the yarn and consequently the spacing between the rows is the same whether there is a run or not. Thus, referring to Fig. 5 which is a view taken on the line 5—5 of Fig. 4, showing the testing finger 148 which is adapted to move at right angles to the rows (or parallel to the ribs) and has a testing head 150 which has a vertical height greater than the distance between two adjacent rows 152 and 154, but less than the distance between alternate rows 152 and 156. If the testing finger is moved vertically over the rows 152, 154, and 156, or if the fabric is moved over the testing finger in this manner, the testing finger will not detect a run, particularly where only one or two knitting needles have failed to function. The yarn at this particular point in the rows 152, 154, and 156 stretches tightly across the stretching surface and the yarn will support the head 150 and hold it out of engagement with the electrically conductive annulus. In Fig. 6, however, which is taken on the line 6—6 of Fig. 4, it is shown that the same form of finger which is adapted to move parallel to the rows (or at right angles to the ribs) and which has the same size of head will drop into the space 158 which is twice the space between adjacent stitches because one needle has failed to function. As previously mentioned, the particular needle along the line 8 (Figure 4) did not re-pickup with the result that there is a double width ladder 11 which constitutes a fine run which in turn produces the space 158 just mentioned, the stitches 162 and 164 having substantially twice the normal space between them.

Having thus described our invention, what we claim is:

1. A circular fabric knitting machine comprising a frame, a cylinder mounted thereon, knitting equipment mounted on the periphery of the cylinder, a shaft disposed on the axis of the cylinder, said cylinder and said shaft being mounted for relative rotation therebetween, a flaw detector wheel mounted on said shaft, pressure rolls for drawing knitted fabric from the knitting cylinder over the flaw detector wheel as knitted, an electrical conductive finger mounted on the periphery of the expander ring, an electrically conductive annulus mounted around the flaw detector wheel, the cross-sectional configuration of the inner surface of said annulus and of the peripheral edge of said expander ring being such that a portion of said peripheral edge extends into an interfitting relation with said inner surface and a portion of said inner surface likewise extends into interfitting relation with peripheral edge, conductors to the finger and the annulus forming a circuit when the finger engages the annulus, and means for stopping the machine disposed in said circuit adapted to be activated when said finger engages said annulus.

2. The knitting machine described in claim 1 wherein the flaw detector wheel has an outwardly directed peripheral channel penetrated by the finger and the annulus has an annular rub line

extending into the channel in lateral alignment with the finger.

3. The knitting machine described in claim 2 wherein the annulus has an annular inwardly directed shoulder on the upper side of the flaw detector wheel for additionally stretching the fabric.

4. The knitting machine of claim 1 wherein the conductor to the finger extends up a hole in the shaft to a point above the knitting stations and thence by brush and slip ring to the frame.

5. A flaw detector attachment for a circular fabric knitting machine having a center stem and a knitting cylinder mounted for relative rotation therebetween comprising a wheel for rigid mounting on the bottom of the said shaft, said wheel having a peripheral outwardly directed groove therein, an electrically conductive finger mounted on the periphery of the wheel, an electrically conductive annulus for mounting on the fixed frame of the knitting machine around the wheel, said annulus having a cross-sectional configuration such that a portion thereof extends into interfitting relation with the peripheral edge of said wheel, a spring urging said finger against said portion of said annulus, electrical conductors forming a circuit through said finger and said annulus, and means for stopping the machine disposed in said circuit adapted to be activated when said finger engages said annulus.

6. In a circular fabric knitting machine adapted to produce a tube of knitted fabric and having a flaw detector wheel and a knitting cylinder mounted for relative rotation therebetween, pressure rollers for drawing said knitted fabric from the knitting cylinder over the expander ring as knitted, an electrically conductive annulus positioned around the expander ring, the adjacent surfaces of said expander ring and said annulus both having substantially complementary cross-sectional configurations such that a portion of said annulus extends into interfitting relation with said expander ring, an electrically conductive finger mounted on the periphery of the expander ring in an engageable relation with the annulus, conductors to the finger and the annulus forming a circuit when the finger engages the annulus, and means for stopping the machine disposed in said circuit adapted to be activated when said finger engages said annulus.

7. A circular fabric knitting machine comprising a frame, a cylinder mounted thereon, pressure rollers for holding the resulting tube of knitted fabric at a selected tension, a testing finger positioned inside the tube of fabric and pressed against the interior surface thereof, the head of said testing finger having a width less than the distance between adjacent knitted rows and a length greater than the distance between adjacent stitches but less than the distance between alternated stitches, and said cylinder and said testing finger being mounted for relative rotation therebetween so that said testing finger moves around the inside of the tube along a line substantially parallel to the knitted rows.

8. A fabric knitting machine comprising a frame, a cylinder mounted thereon, a vertical shaft, said cylinder and said shaft being mounted for relative rotation therebetween, a dial disposed on said shaft in association with and in secured relation to said cylinder, knitting equipment mounted on the periphery of said cylinder, a flaw detector wheel secured to said vertical shaft, means for drawing knitted fabric from the knitting cylinder over the flaw detector wheel as knitted, an electrical conductive finger mounted on the periphery of the expander ring, an electrically conductive annulus mounted around the flaw detector wheel, the cross-sectional configuration of the inner surface of said annulus and of the peripheral edge of said flaw detector wheel being such that a portion of said peripheral edge extends into an interfitting relation with said inner surface and a portion of said inner surface likewise extends into interfitting relation with peripheral edge, conductors to the finger and the annulus forming a circuit when the finger engages the annulus, and means for stopping the machine disposed in said circuit adapted to be activated when said finger engages said annulus.

9. In a fabric knitting machine adapted to knit a continuous tube of fabric, a flaw detector wheel disposed so as to normally be within said tube of fabric, an annulus encircling said flaw detector wheel so that said tube of fabric normally passes between said ring and said annulus, the adjacent surfaces of said flaw detector wheel and said annulus both having substantially complementary cross-sectional configurations such that a portion of said annulus extends into interfitting relation with said expander ring, and an electrically conductive detector finger disposed so as to normally bear against said tube of fabric at a point between said annulus and said flaw detector wheel, means for producing relative motion between said detector finger and said tube of fabric as said fabric is knitted, said detector finger being adapted to close an electrical circuit when it enters a flaw in the form of an opening in said tube of fabric, and means for stopping the machine disposed in said circuit adapted to be activated when said finger engages said annulus.

10. In a fabric knitting machine adapted to knit a continuous tube of fabric, a flaw detector wheel disposed so as to normally be within said tube of fabric, an annulus encircling said flaw detector wheel so that said tube of fabric normally passes between said ring and said annulus, the adjacent surfaces of said flaw detector wheel and said annulus both having substantially complementary cross-sectional configurations such that a portion of said annulus extends into interfitting relation with said flaw detector wheel, means for producing relative motion between said flaw detector wheel and said tube of fabric as said fabric is knitted, an electrically conductive detector finger disposed on said rotatable flaw detector wheel so as to normally bear against said tube of fabric at a point between said annulus and said flaw detector wheel and to close an electrical circuit when it enters a flaw in the form of an opening in said tube of fabric and engages said annulus, and means for stopping the machine disposed in said circuit adapted to be activated when said finger engages said annulus.

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References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
1,097,503	Anthony	May 19, 1914
1,784,446	Jennings	Dec. 9, 1930
2,017,949	Cobb	Oct. 22, 1935
2,140,087	Newell	Dec. 13, 1938
2,357,712	Vossen	Sept. 5, 1944
2,357,714	Vossen et al.	Sept. 5, 1944
2,422,514	Allen	June 17, 1947
2,448,639	Washsman	Sept. 7, 1948