

TITLE OF THE INVENTION
APPARATUS FOR INSPECTING TOP END STOPS
OF SLIDE FASTENER

BACKGROUND OF THE INVENTION

1. Field of the Invention:

The present invention relates to an apparatus for inspecting top end stops of a slide fastener, and more particularly to such a top-end-stop inspection apparatus which is constructed to discriminate the quality of top end stops attached to a slide fastener by an image-processing technique.

2. Description of the Prior Art:

Conventionally, a pair of top end stops attached to a slide fastener is inspected for attachment failures or defects through visual inspection by a human inspector.

However, the visual inspection is laborious, time-consuming, low in efficiency, uneconomical, and unstable as it depends on each person's judgment. Accordingly, there has been a keen demand for an automated inspection system.

SUMMARY OF THE INVENTION

It is accordingly an object of the present invention to provide an apparatus for automatically and accurately inspecting the attached condition of top end stops of a slide fastener.

To attain the object, the present invention provides

an apparatus for automatically inspecting top end stops of a slide fastener while the slide fastener is fed longitudinally along a feed path by pulling it by a pair of grippers toward a discharge station, with a slider having a pull tab and a bottom end stop attached to the slide fastener.

The apparatus comprises an image sensor disposed adjacent to the feed path on an upstream side of the discharge station to read an image of the top end stops for inspecting an attached condition of the top end stops effected on data of the image read by the image sensor using an image-processing technique, and fastener support means disposed in the feed path upstream of the image sensor for supporting a portion of the slide fastener in the vicinity of the bottom end stop to keep the slide fastener lying flat while the image of the top end stops is read by the image sensor.

In an preferred embodiment, the fastener support means comprises a substantially U-shaped support block disposed below the feed path and vertically movable toward the feed path for guiding and supporting the slide fastener. As an alternative, the fastener support means may comprise a substantially U-shaped support member fixedly disposed to contact a front or rear surface of the slide fastener, and a substantially U-shaped resilient presser member fixedly disposed to contact the rear or front surface of the slide fastener for urging the slide fastener against the support

member to resiliently hold therebetween the slide fastener while permitting movement of the slider through the fastener support means without interference.

The apparatus, when used with the slide fastener fed with the pull tab of the slider hanging down from a body of the slider, further includes pull-tab holding means for preventing the pull tab of the slider from pivotally moving toward the top end stops while the image of the top end stops is read by the image sensor. The pull-tab holding means may be a pull-tab holding strip disposed adjacent to and upstream of the image sensor and inclined upwardly toward a direction of feed of the slide fastener for holding thereon the pull tab of the slider while the image of the top end stops is read by the image sensor.

The above and other objects, features and advantages of the present invention will become manifest to those versed in the art upon making reference to the detailed description and the accompanying sheets of drawings in which preferred structural embodiments incorporating the principles of the present invention are shown by way of illustrative example.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is schematic perspective view of a top-end-stop inspecting apparatus according to an embodiment of the present invention shown as incorporated in a slide fastener

manufacturing apparatus;

FIG. 2 is a diagrammatical side view showing a condition of the top-stop-inspecting apparatus before a slide fastener is cut off from a continuous slide fastener chain;

FIG. 3 is a diagrammatical side view showing a condition of the top-end-stop inspecting apparatus after the slide fastener is cut off from the slide fastener chain;

FIG. 4 is a perspective view showing a fastener support unit according to another embodiment of the invention; and

FIG. 5 is a top plan view of a portion of a slide fastener in the vicinity of top end stops to be inspected by the top-end-stop inspecting apparatus of the present invention.

DETAILED DESCRIPTION

A preferred embodiment of the present invention will be described below in greater detail with reference to the accompanying drawings, in which FIG. 1 shows a top-end-stop inspecting apparatus 13 of the present invention incorporated in a slide fastener manufacturing apparatus, and FIG. 5 shows a front end portion of a slide fastener 1 including top end stops 2 to be inspected and a slider 6 mounted on the slide fastener 1.

In the manufacture of slide fasteners 1, a continuous

slide fastener chain C including a pair of stringer tapes T, T each having along its inner longitudinal edge successive spaced rows of coupling elements 4 interengaged with opposed rows of coupling elements 4 on the other stringer tape T is fed longitudinally along a path in a predetermined direction, by pulling the slide fastener chain C with the leading ends of the stringer tapes T, T gripped by a pair of first grippers 8, 8, respectively, as shown in FIG. 1. A bottom end stop 5 is attached to the stringer tapes T at one end (upstream end) of each pair of interengaged rows of coupling elements 4, and after that a slider 6 is mounted on the interengaged rows of coupling elements 4 and, substantially at the same time, a pair of top end stops 2 is attached to the stringer tapes, respectively, at the other end (downstream end) of the interengaged rows of coupling elements 4 by means of a top-end-stop and slider applicator 11. Then, in place of the first grippers 8, a pair of second grippers 9, 9 grips the leading ends of the stringer tapes T and feed the slide fastener chain C further in the predetermined direction toward a discharge station. The slide fastener chain C is cut into a slide fastener 1 of a predetermined product length. The slide fastener 1 is passed through a working zone (inspecting zone) of the top-end-stop inspecting apparatus 13 during which time the presence/absence of the top end stops 2 and slider 6 and

the attached condition of the top end stops 2 and coupling elements 4 in the vicinity of the top end stops 2 are read or recorded as images by an image sensor or camera 14. Data of the recorded images are immediately processed by an image-processing technique using an image processor 14a so as to judge whether the slide fastener 1 being inspected is defective or not. After the judgment, the slide fastener 1 is discharged from the discharge station to the outside of the slide fastener manufacturing machine by means of a pair of discharge rollers 20.

The top-end-stop inspecting apparatus 13 generally comprises the camera (image sensor) 14 disposed in an inspecting station of the slide fastener manufacturing apparatus and used as a part of an image processing system, a fastener support means 16 for supporting a portion of the slide fastener 1 in the vicinity of the bottom end stop 5 during inspection, and a pull-tab holding means 18 for preventing a pull tab 7 of the slider 6 from pivoting or swinging toward the top end stops 2 during inspection.

The fastener support means 16 is composed of a substantially U-shaped support block disposed upstream or behind the camera 14 for guiding and supporting thereon a trailing end portion of the slide fastener 1 which would otherwise hang down after the slide fastener 1 is cut off from the slide fastener chain C. With the trailing end

thus supported by the support block 16, the slide fastener 1 is always kept flat while a leading end portion of the slide fastener 1 including the top end stops 2 and the slider 6 is passed through a reading zone of the camera 14. Thus, the leading end portion can be correctly read by the camera 14 without defocusing. The support block 16 is connected to a piston rod of a fluid-pressure actuator 17, such as an air cylinder, disposed vertically. Thus, in response to the operation of the fluid-pressure actuator 17, the support block 16 is vertically movable toward and away from the feed path of the slide fastener 1, as shown in FIGS. 2 and 3. When the slide fastener 1 is fed longitudinally by the grippers 9, as shown in FIG. 2, the support block 16 is retracted downwardly from the feed path so as not to obstruct the movement of the slider 6. During the inspection, the support block 16 is held in its upper working position to support thereon a portion of the slide fastener 1 in the vicinity of the bottom end stop 5 (FIG. 1), as shown in FIG. 3. The support block 16 shown in FIG. 1 has a substantially U shape, as described above, so that the slide fastener is supported on a bottom surface of the U-shaped support block 16 while it is guided between opposite side walls of the U-shaped support block 16. The U-shaped, vertically movable support block 16 (fastener support means) may be replaced by a fixed fastener support means or unit 16a, such as shown in FIG. 4.

The fixed fastener support unit 16a shown in FIG. 4 is composed of a U-shaped support member 21 fixedly disposed below the feed path for supporting thereon the slide fastener 1 while allowing passage of a slider 6 through a central recessed portion (not designated) of the U-shaped support member 21, and a U-shaped resilient presser member 22 fixedly disposed above the feed path in confrontation to the support member 21 so as to resiliently urge the slide fastener 1 downward against the support member 21. The support member 21 and the resilient presser member 22 resiliently grip the slide fastener 1 as it is fed or pulled by the grippers 9, so that the slide fastener 1 is stretched between the grippers 9 and the fixed fastener support unit 16a. Since the fastener support unit 16a is fixed or immovable, the slide fastener 1 can always be supported in a uniformly-stretched condition regardless of the length of the slide fastener 1. Though not shown, the mechanical fastener support means 16, 16a described above with respect to the embodiments shown in FIGS. 1 and 4 may be replaced by a pneumatic fastener support means which preferably is composed of a pipe vertically movably disposed below the feed path of the slide fastener 1 and having a number of nozzles for ejecting therefrom number of streams of pressurized air against the underside of the slide fastener 1 to floatingly support a trailing end portion of the slide fastener 1.

The pull-tab holding means 18 is disposed adjacent to and upstream of the image-processing camera 14 to keep the pull tab 7 of the slider 6 in position against pivotal or swinging movement toward the top end stops 2 during the inspection. The slider pull tab 7 thus kept does not interfere with the inspection of the leading end portion of the slide fastener 1 by the camera 14. The pull-tab holding means 18 is composed of a pull-tab holding strip inclined upwardly toward the direction of feed of the slide fastener 1 and attached to an upper surface of a support base 19 disposed below the feed path of the slide fastener 1. The inclined pull-tab holding strip 18 is provided such that when a leading end portion of the slide fastener 1 including the top end stops 2 arrives at the reading zone (inspecting zone) of the camera 14, the pull tab 7 of the slider 6 is held on the pull-tab holding strip 18, as shown in FIG. 3. After the inspection, the slider pull tab 7 is automatically released from the pull-tab holding strip 18 as the slide fastener 1 is further moved toward the discharge side. The pull-tab holding means composed of the inclined pull-tab holding strip 18 may be replaced by an air nozzle (not shown) attached to the underside of the grippers 9 for ejecting a stream of pressurized air against the pull tab 7 of the slider 6 to tilt the pull tab 7 in a direction away from the top end stops 2. With the pull tab 7 thus tilted, the leading

end portion of the slide fastener 1 including the top end stops 2 can be inspected smoothly and accurately.

In addition to the camera 14 provided for reading or recording the image of a portion of the slide fastener 1 including the top end stops 2, the inspecting station further includes a light source (backlight) 15 disposed directly above the camera 14 across the feed path of the slide fastener 1 for illuminating the object to be inspected, and an air nozzle 25 disposed on one side of the camera 14 for ejecting a stream of pressurized air to clean up a top surface of the camera 14. The image read or recorded by the camera 14 is sent to the image processor 14a. The image processor 14a processes data of the recorded image by an appropriate image-processing technique to discriminate the presence/absence of the slider 6 and top end stops 2 and the attached condition of the top end stops 2 and the coupling elements 4 located in the vicinity of the top end stops 2, thereby discriminating defective slide fasteners from non-defective slide fasteners.

As shown in FIGS. 2 and 3, the camera 14 is disposed below the feed path of the slide fastener 1 so as to read or record the top end stops 2, slider 6 and coupling elements 4 located adjacent the top end stops 2 from their front side while the slide fastener 1 is fed with its front side facing downwards (with the slider pull tab hanging down from a body

of the slider 6) after it is cut off from the slide fastener chain C. In the case of a slide fastener 1 having a larger length, the inspection completes before the slide fastener 1 is cut off from the slide fastener chain C. Severance of the slide fastener chain C is effected when a prospective slide fastener is partly discharged. When inspecting a slide fastener 1 having coiled filamentary coupling elements 4 attached by sewing to the front side of the slide fastener 1, such as shown in FIG. 5, the camera 14 is preferably disposed below the feed path of the slide fastener 1 to read the front side of the slide fastener 1 in order to secure accurate reading or recording of the attached condition of top end stops 2 each having three prongs 3 and the attached condition of coiled coupling elements 4 on the front side of the slide fastener 1. As described above, the camera 14 is normally disposed below the feed path of the slide fastener 1 to achieve its reading operation from the front side of the slide fastener 1. However, if the attached condition of the top end stops 2 and neighboring coupling elements 4 does not show a substantial difference between the front side and the backside of the slide fastener 1, the camera 14 may be disposed above the feed path of the slide fastener 1 to achieve the required inspection.

As shown in FIG. 1, a second camera (image sensor) 23 and a second backlight (light source) 24 may be disposed

adjacent to a space-detecting unit 10 situated at the most upstream position of the apparatus to read or record the attached condition of the bottom end stop 5 as an image while the slide fastener chain C is at rest in response to the detection of an element-free space S by the space-detecting unit 10. Data of the recorded image is sent to an image processor 23a to discriminate defective bottom end stops from non-defective bottom end stops before top end stops 2 are attached. With the second camera 23 and backlight 24 thus combined with the camera 14 and backlight 15, all items of finished conditions of each slide fastener can be completely inspected, and perfect discrimination between non-defective slide fasteners and defective slide fasteners can therefore be attained.

As described above, the slide fastener 1 with the top end stops 2 and the slider 6 attached thereto is fed longitudinally along a feed path by pulling it by the pair of grippers 9. The slide fastener 1 is inspected by the top-end-stop inspecting apparatus 13 according to the present invention. The top-end-stop inspecting apparatus 13 includes the camera 14 disposed on a discharge side of the feed path of the slide fastener 1 for reading an image of the top end stops, and the fastener support means 16 disposed upstream of the camera 14 for supporting the slide fastener 1 while an attached condition of the top end stops 2 is inspected based on the image read by

the camera 14. With this arrangement, the attached condition of the top end stops 2 can be automatically and continuously inspected after slide-fastener finishing processes with the result that defective slide fasteners can be discriminated efficiently in a short period of time. Since a portion of the slide fastener 1 in the vicinity of the bottom end stop 5 is supported by the fastener support unit 16, the slide fastener 1 in the inspecting station is always kept flat and at a constant height or level. Thus, the camera 14 can read or record the image of the top end stops 2 with high focusing accuracy which will increase the resolution of image processing and eventually insure accurate discrimination of the quality of top end stops 2.

In addition, since the pull-tab holding means 18 holds the pull tab 7 of the slider 6 in a tilted condition inclining away from the top end stops 2, reading operation of the camera 14 can be achieved accurately and smoothly without interference with the slider pull tab 7. This eliminates an inspection error.

Obviously, various minor changes and modifications of the present invention are possible in the light of the above teaching. It is therefore to be understood that within the scope of the appended claims the invention may be practiced otherwise than as specifically described.

CLAIMS:

1. An apparatus (13) for inspecting top end stops (2, 2) of a slide fastener (1) while the slide fastener (1) is fed longitudinally along a feed path by pulling it by a pair of grippers (9) toward a discharge station, with a slider (6) having a pull tab (7) and a bottom end stop (5) attached to the slide fastener (1), characterized by:

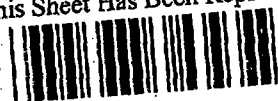
(a) an image sensor (14) disposed adjacent to the feed path on an upstream side of the discharge station to read an image of the top end stops (2) for inspecting an attached condition of the top end stops (2) effected on data of the image read by said image sensor (14) using an image-processing technique; and

(b) fastener support means (16; 16a) disposed in the feed path upstream of said image sensor (14) for supporting a portion of the slide fastener (1) in the vicinity of the bottom end stop (5) to keep the slide fastener (1) stable while the image of the top end stops (2) is read by said image sensor (14).

2. An apparatus according to claim 1, further comprising, another image sensor (23) disposed adjacent to the feed path on a downstream side of a space detecting unit (10) situated at the most upstream position of the apparatus.

3. An apparatus according to claim 1^{or 2}, wherein said fastener support means (16) is composed of a substantially

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U-shaped support block which is vertically movable toward and away from the feed path and is retracted downwardly while said support block (16) is not supporting the slide fastener (1) so as not to obstruct the movement of the slider (6).

4. An apparatus according to ^{any preceding} claim, wherein said fastener support means (16a) comprises a substantially U-shaped support member (21) fixedly disposed to contact a front or rear surface of the slide fastener (1), and a substantially U-shaped resilient presser member (22) fixedly disposed to contact a rear or front surface of the slide fastener (1) for urging the slide fastener (1) against said support member (1) to resiliently hold therebetween the slide fastener (1) while permitting movement of the slider (6) through said fastener support means (16a) without interference.

5. An apparatus according to any one of preceding claims, when used with the slide fastener (1) fed with the pull tab (7) of the slider (6) hanging down from a body of the slider (6), further including pull-tab holding means (18) for preventing the pull tab (7) of the slider (6) from pivotally moving toward the top end stops (2) while the image of the top end stops (2) is read by said image sensor (14).

6. An apparatus according to claim 5, wherein said pull-tab holding means (18) comprises a pull-tab holding strip disposed adjacent to and upstream of said image sensor (14) and inclined upwardly toward a direction of feed of the

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slide fastener (1) for holding thereon the pull tab (7) of the slider (6) while the image of the top end stops (2) is read by said image sensor (14).



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