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(54) **METHOD AND SYSTEM FOR ON-DEMAND
RETAINING RING FORMING AND
INSTALLATION**

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(57) **ABSTRACT**

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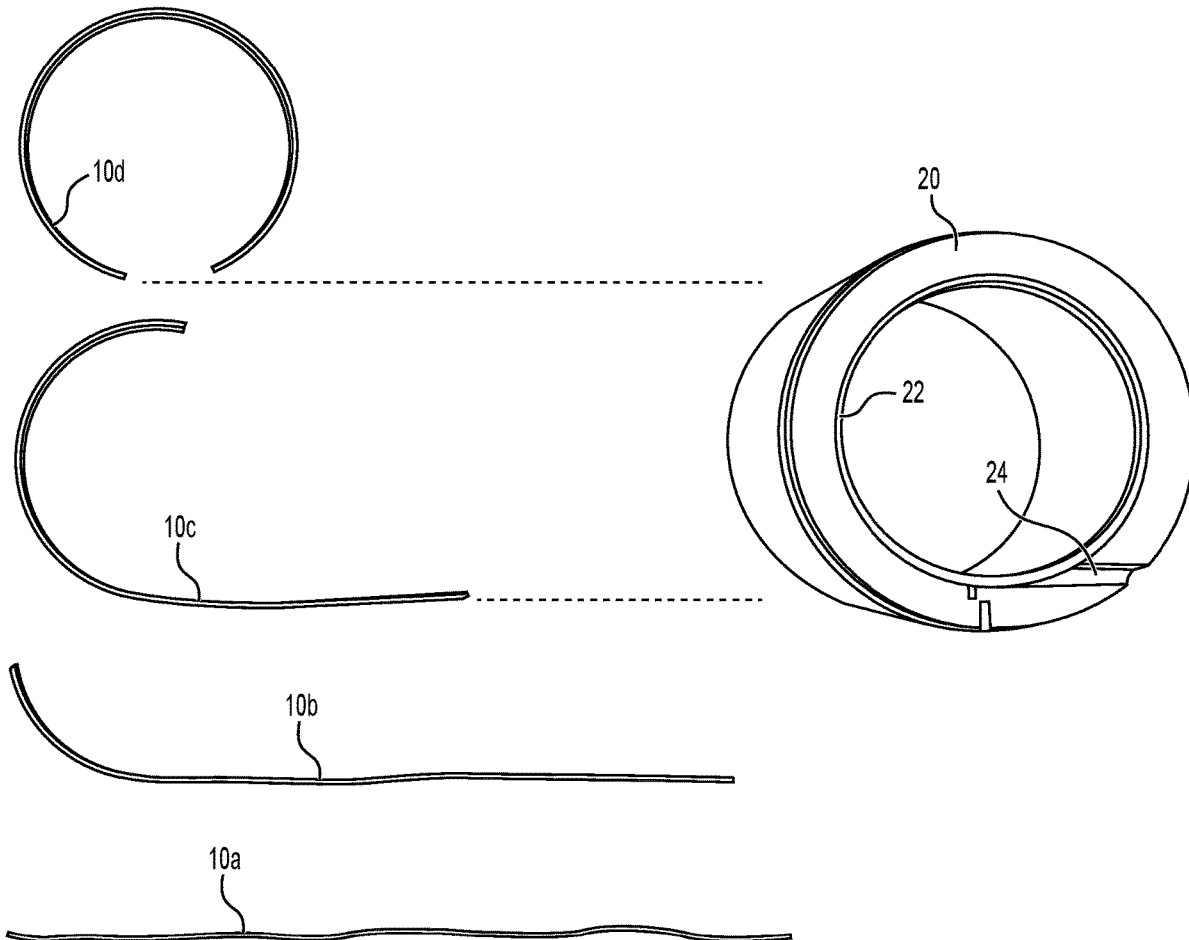
A method for forming and installing a retaining ring comprises: feeding a wire in a linear path into a forming die having a circular bore; forming, using the forming die, the wire into a formed ring having a ring shape; transferring the formed ring from the forming die to a transfer puck; and installing the formed ring, as a retaining ring, in a tube of a product assembly. The formed ring is maintained in a constrained state between forming in the forming die and installation in the product assembly. A system for forming and installing a retaining ring into a product assembly includes a forming die configured to form a wire into a formed ring having a ring shape; and a transfer puck to transfer the formed ring from the forming die. The formed ring is maintained in a constrained state from forming through installation.

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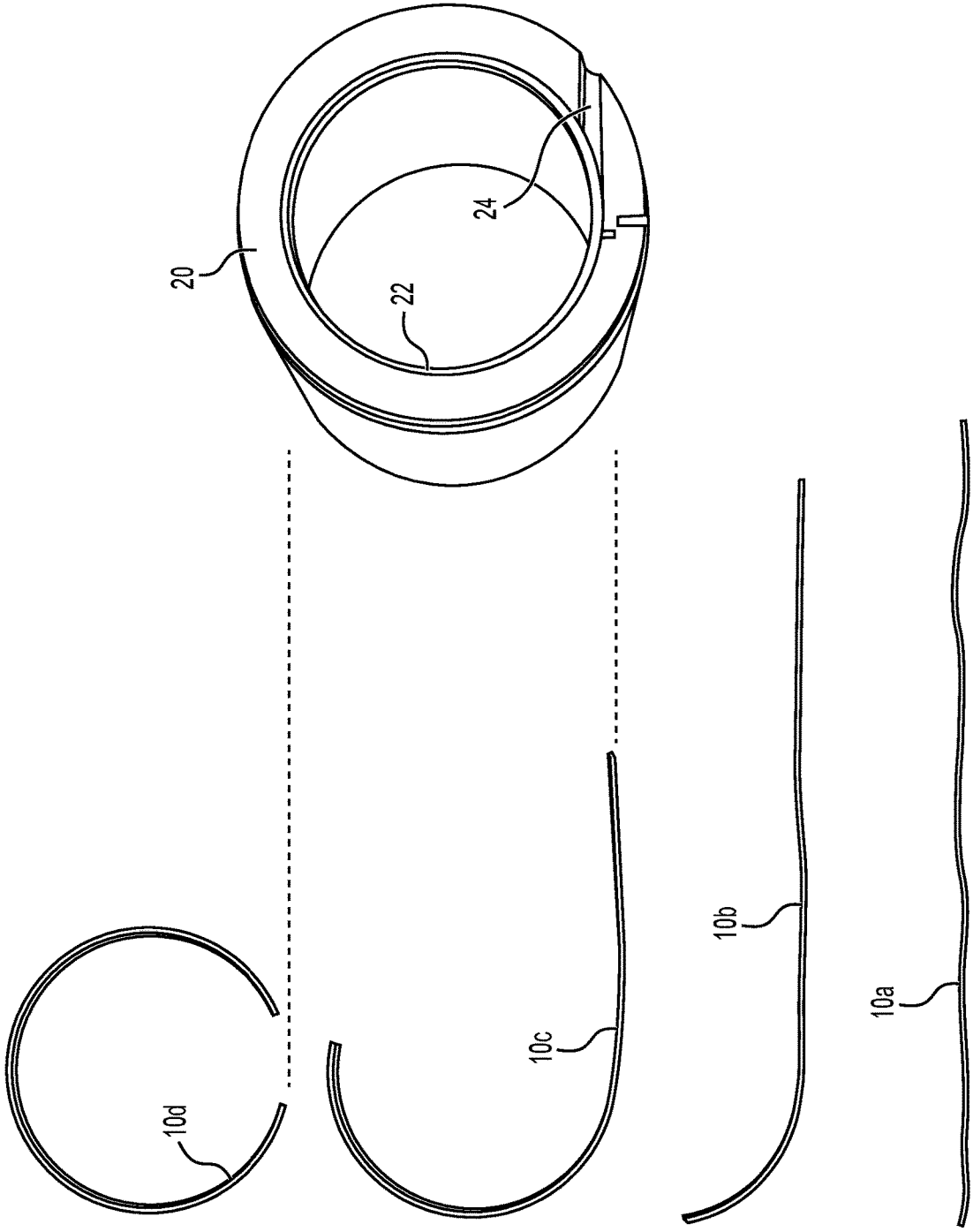


FIG. 1

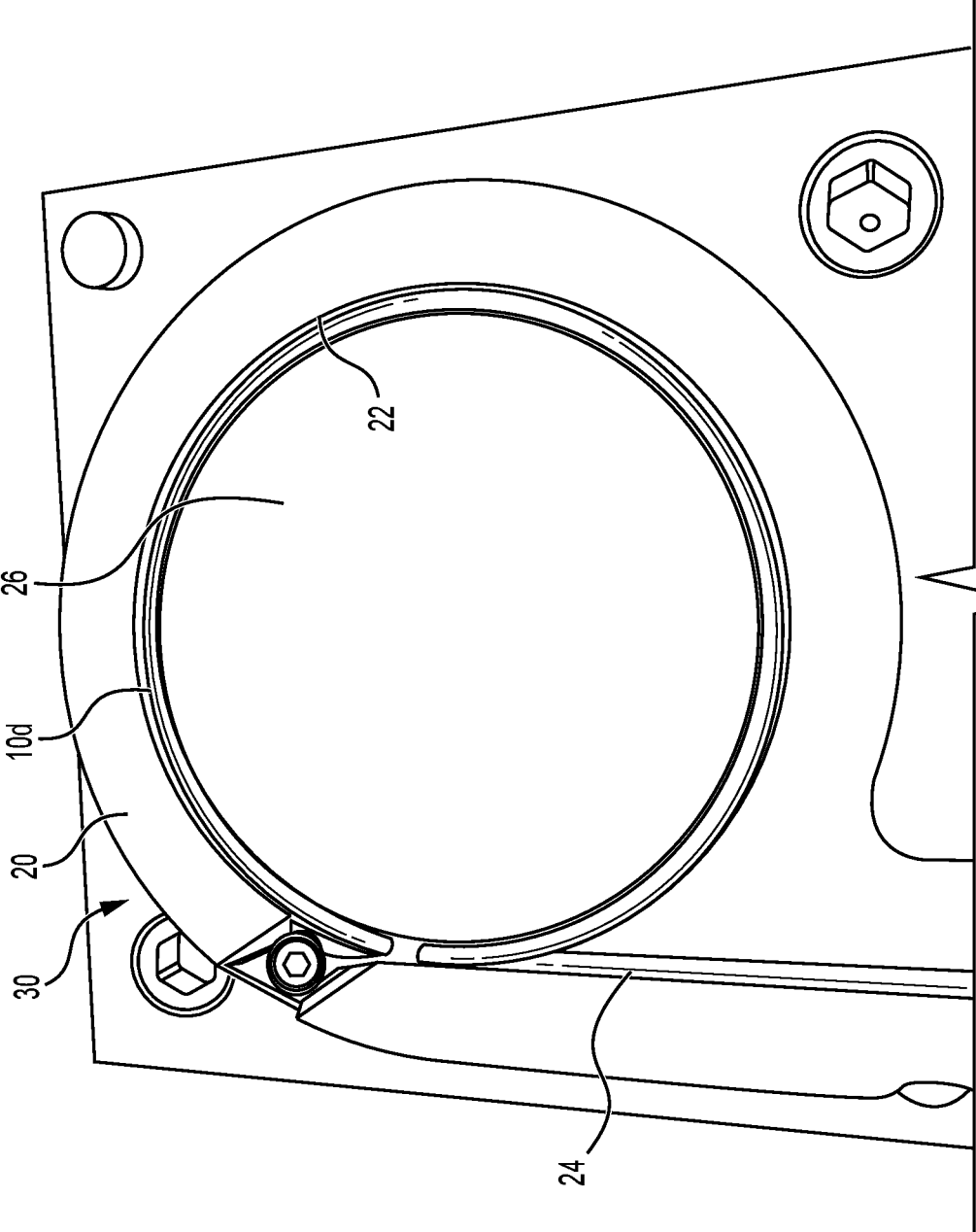


FIG. 2

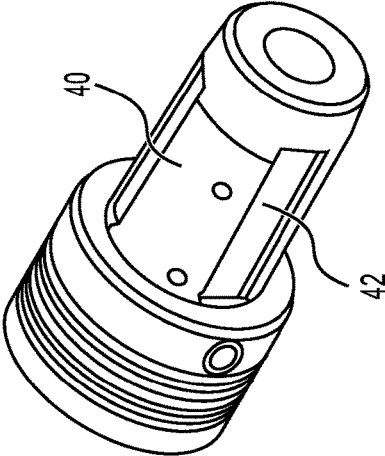


FIG. 3

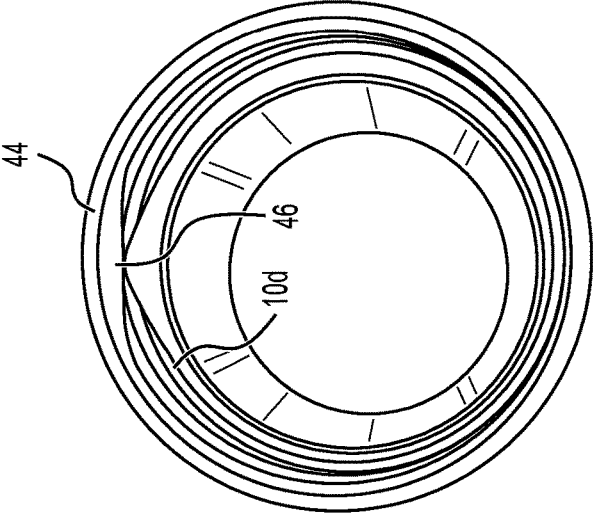


FIG. 4A

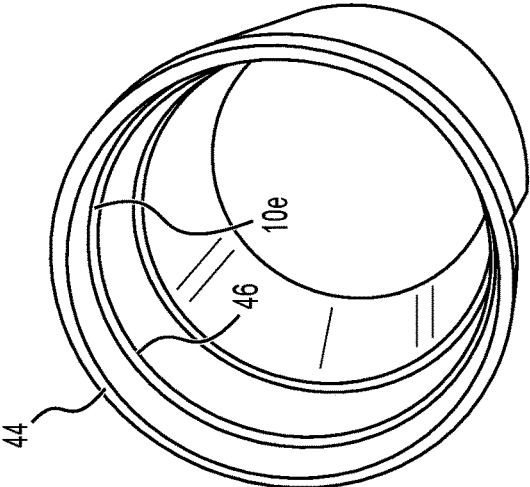


FIG. 4B

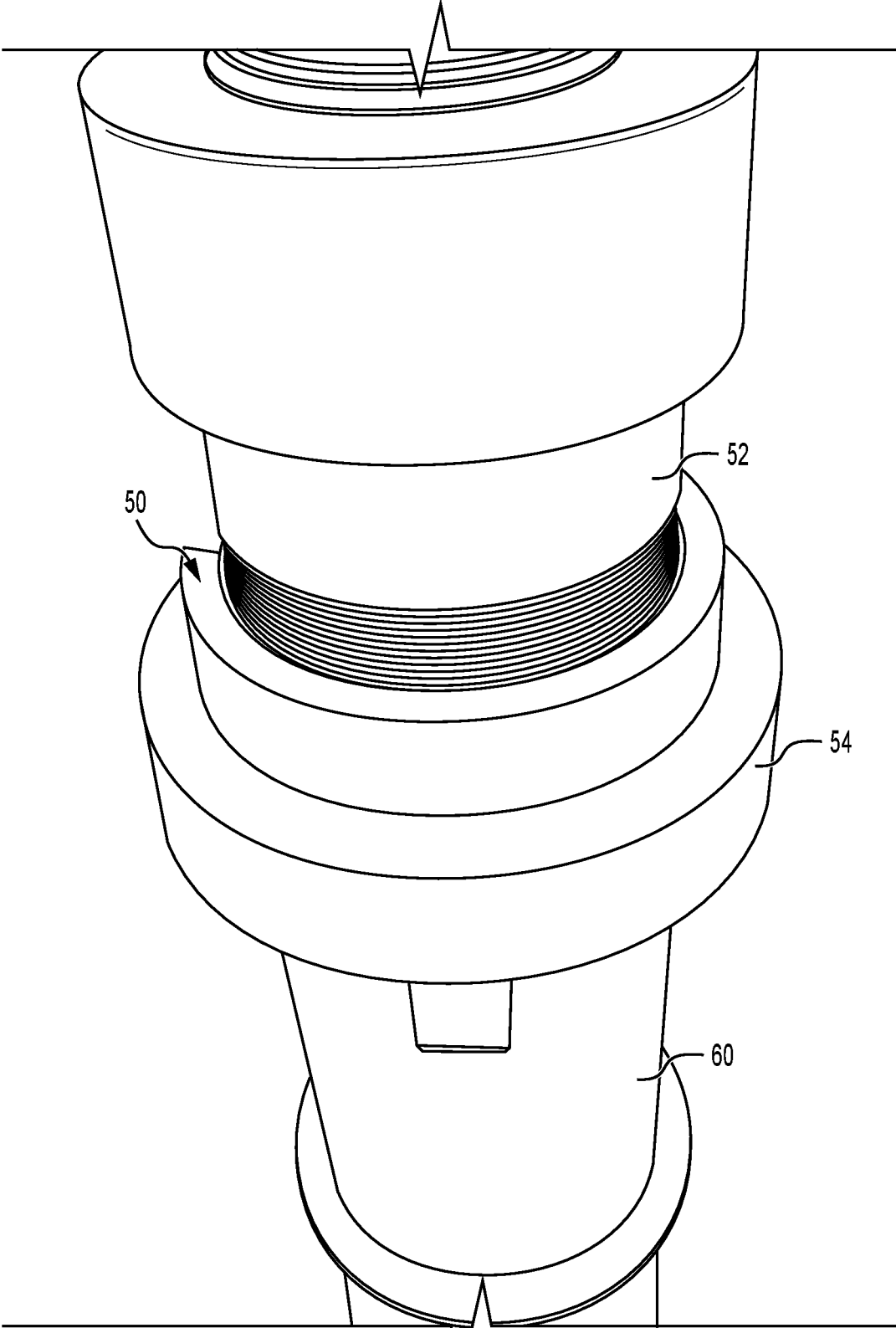


FIG. 5

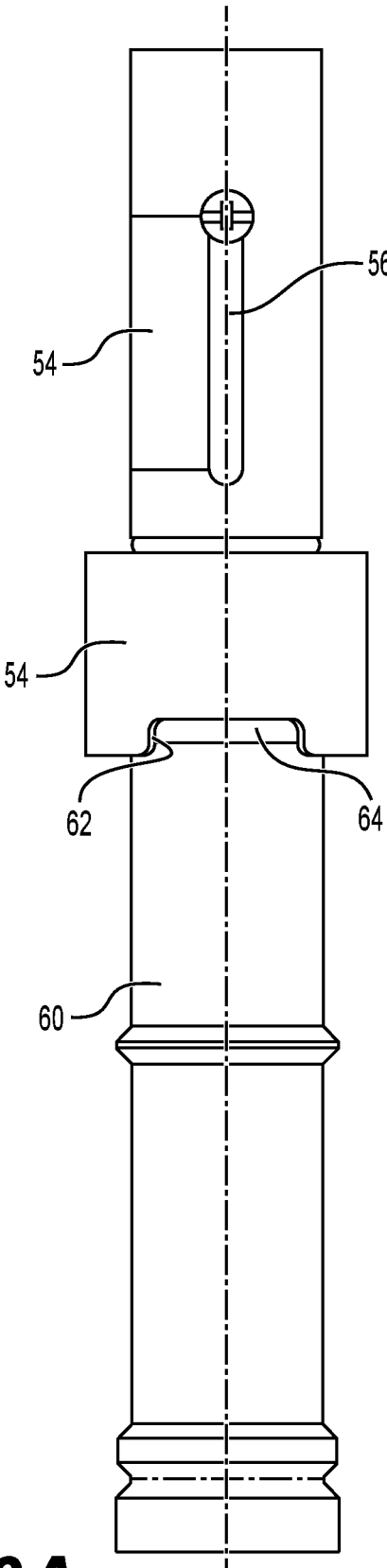


FIG. 6A

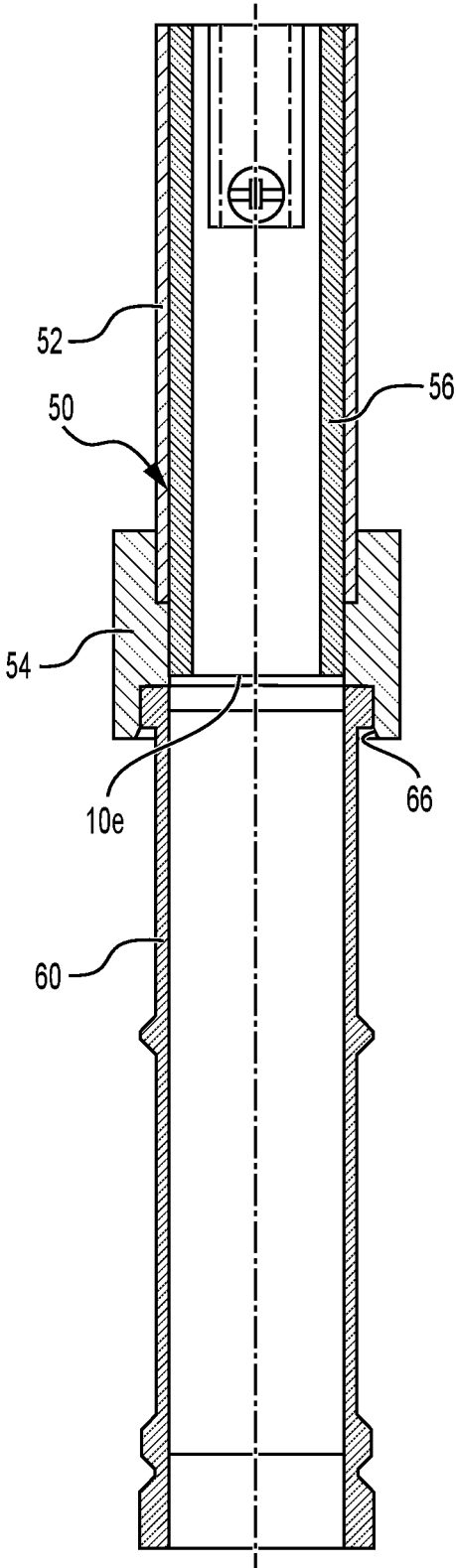


FIG. 6B

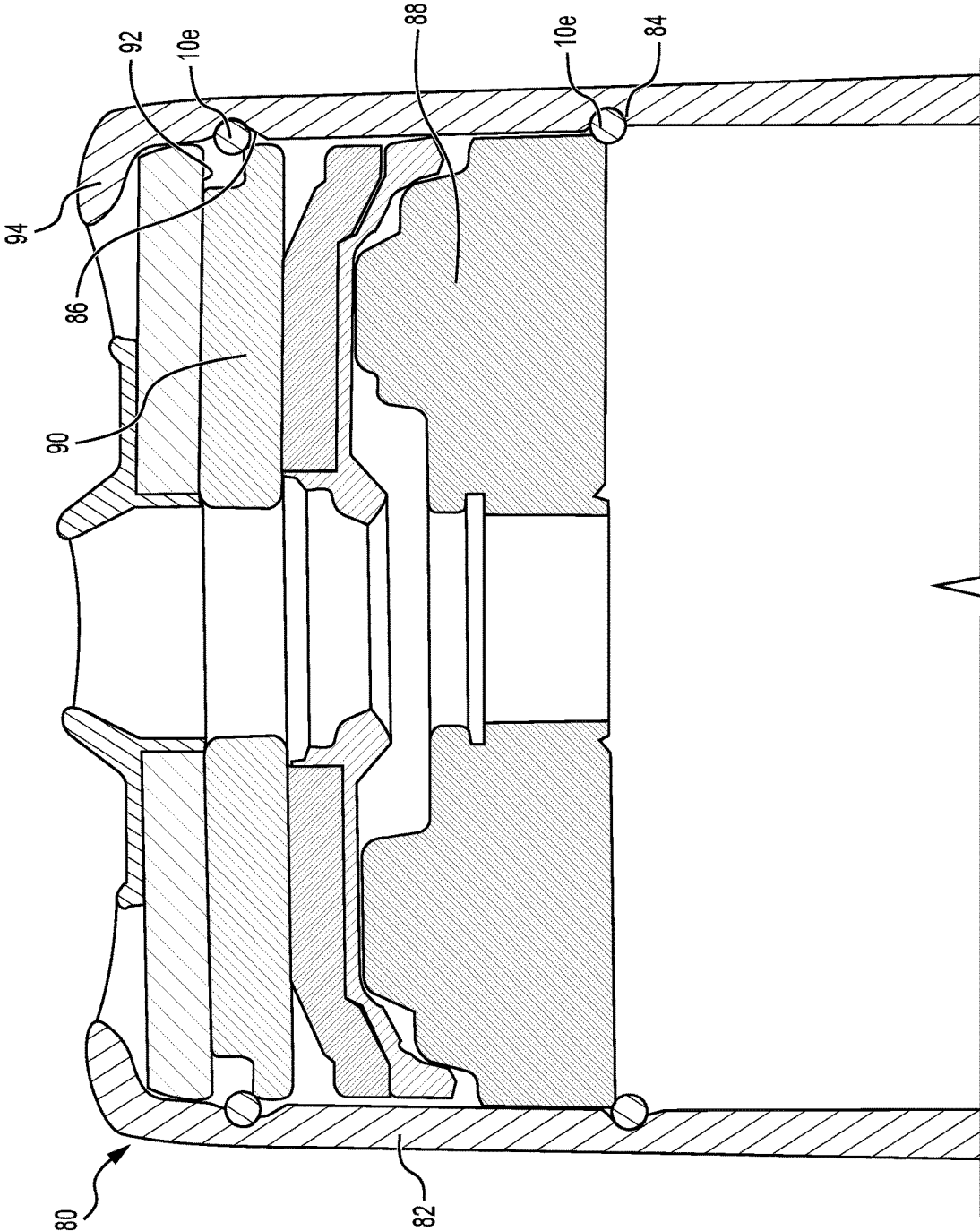


FIG. 7

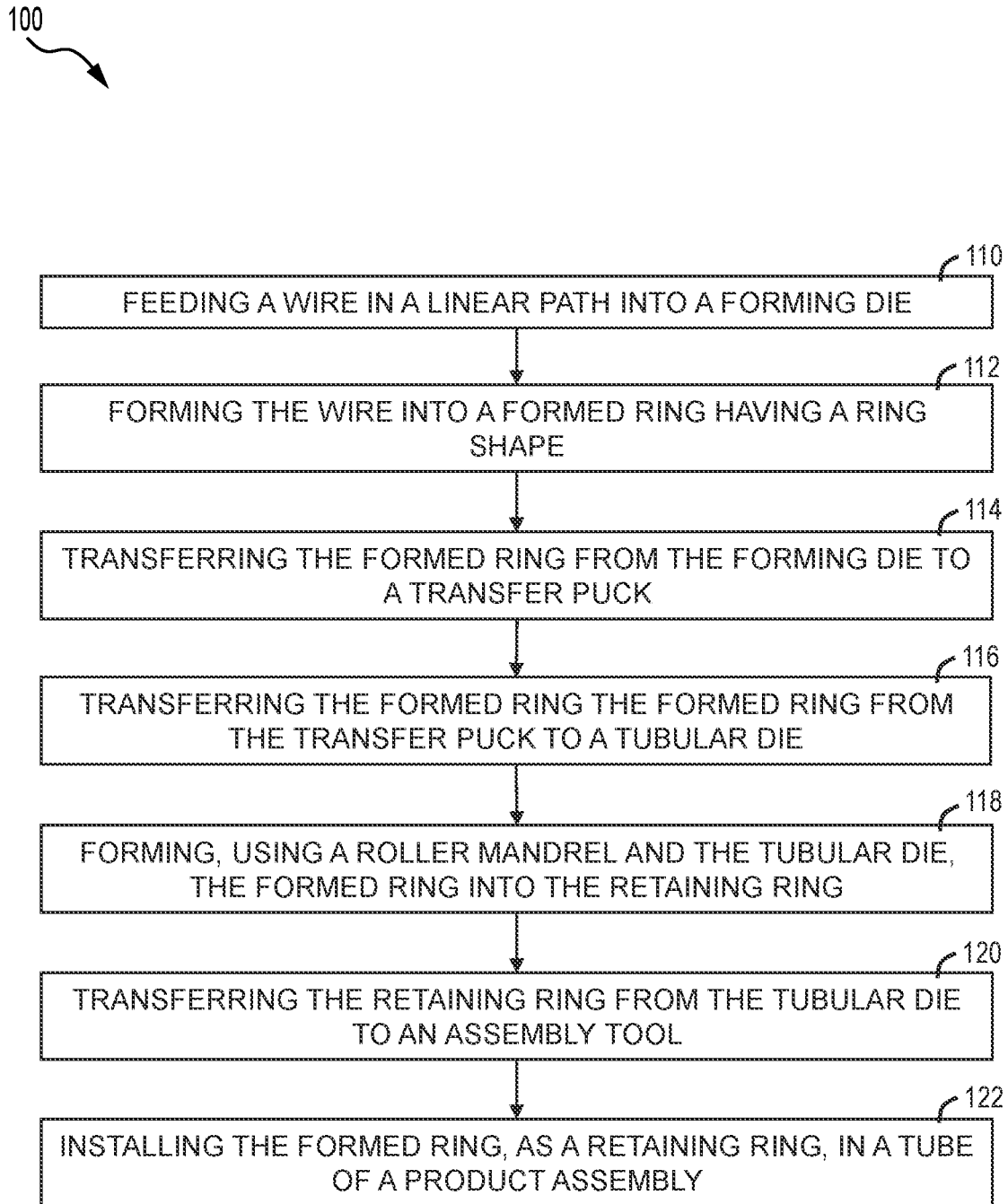


FIG. 8

METHOD AND SYSTEM FOR ON-DEMAND RETAINING RING FORMING AND INSTALLATION

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present disclosure relates generally to systems and methods for forming and installing retaining rings. More specifically, the present disclosure relates to an on-demand method and system for forming retaining rings as needed for installation in a manufactured assembly.

2. Related Art

[0002] Conventional solutions for assembling retaining rings may include forming a length of wire using a die. Retaining rings are typically manufactured separately from their installation in a manufactured assembly, such as a damper tube for a shock absorber.

[0003] Shipping density and storage of retaining rings can cause variation of dimensions. Detangling, aligning, loading and gaging of retaining rings on mandrels prior to installation can be very labor intensive. Automated singulation and alignment of retaining rings requires precise escapement and gripper alignment for retainer rings in an unconstrained state. Furthermore, once the retainer rings are in an unconstrained state, flatness, roundness and/or orientation may need to be re-established during material handling.

SUMMARY OF THE INVENTION

[0004] The present disclosure provides a method for forming and installing a retaining ring. The method comprises: feeding a wire in a linear path into a forming die having a circular bore; forming, using the forming die, the wire into a formed ring having a ring shape; transferring the formed ring from the forming die to a transfer puck; and installing the formed ring, as a retaining ring, in a tube of a product assembly. The formed ring is maintained in a constrained state between forming in the forming die and installation in the product assembly.

[0005] The present disclosure also provides a system for forming and installing a retaining ring into a product assembly. The system includes a forming die configured to form a wire into a formed ring having a ring shape; and a transfer puck configured to transfer the formed ring from the forming die. The system is configured to maintain the formed ring in a constrained state between forming in the forming die and installation in a product assembly.

[0006] The present disclosure also provides a system for forming and installing a retaining ring into a product assembly. The system includes a forming die configured to form a wire into a formed ring having a ring shape. The system also includes a tubular die configured to cooperate with a roller mandrel to form the formed ring into the retaining ring; and a transfer puck configured to transfer the formed ring from the forming die to the tubular die. The transfer puck includes a tapered groove configured to align the transfer puck with at least the forming die.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] Further details, features and advantages of designs of the invention result from the following description of embodiment examples in reference to the associated drawings.

[0008] FIG. 1 shows a progression of forming a segment of wire into a formed ring having a ring shape and a forming die for forming the segment of wire into the ring shape, according to an aspect of the present disclosure;

[0009] FIG. 2 shows a forming assembly for producing the formed ring, according to an aspect of the present disclosure;

[0010] FIG. 3 shows a perspective view of a roller mandrel;

[0011] FIG. 4A shows a tubular die holding the formed ring before forming with the roller mandrel;

[0012] FIG. 4B shows the tubular die holding a retaining ring formed by expanding the formed ring by the roller mandrel;

[0013] FIG. 5 shows a perspective view of a transfer assembly and an assembly tool;

[0014] FIG. 6A shows a side view of the transfer assembly;

[0015] FIG. 6B shows a cross-sectional view of the transfer assembly transferring the retaining ring to the assembly tool;

[0016] FIG. 7 shows a fragmentary cross-sectional view of a damper tube including two retaining rings; and

[0017] FIG. 8 shows a flow chart illustrating steps in a method for forming and installing a retaining ring in an apparatus.

DESCRIPTION OF THE ENABLING EMBODIMENTS

[0018] Referring to the drawings, the present invention will be described in detail in view of following embodiments.

[0019] The present disclosure pertains to a system and process for on-demand or Just-in-Time (JIT) forming and installation of retainer rings. Such retainer rings may be used for retaining structures within a tubular assembly. The retainer ring forming and installation process may be implemented to form and install retainer rings for holding valve assemblies in a damper tube for a suspension damper assembly. However, the retainer ring forming and installation process of the present application may be applied to other assemblies, such as brake boosters, etc.

[0020] FIG. 1 shows a progression of forming a segment of wire **10a** into a formed ring **10d** having a ring shape and a forming die **20** for forming the segment of wire **10a** into the formed ring **10d**. The method and system provides for forming and installing individual retaining rings on demand from a pre-cut segment of stainless steel wire **10a** such that each retaining ring is fully constrained by tooling until assembled into a pallet assembly tube.

[0021] The forming process illustrated on FIG. 1 includes moving the segment of wire **10a** along a linear path as illustrated by the dashed line on FIG. 1 to push the segment of wire **10a** into a forming die **20** having a circular bore **22** with a tangential aperture **24** that extends tangentially to an inside surface of the circular bore **22**. In this way, the segment of wire **10a** is progressively bent, as shown in steps progressive steps and corresponding bent wires **10b** and **10c** until it is shaped as the formed ring **10d** with the shape of the circular bore **22**. The formed ring **10d** may be close to a 360-degree ring, although it may still include a gap between ends thereof.

[0022] FIG. 2 shows a forming assembly **30** for producing the formed ring **10d**. The forming assembly **30** includes the forming die **20** with the circular bore **22** and the tangential

aperture 24 for receiving the wire segment 10a for forming into the formed ring 10d. The forming assembly 30 also include an inner tool 26 that is free to rotate and can be utilized to transfer the formed ring 10d into a transfer tooling.

[0023] FIG. 3 shows a perspective view of a roller mandrel 40 having non-helical rollers 42. The roller mandrel 40 is used with a tubular die 44, shown in FIGS. 4A-4B to form expand the formed ring 10d into a retaining ring 10e. FIG. 4A shows the tubular die 44 with the formed ring 10d before roll-forming, and FIG. 4B shows the tubular die 44 with the retaining ring 10e formed by roll-forming. The formed ring 10d may be first located in the tubular die 44 having a retaining groove 46, and then the roller mandrel 40 is inserted therein and rotated so the rollers 42 push the formed ring 10d outwardly to form the retaining ring 10e. The roller mandrel 40 may include a conventional tool, such as part No. B11004 from Monaghan Tool.

[0024] FIG. 5 shows a perspective view of a transfer assembly 50 and an assembly tool 60 for installing the retaining ring 10e into a final product assembly, such as a damper tube. The transfer assembly 50, which may also be called a transfer puck, is used to transfer the retaining ring 10e into the assembly tool 60 for installation into the final product assembly, such as a damper tube. The transfer assembly 50 includes a tubular member 52 that encircles and retains the retaining ring 10e. The transfer assembly 50 also includes a coupling sleeve 54 disposed around the tubular member 52 and extending axially therefrom and configured to engage and surround the assembly tool 60 for aligning the tubular member 52 with the assembly tool 60 and providing a seamless transfer of the retaining ring 10e therebetween. The transfer assembly 50 also includes a plunger 56 that extends through the tubular member 52 and which translates linearly to push the retaining ring 10e out of the transfer assembly 50 and into the assembly tool 60.

[0025] FIG. 6A shows a side view of the transfer assembly 50 coupled to the assembly tool 60. As shown in FIG. 6A, the coupling sleeve 54 of the transfer assembly 50 also includes a tapered groove 62 configured to receive a corresponding tab 64 of the assembly tool 60. The tapered groove 62 may provide for the transfer assembly 50 to be similarly aligned with each of the forming die 20 and the tubular die 44 for transferring the formed ring 10d and the retaining ring 10e between each of the forming die 20, the tubular die 44, and the assembly tool 60 using the transfer assembly 50 while maintaining the retaining ring 10e in a constrained state throughout the process.

[0026] FIG. 6B shows a cross-sectional view of the transfer assembly 50 transferring the retaining ring 10e to the assembly tool 60. As shown in FIG. 6B, the coupling sleeve 54 of the transfer assembly 50 also includes a cylindrical recess 66 with a conical taper for receiving an end of the assembly tool 60 to align the tubular member 52 of the transfer assembly 50 with the assembly tool 60 along a common axis and to facilitate transferring the retaining ring 10e therebetween while maintaining the retaining ring 10e in the constrained state throughout the process. The cylindrical recess 66 of the coupling sleeve 54 may similarly receive each of the forming die 20 and/or the tubular die 44 for transferring the formed ring 10d and/or the retaining ring 10e between each of the forming die 20, the tubular die 44,

and the assembly tool 60 using the transfer assembly 50 while maintaining the retaining ring 10e in a constrained state throughout the process.

[0027] FIG. 7 shows a fragmentary cross-sectional view of a damper tube 80 including two retaining rings 10e. The damper tube 80 may be part of a shock absorber, which may be used in a motor vehicle, such as a passenger car or truck. The damper tube 80 includes a main tube 82 that defines a first annular recess 84 receiving one of the retaining rings 10e for holding a rod support 88 at a fixed position in the main tube 82 and preventing the damper rod support 88 from moving in an axial direction. The main tube 82 also defines a second annular recess 86 spaced apart from the first annular recess 84 and receiving another one of the retaining rings 10e for holding an end seal assembly 90 at a fixed position in the main tube 82 and preventing the end seal assembly 90 from moving in an axial direction. An axial end of the main tube 82 is bent inwardly to define an annular rim 94 to cooperate with the retaining rings 10e for holding the end seal assembly 90 and the damper rod support 88 in a fixed position at or near the axial end of the main tube 82.

[0028] The assembly tool 60 may be configured to transfer the retaining rings 10e into the main tube 82 of the damper tube 80 while maintaining the retaining rings 10e in constrained state. The constrained state may include the retaining rings 10e being partially or completely annularly surrounded for holding the retaining rings in a fixed location and orientation.

[0029] FIG. 8 shows a flow chart illustrating steps in a method 100 for forming and installing a retaining ring. As can be appreciated in light of the disclosure, the order of operation within the method is not limited to the sequential execution as illustrated in FIG. 8, but may be performed in one or more varying orders as applicable and in accordance with the present disclosure.

[0030] The method 100 includes feeding a wire in a linear path into a forming die at step 110. Step 110 may include feeding a segment of wire 10a through the tangential aperture 24 and into the forming die 20 of the forming assembly 30. In some embodiments, the wire may include a pre-cut segment of wire. Alternatively, the wire may be an extended length that may be cut after being fed into the forming die. A bulk feeder (not shown in the Figures), such as a wire feed hopper capable of holding numerous pre-cut segments of wire 10a, which may be mechanically aligned and positioned with of the forming assembly 30. In some embodiments, a bulk feeder can be reloaded with additional pre-cut segments of wire 10a without interrupting the process of forming and installing the retaining rings.

[0031] The method 100 also includes forming the wire into a formed ring having a ring shape at step 112. Step 112 may include using forming assembly 30 for producing the formed ring 10d. The forming assembly 30 may employ a push die, which may be translated linearly by a dove tail slide (not shown in the Figures). Step 112 may include a pre-cut segment of wire being loaded into a machine breech similar to a bolt action rifle. Step 112 may employ pusher force low enough to utilize a 1.4 mm-diameter pusher pin and allow wire to wrap around tooling inside diameter (ID). The 1.4 mm pusher pin is merely an example, and the pusher pin may be larger than 1.4 mm in diameter or smaller than 1.4 mm in diameter. The pusher pin should have a size and/or material characteristics that are suited for a given size and type of the wire to be formed. The pusher pin may be

sufficiently rigid and/or supported against bending so as to remain straight as the wire is formed to the ring shape.

[0032] The method 100 also includes transferring the formed ring from the forming die to a transfer puck at step 114. The transfer puck may include a circular bore that encircles the ring and retains the ring thereto.

[0033] The method 100 also includes transferring the formed ring from the transfer puck to a tubular die at step 116.

[0034] The method 100 also includes forming, using a roller mandrel and the tubular die, the formed ring into the retaining ring at step 118. Step 118 may include forming the retaining ring to a finished dimension.

[0035] The method 100 also includes transferring the retaining ring from the tubular die to an assembly tool at step 120. Step 120 may include using the transfer assembly 50 to transfer the retaining ring 10e from the tubular die 44 and into the assembly tool 60.

[0036] The method 100 also includes installing the formed ring, as a retaining ring, in a tube of a product assembly at step 122. The product assembly may include, for example, the damper tube 80 for a shock absorber.

[0037] In some embodiments, the formed ring is maintained in a constrained state between forming in the forming die and installation in the product assembly. In other words, the formed ring may be retained around a peripheral edge and never allowed to be in a free or unrestrained state. The retainer ring may, therefore, be confined to a round, flat configuration through the entire process of finishing, transfer, and installation.

[0038] In some embodiments, the forming and installing of the retaining ring at steps 112 through 122 are performed on-demand, proximate in location and in quick succession. For example, steps 112 through 122 may be performed by equipment located in close proximity and without requiring the retaining ring 10e to be transported by more than a few meters. Steps 112 through 122 may be performed in quick succession, no more than a few seconds therebetween. In some embodiments, steps 112 through 122, including forming and installing the retaining ring 10e may be performed within a fraction of a second.

[0039] Individual elements or features of a particular embodiment are generally not limited to that particular embodiment, but, where applicable, are interchangeable and can be used in a selected embodiment, even if not specifically shown or described. The same may also be varied in many ways. Such variations are not to be regarded as a departure from the disclosure, and all such modifications are intended to be included within the scope of the disclosure.

1. A method for forming and installing a retaining ring, comprising:

feeding a wire in a linear path into a forming die having a circular bore;

forming, using the forming die, the wire into a formed ring having a ring shape;

transferring the formed ring from the forming die to a transfer puck; and

installing the formed ring, as a retaining ring, in a tube of a product assembly,

wherein the formed ring is maintained in a constrained state between forming in the forming die and installation in the product assembly.

2. The method of claim 1, wherein the forming and installing of the retaining ring are performed on-demand, proximate in location and in quick succession.

3. The method of claim 1, further comprising transferring the formed ring from the transfer puck to a tubular die; and forming, using a roller mandrel and the tubular die, the formed ring into the retaining ring.

4. The method of claim 3, further comprising transferring the retaining ring from the tubular die to an assembly tool, wherein the assembly tool is configured to install the retaining ring into the product assembly.

5. The method of claim 1, wherein the transfer puck includes a tapered groove configured to align the transfer puck with at least the forming die.

6. The method of claim 1, wherein feeding the wire into the forming die includes feeding a pre-cut segment of the wire into the forming die.

7. The method of claim 1, wherein the product assembly includes a damper tube for a shock absorber.

8. A system for forming and installing a retaining ring into a product assembly, comprising:

a forming die configured to form a wire into a formed ring having a ring shape; and

a transfer puck configured to transfer the formed ring from the forming die, and

wherein the system is configured to maintain the formed ring in a constrained state between forming in the forming die and installation in the product assembly.

9. The system of claim 8, wherein the system is configured to form the formed ring and to install the formed ring on-demand, proximate in location, and in quick succession.

10. The system of claim 8, further comprising a tubular die configured to cooperate with a roller mandrel to form the formed ring into the retaining ring; and/or

an assembly tool configured to install the formed ring, as a retaining ring, in a tube of the product assembly.

11. (canceled)

12. The system of claim 8, further comprising the transfer puck including a tapered groove configured to align the transfer puck with at least the forming die.

13. The system of claim 8, wherein feeding the wire into the forming die includes feeding a pre-cut segment of the wire into the forming die.

14. The system of claim 8, wherein feeding the product assembly includes a damper tube for a shock absorber.

15. A system for forming and installing a retaining ring into a product assembly, comprising:

a forming die configured to form a wire into a formed ring having a ring shape;

a tubular die configured to cooperate with a roller mandrel to form the formed ring into the retaining ring; and

a transfer puck configured to transfer the formed ring from the forming die to the tubular die, the transfer puck including a tapered groove configured to align the transfer puck with at least the forming die.

16. The system of claim 15, further comprising an assembly tool configured to install the retaining ring into a product assembly, and

wherein the system is configured to maintain the formed ring in a constrained state between forming in the forming die and installation in the product assembly.

17. The system of claim 15, further comprising an assembly tool configured to install the retaining ring into a product assembly, and

wherein the tapered groove of the transfer puck is further configured to align the transfer puck with the assembly tool.

18. The system of claim **15**, further comprising an assembly tool configured to install the retaining ring into a product assembly, and

wherein the transfer puck includes a coupling sleeve defining a cylindrical recess configured to receive the assembly tool therein for maintaining the retaining ring in a constrained state as the retaining ring is transferred between the transfer puck and the assembly tool.

19. The system of claim **15**, wherein feeding the wire into the forming die includes feeding a pre-cut segment of the wire into the forming die.

20. The system of claim **15**, wherein the product assembly includes a damper tube for a shock absorber.

21. The method of claim **4**, wherein the transfer puck includes a coupling sleeve defining a cylindrical recess configured to receive the assembly tool therein for maintaining the retaining ring in a constrained state as the retaining ring is transferred between the transfer puck and the assembly tool.

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