

March 31, 1970

G. E. HART
APPARATUS FOR AUTOMATICALLY CLOSING THE ENDS
OF TUBULAR FABRIC ARTICLES

3,503,349

Filed Oct. 7, 1968

5 Sheets-Sheet 1

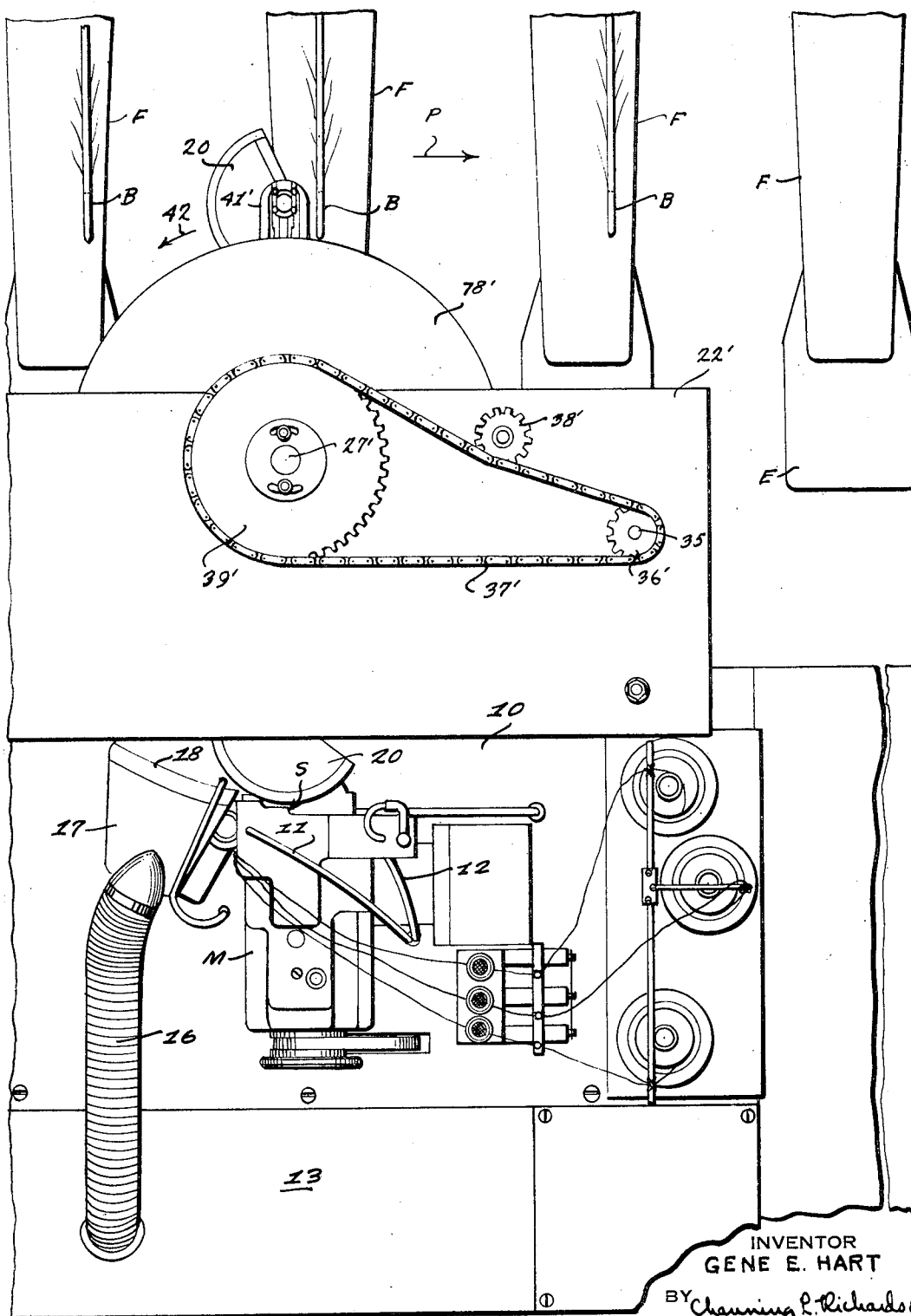


Fig. 1

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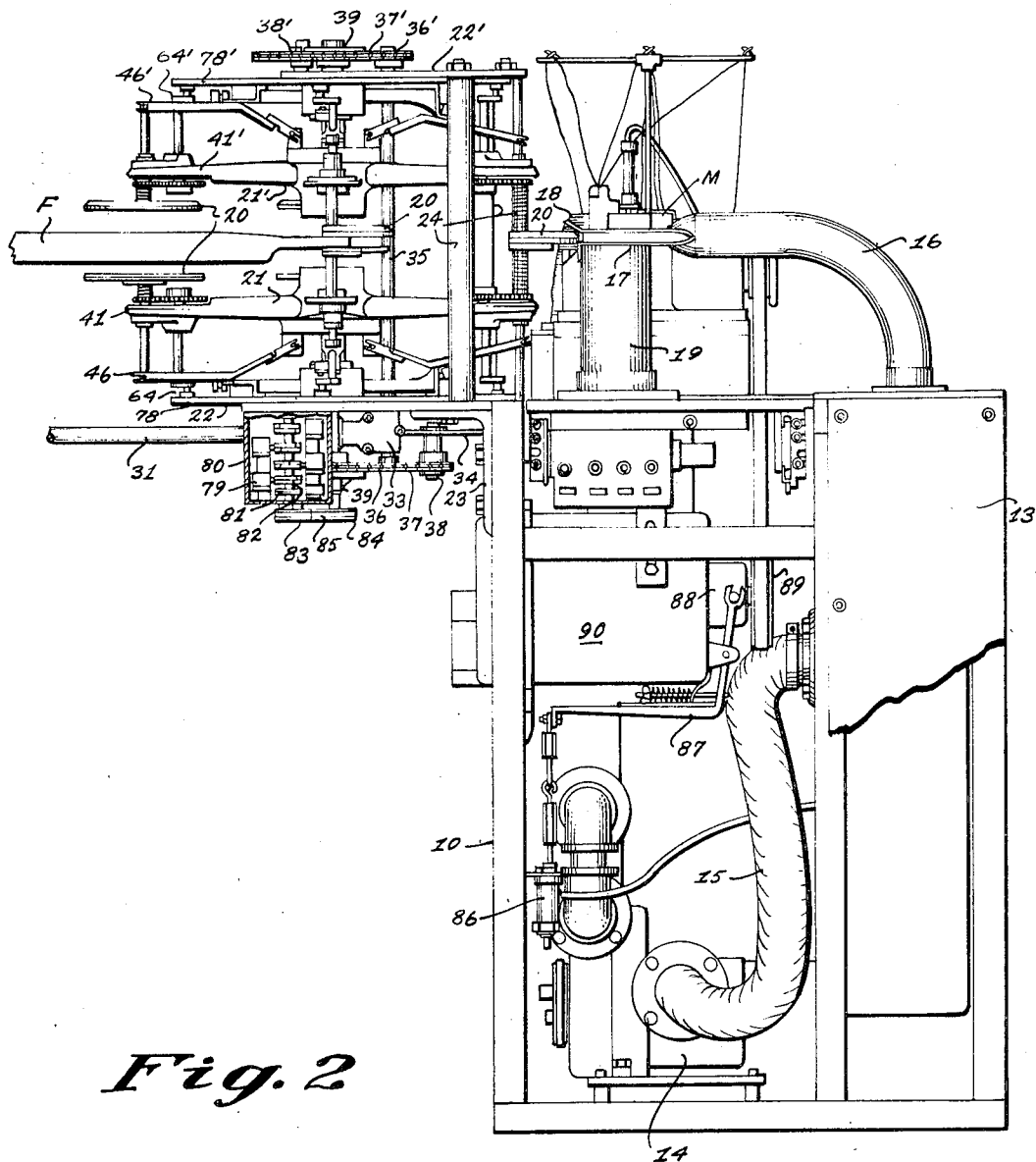
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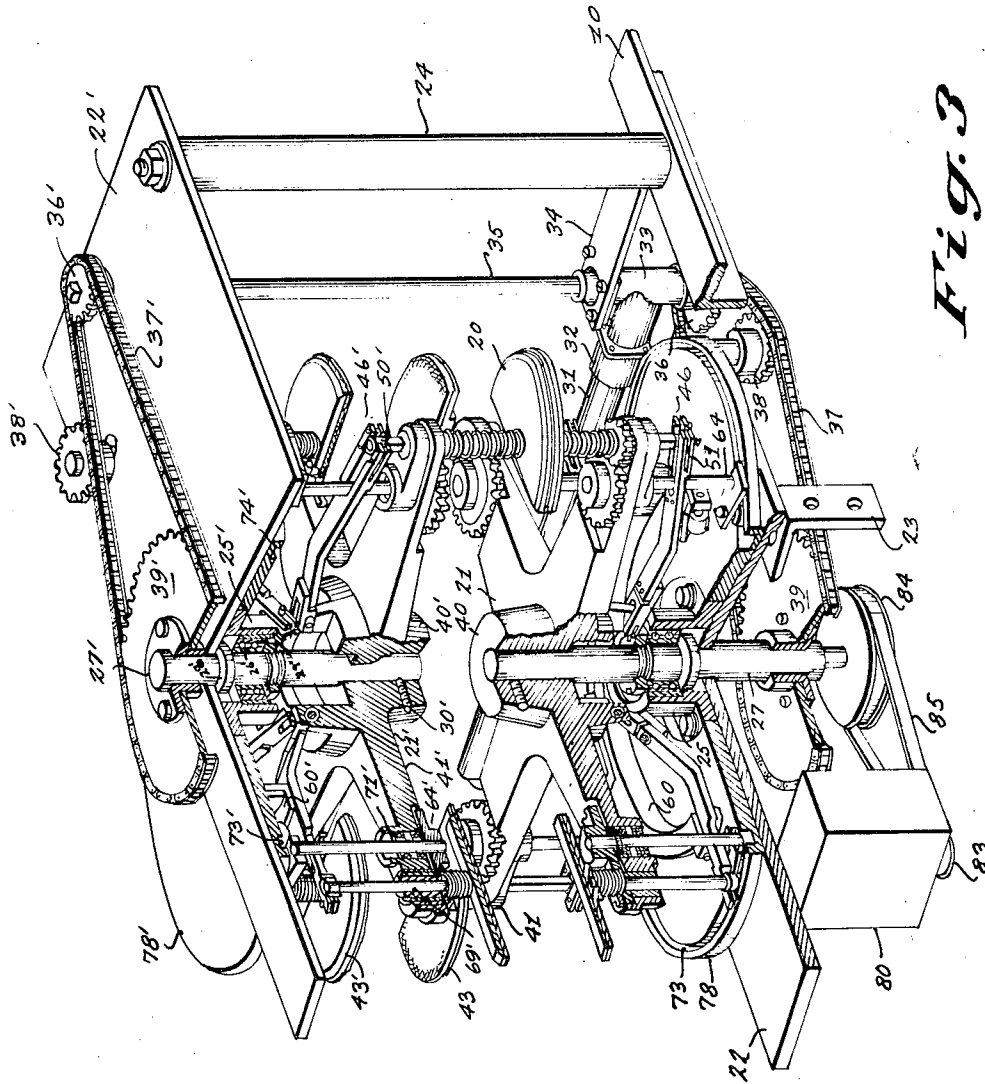
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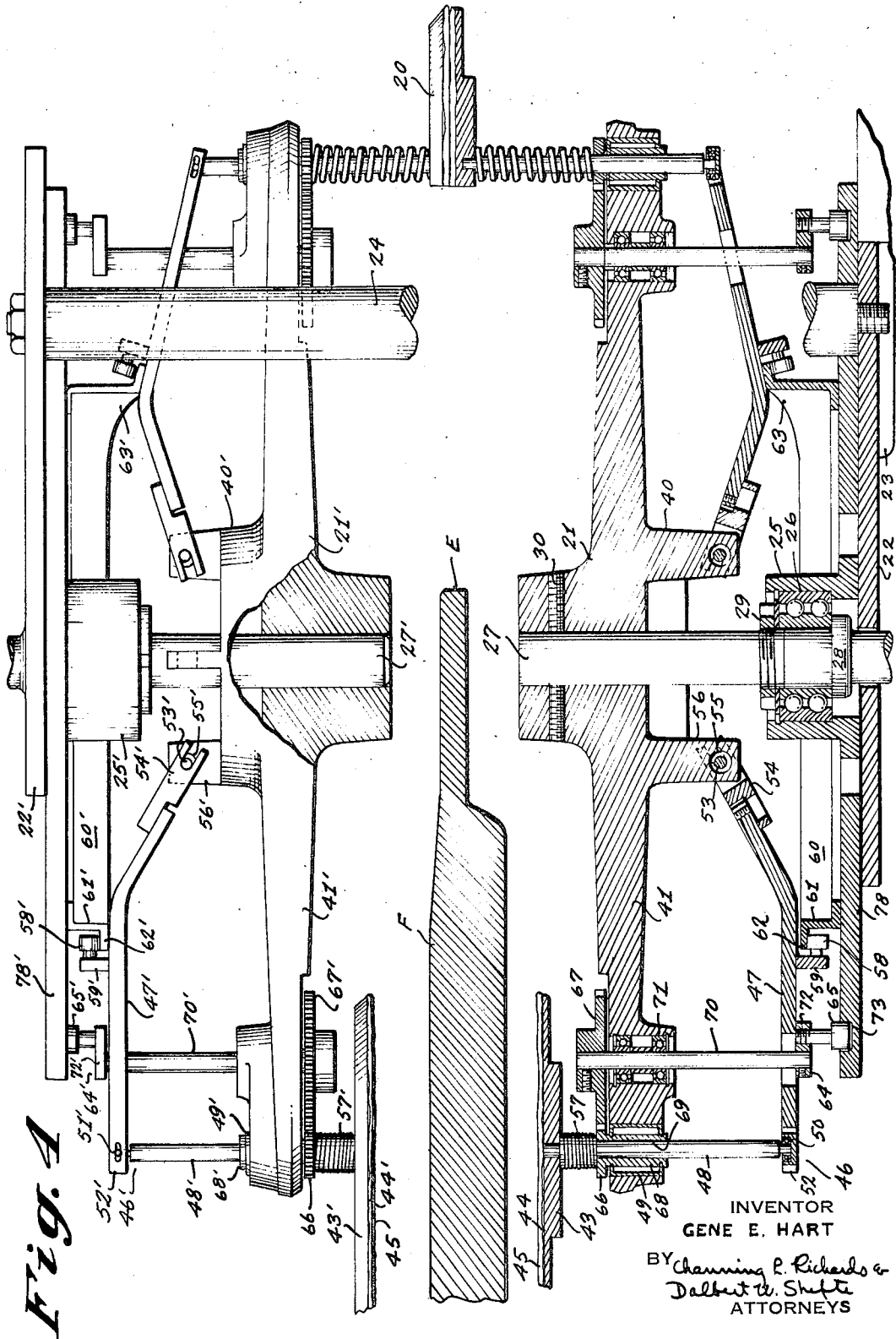
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Fig. 5

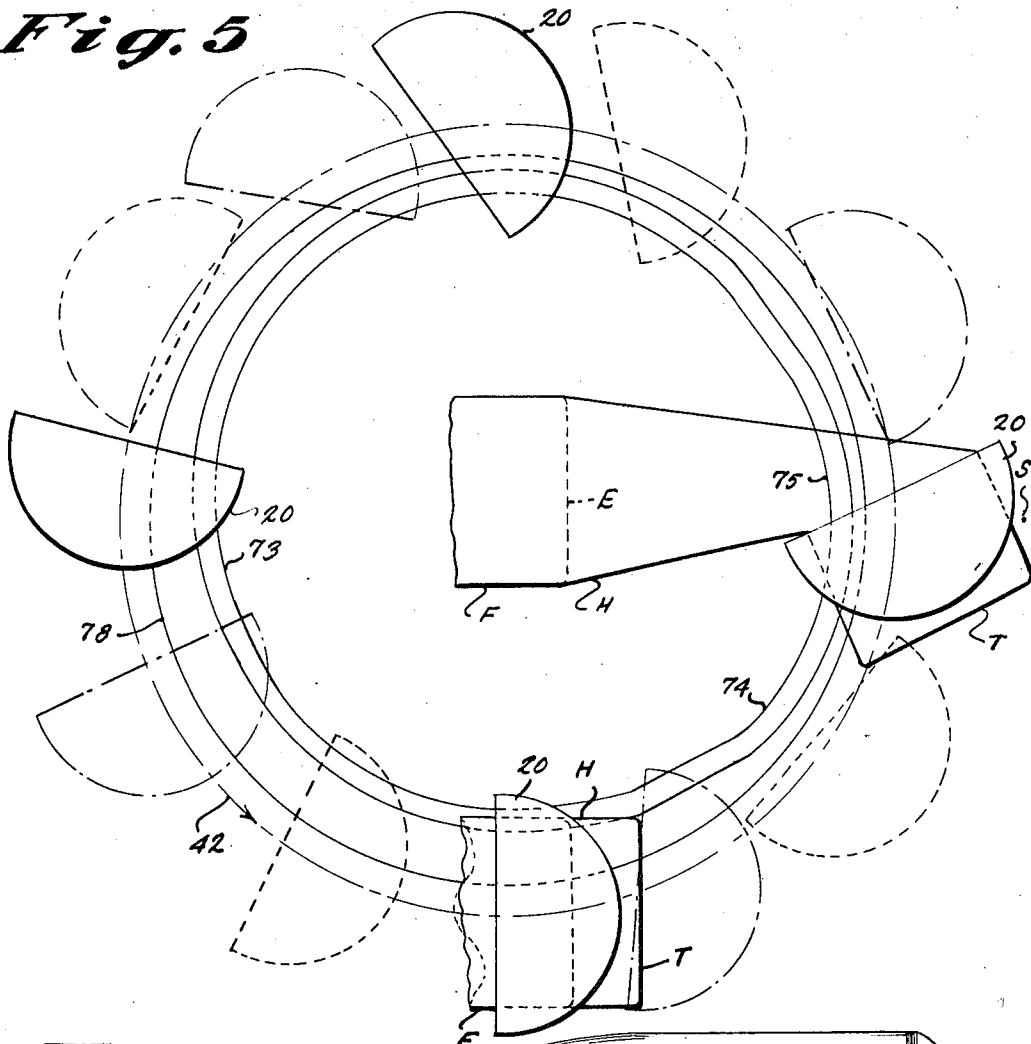


Fig. 6a

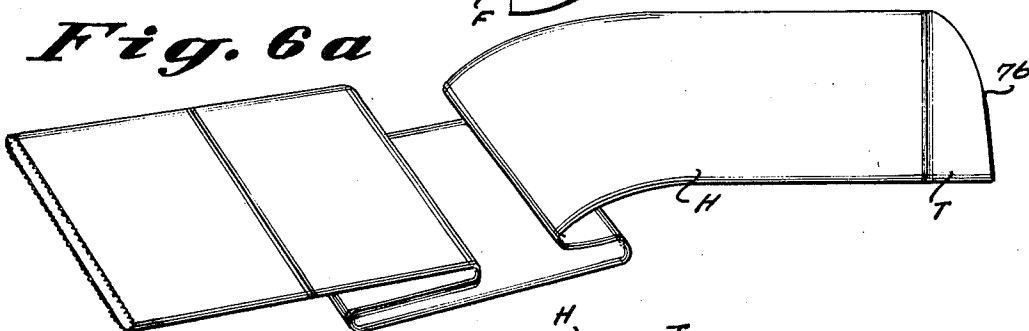
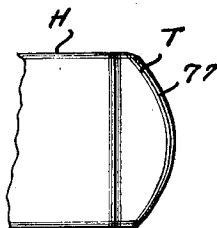


Fig. 6b



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3,503,349

APPARATUS FOR AUTOMATICALLY CLOSING THE ENDS OF TUBULAR FABRIC ARTICLES
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34 Claims

ABSTRACT OF THE DISCLOSURE

An apparatus that automatically closes the ends of tubular fabric articles, such as the toe-ends of hosiery, using clamping sets that travel in an endless path and act sequentially to clamp article ends that are on a series of advancing forms, to advance the clamped article ends from the forms past end closing means, such as a sewing machine, release the article ends after closing, and to return across the forms to the initial clamping position, with the area circumscribed by the endless clamping set path being open to permit free passage therethrough of the advancing forms and the articles carried thereby.

BACKGROUND OF THE INVENTION

The present invention relates to the field of closing, by seaming, sewing, or otherwise, of tubular fabric articles, and particularly to the positioning and feeding of the ends of such articles for and during closing in a manner that provides automatic, high-speed operation.

Particular advantage is obtained with the present invention when it is incorporated in an overall operation of which end closing of a tubular fabric article is a part. An example of such an overall operation is disclosed in Edwards and Levine U.S. Patent No. 3,420,196, issued Jan. 7, 1969, for Method and Means for Processing Tubular Fabric Articles, which discloses a continuous operation for inspecting, seaming and turning of hosiery wherein hosiery articles with open toe ends are placed on a plurality of travelling forms and while on the forms are inspected and the toe ends manually fed through a sewing machine, following which the hosiery articles are everted and removed from the forms automatically.

The manual feeding of articles to the sewing machine in this prior art operation is replaced by automatic means in Forrest and Hart U.S. Patent No. 3,434,438, issued Mar. 25, 1969, for Apparatus for Automatically Closing the Ends of Tubular Fabric Articles, which discloses the use of a clamping mechanism operated automatically to clamp an article end while it is on a form, advance the clamped article end to suction means that positions the end outwardly for sewing, advance the end past a sewing machine for seaming, release the seamed end, and return in the reverse direction in the same path to the initial position for a repeat of the cycle.

The present invention is a further development in the automatic handling of article ends for positioning and feeding for seaming, and is particularly adaptable to an overall integrated operation, which, due to the present invention, is capable of reliable, high-speed performance.

SUMMARY OF THE INVENTION

The advantages of the present invention are obtained by an arrangement that moves a clamping set in an endless path from an article end clamping position, past an end closing means, and back across the path of travelling forms to the initial clamping position without a reverse return over the active article end advancing and feeding portions of the path, thereby permitting high

speed operation and being especially adaptable to the use of a plurality of clamping sets travelling in the same path to increase further the high speed operating capabilities of the apparatus. Further, because the clamping set advances in an endless path and, therefore, does not require any reversing mechanism, the apparatus is relatively uncomplicated. In addition, the apparatus is arranged with all of the operating mechanisms and other components disposed out of the area circumscribed by the path of the clamping set so that the apparatus can be used in conjunction with travelling forms on which the articles remain during the end closing operation, with this open area being free for passage of the forms and articles carried thereby through the area as the clamping set is moving in an endless path that partially overlaps the path of the travelling forms.

Briefly described, the present invention is directed to an apparatus for automatically closing the ends of tubular fabric articles, such as the toe ends of hosiery, sequentially as the articles are carried on a series of forms that travel along a lateral path and have free longitudinal ends at which open ends of the articles are located. The apparatus includes article end closing means disposed outwardly adjacent the form free ends and a clamping set that advances article ends from the forms to the end closing means for closing of the ends thereby. The clamping set is moved by means that cause the clamping set to follow an endless path extending from the form free ends to the end closing means, past the end closing means, and back across the path of the travelling forms in a direction generally opposite the direction of form advance. The clamping set has a pair of opposed clamp members disposed on opposite sides of the form path for clamping the open ends of articles while on the forms, and means are provided for manipulating the clamp members to clamp an article end therebetween at the free end of a form, to retain the article end clamped as the clamping set advances from the form free end past the end closing means for closing of the clamped article end thereby, to unclamp the article end after passing the end closing means, and to retain the clamp members open out of form contact during movement of the clamping set back across the form path. The means for moving the clamping set and the means for manipulating the clamp members, as well as all other components of the apparatus, are disposed out of the area circumscribed by the clamping set path, leaving this area open to permit free passage of the travelling forms and the articles carried thereby through the area.

For efficient, high speed operation a plurality of continuously advancing clamping sets are utilized, and in the preferred embodiment four such clamping sets are disposed in a circular path at equal quadrant spacings, with the end closing means disposed one circular path quadrant from the form free end location at which article ends are initially clamped so that when one clamping set is clamping an article end and initially advancing it from a form the precedingly adjacent clamping set is advancing an article end past the end closing means. Preferably, this circular clamping set path is disposed tangent to the longitudinal extent of the forms at the location where the clamping set path extends initially from the form free ends so that the article ends are advanced from the forms in a direction generally aligned with the forms, and it is tangent also to the feeding direction of the end closing means at the aforementioned quadrant spacing from the initial clamping location so that the article ends will be fed past the end closing means effectively in the general direction of form advance while the remainder of the articles are retained on the travelling forms, which forms advance intermittently with the continuously advancing

clamping sets acting to clamp articles at the form free ends and to feed the articles past the end closing means during a dwell of the intermittently advancing forms, at which time the continuously advancing clamping sets are moved at a reduced speed to accommodate the seaming rate of the end closing means, with the speed being increased substantially between seaming operations for overall high speed operation.

The means for manipulating the clamp members in the preferred embodiment includes a manipulating mechanism associated with each clamp member, with each manipulating mechanism being independent of the manipulating mechanism associated with the opposing clamp members of its clamping set and operating synchronously therewith for complementary manipulation of the opposing clamp members to clamp and unclamp article ends.

In the preferred embodiment means are also provided for pivoting the clamp members in the clamping set path about an axis perpendicular to the clamping set path to reorient the disposition of the clamped article ends with respect to the end closing means so that a desired seam inclination can be obtained. This pivoting means may, if desired, be operable during movement of the clamping sets past the end closing means to obtain a selected closure contour at the article end. Preferably, the pivoting means includes a pivoting mechanism associated with each clamp member, with each pivoting mechanism being independent of the pivoting mechanism associated with the opposing clamp member of its clamping set and operating synchronously therewith for complementary pivoting of the opposing clamp members.

The aforementioned independent arrangement of the manipulating mechanisms and pivoting mechanisms simplifies the apparatus as no connecting linkages or other connecting means are required, and it also makes it possible to avoid the disposition of any components in the area circumscribed by the clamping set path so that the area remains open as aforesaid for free passage of the travelling forms and articles carried thereby through the area.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a plan view of an apparatus for automatically closing the ends of tubular fabric articles according to the preferred embodiment of the present invention;

FIG. 2 is a side elevation view of the apparatus of FIG. 1;

FIG. 3 is a perspective view, partially in section, of the clamping sets and associated mechanisms of the apparatus of FIG. 1;

FIG. 4 is a vertical section view of the clamping sets and associated mechanisms of FIG. 1;

FIG. 5 is a diagrammatic plan view of the sequential positions of the clamping sets of the apparatus of FIG. 1; and

FIGS. 6a and 6b are illustrations of hosiery having toe ends closed by operation of the apparatus of the preceding figures.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The preferred embodiment of the apparatus of the present invention is shown in the accompanying drawings incorporated in a device for automatically inspecting, seaming and turning ladies' hosiery of the type shown in the aforementioned Edwards and Levine U.S. Patent No. 3,420,196, which has a series of laterally spaced horizontal forms F travelling in a lateral path P and having free longitudinal ends E. As disclosed in the aforementioned patent, the forms F travel sequentially through an inspection station at which an operator places hosiery H with open toe ends T on the forms F with the toe ends T at the free ends E of the forms and at which the operator inspects the hosiery H while they are on the forms F. The forms with the hosiery H thereon then travel through a

toe closing station at which the open toe ends T of the hosiery H are drawn from the forms F without completely removing the hosiery therefrom and are fed to a sewing machine M that closes the hosiery toes T by seaming, following which an air blower B directs a stream of air onto the hosiery away from the toe ends T to draw the hosiery back onto the forms F in position for subsequent everting and removing of the hosiery H pneumatically through the forms F, which are hollow for this purpose. When utilized with the apparatus of the present invention, the device of this prior patent is operated to advance the forms F intermittently with a dwell period between intermittent advances to facilitate operation of the apparatus of the present invention as will be described hereinafter.

As the apparatus of the present invention relates to the seaming aspect of this overall inspecting, seaming and everting operation, only the seaming station elements are shown and described herein.

The sewing machine M is located at the seaming station outwardly adjacent the free ends E of the forms F on a table 10 with the direction of feed through the sewing machine M being parallel with the direction of form travel and with the machine operating to effect seaming at a stitch point S. Any one of several different conventional types of sewing machines may be used and for this reason the details of the sewing machine construction and operation are not included herein. An example of a suitable sewing machine is the machine known commercially as Model MFD 45 made by Merrow Machine Company. This machine has a scissors-like cutter in advance of the stitch point P to trim excess material outwardly of the feeding path with the trimmings being removed through a pneumatic suction tube 11, and a hot wire tail clipper following the stitch point S for clipping the chain stitch tail trailing from the hosiery toe T after seaming, the tail clippings being removed by a pneumatic suction tube 12.

The pneumatic suction tubes 11 and 12 are connected to a collection box 13 below the rear of the table 10 for collection of the trimmings and clippings therein. Suction is created in the collection box 13 and tubes 11 and 12 by a conventional pneumatic pump 14 that is driven by a conventional motor (not shown) to draw air from the collection box 13 through a connecting conduit 15.

Also connected to the collection box 13 through a connecting conduit 16 is a suction nozzle 17 that has a wide flat mouth 18 facing the forms in general alignment with the path of feeding to the sewing machine M in advance of and closely adjacent the sewing machine. This nozzle 17 is mounted at the horizontal level of the sewing machine feed on an upstanding bracket 19 that is mounted on the table 10. The mouth 18 of the nozzle 17 is of a width sufficient to receive the toe ends T of hosiery H to position the ends outwardly in proper feeding disposition with respect to the sewing machine as described in detail in the aforesaid Forrest and Hart U.S. Patent No. 3,434,438.

In accordance with the preferred embodiment of the present invention, the toe ends T of hosiery H are advanced from the form free ends E to the suction nozzle 17 and past the sewing machine stitch point S by clamping sets 20 that are mounted on a pair of oppositely spaced carrier members in the form of starwheels 21, 21' which in turn are supported adjacent the sewing machine M for rotation on a pair of oppositely spaced supporting structures 22, 22' that are disposed outwardly of the starwheels 21, 21'.

The supporting structures 22, 22' are in the form of horizontally extending plate-like members disposed in spaced parallel relation, partially overlapping the path P of the forms F, and equally spaced above and below the form path P. The lower structure 22 is attached by brackets 23 to the table 10 and extends therefrom toward the forms F in cantilever fashion. The upper structure 22' is secured for cantilever extension on upstanding posts 24

extending from the lower structure 22 and the table 10.

A lower bearing block 25 is secured centrally on the upper side of the lower supporting structure 22 and an upper bearing block 25' is secured centrally on the underside of the upper supporting structure 22' in axial alignment with the lower bearing block 25. The bearing blocks 25, 25' contain ball bearings 26, 26' that support axially aligned starwheel drive shafts 27, 27' for rotation. These drive shafts 27, 27' are retained against axial displacement in the bearings 26, 26' by annular drive shaft flanges 28, 28' that engage the bearings 26, 26' on the ends thereof adjacent the supporting structures 22, 22' and by retaining rings 29, 29' threaded on the drive shafts 27, 27' at the opposite ends of the bearings 26, 26'.

The drive shafts 27, 27' are located perpendicular to the form path P in overlapping relation to the form free ends E, and terminate short of contact therewith to permit movement therebetween of the forms F and hosiery H carried thereby.

The starwheels 21, 21' are fixed to the inner ends of the starwheel drive shafts 27, 27' by set screws 30, 30' for rotation about a common axis in partially overlapping, parallel relation to the form path P. The starwheels 21, 21' are independent of each other, but are rotated synchronously by means that includes an extension 31 of the main drive shaft (not shown) of the mechanism that advances the forms F, which main drive shaft extension 31 is drivably connected through a universal coupling 32 and a right-angle drive mechanism 33, mounted on a bracket 34 extending from the table 10, to a vertical intermediate drive shaft 35 that extends beyond the supporting structures 22, 22' and to the outwardly extending ends of which are secured drive sprockets 36, 36' around which are trained chains 37, 37' that extend therefrom in engagement with idler sprockets 38, 38' adjustably mounted on the supporting structures 22, 22', and around driven sprockets 39, 39' secured to outwardly extending ends of the starwheel drive shafts 27, 27'.

Each of the starwheels 21, 21' is formed with a central hub 40, 40' and four radially extending, equally spaced, arms 41, 41', with the arms 41, 41' of the opposing starwheels 21, 21' being vertically aligned for support therebetween of the aforementioned clamping sets 20, of which there are four in the preferred embodiment and which are rotated by the synchronous rotation of the starwheels 21, 21' in a horizontal circular endless path 42 in the plane of and partially overlapping the form path P, with the common axis of the starwheel drive shafts 27, 27' being perpendicular to this endless clamping set path 42.

The aforementioned starwheel moving means operates to advance the clamping sets 20 in the circular path 42 from a form free end E location, to the suction nozzle 17, to the sewing machine M, past the sewing machine stitch point S and back across the form path P at which the clamping sets 20 are moved in a direction generally opposite the direction of form advance. In this regard, the circular clamping set path 42 is disposed tangent to the longitudinal extent of the forms F at a location where the clamping set path 42 extends initially from the form free ends E and is also tangent to the sewing machine feed direction for advancing clamped hosiery toe ends T past the sewing machine stitch point S in the direction of form F advance. To provide this tangent arrangement, the sewing machine M is located with its stitch point S approximately one circular clamping set path quadrant from the form free end E location from which the clamping set path 42 initially extends so that when one of the clamping sets 20 is clamping a hosiery toe end T and advancing it initially from its form free end E the preceding adjacent clamping set 20 is advancing a clamped hosiery toe end T past the sewing machine stitch point S for seaming thereof.

The aforementioned intermittent advance of the forms F is controlled so that a form F is at the clamping set path tangent location during each dwell period, and the

clamping sets 20 are moved continuously in their endless path in timed relation to the intermittent form advance so that a clamping set 20 is at the form tangent location for toe end clamping and initial advance from the form F during each dwell period.

Each of the clamping sets 20 comprises a pair of opposed plate-like clamp members 43, 43' with the opposed clamp members 43, 43' of each pair being mounted on opposite starwheels 21, 21' for disposition on opposite sides of the clamping set path 42 and the plane of the form path P. The opposed clamp members 43, 43' having mating flat clamping surfaces 44, 44' covered by felt pads 45, 45' for clamping and retaining hosiery toe ends T therebetween.

The clamp members 43, 43' of each clamping set 20 are manipulated by means comprising a manipulating mechanism 46, 46' associated with each clamp member 43, 43', which manipulating mechanisms are independent of each other but operate synchronously for complementary manipulation of the opposing clamp members 43, 43'.

Each manipulating mechanism 46, 46' includes an operating linkage consisting of a rocker arm 47, 47' and an operating rod 48, 48' connected thereto. Each operating rod 48, 48' is secured to its associated clamp member clamping set path through a bearing 49, 49' in the associated starwheel arm 41, 41' for longitudinal movement therein. A bearing cap 50, 50' is mounted on the outer end of each operating rod 48, 48' and is pivotally attached by pin and slot connections 51, 51' to the outer bifurcated end 52, 52' of the associated rocker arm 47, 47', which extends radially inward to the aforementioned starwheel hub 40, 40', to which it is pivotally attached for pivoting radially with respect to the clamping set path 42 to move the operating rod 48, 48' longitudinally for clamping and unclamping manipulation of the associated clamp member 43, 43'. The rocker arm 47, 47' is attached to the starwheel hub 40, 40' through a transverse rocker shaft 53, 53' that is secured to a bifurcated inner end portion 54, 54' of the rocker arm 47, 47' and is oscillatably mounted in a bearing 55, 55' that extends through a stud extension 56, 56' of the starwheel hub 40, 40' within the confines of the rocker arm bifurcated inner end 54, 54'.

This operating linkage is operated by means including a spring member and cam means. The spring member is in the form of a coil spring 57, 57' encircling the operating rod 48, 48' and acting in compression between the associated clamp member 43, 43' and starwheel arm 41, 41' to bias the linkage and clamp member in a clamping direction. The cam means includes a roller-type cam follower 58, 58' mounted on a stud 59, 59' projecting from the rocker arm 47, 47' intermediate the ends of the arm toward the associated supporting structure 22, 22', with the cam follower 58, 58' projecting from the stud radially inward and being disposed for rolling along a circular path as the associated starwheel 21, 21' rotates. The cam follower 58, 58' is engaged by a stationary cam track 60, 60' that is disposed circularly and concentric with the axis of starwheel rotation on the associated supporting structure surface that faces the rocker arm 47, 47'. The cam track 60, 60' has a base portion 61, 61' extending from the supporting structure 22, 22' and from which base portion 61, 61' an annular cam flange 62, 62' extends radially outward into the space between the cam follower 58, 58' and its rocker arm 47, 47'. The cam follower 58, 58' is biased against the cam flange 62, 62' in following relation by the action of the aforementioned coil spring 57, 57' and the spacing of the cam flange 62, 62' from the flat supporting structure 22, 22' varies to effect rocking of the rocker arm 47, 47' and thereby effect manipulation of the clamp members 43, 43'. As seen in FIGS. 3 and 4, the cam flange 62, 62' is interrupted between the initial clamping position of the clamping sets

20 at the form free ends E and the sewing machine M so that the clamp members 43, 43' are biased in clamping disposition by the coil spring 57, 57' when they are at the form free ends E, when they advance a clamped hosiery toe end T from the form to the suction nozzle 17, and when they feed the clamped hosiery toe end past the sewing machine stitch point S. Just beyond the location at which the clamping set 20 has completed feeding of the hosiery toe end T past the sewing machine stitch point S, the cam flange 62, 62' has an initial cam follower engaging portion 63, 63' that extends at an inclination into the path of the cam follower 58, 58' and slopes toward its associated supporting structure 22, 22' to engage the cam follower 58, 58' and cause it to move toward the associated supporting structure 22, 22' to manipulate the clamp member 43, 43' to an open, unclamped position at which it is maintained by a continuation of the cam flange 62, 62' to the aforementioned initial clamping location, with this cam flange continuation retaining the clamp member 43, 43' open out of contact with the forms F as the clamping sets 20 move back across the form path P.

If desired, the configuration and location of the cam track 60, 60' can be rearranged and the coil spring 57, 57' can be relocated to utilize the cam track to effect clamping and the coil spring to effect unclamping.

In addition to being manipulated perpendicular to the clamping set path 42 for clamping and unclamping, the clamp members 43, 43' of the clamping sets 20 are pivoted in the clamping set path 42 about an axis perpendicular to the clamping set path to reorient the disposition of the clamped hosiery toe end T with respect to the sewing machine M to obtain a desired toe end closure location, and the pivoting means that accomplishes this is operable not only during movement of the clamping sets 20 from the forms F to the sewing machine M, but also during feeding of the toe ends through the sewing machine so that a desired closure contour may be obtained.

This pivoting means includes a pivoting mechanism 64, 64' associated with each clamp member 43, 43', each of which pivoting mechanisms 64, 64' is independent of the mechanism associated with the other clamp member of its associated clamping set 20, but operates synchronously therewith for complementary pivoting of the clamp members of the set. Each pivoting mechanism 64, 64' includes a cam follower 65, 65' that is operatively connected to its associated clamp member 43, 43' for pivoting thereof through gear means that amplifies the extent of clamp member pivoting in proportion to cam follower displacement.

The gear means is mounted on the associated starwheel arm 41, 41' and comprises a small driven gear 66, 66' meshing with a large drive gear 67, 67' in a plane parallel to the clamping set path 42. As the drive gear 67, 67' is larger than the driven gear 66, 66', an arcuate displacement of the drive gear 67, 67' will result in an amplified arcuate displacement of the driven gear 66, 66' and associated clamp member 43, 43', to which the driven gear 66, 66' is connected through the operating rod 48, 48'. For this purpose the driven gear 66, 66' is provided with a cylindrical hub extension 68, 68' that is seated for free rotation in the aforementioned bearing 49, 49' in the associated starwheel arm 41, 41' through which the operating rod 48, 48' extends as aforesaid. This driven gear hub extension has an axial bore 69, 69' that is square in cross-section and receives the operating rod 48, 48', which is also square in cross-section, so that it is keyed thereby to the driven gear 66, 66' for rotation therewith while being slidable therein to permit longitudinal movement for clamping and unclamping manipulation of the clamp members 43, 43' by the aforesaid manipulation mechanism 46, 46' through the operating rod 48, 48'.

The drive gear 67, 67' is mounted on the associated starwheel arm 41, 41' radially inward of and in meshing engagement with the driven gear 66, 66', and is secured coaxially on the end of a gear means drive shaft 70, 70'

that is mounted for free rotation in a bearing 71, 71' in the associated starwheel arm 41, 41' through which it extends toward the adjacent supporting structure 22, 22' perpendicular to the clamping set path 42 and parallel to the operating rod 48, 48'. At the end adjacent the supporting structure 22, 22' the gear means drive shaft 70, 70' has a radially extending arm 72, 72' from the outer end of which the aforesaid cam follower 65, 65' projects toward the adjacent supporting structure 22, 22'. This cam follower 65, 65' is of the roller type and is disposed for rolling about an axis perpendicular to the clamping set path 42 in a cam path parallel to the clamping set path. A cam track in the form of a groove 73, 73' parallel to the clamping set path 42 is formed in the supporting structure surface facing the clamping set path 42 for engagement therein of the cam follower 65, 65'.

As seen in FIG. 5, the cam track groove 73, 73' varies from the circular contour of the clamping set path 42 to effect displacement of the cam follower 65, 65', which displacement causes a corresponding rotation of the gear means drive shaft 70, 70' and gear means for pivoting of the associated clamp member 43, 43'. In this regard, the cam track groove 73, 73' has an initial segment 74, 74' that is inclined outwardly to effect a counterclockwise displacement of the cam follower 65, 65', which results in a clockwise pivoting of the associated clamp member 43, 43' as it moves from the form free end E with a clamped hosiery toe end T to the sewing machine stitch point S so that the side of the hosiery toe end T is reoriented in position for beginning of seaming thereat. This initial outwardly inclined segment 74, 74' is followed by an inwardly inclined segment 75, 75' that effects a clockwise displacement of the cam follower 65, 65', which results in a counterclockwise pivoting of the associated clamp member 43, 43' as it advances while feeding the clamped hosiery toe end T past the stitch point S to produce a contoured closure seam. The remaining portion of the cam track groove 73, 73' is contoured to effect cam follower displacement for pivoting of the clamp member 43, 43' back to its initial clamping disposition.

The particular cam track groove contour shown in FIG. 5 produces a closure seam contour 76 as shown in FIG. 6a, which is known as a Getaz type. However, the cam track groove contour may be varied to produce any desired closure seam contour. For example, an appropriately increased inclination of the inwardly inclined groove segment 75, 75' can effect an increased counterclockwise pivoting of the clamp member 43, 43' during the seaming operation to produce a symmetrical arcuate closure contour 77 of the "fish-mouth" type as shown in FIG. 6b.

To facilitate changing of the closure contour, the cam track groove 73, 73' is formed in a plate portion 78, 78' of the supporting structure 22, 22', which plate portion 78, 78' is removably mounted for replacement with another plate portion having a differently contoured cam track groove. For convenience, the plate portion 78, 78' may be diametrically split to permit replacement of only the component containing the cam track groove segments that effect the closure seam contour.

As seen in FIGS. 3 and 4, the aforementioned manipulating means cam track 60, 60' is also mounted on this supporting structure plate portion 78, 78'.

From the accompanying drawings and the foregoing description it is evident that the apparatus of the present invention advantageously avoids the location of any elements other than the clamping sets 20 themselves in the area circumscribed by the clamping set path 42, with the result that this area is open to permit free passage of the travelling forms and the hosiery carried thereby through the area. This is accomplished in the preferred embodiment by the use of the abovedescribed independent, but synchronously operated, clamp member manipulating mechanisms 46, 46' and pivoting mechanisms 64, 64' mounted on opposingly spaced starwheels 21, 21' and sup-

porting structures 22, 22'. Furthermore, as the clamping sets 20 are open as they are moved back across the form path P, as described hereinabove, there also are no elements disposed in the form path P to interfere with the travelling forms F.

With reference to the operation of the apparatus, the clamping sets 20 are operated in timed relation to the intermittently advancing forms F and to the operation of the sewing machine M, with the timed relation controlled electrically by a series of five microswitches 79 mounted in a control box 80 that is secured to the underside of the lower supporting structure 22. The microswitches 79 are operated by cam discs 81 mounted on a cam shaft 82 that is rotatably mounted in the control box 80 and extends outwardly therebelow for exterior securement thereto of a driven timing pulley 83. A drive timing pulley 84 is secured to the downwardly extending end of the lower starwheel drive shaft 27 below the previously described sprocket 39. A timing belt 85 is trained around these timing pulleys 83 and 84 to rotate the cam shaft 82 in timed relation to rotation of the starwheel drive shaft 27, the ratio of the sizes of the pulleys being such as to rotate the cam shaft 82 one revolution for each quarter revolution of the starwheel drive shaft 27 for identical cycling of the apparatus during each quadrant advance of the four clamping sets 20 in the circular clamping set path 42.

As the main drive shaft extension 31 rotates continuously, thereby rotating the lower starwheel drive shaft 27 continuously, the cam shaft 82 will be rotated continuously so that cycling of all of the components can be controlled by the aforesaid microswitches 79. One of these microswitches 79 functions when each clamping set 20 approaches the initial clamping location at the free end E of a form F to energize a mechanical brake and clutch mechanism of conventional construction in the form drive system to stop the advance of forms F until the clamping set advances from the form free end with a hosiery toe end T clamped therein. At approximately the same time another of the microswitches 79 functions to energize an electrical braking action in the form drive system that prevents coasting of the forms after the mechanical brake and clutch mechanism is actuated. This allows the forms F to be advanced at high speed without slowing down prior to braking. The other three of these microswitches 79 function when a clamping set 20 approaches the sewing machine M, one functions to activate the conventional sewing machine pressure foot to guide a hosiery toe end T to the sewing machine stitch point S, a second functions to energize electrical means that reduces the speed of rotation of the main drive shaft extension 31 to reduce the speed of the clamping sets 20 during feeding of a hosiery toe end T past the sewing machine M, thereby permitting a higher operating speed during the other portions of the cycle, and the other microswitch functions to activate an air valve 86 that pivots a rocker arm 87 to engage a clutch 88 in the sewing machine drive system 89 for operation of the sewing machine M by a sewing machine drive motor 90 to seam a hosiery toe end as it is fed past the sewing machine. All of these three microswitches cease functioning after completion of each sewing operation to cause their controlled elements to release the sewing machine pressure foot, to allow the clamping sets 20 to move at high speed, and to disengage the sewing machine M from its drive motor 90.

As the electrical circuitry for the microswitches 79 and the operating components that function in response to the microswitches to operate the above-identified elements and mechanisms may be wholly conventional, no detailed description is considered necessary herein.

In operation of the above-described preferred embodiment the clamping sets 20 travel continuously in their endless path 42 at a speed related to the intermittent advance of the travelling forms F so that a clamping set

approaches the clamping location of the forms at about the same time that a form carrying hosiery H thereon reaches this location and begins its dwell period thereat, with the forms advancing a distance equivalent to the spacing between forms during each intermittent advance so that a form is at the clamping location during each dwell period. When a clamping set 20 reaches this clamping location the clamp members 43, 43' thereof are closed by the aforementioned associated manipulating mechanisms 46, 46' to clamp a hosiery toe end T therebetween on the form end E, and at about the same time the speed of the clamping sets 20 is reduced to accommodate the rate of feed of the sewing machine M, at which the preceding clamping set is preparing to feed a previously clamped hosiery toe end T past the sewing machine stitch point S with the remainder of the hosiery extending back to its form on which a portion of the hosiery remains. The clamping sets 20 continue to advance at the reduced speed while the clamping set at the sewing machine is advancing the hosiery toe end therepast for seaming thereof. During this time the pivoting mechanisms 64, 64' are pivoting this clamping set to produce the desired closure seam contour, and the clamping set that was at the clamping location is now advancing away from the form end E with a hosiery toe end T clamped therein. After seaming is completed, the clamping sets resume high speed advance as the clamping set previously at the sewing machine M moves away therefrom and is opened by its associated manipulating mechanisms 46, 46' to release the previously clamped and now seamed hosiery toe end T for return to its form for subsequent everting and removal, and the clamping set previously at the clamping location moves to the suction nozzle 17 for positioning of the toe end T for feeding to the sewing machine pressure foot and stitch point S. During this movement from the clamping location to the suction nozzle 17 the clamping set is pivoted by its associated pivoting mechanisms 64, 64' to reorient the clamped hosiery toe end T with respect to the sewing machine. Also during this high-speed advance of the clamping sets 20, an intermittent advance of the forms F occurs, keeping each form generally opposite the clamping set in which the toe end of the hosiery carried by the form is clamped. The speed of the clamping sets is reduced again to begin a repeat of the cycle when a clamping set approaches the sewing machine M and the following clamping set is approaching the clamping location at which another form is positioned with hosiery thereon. After the clamping sets 20 are opened as aforesaid to release the hosiery toe end T after seaming, they are retained open by their associated manipulating mechanisms 46, 46' as they advance back across, but not interfering with, the travelling forms to the clamping location, and during this time the associated pivoting mechanisms 64, 64' pivot the clamping sets to their initial disposition for clamping.

As there are four clamping sets 20, the above described cycle of operation is repeated four times for every single revolution of the starwheels 21, 21', which in combination with the continuous advance of the clamping sets and the high speed of clamping set advance between seaming operations results in a relatively high overall operating rate.

Although the foregoing detailed description is directed to closing the toes of hosiery, the present invention is applicable as well to closing the ends of various other tubular fabric articles by seaming, hot-wire application or otherwise, and is also applicable to handling of tubular articles for purposes other than closing.

I claim.

1. Apparatus for automatically closing the ends of tubular fabric articles sequentially as the articles are carried on a series of forms that travel along a lateral path and have free longitudinal ends at which open ends of the articles are located, said apparatus comprising article end closing means disposed outwardly adjacent

the form free ends, a clamping set having a pair of opposed clamp members disposed on opposite sides of the form path for clamping the open ends of articles while on the forms, means for moving said clamping set in an endless path that partially overlaps said form path and extends from said form free ends to said end closing means, past said end closing means, and back across said form path at which the clamping set is moved in a direction generally opposite the direction of form advance, means for manipulating said clamp members to clamp an article end therebetween at the free end of a form, to retain the article end clamped as the clamping set advances from the form free end past said closing means for closing of the clamped article end thereby, to unclamp the article end after passing said end closing means, and to retain the clamp members open out of form contact during movement of the clamping set back across the form path, and the area circumscribed by said clamping set path being open to permit free passage of said forms and articles through said area.

2. Apparatus for automatically closing the ends of tubular fabric articles according to claim 1 and characterized further in that said clamping set path extends initially from the form free ends in a direction generally aligned with the longitudinal extent of said forms.

3. Apparatus for automatically closing the ends of tubular fabric articles according to claim 1 and characterized further in that said clamping set path extends past said end closing means in the general direction of form advance.

4. Apparatus for automatically closing the ends of tubular fabric articles according to claim 1 and characterized further in that said means for manipulating said clamp members comprises a manipulating mechanism associated with each clamp member, said manipulating mechanisms being independent of each other and operating synchronously for complementary manipulation of said clamp members.

5. Apparatus for automatically closing the ends of tubular fabric articles according to claim 4 and characterized further in that each of said manipulating mechanisms comprises an operating linkage connected to its associated clamp member, and means for operating said linkage to manipulate its associated clamp member perpendicular to said clamping set path for clamping and unclamping manipulation of said clamp members.

6. Apparatus for automatically closing the ends of tubular fabric articles according to claim 5 and characterized further in that said linkage operating means comprises a spring member biasing said linkage in one clamp member manipulating direction and cam means acting on said linkage against the bias of said spring member to manipulate said clamp member in the opposite direction.

7. Apparatus for automatically closing the ends of tubular fabric articles according to claim 6 and characterized further in that said cam means comprises a cam follower mounted on said linkage, and a stationary cam track engageable with said cam follower to cause said linkage to manipulate said clamp member in said opposite direction.

8. Apparatus for automatically closing the ends of tubular fabric articles according to claim 6 and characterized further in that said spring member biases said linkage to manipulate said clamp member in a clamping direction, and said cam means acts on said linkage to manipulate said clamp member in an unclamping direction.

9. Apparatus for automatically closing the ends of tubular fabric articles according to claim 1 and characterized further by means for pivoting said clamp members in said clamping set path about an axis generally perpendicular to clamping set path to reorient the disposition of the clamped article and with respect to said end closing means.

10. Apparatus for automatically closing the ends of tubular fabric articles according to claim 9 and characterized further in that said pivoting means is operable during movement of said clamping set past said end closing means to obtain a desired closure contour at said article end.

11. Apparatus for automatically closing the ends of tubular fabric article according to claim 9 and characterized further in that said pivoting means comprises a pivoting mechanism associated with each of said clamp members, said pivoting mechanisms being independent of each other and operating synchronously for complementary pivoting of said clamp members.

12. Apparatus for automatically closing the ends of tubular fabric articles according to claim 11 and characterized further in that each of said pivoting mechanisms comprises a cam follower operatively connected to its associated clamp member, and a cam track engaged by said cam follower and disposed in a plane generally parallel to said clamping set path, said cam track varying from the contour of said clamping set path to effect displacement of said cam follower for pivoting of the associated clamp member.

13. Apparatus for automatically closing the ends of tubular fabric articles according to claim 12 and characterized further in that said cam follower is connected to its associated clamp member through gear means that amplifies the extent of clamp member pivoting in proportion to cam follower displacement.

14. Apparatus for automatically closing the ends of tubular fabric articles according to claim 13 and characterized further in that each of said pivoting mechanisms includes a gear means drive shaft drivingly connected to said gear means and extending from said gear means generally perpendicular to said clamping set path, said gear means shaft having a radially extending arm on which said cam follower is mounted to transmit displacement of said cam follower into rotation of said gear means shaft for driving of said gear means.

15. Apparatus for automatically closing the ends of tubular fabric articles according to claim 13 and characterized further in that said means for manipulating said clamp members comprises a manipulating mechanism associated with each of said clamp members, each of said manipulating mechanisms having an operating rod secured to its associated clamp member and extending therefrom generally perpendicular to said clamping set path for longitudinal movement to move said clamp member for clamping and unclamping, said operating rod engaging said gear means for longitudinal sliding with respect thereto and being driven by said gear means for rotation of said rod and said clamp member by said gear means.

16. Apparatus for automatically closing the ends of tubular fabric articles sequentially as the articles are carried on a series of forms that travel along a lateral path and have free longitudinal ends at which open ends of the articles are located, said apparatus comprising article end closing means disposed outwardly adjacent the form free ends, a series of clamping sets disposed in spaced relation, means for moving said clamping sets in an endless path that partially overlaps said form path and extends from said form free ends to said end closing means, past said end closing means, and back across said form path at which the clamping sets are moved in a direction generally opposite the direction of form advance, each said clamping set having a pair of opposed clamp members disposed on opposite sides of said endless path, means for manipulating said clamp members to clamp an article end therebetween when the clamp members are at the free end of a form, to retain the article end clamped as the clamp members advance from the form free end past said end closing means for closing of the clamped article end thereby, to unclamp the article end after passing said end closing means, and to retain the clamp members open out of form contact as the clamp members move back across

said form path, and the area circumscribed by said endless path being open to permit free passage of said forms and articles through said area.

17. Apparatus for automatically closing the ends of tubular fabric articles according to claim 16 and characterized further in that said moving means moves said clamping sets continuously.

18. Apparatus for automatically closing the ends of tubular fabric articles according to claim 17 and characterized further in that said moving means moves said clamping sets at a reduced speed when a clamping set is moving past said end closing means.

19. Apparatus for automatically closing the ends of tubular fabric articles according to claim 17 and characterized further in that said forms advance intermittently, and said moving means positions the clamping sets at the form free ends for clamping during a dwell of the intermittently advancing forms.

20. Apparatus for automatically closing the ends of tubular fabric articles according to claim 16 and characterized further in that said clamping set path is circular and is generally tangent to the longitudinal extent of the forms at the location where the clamping set path extends initially from the form free ends.

21. Apparatus for automatically closing the ends of tubular fabric articles according to claim 20 and characterized further in that said clamping set path is generally tangent to the end closing means for advancing clamped article ends past said end closing means in the general direction of form advance.

22. Apparatus for automatically closing the ends of tubular fabric articles according to claim 21 and characterized further in that said series of clamping sets consists of four clamping sets disposed in said circular path at equal quadrant spacings, and said end closing means is disposed approximately one circular path quadrant from the form free end from which said circular path extends so that when one of said clamping sets is clamping an article end and advancing it from the form free end the precedingly adjacent clamping set is advancing an article end past said end closing means.

23. An apparatus for automatically closing the ends of tubular fabric articles according to claim 22 and characterized further in that said clamping sets are moved continuously by said moving means.

24. An apparatus for automatically closing the ends of tubular fabric articles according to claim 23 and characterized further in that said forms advance intermittently, and said moving means positions one clamping sets for movement at the form free end and a precedingly adjacent clamping set for movement past said end closing means during a dwell of the intermittently advancing forms.

25. An apparatus for automatically closing the ends of tubular fabric articles sequentially as the articles are carried on a series of forms that travel along a lateral path and have free longitudinal ends at which open ends of the articles are located, said apparatus comprising article end closing means disposed outwardly adjacent the form free ends, a movable pair of opposingly spaced carrier members disposed adjacent said end closing means and extending in partially overlapping relation with respect to said form path, a series of spaced clamping sets mounted on said carrier members for movement therewith, each of said clamping sets having a pair of clamp members, the clamp members of each pair being mounted on opposite carrier members, means for moving said carrier members synchronously for moving said clamping sets in an endless path that partially overlaps said form path and extends from said form free ends to said end closing means, past said end closing means, and back across said form path at which the clamping sets are moved in a direction generally opposite the direction of form advance, means for manipulating said clamp members to clamp an article end therebetween when the clamp members are at the free end of a form, to retain

the article end clamped as the clamp members advance from the form free end past said end closing means for closing of the clamp article end thereby, to unclamp the article end after passing said end closing means, and to retain the clamp members open out of form contact as the clamp members move back across said form path, and the area circumscribed by said endless path being open to permit free passage of said forms and articles through said area.

26. An apparatus for automatically closing the ends of tubular fabric articles according to claim 25 and characterized further in that said carrier members are mounted for rotation about a common axis generally perpendicular to said endless path for movement of said clamping sets circularly in said endless path.

27. An apparatus for automatically closing the ends of tubular fabric articles according to claim 26 and characterized further in that said means for manipulating said clamp members comprises a manipulating mechanism associated with each clamp member, with the manipulating mechanism associated with one clamp member of each clamping set being independent of the manipulating mechanism associated with the other clamp member of its clamping set and operating synchronously therewith for complementary manipulation of said clamp members.

28. An apparatus for automatically closing the ends of tubular fabric articles according to claim 27 and characterized further in that each of said manipulating mechanisms comprises an operating linkage having a rocker arm mounted on the carrier member on which its associated clamp member is mounted, said rocker arm being disposed for pivoting radially with respect to said clamping set circular path, an operating rod secured to its associated clamp member and extending generally perpendicular to said clamping set path, said operating rod being connected to said rocker arm for longitudinal movement thereby to manipulate said clamp member, and means for operating said linkage by pivoting said rocker arm to effect clamp member manipulation.

29. An apparatus for automatically closing the ends of tubular fabric articles according to claim 28 and characterized further by a pair of opposingly spaced supporting structures disposed outwardly of and supporting said carrier members for rotation thereof, a stationary circular cam track mounted on each of said supporting structures adjacent said carrier members, and said linkage operating means includes a cam follower mounted on each of said rocker arms and engageable with the adjacent cam track for pivoting of said rocker arm thereby to manipulate the associated clamp member.

30. An apparatus for automatically closing the ends of tubular fabric articles according to claim 29 and characterized further in that said cam tracks pivot said rocker arms for manipulation of their associated clamp members in an unclamping direction and said linkage operating means includes a spring member acting on said operating rod for manipulation of said clamp member in a clamping direction.

31. An apparatus for automatically closing the ends of tubular fabric articles according to claim 25 and characterized further by means for pivoting said clamp members in said clamping set path about an axis generally perpendicular to said clamping set path to reorient the disposition of the clamped article end with respect to said end closing means.

32. An apparatus for automatically closing the ends of tubular fabric articles according to claim 31 and characterized further in that said pivoting means is operable during movement of said clamping sets past said end closing means to obtain a desired closure contour at said article end.

33. An apparatus for automatically closing the ends of tubular fabric articles according to claim 31 and characterized further by a pair of opposingly spaced supporting structures disposed outwardly of and supporting said

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carrier members for rotation thereof, said supporting structures having cam tracks thereon adjacent said carrier members, said pivoting means includes a pivoting mechanism associated with each of said clamp members, and each of said pivoting mechanisms includes a cam follower engageable with the adjacent cam track for manipulation of said pivoting mechanism to effect reorienting rotation of the associated clamp member.

34. An apparatus for automatically closing the ends of tubular fabric articles according to claim 33 and characterized further in that said means for manipulating said clamp members comprises a manipulating mechanism associated with each clamp member, each manipulating mechanism having an operating rod secured to its associated clamp member and extending generally perpendicular to said clamping set path, and in that each of said pivoting mechanisms includes gear means slidably en-

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gaging said operating rod to permit longitudinal sliding of said operating rod with respect thereto, said operating rod being driven by said gear means for rotation of said rod and said clamp member thereby in proportion to displacement of said cam follower.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,503,349 Dated March 31, 1970

Inventor(s) Gene E. Hart

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 12, line 8, "article" should be -- articles --; same line, "saccording" should be -- according --. Column 13, line 49, "sets" should be -- set --; line 69, "an" should be -- and --; same line, "dextends" should be -- extends --. Column 14, line 12, "caterized" should be -- acterized --; line 29, "opearting" should be -- operating --; line 75, "strutcures" should be -- structures --. Column 16, line 1, "opearting" should be -- operating --. Column 16, under References Cited, line 12, "Edwards" should be -- Edwards --; line 13, "Forret" should be -- Forrest --.

SIGNED AND
SEALED
SEP 15 1970

(SEAL)

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