Dec. 30, 1969 T. H. DE SPAIN 3,486,471

METHOD AND APPARATUS FOR SEAMING AND INSPECTING HOSIERY

Filed March 31, 1966 5 Sheets-Sheet 1

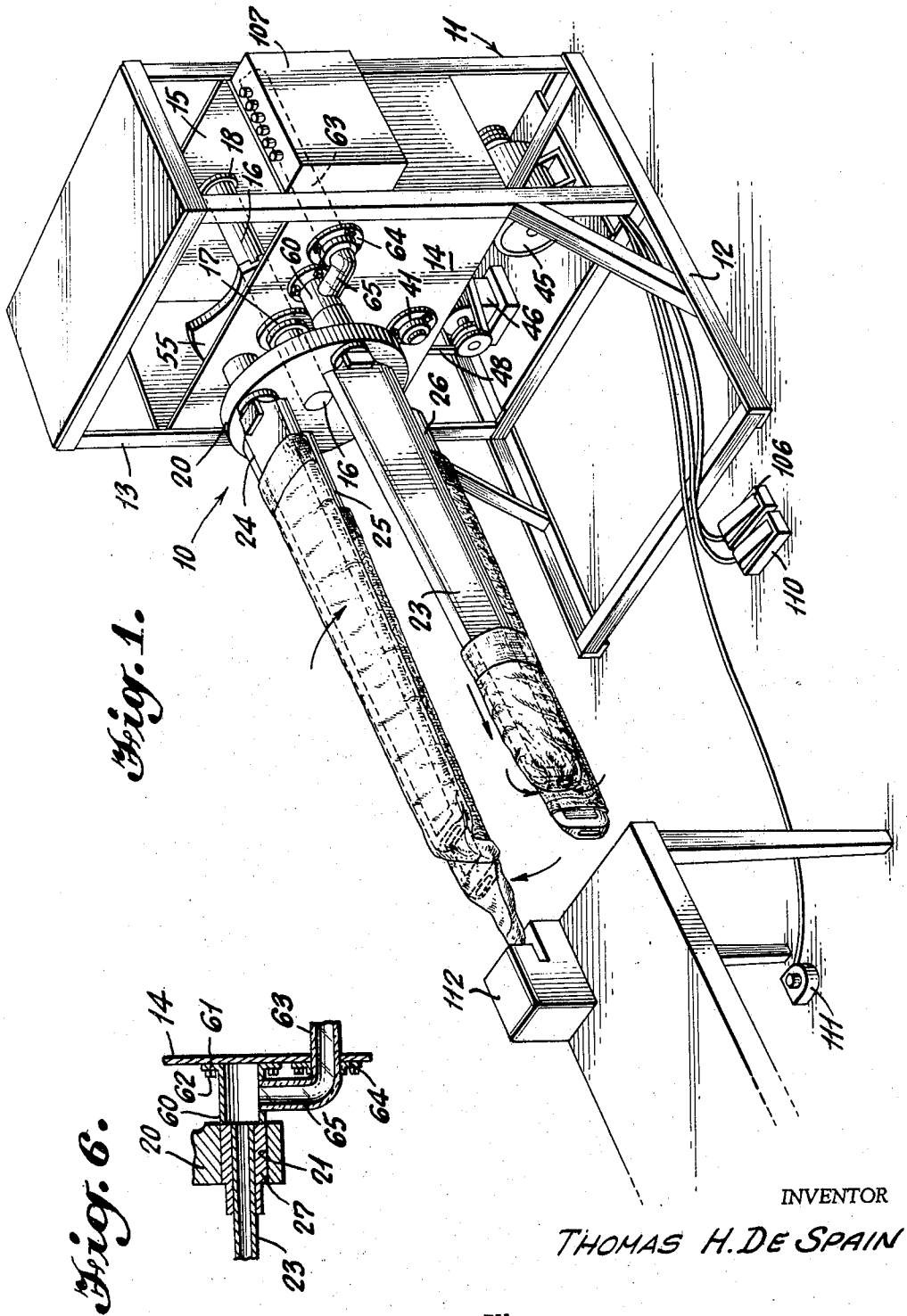


Fig. 1.

Fig. 6.

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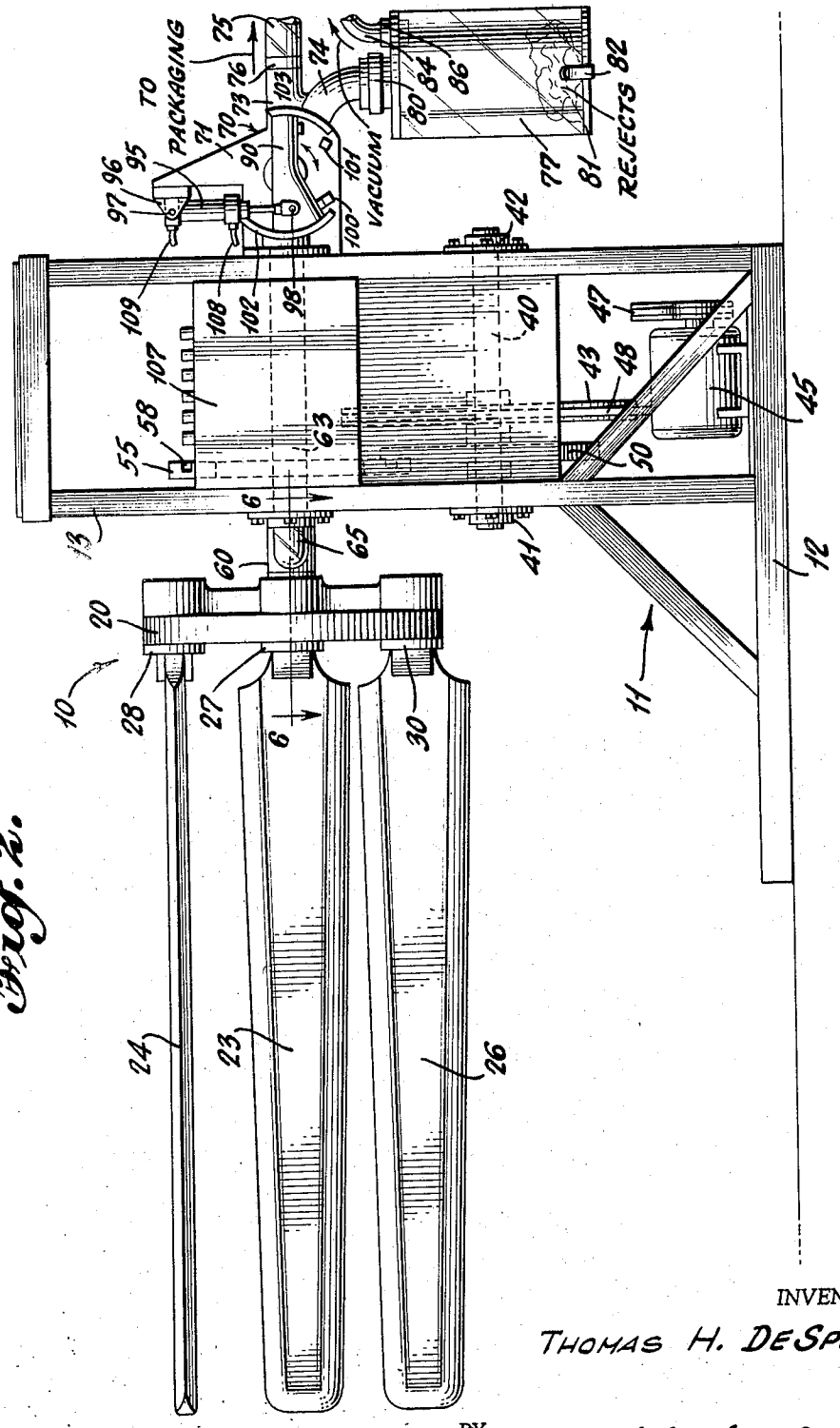


Fig. 2.

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Fig. 4.

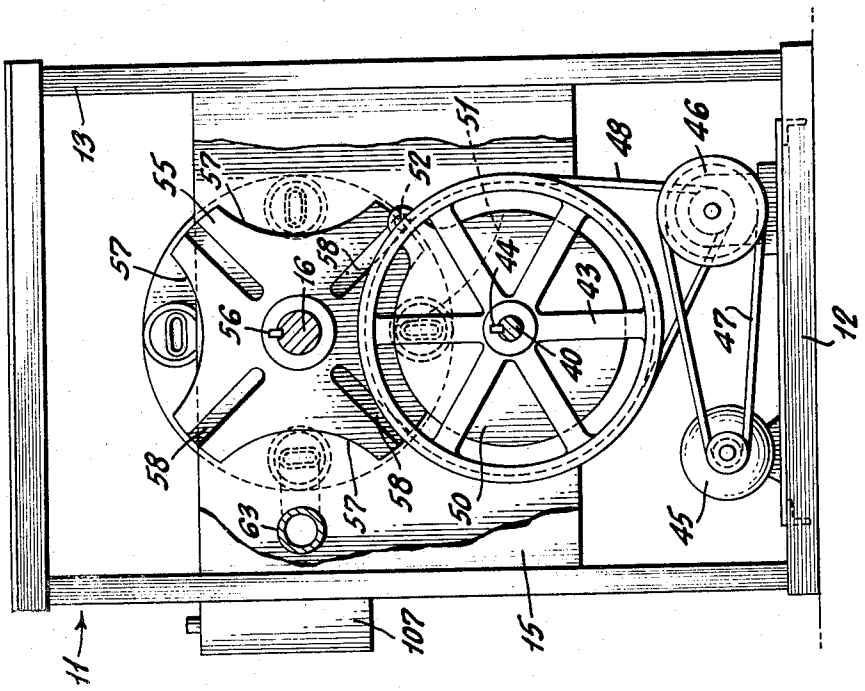
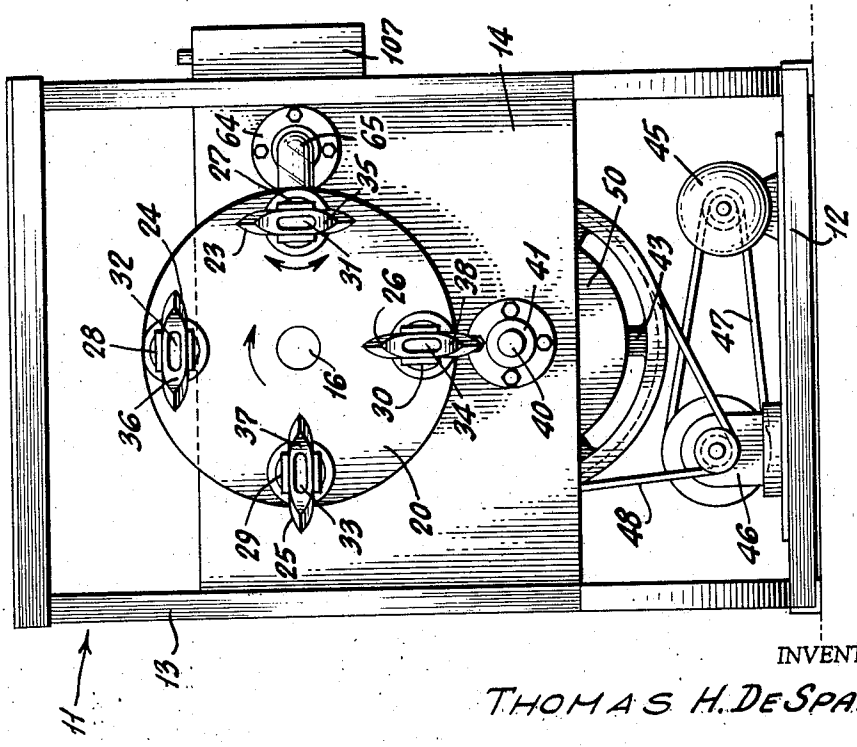


Fig. 3.



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METHOD AND APPARATUS FOR SEAMING AND INSPECTING HOSIERY

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Fig. 5.

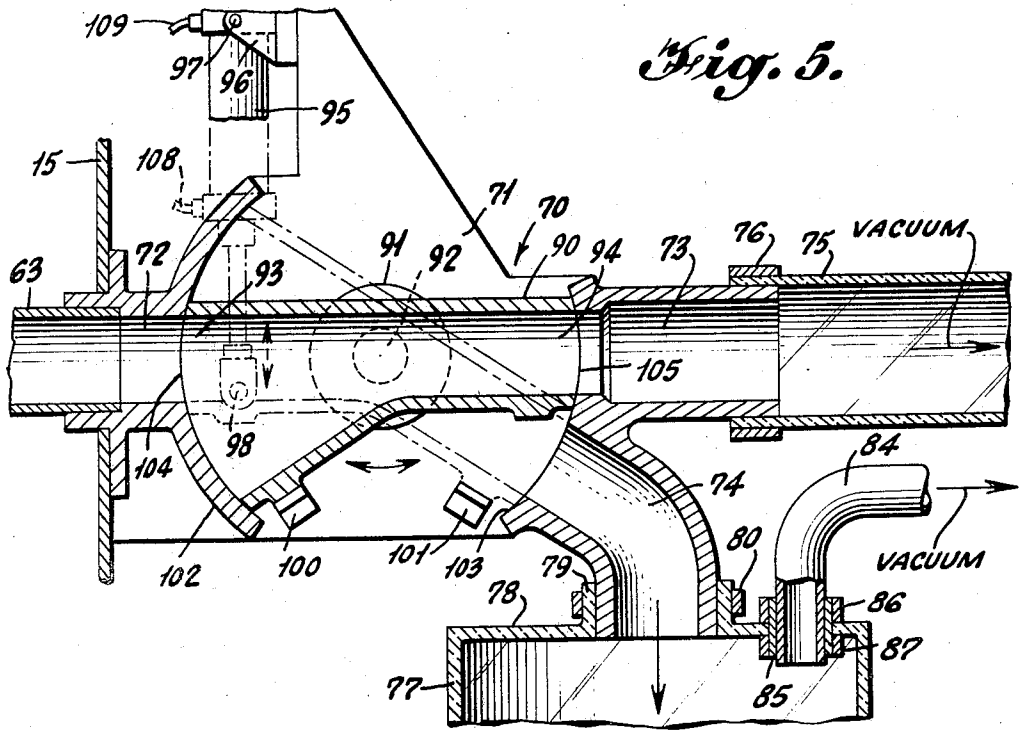
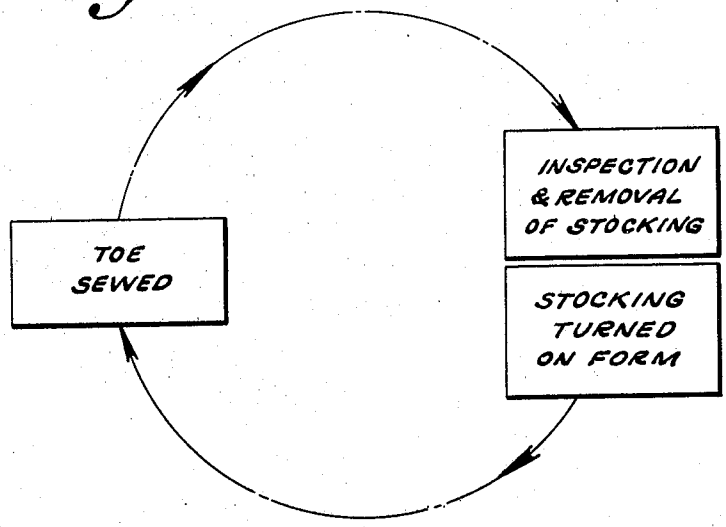


Fig. 7.



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METHOD AND APPARATUS FOR SEAMING AND INSPECTING HOSIERY

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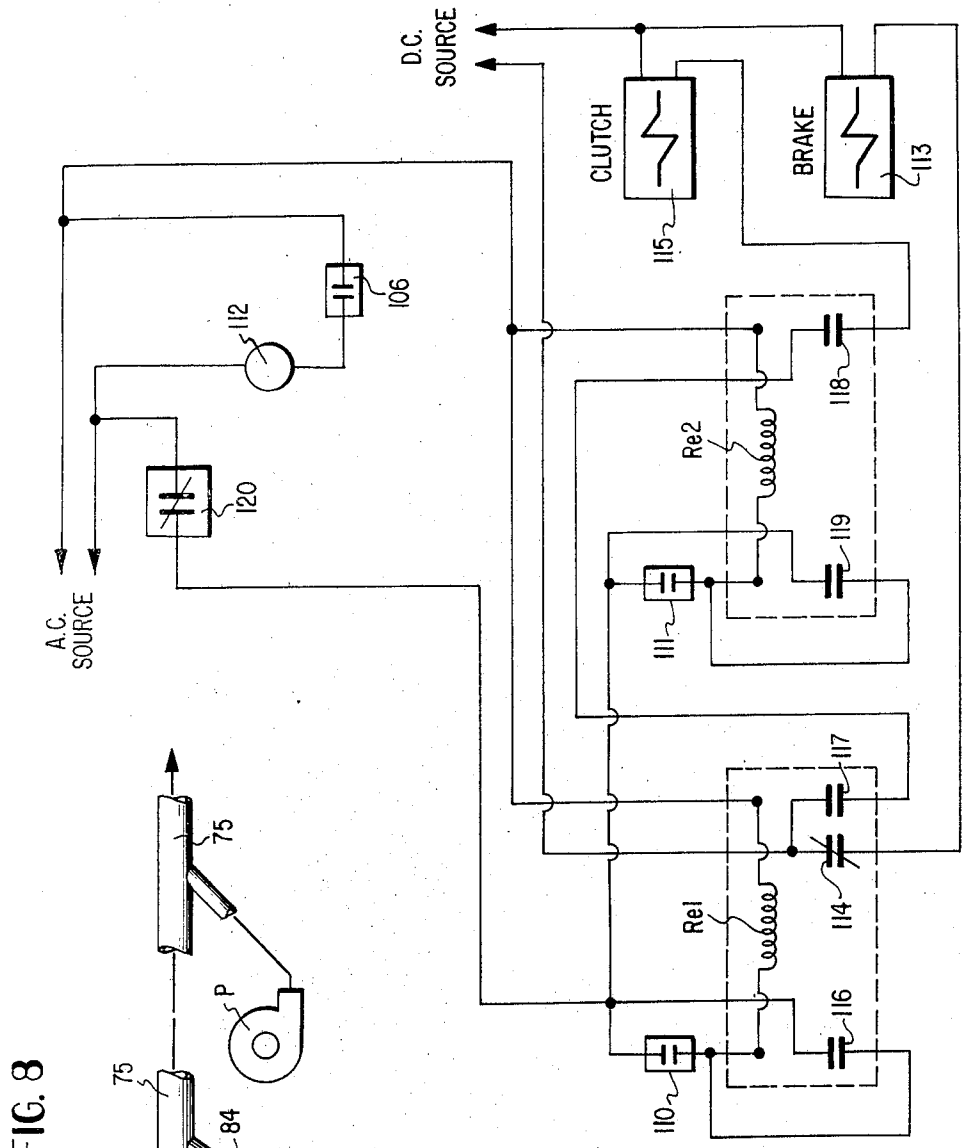


FIG. 9

FIG. 8

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United States Patent Office 3,486,471 Patented Dec. 30, 1969

3,486,471

METHOD AND APPARATUS FOR SEAMING AND INSPECTION HOSIERY

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Filed Mar. 31, 1966, Ser. No. 539,095
Int. Cl. D05f *39/00*; A41h *43/00*
U.S. Cl. 112—121.15 12 Claims

ABSTRACT OF THE DISCLOSURE

Method and apparatus for seaming the open toe of stockings knit on circular knitting machines and inspecting the seamed stockings on an elongated hollow inspection form. A plurality of inspection forms are supported for movement between an inspection and turning station and seaming station. Open-toed stockings are positioned on forms at the inspecting and turning stations, advanced on the forms to the sewing station where the open toe is closed, then returned to the inspecting and turning station where the stockings are inspected then everted through the hollow forms by vacuum.

This invention relates an improved method of closing the toe and inspecting circular knit hosiery and to apparatus used in this operation.

Conventionally, stockings such as women's full fashioned hosiery are knit in the form of an elongated circular tube with the toe end of the hosiery open. The stockings are then individually turned inside-out, by a first operator with the aid of a pneumatic turning apparatus including an elongated hollow form over which the stockings are drawn. After the turning operation, the stockings are delivered, in bundles, to a seaming station where a sewing machine operator picks up the stockings, one at a time, and passes them through the sewing machine to trim and close the open toe while the stockings are in the inside-out condition. From the toe closing, or seaming operation, the stockings are delivered, in bundles, to an inspection station where they are manually drawn onto an elongated hollow inspection form and subjected to a visual inspection, both with respect to the body of the stocking and to the seam closing the toe. After the inspection operation, the individual stockings are everted pneumatically through the hollow inspection form and delivered to a collection point in the right-side-out condition. An apparatus of the type conventionally used in both the turning and the inspection operations is illustrated in U.S. Patent No. 2,957,613 assigned to the assignee of this application.

These repeated manual operations not only slow down production and thereby increase cost of the hosiery but also, the repeated handling of the stockings materially increases the number of "seconds" due to pulled threads, or the like. Accordingly, efforts have recently been made to reduce the number of manual operations and thereby speed the production of hosiery. These efforts have resulted in the development of apparatus in which a combination turning and inspection form is movable from the inspection station to a sewing station to permit the toe of the stocking to be seamed while it remains on the form. While these devices are capable of increasing production over the old conventional methods outlined above, their use have not been entirely satisfactory in that it has been necessary to inspect the hosiery before the seaming operation, with the result that defective seams or other defects resulting from the seaming operation may not be detected. Also, in at least one such apparatus, it has been necessary for the operator to turn and inspect the hosiery on the form and then wait for the form to deliver the hose to the seaming station and return before the next stocking can be placed on the form.

An important feature of the present invention resides in providing a method and apparatus for the production of hosiery wherein the hosiery is turned on a form at a first work station by a first operator, then advanced on the form to a second work station where a second operator closes the toe of the hosiery while it remains on the form. The hosiery is finally returned to the first work station where the seamed hosiery is inspected by the first operator and subsequently everted through a hosiery receiving passage in the form. A plurality of forms are provided, each mounted on a turret for movement therewith successively past the respective work stations, with the forms being positioned on the turret so that a form will be moved to and from each station simultaneously. A duct system, connected to a source of pneumatic pressure differential, is provided to establish a flow of air through the hosiery receiving passage of the respective forms when they are at the first work station to assist in the turning operations and to evert and convey the inspected hosiery from the apparatus.

Further features and advantages of the invention will become apparent from the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a perspective view of an apparatus embodying the present invention;

FIG. 2 is a side elevation view of the apparatus shown in FIG. 1 and including a portion of the pneumatic duct system;

FIG. 3 is an end elevation view of the apparatus as seen from the left of FIG. 2;

FIG. 4 is an end elevation view as seen from the right in FIG. 2, with certain parts broken away to more clearly show other parts;

FIG. 5 is an enlarged fragmentary sectional view of a portion of the pneumatic duct system employed in the apparatus;

FIG. 6 is a fragmentary sectional view taken on line 6—6 of FIG. 2;

FIG. 7 is a schematic flow diagram illustrating the successive steps in closing the toe and inspecting hosiery on the apparatus illustrated in FIGS. 1 through 6;

FIG. 9 is a wiring diagram illustrating the control circuitry.

Referring now to the drawings in detail, the apparatus according to the present invention is indicated generally by the reference numeral **10**, and shall sometime be referred to herein as a hosiery inspection apparatus, it being understood that the utility of the apparatus is not limited to the inspection of hosiery. The hosiery inspection apparatus **10** includes a frame **11** having a base **12** and a generally rectangular box-like upright portion **13** including front and rear structural walls **14**, **15**, respectively.

A drive shaft **16** extends through openings in walls **14**, **15**, and is journalled for rotation therein, as by bearings **17**, **18**, about a generally horizontal axis. Shaft **16** includes a cantilevered section projecting outwardly from wall **14**, and a relatively large disc, or turret **20**, is mounted on the distal end of the cantilevered section for rotation therewith about the longitudinal axis of shaft **16**. Turret **20** is provided with four axial bores **21** extending therethrough, with the respective bores **21** being radially equally spaced adjacent the outer periphery of turret **20**, and circumferentially equally spaced therearound.

A plurality of elongated hollow hosiery inspection and turning forms **23**, **24**, **25**, and **26** (hereinafter sometimes called forms or inspection forms) have one end rotatably mounted in each of the respective openings **21** in turret **20** and journalled for rotation therein about

their respective longitudinal axis, extending generally parallel to the axis of shaft **16**, by bearings **27**, **28**, **29** and **30**, respectively. The inspection forms are provided with a hosiery receiving passage **31**, **32**, **33** and **34**, respectively, extending longitudinally therethrough from the free ends **35**, **36**, **37** and **38** thereof.

A jack shaft **40** is mounted on walls **14**, **15**, as by bearings **41**, **42**, for rotation about an axis parallel to and spaced from the axis of shaft **16**. A large diameter pulley **43** is mounted on jack shaft **40** and rotatably fixed thereto, as by key **44**, for rotation therewith. Suitable drive means, such as electric motor **45** is fixed on base **12** and drives a suitable reduction gear mechanism illustrated generally at **46**, through V-belt **47**, with reduction gear **46** driving pulley **43** through a second V-belt **48**. The gear mechanism **46** includes an electrically actuated clutch and brake mechanism to permit intermittent operation of the Geneva drive mechanism, described below, without interrupting the operation of motor **45**.

A locking and drive disc **50** of a conventional Geneva drive mechanism is mounted on jack shaft **40** for rotation therewith in axially spaced relation with pulley **43**. Disc **50** is formed with a single arcuate notch **51** formed in its outer periphery, and carries a single drive pin **52** in radial alignment and spaced outwardly from notch **51**. Disc **50** cooperates with a transfer plate **55** rotatably fixed, as by key **56** on shaft **16**. Transfer plate **55** is provided with four circumferentially equally spaced arcuate notches **57** formed in its outer periphery for engaging the outer periphery of disc **50** to retain shaft **16** against rotation. Four radially extending, circumferentially equally spaced slots **58** are positioned between notches **57** to engage pin **52** upon each revolution of disc **50**.

Since notch **51** and pin **52** on disc **50** are radially aligned, transfer wheel **55** will be released for rotation through one quarter revolution when pin **52** is in engagement with slot **58**. Thus, it is seen that the specific Geneva drive mechanism shown will provide an intermittent rotation of shaft **16** and turret **20** carried thereon as a result of continuous rotation of shaft **40** by drive motor **45**. Also, since transfer wheel **55** is provided with four peripheral notches and four radial slots while disc **50** has only a single drive pin **52** and a single peripheral notch **51**, turret **20** will be rotated through 90° at an average rate corresponding generally to the rate of rotation of disc **50**, then retained stationary until disc **50** completes a full revolution.

The relative rotational positions of turret **20** and transfer plate **55** is such that, when shaft **16** is held against rotation by transfer plate **55**, two diametrically opposed inspection forms are horizontally aligned one on each side of the hosiery inspection apparatus, while the remaining two forms are vertically aligned. As most clearly seen in FIG. 1, this arrangement permits turning and inspecting operator (hereinafter called an inspector) to work at a first work station at the right side of the apparatus (hereinafter called an inspection station) while a sewing machine operator simultaneously works at a second work station (hereinafter called a sewing station) at the left side of the apparatus. Rotation of the turret is such that an inspection form positioned at the inspection station, which is the three o'clock position as viewed in FIG. 3, will be successively moved to and momentarily retained at the six o'clock, the nine o'clock, and the twelve o'clock position before ultimately being returned to the three o'clock positions.

When the respective inspection forms, for example form **23**, are positioned at the inspection station, the hosiery receiving passage **31** therein is in fluid communication with a duct system, which, in turn, is connected to a source of pneumatic pressure differential **56** to induce a flow of air through passage **31** from the free end **35** thereof. The duct system comprises a short section of hollow pipe **60** (see FIG. 6) mounted on the forward face of wall **14**, as by flange **61** and bolts **62**, and projecting outwardly from wall **14** parallel to shaft **16**. Pipe **60** is aligned with and has an open end overlaying the open end of inspection form **23** extending through turret **20** at the inspection station. A first rigid tubular conduit **63** extends through walls **14** and **15**, and is rigidly mounted thereon, as by flange **64**. Tube **63** terminates in a 90° ell section **65** extending into and establishing fluid communication with the interior of pipe section **60**.

A two-way valve, illustrated generally by the reference numeral **70**, is seen in FIGS. 2 and 5 is mounted on the other end of tube **63** adjacent the outer surface of wall **15**. Valve **70** includes a body portion **71** having an inlet **72**, a first outlet **73** and a second outlet **74**. A first fluid conduit **75**, preferably in the form of a transparent plastic tube having sufficient rigidity to avoid collapsing under relative high vacuum, is rigidly attached, as by band **76**, to the first valve outlet **73**. Conduit **75** is operatively connected to a source of pneumatic pressure differential (not shown) to establish a flow of air through the duct system to convey stockings therethrough to a conventional counting and stacking apparatus, not shown.

A trap chamber in the form of a transparent cylindrical container **77** is mounted on outlet **74** and depends downwardly therefrom as shown in FIG. 2. Container **77** includes an integrally formed top wall **78** having an annular opening therein surrounded by an upwardly extending flange **79** for receiving outlet **74** of valve **70**. A suitable clamp **80** extending around flange **79** releasably retains trap chamber **77** on outlet **74**.

Trap chamber **77** has a removable bottom wall **81** which is releasably retained in place by a plurality of resilient clamps **82**. The interior of trap **77** is connected to a source of pneumatic pressure differential, by a fluid conduit **84**, to induce a flow of air through the trap chamber from valve outlet **72**. Conduit **84** extends through a suitable opening in the top wall of trap chamber **77**, and is retained therein by a suitable bushing **85**, and by clamps **86**, **87**.

An elongated hollow valve element **90** is pivotally mounted, as by bushing **91** and shaft **92**, on valve body **71**, and has an inlet **93** substantially larger than inlet **72** and in fluid communication therewith. Valve element **90** further includes an outlet **94** having a size and shape generally corresponding to the size and shape of valve outlets **73** and **74** and movable therebetween by a double-acting fluid cylinder **95** having one end pivotally supported by bracket **96** and pin **97**, and having the piston thereof pivotally connected, as by pin **98**, to the inlet end of valve element **90**. Suitable stops **100**, **101** are provided on valve body **71** in position to limit movement of valve element **90** between a first position aligning outlet **94** with outlet **73** and a second position aligning outlet **94** with outlet **74** to place valve element **90** in fluid communication alternately with conduit **75** and conduit **84**.

Since the inlet **93** of movable valve element **90** is substantially larger than valve inlet **72**, fluid communication therebetween will not be interrupted by the pivotal movement of the valve element **90** between the first and second positions so that a flow of air will be maintained through the valve regardless of the position of movable valve element **90**. Air leakage in valve **70** is maintained at a minimum by the arcuate flanges **102**, **103** on the valve body slidingly engaging the arcuate end surfaces **104**, **105** respectively, of movable valve element **90**.

Actuation of fluid cylinder **95** to move valve element **90** between the first and second positions is controlled by a normally open, closed manually switch **106** located on the floor at the inspection station in position to be actuated by the operator's foot. Switch **106** controls the position of a solenoid actuated two-way valve **112** (see FIG. 8), located within an enclosure **107** mounted on frame **13**, to alternately direct fluid to inlet ports **108** or

109 of fluid motor 95. When switch 106 is in its normally open position solenoid actuated valve 112 directs fluid to inlet 108 to thereby place valve 70 in fluid communication with conduit 84. When switch 106 is closed by the operator the solenoid actuated valve directs fluid to inlet 109 to move valve element 90 into communication with conduit 75.

A pair of foot actuated switches 110 and 111 are positioned on the floor one at the inspection station and the other at the sewing station and are connected in parallel in the electrical circuit controlling the clutch and braking mechanism of reduction gear 46. As indicated in FIG. 8, direct current is normally supplied to the brake 113 through the normally closed contacts 114 of relay Re1, while clutch 115 is normally de-energized. Thus, in the normal condition of the control circuit as indicated in the drawings, the drive mechanism is disabled. When the normally open contacts of switch 110, for example, are closed, alternating current is supplied to the coil of relay Re1 to open its normally closed contacts 114 to de-energize and thereby release the brake. At the same time, the normally open contacts 117 are closed and the normally open contacts 116 are closed to maintain current to the coil after switch 110 is open. When switch 111 is operated to close its normally open contacts, alternating current will be directed to the coil of relay Re2 to close the normally open contacts 118 and thereby complete the circuit to provide direct current to the clutch 115. At the same time, the normally open contacts 119 are closed to maintain alternating current to the coil so that the clutch remains energized even though switch 111 is now open.

When the drive disc 50 completes one full revolution, thereby indexing the turret through 90°, the normally closed contacts of a manually operable switch 120 are momentarily opened by any suitable means, thereby de-energizing relays Re1 and Re2 and permitting the circuit to return to its normal condition.

In operation of the hosiery inspection apparatus, the Geneva drive mechanism rotates turret 20 to position one of the inspection forms at the inspection station (the three o'clock position as viewed from the free ends of the forms) and into fluid communication with the source of fluid pressure differential to establish a flow of air from the free end of the insepction form through the valve 70 and trap chamber 77. An inspector at the inspection station on the right side of the machine, again as viewed from the free ends of the forms, places the open toe end of a stocking in the vicinity of the open end of the form with one hand and permits the toe end of the stocking to be drawn into the hollow form by the flow of air therethrough while retaining the welt end of the stocking with the other hand. The operator then draws the welt end of the stocking onto the outer surface of the inspection form to evert the stocking in the usual manner. The inspector then actuates switch 110 and, assuming that the sewing machine operator has previously actuated switch 111, the Geneva drive mechanism will drive turret 20 through 90° to move the form having a stocking thereon from the three to the six o'clock position, and to move the next successive form into fluid communication with the duct system at the three o'clock position.

The above steps are repeated until an inspection from having a stocking with an open toe thereon is moved to the nine o'clock position where the sewing machine operator (seated at the sewing station on the left side of the apparatus) passes the toe of the stocking hrough an overedge sewing machine 112 to trim any excess material from the open toe and to seam the trimmed open toe of the stocking. The sewing machine operator then actuates switch 111 and, when switch 110 is also actuated, the turret will be rotated to move the form having a stocking with a closed toe thereon from the nine o'clock position to the twelve o'clock position in clear view of the inspector. In this position the seamed stocking may be visually inspected simultaneously with the everting of a stocking on the form positioned in the three o'clock position. When necessary, inspection may be completed during movement of the turret through the next ninety degrees to position the seamed stocking in the three o'clock position or, on rare occasions, after reaching the three o'clock position.

When a seamed stocking reaches the three o'clock position with the inspection form in fluid communication with the duct system, the operator actuates switch 106 (assuming the stocking to have passed the visual inspection) and manually moves the welt end of the stocking slightly toward the free end of the form to loosen the stocking on the form and to permit the stocking to be drawn through the open end of the form and everted to the right-side-out condition. Since switch 106 has been actuated, valve 70 will be positioned to direct the stocking through duct 75 to be delivered to the conventional counting and stacking apparatus.

As soon as the welt end of the inspected stocking passes through the hollow inspection form, the operator releases switch 106, thereby permitting the movable element 90 of valve 70 to establish fluid communication between the form and the trap chamber, and another stocking having an open toe is placed on the form. Thus, in the event that the operator inadvertently releases an open-toed stocking during the initial turning operation, such stocking will then be caught in the trap chamber 77 and will not be delivered to the counting and stacking system with the complete and inspected stockings. Also, if a seamed stocking fails to pass the visual inspection, due to defect either in the body of the stocking or in the seam closing the toe, the inspector does not actually switch 106, but rather permits the defective stocking to be everted through the form and caught in trap chamber 77.

Since two operators, namely the turning and inspection operator and the sewing machine operator, are simultaneously working on stockings supported by separate inspection forms on the turret 20 it is necessary that precautions be taken to prevent rotation of the turret 20 before both operators have completed their separate operations. This is accomplished by providing the two switches 110 and 111 connected in series and positioned so that one switch is to be actuated by each operator after completing his respective operation.

While I have disclosed and described a preferred embodiment of my invention, I wish it understood that I do not intend to be restricted solely thereto, but that I do intend to cover all embodiments thereof which would be apparent to one skilled in the art and which come within the spirit and scope of my invention.

I claim:

1. A hosiery inspection apparatus comprising a turret mounted for rotation about a generally horizontal axis, a plurality of elongated hosiery inspection forms mounted on said turret for rotation therewith about said generally horizontal axis, said forms being radially and circumferentially equally spaced on said turret and each having a free hosiery receiving end with an opening therein and each including a hosiery receiving passage extending longitudinally therethrough and communicating with said opening in said free end, duct means having a source of pneumatic pressure differential for inducing flow of air therethrough, drive means for rotating said turret about said horizontal axis to move the respective forms successively between an inspecting and everting station and a sewing station, said drive means including means for intermittently rotating said turret an amount corresponding to the angular spacing of said forms to successively position said forms at said inspection and everting station and at said sewing station, and means establishing fluid communication between said duct means and said hosiery receiving passage when said forms are at said inspecting and everting station to induce a flow of air

through said hosiery receiving passage from said free end.

2. A hosiery inspection apparatus as defined in claim 1 wherein said duct means includes first and second fluid conduits each having a source of fluid pressure differential, and wherein said means establishing fluid communication between said duct means and said passage incluudes valve means selectively operable to establish fluid communication between said passage and said first and second fluid conduits alternately.

3. A hosiery inspection apparatus as defined in claim 1 further comprising bearing means mounting said inspection forms on said turret for rotation thereon about their respective longitudinal axes.

4. A hosiery inspection apparatus as defined in claim 1 wherein said duct means comprises a fixed tube for establishing fluid communication with said hosiery receiving passage at said one end of said form, first and second fluid conduits each having a source of pneumatic pressure differential for inducing a flow of air therethrough and valve means operatively connecting said fixed tube to said first and second fluid conduits alternately to provide continuous fluid communication between said tube and one of said fluid conduits to induce a flow of air throgh said form from said free end.

5. A hosiery inspecting apparatus as defined in claim 4 wherein said valve means includes an inlet connected to said tube and first and second outlets connected to said first and second fluid contents, a valve element movable between first and second positions for connecting said inlet to said first and second positions for connecting said inlet to said first and said second outlets alternatively, and selectively operable means for moving said valve element between said first and second positions.

6. A hosiery inspecting apparatus as defined in claim 5 wherein said second conduit includes a trap chamber having means to receive and retain stockings moving therein while permitting a flow of air therethrough.

7. A hosiery inspecting apparatus as defined in claim 5 wherein said selectively operable means includes a fluid motor normally retaining said valve element in said second position, said motor being operable to move said valve element to said first position.

8. A hosiery inspection apparatus as defined in claim 1 wherein said drive means includes motor means, and said means intermittently rotating said turret includes a Geneva drive mechanism operably connecting said turret to said motor for rotation thereby, said Geneva drive being operable to intermittently rotate said turret an amount corresponding to the angular spacing of said forms and to retain said turret against rotation for a predetermined minimum time after each intermittent rotation thereof.

9. A hosiery inspecting apparatus as defined in claim 8 wherein said drive means further includes control means operably connecting said motor means and said Geneva drive mechanism, said control means including means automatically disabling Geneva drive means after each intermittent rotation of a turret.

10. The method of seaming the open toe of stockings knit on a circular knitting machine and inspecting the seamed stockings on an inspection form having an opening in one end thereof in communication with a stocking receiving passage extending longitudinally through the form, said method comprising the steps of inducing a flow of air through said form from said opening in said one end, manually placing the open toe of a stocking adjacent said opening to permit the flow of air to distend the stocking within said passage while retaining the welt end of the stocking, advancing the welt end of the distended stocking onto said form away from said one end to evert and withdraw the stocking from within said passage and to locate the hosiery in an inspection position on the external surface of the form, seaming the open toe of the stocking while the hosiery remains on the form, visually inspecting the stocking and the toe seam while the stocking remains on the form, and everting the stocking through the stocking receiving passage in the form.

11. The method of seaming and inspecting stockings as defined in claim 10 further including the steps of discontinuing the flow of air through said passage after the stocking has been positioned on the form, and re-establishing the flow of air through the form after the open toe of the stockings has been seamed.

12. The method of seaming and inspecting stockings as defined in claim 11 wherein the stocking is positioned on the form at an inspection station, said method further including the steps of moving the form with the stocking thereon from the inspection station to a sewing station to discontinue the flow of air through the form while the open toe of the stocking is being seamed closed, and returning the form to the inspection station to re-establish the flow of air through the form.

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U.S. Cl. X.R.

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