

- [54] MACHINE FEED AND OUTPUT MONITORING APPARATUS
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- [58] Field of Search: 66/1 R, 125 R, 154 A, 157; 235/92 DN, 92 PD, 92 CC, 92 TF; 250/219 S

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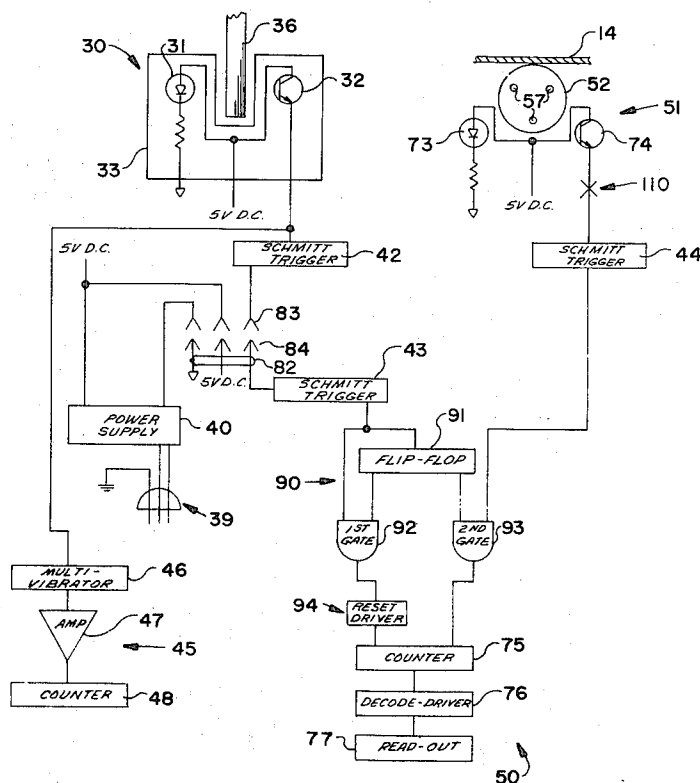
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[57] ABSTRACT

An electric pulse generator of photoelectric form emits pulses corresponding to the formation of discrete courses in a knitted fabric by a circular knitting machine. A second electric pulse generator of the same type emits pulses corresponding to units of length of yarn used in the formation of each discrete course. The two sets of pulses are shaped by shaping circuits, forming input signals for logic circuits and a counting circuit. In the logic circuits, the signals corresponding to course formation control input to the counting circuit of the signals corresponding to units of yarn length. In the counting circuit, units of length of yarn are accumulated during the formation of selected courses and visually displayed on a read-out panel. A second counting circuit may be used to accumulate a continuous count of courses in the knitted fabric. A metering unit associated with the second electric pulse generator includes a measuring-wheel-enclosing housing assembly, telescopically assembled and disassembled. The metering unit is mounted as a portable hand unit.

8 Claims, 7 Drawing Figures



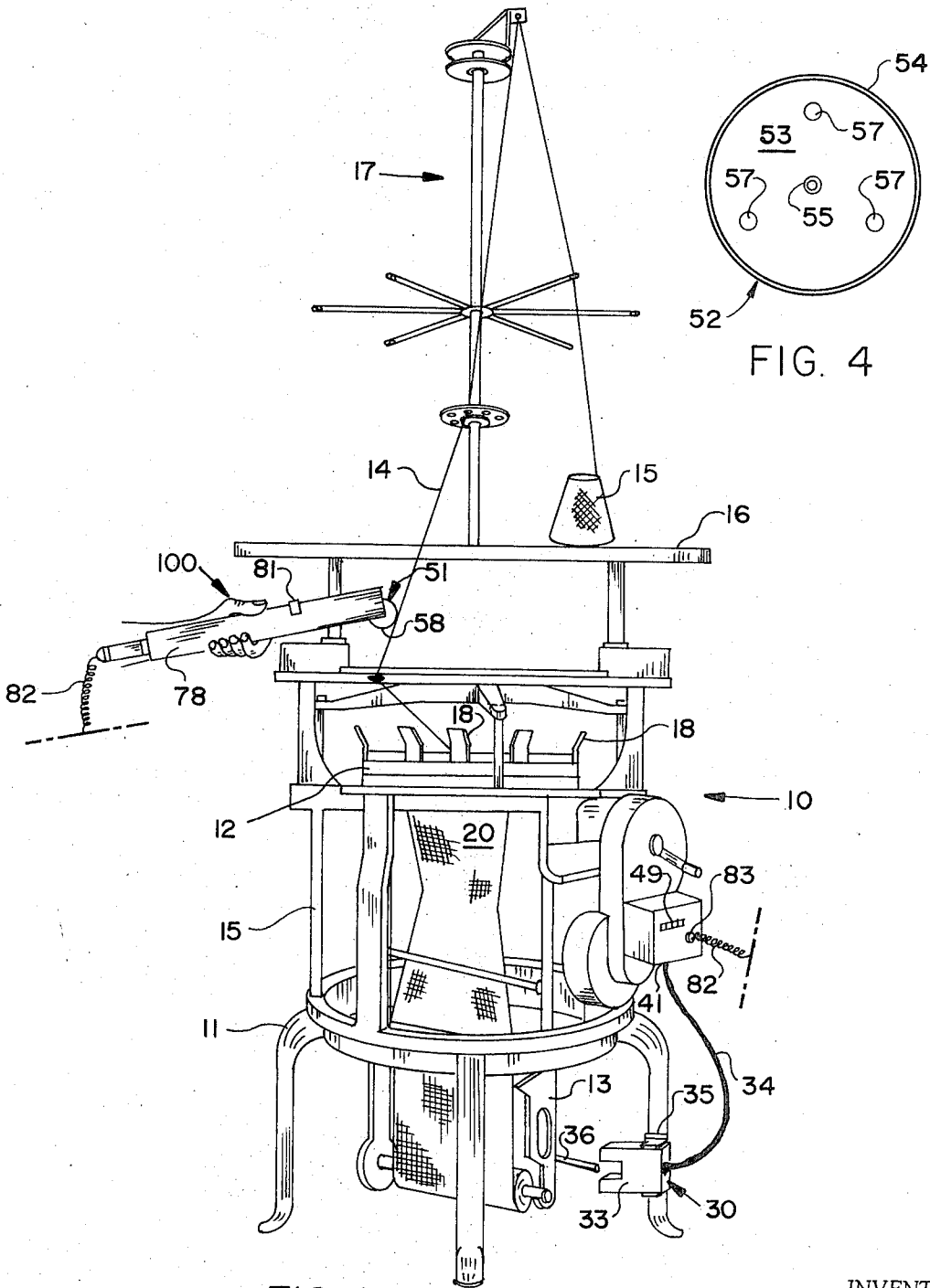


FIG. 1

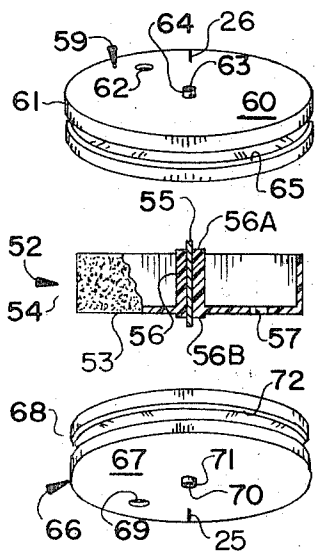
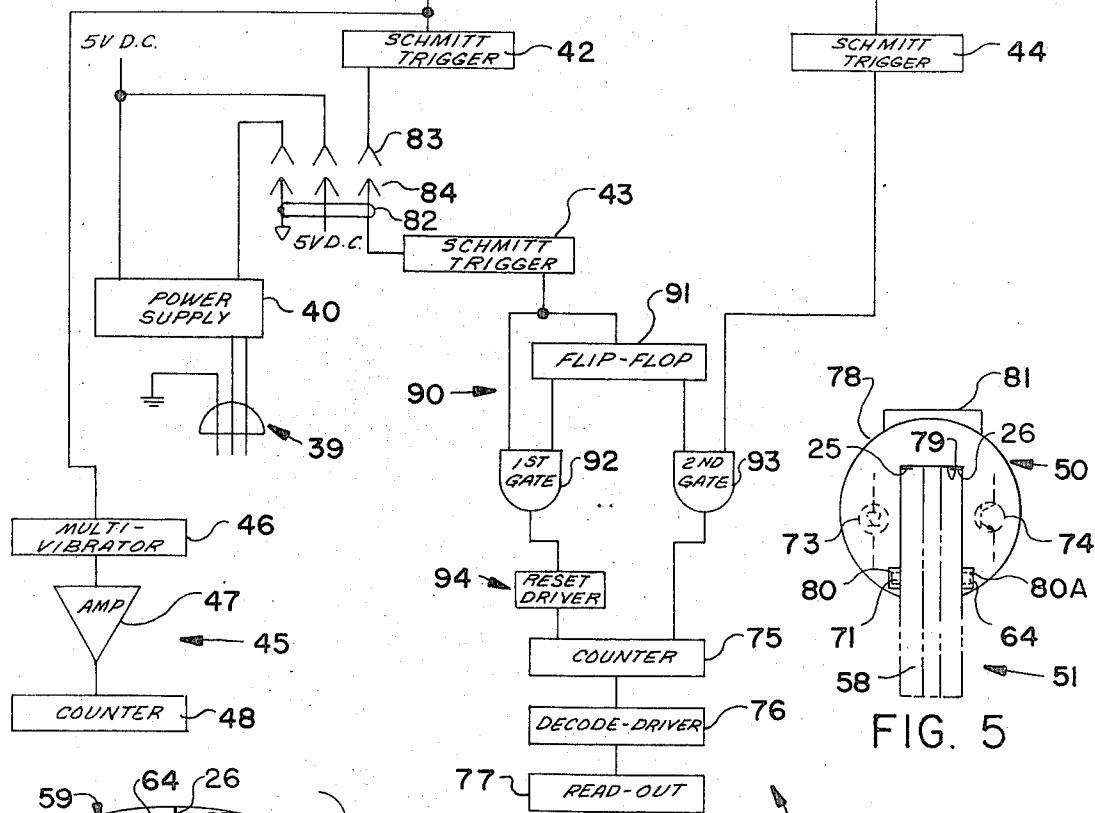
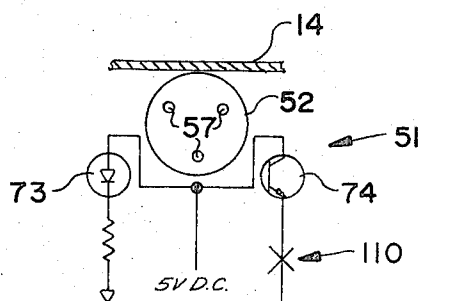
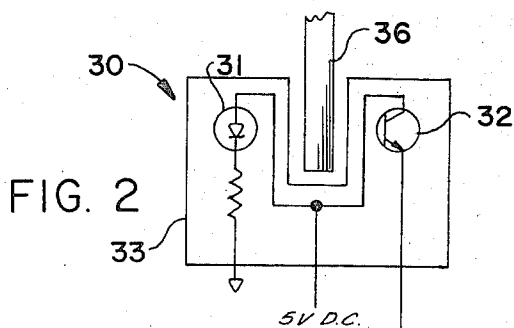
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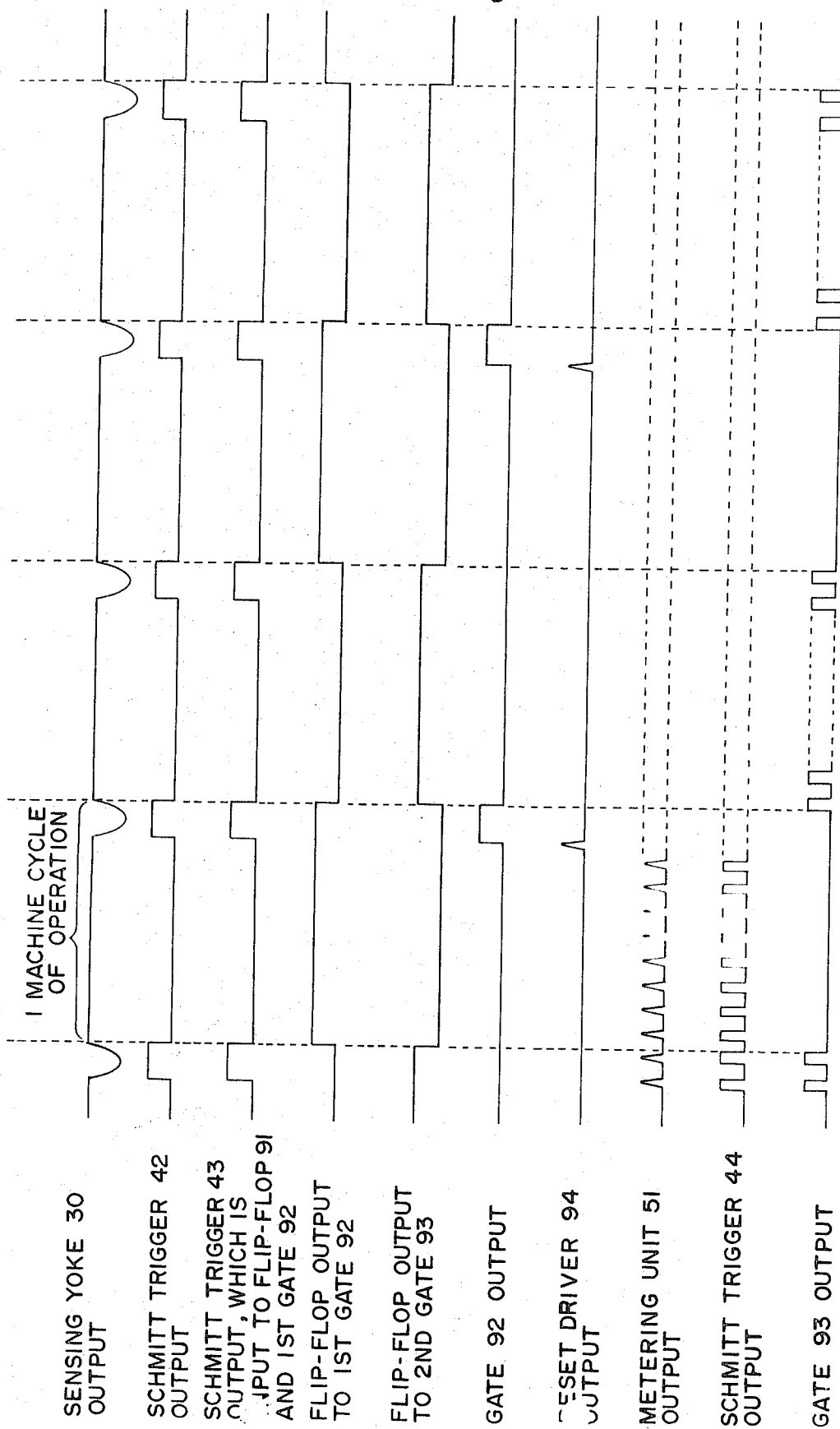
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FIG. 7



MACHINE FEED AND OUTPUT MONITORING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to devices for continuously monitoring the length of yarn used to form selected, discrete courses in fabric knitted on a circular knitting machine, including the number of courses formed in a particular portion of knitted fabric. The information thus obtained is used to perform the necessary operating adjustments and controls on knitting machines, hosiery machines and the like, so that a more uniform output from a single machine or more uniform outputs from a number of separate machines, having the same style and construction, may be attained.

Illustrative of known devices of the type in question are those disclosed in U.S. Pat. Nos. 3,566,134 and 3,293,760 and in Great Britain Pat. Nos. 1,058,073 and 1,089,194.

The known measuring devices, however, are not entirely satisfactory in all respects. Some are difficult and time consuming in that they require manual resetting of counter dials or electrical switches or the both at the end of a measuring cycle. In some instances manual actuation is required to initiate a measuring cycle. Accordingly, the operator's attention and time are devoted to resetting and actuating the device in addition to taking the measurement and making any operating adjustments that may be needed.

Also, the measuring cycle in some of the known measuring devices is excessively long, sometimes extending for ten or more machine operating cycles, thereby increasing the time required for the operator to obtain a measurement reading, respond with any necessary adjustment and re-measure to insure that the adjustment was properly made. Unduly long measuring cycles are required by some of the known devices to minimize in magnitude the error introduced because the yarn metering unit does not start and end just before or just after a pulse generating point when the yarn counting circuit is actuated and deactuated. Furthermore, in using some of the known devices the knitting machine must be completely stopped before actuating a measuring cycle. As a result, productivity of the machine and the operator is decreased and additional error due to irregular yarn feed during starting and stopping is introduced. None of the known measuring devices are believed to include a course counting capability whereby a continuous total count of the courses formed is accumulated in addition to the measurement readings that are obtained.

A common and more serious deficiency is that most if not all the known measuring devices are substantially adapted for operation at only one yarn feed station. In some instances the device is permanently mounted in association with the feed station and measures only the yarn passing therethrough. Accordingly, duplicate instruments must be mounted in association with each yarn feed station where measurements are to be taken, with a duplication of this equipment on each machine upon which such measurements are desired. One can appreciate the limitations imposed upon the use of such devices by cost considerations alone. In other instances the device is partially portable, however movement of the portable components from station to station or ma-

chine to machine frequently requires interruption of the knitting machine operation.

SUMMARY OF THE INVENTION

With the foregoing in mind, the present invention provides an apparatus for monitoring the operation of a machine and more specifically an improved apparatus for measuring the length of yarn used to form selected discrete courses in a knitted fabric; which apparatus is of a simple, highly compact and durable construction having no manually operated resetting and/or actuating controls to divert the operator's attention from measurement taking and adjustment making; which has a measuring time of one machine-cycle duration during which one discrete course is formed and has a hold time of at least one subsequent machine-cycle duration during which the measurement is held on a visual read-out panel; which has a high degree of accuracy, notwithstanding a measuring time of only one machine-cycle duration; which avoids the need to interrupt the machine's operation when a measurement cycle is initiated or when the apparatus is moved from station to station on a machine or moved from machine to machine; and which includes a course counting capability to accumulate total course count in the knitted fabric.

In a preferred embodiment of the invention an electric pulse generator unit is attached, as by clipping in a mounting bracket for example, to the stationary portion of a circular knitting machine. The generator unit selected is of the photoelectric type, although pulse generating units of other types such as magnetic sensing, micro-switch-mechanical and the like are also suitable for use with the invention. The pulse generator unit, when attached to the machine, is positioned so that the photoelectric beam thereof is interrupted each time the machine completes one cycle of operation by an interrupting device attached to a rotating portion of the knitting machine. Pulses emitted from the electric pulse generator correspond to the formation of discrete courses, and are fed into a counting circuit associated with the knitting machine for accumulation on the dial thereof. The course counter, preferably, is a presettable electro-mechanical type counter that can be preset to actuate a stop mechanism, thereby stopping the knitting machine after a preselected number of courses to provide knit goods of uniform course length.

A second electric pulse generator of the same type has included therewith a metering unit adapted for manual positioning in measuring contact with a yarn as it is fed into operative portions of the knitting machine. As a result, pulses are generated therefrom that correspond to units of length of the yarn fed.

The second pulse generator is mounted in an elongated housing having the form of a hand unit adapted for manual positioning of the metering unit in measuring contact with selected feed yarns, and includes a counting circuit to count the pulses corresponding to units of yarn length measured. Also, the hand unit includes a control-circuit to actuate and deactuate the counting circuit through successive cycles of measure-hold-reset. The control circuit itself is controlled by signals derived from the first electrical pulse generator and establishes a measuring time of one machine-cycle duration, a hold time of at least one subsequent machine-cycle duration or unitary multiples thereof and resets the counter circuit immediately preceding the

next machine-cycle of operation which becomes the measure portion of a repeated measure-hold-reset cycle. The measure-hold-reset cycle is repeated as long as the hand unit is held in measuring contact with the feed yarn.

Electrical interconnecting means, including mating contacts, interconnect the hand unit components of the monitoring apparatus with the machine based components, allowing an operator to carry the hand unit components, which are normally the more expensive parts of the apparatus, from machine to machine. In this manner costly duplication is avoided. With slight modification, the entire apparatus can be substantially portable, requiring only the mounting bracket attached to a stationary portion of the machine and the interrupting device attached to a rotating portion of the machine as the machine based components. The remaining components of the monitoring apparatus would be moved from machine to machine.

The metering unit of the second pulse generator includes a wheel of known circumference rotatably mounted in a two part telescopically assembled housing. An elongated slot extending part way around the housing's outer periphery allows measuring-contact between a feed yarn, for measurement taking purposes, and the wheel enclosed therein. A readout display panel is positioned on the elongated hand unit housing in spatial alignment with the metering unit so that when the hand unit is held in the position for convenient viewing of the read-out display, the metering unit is at a proper cant for measuring contact with a feed yarn.

DESCRIPTION OF THE DRAWING

The foregoing and other features and advantages of the invention will be in part evident and in part pointed out in the following description of an illustrative embodiment thereof, which should be read in conjunction with the accompanying drawings, in which:

FIG. 1 is an environmental view showing the present invention as contemplated for use with a circular knitting machine;

FIG. 2 illustrates a circuit for measuring in repeating measure-hold-reset cycles the length of yarn forming one course in a knitted fabric, and includes a circuit for accumulating the total course count;

FIG. 3 illustrates an exploded view, with parts in section, of the housing assembly and wheel of the present invention;

FIG. 4 is a plan view of a component of the metering unit, comprising the wheel portion thereof;

FIG. 5 is a view of the hand unit, looking from the front, showing, in phantom lines, the metering unit positioned therein;

FIG. 6 is an assembled view in cross-section of the components illustrated in FIG. 3; and

FIG. 7 illustrates schematically the signal train of the circuits in FIG. 2.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The machine shown in FIG. 1 is a conventional circular knitting machine 10 and is included to illustrate an environmental application of the invention in its preferred embodiment. The knitting machine 10 generally includes a stationary support frame 11 with rotating elements, such as rotating cylinder 12 having associated therewith take-up mechanism 13, which elements com-

plete one rotation for each cycle of operation of the machine 10 during which one discrete course is formed into the machine output of knitted fabric 20.

An elongated input material, such as yarn 14, is fed to an operative position (not shown) of cylinder 12 by a yarn guide 18 mounted on some portion of the machine 10, generally in proximity with the cylinder 12. Yarn 14 is supplied to the yarn guide 18 from a cone 15, suitably located on a yarn supply stand 16, supported by the machine's frame 11. A yarn guide unit 17 receives yarn 14 from the cone 15 and controls its flow path and tension substantially from the cone 15 to the yarn guide 18.

Additional detailed explanation of the circular knitting machine is not deemed necessary for purposes of this description; the knowledge that a yarn 14 is fed into an operative portion of the rotating cylinder 12 and there, formed into a discrete course of knitted fabric 20 during each rotation of the cylinder 12, comprising a cycle of operation of the knitting machine 10, is sufficient for an understanding of the present invention, its application and use, in the preferred embodiment. While FIG. 1 shows only one feed yarn 14, a plurality of separate yarns would normally be fed, each to separate operative portions of the rotating cylinder 12 where each would form simultaneously a course-output each cycle of operation of the machine 10.

Problems associated with obtaining uniform output from a circular knitting machine, hosiery machine and the like and from a plurality of such machines all adapted to produce knitted fabric of the same type and construction have been approached by attempts to monitor the length of yarn input relative to units of fabric output and using the information thus obtained, to establish and maintain uniformity in the yarn input length.

Operation of the circular knitting machine 10 is monitored by the apparatus shown in FIG. 1 comprising generally, means for detecting discrete cycles of operation of the knitting machine 10, which means is referred to herein as a sensing yoke 30 and includes: an interrupting means, such as an opaque body 36, a measuring means (see FIG. 2) including a metering unit 51 mounted in an elongated housing 78 forming a hand unit for manual positioning thereof in measuring contact with the feed yarn 14; and a pulse accumulator and read-out 50 that itself includes a read-out display member 77 to provide a visual read-out of the units of lengths measured; and control means 90 (see FIG. 2) for actuating and deactuating the measuring means through repeating measure-hold-reset cycles in response to signals derived from the sensing yoke 30.

Turning now to FIG. 2, the sensing yoke 30 includes a bifurcate housing 33 (see FIG. 1), fabricated from any suitable material such as plastic, metal or the like and has mounted in one branch thereof a light source. A photosensitive device is mounted in the other branch so that light from the light source is received thereby. Preferably, the light source is a light emitting diode 31, although other light sources such as an incandescent lamp are not to be excluded, and the photosensitive device is a phototransistor 32, although, again, not limited thereto. The bifurcate housing 33 is mounted to the knitting machine frame 11 by any suitable means, a mounting bracket 35 attached to the frame 11 so that the housing 33 will be spatially held in a position to be described later being preferred.

A power supply and course counter housing 41 (see FIG. 1), generally rectangular in shape and fabricated from any suitable material such as metal or plastic, is attached to a stationary portion of the knitting machine 10, preferably, in a location accessible to the view and reach of operating personnel. Mounted in one of the walls of the power supply and course counter housing 41 is the counter display dial 49 of a course counting means 45 (see FIG. 2). A three-contact receptacle 83 is also mounted in one wall of the housing 41. Mounted inside the housing 41 are a power supply unit 40, the course counting means 45 and a signal shaping means such as a Schmitt Trigger 42.

Components requiring a 5 v. Direct Current have been selected for use in the preferred embodiment. The reason for this selection is to minimize the danger of electric shock should any of the system's interconnecting cables become severed or should the system somehow develop a short. Those familiar with electrical systems of the type herein discussed will recognize that components utilizing other voltage levels could be used if desired.

The power supply unit 40 furnishes a 5 v. Direct Current to power the monitoring apparatus and may consist of a battery pack adapted to supply the aforementioned current. Alternatively, conventional 115-220 v. Alternating Current may be used as the power source, in which case the power supply unit 40 would comprise a transformer and rectifier circuit of a type adapted to convert alternating current to Direct Current of the voltage desired. An interconnecting means 39, comprising an electrical conductor and a contact plug, would then be used to interconnect the power supply unit 40 with a conventional 115-220 v. A.C. source (not shown).

A three conductor cable 34 interconnects the sensing yoke 30 with components mounted in the course counter and power supply housing 41 (see FIGS. 1 and 2). One of the conductors delivers the 5 v. D.C. from the power supply unit 40 to the sensing yoke 30, one of the other conductors delivers the pulses from the photo-transistor 32 to the Schmitt Trigger 42 and the remaining conductor serves as a common ground for both of the first described conductors. The sensing yoke 30 output feeds also to the course counting means 45 where it is received by the input of a one-shot multivibrator 46, the output of which is fed to a driver amplifier 47. Output of the driver amplifier 47 is fed to the course counter 48 which, preferably, is a electro-mechanical counter and includes the counter display dial 49 (see FIG. 1). The course counting unit 45 is not an essential element of this invention and, accordingly, may be included or omitted without effecting the yarn measuring function to be described below.

The metering unit 51, comprising a component of the measuring means, includes an electrical pulse generator of photoelectric form, comprising a light emitting diode 73 and a phototransistor 74. Other light sources and photosensitive devices may be used in place of the ones described. The light emitting diode is selected because it has a longer life and a tendency to generate less heat than the other light sources, incandescent lamps for example, and the phototransistor is selected because of its faster response to differences in light intensity and its ability to fit into compact systems. A rotating wheel 52 of known circumference, having located radially from its center at least one opening 57, is

mounted for rotation so that the light emitting diode 73 is positioned on one side thereof and the phototransistor 74 is positioned on the other side to receive the light emitted by the diode 73 that passes through the openings 57 as the wheel 52 rotates about its axis. Rotation of the wheel 52 is brought about by frictional contact of the wheel's known circumference with the feed yarn 14 at a point before the yarn is fed into the rotating cylinder 12 (see FIG. 1).

Output of the phototransistor 74 is fed into a Schmitt Trigger 44, where it is shaped to provide a clearly defined signal front and time interval, the output of which is fed through the control means 90 to one input of a measuring counter, preferably, a decade counter 75, having two inputs feeding therein. The other input of the counter 75 connects through a reset driver 94 to the control means 90. Output of the decade counter 75 is fed to decade decode-drivers 76, the output of which is fed to the read-out display member 77, which preferably comprises a light emitting diode display panel. The decade counter 75, decade decode-drivers 76 and read-out display member 77 form a pulse accumulator and read-out 50, which combines with the metering unit 51 to provide the measuring means of the apparatus.

The control means 90, in addition to the reset drive 94 mentioned above, includes a flip flop 91 having one input and two outputs, a first AND gate 92 and a second AND gate 93, each of said AND gates having two inputs and one output. Input of the control means 90 is connected to the output of a Schmitt Trigger 43, which performs, generally, the same shaping function as the Schmitt Trigger 44. Output of the Schmitt Trigger 43 is fed to the control means by entering the flip flop 91 input and one input of the gate 92. One of the two outputs of the flip flop 91 is fed to the gate 92 through that gate's other input. The other output of the flip flop 91 is fed to one input of the gate 93, that gate's other input being connected to the Schmitt Trigger 44 output. Output of the gate 92 is fed through the reset driver 94 to one input of the counter 75, with output of the gate 93 being fed to the other input of the counter 75.

Components of the measuring means, which comprises the metering unit 51 and the pulse accumulator and read-out 50, the control means 90 and the Schmitt Trigger 43, are interconnected, as hereinbefore described, by electrical conductors and, in the preferred embodiment, mounted in an elongated housing 78 (see FIG. 1), fabricated in the form of a hand unit 100 from metal, plastic or any other suitable material. The hand unit 100 is manually positioned with the metering unit 51 in measuring contact with the yarn 14 (see FIG. 1). A display window 81 permits visual inspection of the measurement reading appearing on the read-out display member 77.

The hand unit 100 is interconnected with the power supply and course counter housing 41 through a three-conductor cable 82 (shown broken in FIG. 1), having one end connected with selected hand unit components and the other end terminating in a three-contact plug 84. The plug 84 mates with the three-contact receptacle 83 mounted on the wall of said housing 41 and permits movement of the hand unit 100 from machine to machine by merely connecting and disconnecting the contacts of the plug 84 and receptacle 83. When the plug 84 and receptacle 83 are connected, one conduc-

tor of the cable 83 interconnects the output of the Schmitt Trigger 42 to the input of the Schmitt Trigger 43 (see FIG. 2). A second conductor furnishes the 5 v. D.C. supplied by the power supply unit 40 to the light emitting diode 73, as well as to other components mounted in the housing 78 that require such current. The remaining conductor provides the ground return.

The invention is also suitable for use with knitting machines of the type having a rotating top portion supporting the yarn feeds, thereby preventing the operator from gaining access to the yarn being fed with a conventional metering device. Access can be obtained by introducing a telemetry link 110 into the circuit of the measuring means 50 at a point, preferably, between the phototransistor 74 and the Schmitt Trigger 44 (see FIG. 2). The telemetry link 110 comprises a battery powered miniature transmitter connected to the phototransistor 74 output and a receiver connected to the input of the Schmitt Trigger 44. The metering unit 51, of course, would then be provided with a suitable battery pack or other means to furnish 5 v. D.C. power.

There are many transmitter and receiver units available commercially that are suitable for establishing the telemetry link 110, therefore a detailed description of these components is not deemed necessary. Using the telemetry link 110, the metering unit 51 is stationarily mounted by magnetic base for example, on the rotating yarn feed in measuring contact with the yarn to be measured, and the remaining components normally associated with the hand unit 100, including the receiver portion of the telemetry link 110, are mounted in a suitable housing and positioned on a stationary part of the knitting machine.

The metering unit 51, FIGS. 3-6, includes a housing assembly 58 that encloses the wheel 52, hereinbefore mentioned, protecting the wheel from lint, dust and other foreign matter that might interfere with its operation. The housing assembly 58 has an upper portion 59 and a lower portion 66 (see FIG. 3), each of said portions being substantially can shaped and having dimensions that allow them to be telescopically assembled, forming thereby a housing similar in appearance to a pill box.

The upper portion 59 includes a circular top 60 that is substantially flat, with a depending wall 61 extending integrally around the periphery thereof. The top 60 has centered therein a lug 64 extending upwardly from its surface, and a bore 63 extends concentrically through the lug 64 to form a lubrication inlet and journal bearing that will be explained in more detail shortly. Also, located radially from the center of the top 60 and extending therethrough is an opening 62. The radial distance between the opening 62 and the top's center corresponds to the radial distance between the openings 57 and the center of the wheel 52. Extending peripherally part of the way around the wall 61 is a slit 65 forming an access opening for the yarn 14 when the metering unit 51 is in measuring contact therewith.

The lower portion 66, is substantially a mirror image of the upper portion 59 and includes also a circular bottom 67 that is substantially flat with an upwardly extending wall 68. The bottom 67 has centered therein a lug 71 depending therefrom and a bore 70 extending concentrically therethrough. An opening 69, corresponding to the opening 62 in the top 60, is provided in the bottom 67 and a slit 72, corresponding to the slit 65, extends part way around the wall 68.

The lower portion 66 has an outer diameter slightly smaller than the inner diameter of the upper portion 59 that permits snug telescoping assembly of the two parts as shown in FIG. 6. The shape and position of the slits 65, 72 in their respective walls are such that by relative rotation of the two portions 59, 66, when telescopically assembled, the slits are brought into overlying registry forming one slit through the peripheral wall of the housing assembly 58. When the slits 65, 72 are moved into overlying registry, the openings 62, 69, in the upper portion 59 and lower portion 66 respectively are also positioned in overlying registry, forming a passage through the housing 58 for a light beam to pass.

The upper and lower portions 59, 66 forming the housing assembly 58 may be fabricated by any suitable means such as by molding or by turning on a lathe, from any suitable non-corrosive material such as plastic, brass or the like.

The wheel 52 is rotatably mounted inside the housing assembly 58 and includes a circular body member 53, preferably of molded plastic construction, having a shaft 55 of steel or some other relatively hard, wear resistant material, embedded concentrically therein and forming the axis of rotation of the wheel. The portion of the body member 53 surrounding the shaft 55 forms a spacer sleeve 56, the upper and lower ends 56A, 56B of which protrude axially on each side of the wheel 52, spacing the wheel in the housing assembly so as to avoid contact therebetween except at the ends 56A, 56B and the journal portions of the shaft 55. A high friction surface 54 extends around the outer circumference of the wheel 52, parallel to the wheel's axis of rotation, and may be formed, for example, by attaching a fine grain abrasive coating thereto. The outer circumference formed by the high friction surface 54 is of a known dimension, that dimension being three inches for the application contemplated in the preferred embodiment of the invention. As mentioned previously, the openings 57 are spaced radially from the center of the wheel 52 the same as the openings 62, 69 from the centers of the upper and lower portions 59, 66 respectively. Also, they are spaced equidistant around the wheel 52 so that the segment of the wheel's circumference between any two of the openings 57 is 1 inch. As a result, the wheel 52 aligns one opening 57 between the openings 62, 69, permitting a light beam to pass therethrough, each inch of rotation of the high friction surface 54, thereby emitting one pulse for each inch of length measured.

The ratio of at least one pulse per unit of measurement length has been found to result in a measurement accuracy that is suitable for maintaining a satisfactory degree of control in the machine output. Therefore, a ratio of at least 1:1, pulse to unit of measurement length, is deemed necessary for a satisfactory degree of accuracy in the measurement reading. More pulses per unit of measurement length would increase the reading accuracy and might be necessary in some applications of the invention; less than one pulse per unit of measurement, while possibly acceptable in some applications, generally would not result in a satisfactory degree of accuracy. To assemble the metering unit 51, the wheel 52 is placed in the lower portion 66 with the lower end of its shaft 55 journaled in the bore 70. The upper portion 59 is telescoped over the lower portion 66, insuring that the shaft's upper end is journaled in the bore 63. The slits 65, 72 are aligned by relative ro-

tation of the two portions 59, 66, thereby also aligning the openings 62, 69.

The housing 78 (see FIG. 5) has a recess 79 in the outer end thereof having dimensions suitable for receiving a segment of the housing assembly 58 approximately equivalent to one quadrant thereof. Smaller recesses 80, 80A are also provided in the outer end of the housing 78 to receive the lugs 71, 64. The housing assembly 58, with the wheel 52 rotatably mounted therein, is pressfitted into the recess 79 so that the lugs 71, 64 are fully received by the recesses 80, 80A. Aligning means facilitate alignment of the openings 62, 69 between the light emitting diode 73 and the phototransistor 74. One form of the aligning means contemplates the use of an index mark 25, 26. With the housing assembly seated in the recess 79 it is rotated about its axis until the index mark 25, 26, provided on the outer wall thereof, is aligned with the housing 78. When this is done the openings 62, 69 are in proper alignment between the light emitting diode 73 and the phototransistor 74. Another means (not shown) for positioning the openings 62, 69 relative to the photo-light beam, which comprises a self aligning means, consists of forming those portions of the top 60 and bottom 67 that are not included in the segments received in the recess 79 in relief thereby leaving the segmented portions thereof recessed. The housing assembly 58 self aligns the openings 62, 69 therein between the light emitting diode 73 and the phototransistor 74 when the recessed segments thereof are pressfitted into the recess 79 of the hand unit housing 78. Furthermore, the relief portion of the top 60 and bottom 67 extends over the edge of the housing 78 defining the recess 79, thereby preventing entanglement of the yarn 14 between the hand unit housing 78 and the housing assembly 58 during use of the apparatus.

A tab (not shown) having an opening therein, may extend from the housing assembly in such a manner that will permit the housing assembly 58 to be reliably received in the recess 79 by a fastening means, such as a screw (not shown) passing through the tab's opening and threaded in a bore suitably tapped therefor in the housing 78.

With slight modifications the housing 41 with the elements contained therein can be converted into a portable unit so that substantially all of the monitoring apparatus can be moved from machine to machine. Either a battery pack can be used for the power source or a 115-120 v. A.C. outlet, provided sufficient outlets are located in proximity to the machines upon which the apparatus is to be used. The only machine based components needed on each machine would, therefore, be the opaque body 36 and the clamping bracket 35.

In the preferred embodiment, however, the housing unit 41, having the aforementioned elements mounted therein, and the sensing yoke 30 is provided with each knitting machine that is to be monitored. The cost of these machine based components is relatively low, considering that a course counting capability to accumulate the total count of courses as they are knitted is thus provided for each knitting machine.

The hand unit 100 has included therewith the control means 90, the two Schmitt Triggers 43, 44, the metering unit 51 and the pulse accumulator and read-out 50, all mounted in the elongated housing 78, forming with the cable 82 and contact plug 84 the aforementioned hand unit.

Having the foregoing description in mind, operation of the invention will next be discussed keeping in view that specific groupings and arrangements of the elements are for purposes of illustrating a preferred embodiment thereof and do not constitute a limitation thereto. In the preferred embodiment, the sensing yoke 30 is attached to a stationary portion of the knitting machine 11 so that the opaque body 36 attached to the take-up mechanism 13 will interrupt the light beam transmitted by the light source 31 and received by the photoelectric cell 32 each time the machine completes one cycle of operation (see FIGS. 1 and 2). Attached also to a stationary portion of the knitting machine 10 is the power supply and the course counter housing 41, having mounted therein the course counting unit 45, power supply 40 and Schmitt Trigger 42.

With the hand unit 100 interconnected with the machine based components, the metering unit 51 is manually positioned in measuring contact with the yarn 14. The operator is provided a visual read-out through display window 81 of the units of length of yarn used in forming one course of knitted fabric.

Referring to FIG. 2, each time the opaque body 36 interrupts the light beam between the light source 31 and the phototransistor 32, a pulse is emitted to the Schmitt Trigger 42. The Schmitt Trigger 42 has the function of shaping the pulse to provide a clearly defined signal front and time interval, thereby promoting a more accurate measurement read-out. The pulses emitted by the sensing yoke 30 are also fed to the course counting unit 45 and advance the counter one step for each cycle of operation of the knitting machine. When the coupling between the contact receptacle 83 and contact plug 84 is complete output of the Schmitt Trigger 42 is fed into the Schmitt Trigger 43, which reshapes the signal to remove any distortion or irregularity introduced by transmission through the cable 82 and mating contacts 83, 84, after which the signal is fed into the control means 90.

Returning now to the metering unit 51, as the yarn 14 causes the wheel 52 to rotate, the openings 57 therein rotate between the light source 73 and the phototransistor 74, permitting the light to pass therebetween and to generate a pulse. The pulses generated therefrom, correspond to inches of yarn 14 passing in measuring contact with the wheel 52, and enter the Schmitt Trigger 44. The signal emitted from the Schmitt Trigger 44, therefore, corresponds to units of length of yarn 14, while the signal emitted from the Schmitt Trigger 43 corresponds to cycles of operation of the knitting machine 10 and more specifically the formation of discrete courses in the output therefrom.

The control means 90, which is itself controlled by the signals corresponding to cycles of operation of the knitting machine, actuates, deactuates and reactuates the measuring means, more specifically the pulse accumulator and read-out 50 thereof, through continuous measuring, hold and reset cycles. Logic circuits comprising the flip flop 91, first gate 92 and the second gate 93 perform this control function and are interconnected as hereinbefore described so that as the flip flop changes states responsive to each signal received from the Schmitt Trigger 43, first one and then the other of the gates 92, 93 are actuated to respond to certain conditions as they occur at that respective gate. When the flip flop 91 is in a first position, with the second gate 93 activated while the first gate 92 is deactivated, the sec-

ond gate 93 responds to signals received from the Schmitt Trigger 44, corresponding to units of length of yarn 14, and permits those signals to enter the pulse accumulator and read-out 50 through one input of the counter 75 thereof, then to appear on the read-out 77 in the form of inches of yarn measured. This condition exists for one complete cycle of operation of knitting machine 10. When the next signal is received by the flip flop 91 from the Schmitt Trigger 43, the flip flop 91 changes to a second state, deactuating the second gate 93 and actuating the first gate 92. The gate 93 now inhibits the passage therethrough of signals from the Schmitt Trigger 44. During this time, which includes at least one cycle of operation of the knitting machine 10, the yarn measurement read-out displayed through the display window 81 is held for operator viewing. If a hold time of more than one cycle of operation is desired, which might be desirable when the apparatus is used with a high speed hosiery machine for example, a counter-delay means may be introduced into the system at a point, preferably, before the Schmitt Trigger 42 to inhibit selected pulses, thereby increasing the hold time of the yarn measurement read-out to the desired number of complete machine cycles. The next signal fed from the Schmitt Trigger 43 passes through the first gate 92 to the reset driver 94, into the reset input of the counter 75 and resets the read-out display device 77 to zero. The same signal returns the flip flop 91 to the first state, whereby the cycle is repeated.

To facilitate an understanding of the invention's operation as hereinbefore described, FIG. 7 presents a signal train illustrating schematically the electrical signals emitted from the various sub-circuits and components of the monitoring apparatus. The sensing yoke 30 emits a pulse each time the opaque body 36 interrupts the light beam between the light source 31 and the photoelectric cell 32, which pulse occurs each machine cycle of operation. This pulse is inverted and shaped so that it appears as a positive going wave having a square shape as it emerges from the Schmitt Triggers 42 and 43. The trailing edge (negative going portion) thereof causes the flip-flop 91 to change states each machine cycle of operation, while the leading edge (positive going portion) passes through the AND gate 92 when the flip-flop 91 output thereto is also a logical 1 or positive and causes the reset driver 94 to reset the read-out 77 of the pulse accumulator and read-out 50. Accordingly, the measure-hold-reset cycles, previously discussed herein, are further illustrated in FIG. 7, with the measuring cycle occurring during one machine cycle of operation when the pulses generated by the metering unit 51 and shaped by the Schmitt Trigger 44 pass through the AND gate 93 because the flip-flop 91 is set to emit a logical 1 or positive to the input of said gate 93 connected to said flip-flop. The pulses passing therethrough are recorded in the pulse accumulator and read-out 50 at the length (in inches) of yarn 14 consumed during one machine cycle of operation, representing one course in the knitted fabric. During the next succeeding machine cycle of operation, as signalled by the next pulse generated by the sensing yoke 30, the flip-flop 91 changes states, causing a logical 1 or positive to appear at the AND gate 92 and a logical 0 or negative to appear at the AND gate 93, enabling the gate 92 while inhibiting the gate 93. There being no logical 1 appearing at the gate 92 input connected to the Schmitt Trigger 43 output, the yarn length reading

appearing on the read-out 77 is held thereon until the next pulse is generated by the sensing yoke 30. At this time, the leading or positive going edge of the pulse passes through the gate 92 and the reset driver 94 to reset the read-out 77, while the trailing or negative going edge thereof resets the flip-flop 91 and initiates another cycle of measuring, which measuring cycle occurs during the next machine cycle of operation. This measure cycle is followed by a hold-reset cycle which occurs during the next subsequent machine cycle of operation. The measure-hold-reset cycles are repeated as long as the metering unit 51 is held in measuring contact with the yarn 14.

As a result, the operator may obtain a quick and accurate measurement of the yarn 14 used in forming one course of the knitted fabric 20 without interruption to the knitting machine's operation. The measurement reading thus obtained is held for a sufficient duration so that the operator has time to read the length measured. The necessary corrective adjustments are made to the machine and a second measurement taken to insure that the unsatisfactory condition was corrected. The operator then moves to the next feed station or machine as required to repeat the operation.

While a preferred embodiment of the invention has been specifically shown and described, it will be appreciated that this was for purposes of illustration only, and not for purposes of limitation, the scope of the invention being in accordance with the following claims.

What is claimed is:

1. Apparatus for monitoring the operation of a machine of the type adapted to receive at least one elongated input material fed thereto and having an output controlled by the cycles of operation of the machine, said apparatus comprising:

- a. first means for determining each cycle of operation of the machine and emitting a pulse in response thereto;
- b. second means effective when actuated for measuring the length of the input material fed into the machine and for registering a visual read-out of said length, which second means includes means for emitting pulses corresponding to units of length of said elongated input material; and

c. control means including:

- i. a flip-flop having one input and two outputs, said input receiving the pulses emitted from said first means, which pulses cause said flip-flop to change states each time one of said pulses is generated thereto; and
- ii. a first gate and a second gate, each of said gates having two inputs and one output, said first gate having one input thereof receiving the pulses emitted by said first means with the other input thereof connected to one output of said flip-flop, said second gate having one input thereof receiving the pulses emitted by said second means with the other input thereof connected to the other output of said flip-flop,

said control means responsive to the pulses emitted by said first means to actuate said second means during one cycle of operation of the machine, deactuate said second means during the next succeeding cycle of operation thereof and reset said second means before a next cycle of operation during which cycle said second means is reactivated.

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2. Apparatus as claimed in claim 1, wherein: the first means includes a sensing yoke, the sensing yoke includes a light source and a photosensitive device positioned to receive light emitted from the light source, the first means further includes an interrupting means adapted to interrupt the light received by the photosensitive device at intervals corresponding to cycles of operation of the machine.

3. Apparatus as claimed in claim 2, wherein: the interrupting means is an opaque body mounted on a rotating element of the machine with the sensing yoke mounted on a stationary portion of the machine.

4. Apparatus as claimed in claim 1, wherein; the second means includes:

a metering unit emitting pulses corresponding to units of length of the elongated input material fed into the machine; and

a pulse accumulator and read-out to accumulate the pulses emitted by the metering unit and register a visual read-out of the units of length measured.

5. Apparatus as claimed in claim 4, wherein; the metering unit includes:

a light source;
a photosensitive device spaced apart from the light source and positioned to receive light therefrom; and

a measuring wheel of known circumference rotatably

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mounted between the light source and the photosensitive device and in measuring contact with the elongated input material, the wheel having an opening therein to permit light emitted from the light source to be received intermittently by the photosensitive device during rotation of the wheel.

6. Apparatus as claimed in claim 5, wherein; the pulse accumulator and read-out includes:

a decade counter to receive and accumulate the pulses from the metering unit;

a decade decode-driver energized by the decade counter; and

an electrically activated numerical display to register the visual read-out of the units of length measured by advancing one unit responsive to pulses from the decade decode-driver.

7. Apparatus as claimed in claim 4, including:

an elongated housing providing an enclosure for the pulse accumulator and read-out and having the metering unit operatively mounted at one end thereof to form a hand unit adapted for manual positioning of the metering unit in measuring contact with the elongated input material.

8. Apparatus as claimed in claim 15, including:

a counter connected to the first means to record cycles of rotation of the machine.

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