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QUALITY CONTROL STRUCTURES FOR AUTOMATED FASTENING MACHINES

Abstract

Quality control structures of automated fastening machines comprise an elongate body defining a passageway and comprising one or more walls configured so that properly sized collars are urged against one of the one or more walls when passing through the passageway. The one of the one or more walls define a secondary outlet that is configured to restrict passage of the properly sized collars through the secondary outlet and permit passage of undesirable structures through the secondary outlet.

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Background/Summary

FIELD

[0001] The present disclosure relates to automated fastening machines.

BACKGROUND

[0002] Automated fastening machines are used in the manufacture of large structures, such as aircraft, to install fasteners. These fasteners typically include a pin and a collar that is crimped, or swaged, on the pin. The collars are fed to the swaging device typically from a vibratory bowl via blast air to a buffer, which then sends individual collars on demand. The vibratory bowls are manually filled by operators. On occasion, an operator may fill a vibratory bowl with an incorrectly sized supply of collars. In addition, the bulk source of collars may include incorrectly sized collars and so-called slugs (i.e., remnants from the manufacturing of the collars). Under-sized collars and slugs may jam the delivery of collars downstream of the vibratory bowl, leading to downtime and significant technician work.

SUMMARY

[0003] Quality control structures of automated fastening machines comprise an elongate body that defines a passageway between an inlet and a primary outlet and that comprises one or more walls that are configured so that properly sized collars are urged against one of the walls when passing through the passageway from the inlet toward the primary outlet. One or more of these walls may each define a secondary outlet that is configured to restrict passage of the properly sized collars while permitting passage of undesirable structures—for example, under-sized collars and/or slugs. In other words, by allowing passage of undesirable structures through the secondary outlet(s) instead of allowing them to proceed to the primary outlet, a quality control structure may function to filter out these undesirable structures while permitting only properly sized collars to pass through to the primary outlet.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] FIG. **1** is a schematic diagram representing quality control structures and automated fastening machines according to the present disclosure.

[0005] FIG. **2** is an isometric view of an example quality control structure according to the present disclosure.

[0006] FIG. **3**. Is a side view of the example quality control structure of FIG. **2**.

[0007] FIG. **4** is another side view of the example quality control structure of FIG. **2**.

[0008] FIG. **5** is another side view of the example quality control structure of FIG. **2**.

[0009] FIG. **6** is another side view of the example quality control structure of FIG. **2**.

[0010] FIG. **7** is a cross-sectional view of the example quality control structure of FIG. **2**, taken along line **7**-**7** in FIG. **3**.

[0011] FIG. **8** is a cross-sectional view of the example quality control structure of FIG. **2**, taken along line **8**-**8** in FIG. **4**.

[0012] FIG. **9** is a cross-sectional view of the example quality control structure of FIG. **2**, taken along line **9**-**9** in FIG. **6**

[0013] FIG. **10** is a flow chart schematically representing methods according to the present disclosure.

[0014] FIG. **11** is a flow chart schematically representing methods according to the present disclosure.

DESCRIPTION

[0015] Automated fastening machines **10** and quality control structures **12** for automated fastening machines **10** are disclosed herein and schematically represented in FIG. **1**. Generally, in FIG. **1**, elements that are likely to be included in a given example are illustrated in solid lines, while elements that are optional to a given example or that correspond to a specific example are illustrated in broken lines. However, elements that are illustrated in solid lines are not essential to

all examples of the present disclosure, and an element shown in solid lines may be omitted from a particular example without departing from the scope of the present disclosure.

[0016] Quality control structures **12** are installed in automated fastening machines **10** for removal of undesirable structures **20** from a stream of collars being transported from a supply **16** of collars to an installation tool **18** (e.g., a swaging tool). The undesirable structures **20** may be undersized collars and/or slugs that otherwise may cause a jam in the stream of collars. Quality control structures **12** additionally or alternatively may be described as filters, or as collar filters, for filtering out the undesirable structures **20**.

[0017] As schematically represented in FIG. **1**, quality control structures **12** comprise at least an elongate body **22** that defines a passageway **24** and that comprises one or more walls **23** that configured so that properly sized collars **14** are urged against one of the walls **23** when passing through the passageway **24**. The one wall **23** against which the properly sized collars **14** are urged defines a secondary outlet **30** that is configured to restrict passage of the properly sized collars **14** through the secondary outlet **30** while permitting passage of any undesirable structures **20** through the secondary outlet **30**. As schematically represented in the cross-section of the elongate body **22** presented in FIG. **1**, in some examples, the wall **23** against which the properly sized collars **14** are urged comprises a lip **46** that at least partially defines and extends along the secondary outlet **30**. The lip **46** is configured to engage the properly sized collars **14** as the properly sized collars pass through the passageway **24**.

[0018] Additionally or alternatively, as schematically represented in FIG. **1**, quality control structures **12** may be described as comprising an elongate body **22** that defines a passageway **24**, an inlet **26** to the passageway **24** that is sized to receive the properly sized collars **14**, a primary outlet **28** from the passageway **24** that is sized to dispense the properly sized collars **14**, and one or more secondary outlets **30** from the passageway **24** between the inlet **26** and the primary outlet **28**. The secondary outlet(s) **30** are sized to dispense the undesirable structures **20** and restrict passage of the properly sized collars **14**. In some examples, the quality control structure **12** is configured to be operatively installed with the secondary outlets **30** being positioned vertically below directly adjacent regions of the passageway **24**. Accordingly, gravity may serve to cause the undesirable structures **20** to pass through the secondary outlet(s) **30** as the undesirable structures **20** pass through the passageway **24**.

[0019] Herein, with respect to a quality control structure **12** and the elongate body **22** thereof, toward the inlet **26** may be described as upstream and toward the primary outlet **28** may be described as downstream.

[0020] In some examples, the inlet **26** is sized and shaped to correspond to a specifically dimensioned collar, for example, corresponding to the diameter and height of the properly sized collars **14**. Accordingly, the inlet **26** may serve to restrict oversized structures from entering the passageway **24**, such that the quality control structure **12** need only remove, or filter out, undesirable structures that are undersized.

[0021] As schematically represented in FIG. **1**, each secondary outlet **30** has a secondary-outlet length **32** and a secondary-outlet width **34** that is less than the secondary-outlet length **32** and that is less than a diameter **36** of the properly sized collars **14**. Accordingly, the properly sized collars **14** will be restricted from passing through the secondary outlet(s) **30** as they pass through the passageway **24**. Moreover, by having a secondary-outlet length **32** longer than the secondary-outlet width **34**, more opportunities are provided for the undesirable structures **20** to exit the passageway **24** via the secondary outlet(s) **30** and the less likely an undesirable structure **20** may become jammed within the secondary outlet(s) **30**. In some examples, the secondary-outlet length **32** is 2 to 5, or more, times greater than the secondary-outlet width **34**.

[0022] With continued reference to FIG. **1**, in some examples, the elongate body **22** comprises a first floor **38** that faces the passageway **24** and along which the properly sized collars **14** are configured to roll or slide as they pass through the passageway **24**. In such examples, the elongate

body **22** also may comprise a first side wall **40** that comprises a first-side-wall outer face **42** that faces away from the passageway **24**, and a first-side-wall inner face **44** that faces the passageway **24** and that extends from the first floor **38**. A first secondary outlet **30**′ of the one or more secondary outlets **30** extends through the first side wall **40**. In some such examples and as perhaps best seen in the schematic cross-section of the elongate body **22** illustrated in solid lines in FIG. **1**, the first-side-wall inner face **44** comprises a first-side-wall lip **46** that extends along the first secondary outlet **30**′ opposite the first floor **38**. In some examples, the first-side-wall inner face **44** has a first-side-wall maximum inner-face width **48** that is greater than the secondary-outlet width **34**. Accordingly, the first-side-wall maximum inner-face width **48** is sized to accommodate the diameter **36** of the properly sized collars **14**. As a result, as the properly sized collars **14** slide or roll along the first floor **38** and are urged against the first side wall **40** as the properly sized collars **14** pass through the passageway **24**, the first-side-wall lip **46** engages the properly sized collars **14** to restrict the properly sized collars **14** from exiting the passageway **24** via the first secondary outlet **30**′.

[0023] As best seen in the cross-section illustrated in broken lines in FIG. **1**, in some examples of quality control structures **12**, the elongate body **22** further comprises a second floor **50** that faces the passageway **24** and along which the properly sized collars **14** are configured to roll or slide. In such examples, the elongate body **22** also comprises a second side wall **52** that comprises a second-side-wall outer face **54** that faces away from the passageway **24** and a second-side-wall inner face **56** that faces the passageway **24** and that extends from the second floor **50**. In such examples, a second secondary outlet **30**″ of the one or more secondary outlets **30** extends through the second side wall **52**. In some such examples and as perhaps best see in the schematic cross-section of the elongate body **22** illustrated in dashed lines in FIG. **1**, the second-side-wall inner face **56** comprises a second-side-wall lip **58** that extends along the second secondary outlet **30**″ opposite the second floor **50**. In some examples, the second-side-wall inner face **56** has a second-side-wall maximum inner-face width **60** that is greater than the secondary-outlet width **34**. Accordingly, the second-side-wall maximum inner-face width **60** is sized to accommodate the diameter **36** of the properly sized collars **14**. As a result, as the properly sized collars **14** slide or roll along the second floor **50** and are urged against the second side wall **52** as the properly sized collars **14** pass through the passageway **24**, the second-side-wall lip **58** engages the properly sized collars **14** to restrict the properly sized collars **14** from exiting the passageway **24** via the second secondary outlet **30**″. While FIG. **1** schematically illustrates two secondary outlets **30**, any number of secondary outlets **30** may be utilized with a quality control structure **12**, including three or more secondary outlets **30**.

[0024] In some examples that include two secondary outlets **30**, the second floor **50** is not coextensive with the first floor **38**, and the second-side-wall inner face **56** is not coextensive with the first-side-wall inner face **44**. In particular and as schematically represented by the schematic break in the elongate body **22** in FIG. **1**, the second floor **50** may be distinct from the first floor **38**, and the second side wall **52** may be distinct from the first side wall **40**. In other words, the elongate body **22** may be shaped or otherwise configured so that the properly sized collars **14** roll or slide along and are urged against different walls of the elongate body **22** as they pass through the passageway **24**.

[0025] In some such examples, the second floor **50** is opposite the first floor **38** relative to the passageway **24**, and the second-side-wall inner face **56** is opposite the first-side-wall inner face **44** relative to the passageway **24**. For example, one or more of the walls **23** of the elongate body **22** may be configured to define a curve or curves to the passageway, such that when the quality control structure **12** is operatively installed, each of the first side wall **40** and the second side wall **52** is positioned generally on an underside of the quality control structure **12** so that gravity will enable undesirable structures **20** to pass through a first secondary outlet **30**′ or a second secondary outlet **30**″ as they pass through the passageway **24**.

[0026] With continued reference to FIG. **1**, in some examples, the passageway **24** may be described

as having a longitudinal axis **62**, and the elongate body **22** may be described as comprising an inlet region **64** that defines the inlet **26**, a primary outlet region **66** that defines the primary outlet **28**, and a first secondary-outlet region **68** that defines the first secondary outlet **30′**. In some examples, the longitudinal axis **62** curves and is not straight along its entire length. In some examples, the longitudinal axis **62** is straight within the inlet region **64** and curves within the first secondary-outlet region **68**. Accordingly, the inlet region **64** may be configured to operatively and easily receive the properly sized collars **14** via the inlet **26** (e.g., due to gravity), and then because of the curve in the longitudinal axis **62** within the first secondary-outlet region **68**, the properly sized collars **14** are urged against the first side wall **40** as they pass through the first secondary-outlet region **68**. In particular, when the quality control structure **12** is operatively installed, the longitudinal axis **62** may curve away from vertical within the first secondary-outlet region **68** so that the first secondary outlet **30′** at least partially faces vertically downward.

[0027] In some examples, the elongate body **22** also may be described as comprising a second secondary-outlet region **70** that defines the second secondary outlet **30″**, and in some such examples, the longitudinal axis **62** curves within the second secondary-outlet region **70**. In some such examples when the quality control structure **12** is operatively installed, the longitudinal axis **62** may curve toward vertical within the second secondary-outlet region **70** so that the second secondary outlet **30″** at least partially faces vertically downward.

[0028] In some examples, the longitudinal axis **62** is straight within the primary outlet region **66**, and in some such examples, the longitudinal axis **62** within the inlet region **64** is parallel to or colinear with the longitudinal axis **62** within the primary outlet region **66**.

[0029] By including two secondary outlets **30** through different walls **23** of the elongate body **22** and having the longitudinal axis **62** curve away from and back toward vertical along its length, the linear distance between the inlet **26** and the primary outlet **28** may be reduced when the inlet region **64** and the primary outlet region **66** are parallel or colinear with each other. This may be particularly useful when installing a quality control structure **12** into an existing automated fastening machine **10**, such as by simply replacing a down tube with the elongate body **22**.

[0030] In some examples, the first floor **38** twists within the first secondary-outlet region **68** from proximate the inlet region **64** toward the primary outlet region **66**, and in some such examples, the second floor **50** similarly twists within the second secondary-outlet region **70** from proximate the first secondary-outlet region **68** toward the primary outlet region **66**.

[0031] In other examples, the longitudinal axis **62** is straight along an entirety of its length.

[0032] In some examples, the first-side-wall inner face **44** ramps away from the longitudinal axis **62** toward the first secondary outlet **30′** opposite the outlet region **66**, that is, on the upstream end of the first secondary outlet **30′**. Similarly, in some examples, the second-side-wall inner face **56** ramps away from the longitudinal axis **62** toward the second secondary outlet **30″** opposite the outlet region **66**, that is, on the upstream end of the second secondary outlet **30″**. These regions of the first-side-wall inner face **44** may be described as ramped, as ramped surfaces, as tapered, or as tapered surfaces. In such examples, an undesirable structure **20** may more easily pass through the respective secondary outlet **30** than if the ramped surface were not present.

[0033] In some examples, the second-side-wall inner face **56** ramps toward the longitudinal axis **62** away from the first secondary outlet **30′** opposite the inlet region **64**, that is, on the end downstream of first secondary outlet **30′**. Similarly, in some examples, the second-side-wall inner face **56** ramps toward the longitudinal axis **62** away from the second secondary outlet **30″** opposite the inlet region **64**, that is, on the downstream end of the second secondary outlet **30″**. These regions of the second-side-wall inner face **56** may be described as ramped, as ramped surfaces, as tapered, or as tapered surfaces. In such examples, the properly sized collars **14** may be less likely to become jammed within the passageway **24** as the properly sized collars **14** pass the secondary outlet(s) **30**.

[0034] In some examples, the elongate body **22** is a monolithic structure, such that may be additively manufactured.

[0035] With continued reference to FIG. **1**, automated fastening machines **10** may comprise a supply **16** for properly sized collars **14**, an installation tool **18** configured to operatively install the properly sized collars **14**, and a quality control structure **12** positioned to receive the properly sized collars **14** and the undesirable structures **20** from the supply **16** and to deliver only the properly sized collars **14** toward the installation tool **18**.
[0036] Some examples of automated fastening machines **10** further comprise a collection structure **72**, such as a bin or a basin, that is positioned external to the quality control structure **12** to collect the undesirable structures **20** as they exit the quality control structure **12** through a secondary outlet **30**.
[0037] Some examples of automated fastening machines **10** further comprise a buffer **74** that is operatively positioned between the quality control structure **12** and the installation tool **18** and that is configured to buffer the properly sized collars **14** for delivery to the installation tool **18**.
[0038] In some examples of automated fastening machines **10**, the supply **16** comprises a hopper **76**, such as a vibratory bowl.
[0039] Turning now to FIGS. **2-9**, an illustrative non-exclusive example of a quality control structure **12** in the form of quality control structure **300** is illustrated. Where appropriate, the reference numerals from the schematic illustration of FIG. **1** are used to designate corresponding parts of the quality control structure **300**; however, the example of FIGS. **2-9** is non-exclusive and does not limit quality control structures **12** to the illustrated embodiment of the quality control structure **300**. That is, quality control structures **12** are not limited to the specific embodiment of the illustrated quality control structure **300**, and quality control structures **12** may incorporate any number of the various aspects, configurations, characteristics, properties, etc. of quality control structures **12** that are illustrated in and discussed with reference to the schematic representation of FIG. **1** and/or the embodiment of FIGS. **2-9**, as well as variations thereof, without requiring the inclusion of all such aspects, configurations, characteristics, properties, etc. For the purpose of brevity, each previously discussed component, part, portion, aspect, region, etc. or variants thereof may not be discussed, illustrated, and/or labeled again with respect to the quality control structure **300**; however, it is within the scope of the present disclosure that the previously discussed features, variants, etc. may be utilized with the quality control structure **300**.
[0040] The quality control structure **300** is an example of a quality control structure **12** whose elongate body **22** defines two secondary outlets **30** through opposing walls **23** of the elongate body **22**. Moreover, the elongate body **22** of the quality control structure **300** has an inlet region **64** that is straight, a first secondary-outlet region **68** that curves away from vertical, a second secondary-outlet region **70** that curves back toward vertical, and a primary outlet region **66** that is straight and parallel with the inlet region **64**. Moreover, within the first secondary-outlet region **68**, the profile of the elongate body **22** twists clockwise (when viewed from above) away from the inlet region **64**, and within the second secondary-outlet region **70**, the profile of the elongate body **22** twists counterclockwise (when viewed from above) away from the inlet region **64**. The quality control structure **300** is configured to be installed with the inlet **26** positioned above the primary outlet **28**.
[0041] As best seen in FIGS. **7** and **8**, the quality control structure **300** also is an example of a quality control structure **12** whose first-side-wall inner face **44** and second-side-wall inner face **56** ramp away from the longitudinal axis **62** upstream of the first secondary outlet **30′** and the second secondary outlet **30″**, respectively, and toward the longitudinal axis **62** downstream of the first secondary outlet **30′** and the second secondary outlet **30″**. It can thus be seen that the physical configuration of the passageway **24**, as defined by the walls **23** of the quality control structure **300** and the positions of the secondary outlets **30′** and **30″**, that both properly sized collars and undesirable structures fed through the inlet **26** will be urged by gravity against the walls that define the secondary outlets **30**. However, the dimensions of the secondary outlets **30** will allow undesirable structures, such as undersized collars and/or slugs to pass through, and thereby exit the passageway **24** before reaching the primary outlet **28**, while ensuring that properly sized collars

stay in the passageway **24** and are guided toward the primary outlet **28**.
[0042] FIGS. **10** and **11** schematically provide flowcharts that represent illustrative, non-exclusive examples of methods according to the present disclosure. In FIGS. **10** and **11**, some steps are illustrated in dashed boxes indicating that such steps may be optional or may correspond to an optional version of a method according to the present disclosure. That said, not all methods according to the present disclosure are required to include the steps illustrated in solid boxes. The methods and steps illustrated in FIGS. **10** and **11** are not limiting, and other methods and steps are within the scope of the present disclosure, including methods having greater than or fewer than the number of steps illustrated, as understood from the discussions herein.
[0043] As schematically represented in FIG. **10**, methods **100** comprise receiving **102** properly sized collars **14** and undesirable structures **20** in a collar stream, removing **104** the undesirable structures **20** from the collar stream, and delivering **106** the collar stream without the undesirable structures **20** to an installation tool **18**. In some examples, the receiving **102** comprises receiving the properly sized collars **14** and the undesirable structures **20** via gravity, and the removing **104** comprises removing the undesirable structures **20** via gravity. In some examples, the removing **104** comprises restricting **108** the properly sized collars **14** from exiting the collar stream and permitting **110** the undesirable structures **20** to exit the collar stream. Some methods **100** are performed by a quality control structure **12** according to the present disclosure.
[0044] As schematically represented in FIG. **11**, methods **200** comprise feeding **202** properly sized collars **14** and undesirable structures **20** into a passageway **24**, urging **204** the properly sized collars **14** and the undesirable structures **20** against a wall **23** that at least partially defines the passageway **24**, and restricting **206** the properly sized collars **14** from passing through a secondary outlet **30** defined in the wall **23** while permitting **208** the undesirable structures **20** to pass through the secondary outlet **30**. In some examples, the feeding **202**, the urging **204**, and the permitting **208** are caused at least in part by gravity. Some methods **200** are performed by a quality control structure **12** or an automated fastening machine **10** according to the present disclosure.
[0045] Illustrative, non-exclusive examples of inventive subject matter according to the present disclosure are described in the following enumerated paragraphs:
[0046] A. A quality control structure (**12**) of an automated fastening machine (**10**), the quality control structure (**12**) comprising: [0047] an elongate body (**22**) defining a passageway (**24**) and comprising one or more walls (**23**) configured so that properly sized collars (**14**) are urged against one of the one or more walls (**23**) when passing through the passageway (**24**), wherein the one of the one or more walls (**23**) defines a secondary outlet (**30**) that is configured to restrict passage of the properly sized collars (**14**) through the secondary outlet (**30**) and permit passage of undesirable structures (**20**) through the secondary outlet (**30**).
[0048] A1. The quality control structure (**12**) of paragraph A, wherein the one of the one or more walls (**23**) comprises a lip (**46**) that at least partially defines and extends along the secondary outlet (**30**) and that is configured to engage the properly sized collars (**14**) as the properly sized collars pass through the passageway (**24**).
[0049] A2. The quality control structure (**12**) of any of paragraphs A-A1, further comprising the subject matter of any of paragraphs B-B3.8.
[0050] B. A quality control structure (**12**) of an automated fastening machine (**10**) for transporting properly sized collars (**14**) from a supply (**16**) of the properly sized collars (**14**) toward an installation tool (**18**) and for removing undesirable structures (**20**) from the supply (**16**) of the properly sized collars (**14**), the quality control structure (**12**) comprising: [0051] an elongate body (**22**) defining a passageway (**24**), an inlet (**26**) to the passageway (**24**) sized to receive the properly sized collars (**14**), a primary outlet (**28**) from the passageway (**24**) sized to dispense the properly sized collars (**14**), and one or more secondary outlets (**30**) from the passageway (**24**) between the inlet (**26**) and the primary outlet (**28**), wherein the one or more secondary outlets (**30**) are sized to dispense the undesirable structures (**20**) and restrict passage of the properly sized collars (**14**);

wherein the quality control structure (**12**) is configured to be operatively installed with the one or more secondary outlets (**30**) positioned vertically below directly adjacent regions of the passageway (**24**).
[0052] B1. The quality control structure (**12**) of paragraph B, wherein each of the one or more secondary outlets (**30**) has a secondary-outlet length (**32**) and a secondary-outlet width (**34**) that is less than the secondary-outlet length (**32**) and that is less than a diameter (**36**) of the properly sized collars (**14**).
[0053] B2. The quality control structure (**12**) of any of paragraphs B-B1, wherein the elongate body (**22**) comprises: [0054] a first floor (**38**) that faces the passageway (**24**) and along which the properly sized collars (**14**) are configured to roll or slide; and [0055] a first side wall (**40**) comprising a first-side-wall outer face (**42**) that faces away from the passageway (**24**) and a first-side-wall inner face (**44**) that faces the passageway (**24**) and extends from the first floor (**38**);
[0056] wherein a first secondary outlet (**30′**) of the one or more secondary outlets (**30**) extends through the first side wall (**40**).
[0057] B2.1. The quality control structure (**12**) of paragraph B2, wherein the first-side-wall inner face (**44**) comprises a first-side-wall lip (**46**) extending along the first secondary outlet (**30′**) opposite the first floor (**38**).
[0058] B2.2. The quality control structure (**12**) of any of paragraphs B2-B2.1 when depending from paragraph B1, wherein the first-side-wall inner face (**44**) has a first-side-wall maximum inner-face width (**48**) that is greater than the secondary-outlet width (**34**).
[0059] B2.3. The quality control structure (**12**) of any of paragraphs B2-B2.2, wherein the elongate body (**22**) further comprises: [0060] a second floor (**50**) that faces the passageway (**24**) and along which the properly sized collars (**14**) are configured to roll or slide; and [0061] a second side wall (**52**) comprising a second-side-wall outer face (**54**) that faces away from the passageway (**24**) and a second-side-wall inner face (**56**) that faces the passageway (**24**) and extends from the second floor (**50**); [0062] wherein a second secondary outlet (**30″**) of the one or more secondary outlets (**30**) extends through the second side wall (**52**).
[0063] B2.3.1. The quality control structure (**12**) of paragraph B2.3, wherein the second-side-wall inner face (**56**) comprises a second-side-wall lip (**58**) extending along the second secondary outlet (**30″**) opposite the second floor (**50**).
[0064] B2.3.2. The quality control structure (**12**) of any of paragraphs B2.3-B2.3.1 when depending from paragraph B1, wherein the second-side-wall inner face (**56**) has a second-side-wall maximum inner-face width (**60**) that is greater than the secondary-outlet width (**34**).
[0065] B2.3.3. The quality control structure (**12**) of any of paragraphs B2.3-B2.3.2, wherein the second floor (**50**) is not coextensive with the first floor (**38**), and wherein the second-side-wall inner face (**56**) is not coextensive with the first-side-wall inner face (**44**).
[0066] B2.3.4. The quality control structure (**12**) of any of paragraphs B2.3-B2.3.2, wherein the second floor (**50**) is opposite the first floor (**38**) relative to the passageway (**24**), and wherein the second-side-wall inner face (**56**) is opposite the first-side-wall inner face (**44**) relative to the passageway (**24**).
[0067] B3. The quality control structure (**12**) of any of paragraphs B-B2.3.4, [0068] wherein the passageway (**24**) has a longitudinal axis (**62**); and [0069] wherein the elongate body (**22**) comprises an inlet region (**64**) defining the inlet (**26**), a primary outlet region (**66**) defining the primary outlet (**28**), and a first secondary-outlet region (**68**) that defines a/the first secondary outlet (**30′**) of the one or more secondary outlets (**30**).
[0070] B3.1. The quality control structure (**12**) of paragraph B3, wherein the longitudinal axis (**62**) curves.
[0071] B3.2. The quality control structure (**12**) of any of paragraphs B3-B3.1, wherein the longitudinal axis (**62**) is straight within with inlet region (**64**) and curves within the first secondary-outlet region (**68**).

[0072] B3.2.1. The quality control structure (**12**) of paragraph B3.2, wherein the elongate body (**22**) further comprises a second secondary-outlet region (**70**) that defines a/the second secondary outlet (**30**) of the one or more secondary outlets (**30**); and wherein the longitudinal axis (**62**) curves within the second secondary-outlet region (**70**).
[0073] B3.2.2. The quality control structure (**12**) of any of paragraphs B3.2-B3.2.1, wherein the longitudinal axis (**62**) is straight within the primary outlet region (**66**).
[0074] B3.2.2.1. The quality control structure (**12**) of paragraph B3.2.2, wherein the longitudinal axis (**62**) within the inlet region (**64**) is parallel to or colinear with the longitudinal axis (**62**) within the primary outlet region (**66**).
[0075] B3.3. The quality control structure (**12**) of any of paragraphs B3-B3.2 when depending from paragraph B2, wherein the first floor (**38**) twists within the first secondary-outlet region (**68**) from proximate the inlet region (**64**) toward the primary outlet region (**66**).
[0076] B3.3.1. The quality control structure (**12**) of paragraph B3.3 when depending from paragraph B3.2.1 and paragraph B2.3, wherein the second floor (**50**) twists within the second secondary-outlet region (**70**) from proximate the first secondary-outlet region (**68**) toward the primary outlet region (**66**).
[0077] B3.4 The quality control structure (**12**) of paragraph B3, wherein the longitudinal axis (**62**) is straight along an entirety of its length.
[0078] B3.5. The quality control structure (**12**) of any of paragraphs B3-B3.4 when depending from paragraph B2, wherein the first-side-wall inner face (**44**) ramps away from the longitudinal axis (**62**) toward the first secondary outlet (**30**′) opposite the outlet region (**66**).
[0079] B3.6. The quality control structure (**12**) of any of paragraphs B3-B3.5 when depending from paragraph B2, wherein the first-side-wall inner face (**44**) ramps toward the longitudinal axis (**62**) away the first secondary outlet (**30**′) opposite the inlet region (**64**).
[0080] B3.7. The quality control structure (**12**) of any of paragraphs B3-B3.6 when depending from paragraph B2.3, wherein the second-side-wall inner face (**56**) ramps away from the longitudinal axis (**62**) toward the second secondary outlet (**30**″) opposite the outlet region (**66**).
[0081] B3.8. The quality control structure (**12**) of any of paragraphs B-B3.7 when depending from paragraph B2.3, wherein the second-side-wall inner face (**56**) ramps toward the longitudinal axis (**62**) away from the second secondary outlet (**30**″) opposite the inlet region (**64**).
[0082] C. An automated fastening machine (**10**), comprising: [0083] a supply (**16**) for properly sized collars (**14**); [0084] an installation tool (**18**) configured to operatively install the properly sized collars (**14**); and [0085] the quality control structure (**12**) of any of paragraphs A-B3.8 positioned to receive the properly sized collars (**14**) and the undesirable structures (**20**) from the supply (**16**) and to deliver only the properly sized collars (**14**) toward the installation tool (**18**).
[0086] C1. The automated fastening machine (**10**) of paragraph C, further comprising a collection structure (**72**) positioned to collect the undesirable structures (**20**) as they exit the quality control structure (**12**).
[0087] C2. The automated fastening machine (**10**) of any of paragraphs C-C1, further comprising a buffer (**74**) operatively positioned between the quality control structure (**12**) and the installation tool (**18**) and configured to buffer the properly sized collars (**14**) for delivery to the installation tool (**18**).
[0088] C3. The automated fastening machine (**10**) of any of paragraphs C-C2, wherein the supply (**16**) comprises a hopper (**76**).
[0089] C3.1. The automated fastening machine (**10**) of paragraph C3.1, wherein the hopper (**76**) comprises a vibratory bowl.
[0090] D. Additively manufacturing the quality control structure (**12**) of any of paragraphs A-B3.8.
[0091] E. A method (**100**), comprising: [0092] receiving (**102**) properly sized collars (**14**) and undesirable structures (**20**) in a collar stream; [0093] removing (**104**) the undesirable structures (**20**) from the collar stream; and [0094] delivering (**106**) the collar stream without the undesirable

structures (**20**) to an installation tool (**18**).
[0095] E1. The method (**100**) of paragraph E, wherein the receiving (**102**) comprises receiving the properly sized collars (**14**) and the undesirable structures (**20**) via gravity; and wherein the removing (**104**) comprises removing the undesirable structures (**20**) via gravity.
[0096] E2. The method (**100**) of any of paragraphs E-E1, wherein the removing (**104**) comprises restricting (**108**) the properly sized collars (**14**) from exiting the collar stream and permitting (**110**) the undesirable structures (**20**) to exit the collar stream.
[0097] E3. The method (**100**) of any of paragraphs E-E2, performed by the quality control structure (**12**) of any of paragraphs A-B3.8 or the automated fastening machine (**10**) of any of paragraphs C-C3.1.
[0098] F. A method (**200**), comprising: [0099] feeding (**202**) properly sized collars (**14**) and undesirable structures (**20**) into a passageway (**24**); [0100] urging (**204**) the properly sized collars (**14**) and the undesirable structures (**20**) against a wall (**23**) that at least partially defines the passageway (**24**); and [0101] restricting (**206**) the properly sized collars (**14**) from passing through a secondary outlet (**30**) defined in the wall (**23**) while permitting (**208**) the undesirable structures (**20**) to pass through the secondary outlet (**30**).
[0102] F1. The method (**200**) of paragraph F, wherein the feeding (**202**), the urging (**204**), and the permitting (**208**) are caused at least in part by gravity.
[0103] F2. The method (**200**) of any of paragraphs F-F1, performed by the quality control structure (**12**) of any of paragraphs A-B3.8 or the automated fastening machine (**10**) of any of paragraphs C-C3.1.
[0104] G. The use of the quality control structure (**12**) of any of paragraphs A-B3.8 to remove undesirable structures (**20**) from a supply (**16**) of properly sized collars (**14**).
[0105] As used herein, the terms “adapted” and “configured” mean that the element, component, or other subject matter is designed and/or intended to perform a given function. Thus, the use of the terms “adapted” and “configured” should not be construed to mean that a given element, component, or other subject matter is simply “capable of” performing a given function but that the element, component, and/or other subject matter is specifically selected, created, implemented, utilized, programmed, and/or designed for the purpose of performing the function. It is also within the scope of the present disclosure that elements, components, and/or other recited subject matter that is recited as being adapted to perform a particular function may additionally or alternatively be described as being configured to perform that function, and vice versa. Similarly, subject matter that is recited as being configured to perform a particular function may additionally or alternatively be described as being operative to perform that function.
[0106] As used herein, the term “and/or” placed between a first entity and a second entity means one of (1) the first entity, (2) the second entity, and (3) the first entity and the second entity. Multiple entries listed with “and/or” should be construed in the same manner, i.e., “one or more” of the entities so conjoined. Other entities optionally may be present other than the entities specifically identified by the “and/or” clause, whether related or unrelated to those entities specifically identified. Thus, as a non-limiting example, a reference to “A and/or B,” when used in conjunction with open-ended language such as “comprising,” may refer, in one example, to A only (optionally including entities other than B); in another example, to B only (optionally including entities other than A); in yet another example, to both A and B (optionally including other entities). These entities may refer to elements, actions, structures, steps, operations, values, and the like.
[0107] The various disclosed elements of apparatuses and steps of methods disclosed herein are not required to all apparatuses and methods according to the present disclosure, and the present disclosure includes all novel and non-obvious combinations and subcombinations of the various elements and steps disclosed herein. Moreover, one or more of the various elements and steps disclosed herein May define independent inventive subject matter that is separate and apart from the whole of a disclosed apparatus or method. Accordingly, such inventive subject matter is not

required to be associated with the specific apparatuses and methods that are expressly disclosed herein, and such inventive subject matter may find utility in apparatuses and/or methods that are not expressly disclosed herein.

Claims

1. A quality control structure of an automated fastening machine, the quality control structure comprising: an elongate body defining a passageway and comprising one or more walls configured so that properly sized collars are urged against one of the one or more walls when passing through the passageway, wherein the one of the one or more walls define a secondary outlet that is configured to restrict passage of the properly sized collars through the secondary outlet and permit passage of undesirable structures through the secondary outlet.
2. The quality control structure of claim 1, wherein the one of the one or more walls comprises a lip that at least partially defines and extends along the secondary outlet and that is configured to engage the properly sized collars as the properly sized collars pass through the passageway.
3. An automated fastening machine, comprising: a supply for properly sized collars; an installation tool configured to operatively install the properly sized collars; and the quality control structure of claim 1 positioned to receive the properly sized collars and the undesirable structures from the supply and to deliver only the properly sized collars toward the installation tool).
4. The automated fastening machine of claim 3, further comprising a collection structure positioned to collect the undesirable structures as they exit the quality control structure.
5. A quality control structure of an automated fastening machine for transporting properly sized collars from a supply of the properly sized collars toward an installation tool and for removing undesirable structures from the supply of the properly sized collars, the quality control structure comprising: an elongate body defining a passageway, an inlet to the passageway sized to receive the properly sized collars, a primary outlet from the passageway sized to dispense the properly sized collars, and one or more secondary outlets from the passageway between the inlet and the primary outlet, wherein the one or more secondary outlets are sized to dispense the undesirable structures and restrict passage of the properly sized collars; wherein the quality control structure is configured to be operatively installed with the one or more secondary outlets positioned vertically below directly adjacent regions of the passageway.
6. The quality control structure of claim 5, wherein each of the one or more secondary outlets has a secondary-outlet length and a secondary-outlet width that is less than the secondary-outlet length and that is less than a diameter of the properly sized collars.
7. The quality control structure of claim 5, wherein the elongate body comprises: a first floor that faces the passageway and along which the properly sized collars are configured to roll or slide; and a first side wall comprising a first-side-wall outer face that faces away from the passageway and a first-side-wall inner face that faces the passageway and extends from the first floor; wherein a first secondary outlet of the one or more secondary outlets extends through the first side wall.
8. The quality control structure of claim 7, wherein the first-side-wall inner face comprises a first-side-wall lip extending along the first secondary outlet opposite the first floor.
9. The quality control structure of claim 7, wherein each of the one or more secondary outlets has a secondary-outlet length and a secondary-outlet width that is less than the secondary-outlet length and that is less than a diameter of the properly sized collars; and wherein the first-side-wall inner face has a first-side-wall maximum inner-face width that is greater than the secondary-outlet width.
10. The quality control structure of claim 7, wherein the elongate body further comprises: a second floor that faces the passageway and along which the properly sized collars are configured to roll or slide; and a second side wall comprising a second-side-wall outer face that faces away from the passageway and a second-side-wall inner face that faces the passageway and extends from the second floor; wherein a second secondary outlet of the one or more secondary outlets extends

through the second side wall.
11. The quality control structure of claim 10, wherein the second-side-wall inner face comprises a second-side-wall lip extending along the second secondary outlet opposite the second floor.
12. The quality control structure of claim 10, wherein each of the one or more secondary outlets has a secondary-outlet length and a secondary-outlet width that is less than the secondary-outlet length and that is less than a diameter of the properly sized collars; and wherein the second-side-wall inner face has a second-side-wall maximum inner-face width that is greater than the secondary-outlet width.
13. The quality control structure of claim 10, wherein the second floor is not coextensive with the first floor, and wherein the second-side-wall inner face is not coextensive with the first-side-wall inner face.
14. The quality control structure of claim 10, wherein the second floor is opposite the first floor relative to the passageway, and wherein the second-side-wall inner face is opposite the first-side-wall inner face relative to the passageway.
15. The quality control structure of claim 5, wherein the passageway has a longitudinal axis; and wherein the elongate body comprises an inlet region defining the inlet, a primary outlet region defining the primary outlet, and a first secondary-outlet region that defines a first secondary outlet of the one or more secondary outlets.
16. The quality control structure of claim 15, wherein the longitudinal axis curves.
17. The quality control structure of claim 15, wherein the longitudinal axis is straight within with inlet region and curves within the first secondary-outlet region.
18. The quality control structure of claim 17, wherein the elongate body further comprises a second secondary-outlet region that defines a second secondary outlet of the one or more secondary outlets; and wherein the longitudinal axis curves within the second secondary-outlet region.
19. The quality control structure of claim 17, wherein the longitudinal axis is straight within the primary outlet region.
20. The quality control structure of claim 19, wherein the longitudinal axis within the inlet region is parallel to or colinear with the longitudinal axis within the primary outlet region.
21. The quality control structure of claim 15, wherein the elongate body comprises: a first floor that faces the passageway and along which the properly sized collars are configured to roll or slide; and a first side wall comprising a first-side-wall outer face that faces away from the passageway and a first-side-wall inner face that faces the passageway and extends from the first floor; wherein a first secondary outlet of the one or more secondary outlets extends through the first side wall; wherein the first floor twists within the first secondary-outlet region from proximate the inlet region toward the primary outlet region.
22. The quality control structure of claim 21, wherein the elongate body further comprises: a second floor that faces the passageway and along which the properly sized collars are configured to roll or slide; and a second side wall comprising a second-side-wall outer face that faces away from the passageway and a second-side-wall inner face that faces the passageway and extends from the second floor; wherein a second secondary outlet of the one or more secondary outlets extends through the second side wall; wherein the elongate body further comprises a second secondary-outlet region that defines a second secondary outlet of the one or more secondary outlets; wherein the longitudinal axis curves within the second secondary-outlet region; and wherein the second floor twists within the second secondary-outlet region from proximate the first secondary-outlet region toward the primary outlet region.
23. The quality control structure of claim 15, wherein the elongate body comprises: a first floor that faces the passageway and along which the properly sized collars are configured to roll or slide; and a first side wall comprising a first-side-wall outer face that faces away from the passageway and a first-side-wall inner face that faces the passageway and extends from the first floor; wherein a first secondary outlet of the one or more secondary outlets extends through the first side wall; and

wherein the first-side-wall inner face ramps toward the longitudinal axis away the first secondary outlet opposite the inlet region.