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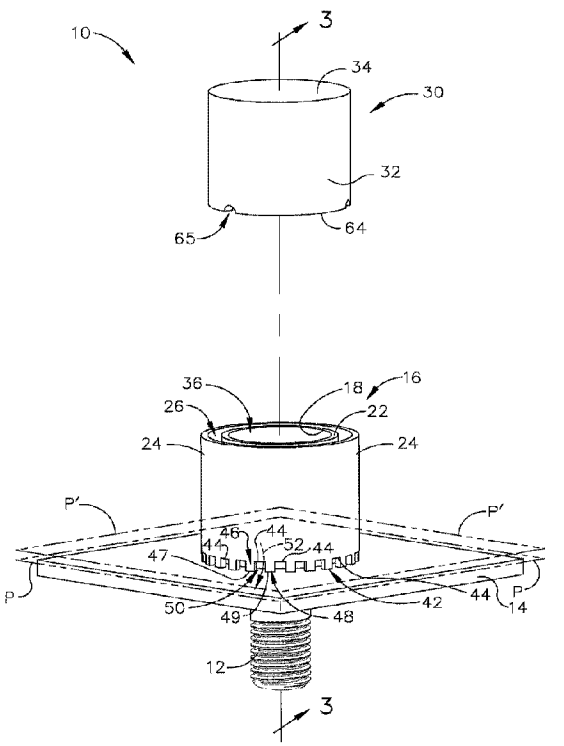

(57) Abrégé/Abstract:
A cap assembly for enclosing a metallic fastener which extends through a structure. The assembly includes a housing having an inner wall and an outer wall which extends about and is spaced apart from the inner wall defining a space positioned between the inner wall and outer wall. The assembly further includes a plunger member with a side wall portion secured to an end wall portion. The side wall portion of the plunger member has a thickness dimension smaller than a distance between the inner wall and the outer wall to position the sidewall portion of the plunger member within the space. With the side wall portion positioned within the space, the end wall portion is positioned in alignment with the inner wall and with an opening defined by and through the inner wall.

ABSTRACT

A cap assembly for enclosing a metallic fastener which extends through a structure. The assembly includes a housing having an inner wall and an outer wall which extends about and is spaced apart from the inner wall defining a space positioned between the inner wall and outer wall. The assembly further includes a plunger member with a side wall portion secured to an end wall portion. The side wall portion of the plunger member has a thickness dimension smaller than a distance between the inner wall and the outer wall to position the sidewall portion of the plunger member within the space. With the side wall portion positioned within the space, the end wall portion is positioned in alignment with the inner wall and with an opening defined by and through the inner wall.

EME PROTECTION CAP SYSTEM WITH PUSH SEALANT EXTRUSION MECHANISM

BACKGROUND

[0001] This disclosure relates to an electrical insulation containment apparatus which electrically insulates a metallic fastener from transmitting electrical current or sparks into a vicinity of the metallic fastener upon an occurrence of an electromagnetic effect ("EME") or lightning strike event and more particularly to a cap assembly used in conjunction with a sealant.

[0002] In fabricating assemblies, such as an aircraft, cap assemblies are installed to enclose a metallic fastener that extends through a structure so as to protect the vicinity in which the metallic fastener is located within the aircraft from a transmission of any electrical current or spark from the metallic fastener. The cap assembly is used to insulate the metallic fastener from transmitting any current or electrical spark from the metallic fastener to the vicinity of the location of the metallic fastener within the aircraft upon an occurrence of an electromagnetic effect ("EME") or lightning strike event.

[0003] In installing cap assemblies for electrically isolating a metallic fastener, which extends from a structure, the cap assembly is filled with uncured sealant and the cap assembly is placed over the metallic fastener and onto a surface of the structure. The uncured sealant tends to expand once the cap assembly is installed and the expansion of the uncured sealant tends to lift off the cap assembly from the surface of the structure such that the cap assembly no longer secures an enclosure of the metallic fastener. Cap assemblies that have experienced lift off from the surface of the structure are reinstalled thereby increasing the cost of providing electrical isolation of the metallic fasteners which extend from structures within the aircraft. In addition, sealant which can be constructed from high density material can add additional weight to the aircraft with filling the internal volume of the cap assembly with sealant when the cap assembly is installed. The additional weight to the aircraft can result in an increase in cost of operation of the aircraft.

[0004] There is a need for cap assemblies to avoid unnecessary additional weight with filling the cap assemblies with uncured sealant and there is a need to design a cap assembly in which uncured sealant expansion will have minimal or no lift off effect to a cap assembly.

SUMMARY

[0005] In a first aspect, there is described a cap assembly for enclosing a metallic fastener which extends through a structure, comprising: a housing comprising: an inner wall to position about the metallic fastener and having a first end for abutting the structure and an opposing second end positioned spaced apart from the first end; and an outer wall which extends about and is spaced apart from the inner wall defining a space positioned between the inner wall and outer wall, wherein with the first end of the inner wall in contact with the structure, a first end of the outer wall or a portion of the first end of the outer wall is positioned spaced apart from the structure; and a plunger member comprising a side wall portion secured to an end wall portion, wherein: the side wall portion of the plunger member has a thickness dimension smaller than a distance between the inner wall and the outer wall to position the side wall portion of the plunger member within the space; and with the side wall portion positioned within the space, the end wall portion is positioned in alignment with the opposing second end of the inner wall and with an opening defined by and through the inner wall.

[0005a] There is further described a cap assembly for enclosing a metallic fastener which extends through a structure, comprising: a housing comprising: an inner wall to position about the metallic fastener and having a first end for abutting the structure and an opposing second end positioned spaced apart from the first end; and an outer wall which extends about and is spaced apart from the inner wall defining a space positioned between the inner wall and outer wall, and a plunger member comprising a side wall portion secured to an end wall portion, wherein: the side wall portion of the

Date Reçue/Date Received 2023-04-03

plunger member has a thickness dimension smaller than a distance between the inner wall and the outer wall to position the side wall portion of the plunger member within the space; and with the side wall portion positioned within the space, the end wall portion is positioned in alignment with the opposing second end of the inner wall and with an opening defined by and through the inner wall, wherein: a portion of the first end of the outer wall is spaced apart from a first plane defined by the first end of the inner wall of the housing; and the first end of the outer wall defines a first tab and a second tab which are spaced apart from one another about the outer wall and a first end portion of the first tab and a second end portion of the second tab are positioned coplanar with the first plane.

[0005b] There is also described a cap assembly for enclosing a metallic fastener which extends through a structure, comprising: a housing comprising: an inner wall to position about the metallic fastener and having a first end for abutting the structure and an opposing second end positioned spaced apart from the first end; and an outer wall which extends about and is spaced apart from the inner wall defining a space positioned between the inner wall and the outer wall, wherein at least a portion of a first end of the outer wall is spaced apart from a first plane defined by the first end of the inner wall of the housing and with the first end of the inner wall abutting the structure a flow path is defined from the space through the at least a portion of the first end of the outer wall spaced apart from the first plane; and a plunger member comprising a side wall portion secured to an end wall portion, wherein: the side wall portion of the plunger member has a thickness dimension smaller than a distance between the inner wall and the outer wall to position the side wall portion of the plunger member within the space; and with the side wall portion positioned within the space, the end wall portion is positioned in alignment with the opposing second end of the inner wall and with an opening defined by and through the inner wall, wherein the alignment provides an enclosure provided by the housing and the plunger member in which to contain the metallic fastener.

Date Reçue/Date Received 2023-04-03

[0006] There is also described a method for enclosing a metallic fastener extending through a structure, comprising the steps of: positioning a housing comprising an inner wall and outer wall onto the structure, such that a first end of the inner wall is placed into contact with the structure, wherein: the inner wall surrounds the metallic fastener extending through the structure; and the outer wall extends about and is spaced apart from the inner wall defining a space between the inner wall and the outer wall which contains an uncured sealant and a first end of the outer wall or a portion of the first end of the outer wall is positioned spaced apart from the structure; and moving a side wall portion of a plunger member between the inner wall and the outer wall within the space displacing the uncured sealant within the space.

[0006a] There is further described a method for enclosing a metallic fastener extending through a structure, comprising the steps of: positioning a housing comprising an inner wall and an outer wall onto the structure wherein: the inner wall surrounds the metallic fastener extending through the structure and is positioned such that a first end of the inner wall abuts the structure and an opposing second end of the inner wall is spaced apart from the first end; and the outer wall extends about and is spaced apart from the inner wall defining a space between the inner wall and the outer wall which contains an uncured sealant, and at least a portion of a first end of the outer wall is spaced apart from a first plane defined by the first end of the inner wall of the housing and with the first end of the inner wall abutting the structure a flow path is defined from the space through the at least a portion of the first end of the outer wall spaced apart from the first plane; and moving a side wall portion of a plunger member between the inner wall and the outer wall within the space displacing the uncured sealant within the space, and such that an end wall portion of the plunger member, that is secured to the side wall portion of the plunger member, is in alignment with the opposing second end of the inner wall and with an opening defined by and through the inner wall, said alignment providing an enclosure provided by the housing and the plunger member in which to contain the metallic fastener.

Date Reçue/Date Received 2023-04-03

[0007] The features, functions, and advantages that have been discussed can be achieved independently in various embodiments or may be combined in yet other embodiments further details of which can be seen with reference to the following description and drawings.

BRIEF SUMMARY OF THE DRAWINGS

[0008] FIG. **1** is an exploded view of the cap assembly for enclosing a metallic fastener extending from a structure;

[0009] FIG. **2** is a perspective view of the exploded view of the cap assembly of FIG. **1**;

[0010] FIG. **3** is a cross section view along line **3-3** of the cap assembly of FIG. **1**;

[0011] FIG. **4** is an assembled cross section view of the cap assembly of FIG. **3**;

[0012] FIG. **5** is a perspective view of the cap assembly of FIG. **1**;

[0013] FIG. **6** is a cross section view along line **6-6** of the assembled cap assembly of FIG. **4**;

[0014] FIG. **7** is an exploded view of the cap assembly for enclosing a metallic fastener extending from a structure having a second example of the outer wall;

[0015] FIG. **8** is a cross section view of the cap assembly of FIG. **7** with the outer wall and the plunger member assembled enclosing the metallic fastener; and

[0016] FIG. **9** is a flow chart of a method for enclosing a metallic fastener extending through a structure.

Date Reçue/Date Received 2023-04-03

DESCRIPTION

[0017] In referring to FIGS. **1-4**, cap assembly **10** is shown for enclosing metallic fastener **12**, which extends through structure **14**. Housing **16** includes an inner wall **18** to position about metallic fastener **12** and having a first end **20** for abutting structure **14** and an opposing second end **22**. The shape of inner wall **18** can take on one of any number of shapes. The example shown herein utilizes a circular shape. Metallic fastener **12**, which is positioned within housing **16**, can be any one of a number of metallic fasteners. In this example, bolt head **13** is positioned within housing **16** of cap assembly **10**. Bolt head **13** can be accompanied by one or more washers as needed. In other examples of metallic fasteners positioned within housing **16** of cap assembly **10**, a threaded shaft with a secured nut(s) can be positioned within housing **16** of cap assembly **10**, as well as, with washers as needed. Cap assembly **10** can enclose many other types and configurations of metallic connectors, as needed, for securement of structure **14**.

[0018] Outer wall **24**, which extends about and is spaced apart from inner wall **18**, defines space **26** positioned between inner wall **18** and outer wall **24**. The shape of outer wall **24** can take on one of any number of shapes. The example shown herein utilizes a circular shape. Space **26**, as will be discussed, is utilized in this example to contain an uncured sealant or adhesive **28**, as seen in FIGS. **2-4**. Plunger member **30** includes side wall portion **32** secured to end wall portion **34**. Side wall portion **32** of plunger member **30** has a thickness T dimension which is smaller than distance D dimension between inner wall **18** and outer wall **24**, as seen in FIGS. **2**, **3** and **6**, which enables to position side wall portion **32** of plunger member **30** within space **26**.

[0019] Positioning side wall portion **32** within space **26** can displace uncured sealant **28** which can be positioned within space **26**, as will be further discussed. A controlled amount of uncured sealant **28** is positioned within space **26** such that with side wall portion **32** positioned within space **26** side wall portion **32** displaces uncured sealant **28**. As will be discussed, uncured sealant **28** displaced from within space **26**

provides for a controlled amount of squeeze out of uncured sealant **28** out of cap assembly **10**.

[0020] With uncured sealant **28** contained within space **26** positioned between inner wall **18** and outer wall **24** and with side wall portion **32** of plunger member **30** positioned within space **26**, uncured sealant **28** is positioned between at least one of inner wall **18** of housing **16** and side wall portion **32** of plunger member **30** or outer wall **24** of housing **16** and side wall portion **32** if plunger member **30**. In this example, with side wall portion **32** positioned within space **26**, uncured sealant **28** is positioned between side wall portion **32** of plunger member **30** and inner wall **18** and between side wall portion **32** and outer wall **24**, space **26** is sealed closed. With sealing closed space **26**, metallic fastener **12** is sealed within opening **36**, which is defined by and which extends through inner wall **18**. With using a controlled amount of uncured sealant **28**, sealing closed space **26** is accomplished with minimizing or avoiding extruding uncured sealant **28** from space **26** into opening **36** and thereby avoiding positioning unnecessary additional weight of uncured sealant **28** within opening **36**. In addition, with employment of side wall portion **32** within space **26**, uncured sealant **28** positioned within space **26** is displaced within space **26** and will be positioned as squeeze out of cap assembly **10** as seen in FIG. **4**. Uncured sealant **28** in contact with housing **16**, side wall portion **32** and structure **14**, when cured, secures cap assembly **10** to structure **14**, as seen in FIG. **5**. With side wall portion **32** positioned within space **26**, end wall portion **34** is positioned in alignment with opposing second end **22** of inner wall **18** and with opening **36**. This alignment provides an enclosure provided by housing **16** and plunger member **30** in which to contain metallic fastener **12**.

[0021] In this example, housing **16** and plunger member **30** are constructed of a polymer material. The polymer material can be a material from one of many material compositions such as including a thermoplastic or thermoset polymers which provide electrical shielding with respect to the vicinity of metallic fastener **12** from metallic fastener **12**. Plunger member **30** can also be constructed from one of phenolic,

epoxy or other non-thermoplastic materials, as well as, polymers such as thermoplastics and thermosets which can also successfully shield the vicinity in which metallic fastener **12** is located from transmission of current or sparks from metallic fastener **12**.

[0022] Uncured sealant contained within space **26** positioned between inner wall **18** and outer wall **24** can include one of a wide variety of materials such as polysulfides, silicones, urethanes, acrylics, epoxies, or other type of polymeric system that either cures or hardens in place to form a solid and adheres to an underlying structure. Uncured sealant **28** is deformable and moveable within cap assembly **10** with moving of side wall portion **32** within space **26** and within uncured sealant **28**. Uncured sealant **28** is positioned within space **26** either at the time of installation by the installer or can be placed within space **26** by the vendor prior to delivery to the location of installation. In the latter occurrence, plunger member **30** can be positioned such that side wall portion **32** is positioned within space **26** at a location near an upper surface of the uncured sealant **28** positioned within space **26** or partially submerged within uncured sealant **28**. In either occurrence, the installer at the time of installing will move plunger member **30** in a direction toward housing **16** and side wall portion **32** will penetrate or further penetrate uncured sealant **28** displacing the uncured sealant **28** within space **26**.

[0023] In referring to FIGS. **3** and **4**, plunger member **30** is positioned within housing **16**. Side wall portion **32** of plunger member **30**, as earlier mentioned, is positioned within space **26** and displaces uncured sealant **28** which is positioned within space **26**. With side wall portion **32** penetrating or, if initially positioned partially submerged within uncured sealant **28**, further penetrating uncured sealant **28**, uncured sealant **28** is positioned between at least one of inner wall **18** of housing **16** and side wall portion **32** of plunger member **30** or outer wall **24** of housing **16** and side wall portion **32** of plunger member **30**. In this example, as mentioned earlier, uncured sealant **28** is positioned between both side wall portion **32** and inner wall **18**

and side wall portion **32** and outer wall **24**, such that side wall portion **32** and uncured sealant **28** occupy space **26** sealing closed space **26**.

[0024] With side wall portion **32** immersed within uncured sealant **28**, any expansion of uncured sealant **28** that can create a lift off force does not lift inner wall **18**. In this example, inner wall **18** has flat surface **38** abutting structure **14** with surface **40** having a flat configuration absent uncured sealant **28** being positioned between inner wall **18** and structure **14**. Thus, any expansion of uncured sealant **28** does not place a lift force on inner wall **18**. Any expansion of uncured sealant **28** confined within space **26** can be imparted to side wall portion **32** of plunger member **30** such that side wall portion **32** of plunger member **30** can move within space **26**. With side wall portion **32** positioned sufficiently within space **26** side wall portion **32** remains within space **26** despite experiencing any lift off force and thereby maintains metallic fastener **12** contained within cap assembly **10** and maintains metallic fastener **12** sealed and isolated from outside of outer wall **24**.

[0025] In referring to FIGS. **1-5**, an example of configuration of first end **42** of outer wall **24** is shown and in FIGS. **7** and **8** a second example of configuration of first end **42'** of outer wall **24** is shown. Both configurations, first end **42** and first end **42'**, as will be discussed, provide for a flow path to extend from space **26** through outer wall **24** to permit uncured sealant **28** to be extruded as squeeze out through outer wall **24** with movement of side wall portion **32** of plunger member **30** within space **26** which contains uncured sealant **28**. In referring to FIGS. **1-5**, outer wall **24** of housing extends about inner wall **18** wherein at least a portion **44** of first end **42** of outer wall **24** is spaced apart from first plane P, which is defined by first end **20**, in this example. First end **20** includes flat surface **38** of inner wall **18** of housing **16**, as seen in FIGS. **3** and **4**. First end **42** of the outer wall **24** defines first tab **46** and second tab **48** spaced apart from one another about outer wall **24** as seen in FIGS. **1** and **2**. First end portion **47** of the first tab **46** of first end **42** of the outer wall **24** and second end portion **49** of the second tab **48** of first end **42** of outer wall **24** are positioned coplanar with first plane P.

[0026] At least a portion **44** of first end **42** of outer wall **24**, defines, in this example, second plane P' as seen in FIGS. **1**, **3** and **4**, spaced apart from first plane P. At least a portion **44** of first end **42** extends between first tab **46** and second tab **48** positioned spaced apart from first plane P wherein first tab **46**, second tab **48** and the at least a portion **44** of the first end **42** define recess **50** within outer wall **24** which extends through outer wall **24** and is in communication with space **26**. With first end **20** of the inner wall **18** abutting surface **40** of structure **14**, first flow path **52** is defined from space **26** through recess **50** of outer wall **24**. This configuration in defining recess **50** through outer wall **24** permits uncured sealant **28**, when displaced by side wall portion **32**, to flow along first flow path **52** from space **26** and through recess **50** and be positioned outside of and adjacent to cap assembly **10**. With uncured sealant **28** positioned outside and adjacent to housing **16**, the installer can then smooth out the uncured sealant **28**, further sealing closed space **26** from outside of outer wall **24** and sealing metallic fastener **12** within cap assembly **10** and at the same time providing a secure bond of cap assembly **10** to structure **14**.

[0027] As can be seen in this example, other portions **44** of first end **42** of outer wall **24** are positioned similarly spaced apart from first plane P and similarly spaced apart tabs such as first tab and second tab **46**, **48** are positioned about outer wall **24** having ends such as first end portion **47** and second end portion **49**, respectively, coplanar with first plane P defining recess **50**. As a result a number of first flow paths **52** are defined from space **26** through various recesses **50** of outer wall **24**. With first end **42** of outer wall **24** constructed with a plurality of recesses **50**, a plurality of first flow paths **52** from space **26** through recesses **50** are provided. Uncured sealant **28**, when displaced from space **26** with side wall portion **32** of plunger member **30**, moves through first flow path **52** and outside of outer wall **24** as seen in FIGS. **4** and **5**. With a controlled amount of uncured sealant **28** positioned in space **26**, the amount of uncured sealant **28** can be controlled which flows out of or squeezes out of recesses **50**. Uncured sealant **28** which extrudes from recesses **50** can be smoothed out as mentioned earlier.

[0028] In referring to FIGS. **7** and **8**, first end **42'** of the outer wall **24** extends about inner wall **18** spaced apart from first plane P, which is defined by first end **20** of inner wall **18**. This can be seen in FIG. **7** wherein first end **42'** defines third plane P" spaced apart from first plane P. With first end **20** of inner wall **18** abutting surface **40** of structure **14**, second flow path **54** is defined from space **26** through gap **56** defined by first end **42'** of outer wall **24** and surface **40** of structure **14** for permitting flow of displaced uncured sealant **28** from space **26**. With a controlled amount of uncured sealant **28** positioned in space **26**, the amount of uncured sealant **28** is also controlled which flows out of gap **56**. With side wall portion **32** of the plunger member **30** having displaced uncured sealant **28** within space **26**, uncured sealant **28** is positioned between at least one of between inner wall **18** of the housing **16** and side wall portion **32** of plunger member **30** or outer wall **24** of housing **16** and side wall portion **32** of plunger member **30**. In this example, as mentioned earlier, uncured sealant **28** is positioned between inner wall **18** and the side wall portion **32** and between outer wall **24** and side wall portion **32**. As discussed earlier, uncured sealant **28** and side wall portion **32** occupy space **26** such that space **26** is sealed closed sealing off opening **36** and metallic fastener **12** from outside of outer wall **24** at structure **14**. Uncured sealant **28** that extrudes through gap **56** can, as earlier discussed, be smoothed out about outer wall **24** further sealing closed access to space **26** from outside of outer wall **24**. When uncured sealant **28** is cured, a strong bond is established between housing **16** and side wall portion **32** and between structure **14** with respect to housing **16** and sidewall portion **32**, securing cap assembly **10** to structure **14**.

[0029] In referring to FIG. **6**, cross section of inner wall **18** includes circular configuration **58** and cross section of outer wall **24** includes circular configuration **60**, which in this example, provides ease in handling, installing and optimizes cap assembly **10** enclosing various shapes of fasteners and minimize the amount of space occupied with respect to structure **14** and with respect with the vicinity of metallic fastener **12**. Inner wall **18** and outer wall **24** of cap assembly **10** can take one

of numerous configurations that will enclose metallic fastener **12** and accommodate confinements associated with structure **14**. Connector member **62** secures inner wall **18** to outer wall **24**. As seen in FIG. **6** connector member **62** extends across space **26** and are spaced apart from first end **20** of inner wall **18** as seen in FIGS. **3** and **4**. At least two connector members **62**, and in this example three, are positioned spaced apart from one another about inner wall **18** as seen in FIG. **6**. Connector members **62** provides structural support strength for housing **16** and provides alignment of inner wall **18** with respect to outer wall **24**. In addition, connector members **62** provide a stop for the travel of side wall portion **32** of plunger member **30** within space **26**, as will be discussed below.

[0030] Side wall portion **32** of plunger member **30** has length L, as seen in FIG. **3**, which is less than length L' of inner wall **18** of housing **16**. With first end **64** of side wall portion **32** of plunger member **30** in contact with connector member **62**, and in this example, in contact with three connector members **62**, end wall portion **34** of the plunger member, as seen in FIG. **4**, is positioned spaced apart from opposing second end **22** of inner wall **18** of housing **16**. The spacing apart of end wall portion **34** from opposing second end **22** of inner wall **18** provides for an occurrence of any excess of uncured sealant **28** positioned in space **26** to flow into opening **36** and alleviate back pressure during movement of plunger member **30** toward housing **16** during installation. Similarly, the spacing apart of end wall portion **34** and opposing second end **22** will permit expansion of uncured sealant **28** to expand in the direction of spaced apart opposing second end **22** and end wall portion **34** and into opening **36** and reduces movement of plunger member **30** by way of the expansion of uncured sealant **28**.

[0031] In this example, first end **64** of side wall portion **32** defines notches **65**, as seen in FIGS. **2** and **3**, which engage connector member(s) **62** with side wall portion **32** contacting connector members **62**. Notches **65** provide a secure engagement of side wall portion **32** with connector members **62**. Positioning of connector members **62** spaced apart from first end **20** of inner wall **18**, as seen in FIG. **3**, prevents side

wall portion **32** of plunger member **30** from over traveling within space **26** and causing a reduction of uncured sealant **28** within space **26** used in securing cap assembly **10** to structure **14** and for maintaining space **26** sealed closed sealing opening **36**, which contains metallic fastener **12**, from outside of outer wall **24**. Providing a controlled amount of uncured sealant **28** within space **26** results in controlled amount of uncured sealant **28** being positioned around cap assembly **10** and limits the amount of uncured sealant **28** to be positioned within cap assembly **10** between inner wall **18** and outer wall **24**, as seen in FIG. **4**. Using a controlled amount of uncured sealant **28** also avoids extruding uncured sealant **28** from space **26** into opening **36**, which can unnecessarily add weight to installed cap assembly **10**. With avoiding filling opening **36** with high density uncured sealant **28**, cap assembly **10** provides a secure and electrically shielding apparatus without adding of unnecessary weight with filling opening **36** with uncured sealant **28**.

[0032] In referring to FIG. **9**, method **66** for enclosing metallic fastener **12** which extends through structure **14** includes step **68** of positioning housing **16**, which includes inner wall **18** and outer wall **24** onto structure **14**. Inner wall **18** of housing **16** surrounds metallic fastener **12** extending through structure **14**. Outer wall **24** extends about and is spaced apart from inner wall **18** defining space **26** between inner wall **18** and outer wall **24** which contains uncured sealant **28**. Method **66** further includes step **70** of moving side wall portion **32** of plunger member **30** between inner wall **18** and outer wall **24** within space **26** displacing uncured sealant **28** within space **26**. This method encloses metallic fastener **12** from surrounding vicinity of metallic fastener **12** and shields the vicinity from electrical transmission or sparks which can originate from metallic fastener **12**. Uncured sealant **28** is positioned within space **26** without sealant being positioned throughout an internal volume of housing **16**, thereby providing for the benefit of enclosing of metallic fastener **12** without providing additional weight with placing uncured sealant **28** throughout housing **16**.

[0033] Step **70** of moving side wall portion **32** of plunger member **30** further includes moving the plunger member **30** in direction **72** toward housing **16** as seen in

FIG. **3**. Moving in the direction of housing **16** allows side wall portion **32** of plunger member **30** to move uncured sealant **28** in the direction toward structure **14** and outside outer wall **24**. Moving side wall portion **32** of plunger member **30** within space **26** includes positioning uncured sealant **28** between at least one of side wall portion **32** of plunger member **30** and inner wall **18** of housing **16** or the side wall portion **32** of plunger member **30** and outer wall **24** of housing **16**. As mentioned earlier, in this example, uncured sealant **28** is positioned between side wall portion **32** and plunger member **30** and between inner wall **18** and side wall portion **32**, as seen in FIG. **4**. Displacing uncured sealant **28** further includes in one example as seen in FIGS. **3** and **4** positioning uncured sealant **28** between at least a portion **44** of first end **42** of outer wall **24** and structure **14** and in another example as seen in FIGS. **7** and **8** positioning uncured sealant **28** between first end **42'** of outer wall **24** and structure **14**. Displacing uncured sealant **28** further includes extruding uncured sealant **28** from between first end **42** of outer wall **24** and structure **14** and away from outer wall **24** as seen in the first example in FIG. **4** and extruding uncured sealant **28** from between first end **42'** of outer wall **24** and structure **14** and away from outer wall **24** as seen in the second example in FIG. **8**. With extruding uncured sealant **28** outside of outer wall **24**, the installer, as mentioned earlier, can smooth out the uncured sealant **28**, further seal closed space **26** from outside of outer wall **24** and further secure housing **16** and plunger member **30** to structure **14**.

[0034] While various embodiments have been described above, this disclosure is not intended to be limited thereto. Variations can be made to the disclosed embodiments that are still within the scope of the appended claims.

EMBODIMENTS IN WHICH AN EXCLUSIVE PROPERTY OR PRIVILEGE IS CLAIMED ARE DEFINED AS FOLLOWS:

1. A cap assembly for enclosing a metallic fastener which extends through a structure, comprising:

a housing comprising:

an inner wall to position about the metallic fastener and having a first end for abutting the structure and an opposing second end positioned spaced apart from the first end; and

an outer wall which extends about and is spaced apart from the inner wall defining a space positioned between the inner wall and outer wall, wherein with the first end of the inner wall in contact with the structure, a first end of the outer wall or a portion of the first end of the outer wall is positioned spaced apart from the structure; and

a plunger member comprising a side wall portion secured to an end wall portion, wherein:

the side wall portion of the plunger member has a thickness dimension smaller than a distance between the inner wall and the outer wall to position the side wall portion of the plunger member within the space; and

with the side wall portion positioned within the space, the end wall portion is positioned in alignment with the opposing second end of the inner wall and with an opening defined by and through the inner wall.

2. The cap assembly of claim **1**, wherein the housing and the plunger member are constructed of a polymer material.

Date Reçue/Date Received 2023-04-03

3. The cap assembly of claim **1** or **2**, further includes an uncured sealant contained within the space positioned between the inner wall and the outer wall.

4. The cap assembly of claim **3**, wherein, with the side wall portion of the plunger member positioned within the space the side wall portion of the plunger member displaces the uncured sealant contained within the space and the uncured sealant is positioned between at least one of the inner wall of the housing and the side wall portion of the plunger member or the outer wall of the housing and the side wall portion of the plunger member.

5. The cap assembly of any one of claims **1** to **4**, wherein:

a cross section of the inner wall comprises a circular configuration; and

a cross section of the outer wall comprises a circular configuration.

6. The cap assembly of any one of claims **1** to **5**, further includes a connector member secured to the inner wall of the housing and secured to the outer wall of the housing with the connector member positioned spaced apart from the first end of the inner wall.

7. The cap assembly of any one of claims **1** to **5**, further includes at least two connector members positioned spaced apart from one another about the inner wall of the housing.

8. The cap assembly of any one of claims **1** to **7**, wherein the side wall portion of the plunger member has a length less than a length of the inner wall of the housing.

9. The cap assembly of claim **8**, wherein with a first end of the side wall portion of the plunger member in contact with the connector member, the first end of the side wall portion of the plunger member is positioned spaced apart from the opposing second end of the inner wall of the housing.

Date Reçue/Date Received 2023-04-03

10. The cap assembly of any one of claims **1** to **9**, wherein the first end of the inner wall of the housing comprises a flat surface.

11. The cap assembly of any one of claims **1** to **10**, wherein the portion of the first end of the outer wall is positioned spaced apart from a first plane defined by the first end of the inner wall of the housing.

12. The cap assembly of any one of claims **1** to **10**, wherein the first end of the outer wall extends about the inner wall spaced apart from a first plane defined by the first end of the inner wall.

13. The cap assembly of claim **12**, wherein, with the first end of the inner wall abutting the structure, a flow path is defined from the space through a gap defined by the first end of the outer wall and the structure

14. A cap assembly for enclosing a metallic fastener which extends through a structure, comprising:

a housing comprising:

an inner wall to position about the metallic fastener and having a first end for abutting the structure and an opposing second end positioned spaced apart from the first end; and

an outer wall which extends about and is spaced apart from the inner wall defining a space positioned between the inner wall and outer wall, and

a plunger member comprising a side wall portion secured to an end wall portion, wherein:

the side wall portion of the plunger member has a thickness dimension smaller than a distance between the inner wall and the

Date Reçue/Date Received 2023-04-03

outer wall to position the side wall portion of the plunger member within the space; and

with the side wall portion positioned within the space, the end wall portion is positioned in alignment with the opposing second end of the inner wall and with an opening defined by and through the inner wall, wherein:

a portion of the first end of the outer wall is spaced apart from a first plane defined by the first end of the inner wall of the housing; and

the first end of the outer wall defines a first tab and a second tab which are spaced apart from one another about the outer wall and a first end portion of the first tab and a second end portion of the second tab are positioned coplanar with the first plane.

15. The cap assembly of claim **14**, wherein the portion of first end of the outer wall extends between the first tab and the second tab positioned spaced apart from the first plane wherein the first tab, the second tab and the portion of the first end of the outer wall define a recess within the outer wall which extends through the outer wall and is in communication with the space, such that, with the first end of the inner wall abutting the structure, a flow path is defined from the space through the recess of the outer wall.

16. A method for enclosing a metallic fastener extending through a structure, comprising the steps of:

positioning a housing comprising an inner wall and outer wall onto the structure, such that a first end of the inner wall is placed into contact with the structure, wherein:

Date Reçue/Date Received 2023-04-03

the inner wall surrounds the metallic fastener extending through the structure; and

the outer wall extends about and is spaced apart from the inner wall defining a space between the inner wall and the outer wall which contains an uncured sealant and a first end of the outer wall or a portion of the first end of the outer wall is positioned spaced apart from the structure; and

moving a side wall portion of a plunger member between the inner wall and the outer wall within the space displacing the uncured sealant within the space.

17. The method of claim **16**, wherein moving the side wall portion of the plunger member further includes moving the plunger member in a direction toward the housing.

18. The method of claim **16** or **17**, wherein moving the side wall portion of the plunger member within the space includes positioning the uncured sealant between at least one of the side wall portion of the plunger member and the inner wall of the housing or the side wall portion of the plunger member and the outer wall of the housing.

19. The method of any one of claims **16** to **18** wherein displacing the uncured sealant further includes positioning the uncured sealant between the portion of a first end of the outer wall and the structure.

20. The method of any one of claims **16** to **18**, wherein displacing the uncured sealant further includes extruding the uncured sealant from between the first end of the outer wall and the structure and away from the outer wall.

21. A cap assembly for enclosing a metallic fastener which extends through a structure, comprising:

Date Reçue/Date Received 2023-04-03

a housing comprising:

an inner wall to position about the metallic fastener and having a first end for abutting the structure and an opposing second end positioned spaced apart from the first end; and

an outer wall which extends about and is spaced apart from the inner wall defining a space positioned between the inner wall and the outer wall, wherein at least a portion of a first end of the outer wall is spaced apart from a first plane defined by the first end of the inner wall of the housing and with the first end of the inner wall abutting the structure a flow path is defined from the space through the at least a portion of the first end of the outer wall spaced apart from the first plane; and

a plunger member comprising a side wall portion secured to an end wall portion, wherein:

the side wall portion of the plunger member has a thickness dimension smaller than a distance between the inner wall and the outer wall to position the side wall portion of the plunger member within the space; and

with the side wall portion positioned within the space, the end wall portion is positioned in alignment with the opposing second end of the inner wall and with an opening defined by and through the inner wall, wherein the alignment provides an enclosure provided by the housing and the plunger member in which to contain the metallic fastener.

22. The cap assembly of claim **21**, further including an uncured sealant contained within the space positioned between the inner wall and the outer wall.

23. The cap assembly of claim **22**, wherein:

Date Reçue/Date Received 2023-04-03

with the side wall portion of the plunger member positioned within the space, the side wall portion of the plunger member displaces the uncured sealant contained within the space; and

the uncured sealant is positioned between at least one of:

the inner wall of the housing and the side wall portion of the plunger member; and

the outer wall of the housing and the side wall portion of the plunger member.

24. The cap assembly of any one of claims **21** to **23**, wherein:

a cross section of the inner wall comprises a circular configuration; and a cross section of the outer wall comprises a circular configuration.

25. The cap assembly of any one of claims **21** to **24**, further including at least one connector member secured to the inner wall and to the outer wall and is spaced apart from the first end of the inner wall.

26. The cap assembly of claim **25**, wherein the side wall portion of the plunger member has a length L less than a length L' of the inner wall of the housing and wherein, with a first end of the side wall portion of the plunger member in contact with the connector member, the end wall portion of the plunger member is positioned spaced apart from the opposing second end of the inner wall of the housing.

27. The cap assembly of claim **21**, wherein the first end of the outer wall defines a first tab and a second tab which are spaced apart from one another about the outer wall, and a first end portion of the first tab and a second end portion of the second tab are positioned coplanar with the first plane.

28. The cap assembly of claim **27**, wherein the at least a portion of first end of the outer wall extends between the first tab and the second tab positioned spaced

Date Reçue/Date Received 2023-04-03

apart from the first plane wherein the first tab, the second tab and the at least a portion of the first end define a recess within the outer wall which extends through the outer wall and is in communication with the space, such that, with the first end of the inner wall abutting the structure, the first flow path is defined from the space through the recess of the outer wall.

29. The cap assembly of claim **21**, wherein the first end of the outer wall extends about the inner wall spaced apart from the first plane defined by the first end of the inner wall, and the cap assembly is further configured such that when the first end of the inner wall abuts the structure the flow path from the space is formed through a gap, wherein the gap is defined by the first end of the outer wall and the structure.

30. A structure comprising a metallic fastener and the cap assembly of any one of claims **21** to **29**, wherein the metallic fastener extends through the structure and the cap assembly encloses the metallic fastener.

31. An aircraft comprising the structure of claim **30**.

32. A method for enclosing a metallic fastener extending through a structure, comprising the steps of:

positioning a housing comprising an inner wall and an outer wall onto the structure wherein:

the inner wall surrounds the metallic fastener extending through the structure and is positioned such that a first end of the inner wall abuts the structure and an opposing second end of the inner wall is spaced apart from the first end; and

the outer wall extends about and is spaced apart from the inner wall defining a space between the inner wall and the outer wall which contains an uncured sealant, and at least a portion of a first end of the outer wall is spaced apart from a first plane defined by the first end of the inner wall of the housing and with the

Date Reçue/Date Received 2023-04-03

first end of the inner wall abutting the structure a flow path is defined from the space through the at least a portion of the first end of the outer wall spaced apart from the first plane; and

moving a side wall portion of a plunger member between the inner wall and the outer wall within the space displacing the uncured sealant within the space, and such that an end wall portion of the plunger member, that is secured to the side wall portion of the plunger member, is in alignment with the opposing second end of the inner wall and with an opening defined by and through the inner wall, said alignment providing an enclosure provided by the housing and the plunger member in which to contain the metallic fastener.

33. The method of claim **32**, wherein moving the side wall portion of the plunger member further includes moving the plunger member in a direction toward the housing.

34. The method of claim **32** or **33**, wherein moving the side wall portion of the plunger member within the space includes positioning the uncured sealant between at least one of: the side wall portion of the plunger member and the inner wall of the housing; or the side wall portion of the plunger member and the outer wall of the housing.

35. The method of any one of claims **32** to **34** wherein displacing the uncured sealant further includes positioning the uncured sealant between at least the portion of the first end of the outer wall and the structure.

36. The method of any one of claims **32** to **34**, wherein displacing the uncured sealant further includes extruding the uncured sealant from between the first end of the outer wall and the structure and away from the outer wall.

Date Reçue/Date Received 2023-04-03

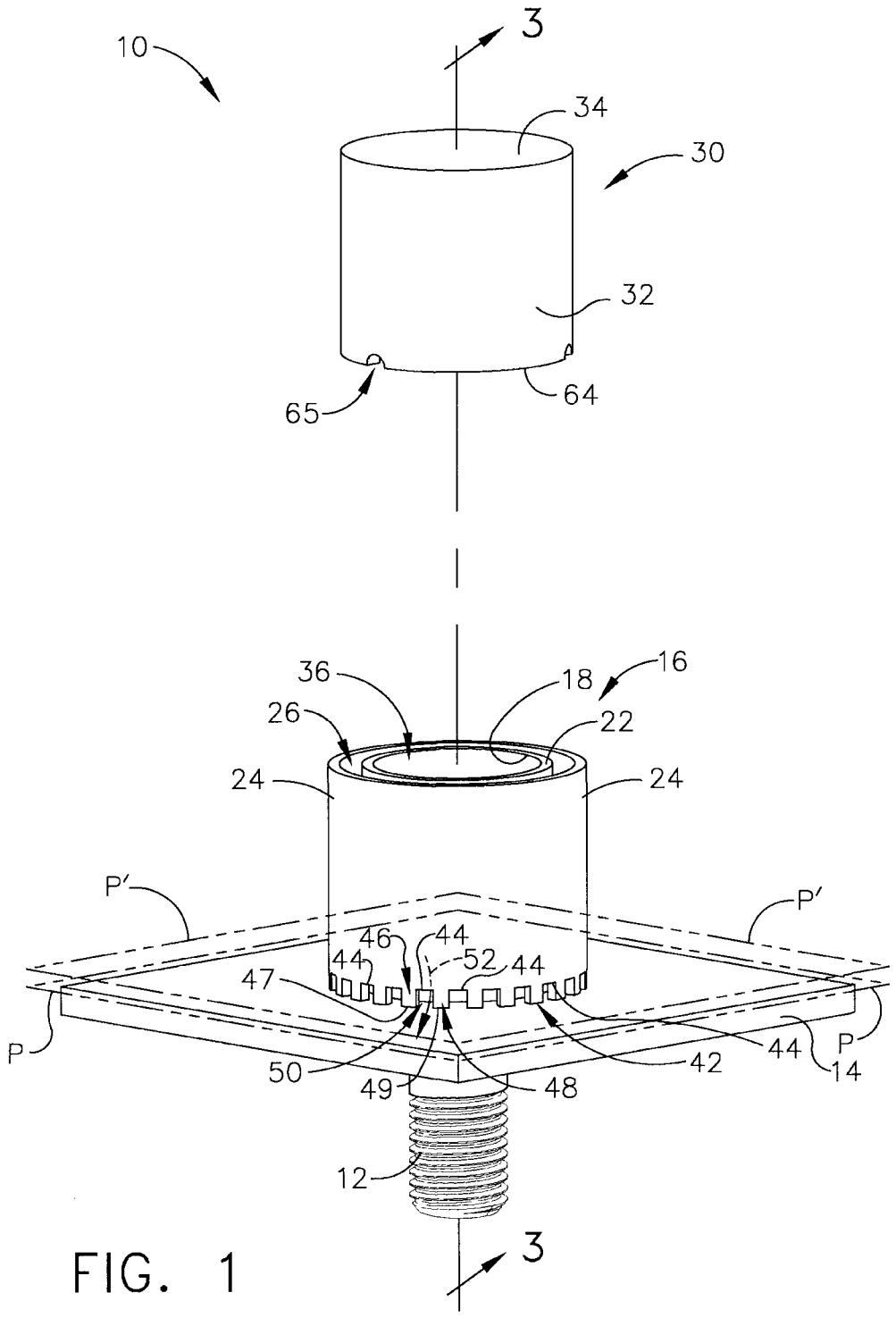
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FIG. 1

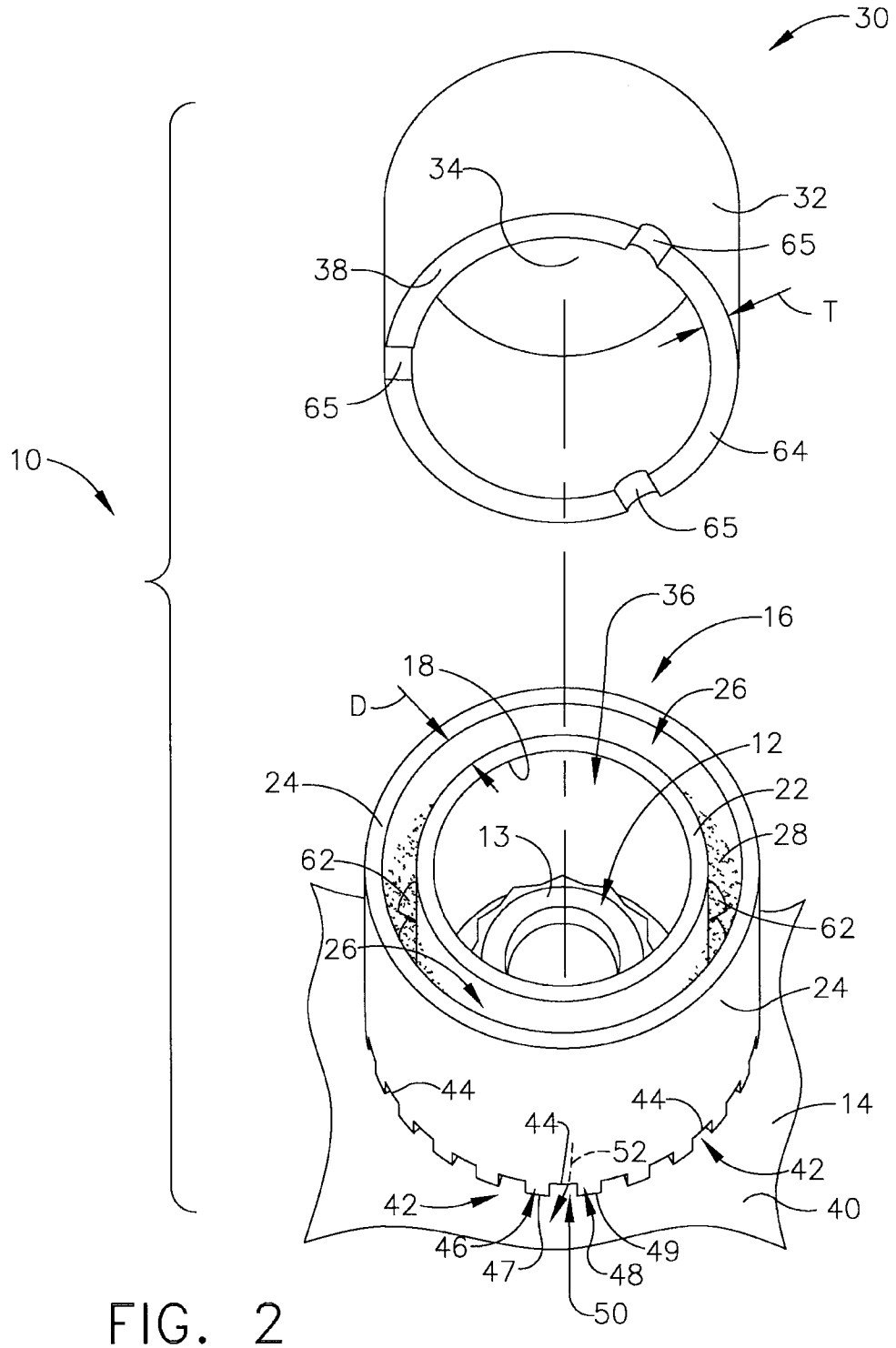
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FIG. 2

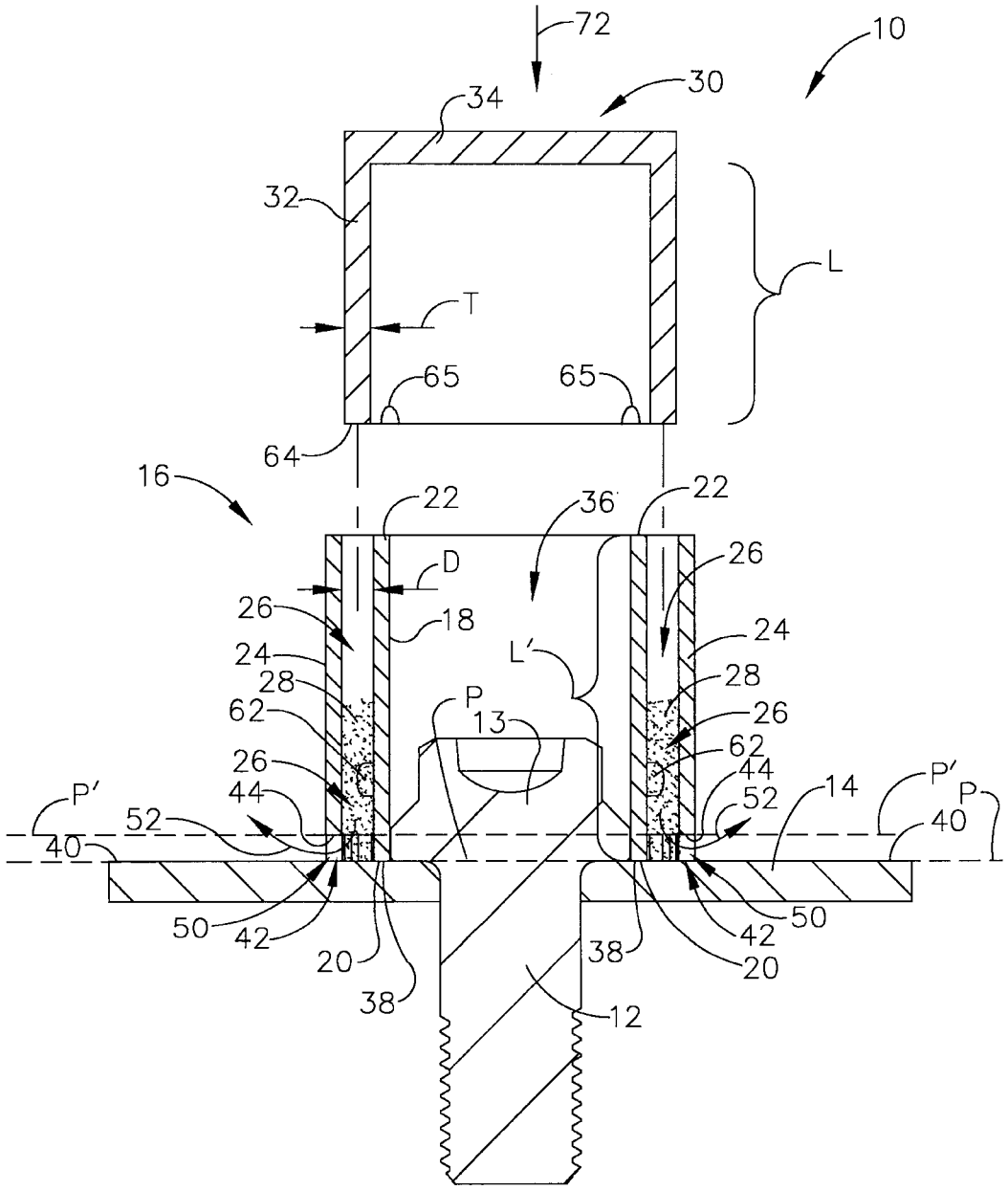
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FIG. 3

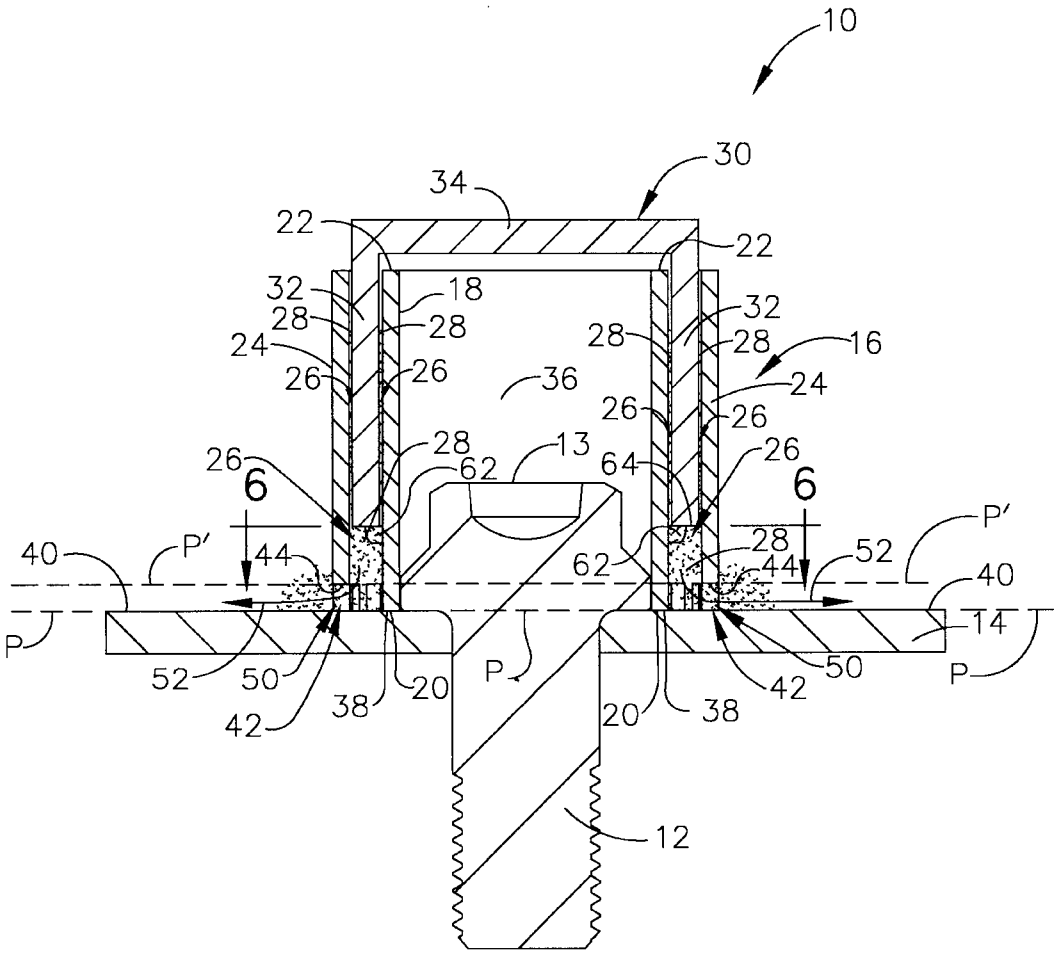
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FIG. 4

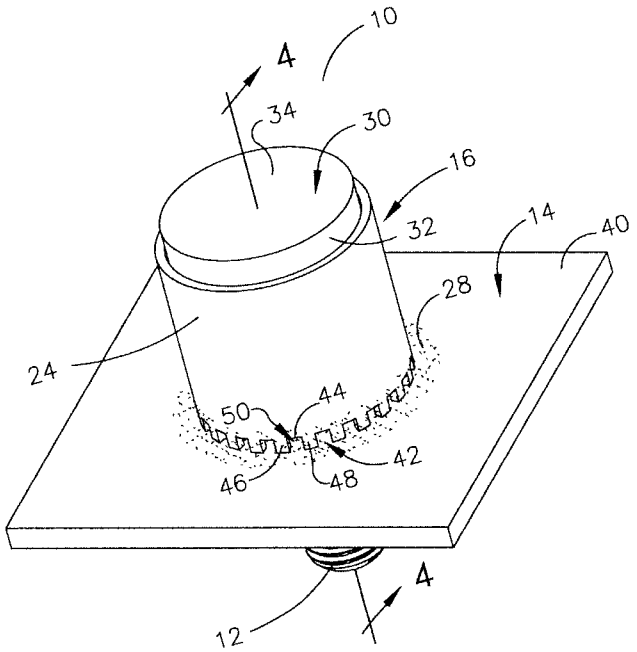

FIG. 5

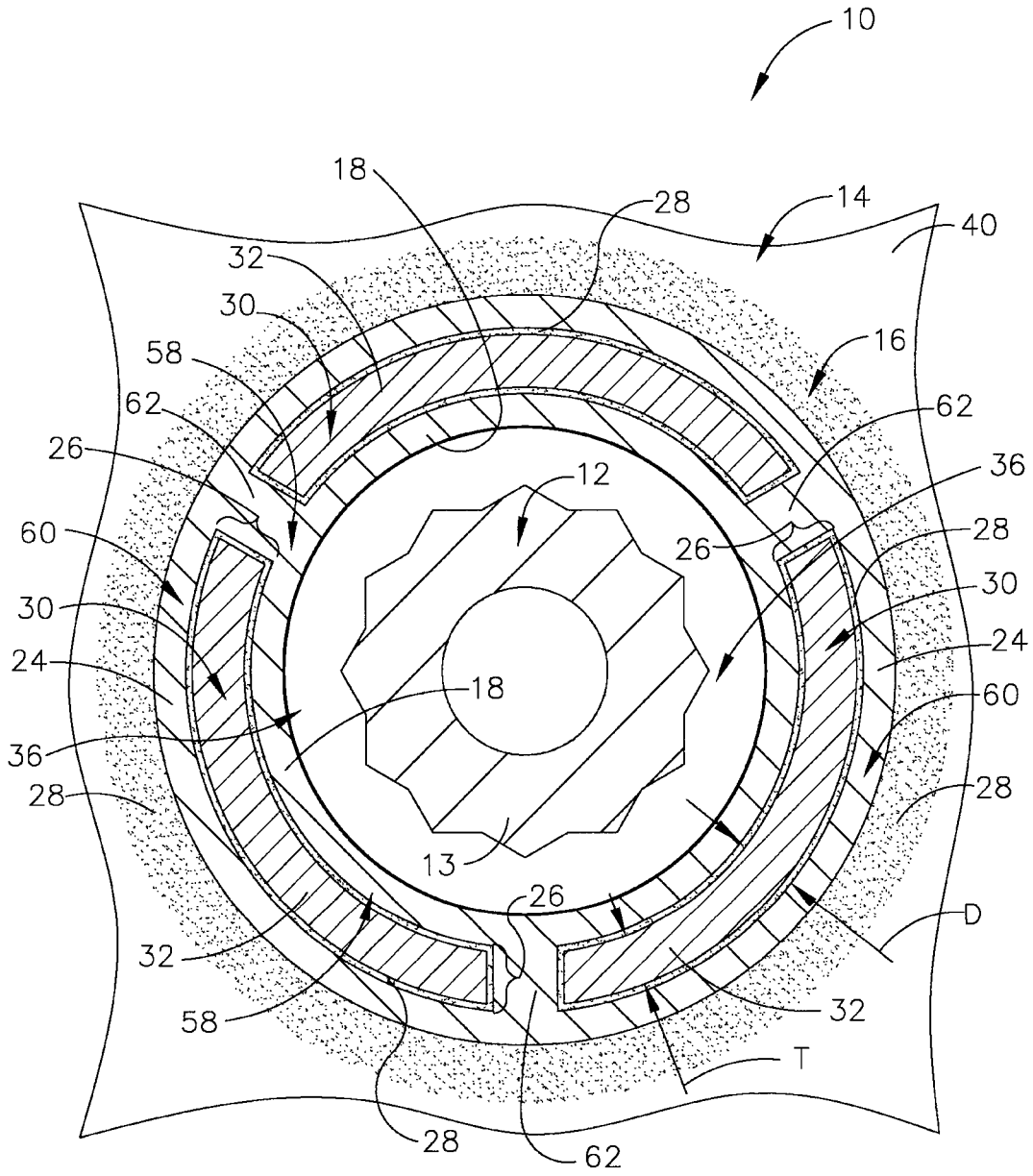
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FIG. 6

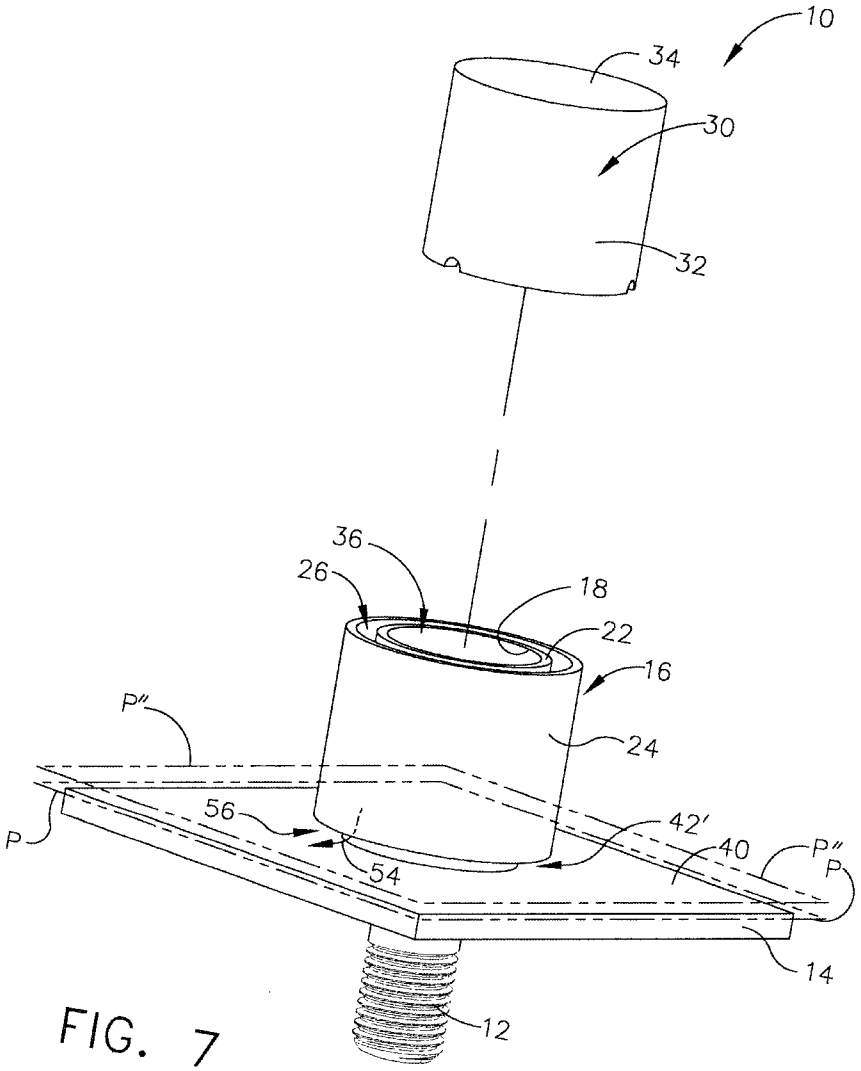


FIG. 7

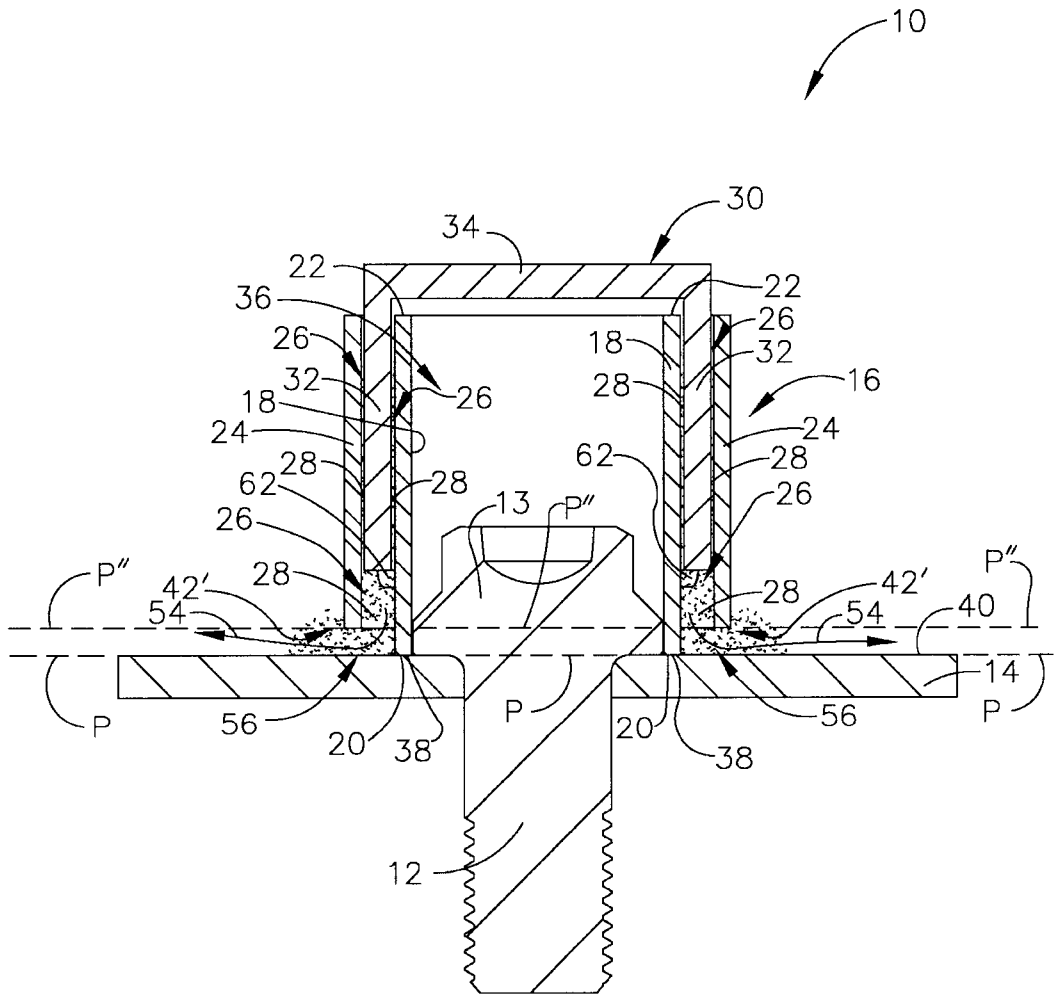
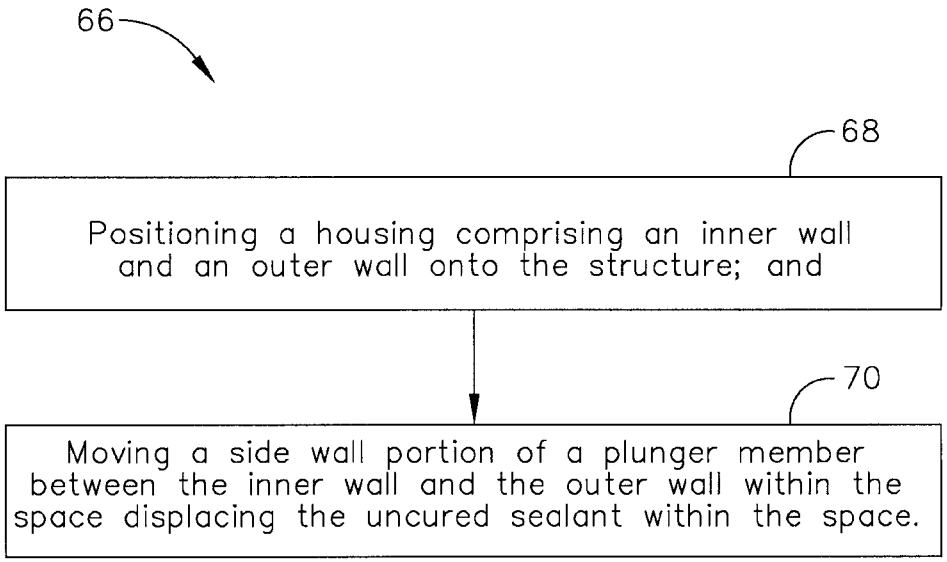


FIG. 8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Positioning a housing comprising an inner wall and an outer wall onto the structure; and
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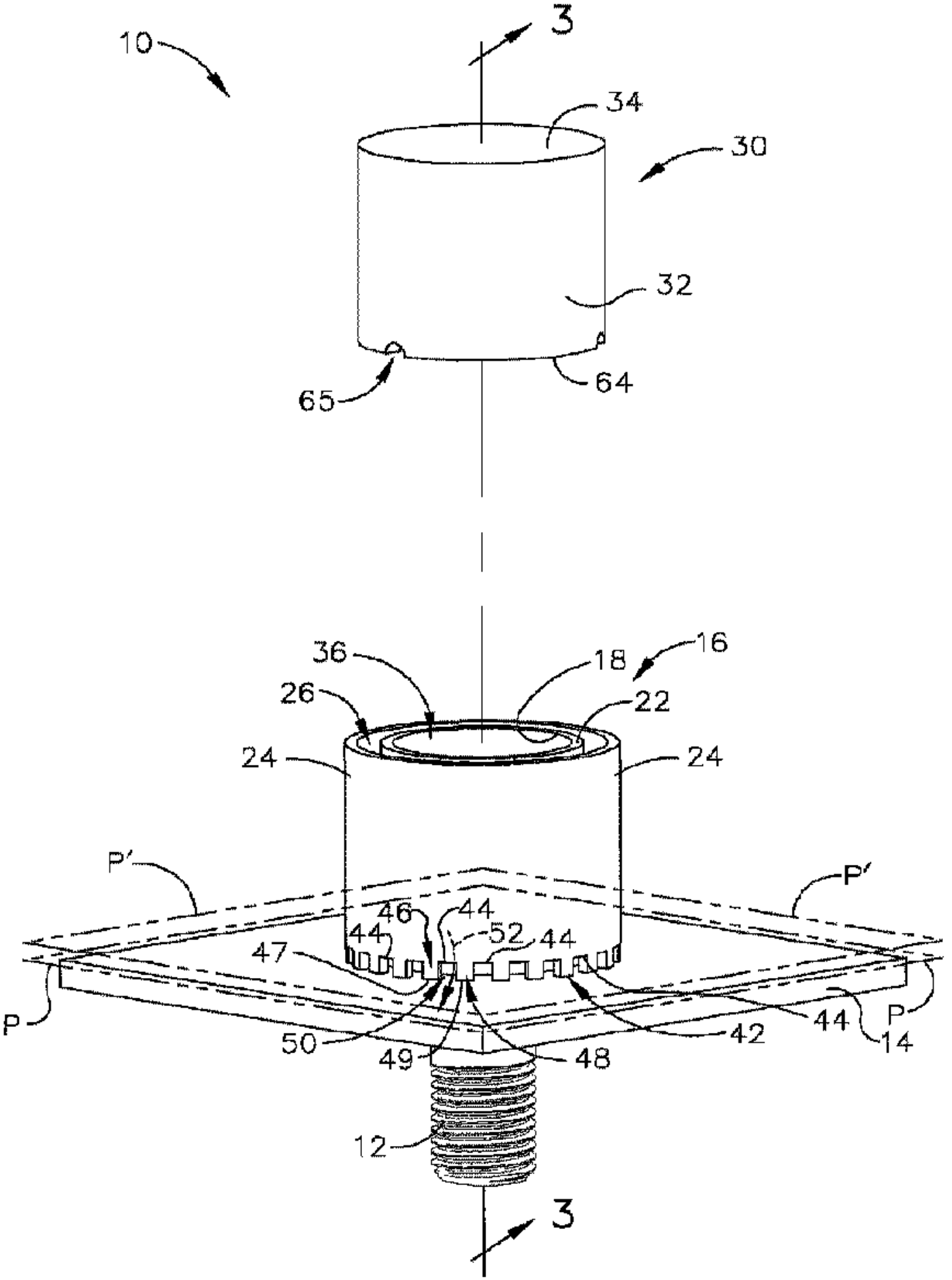
Moving a side wall portion of a plunger member between the inner wall and the outer wall within the space displacing the uncured sealant within the space.

FIG. 9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