Dec. 27, 1966 R. O. WELLER 3,293,760

YARN FEED CALCULATOR

Filed June 19, 1964 2 Sheets-Sheet 1

FIG. 1

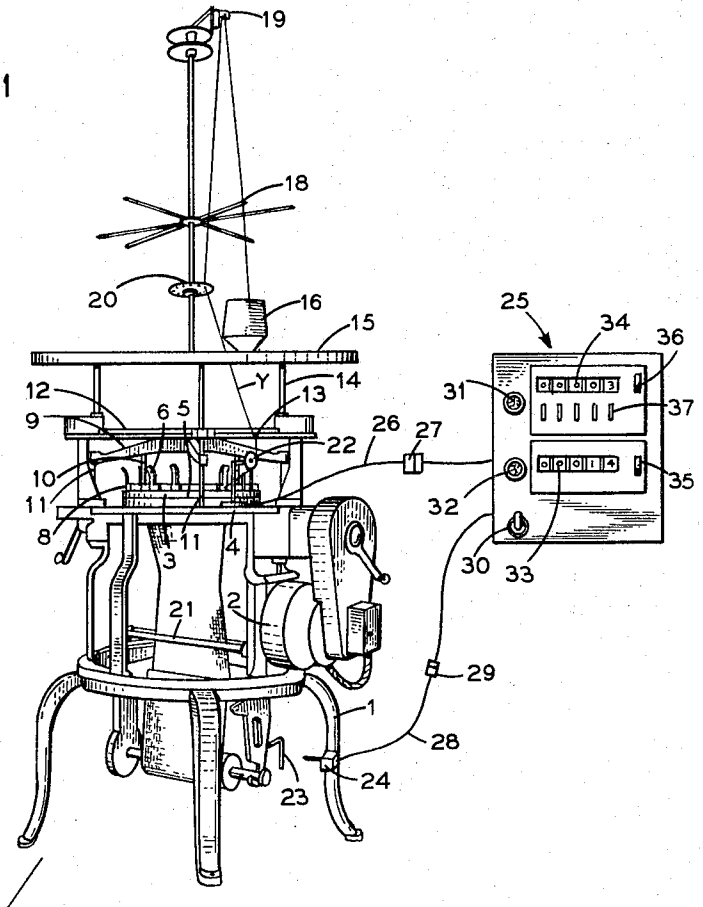
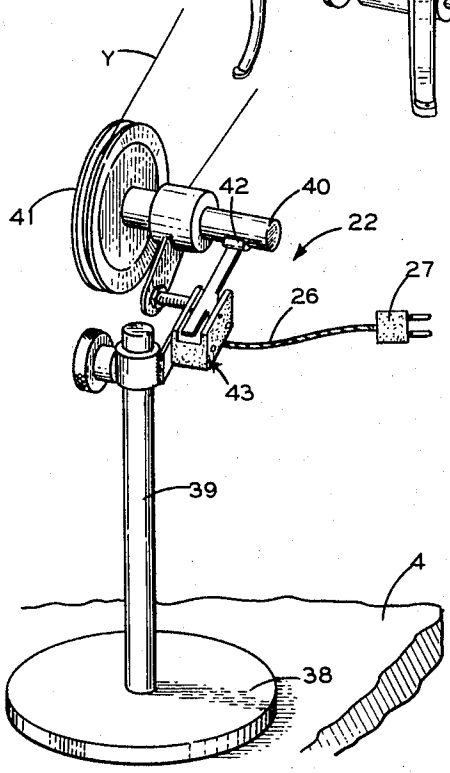


FIG. 2

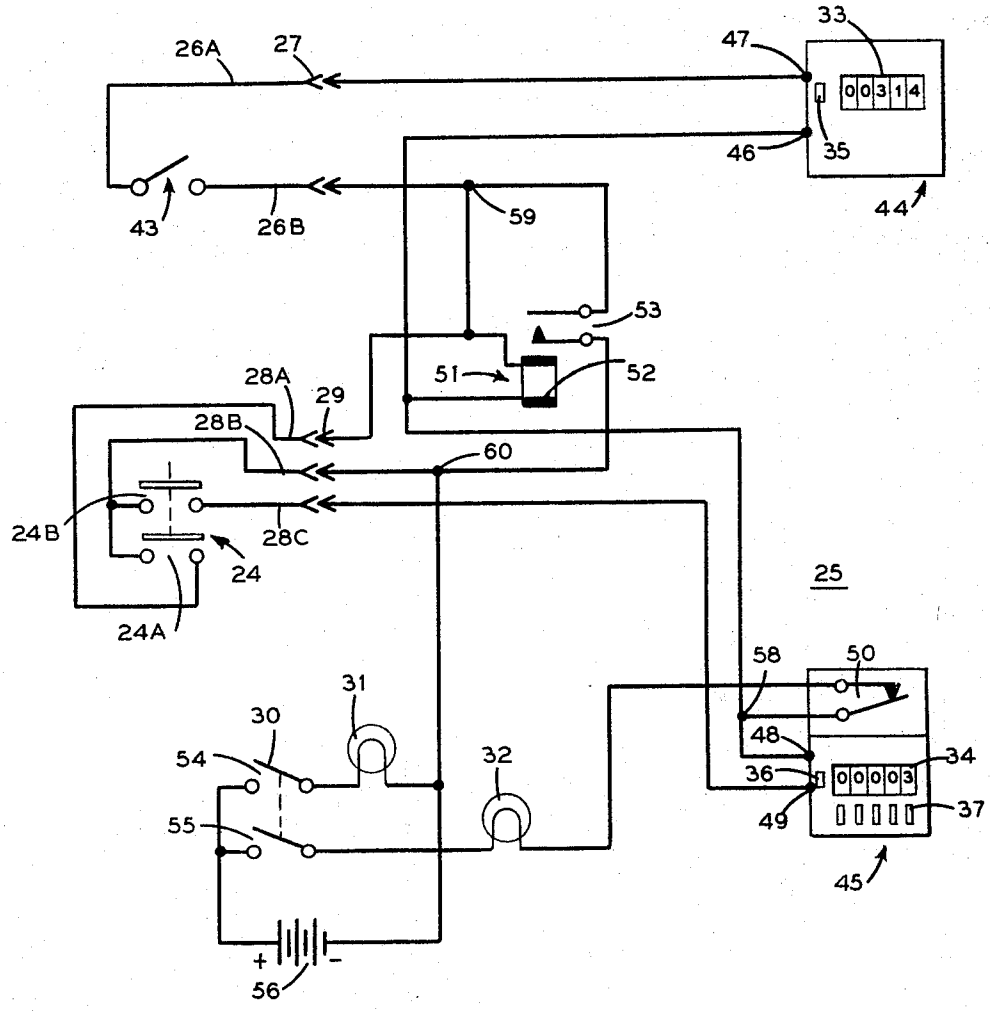


Dec. 27, 1966 R. O. WELLER 3,293,760

YARN FEED CALCULATOR

Filed June 19, 1964 2 Sheets-Sheet 2

FIG. 3



United States Patent Office 3,293,760
Patented Dec. 27, 1966

3,293,760

YARN FEED CALCULATOR

Robert Oswald Weller, Reinsfeld, Germany, assignor to Uniwave Inc., Farmingdale, N.Y., a corporation of New York

Filed June 19, 1964, Ser. No. 376,349
4 Claims. (Cl. 33—129)

This invention relates to the manufacture of knitted fabric and more particularly to the measurement and indication of the amount of yarn used during manufacture of knitted fabric.

Although this invention will be described hereinbelow as applied to circular knitting machinery, this invention may be used to advantage with any known mechanism for linking yarn, thread or other fibers into fabrics by either weaving or knitting processes.

In a circular knitting machine, each yarn which is directed to the needles is formed by the needles into a row or course of loops which are combined by the needles in various ways with preceding rows or courses of loops to form the fabric.

The quality of the knitted fabric is related to the length of the stitches. If the stitch length varies, the density of the weave varies and the weight of yarn per length of fabric varies. Furthermore, the evenness of the fabric is a function of stitch length. Accordingly, to maintain the uniform quality of the fabric it is necessary to control stitch length. In a circular knitting machine this can be accomplished generally by controlling the length of travel of the needles. It is also possible to control stitch length by controlling the tension of the yarn.

Generally, in order to control stitch length it is necessary to know the length of the stitch or an equivalent thereof. The length of a stitch can be determined by the quantity of yarn fed to a needle. Therefore, it is simpler to measure the quantity of yarn fed to the needles and therefrom obtain an indication of stitch length. In the past, devices have been provided in attempts to perform this measurement. A first class of these devices measures yarn feed speed to the needles and are in a sense tachometers. Such rate measuring devices while giving fast readings are unsuitable in most practical applications. The readings from one knitting machine cannot easily be transferred to for use with another knitting machine when it is desired that the second machine duplicate the knitting pattern of the first machine since the machines may be rotating at different speeds. Consequently, the rate of yarn feed is different while the amount of yarn per revolution is the same.

Accordingly, it is more desirable to measure actual length of yarn feed to indicate stitch length since an absolute instead of a relative quantity is measured. Heretofore, attempts have been made to measure the length of yarn used by circular knitting machines per operating revolution of the machine. In such attempts, a technician precisely and slowly rotates the machine through one or two revolutions starting at a known starting point and ending at that point. At the same time, an odometer and pulley arrangement driven by the yarn fed to the needles measures the length of yarn used. Such a scheme has two disadvantages. First, it is slow. Second, it is inaccurate. It is inaccurate because the amount of yarn used is not the same as that used under actual high-speed operating conditions. Under such conditions inertial and other forces cause the needles to travel greater distances than under hand driven slow speed conditions. In order to remove this inaccuracy attempts have been made to rotate the machine under actual operating conditions by starting and stopping it after a number of revolutions. However, the final coasting of the machine to a stop prevents the actual stopping to occur at a precise point. In addition, the periods of time during acceleration and deceleration introduce further inaccuracies. These inaccuracies can be minimized by allowing the machine to rotate through hundreds of revolutions. However, this is both time consuming and wasteful of yarn.

It is, accordingly, a general object of the invention to provide an improved quality control instrument for knitting machines.

It is another object of the invention to provide an improved quality control instrument for circular knitting machines which can give an indication of stitch length in terms of yarn used in a knitting course.

It is a further object of the invention to provide an instrument of indicating stitch length indirectly as length of yarn per knitting course which is insensitive to operating speeds of the knitting machine.

It is yet another object of the invention to provide an improved stitch length indicating instrument for knitting machines which by measuring aboslute lengths of yarn in a knitting course yields fast, reliable and reproducible measurements.

It is a still further object of the invention to provide an improved method of indicating the length of yarn used per knitting cycle of a knitting machine.

Briefly, the invention contemplates indicating the length of yarn moving from a source of yarn to a knitting machine in at least one knitting course by registering the units of length of yarn so fed while the knitting machine is operating and simultaneously registering a given number of knitting courses.

It should be noted that in accordance with the invention there is no need to start and stop the knitting machine to perform the measurement.

Other objects, and the features and advantages of the invention will be apparent from the following deailed description when read with the accompanying drawings which show, by way of example and not limitation the now preferred embodiment of the invention.

In the drawings:

FIGURE 1 is a skeleton perspective view of a circular knitting machine in which the invention may be embodied;

FIGURE 2 is a perspective view of the yarn length meter incorporated in the invention; and

FIGURE 3 is a schematic diagram of the circuitry of yarn feed calculator in accordance with the invention.

Referring now to FIGURE 1, a circular knitting machine is shown having the usual frame **1** and is driven by motor **2**. The usual revolving needle cylinder **3** contains needles arranged vertically and is supported by the usual stationary bedplate **4**. There is also a dial **5** whose needles cooperate with the cylinder needles in the production of rib fabric. There is a plurality of yarn guides **6** which feed yarns directly to the needles in the usual manner. These yarn guides **6** are carried on the stationary dial cap **8** which in turn is supported on a cross bar or spider **9**. The spider is supported from the bedplate **4** by posts **11**. There are posts **10** which extend downward from the spider and serve to prevent rotation of the dial cap **8**. There are posts **14** also extending above the spider. The spider does not revolve. Mounted above the spider **9** is a dial gear guard ring **12**. Around the periphery of this ring are eyes **13** through which the yarns Y pass down to the yarn guides **6**. This guard ring **12** is supported in part by the long posts **14** and in part by housings for the dial gear drive. The long posts extend above the guard ring some distance to assist in supporting a yarn bobbin stand **15**. The yarn cones **16** rest on the bracket **15**. Preferably, the yarn from the cones **16** first passes upwardly through eyes **18** to droppers **19** supported well above the rest of the machine and thence downwardly

through a guide circle 20 to the eyes 13 in the guard ring 12.

One of the yarns passes over yarn length meter 22 to the needles on needle cylinder 3 via yarn guides 6. There is also provided the usual rotating fabric takeup mechanism 21 near the bottom of the frame. Fixed to mechanism 21 is a cam 23. Fixed to frame 1 is a cam-operated electrical switch 24 which is operated or closed by cam 23 once per revolution of takeup mechanism 21.

As will hereinafter become apparent meter 22 is electrically connected to indicator 25. Accordingly, electrical cable 26 leads from meter 22 to indicator 25. Similarly, cam-operated electrical switch 24 is electrically connected to indicator 25 by electrical cable 28. It should be noted that jacks 27 and 29 permit the rapid disconnection of indicator 25 so that it can be used with another knitting machine.

Indicator 25 includes an on-off switch 30, lamps 31 and 32, two electromechanical counters and associated electrical circuitry. Associated with each counter is a digital indicating dial. Dial 33 of the first counter indicates units of length of yarn passing over meter 22 to the needles. Dial 34 of the second counter indicates revolution of takeup mechanism 21. The first counter is provided with a reset button 35 to reset the counter to zero. The second counter is not only provided with a similar reset button 36 but also with preset wheels 37 to manually preset the counter to an initial count. The operation of the counters is hereinafter described.

Referring now to FIGURE 2 the yarn length meter 22 which is on bed plate 4 includes a base 38 from which extends an upright 39 supporting a journaled shaft 40. Fixed to shaft 40 is a pulley wheel 41 of known diameter. Also fixed to shaft 40 is a cam 42. A cam-operated electrical switch 43 is positioned in the path of cam 42. Wires 26 from switch 43 lead to jack 27. Therefore, as yarn Y moves to the needles it rotates pulley wheel 41 causing cam 42 to periodically close cam-operated electrical switch 43. Since the diameter of pulley wheel 41 is known each switch closure indicates that a known absolute length of yarn has been fed to the needles.

The electrical details of the indicator 25 are shown in FIGURE 3. Indicator 25 includes the impulse counter 44, a conventional electromechanical counter which accumulates in mechanical register wheels the count of electrical impulses received via terminals 46 and 47. These impulses are generated by cam-operated electrical switch 43. The count is displayed digitally by dial 33 and represents the units of length of yarn passing over pulley wheel 41. The impulse counter 44 can be cleared by depressing push button 35. Impulse counter 45 is also a conventional electromechanical counter which accumulates electrical impulses received at terminals 48 and 49 from cam-operated electrical switch 24. The count of the impulses is displayed digitally by dial 34. Impulse counter 45 also includes a mechanical reset button 36. In addition, counter 45 includes wheels 37 which permit the presetting of the counter 45 to a particular count. Thereafter, the counter 45 will count down to zero. In other words, each received impulse will cause a unit subtraction of the preset count. Impulse counter 45 also includes a switch 50. Switch means 50 is open whenever the registered count is zero and is closed at all other times. Although any conventional counters having these properties can be used, in the working embodiment of the invention, the counters actually were supplied by J. Hengstler KG., Germany. Included in indicator 25 is the normally open single-pole single-throw relay 51 including the coil 52 and normally open contact set 53; the double-pole single-throw on-off toggle switch 30 including contact sets 54 and 55; the battery 56 (a source of electrical energy); and indicator lamps 31 and 32.

The operation of the apparatus will now be described. Generally, the impulse counter 45 is preset to count a given number of revolutions of the takeup mechanism 21 (FIGURE 1) i.e. knitting courses. During this count, impulse counter 44 is rendered responsive to electrical impulses received from cam-operated switch 43 and effectively counts absolute units of length of yarn fed to the needles via pulley wheel 41 (FIGURE 2). Impulse counter 45 counts down from its preset value and when it reaches zero, power is removed from the apparatus and the count then present in counter 44 is frozen. This count indicates the units of length of yarn fed to the needles for a given number of revolutions of takeup mechanism 21 or knitting courses. Since pulley wheel 41 has a known diameter and since each impulse counted by impulse counter 44 represents one rotation of pulley wheel 41, a simple multiplication indicates the total length of yarn fed. By dividing this total length by one less than the initial preset count in impulse counter 45 yields the length of yarn per knitting course. A further calculation can give stitch length. However, it should be noted that as a practical matter actual stitch length is not required and an indirect indication of stitch length such as the length of yarn fed per knitting course is all that is required.

The operation of the apparatus will now be described in detail. Initially, with yarn length meter 22 in place, the technician presets impulse counter 45 through the agency of wheels 37 to a number, for example, five. The contact set of switch 50 closes since impulse counter 45 is registering a number other than zero. The technician now closes on-off switch 30. Power on-off indicator lamp 31 ignites by virtue of the path established by contact set 54 between the positive and negative terminals of battery 56. Nothing further happens until cam 23 (FIGURE 1) momentarily closes cam-operated electrical switch 24. It should be noted that although during the time before the first closing of switch 24, cam-operated electrical switch 43 is opening and closing, no electrical impulses are fed to impulse counter 44. In particular, the circuit feeding counter 44 starts at the positive terminal of battery 56 passes via now closed contact set 55, lamp 32, closed switch 50, junction 58, impulse counter 44, cam-operated electrical switch 43 to junction 59. From junction 59 the return to the negative terminal of the battery 56 is either via the contact set 53 of relay 51 to junction 60 or via lead 28A, contact set 24A and lead 28B to junction 60. Since, initially, the contact set 53 of relay 51 is open, pulsing of impulse counter 44 can then only occur if switches 24 and 43 are simultaneously operated. Therefore, there will be accumulated an impulse in impulse counter 44 when cam-operated electrical switch 43 is closed only when relay 51 is energized or when cam-operated electrical switch 43 simultaneously operates. Generally, simultaneous operation is the exception. In any event, the first operation of cam-operation switch 24 closes a circuit from junction 58 (now connected to the positive terminal of battery 56) via relay coil 51, lead 28A, contact set 24A, and lead 28B to junction 60 connected to the negative terminal of battery 56. Contact set 53 of relay 51 closes and is latched closed. Lamp 32 ignites indicating that the counting operation is in progress. The latching circuit is from coil 52 via junction 59 and contact set 53 to junction 60.

In addition, every operation of cam-operated electrical switch 24 by cam 23 closes a circuit from junction 58 via counter terminals 48 and 49, lead 28C, contact set 24B and lead 28B to junction 60. In this manner, electrical impulses are generated by cam-operated electrical switch 24 and are counted by impulse counter 45.

Once the contact set 53 of relay 51 is closed and latched, each operation of cam-operated electrical switch 43 by cam 42 (FIGURE 2) results in an electrical impulse being fed to impulse counter 44. Each electrical impulse received by impulse counter 44 results in the adding of one to the accumulation indicated on dial 33.

Each electrical impulse received by impulse counter 45

results in the subtracting of one from the preset count. When impulse counter **45** counts down to zero as a result of the fifth operation of cam-operated electrical switch **24** for the example given, switch means **50** opens to remove all voltage from the system. Accordingly, lamp **32** is extinguished, indicating the counting process is finished, and no further electrical impulses can be generated even though cam-operated electrical switches **24** and **43** are still periodically operated by their respective cams **23** and **42**.

It should be noted that cam **23** operated cam-operated electrical switch **24** five times. During that time takeup mechanism **21** (FIGURE 1) rotated four times plus the insignificant portion of a rotation to allow the fifth operation of cam-operated electrical switch **24**. Therefore, the number of knitting courses is always one less than the count to which impulse counter **45** is preset. The error introduced by the fraction of a revolution is insignificant and can be made even less by increasing the number of knitting courses during the measuring run. The second source of error concerns the electrical impulses generated by cam-operated electrical switch **43**. The accuracy is to within one electrical impulse. Therefore, by employing smaller diameter pulley wheels or increasing the number of knitting courses this error can be minimized.

There has thus been shown a method and apparatus for indirectly indicating stitch length which, since it measures absolute units of length of yarn as opposed to the rate of feed of yarn, is extremely accurate and easily reproducible from knitting machine to knitting machine.

Although the impulses to be counted are shown as being generated by cam-operated electrical switches, these impulses could be generated by: a segmented conductive commutator; a capacitive commutator; a magnetic pulsing device wherein a rotating element which includes magnets moves past a magnetic head or a rotating shielding vane can break a magnetic field; a photoelectric means wherein a rotating element interrupts a light beam; etc.

While the embodiment shows only the measurement of yarn used for knitting course and from this measurement a technician can adjust the knitting mechanism to the desired stitch length, it should be apparent that the indicator **25** could be incorporated in a servosystem wherein the count in impulse counter **44** is converted to an electrical signal which drives a servomotor to adjust the knitting mechanism. However, this and other variations while satisfying the objects and gaining the advantages of the invention do not depart from its spirit as defined in the appended claims.

What is claimed is:

1. Apparatus for indicating the length of yarn fed from a source of yarn to the knitting mechanism of a knitting machine during a predetermined number of knitting courses of the knitting machine, comprising a yarn-driven electrical switch means for closing an electrical circuit in response to the movement of a predetermined length of yarn from said source to said knitting mechanism, a source of electrical energy, a first electrical impulse counter, first means for serially interconnecting said source of electrical energy, said yarn-driven electrical switch means

and said first electrical impulse counter, said serially interconnecting means including a latchable electrical switch means including a control means which is energized to close an electrical circuit from said source of electrical energy to said first electrical impulse counter only after the receipt of a pulse of electrical energy at said control means, a mechanically operated switch means which is operatively coupled to the knitting machine to close at least once during each knitting course, second means for serially interconnecting said mechanically operated switch means, said source of electrical energy and the control means of said latchable electrical switch means so that electrical energy is transmitted to said control means at least the first time said mechanically operated switch means closes while said latchable electrical switch means is deenergized, a second electrical impulse counter, third means for serially interconnecting said source of electrical energy, said mechanically operated switch means and said second electrical impulse counter whereby each time said mechanically operated switch means closes a pulse of electrical energy is received by said second electrical impulse counter, and deenergizing means connected to said second electrical impulse counter for deenergizing said latchable switch means when said second electrical impulse counter counts a number of electrical pulses related to the predetermined number of knitting courses.

2. The apparatus of claim **1** wherein said yarn-driven electrical switch means comprises a rotatable pulley over which the yarn runs, a cam driven by said pulley and an electrical switch operated by the cam driven by said pulley.

3. The apparatus of claim **1** wherein said knitting machine is a circular knitting machine which includes a rotary part which makes one revolution per knitting course, said rotary part including a cam, and wherein said mechanically operated electrical switch means includes an electrical switch which is operated by the cam on said rotary part.

4. The apparatus of claim **1** wherein said yarn-driven electrical switch means comprises a rotatable pulley over which the yarn runs, a cam driven by said pulley and an electrical switch operated by the cam driven by said pulley, wherein said knitting machine is a circular knitting machine which includes a rotary part which makes one revolution per knitting course, said rotary part including a cam, and wherein said mechanically operated electrical switch means includes an electrical switch which is operated by the cam on said rotary part.

References Cited by the Examiner

UNITED STATES PATENTS

2,673,686	3/1954	Hoffman	235—132
2,852,195	9/1958	Coleman et al.	
2,896,329	7/1959	Szabo	33—129
2,960,773	11/1960	Mott	33—134
3,099,142	7/1963	Mishcon	66—1
3,108,353	10/1963	Rust	235—132

LEONARD FORMAN *Primary Examiner.*

WILLIAM K. QUARLES, *Assistant Examiner.*