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TAMPER-INDICATING DEVICE INSTALLATION TOOLS AND RELATED TAMPER-INDICATING DEVICES, ASSEMBLIES, SYSTEMS, AND METHODS

Abstract

In one aspect, a method for installing tamper-indicating assemblies relative to drum enclosure assemblies includes supporting, with an installation tool, a tamper-indicating assembly relative to a drum enclosure assembly such that at least a portion of a closure bolt of the drum enclosure assembly and first and second flanged ends of a lid ring of the drum enclosure assembly are received within a cavity of a tamper-indicating device (TID) of the tamper-indicating assembly. The method also includes inserting, with the installation tool, a pin of the tamper-indicating assembly through a bore of the TID and across a cavity of the TID and deforming, with the installation tool, a portion of the pin relative to the TID to secure the pin within the bore of the TID.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS [0001] The present application is based upon and claims the right of priority to U.S. Provisional Patent Application No. 63/556,109, filed Feb. 21, 2024, the disclosure of which is hereby incorporated by reference herein in its entirety for all purposes.

FIELD

[0003] The present subject matter relates generally to tamper-indicating device (TID) installation tools, as well as associated tamper-indicating devices (TIDs) and related assemblies, systems and methods, for use with a radioactive material drum enclosure. In particular, the present subject matter relates to automated and manual TID installation tools/methods/systems/assemblies, such as by through automated robotic application and/or manual application.

BACKGROUND

[0004] Containers and associated systems used to store and ship radioactive materials must be designed and demonstrated to safely contain the radioactive materials and limit personnel exposure, both under normal conditions and in a variety of accident scenarios. For example, the containers and associated systems may be subjected to a variety of tests demonstrating the ability to withstand normal conditions of transport, e.g., water spray test, free drop test, penetration test, compression test, or others, without the loss of any radioactive contents.

[0005] Generally, these engineered containers are in the form of cylindrically shaped drum enclosures that are used to confine the radioactive material for the purposes of transportation and storage. These engineered containers are typically referred to as “packagings” and must be secured in a way that provides adequate confinement of the radioactive material. Typically, the ends of the drums are closed utilizing standard bolted drum closure rings, welded fittings, and/or bolts to provide an adequate level of integrity for the package to meet safety and testing regulations required to ship radioactive material.

[0006] Once a drum enclosure containing radioactive material is closed and sealed, it is important that the drum enclosure is not opened thereafter by any unauthorized personnel (e.g., the drum enclosure should only be opened by the intended recipient). Additionally, the intended recipient should be made aware if the drum enclosure has been opened or tampered with prior to receipt in order to take appropriate safety precautions.

[0007] In this regard, tamper-indicating devices (TIDs) have been developed for indicating whether or not the drum enclosure has been opened and/or tampered with. For instance, US2023/0147819 to Dalmaso et al. (the contents of which are hereby incorporated by reference herein in their entirety for all purposes) discloses a TID having features that facilitate the robotic application of the TID onto a drum disclosure, which allows for application or installation of the TID without requiring human contact or exposure to the drum enclosure. While this TID provides numerous advantages, further improvements and/or refinements to TIDs, themselves, and/or the installation tools/methods used to install/apply such TIDs relative to a drum enclosure would be welcomed in the art.

BRIEF SUMMARY

[0008] Aspects and advantages of the present subject matter will be set forth in part in the following description, or may be obvious from the description, or may be learned through practice of the present subject matter.

[0009] In one aspect, the present subject matter is directed to a tamper-indicating device (TID) installation tool in accordance with one or more of the embodiments described herein.

[0010] In another aspect, the present subject matter is directed to a system for installing tamper-indicating assemblies relative to drum enclosure assemblies in accordance with one or more embodiments described herein.
[0011] In several embodiments, the system includes a drum enclosure assembly including a lid ring extending from a first flanged end to a second flanged end. The drum enclosure assembly further includes a closure bolt extending through the first and second flanged ends. The system also includes a tamper-indicating device (TID) defining a cavity configured to receive at least a portion of the closure bolt and the first and second flanged ends of the lid ring. The TID defines a bore relative to the cavity. The system further includes a pin configured to extend through the bore of the TID and across the cavity of the TID, with the pin including a pin body extending from a body end to a head end. Additionally, the system includes an installation tool for installing and securing the pin relative to the TID. The installation tool includes a support assembly configured to support the TID and a pin deformation assembly having first and second pin actuators. The first pin actuator is configured to push the pin through the bore of the TID, and the second pin actuator is configured to deform the head end of the pin relative to the TID.
[0012] In a further aspect, the present subject matter is directed to a method for installing tamper-indicating assemblies relative to drum enclosure assemblies in accordance with one or more of the embodiments described herein.
[0013] In several embodiments, the method includes supporting, with an installation tool, a tamper-indicating assembly relative to a drum enclosure assembly such that at least a portion of a closure bolt of the drum enclosure assembly and first and second flanged ends of a lid ring of the drum enclosure assembly are received within a cavity of a tamper-indicating device (TID) of the tamper-indicating assembly. The method also includes inserting, with the installation tool, a pin of the tamper-indicating assembly through a bore of the TID and across a cavity of the TID and deforming, with the installation tool, a portion of the pin relative to the TID to secure the pin within the bore of the TID.
[0014] In yet another aspect, the present subject matter is directed to a tamper-indicating device (TID) in accordance with one or more of the embodiments described herein.
[0015] These and other features, aspects, and advantages of the present subject matter will become better understood with reference to the following Detailed Description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate embodiments of the present subject matter and, together with the description, serve to explain the principles of the present subject matter.
[0016] This Brief Description is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Brief Description is not intended to identify key features or essential features of the claimed subject matter, nor is it intended as an aid in determining the scope of the claimed subject matter.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
[0017] A full and enabling disclosure of the present subject matter, including the best mode thereof, directed to one of ordinary skill in the art, is set forth in the specification, which makes reference to the appended figures, in which:
[0018] FIG. **1** illustrates a perspective view of one embodiment of a drum enclosure assembly in accordance with aspects of the present subject matter;
[0019] FIG. **2** illustrates an enlarged view of an aspect of the drum enclosure assembly of FIG. **1** in accordance with aspects of the present subject matter;
[0020] FIGS. **3**-**5** illustrate various views of one embodiment of a tamper-indicating assembly in

accordance with aspects of the present subject matter;
[0021] FIGS. **6-9** illustrate various views of the tamper-indicating assembly shown in FIGS. **3-5** as installed relative to a drum enclosure assembly in accordance with aspects of the present subject matter;
[0022] FIGS. **10-15** illustrate various views of one embodiment of a TID suitable for use within embodiments of the disclosed tamper-indicating assembly in accordance with aspects of the present subject matter;
[0023] FIGS. **16-20** illustrate various views of one embodiment of a pin suitable for use within embodiments of the disclosed tamper-indicating assembly in accordance with aspects of the present subject matter;
[0024] FIG. **21** illustrates a perspective of one embodiment of a tamper-indicating assembly installed relative to a drum enclosure assembly in accordance with aspects of the present subject matter;
[0025] FIG. **22** illustrates a cross-sectional view of the tamper-indicating assembly shown in FIG. **21** taken about line **22**, **24-22**, **24**, particularly illustrating the pin of the tamper-indicating assembly in a non-deformed state;
[0026] FIG. **23** illustrates an enlarged view of a portion of the tamper-indicating assembly shown in FIG. **22**, particularly illustrating a head end of the pin positioned relative to an adjacent portion of a TID of the tamper-indicating assembly;
[0027] FIG. **24** illustrates a cross-sectional view of the tamper-indicating assembly shown in FIG. **21** taken about line **22**, **24-22**, **24**, particularly illustrating the pin of the tamper-indicating assembly in a deformed state;
[0028] FIG. **25** illustrates an enlarged view of a portion of the tamper-indicating assembly shown in FIG. **24**, particularly illustrating a head end of the pin positioned relative to an adjacent portion of a TID of the tamper-indicating assembly;
[0029] FIG. **26** illustrates an even further enlarged view of the head end of the pin shown in FIG. **25**, particularly illustrating aspects of a deformed lip of the head end of the pin;
[0030] FIG. **27** illustrates a perspective view of one embodiment of a TID installation tool in accordance with aspects of the present subject matter;
[0031] FIG. **28** illustrates a partially exploded view of the TID installation tool shown in FIG. **27**;
[0032] FIG. **29** illustrates a rear perspective view of a TID support assembly of the TID installation tool shown in FIGS. **27** and **28**, particularly illustrating clamping blocks of the TID support assembly at an opened or non-clamped position relative to the tamper-indicating assembly;
[0033] FIG. **30** illustrates another rear perspective view of the TID support assembly of the TID installation tool shown in FIGS. **27** and **28**, particularly illustrating the clamping blocks of the TID support assembly at a closed or clamped position relative to the tamper-indicating assembly;
[0034] FIG. **31** illustrates a cross-sectional view of the TID installation tool shown in FIG. **27**;
[0035] FIGS. **32-35** illustrate enlarged, cross-sectional views of portions of the TID installation tool shown in FIG. **31** during the pin installation/deformation process in accordance with aspects of the present subject matter;
[0036] FIG. **36** illustrates a side view of one embodiment of a system for installing a tamper-indicating assembly relative to a drum enclosure assembly, particularly illustrating a TID installation tool of the system being positioned relative to the drum enclosure assembly via an associated robotic arm;
[0037] FIGS. **37-39** illustrate various views of the TID installation tool and the drum enclosure assembly shown in FIG. **36** during the installation process in accordance with aspects of the present subject matter;
[0038] FIG. **40** illustrates a perspective view of one embodiment of a manual TID installation tool in accordance with aspects of the present subject matter;
[0039] FIG. **41** illustrates a side view of the TID installation tool shown in FIG. **40** with a tamper-

indicating assembly position relative to the tool in accordance with aspects of the present subject matter; and

[0040] FIG. **42** illustrates a cross-sectional view of the TID installation tool and tamper-indicating assembly shown in FIG. **41**.

DETAILED DESCRIPTION

[0041] Reference now will be made in detail to embodiments of the invention, one or more examples of which are illustrated in the drawings. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment can be used with another embodiment to yield still a further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents.

[0042] In general, the present subject matter is directed to tamper-indicating device (TID) installation tools for installing a TID relative to a drum enclosure assembly. In addition, the present subject matter is also directed to TIDs and tamper-indicating assemblies, as well as related systems and methods for installing TIDs relative to drum enclosure assemblies.

[0043] Referring now to the drawings, FIGS. **1** and **2** illustrate views of one embodiment a drum enclosure assembly **100** in accordance with aspects of the present subject matter. Specifically, FIG. **1** illustrates a perspective view of the drum enclosure assembly **100**, while FIG. **2** illustrates an enlarged perspective view of the drum enclosure assembly **100**.

[0044] As shown, the drum enclosure assembly **100** may include a drum body **102**, a lid **104**, and a lid ring **106** securing the lid **104** to the drum body **102**. For example, the drum body **102** may define one or more open ends, and the lid **104** may be disposed on the open end of the drum body **102** such that the lid **104** and the drum body **102** collectively define an enclosed interior (e.g., which may be used for storage or shipment of one or more products). The lid ring **106** may extend (e.g., annularly about an axial centerline **172** of the drum enclosure assembly **100**) from a first flanged end **108** to a second flanged end **110**. The first flanged end **108** and the second flanged end **110** may be spaced apart from one another such that a gap **109** is defined therebetween. A closure bolt **120** having a head **122** and a body **124** may extend through the first flanged end **108** and the second flanged end **110**. For example, the body **124** of the closure bolt **120** may define exterior threads, and the flanges may define internal threads such that rotation of the closure bolt **120** relative to the flanged ends **108**, **110** adjusts the width of the gap **109** defined between the flanged ends **108**, **110**. In this way, the closure bolt **120** may be rotated to adjust the width of the gap **109** between the flanged ends **108**, **110**, which in turn increases the pressure applied by the lid ring **106** onto the lid **104** and the drum body **102**, thereby securely coupling the lid **104** to the drum body **102**. Thus, the closure bolt **120** couples the lid ring **106** and the lid **104** to the drum body **102**, and the removal of the closure bolt **120** allows the lid **104** to be removed and the interior of the drum body **102** to be accessed.

[0045] Referring now to FIGS. **3-15**, various views of components of one embodiment of a tamper-indicating assembly **200** that can be installed/applied relative to a drum enclosure assembly (e.g., the drum enclosure assembly **100** of FIG. **1**) are illustrated in accordance with aspects of the present subject matter. Specifically, FIGS. **3-5** illustrate various views of the tamper-indicating assembly **200** alone, while FIGS. **6-9** illustrate various views of the tamper-indicating assembly **200** installed relative to a drum enclosure (e.g., drum enclosure assembly **100**), particularly illustrating the tamper-indicating assembly **200** installed relative to the closure bolt **120** and flanged ends **108**, **110** of the lid ring **106**. Additionally, FIGS. **10-15** illustrate various views of a TID **220** of the tamper-indicating assembly **200** shown in FIGS. **3-9**. Specifically, FIG. **10** illustrates a perspective view of the TID **220** and FIGS. **11** and **12** illustrate respective top and bottom views of the TID **220**. FIG. **13** illustrate a side view of the TID **220**, while FIGS. **14** and **15** illustrate

respective first and second end views of the TID **220**.
[0046] As shown in FIGS. **3**-**9**, the tamper-indicating assembly **200** generally includes a TID **220** and a pin **250** configured to be coupled to a drum enclosure assembly **100**. In exemplary embodiments, the tamper-indicating assembly **200** may be non-removably coupled to the drum enclosure assembly **100**. For example, as should be appreciated, once the tamper-indicating assembly **200** is coupled to the drum enclosure assembly **100**, it may not be removed without being destroyed (e.g., partially destroyed or entirely destroyed), thereby indicating to any subsequent handlers that the drum enclosure has been tampered with and potentially opened.
[0047] In several embodiments, the TID **220** may define a cavity **222** sized to receive at least a portion of the closure bolt **120**, as well as the first and second flanged ends **108**, **110** of the lid ring **106**, to prevent movement of the closure bolt **120**. For example, the TID **220** may surround the closure bolt **120** and the flanged ends **108**, **110** of the lid ring **106** in order to prevent the closure bolt **120** from being moved or removed from the drum enclosure assembly **100** without destruction of at least a portion of the tamper-indicating assembly **200**. For example, as shown in FIGS. **6**-**9**, at least a portion of the closure bolt **120**, the lid ring **106**, and/or other components of the drum enclosure assembly **100** may extend into the cavity **222** of the TID **220** (e.g., when the TID **220** is coupled to the drum enclosure assembly **100**). In various embodiments, the cavity **222** of the TID **220** may correspond with or match a shape of at least a portion of the drum enclosure assembly **100** such that at least a portion of the drum enclosure assembly **100** may extend into the cavity **222** and make flush contact (e.g., continuous contact) with the TID **220**.
[0048] In particular embodiments, the pin **250** may be non-removably coupled to the TID **220** such that it cannot be removed without destroying either or both of the pin **250** and/or the TID **220**. Particularly, the pin **250** may extend through the TID **220** and across the cavity **222** such that the TID **220** and the pin **250** collectively surround the closure bolt **120** when attached to the drum enclosure assembly **100**. In this way, the pin **250** ensures that the tamper-indicating assembly **200** may not be removed from the drum enclosure assembly **100** once coupled thereto.
[0049] Referring particularly to FIGS. **3**-**5**, the TID **220** may include a mid-body portion **224**, a first arm **226** extending from the mid-body portion **224**, and a second arm **228** extending from the mid-body portion **224** opposite the first arm **226**. The mid-body portion **224** of the TID **220** may be disposed between the first arm **226** and the second arm **228**, and both the first arm **226** and the second arm **228** may extend from the mid-body portion **224**. The mid-body portion **224** may be sized to receive a portion of the closure bolt **120**. For example, the mid-body portion **224** may be generally U-shaped, and a portion of the body **124** of the closure bolt **120** may extend through the portion of the cavity **222** defined by the U-shaped mid-body portion **224** of the TID **220**. Stated otherwise, the mid-body portion **224** of the TID **220** may at least partially surround a portion of the body **124** of the closure bolt **120**. Particularly, when coupled to the drum enclosure assembly **100**, the mid-body portion **224** of the TID **220** may be disposed between the first and second flanged ends **108**, **110** of the lid ring **106** and may at least partially surround a portion of the body **124** of the closure bolt **120**.
[0050] Both the first arm **226** and the second arm **228** may extend from the mid-body portion **224** of the TID **220** in opposite directions. For example, the first arm **226** may extend from the mid-body portion **224** and at least partially surround the first flanged end **108** of the lid ring **106** and the head **122** of the closure bolt **120**, and the second arm **228** may extend from the mid-body portion **224** and at least partially surround the second flanged end **110** of the lid ring **106** and the body **124** of the closure bolt **120**.
[0051] In exemplary embodiments, the first arm **226** may include an axial portion **230** (FIGS. **3** and **4**) and a radial wall **232** (FIGS. **3** and **4**) that prevents axial movement of the closure bolt **120**. For example, the axial portion **230** of the first arm **226** may extend generally axially from the mid-body portion **224** of the TID **220** to the radial wall **232**. Particularly, when installed relative to the drum enclosure assembly **100**, the axial portion **230** may extend from the mid-body portion **224**, along

the first flanged end **108** of the lid ring **106** and the head **122** of the closure bolt **120**, to the radial wall **232**. The radial wall **232** may prevent axial movement of the closure bolt **120** (e.g., the radial wall **232** may prevent the closure bolt **120** from being moved or removed without destruction of a portion of the tamper-indicating assembly **200**). For example, the radial wall **232** may contact the head **122** of the closure bolt **120** to prevent the closure bolt **120** from being moved or removed from the flanged ends **108**, **110** of the lid ring **106**. Particularly, the radial wall **232** may extend generally perpendicularly to the axial centerline of the tamper-indicating assembly **200**. The radial wall **232** impedes or blocks the closure bolt **120** from being removed (e.g., unless the tamper-indicating assembly **200** is destroyed). For example, attempting to remove the closure bolt **120** while the tamper-indicating assembly **200** is in place would result in contact between the head **122** and the radial wall **232**. If enough force is applied to the closure bolt **120**, the radial wall **232** will be permanently destroyed, thereby indicating to users thereafter that the drum enclosure assembly **100** has potentially been opened and is unsafe to handle.

[0052] In many embodiments, the second arm **228** may extend opposite the first arm **226** and may be configured to at least partially surround the second flanged end **110** of the lid ring **106** and the body **124** of the closure bolt **120**. For example, the second arm **228** may include an axial portion **234** (FIGS. **3** and **4**) and a radial portion **236** (FIGS. **3** and **4**). Particularly, when installed relative to the drum enclosure assembly **100**, the axial portion **234** of the second arm **228** may extend from the mid-body portion **224**, along the second flanged end **110** of the lid ring **106**, to the radial portion **236** of the second arm **228**. As shown, the radial portion **236** of the second arm **228** may be generally perpendicular to the axial portion **234** of the second arm **228** and may contact the closure bolt **120**. In exemplary embodiments, the first and second flanged ends **108**, **110** of the lid ring **106**, along with the head **122** of the bolt **120**, may be disposed between the radial wall **232** of the first arm **226** and the radial portion **236** of the second arm **228**, in order to prevent removal of the closure bolt **120** when the tamper-indicating assembly **200** is coupled to the drum enclosure assembly **100**. In various embodiments, the radial portion **236** of the second arm **228** may be generally U-shaped and may at least partially surround the body **124** of the closure bolt **120**. For example, the U-shaped radial portion **236** of the second arm **228** allows the TID **220** to securely couple to the drum enclosure assembly **100** regardless of the excess length of the body **124** of the closure bolt **120** extending from the second flanged end **110** of the lid ring **106**. Additionally, the radial portion **236** of the second arm **228** may extend adjacent to the second flanged end **110** of the lid ring **106**, such that movement (or an attempted removal) of the closure bolt **120** would result in the head **122** of the closure bolt **120** engaging the radial wall **232** of the first arm **226**, and in turn, the radial portion **236** of the second arm **228** engaging the second flanged end **110** of the lid ring **106**.

[0053] As shown in FIGS. **3-9**, the pin **250** may be inserted through a portion of the TID **220** to couple the tamper-indicating assembly **200** to the drum enclosure assembly **100**. Specifically, in several embodiments, the TID **220** may define a bore **238** (See FIGS. **10-12**) for receiving the pin **250**. For example, the bore **238** may be a drilled or formed hole/aperture (e.g., a through-hole) having a generally cylindrical shape that extends at least partially through the TID **220**. In particular embodiments, the bore **238** may be defined in the mid-body portion **224** of the TID **220**. For example, the bore **238** may include a first portion **238***a* (FIG. **10**) defined in a first side wall **240** of the mid-body portion **224** and a second portion **238***b* (FIG. **10**) defined in a second side wall **242** of the mid-body portion **224**. The first and second portions **238***a*, **238***b* of the bore **238** may be coaxially aligned (such that the center point of the holes is along a common axis). As shown in FIGS. **3** and **5-9**, once the pin **250** is inserted into the bore **238**, a head end **254** of the pin **250** may be exposed to allow such head end **254** to be deformed to retain the pin **250** within the bore **238**. In various implementations, the pin **250** may extend through the first side wall **240**, across the cavity **222**, and into the second side wall **242**.

[0054] FIGS. **16-20** illustrate various views of the pin **250** of the tamper-indicating assembly **200**

shown in FIGS. **3-9**. Specifically, FIG. **16** illustrates a perspective view of the pin **250**. FIG. **17** illustrates a side view of the pin **250**, while FIG. **18** illustrates an end view of the pin **250**. Additionally, FIGS. **19** and **20** illustrate further perspective views of the pin **250**.

[0055] As shown in FIGS. **16-20**, the pin **250** includes a body **252** extending lengthwise between a head end **254** and a body end **256**. In the illustrated embodiment, the pin body **252** generally has a square cross-sectional shape with rounded or chamfered corners. However, in other embodiments, the pin body **252** may be more cylindrically shaped. As particularly shown in FIGS. **16**, **18**, and **20**, the head end **254** of the pin **250** is generally cylindrically shaped and includes an annular flange or lip **258** extending outwardly therefrom, thereby creating a small, circular cavity **260** at the head end **254** of the pin **250**. As shown in FIGS. **16-18** and **20**, a small, circular tapered locating notch **261** is also centrally located within the bottom of the cavity **260**. The annular lip **258** of the head end **254** may be configured to be deformed or flared outwardly to secure the pin **250** within the bore **238** of the TID **220** and prevent the pin **250** from being backed-out of or otherwise removed from the bore **238**. For instance, as will be described below, a portion of the installation tool disclosed herein may be configured to be inserted or compressed into the cavity **260** to deform or flare the annular lip **258** radially outwardly into engagement with the second side wall **242** of the mid body portion **224** of the TID **220**.

[0056] Additionally, an annular groove **263** may also be provided around the outer perimeter or circumference of the head end **254** of the pin **250**. As particularly shown in FIG. **17**, in one embodiment, the annular groove **263** may extend around the outer perimeter of the head end **254** of the pin **250** at a location slightly axially offset from the cavity **260** so as to be generally aligned with a portion of the locating notch **261** extending from the bottom of the cavity **260**. As will be described below, this annular groove **263** may help to facilitate deformation of the annular lip **258** when securing the pin **250** within the TID **220**.

[0057] It should be appreciated that, in several embodiments, the head end **254** of the pin **250** may define an outer dimension (e.g., an outer diameter) that is smaller than a corresponding outer dimension (e.g., a width, height, outer diameter, etc.) of at least a portion the body **252** of the pin **250**. In such an embodiment, it may be desirable to select the size (e.g., diameter) of the second portion **238***b* of the bore **238** (FIG. **10**) so that the head end **254** of the pin **250** may be received within the second portion **238***b* of the bore **238** but the pin body **252** (due to its larger size) cannot be received within the second portion **238***b* of the bore **238**, thereby preventing the pin **250** from being pushed outwardly from the bore **238** via the second portion **238***b*. In this regard, the first portion **238***b* of the bore **238** may be sized appropriately to allow the pin body **252** to be inserted therethrough. Accordingly, the engagement of the pin body **252** against the second side wall **242** of the mid body portion **224** of the TID **220** may prevent the pin **250** from being pushed fully through the bore **238** in a first or installation direction, while the engagement of the flared lip **258** of the pin **250** along the opposed side of the second side wall **242** of the mid body portion **224** of the TID **220** may prevent the pin **250** from being pushed back out of the bore **238** in an opposed, second or retention direction.

[0058] As particularly shown in FIGS. **19** and **20**, the pin **250** may, in certain embodiments, be labeled with a serial number or other identification number **265** to allow for tracking, identification, etc. For instance, during installation of the tamper-indicating assembly **200**, the serial number may be captured automatically (via camera) or by a worker and logged/added to an inspection data package associated with the drum enclosure assembly **100**.

[0059] FIGS. **21-23** show additional views of the tamper-indicating assembly **200** described above as installed relative to a drum enclosure assembly **100**. Specifically, FIG. **21** illustrates a partial, perspective view of the drum enclosure assembly **100** with the tamper-indicating assembly **200** installed relative thereto (and with the pin **250** of the assembly **200** in a deformed state). FIG. **22** illustrates a side, cross-sectional view of a portion of the drum enclosure assembly **100** and tamper-indicating assembly **200** shown in FIG. **21** (e.g., taken about line **22**, **24-22**, **24**), while FIG. **23**

illustrates a close-up view of the portion of the illustration of FIG. **22** shown in dashed box **23**, with both FIGS. **22** and **23** illustrating the head end **254** of the pin **250** in a non-deformed state.

[0060] As shown in the illustrated embodiment, the TID **220** is shown as installed relative to the closure bolt **120** and the flanged ends **108**, **110** of the lid ring **106**. Additionally, as particularly shown in FIGS. **22** and **23**, the pin **250** is shown installed relative to the TID **220** (i.e. by being inserted through the bore **238** of the TID **220**) but prior to the annular lip **258** of the head end **254** of the pin **250** being deformed or flared outwardly to secure the pin **250** in place relative to the TID **220**. For example, as particularly shown in FIG. **23**, the pin **250** extends through the second side wall **242** of the mid body portion **224** of the TID **220** such that the head end **254** of the pin **250** is exposed along the exterior of the TID **220**. This allows the annular lip **258** of the head end **254** to be deformed or flared outwardly via the installation tool, as will be described below in greater detail. As shown in FIG. **23**, the second side wall **242** of the mid body portion **224** of the TID **220** defines a small, recessed cavity **244** surrounding the head end **254** of the pin **250**, with the cavity forming a retention shoulder **245** (e.g., an angled retention shoulder) within the second side wall **242** of the mid body portion **224**. As will be described below, the annular lip **258** is generally configured to be deformed or flared radially outwardly into this recessed cavity **244** such that the lip **258** radially overlaps the retention shoulder **245**, thereby ensuring that the pin **250** cannot backout of the bore **238** due to the engagement between the lip **258** and the retention shoulder **245** (i.e., thus, securing the pin **250** within the TID **220**).

[0061] FIGS. **24** and **25** illustrate similar views as those shown above in FIGS. **22** and **23**, respectively, except that the head end **254** of the pin **250** is illustrated in the deformed state. Specifically, FIG. **24** illustrates a side, cross-sectional view of a portion of the drum enclosure assembly **100** and tamper-indicating assembly **200** shown in FIG. **21** (e.g., taken about line **22**, **24**-**22**, **24**), while FIG. **25** illustrates a close-up view of the portion of the illustration of FIG. **24** shown in dashed box **25**, with both FIGS. **24** and **25** illustrating the head end **254** of the pin **250** in the deformed state.

[0062] As particularly shown in FIGS. **24** and **25**, upon deformation of the annular lip **258** of the head end **254** of the pin **250**, the lip **258** is flared or deformed radially outwardly such that the lip **258** radially overlaps the retention shoulder **245** of the second side wall **242** of the mid body portion **224** of the TID **220**. As a result, the engagement between the deformed lip **258** and the retention shoulder **245** will prevent the pin **250** from backing out or otherwise being removed from the bore **238** in a pin retention direction of the TID **220** (indicated by arrow **246** in FIG. **25**). Additionally, as described above, the outer dimension (e.g., a width, height, outer diameter, etc.) of the body **252** of the pin **250** may be sized such that the body **252** cannot be received into the smaller sized second portion **238***b* of the bore **238**. As such, the engagement of the pin body **252** against the second side wall **242** of the mid body portion **224** of the TID **220** may prevent the pin **250** from being pushed through the bore **238** in a pin installation direction of the TID **220** (indicated by arrow **248** in FIG. **25**). Accordingly, the engagement of the pin **250** along the opposed sides of the second side wall **242** (e.g., via the flared lip **258** and the enlarged pin body **252**) may function to secure the pin **250** in place relative to the TID **220**.

[0063] FIG. **26** illustrates a close-up, cross-sectional view of a portion of the second side wall **242** of the TID **220** and the pin **250** shown in FIGS. **24** and **25**, particularly illustrating a more detailed view of the flared lip **258** in its deformed state. As shown in FIG. **26**, the deformed lip **258** extends outwardly and radially overlaps the retention shoulder **245** defined by the second side wall **242** of the TID **220**. In one embodiment, the deformed lip **258** may take on a curled or curved profile in the deformed state, which may result from the deformation process (as will be described below).

[0064] It should be appreciated that the annular groove **263** formed around the outer perimeter of the pin **250** may function to facilitate deformation or flaring of the lip **258** outwardly during the deformation process. As described above (and as particularly shown in FIG. **17**), the annular groove **263** is generally formed around the outer perimeter of the pin **250** at a location immediately

below the bottom end of the cavity **260** defined in the head end **254** of the pin **250** (e.g., at a location axially aligned with a portion of the locating notch **261**) such that the groove **263** is positioned adjacent or immediately below the location at which the annular lip **258** intersects the bottom end of the cavity **260**. Such placement of the groove **263** allows the pin material extending between the bottom end of the lip **258** and the cavity **260** to be displaced into the groove **263** as the lip **258** is flared outwardly. For instance, as shown in FIG. **26**, with the lip **258** in its deformed state, a portion of the groove **263** is occupied by pin material that has been deformed or displaced during the deformation process, thereby allowing for proper outward flaring or deformation of the lip **258**.

[0065] Additionally, it should also be appreciated that the groove **263** may also function to create a weak point below the lip **258** due to the reduced wall thickness, thereby providing a location at which a crack or break can form in the head end **254** of the pin **250** to further facilitate outward deformation or flaring of the lip **258**. For instance, as shown in FIG. **26**, a small failure point or break (e.g., at the location indicated by arrows **270**) may occur at the intersection between the lip **258** and the bottom end of the cavity **260** to facilitate enhanced outward flaring of the lip **258**.

[0066] FIGS. **27-30** illustrate differing views of one embodiment of a TID installation tool **300** in accordance with aspects of the present subject matter. Specifically, FIG. **27** illustrates a perspective view of the installation tool **300** with the tamper-indicating assembly **200** described above positioned relative to the tool **300**, while FIG. **28** illustrates an exploded view of the TID installation tool **30** shown in FIG. **27**. Additionally, FIGS. **29** and **30** illustrate rear, perspective views of a portion of the tool **300** shown in FIGS. **27** and **28** (e.g., a TID support assembly **302** of the tool **300**).

[0067] As shown in FIGS. **27** and **28**, the tool **300** may generally include a TID support assembly **302**, first and second TID actuator assemblies **304**, **306**, a valve assembly **308** (e.g., a solenoid valve assembly), robot/tool adapter assembly **310**, a control box **312** (FIG. **28**), a pin deformation assembly **314**, and a pneumatic manifold assembly **316**.

[0068] The TID support assembly **302** may generally be configured to support/grip the tamper-indicating assembly **200** for installation onto the drum enclosure assembly **100**. For instance, the TID support assembly **302** may include clamping features that are configured to be pneumatically actuated relative to the tamper-indicating assembly **200** to allow the tool **300** to pick-up and support the tamper-indicating assembly **200**. For instance, as shown in FIGS. **28-30**, opposed clamping blocks **324** may be provided along either side of the TID support assembly **302** for clamping against the opposed ends of the TID **220** (e.g., against the radial walls/portions **232**, **236** of the first and second arms **226**, **228** of the TID **220**). As particularly shown in FIGS. **29** and **30**, the clamping blocks **324** may also be configured to clamp around portions of the pin **250** to maintain the pin **250** in place relative to the TID **220** (e.g., prior to full insertion of the pin **250** through the bore **238** of the TID **220**) and to maintain proper alignment of the pin **250** relative to the bore **238** during insertion of the pin **250** therein.

[0069] As particularly shown in FIGS. **29** and **30**, to facilitate actuation of the clamping blocks **324** between a non-clamped position (see FIG. **29**) and a clamped position (see FIG. **30**), the TID support assembly **302** may also incorporate first and second clamp actuators **325** (e.g., pneumatic actuators) configured to actuate the clamping blocks **324** via a gearbox **326** to ensure that the clamping blocks **324** are pneumatically actuated inwardly at the same rate when clamping the tamper-indicating assembly **200**. For instance, the clamp actuators **325** may be coupled to the gearbox **326** via racks **327** that engage a pinion gear **329** of the gearbox **326** such that linear actuation of the racks **327** (e.g., see the transition between FIGS. **29** and **30**), rotationally drive the pinion gear **329** to facilitate actuation of the clamping blocks **324** between the non-clamped and clamped positions. As shown in FIG. **29**, at the non-clamped position, the clamping blocks **324** are spaced apart from the tamper-indicating assembly **200**, thereby allowing the assembly **200** to be installed between the clamping blocks **324**. As shown in FIG. **30**, at the clamped position, the

clamping blocks **324** are engaged or clamped against the opposed ends of the TID **200** and around the outer perimeter the pin **250**. In one embodiment, as shown in FIG. **30**, the clamping blocks **324** may be configured to engage around or contact the pin **250** at two separate locations (e.g., first and second contact locations **321**, **323**) to ensure that the pin **250** is maintained coaxially aligned with the bore **238** of the TID **200**.

[0070] The first and second actuator assemblies **304**, **306** may generally be configured to actuate the TID support assembly **302** relative to a main frame or support structure **318** of the tool **300**. For instance, each actuator assembly **304**, **306** may include an actuator **320** (e.g., a pneumatic actuator) coupled between the main support structure **318** and the TID support assembly **302** for actuating the TID support assembly **302** relative to the support structure **318**. For instance, as shown in FIG. **27**, the actuators **320** may be configured to actuate or move the TID support assembly **302** up and down relative to the support structure **318** (e.g., in the direction of arrow **322** shown in FIG. **27**). In one embodiment, each actuator **320** may be a double-acting pneumatic cylinder configured to raise and lower the TID support assembly **302** relative to the support structure **318** between an extended position (FIG. **27**) and a retracted position (see FIG. **31**). In the view of FIG. **27**, the TID support assembly **302** is shown in an extended state (or at the extended position) relative to the support structure **318** such that the TID support assembly **302** (and the tamper-indicating assembly **200** supported therein) are spaced apart from the support structure **318** as well as the pin deformation assembly **314**. However, as will be described below, by actuating the actuators **320** to raise the TID support assembly **302** upwards towards the support structure **318** into a retracted state (or at the retracted position-see FIG. **31**), the tamper-indicating assembly **200** supported within the TID support assembly **320** may be brought into alignment with or otherwise properly positioned relative to the components of the pin deformation assembly **314**, thereby allowing the pin **250** of the tamper-indicating assembly **200** to be subsequently deformed to secure the pin **250** within such assembly **200**.

[0071] The valve assembly **308** may generally be configured to control the flow of pressurized air from the pneumatic manifold assembly **316** to each pneumatic component of the tool **300** (e.g., the clamping actuators **325** of the TID support assembly **302**, the actuators **320** of the actuator assemblies **304**, **306**, the pin actuators **340**, **342** and locking actuator **343** (described below) of the pin deformation assembly **314**, etc.). Additionally, the control box **312** may house various electronic equipment and other electrical components for the tool **300**.

[0072] The robot/tool adapter assembly **310** may generally be configured to allow the installation tool **300** to be coupled to a robotic arm assembly (e.g., a FANUC robotic arm). For instance, the robot/tool adapter assembly **310** may incorporate quick-change components or other features for allowing the tool **300** to be quickly and easily coupled to a robotic arm assembly. For example, the robot/tool adapter assembly **310** may allow the robotic arm assembly to couple itself to the tool **300** without any human interaction, such as by including quick or automatic connect/disconnect features.

[0073] The pin deformation assembly **314** is generally configured to press the pin **250** through the TID **220** and subsequently deform the pin **250** (i.e., by flaring the annular lip **258** outwardly relative to the TID **220**) once the TID **220** has been installed relative to the drum enclosure assembly **100** using the tool **300** (and associated robotic arm assembly). As particularly shown in FIG. **28**, in several embodiments, the pin deformation assembly **314** includes first and second pin actuators **340**, **342** (e.g., pneumatic actuators or cylinders) configured to press the pin **250** into the TID **220** and subsequently deform the pin **250**. As will be described below, when the tamper-indicating assembly **200** is installed onto the drum enclosure assembly **100** via the tool **300** and the TID support assembly **320** is in the retracted position, the pin actuators **340**, **342** are generally configured to be positioned along the opposed ends **254**, **256** of the pin **250** such that respective actuatable components of the pin actuators **340**, **342** (e.g., a push rod **344** of the first pin actuator **340** and a deformation punch assembly **345** of the second pin actuator **346**) can be actuated into

and engage the ends **254**, **256** of the pin **250**. Additionally, in several embodiments, the pin deformation assembly **314** may also include a locking actuator **342** (e.g., a pneumatic actuator or cylinder). As will be described below, the locking actuator **342** may function to lock the push rod **344** of the first pin actuator **340** in place during the pin deformation process to ensure that the pin **250** does not back out of the bore **238** of the TID **220** as the head end **254** of the pin **250** is being deformed by the deformation punch assembly **354** of the second pin actuator **346**.

[0074] Exemplary cross-sectional views of the installation tool **300** are shown in FIGS. **31**-**35**, specifically illustrating the components of the pin deformation assembly **314** (e.g., the pin actuators **340**, **342** and locking actuator **343**) positioned relative to the tamper-indicating assembly **200** during the installation process. Specifically, FIG. **31** generally illustrates a cross-sectional view of the tool **300**, while FIGS. **32**-**35** illustrate enlarged, cross-sectional views of the relative positioning of the components of the pin deformation assembly **314** and the tamper-indicating assembly **200** during the pin installation/deformation process.

[0075] As shown in the cross-sectional view of FIG. **31**, the TID support assembly **302** is disposed at its retracted position relative to the support structure **318** such that the actuatable components of the pin actuators **340**, **342** are positioned along the opposed ends of the pin **250**. Specifically, as shown in the illustrated embodiment, the first pin actuator **340** includes a push rod **344** aligned with and positioned relative to the body end **256** of the pin **250**, with the push rod **344** being coupled to a respective piston **347** of the first pin actuator **340**. As such, by extending the push rod **344** into engagement with the body end **256** of the pin **250** (e.g., via actuation of the corresponding piston **247**), the first pin actuator **340** may be configured to push or press the pin **250** through the bore **238** of the TID **220**. Additionally, as shown in the illustrated embodiment, the second pin actuator **342** includes a deformation punch assembly **345** aligned with and positioned relative to the head end **254** of the pin **250**, with the punch assembly **345** being coupled to a respective piston **349** of the second pin actuator **342** to allow for actuation of the punch assembly **345** relative to the pin **250**. In several embodiments, the punch assembly **345** may generally include an outer deformation punch **351** coupled to the piston **349** and a spring-loaded locating pin **353** positioned or housed within the deformation punch **351**. In such embodiments, by extending the punch assembly **345** into engagement with the head end **254** of the pin **250** (e.g., via actuation of the corresponding piston **349**), the punch assembly **345** may be configured to deform the head end **254** of the pin **250** to secure the pin **250** in place within the TID **220**.

[0076] Additionally, as shown in FIG. **31**, the locking actuator **343** may be oriented perpendicular to the actuation directions of the first and second pin actuators **340**, **342** and may include an actuatable piston **355** and a lock tab **357** coupled to the piston **355**. As described above, the locking actuator **342** may function to lock the push rod **344** of the first pin actuator **340** in place during the pin deformation process. Specifically, the push rod **344** may include an annular locking shoulder **360** extending radially outwardly therefrom that is configured to be engaged by the lock tab **357** when the push rod **344** is moved to an extended position (e.g., as shown in FIG. **33**) to push the pin **250** through the bore **238** of the TID **220**. For example, as shown in FIGS. **31** and **32**, when the push rod **344** is at its initial retracted position, the locking shoulder **360** may be positioned on the non-TID side of the locking actuator **343** (e.g., to the right of the lock tab **357**). However, when the push rod **344** is actuated to push the pin **250** through the bore **238**, the locking shoulder **360** shifts to the TID side of the locking actuator **343** (e.g., to the left of the lock tab **357**). At such position, the locking actuator **243** may be actuated (e.g., in the direction shown by arrow **362** in FIG. **33**) so that the locking tab **357** engages against the back end of the locking shoulder **360**, thereby preventing the push rod **344** from retracting as the second pin actuator **342** is being actuated against the pin **250** to deform the lip **258**.

[0077] As particularly shown in the transition between FIGS. **32** and **33**, when initially pressing the pin **250** into the TID **220**, the first pin actuator **340** may be actuated such that the push rod **344** is pushed into the body end **256** of the pin **250** (e.g., in a first actuation direction indicated by arrow

364 in FIG. **33**), thereby pressing the pin **250** through the bore **238** until the body **252** contacts or engages against the inner side of the second side wall **242** of the mid body portion **224** of the TID **220**, at which point the head end **254** of the pin **250** is exposed along the opposed outer side of the second side wall **242** of the mid body portion **224** of the TID **220**. In this regard, it should be appreciated that the pin **250** may be positioned in a partially installed state relative to the TID **220** when the tamper-indicating assembly **200** is initially picked-up and clamped by the tool **300** (e.g., via the TID support assembly **302**). For instance, as shown in FIG. **32**, the pin **250** may be initially installed relative to the TID **220** such that the pin **250** is received within the first portion **238***a* of the bore **238** but does not extend outwardly into the cavity **222** of the TID **220**, thereby allowing the TID **220** to be installed relative to the closure bolt **120** and flanged ends **108**, **110** of the lid ring **106** of the drum enclosure assembly **100**.

[0078] Once the pin **250** has been pressed fully into the bore **238**, the push rod **344** of the first pin actuator **340** is maintained in engagement against the body end **256** of the pin **250** via the operation of the locking actuator **343** (e.g., via the locking engagement between the locking tab/shoulder **357**, **360**) while the deformation punch assembly **345** of the second pin actuator **342** is actuated into and against the head end **254** of the pin **250** (e.g., in a second actuation direction indicated by arrows **366** in FIGS. **34** and **35**), thereby allowing the pin to be "compressed" between the push rod **344** and the punch assembly **345** of the first and second pin actuators **340**, **342**, respectively. As particularly shown in the transition between FIGS. **33** and **34**, upon initial actuation of the punch assembly **345** in the second actuation direction **366**, the spring-loaded locating pin **353** may initially contact the head end **254** of the pin **250** to ensure that the punch assembly **345** is properly aligned with the pin **250**. Specifically, as shown in FIGS. **33** and **35**, a locating end **356** (FIG. **33**) of the pin **353** may be configured as a pointed end (e.g., having a pyramidal shape) that is configured to be received within the complementarily shaped locating notch **261** defined in the bottom end of the cavity **260** of the head end **254** of the pin **250**. Such engagement between the locating pin **353** and the pin **250** (i.e., via the locating notch **261**) ensures proper alignment and centering of the pin **250** relative to the punch assembly **345** (particularly the outer deformation punch **351** of the assembly **345**).

[0079] As particularly shown in the transition between FIGS. **34** and **35**, upon further actuation of the punch assembly **345** in the second actuation direction **366**, the deformation punch **351** of the assembly **345** is configured to be brought into contact with the annular lip **258** of the head end **254** of the pin **250**, thereby allowing the punch **351** to deform or flare the lip **28** radially outwardly. For example, as shown in FIG. **34**, a conical-shaped distal end **370** of the punch **351** may be configured to include a short conical portion extending from the distal end **370** to a deflection shoulder **372** of the punch **351**, with the deflection shoulder **372** being generally oriented perpendicular to the actuation direction **366**. As shown in the illustrated embodiment, the conical-shaped distal end **370** of the punch **351** defines an outwardly tapered or ramped profile such that the diameter of the punch **351** increases as the punch **351** extends away from its distal end **370** towards the deflection shoulder **372**. In such an embodiment, as the punch **351** is being actuated into engagement with the head end **251** of the pin **250**, the distal end **370** of the punch **351** may be received within the cavity **260** defined at the head end **241** of the pin **250** (e.g., at a location adjacent to the inner perimeter of the annular lip **258**) such that the lip **258** contacts the tapered or ramped profile of the distal end **370**, thereby causing the lip **258** to begin to flare outwardly as the lip **258** rides radially outwardly along such tapered or ramped profile. As the punch **351** is further actuated relative to the pin **259** in the second actuation direction **366**, the lip **258** contacts the deflection shoulder **372** of the punch **351** extending radially outwardly from the distal end **370** of the punch **351**, which causes the lip **258** to be deformed radially outwardly as it rides along the deflection shoulder **372**. For example, as shown in FIG. **35**, the lip **258** may have a tendency to curl outwardly as the distal end **370** of the punch **351** is pressed further against the pin **250** due to the contact between the lip **258** and the deflection shoulder **372** of the punch **351**. As described above with reference to FIGS. **24**-**26**, in

this deformed state, the lip **258** may radially overlap with the retention should **245** defined by the second side wall **242** of the TID **220**, thereby locking the pin **250** in place within the TID **220**. Upon deforming the lip **258** to such deformed state, the push rod **344** and punch assembly **345** of the first and second pin actuators **340**, **342**, respectively, may be retracted (e.g., via retraction of the respective pistons **347**, **349** of the actuators **340**, **342**) away from the tamper-indicating assembly **200** (e.g., to the initial positions shown in FIG. **31**).

[0080] FIGS. **36-39** illustrate various views of the installation tool **300** and a drum enclosure assembly **100** during the TID installation process. The general installation process will now be described with reference such figures. Additionally, FIGS. **36-39** generally illustrate various views of one embodiment of a system **400** for installing a tamper-indicating assembly **200** relative to a drum enclosure assembly in accordance with aspects of the present subject matter.

[0081] Initially, the installation tool **300** (as equipped or installed on an associated robotic arm assembly **402** (indicated by dashed lines) of the system **400**) picks-up a tamper-indicating assembly **200** (including the TID **220** and the pin **250** partially installed relative to the TID **220**). For example, the robotic arm assembly **402** may be used to position the installation tool **300** relative to the tamper-indicating assembly **200** such that the clamp blocks **324** of the TID support assembly **302** are positioned along the opposed ends or sides of the tamper-indicating assembly **200**. The clamp blocks **324** may then be pneumatically actuated to clamp the tamper-indicating assembly **200** therebetween. The robotic arm assembly **402** and the installation tool **300** are then used to install the tamper-indicating assembly **200** relative to the drum enclosure assembly **100**, i.e., by positioning the TID **220** relative to the flanged ends **108**, **110** of the lid ring **106** and the closure bolt **120** such that the flanged ends **108**, **110** and the bolt **120** are received within the cavity **222** of the TID **220** (e.g. (1) with the flanged ends **108**, **110** being positioned between the radial walls/portions **232**, **236** of the first and second arms **226**, **228** of the TID **220**; and (2) with the head **122** of the bolt **120** being positioned adjacent to the radial wall **232** of the first arm **226** and the body of the bolt **120** extending through both the mid body portion **224** of the TID **220** and the radial portion **236** of the second arm **226** of the TID **220**). In positioning the tamper-indicating assembly **200** relative to the drum enclosure assembly **100**, the robotic arm assembly **402** may be configured to orient the installation tool in the orientation shown in FIGS. **36** and **37**. Specifically, the robotic arm assembly **402** is configured to initially position the tool **300** (in the orientation shown in FIGS. **36** and **37**) relative to the drum enclosure assembly **100** such that the tamper-indicating assembly **200** is positioned immediately below the closure bolt **120** and flanged ends **108**, **110** of the lid ring **106**. The robotic arm assembly **402** may then raise the installation tool **300** (and the tamper-indicating assembly **200** supported thereby) such that the closure bolt **120** and flanged ends **108**, **110** are received within the cavity **222** of the TID **220** (which is unobstructed given the partially installed state of the pin **250**)

[0082] As shown in the transition from FIG. **37** to FIG. **38**, once the TID **220** has been installed relative to the closure bolt **120** and flanged ends **108**, **110**, the robotic arm assembly **402** may be configured to reorient the installation tool **300** relative to the drum enclosure assembly **100** to the orientation shown in FIG. **38**, thereby providing clearance for the pin deformation assembly **314** to be positioned relative to the opposed ends of the pin **250**. Thereafter, as shown in the transition from FIG. **38** to FIG. **39**, the actuators **320** of the first and second actuator assemblies **304**, **306** of the tool **300** may be actuated to lower the pin deformation assembly **314** (and the remainder of the tool **300**) relative to the TID support assembly **302** (and the tamper-indicating assembly **200** supported thereby). As described above, the first actuator **342** of the pin deformation assembly **314** is then used to press the pin **250** through the TID **220** (i.e., by pressing the pin **250** through the bore **238** of the TID **220** such that the head end **254** of the pin **250** is exposed along the exterior of the second side wall **242** of the mid body portion **224** of the TID **220**). The second actuator **344** of the pin deformation assembly **314** is then used to deform the head end **254** of the pin **250** relative to the TID **220** (i.e., by flaring the annular lip **258** of the pin **250** radially outwardly relative to the second

side wall **242** of the mid body portion **224** of the TID **220** using the punch assembly **345**), thereby locking the pin **250** in place relative to the TID **220**. In one embodiment, the installation tool **300** (and/or the robotic arm assembly **402** associated therewith) may then be used to capture an image of the serial number located on the pin **250** and store such image together with other data related to the drum enclosure assembly **100** within a data package. This information can then be subsequently verified when the tamper-indicating assembly **200** is ultimately removed when reopening the drum enclosure assembly **100**.

[0083] It should be appreciated that, to allow the installation tool **300** to be properly maneuvered/positioned relative to the drum enclosure assembly **100**, the robotic arm assembly **402** is generally required to perform complex maneuvers. In one embodiment, the robotic motion and associated pneumatic process may be hard-coded and a vision process (including associated cameras) may be used to precisely locate the bolt **120** of the drum enclosure assembly **100**. The hard-coded robot motions may then be offset based on the position of the bolt **120** found via the vision process to ensure that the tool **300** is positioned/moved properly relative to the drum enclosure assembly **100** in a manner to permit the bolt **120** and flanged ends **108**, **110** of the lid ring **106** to be received within the TID **220**.

[0084] Additionally, it should be appreciated that various sensors may be utilized during the installation process. Sensors in the tool **300** (including in the pneumatic cylinders) prevent the robot from transitioning to the next phase in the process until each step has been verified; this verification enhances the reliability of the application without excessive additions to process time. In this regard, multiple sensors may be utilized throughout the process, including an inductive sensor to ensure the TID **220** is in the proper position before deformation and sensors embedded along the pneumatic cylinders to confirm the pin **250** is compressed properly. With this sensor feedback, physical verification is present throughout the application process.

[0085] Moreover, in several embodiments, methods of verification are measured to ensure the successful application of the tamper-indicating assembly **200** (e.g., due to security requirements). For example, once the tamper-indicating assembly **200** is applied with no negative sensor feedback, the robotic arm assembly **402** may be configured to change tools from the TID installation tool **300** to a laser profiler or scanner (e.g., a Keyence laser profiler). The scanner may be used to pass over the tamper-indicating assembly **200** to verify that the pin **250** is present and to collect/record the TID serial identification for the data package. Moreover, the laser may be used to scan the deformed end of the pin **250** to ensure a proper seal. By identifying the diameter of the depressed pin **250**, automated software may be used to determine if the pin **250** was properly flared during installation. In one embodiment, this software program can function to recognize both whether the pin **250** was fully compressed using a predetermined diameter tolerance and if a section of the pin **250** did not flare out properly using a flaw detection algorithm on the circle. In one embodiment, to pass the verification process, the inspection must meet both metrics. This verification gives a benchmark reference for the manual inspection of the tamper-indicating assembly **200** upon the subsequent receipt of the drum enclosure assembly **100** within a secured facility.

[0086] Referring now to FIGS. **40**-**42**, different views of one embodiment of a manual TID installation tool **500** are illustrated in accordance with aspects of the present subject matter. Specifically, FIG. **40** illustrates a perspective view of the manual tool **500** while FIG. **41** illustrates a side view of the tool **500** positioned relative to the tamper-indicating assembly **200** to allow the tool **500** to be used to deform the pin **250**. Additionally, FIG. **42** illustrates a cross-sectional side view of the tool **500** and the tamper-indicating assembly **200** shown in FIG. **41**, particularly illustrating details of a deformation punch assembly **545** of the manual tool **500**.

[0087] As shown in FIGS. **40** and **41**, the tool **500** includes a main tool body **501**, first and second handles **503**, **505** and a deformation punch assembly **545** coupled to the second handle **505**. The first handle **503** is secured to the main body **501** (e.g., by being non-movably coupled to the body **501**). The second handle **505** is pivotably coupled to the tool body **501** at a pivot joint **507** such that

movement of the second handle **505** towards the first handle **503** (e.g., by squeezing the handles **503**, **505** together) results in the punch assembly **545** being actuated in an actuation direction (indicated by arrow **509** in FIGS. **40**-**42**).

[0088] In general, the punch assembly **545** may be configured the same as or similar as the punch assembly **345** described above with reference to the robotic installation tool **300**. For instance, as shown in FIG. **42**, the punch assembly **545** may generally include an outer deformation punch **551** coupled to the second handle **505** (e.g., via a lever portion **511** extending from the pivot joint **507** and a punch drive **513**) and a spring-loaded locating pin **553** positioned or housed within the deformation punch **551**. The **551** punch and locating pin **553** may generally be configured the same as or similar to the punch **351** and locating pin **353** described above. Thus, as the punch assembly **545** is being actuated in the actuation direction **509** towards the head end **254** of the pin **250**, the locating pin **553** may initially be configured to be received within the locating notch **261** of the pin **250**, thereby ensuring proper alignment of the punch assembly **545** with the pin **250**. Thereafter, further actuation of the punch assembly **545** in the actuation direction **509** results in the annular lip **258** of the pin **250** being deformed outwardly to secure the pin **250** in place within the TID **220**.

[0089] In addition, the tool **500** includes support structure for supporting the TID **220** and the pin **250** relative to the tool **500** during the deformation process. For instance, as particularly shown in FIGS. **40** and **41**, the tool **500** may include a cradle **515** extending outwardly from the tool body **501** that includes first and second cradle portions **517**, **519** configured to retain the TID/pin **220**, **250** relative to the tool **500** during the deformation process. In several embodiments, the first cradle portion **517** may be configured to function as an endstop for the body end **256** of the pin **250** while also supporting the TID **220** relative to the tool **500**. For instance, as shown in FIG. **40**, the first cradle portion **519** defines a pin cavity **521** for receiving the body end **256** of the pin **250** and a support ledge **523** on top of which the TID **220** is configured to be supported. Moreover, the second cradle portion **519** may define a pin slot **525** configured to cradle or extend around a portion of the pin **250** extending between its opposed ends **254**, **256**. For instance, as shown in FIGS. **41** and **42**, with the TID/pin **220**, **250** positioned relative to the tool **500**, the second cradle portion **519** may wrap around a portion the pin **250** and extend partially into the cavity **222** of the TID **220**. As shown in the illustrated embodiment, the tool **500** may also include support structure for the punch assembly **545** as it is being actuated in the actuation direction **509** (e.g., as the handles **503**, **505** are being squeezed together). For instance, as particularly shown in FIGS. **40**-**42**, the tool **500** may include a punch guide **555** extending outwardly from the main body **501**, with the punch guide **555** defining a through-hole for receiving the punch assembly **545**. As such, during actuation of the tool **500**, the punch assembly **545** may slide through the punch guide **555** to ensure that the punch assembly **545** is maintained in proper alignment with the pin **250**.

[0090] To install the tamper-indicating assembly **200** using the tool **500**, the tamper-indicating assembly **200** may be initially installed relative to the drum enclosure assembly **100**, such as by manually positioning the TID **220** relative to the closure bolt **120** and flanged ends **108**, **110** of the lid ring **106** and then inserting the pin **250** through the bore **238** of the TID **220**. The tool **500** may then be positioned relative to the tamper-indicating assembly **200** such that the body end **256** of the pin **250** is received within the pin cavity **521** of the first cradle portion **517** and a separate portion of the pin **250** is received within the pin slot **525** of the second cradle portion **519**. With the head end **254** of the pin **250** exposed along the outer side of the second side wall **242** of the TID **220**, the punch assembly **545** may be actuated in the actuation direction **509** by squeezing the handles **503**, **505** to deform the annular lip **258** of the pin **250** outwardly. In doing so, the first cradle portion **517** may function as an endstop to retain the body end **256** of the pin **250** in place as the punch assembly **545** is being actuated into the head end **254** of the pin **250** to deform the lip **258**.

[0091] This written description uses examples to disclose the technology, including the best mode, and also to enable any person skilled in the art to practice the technology, including making and using any devices or systems and performing any incorporated methods. The patentable scope of

the technology is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they include structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

Claims

1. A system for installing tamper-indicating assemblies relative to drum enclosure assemblies, the system comprising: a drum enclosure assembly including a lid ring extending from a first flanged end to a second flanged end, the drum enclosure assembly further including a closure bolt extending through the first and second flanged ends; a tamper-indicating device (TID) defining a cavity configured to receive at least a portion of the closure bolt and the first and second flanged ends of the lid ring, the TID defining a bore relative to the cavity; a pin configured to extend through the bore of the TID and across the cavity of the TID, the pin including a pin body extending from a body end to a head end; an installation tool for installing and securing the pin relative to the TID, the installation tool comprising: a support assembly configured to support the TID; a pin deformation assembly having first and second pin actuators, the first pin actuator being configured to push the pin through the bore of the TID, the second pin actuator being configured to deform the head end of the pin relative to the TID.
2. The system of claim 1, wherein the TID includes a first side wall and a second side wall and wherein the bore includes a first bore portion defined through the first side wall and a second bore portion defined through the second side wall, the pin being configured to extend through the first bore portion across the cavity and into the second bore portion.
3. The system of claim 2, wherein the first pin actuator is configured to be actuated such that a push rod of the first pin actuator contacts the body end of the pin and pushes the pin through the first bore portion across the cavity and into the second bore portion in an installation direction.
4. The system of claim 3, wherein the pin deformation assembly further comprises a locking actuator configured to lock the push rod in place relative to the TID to prevent movement of the pin in a removal direction opposite the installation direction while the second pin actuator is being actuated to deform the head end of the pin.
5. The system of claim 2, wherein the second bore portion of the bore is sized such that the head end of the pin body is configured to be received within the second bore portion but at least a portion of the pin body extending from the head end is not configured to be received within the second bore portion, the first pin actuator being configured to push the pin through the bore until the at least a portion of the body contacts against an inner side of the second side wall and the head end of the pin is exposed along an opposed, outer side of the second side wall.
6. The system of claim 5, wherein the second pin actuator is configured to deform the head end of the pin such that a deformed portion of the head end is configured to engage at least a portion of the outer side of the second side wall.
7. The system of claim 1, wherein the head end of the pin includes an annular lip defining a cavity at the head end of the pin, the second pin actuator being configured to deform the annular lip radially outwardly relative to an adjacent portion of the TID.
8. The system of claim 7, wherein the second pin actuator comprises a deformation punch configured to be actuated relative to the head end of the pin to deform the annular lip radially outwardly relative to the adjacent portion of the TID.
9. The system of claim 8, wherein the second pin actuator comprises a spring-loaded locating pin housed within the deformation punch, the locating pin configured to be received within the cavity as the deformation punch is being actuated relative to the head end of the pin.
10. The system of claim 9, wherein the pin defines a locating notch within a portion of the cavity, the locating pin configured to be received within the locating notch as the deformation punch is

being actuated relative to the head end of the pin.

11. The system of claim 1, wherein the support assembly comprises first and second clamping blocks movable between an unlocked position, at which the first and second clamping blocks are spaced apart from the TID, and a locked position, at which the first and second clamping blocks are engaged against the TID.

12. The system of claim 11, wherein, at the locked position, the first and second clamping blocks are further configured to engage at least a portion of the pin.

13. The system of claim 1, further comprising a robotic arm coupled to the installation tool and being configured to position the installation tool relative to the drum enclosure assembly.

14. A method for installing a tamper-indicating assembly relative to a drum enclosure assembly, the drum enclosure assembly including a lid ring extending from a first flanged end to a second flanged end and a closure bolt extending through the first and second flanged end, the tamper-indicating assembly including a tamper-indicating device (TID), the method comprising: supporting, with an installation tool, the tamper-indicating assembly relative to the drum enclosure assembly such that at least a portion of the closure bolt and the first and second flanged ends of the lid ring are received within a cavity of the TID; inserting, with the installation tool, a pin of the tamper-indicating assembly through a bore of the TID and across the cavity of the TID; deforming, with the installation tool, a portion of the pin relative to the TID to secure the pin within the bore of the TID.

15. The method of claim 14, wherein the pin extends from a head end to a body end, wherein the TID includes a first side wall and a second side wall and wherein the bore includes a first bore portion defined through the first side wall and a second bore portion defined through the second side wall, wherein inserting the pin comprises contacting the body end of the pin to push the pin through the first bore portion across the cavity and into the second bore portion in an installation direction.

16. The method of claim 15, further comprising locking the push rod in place relative to the TID to prevent movement of the pin in a removal direction opposite the installation direction while the portion of the pin is being deformed relative to the TID.

17. The method of claim 15, wherein the second bore portion of the bore is sized such that the head end of the pin body is configured to be received within the second bore portion but at least a portion of the pin body extending from the head end is not configured to be received within the second bore portion, wherein inserting the pin further comprises pushing the pin through the first bore portion across the cavity and into the second bore portion in the installation direction until the at least a portion of the body contacts against an inner side of the second side wall and the head end of the pin is exposed along an opposed, outer side of the second side wall.

18. The method of claim 17, wherein deforming the portion of the pin relative to the TID comprises deforming the head end of the pin such that a deformed portion of the head end is configured to engage at least a portion of the outer side of the second side wall.

19. The method of claim 14, wherein the pin extends from a head end to a body end, the head end of the pin including an annular lip defining a cavity at the head end of the pin, wherein deforming the portion of the pin comprises deforming the annular lip radially outwardly relative to an adjacent portion of the TID.

20. The method of claim 19, wherein deforming the annular lip comprises: actuating a punch assembly relative to the pin such that a locating pin of the punch assembly is received within the cavity defined at the head end of the pin, the locating pin being housed within a punch of the punch assembly; further actuating the punch assembly such that the punch deforms the annular lip radially outwardly relative to the adjacent portion of the TID.