ARTICLE DETECTING AND COUNTING APPARATUS

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ABSTRACT
Pneumatically conveyed knitted articles are accurately counted by inexpensive apparatus including protectively mounted photoelectric components and controls for adjusting the magnitude and maximum frequency of signals transmitted therefrom to a counting device.

6 Claims, 3 Drawing Figures
ARTICLE DETECTING AND COUNTING APPARATUS

BACKGROUND OF THE INVENTION

This invention relates to the photoelectric detection of moving articles, and more specifically relates to apparatus particularly but not necessarily exclusively adapted for detecting and counting knitted articles, such as ladies hosiery, as the same are pneumatically conveyed through various processing stations in the course of their manufacture. It is known to pneumatically convey socks, ladies hose, leotards and similar knit articles, during or immediately following their manufacture, through suitable ducts extending between various processing, inspecting, packaging or other stations. The automatic counting of such articles during their pneumatic conveyance is frequently desirable, and has been attempted by apparatus using a photoelectric cell for producing counter-actuating signals in response to interruption of a light beam directed across the articles' path of travel. Such apparatus, as opposed to that employing article-engaged microswitches and the like, has the important advantage of not tending to snag the articles or impede their movement. It has not, however, heretofore been entirely satisfactory from the important viewpoints of reliability, durability and cost. Consistently obtaining an accurate count by photoelectric means is more difficult than might be readily apparent. Ladies hose each include welt and toe portions of considerably denser and more opaque construction than the intervening leg portion. Even if each hose interrupting the light beam should be in a perfectly elongated condition and moving at a uniform speed, the several changes in light intensity produced by its aforesaid portions and sensed by the photoelectric cell might cause the latter to produce more than the desired single signal. The problem is further aggravated by the fact that the hose of course do not pass by the cell in the same perfectly elongated condition or at the same speed. Each is bunched or folded upon itself in a different way and to a different extent, and successive ones may also differ in size and/or other details of construction. In the latter regard, the articles to be counted might include, in addition to or in lieu of various sizes of conventional ladies hose, such items as "pantry-hose," socks or leotards. The differences in condition and/or construction of the articles conveyed past the photoelectric cell cause a wide variety of light intensity changes to take place at varying speeds. The rapidity with which these changes take place is also significant, since the output signals produced by the cell are a result of not only the magnitude of the changes in light intensity but also of the rate at which such changes transpire.

The lint, dust and "fly" prevalent in many textile mills also contribute to the problem of reliably and consistently obtaining an accurate count. If the photoelectric cell is overly sensitive or the light beam is not properly concentrated, an erroneous counting signal may be produced upon each incidental passage of a particle of such foreign material through the duct. Even if the foregoing should not occur, lint and the like will eventually cause an erroneous count if given the opportunity to accumulate over a period of time on or between the lamp and cell components of the photoelectric unit. Shielding the components to prevent such accumulations may cause overheating of the lamp and/or excessive diffusion of the light emitted by it. Compensating for the light diffusion by the provision of a lamp of greater size and power increases costs, and also makes the possibility of overheating even more likely. Notwithstanding the foregoing considerations, it is also highly desirable for other reasons to shield and/or protectively mount the photoelectric components of the apparatus. The operation of such components can easily be adversely affected by, for instance, their exposure to ambient light or to impacts which the apparatus might accidentally receive while being transported or used. In a textile-mill environment, in particular, some abuse of the latter type must be expected.

SUMMARY OF THE INVENTION

The present invention provides a highly reliable, durable and economical apparatus which is particularly adapted, among other possible uses, for counting with consistent accuracy hosiery and other knit articles pneumatically conveyed in the manner described above. In a preferred embodiment of the invention, the apparatus includes a photoelectric cell and associated lamp which are cooperatively mounted upon diametrically opposite sides of the path of travel of the conveyed articles in such a way as to be shielded and protected from impacts, ambient light, and lint or other foreign material, while at the same time being free from problems of overheating and light diffusion. The electrical signals produced by the photoelectric cell in response to sensed variations in light intensity are directed through a variable resistance to an amplifier. When a signal of sufficient magnitude, the amplifier energizes a relay which simultaneously closes two circuits. One of these includes the operating sole-noid of a counting and recording device. The other is a feedback circuit including a capacitor, the resulting discharge of which saturates the amplifier and renders the same temporarily unresponsive to further signals from the photoelectric cell. The feedback circuit includes a variable resistance by which the rate of the capacitor's discharge may be varied, and therefore the duration of the amplifier's nonresponsiveness, can be adjusted as desired. By suitable adjustment of both of the aforesaid variable resistances to meet the operating conditions then present, accurate counting of the articles conveyed through the duct can be consistently realized.

To further insure absolute accuracy of count, the apparatus also includes means effective upon its initial energization to temporarily disable the circuit including the operating solenoid of the counting device. This prohibits a false count from being registered during the brief but significant time interval required for a "light" condition to be established at the photoelectric cells by the associated lamp. As soon as the lamp of the photoelectric unit has succeeded in establishing such a condition, the counter-solenoid circuit is automatically restored to and maintained in operating condition.

The aforesaid and other features and advantages of the invention will be in part evident and in part pointed out hereinafter 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 perspective view of apparatus constructed in accordance with the invention, in association with a fragmentarily shown duct such as is employed for pneumatically conveying hosiery and similar articles in a textile mill.

FIG. 2 is an enlarged vertical section taken generally along the line 2—2 through a portion of the apparatus of FIG. 1, and FIG. 3 is a schematic diagram of the circuitry of the apparatus.

Referring more particularly to the drawing, the apparatus identified in its entirety in FIG. 1 by the numeral 10 generally includes a cabinet 12 adapted to be mounted by a cable or cord 14 to a conventional AC power outlet, and connected by a cord 16 to a tubular housing member 18 adapted to be mounted in association with a hollow cylindrical duct 20 such as is employed in textile mills for pneumatically conveying articles such as ladies hose, one of which is designated by the numeral 22, between desired locations by means of an airflow directed in the desired direction through the duct. Duct 20 is customarily formed of butyrate or similar plastic material and may, depending upon the particular installation and/or supplier, be either of transparent or opaque construction.

Cabinet 12 houses a solenoid-operated counting device and various other electrical components hereinafter described, and on its exterior mounts a master switch 24, control knobs 26, 28, lamps 30, 32, and a viewing window through which the counter dial 33 can conveniently be read. The cabinet is of compact and lightweight construction, so as to permit its con-
venient transportation to a desired location of intended use, and is ventilated in such a way as to prevent overheating of its interior components but discourage the entry of lint, dust and similar foreign material such as is sometimes prevalent in the ambient atmospheres of textile mills.

Referring now to FIG. 2, member 18 comprises a col larlike main body portion 34 within which are coaxially mounted a central ring element 36 and the inner ends of a pair of sleeve elements 38. Ring 36 and sleeves 38 have the same inner and outer diameters as duct 20, and may be formed of the same material as the duct. Collar 34 has an inner diameter substantially equal to the outer diameter of duct 20, and is formed of material possessing good shock-resisting and impact-absorbing characteristics. Ring 36 is permanently mounted within collar 34, as by a press-fit and/or bonding, and has two small transparent sections 36' spaced diametrically from each other about its circumference. The remainder of ring 36, including its end surfaces, is opaque, being provided if required to this end with a coating of suitable flat black paint. Sleeves 38 are entirely of opaque and nonreflective construction, and are detachably secured at their inner ends within collar 34 as by means of setscrews 40. If duct 20 is also of opaque construction, sleeves 38 are not required or used. They are removed from collar 34 and confronting ends of duct 20 are secured to sleeves collar 34 by the setscrews 40 in abutting relationship to the respective end surfaces of ring 36. If, however, duct 20 is of transparent construction, as shown in FIG. 1, sleeves 38 are employed to shield the interior of collar 34 from ambient light, the outer end of each sleeve 38 being secured to and in coaxial abutting relationship with one of the confronting duct ends as by suitable clamp means (not shown) encircling the same. The ends of duct 20, sleeves 38 and ring 36 are of course smoothly finished so as to be free from projections which might tend to snag the articles conveyed through the duct.

Protectively mounted within chambers provided in the annular body of collar 34 is a photoelectric article-detecting unit including a lamp component 42 and a photoelectric cell component 44, each of which is electrically connected by lines contained within cord 16 to cabinet 12. The chamber 46 mounting cell 44 has its inner end aligned with and adjacent one of the transparent sections 36' of ring 36, and extends radially outwardly therefrom. The chamber 48 mounting lamp 42 extends generally parallel to the axis of collar 34 and is open at its end opposite the lamp's base. Ramps 50, 52 respectively extend inwardly and outwardly from chamber 48 and through collar 34 to the second transparent section 36' of ring 36 and to the outer periphery of the collar.

During operation of apparatus 10, bore 50 concentrates and directs a narrow beam of light from lamp 42 through transparent sections 36' of ring 36, and therefore across the center of the path of travel of articles conveyed through duct 20, to cell 44, which in accordance with well-known principles has a resistance which varies in accordance with the intensity of the light received by it. Ring 36 serves the dual functions of preventing diffusion of the light beam conducted through its sections 36', by its otherwise opaque nature, and of preventing particles of lint and like foreign material occasionally present within duct 20 from accumulating in the vicinity of bore 50 and/or cell 44 and thus impeding the passage of the light beam therebetween. As previously noted, sleeves 38 serve when required for such purpose to shield the interior of collar 34, and more particularly cell 44, from ambient light. The aforesaid shielding and concentrating of the light beam enables the lamp 42 producing the same to be of a quite small size and output. This, in turn and apart from other benefits, permits not only cell 44 but also lamp 42 to be protectively mounted completely within the annular body of collar 34, as shown, and thereby shielded from accidental breakage. Bore 52 and the open end of chamber 48 permit a sufficient circulation of air through the chamber to effectively dissipate the relatively small quantity of heat generated by lamp 42 during its use, and to thus prevent failures due to overheating. Although usually not required, additional vent openings such as bore 52 may of course be provided in communication with chambers 46 and 48.

Referring now particularly to FIG. 3, the circuitry of apparatus 10 includes input power lines 54, 56 connectable via cord 14 (FIG. 1) to a standard 110-volt AC power source and bridged by parallel circuits 58, 60, 62, 64, 66 and 68. Circuit 58 contains pilot lamp 38, which gives visual indication of the energized condition of apparatus 10 when master switch 24, within line 54, is closed. The alternating current supplied to circuit 60 is converted by transformer rectifier unit 70 into 12-volt direct current employed in a subcircuit including photoelectric cell 44, a variable resistor 72 which may be adjusted by control knob 26 (FIG. 1) to control as desired the current flow through cell 44, an amplifier assembly 74, a DC relay 76 having two bridging contacts 76-1 and 76-2, a capacitor 78, and a variable resistance 80 which may be adjusted by control knob 28 (FIG. 1) to vary the rate of discharge of capacitor 78. Circuit 62 supplies alternating current to lamp 42 of the photoelectric unit within collar 34. Circuit 64 has a pair of terminals 66' for energization of DC relay 76 by its contact 76-2, and includes an AC relay 82 having a single contact 82-1. Circuit 66 has a pair of terminals 66' which are bridged by the aforesaid contact 82-1 when relay 82 is energized, another pair of terminals 66' bridged by contact 76-2 of relay 76 when the latter is deenergized, and includes the operating solenoid 84 of the counting device within cabinet 12 (FIG. 1) of apparatus 10. Each energization of solenoid 84 causes an additional count to be registered upon dial 33 of the counting device. When the articles being counted are hosiery, it is sometimes desirable for a visual signal to be given after each dozen pairs of hose has passed through duct 20. For this purpose, circuit 68 includes the lamp 32 positioned atop cabinet 12 and a switch 86 which permits the passage of a direct current signal from it, through variable resistance 72 and via circuit 90, to the base of amplifier assembly 74. The amplified signal is then transmitted via circuit 92 to relay 76, energizing the same and thus causing its contact 76-2 to move out of bridging engagement with terminals 66' of circuit 66 and into bridging engagement with terminals 64' of circuit 64. The closing of circuit 64 energizes relay 82, which immediately locks itself into place and circuit 94 by movement of its contact 82-1 into bridging engagement with terminals 66' of circuit 66. Relay 82 thereafter remains in its locked condition for so long as master switch 24 remains closed, leaving contact 82-1 of relay 82 under the exclusive control of contact 76-2 of relay 76.

In addition to moving contact 76-2 out of bridging engagement with terminals 66' of circuit 66, energization of relay 76 moves its contact 76-1 out of bridging engagement with the terminals 96' of a feedback circuit 96, which interconnects capacitor 78 and amplifier 74, and into bridging engagement with the terminals 98' of an input circuit 98 interconnecting capacitor 78 and DC power source 70. The apparatus is then in its normal operating condition.
Relay 76 is maintained in an energized condition for so long as no significant variations in light intensity are reported by cell 44 to amplifier 74. The sensitivity of the apparatus to changes in light intensity can be readily adjusted as required by increasing or decreasing the value of resistance 72 by manual adjustment of knob 26. The apparatus can be rendered completely insensitive to light intensity variations caused by the occasional passage of light through duct 20 and the beam of light directed from lamp 42 to cell 44, while at the same time retaining a high degree of sensitivity to the greater magnitude variation in light intensity caused by the interruption of the beam by any portion of an article, such as the hose 22, to be counted. When such an article does pass across the light beam, the increase in resistance of cell 44 interrupts the normal current flow into and from amplifier 74 through the respective circuits 90, 92, deenergizing relay 76 and thereby causing movement of its contacts 76–1 and 76–2 to their positions illustrated in FIG. 3. Contact 82–1 of relay 82 then being in bridging engagement with terminals 66– of circuit 66, the aforesaid movement of relay contact 76–2 to terminals 66– of circuit 66 energizes counter solenoid 84. This registers a single count upon dial 33 of the counting device.

But for the provision of capacitor 78, relay 76 would be immediately reenergized as soon as cell 44 again sensed a "light" condition of prescribed intensity. As previously noted, this couldwith articles such as ladies hosiery occasion the recording of false counts, since each hose passing through duct 20 and the light beam might produce a plurality of rapidly transpiring variations in the intensity of the light received by cell 44. To prohibit the foregoing undesirable result, relay 76 is maintained in a deenergized condition for a period of time sufficient for the entire length of each counted article to have passed through collar 34. Thus, the closing of circuit 96 by contact 76–1 of relay 76, upon each deenergization of the relay, interconnects capacitor 78 and amplifier 74 and permits discharge of the former into the latter through variable resistance 80. Such discharge saturates the amplifier, while transpiring, and renders the same unresponsive to signals received from photoelectric cell 44, such that relay 76 is then maintained deenergized notwithstanding the possible sensing of additional variations in light intensity by cell 44. The rate of discharge of capacitor 78, and therefore the time period during which relay 76 is maintained deenergized irrespective of light intensity changes sensed by cell 44, is controlled by resistance 80 and can be adjusted as desired by means of control knob 28. The precise setting of knob 28 will be governed in any given installation by, among other possible factors, the maximum length and speed, and the minimum speed, of the articles conveyed through duct 20.

When discharge of capacitor 78 has been completed, relay 76 is again energized, via circuit 90 and amplifier 74, by a light condition at cell 44. Relay contacts 76–1 and 76–2 open circuits 96 and 66, respectively, and the former contact simultaneously closes circuit 98 to recharge capacitor 78 and thus place the apparatus in readiness for another cycle of operation. During every 24th cycle of operation, switch 86 is momentarily closed by cam mechanism 88 to cause illumination of "dovens" lamp 32. At the completion of the counting operation, opening of master switch 24 restores relay 82 and the other components of the apparatus to the condition shown in FIG. 3.

Compensation for any decrease in the intensity of lamp 42, due to "aging" after prolonged use, can readily be achieved through adjustment of resistance 72 by knob 26.

It will be appreciated that various modifications can be made, if desired. For example, the counting device might be completely electrical, rather than electromechanical. Also, a second photoelectric unit, wired in series with that described and directing a coplanar second light beam at another angle across the articles' path of travel, might be provided. The provision of a second unit would be particularly desirable if there were a great disparity between the duct diameter and the size of the conveyed articles.

While a preferred embodiment of the apparatus has been specifically shown and described, 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.

That which is claimed is:

1. Apparatus for detecting and counting hosiery and like articles conveyed along a predetermined path of travel, comprising:
   - photoelectric means including a photoelectric cell, and being adapted to be mounted adjacent said path of travel for producing signals in response to light intensity variations caused by conveyance of the articles thereby;
   - a counting device;
   - means operatively interconnecting said photoelectric means and said counting device for causing actuation of said counting device in response to a signal of predetermined magnitude produced by said photoelectric means;
   - said interconnecting means including an amplifier assembly connected to said photoelectric cell and to a variable resistance interposed between said cell and said amplifier assembly for adjustment of the sensitivity of the apparatus to the light intensity variations upon said cell;
   - adjustable means for automatically rendering said interconnecting means unresponsive to signals produced by said photoelectric means for a desired period of time following each actuation of said counting device; and
   - said adjustable means including a connectable capacitor with said amplifier upon actuation of said counting device for then discharging into and saturating said amplifier, and a variable resistance interposed between said capacitor and said amplifier for adjustment of the rate of the discharge of said capacitor and the duration of the saturation of said amplifier.

2. Apparatus as in claim 1, wherein said interconnecting means further includes a relay energizable by said amplifier, said relay having a first contact for interconnecting said capacitor and said amplifier, and a second contact for causing actuation of said counting device, upon energization thereof by said amplifier.

3. Apparatus as in claim 2, including circuit means for charging said capacitor, said circuit means being closed by said first contact upon energization of said relay.

4. Apparatus for detecting and counting hosiery and like articles conveyed along a predetermined path of travel, comprising:
   - photoelectric means including a lamp and a photoelectric cell, and being adapted to be mounted adjacent said path of travel for producing signals in response to light intensity variations caused by conveyance of the articles thereby;
   - a housing member being adapted to encircle said path of travel, and mounting said lamp and said cell each on opposite sides thereof whereby said lamp and said cell are shielded by and are disposed entirely within the confines of said housing member;
   - said housing member including an annular collar having first and second chambers therein, said first chamber extending generally radially of said collar and through its inner periphery and enclosing said cell, and said second chamber extending generally parallel to the axis of said collar and enclosing said lamp;
   - said collar having a first bore interconnecting its inner periphery and said second chamber for directing a beam of light from said lamp to said cell, and a second bore interconnecting its outer periphery and said second chamber for facilitating the dissipation of heat generated by said lamp;
   - a counting device;
   - means operatively interconnecting said photoelectric means and said counting device for causing actuation of said counting device in response to the production of a signal of predetermined magnitude by said photoelectric means; and
adjustable means for automatically rendering said interconnecting means unresponsive to signals produced by said photoelectric means for a desired period of time following each actuation of said counting device.

5. Apparatus as in claim 4, wherein said housing further includes a ringlike element concentrically mounted within said collar for shielding said photoelectric means from lint and the like, said ringlike element having transparent sections for passage of said light beam and otherwise being of opaque construction to discourage diffusion of said beam.

6. Apparatus as in claim 5, wherein said housing further includes a pair of opaque sleevelike elements for shielding the interior of said collar from ambient light, each of said sleevelike elements having its inner end portion detachably mounted within said collar in abutting relationship to an end of said ringlike element and extending outwardly from said collar and said ringlike element in coaxial relationship therewith.