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(54) **SHEARING FASTENER FOR SEALING A FASTENER HOLE**

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(57) **ABSTRACT**

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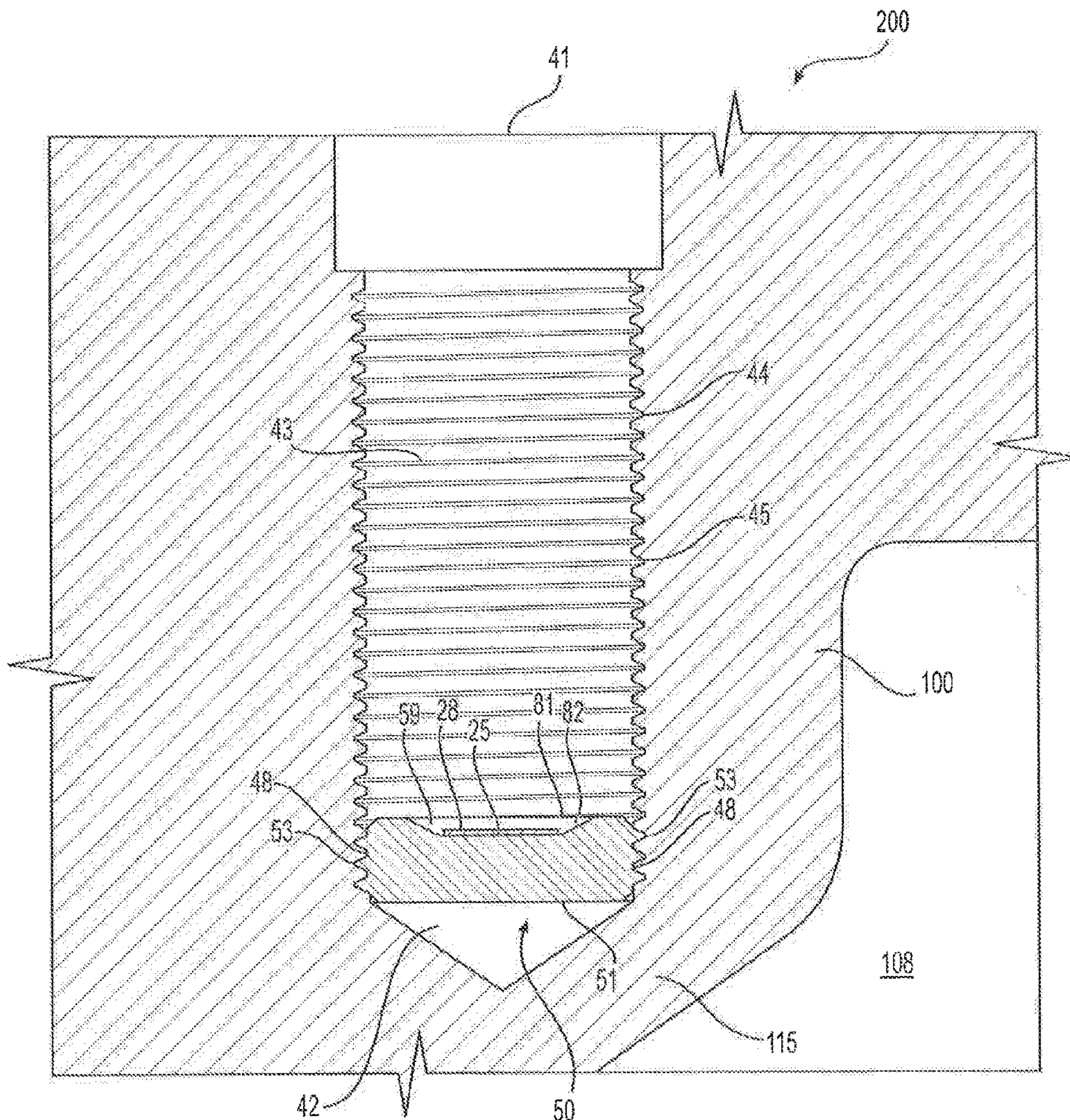
A shearing fastener for sealing a fastener hole in a work piece includes a shank, a plug, and a fastener head. The fastener head is disposed along the upper end of the shank, while the lower end of the shank further includes a transition section that tapers inward and intersects with an upper surface of the plug at a neck. The plug has a threaded outer surface and an outer diameter greater than the shank. The plug engages the threaded bore of the fastener hole when inserted therein. The shank is configured to shear across the neck and separate the shank from the plug when the fastener head is torqued above a threshold torque. The plug is retained within the threaded bore of the fastener hole to seal the lower end of the fastener hole, forming a repaired work piece.

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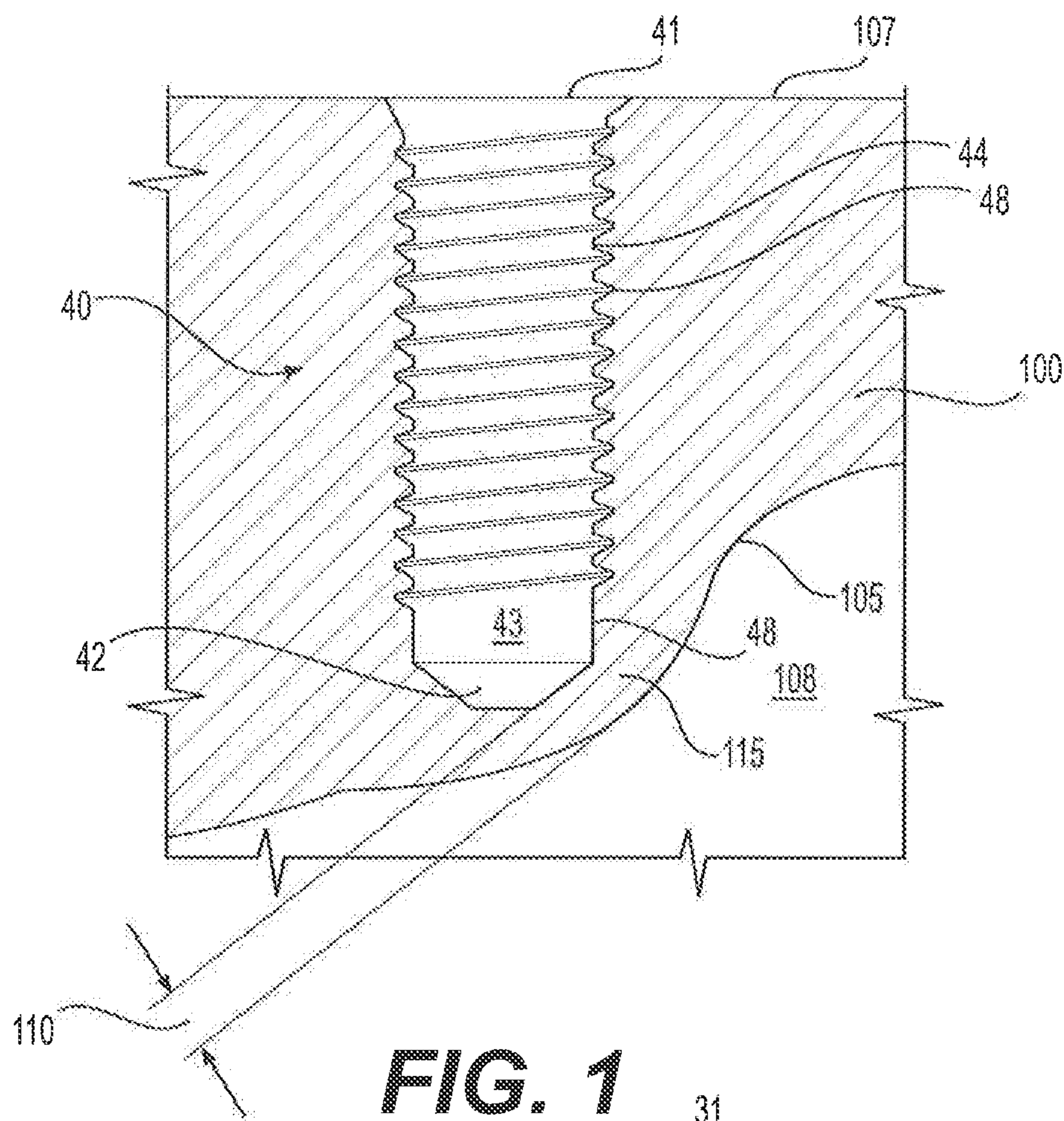


FIG. 1

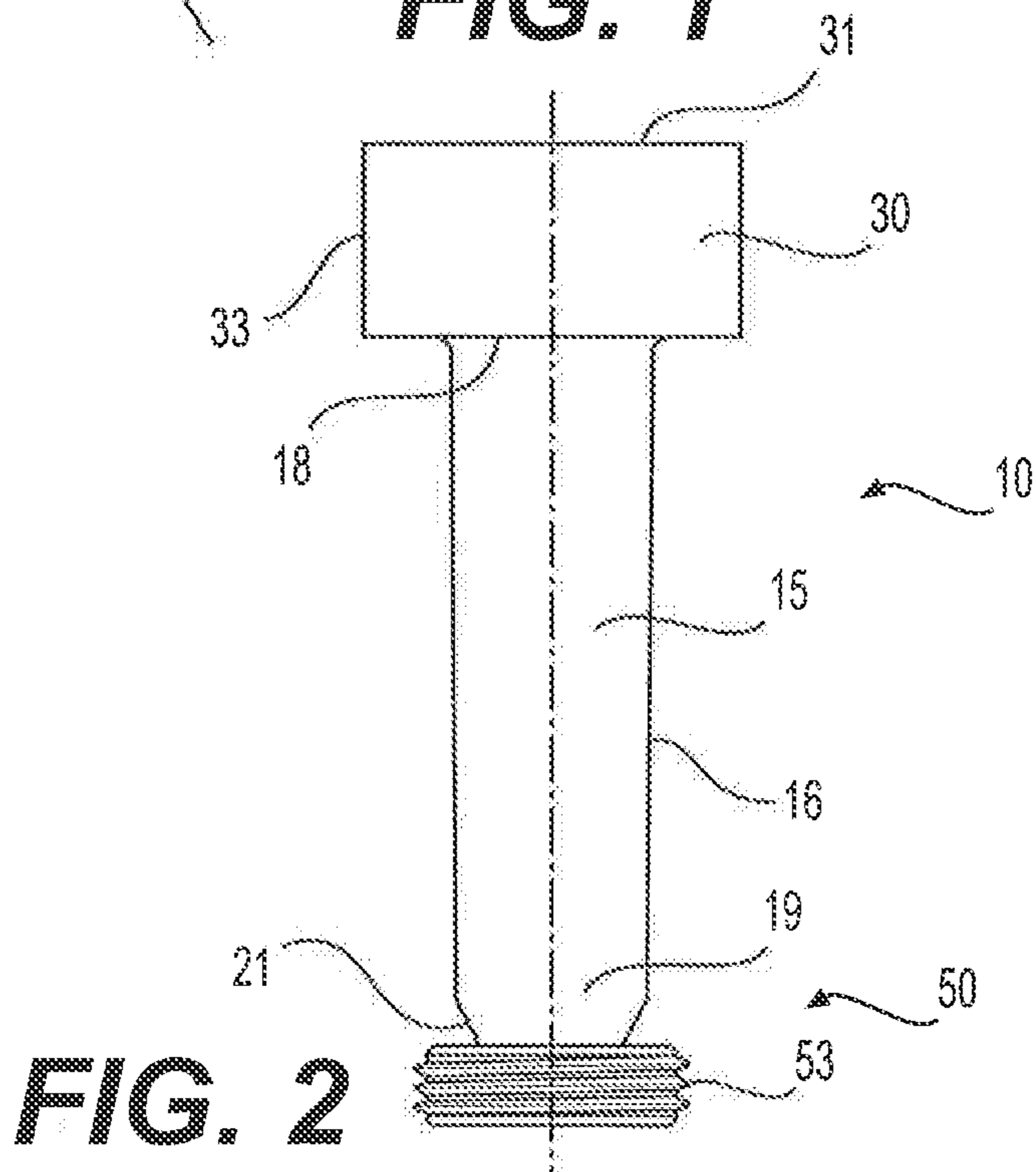


FIG. 2

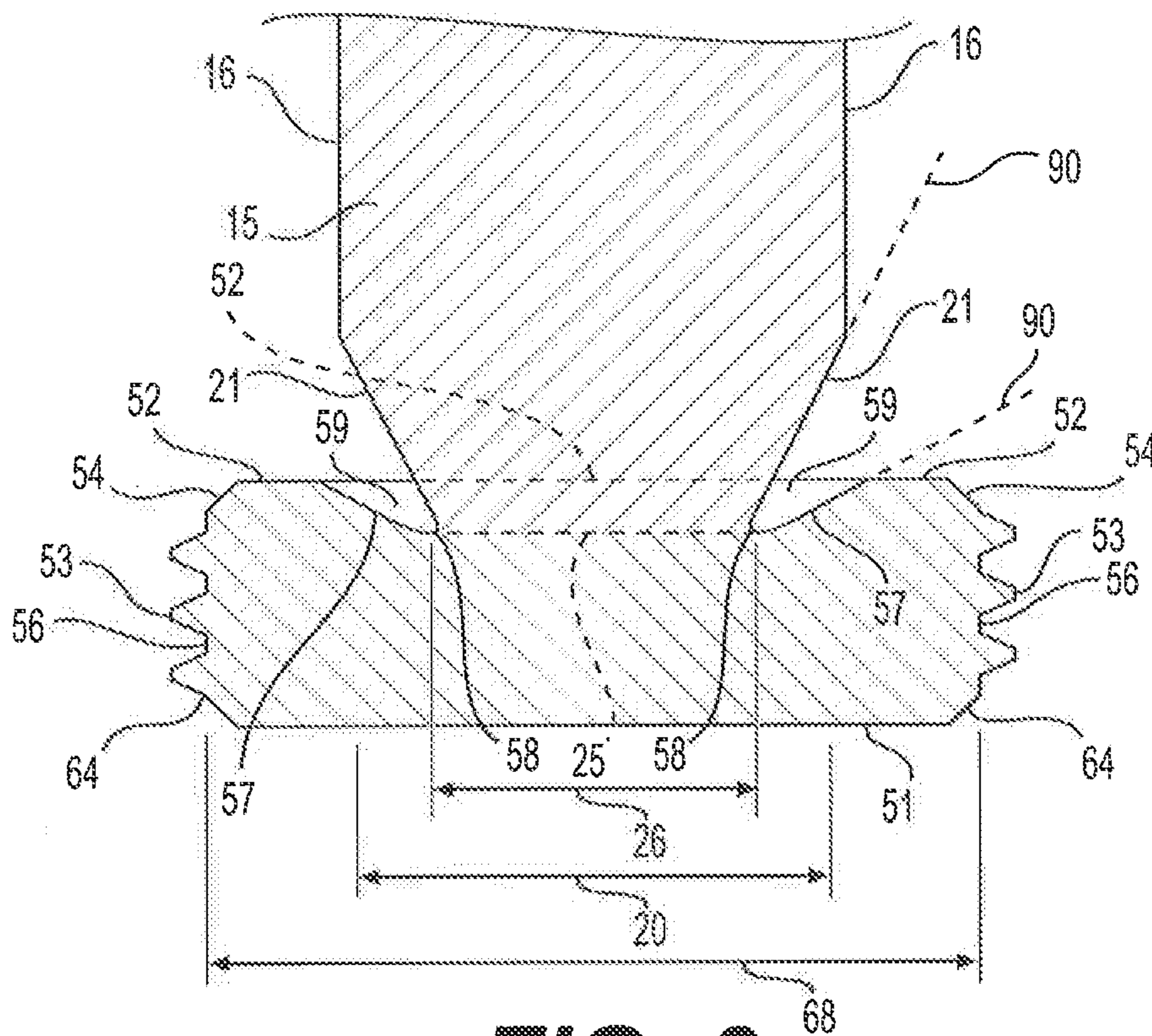


FIG. 3

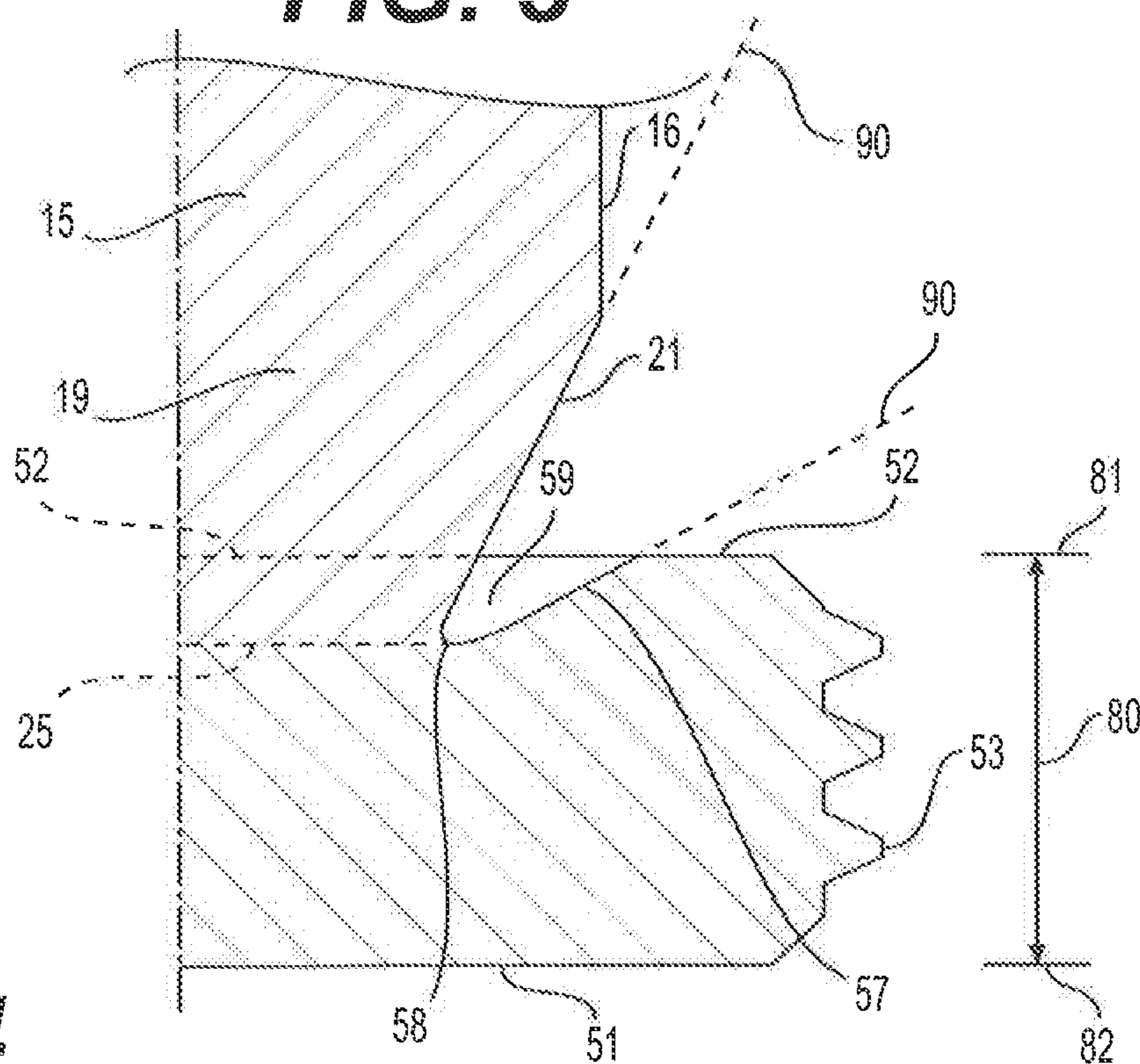


FIG. 4

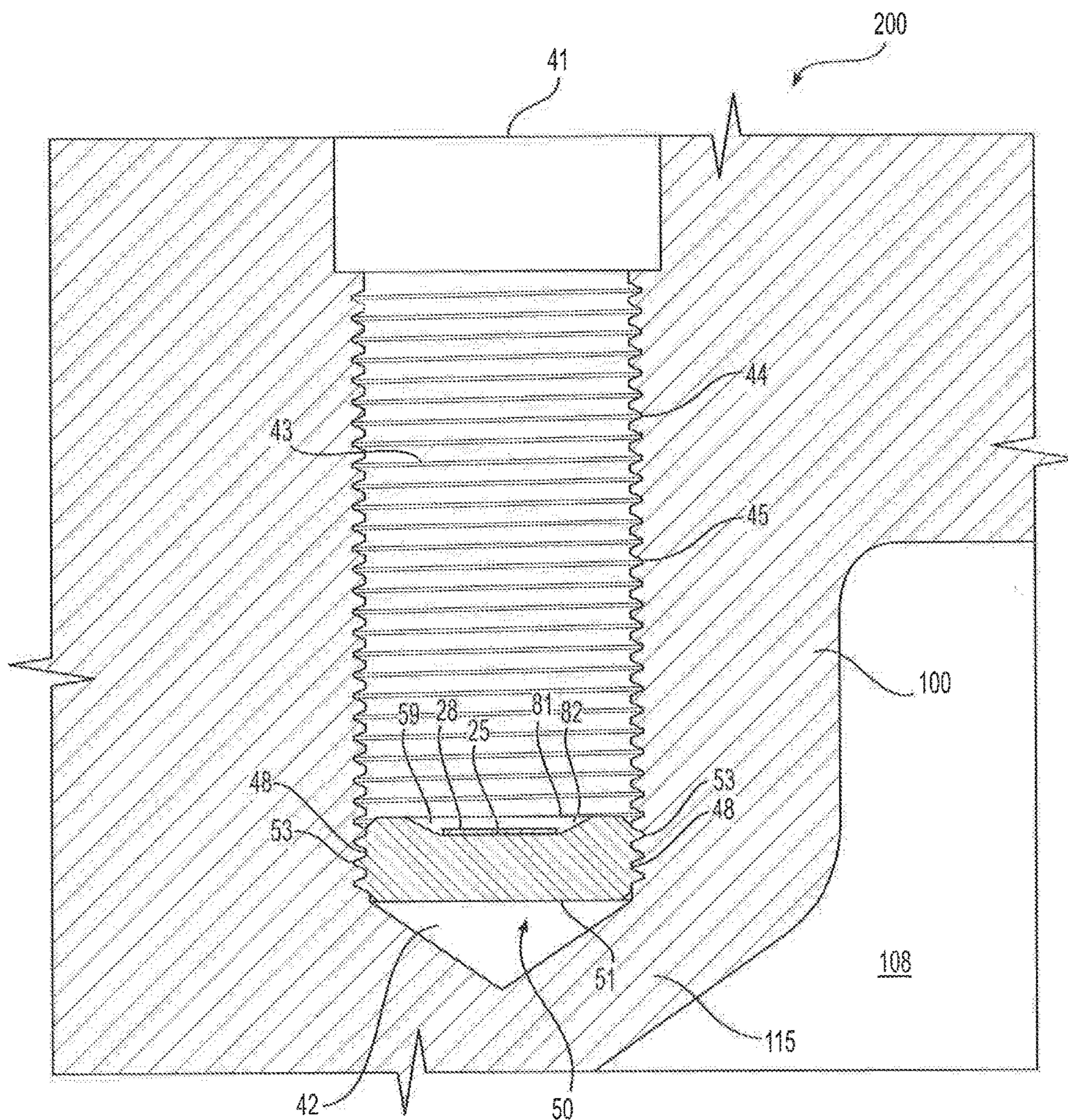


FIG. 5

SHEARING FASTENER FOR SEALING A FASTENER HOLE

TECHNICAL FIELD

[0001] The present disclosure relates generally to a fastener, and more particularly to a shearing fastener for sealing a fastener hole.

BACKGROUND

[0002] The ability to repair a flaw within the interior of a fastener hole is sometimes limited because of the restricted access within the interior of the hole and the inability to insert tooling to conduct repairs. In the context of a cast work piece, core shifts and other casting irregularities can sometimes create thin wall sections adjacent to fastener holes. These thin wall sections are prone to leaks, either by way of material failure at the flaw location or because of porosity of the work piece material. This can result in an irreparable work piece and thus a complete loss of the casting.

[0003] Repairing thin wall sections of a work piece generally entails a drilling and tapping process. The thin wall section is drilled, tapped, and then a set screw is inserted into the newly-formed hole to seal the section and prevent leaks. This process is feasible where the flaw is accessible. However, for thin wall sections adjacent to fastener holes and internal to the work piece, access is limited for tooling to repair the flaw both from within the hole and from the interior of the work piece.

[0004] The disclosed shearing fastener is directed to address these and other problems.

SUMMARY OF THE INVENTION

[0005] In one aspect, the present disclosure is directed to a shearing fastener for sealing a fastener hole including a shank, a plug, and a fastener head. The shank has an upper end, a lower end, and an outer diameter. The fastener head is disposed along the upper end of the shank and the lower end of the shank includes a transition section that tapers inward to a neck that intersects with an upper surface of the plug. The plug has a threaded outer surface and an outer diameter that is greater than the outer diameter of the shank.

[0006] In another aspect, the present disclosure is directed to a method of sealing a fastener hole in a work piece that includes threading a shearing fastener into a threaded bore of the fastener hole, the shearing fastener including a shank, a plug, and a fastener head. The shank has an upper end, a lower end, and an outer diameter. The fastener head is disposed along the upper end of the shank, while the lower end of the shank further includes a transition section that tapers inward to a neck disposed along an upper surface the plug. The plug has a threaded outer surface that engages the threaded bore and an outer diameter that is greater than the outer diameter of the shank. The method further includes rotating the fastener head of the shearing fastener until its plug bottoms out in the threaded bore. Then torque is applied to the fastener head sufficient to shear a neck of the shearing fastener to separate its shank from the plug. The shank is then removed from the threaded bore, retaining the plug within the threaded bore.

[0007] In yet another aspect, the present disclosure is directed to a repaired work piece having a fastener hole with a sealed bore made by a process including the steps of

threading a shearing fastener into a threaded bore of the fastener hole. The shearing fastener includes a shank, a plug, and a fastener head. The shank also has an upper end, a lower end, and an outer diameter. The fastener head is disposed along the upper end of the shank, while the lower end of the shank further includes a transition section that tapers inward to a neck disposed along an upper surface the plug. The plug has a threaded outer surface that engages the threaded bore and an outer diameter that is greater than the outer diameter of the shank. The fastener head of the shearing fastener is rotated until its plug bottoms out in the threaded bore. A torque is applied to the fastener head sufficient to shear a neck of the shearing fastener to separate its shank from the plug, after which the shank is removed from the threaded bore and the plug is retained within the threaded bore.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1 is a cross-sectional view of an exemplary work piece with a fastener hole and thin wall section at the bottom of the fastener hole;

[0009] FIG. 2 is a side elevation view of an exemplary disclosed shearing fastener;

[0010] FIG. 3 is a cross-sectional view of the exemplary shearing fastener of FIG. 2;

[0011] FIG. 4 is a close-up of the cross-sectional view of the exemplary shearing fastener of FIG. 2; and

[0012] FIG. 5 is a cross-sectional view illustrating an exemplary repaired work piece using a disclosed method of operating the shearing fastener of FIG. 2.

DETAILED DESCRIPTION

[0013] FIG. 1 illustrates an exemplary fastener hole **40** disposed within a work piece **100**. In various exemplary implementations of the apparatus and method according to this disclosure, the work piece may be any part having a fastener hole, including an engine block. The fastener hole **40** has an open upper end **41**, interior walls **44**, and an interior volume **43**. The fastener hole **40** is generally a tapped hole extending through an upper surface **107** of the work piece **100** with threads **45** along its interior walls **44**. A tap is used to create the threads **45**, where the tap sometimes stops short of a lower end **42** of the fastener hole. In these instances, a smooth wall section **48** can be present along the lower end **42** of the hole **40**. The length of threads **45** along the walls **44** of the fastener hole **40** and the size of its interior volume **43**, however, enable the fastener hole **40** to receive a threaded fastener therein. To receive the threaded fastener, the fastener hole **40** has a defined diameter, depth, and thread pitch that are all complementary to the threaded fastener.

[0014] An exemplary fastener hole **40** of the present disclosure is a fastener hole with an enclosed lower end **42** as presented in FIGS. 1 and 5. Enclosed fastener holes, or blind fastener holes, do not pass completely through the work piece **100**. While these types of fastener holes **40** are illustrative of potential applications for the apparatus and techniques disclosed herein, the disclosure is not limited to sealing enclosed or blind fastener holes.

[0015] Creating fastener holes in a work piece can create flaws if the holes are improperly located or the work piece has shifted during manufacturing. In particular, fastener holes **40** such as shown in FIG. 1 may be drilled too closely

to an interior cavity **108** within the work piece. This locates the lower end **42** of the fastener hole **40** a short distance away from an interior wall **105** within the work piece, resulting in a thin wall section **115** between the interior cavity **108** and the fastener hole **40**. These thin wall sections **115** may have a dimension **110** (i.e. a material thickness) smaller than design limits allow. This can lead to premature structural failure at this location or fluid pass-through by way of material porosity and short travel distance.

[0016] FIG. 2 illustrates a side view of an exemplary shearing fastener of the present disclosure. The shearing fastener **10** includes a shank **15**, a plug **50**, and a fastener head **30**. The shank **15** is an elongated member with an upper end **18** and a lower end **19**. In one embodiment, the shank **15** forms an elongated cylindrical member with an outer profile **16** having a smooth surface. The outer profile **16** of the shank **15** has an outer diameter that may be uniform along its length and configured to be less than the diameter of the fastener hole **40**. This allows the outer profile of the shearing fastener **10** to be inserted into the fastener hole without the shank **15** engaging the threads **45** of the fastener hole **40**, while also being sized to be received without interference into the interior volume **43** of the fastener hole **40**.

[0017] As shown in FIGS. 2-4, the lower end **19** of the shank **15** includes a transition section **21** that tapers inward to a neck **25** that intersects the plug **50**. The plug **50** extends outward and has an outer diameter **68** that is greater than the diameter of the shank **20** along its length. The plug **50** has a threaded outer surface **53** along its outer diameter that is configured to engage the threads **45** of the fastener hole **40**. In this manner, the threaded outer surface **53** of the plug **50** is configured to engage the threads **45** of a fastener hole **40** while the smaller-diameter shank **15**, with its smooth outer profile, is received within the hole without engaging the hole threads **45**. The shank **15** therefore connects to the plug **50** and drives the plug **50** into the fastener hole **40** by appropriate rotation of the shank **15**.

[0018] Along the upper end **18** of the shank is a fastener head **30** that has an upper surface **31**. The fastener head **30** is configured to connect to a torqueing tool, such as a wrench, driver, or another suitable tool for applying a rotation to the fastener head **30**. In one example, the upper surface **31** of the fastener **10** may have a depression forming a hexagonal socket, a Phillips head socket, a torx socket, or the like. Alternatively, the sides of the fastener head **30** may be faceted to allow a wrench, socket, or similar torqueing tool to apply a rotation and torque to the outer surface **33** of the fastener head. The rotation applied to the fastener head **30** via the particular tool imparts a rotation on the shank **15** and a like rotation on the plug **50**, driving the plug **50** into the fastener hole **40** when the complementary threads of the fastener hole **40** and plug **50** are aligned. As the head **30** is rotated, the plug **50** rotates and is drawn into the interior volume **43** of the hole **40**.

[0019] FIGS. 3 and 4 show side section views of the exemplary shearing fastener **10** of the present disclosure at the intersection of the shank **15** and the plug **50**. The lower end **19** of the shank **15** has a transition section **21** that tapers inward, reducing the diameter of the shank **20** until intersecting with the plug **50**. The transition section **21** tapers the diameter of the shank **20**. In one embodiment, the transition section **21** may taper the shank **15** equally around the periphery of the shank **15** and linearly until the shank **15**

intersects an upper surface **52** of the plug **50**. The intersection between the shank **15** and the plug **50** forms a neck **25**, which has a neck diameter **26**. The neck diameter **26** is smaller than the diameter of the shank **15** and the transition section **21** tapers the lower end **19** of the shank to the neck **25**. Therefore, the neck **25** has a smaller cross-sectional area than the cross-sectional area of the shank **15** along its upper end **18**.

[0020] The plug **50** further includes an upper surface **52**, a height **80**, an upper extent **81**, and a lower extent **82**. The upper surface **52** of the plug in one embodiment is not planar and not coincident with the upper extent **81** of the plug across its surface area. Rather, the upper surface **52** may include a recess **59** that extends into the plug **50** and below its upper extent **81**. The upper surface **52** may be aligned with the upper extent **81** of the plug **50** along the outer periphery of the upper surface **52**, while the recess **59** extends downward into the plug at the intersection of the transition section **21** and the plug upper surface **52**. The transition section **21** of the shank **15** intersects the plug **50** at the neck **25**. The neck **25** is disposed within the recess **59** and below the upper extent **81** of the plug. Therefore the neck **25** is disposed within the interior of the plug's height **80** (i.e. below its upper extent **81**).

[0021] Additionally, the plug **50** may have a round outer profile **56** with a threaded outer surface **53**. The threads **53** extend around the round outer profile **56** of the plug and along the height **80** of the plug. Along the upper corner **54** and lower corner **64** of the plug, material may be removed so the corners **54**, **64** are chamfered. This eliminates right-angle transitions between the outer profile **56** of the plug and the upper surface **52**, and between the outer profile **56** and a lower surface **51**. The chamfered corners **54**, **64** facilitate insertion of the plug **50** into the open upper end **41** of the fastener hole **40**, and further prevent the plug **50** from catching any burrs or flaws within the interior of the fastener hole **40** while being threaded therein.

[0022] Along the upper surface **52** of the plug is the recess **59**. The recess **59** is a cavity formed between the transition section **21** of the shank **15** and an angled surface **57** extending downward from the upper extent **81** of the plug **50** along its upper surface **52**. The transition section **21** of the shank **15** and the angled surface **57** converge at a radius **58** along the periphery of the neck **25**. This radius **58** forms an acute angle or "sharp" angle that is configured to create a stress riser or stress concentration when the fastener **10** is subjected to physical load. A stress riser is an area that experiences particularly high stresses or concentrations of stress when a part is subjected to load. The stress riser created by the radius **58** therefore forms a designed weak point across the neck **25**, and therefore a weak point between the shank **15** and the plug that can be used as a designed separation plane. In particular, the radius **58** extending around the periphery of the neck **25** at the smallest diameter section of the transition section **21** (i.e. the neck) forms a shear plane across the neck. This is a designed failure location and is used to separate the shank **15** from the plug **50** at the neck **25** when the shank is subjected to a threshold torque. This shear plane extends across the neck **25** and may be disposed within the recess **59** below the upper extent **81** of the plug **50**.

[0023] Described in more detail, the neck **25** is a designed failure location between the shank **15** and the plug **50** such that the two separate when a threshold stress develops at the

radius **58** and across neck **25**. In a preferred embodiment, the designed stress riser, at the radius **58** at the intersection of the transition section **21** and the plug **50**, develops a higher concentration of stress than the rest of the fastener **10** when the fastener is subjected to load at the fastener head **30**. The placement of the radius **58** adjacent to the small-diameter neck **25** forms a designed shear plane across the neck **25**. The shank **15** and the plug **50** separate across the neck **25** when sufficient shear load develops at this location. This facilitates a particular mode of failure, in which the shank **15** will separate from the plug **50** and the failure point will be across the neck **25** and below the plug upper extent **81**. Any barbs or burrs that inadvertently develop at the neck **25** at failure will therefore be maintained within the recess **59** and not protrude above the plug upper extent **81**. This is particularly useful when maximizing available space in a fastener hole by preventing protruding burrs from consuming any useful space.

[0024] The shear force used to separate the shank **15** from the plug **50** is generally introduced by a torque applied to the fastener head **30**. The threshold torque, or torque necessary to shear the shank **15** from the plug **50** at the neck **25**, will be dependent on several factors. These include primarily the ultimate stress of the fastener material and the diameter of the neck **25**. The choice of material used to form the fastener (i.e. stainless steel, etc.) and the method in which the material is manufactured (i.e. forged, etc.) will dictate the ultimate stress. The designed diameter of the neck **25** for failing at a specific shear load (i.e. threshold torque) will be dependent on the diameter of the fastener hole **40**, which will limit the neck diameter **26**. Therefore, the threshold torque required to separate the shank **15** from the plug **50** will be based on the dimensions, material, and design limitations of the particular application.

[0025] With respect to forming the shearing fastener **10** of the present disclosure, several methods are contemplated. In one process, the recess **59** is formed in the upper surface **52** of the plug using a milling process. In an embodiment, a carbide bit of a milling machine, or another type of bit driven by another suitable machine, is plunged at an angle into the area forming the recess **59** between the plug **50** and shank **15** to remove material. At the same time, this same cutting process forms the radius **58** around the periphery of the neck **25**. The radius **58** is a tight bend or sharp radius as described above, forming the stress riser around the perimeter of the neck **25**. At the same time, the milling operation also forms the transition section **21** at lower end **19** of the shank **15** and the angled surface **57** in the upper surface **52** of the plug. The bit, having a substantially conical cutting surface, forms the radius **58** at the same time the recess **59** and transition section **21** are cut. The conical bit, shown by the conical cut lines **90** in FIG. 3, defines the profile of the recess **59**, the transition section **21**, and the radius **58** in one operation. While this is one method of manufacturing, other operations are also contemplated for forming these features. The disclosed milling operation is but one process that is not intended to be limiting.

[0026] Along with the disclosed milling operation, the shearing fastener of the present disclosure may also be formed from an existing threaded fastener. In one embodiment, an existing threaded fastener can be used as the basis for forming the smooth shank, threaded plug, and intersection between the two. The existing fastener is turned on a lathe or milling machine to remove the threads from its shank

and to reduce its diameter. This process is conducted along the shank and below its fastener head, and stops short of a distal end of the shank. This leaves a section of threads remaining for forming the new plug. Once turned, a cutting bit can be plunged into the intersection of the smooth shank and the plug to form the radius and recess. The result is a smooth surface shank and a threaded plug with the radius and transition section described above.

[0027] In an alternative embodiment, the shearing fastener of the present disclosure may be formed from scratch using a rolled forging technique. The rolled forging is heat treated and machined to form the shank and plug. The rolled forging is rolled using a tool to form the threads of the plug. Machining operations can then form the recess and radius.

INDUSTRIAL APPLICABILITY

[0028] The disclosed shearing fastener may be applicable to any work piece having a fastener hole. This includes work pieces where a fastener hole is adjacent to an interior cavity within the work piece, and a thin wall section exists between the bottom of the fastener hole and the cavity. The thin wall section occurring at the bottom of a threaded fastener hole may be subject to failure or may create potential locations for leakage. Example work pieces include engine blocks with fastener holes improperly located adjacent to interior coolant passages. This can occur when technicians drill fastener holes in the block and misplace their locations. This can also result from an improper design or shifts during the block casting process, in which irregularities in the block are formed. In any case, when this occurs and a fastener hole is too close to an interior passage, the block is generally scrapped and a new block must be cast.

[0029] The disclosed shearing fastener can be installed into a threaded fastener hole of a machine component using standard tools. The shearing fastener facilitates the repair of a thin wall section at the bottom of the fastener hole by sealing the lower end of the fastener hole with a plug portion of the fastener configured to break off from the rest of the shearing fastener at a threshold torque. By sealing the hole, any thin wall section between the fastener hole and an interior cavity in the work piece will not result in fluid pass-through or leakage into the fastener hole. The following description sets forth an exemplary implementation of a repair method using the disclosed shearing fastener.

[0030] As shown in FIG. 5, when a work piece **100** is inspected and either an interior failure or thin wall section **115** is found adjacent to a fastener hole **40**, the shearing fastener **10** of the present disclosure can be used to seal the lower end **42** of the fastener hole **40**. The plug **50** of the shearing fastener **10** is ideally positioned within the lower end **42** of the hole **40**. This retains sufficient volume **43** within the hole **40** and thus a sufficient number of threads **45** along the walls **44** of the hole **40** to grip a subsequent fastener inserted above the plug **50** after the plug **50** has been positioned and separated from the shank **15**.

[0031] To place the plug **50** within the lowermost portion of the hole lower end **42**, additional threads **45** may need to be added. As described previously, the original tapping of the hole **40** may leave a smooth wall section **48** along the lower end **42** of the fastener hole **40**. To ensure the plug **50** can thread to the lower end **42** of the fastener hole, a bottoming tap can be inserted to cut additional threads **45** along the smooth wall section **48** as shown in FIG. 5. This

ensures the plug 50 will bottom out as far into the fastener hole 40 as possible to retain sufficient room above the plug 50 for a subsequent fastener.

[0032] The threaded outer surface 53 of the plug 50 is configured to engage the female threads 45 of a fastener hole 40, while the shank 15 is configured to shear across the neck 25 and form a fracture surface 28 across the neck 25 when separating the shank 15 from the plug 50. To separate the shank 15 from the plug 50, the fastener head 30 is torqued above a threshold torque necessary to develop shear across the neck 25 sufficient to fail the part at this location.

[0033] To seal the hole 40 and separate the plug 50 from the shank 15, the hole 40 may first need to be prepared by adding additional threads to the lower end 42 of the hole 40 using the bottoming tap described above. The shearing fastener 10 is then inserted into the open upper end 41 of the fastener hole 40. The threaded outer surface 53 of the plug 50 is threaded onto the complementary threads 45 of the fastener hole 40. A tool is used to advance the plug 50 into the hole 40 by rotating the fastener head 30 until the plug 50 reaches the lower end 42 of the hole 40 and the end of the threads 45 therein. The plug 50 is thus bottomed-out in the threaded bore of the hole 40 as far as the threads 45 and geometry of the hole will allow.

[0034] The fastener head 30 is then torqued using a tool that applies a torque to the fastener head 30. The torque is transmitted from the fastener head 30 to the shank 15 and thus to the neck 25 and the plug 50. As the fastener head 30 is torqued, torsional stress develops in the shank 15 and the neck 25 at the intersection of the neck with the plug. Once the plug 50 has bottomed-out in the hole 40, the stress becomes concentrated in the neck 25 because of the radius 58 and the cross-sectional area of the neck 25. The torque applied to the fastener head results in a concentrated shear load across the neck 25, where the shear load will cause the material across the neck 25 to fail when a sufficient shear load develops. Therefore, a torque is applied to the fastener head 30 sufficient to shear the neck 25 to separate the shank 15 from the plug 50. Once the threshold torque is reached, the shear load across the neck 25 will fail the shearing fastener across the neck 25 and separate the shank 15 from the plug 50.

[0035] Once the threshold torque is applied and the neck 25 fails, the shank 15 is separated from the plug 50. The shank 15 can then be removed from the threaded bore of the hole 40. The plug 50 is retained within the threaded bore of the hole 40 along its lower end 42. The torque applied to the plug 50 ensures that the plug 50 will remain within the lower end 42 and will not become unseated. To further ensure this, an anaerobic thread locker material can be added to the threaded outer surface 53 of the plug 50 prior to the shearing fastener 10 being inserted into the hole 40. The anaerobic thread locker material cures in the absence of oxygen, and thus seals the threaded outer surface 53 of the plug 50 to the thread 45 of the hole 40 when the plug 50 is seated within the lower end 42.

[0036] Once seated, the plug 50 forms a seal along the lower end 42 of the hole 40. The lower surface 51 of the plug 50 extends across the bore of the hole 40, while the threaded outer surface 53 of the plug 50 and any additional thread-locking compound seals the lower end 42 of the hole. This prevents leakage of fluid from any interior passageways or cavities 108 in the work piece, which can occur in the event of material failure at the thin wall section 115 or leakage

across the thin wall section 115. Thus, the work piece will not leak through the fastener hole 40 when a pressurized or non-pressurized fluid is present in an interior cavity 108 adjacent to the fastener hole 40.

[0037] As illustrated in FIG. 5, in a preferred embodiment, the fracture surface 28 of the neck 25 after being separated from the shank 15 is below an upper extent 81 of the plug 50. That is, the neck 25 is positioned along the upper surface 52 of the plug 50 within a recess 59, below an upper extent 81 of the plug 50. This ensures the fracture surface 28 is disposed within the interior of the plug 50 and no portion of the fracture surface 28 extends above the plug 50. This maximizes room within the bore of the hole 40 and minimizes the volume consumed by the plug 50.

[0038] In addition, the chamfered corners 54, 64 of the plug 50 prevent the plug 50 from catching burrs or imperfections within the threaded bore of the hole 40. This prevents the plug 50 from catching in the hole 40 before reaching the lower end 42. This would create a situation in which the plug 50 may have to be removed from the hole 40 to clean threads 45 of the hole 40, or may cause the installer to apply a greater torque to the fastener head 30 to overcome the obstruction. This can result in unnecessary stress developing in the neck 25 before the plug 50 bottoms out, thus creating the risk of premature failure across the neck 25 before the plug bottoms out. This would reduce the useable volume in the bore of the hole 40, necessitating a smaller fastener above the plug 50 or an operation to remove the plug 50. Neither of these is preferred.

[0039] Several advantages may be achieved with the shearing fastener of the present disclosure. First, the shearing fastener makes it possible to insert a plug 50 within the threaded bore of a fastener hole 40 to plug any potential leaks. Thus, entire work pieces can be saved and prevented from being scrapped if a fastener hole 40 is located too close to an internal cavity 108. A repaired work piece 200, as shown in FIG. 5, can be achieved by the process described above, where the shearing fastener 10 is inserted into the threaded bore of the fastener hole 40, bottomed out, and then torqued above a threshold torque to separate the plug 50 from its shank 15. The plug 50 seals the hole and prevents unwanted leakage through the fastener hole 40, and thus allows for a repaired work piece 200. This prevents material waste, prevents economic waste, and reduces lost time. The threaded bore of the fastener hole 40 becomes a sealed bore, and the work piece can be used as intended despite the proximity of the hole 40 to an interior cavity 108.

[0040] It will be apparent to those skilled in the art that various modifications and variations can be made to the shearing fastener of the present disclosure. Other embodiments will be apparent to those skilled in the art from consideration of the specification and practice of the disclosed shearing fastener. It is intended that the specification and examples be considered as exemplary only, with a true scope being indicated by the following claims and their equivalents.

What is claimed is:

1. A method of sealing a fastener hole in a work piece, comprising:
 - threading a shearing fastener into a threaded bore of the fastener hole, the shearing fastener comprising:
 - a plug having an upper surface and a threaded outer surface;

a shank having an upper end, a lower end, and a diameter;

a transition section along the lower end of the shank that tapers inwardly and intersects the upper surface of the plug at a neck; and

a fastener head disposed along the upper end of the shank;

wherein the plug has a threaded outer surface that is configured to engage the threaded bore and an outer diameter that is greater than the diameter of the shank;

rotating the fastener head until the plug bottoms out in the threaded bore;

applying a torque to the fastener head sufficient to shear the neck of the shearing fastener to separate the shank from the plug;

removing the shank from the threaded bore; and

retaining the plug within the threaded bore.

2. The method of claim 1, further including:

before the step of threading the shearing fastener into the threaded bore, inserting a bottoming tap into the threaded bore; and

cutting additional threads into the threaded bore along a lower end thereof.

3. The method of claim 1, further including:

applying an anaerobic thread locker material to the threaded outer surface of the plug before the step of threading the shearing fastener into the threaded bore.

4. The method of claim 1, wherein the neck of the shank is disposed within a recess along the upper surface of the plug and the step of applying torque to the fastener head sufficient to shear the neck creates a fracture surface within the recess and below an upper extent of the plug.

5. The method of claim 1, wherein the shearing fastener further includes a radius extending around a periphery of the neck at the intersection between the transition section and the upper surface of the plug.

6. The method of claim 5, wherein the radius further includes an acute angle between the transition section and the upper surface of the plug.

7. A repaired work piece having a fastener hole with a sealed bore, the repair of the work piece made by a process comprising:

threading a shearing fastener into a threaded bore of the fastener hole, the shearing fastener comprising:

a shank, a plug, and a fastener head;

the shank having an upper end, a lower end, and a diameter;

the fastener head being disposed along the upper end of the shank;

the lower end of the shank further comprising a transition section that tapers inward and intersects with an upper surface the plug at a neck;

wherein the plug has a threaded outer surface that engages the threaded bore and an outer diameter that is greater than the diameter of the shank;

rotating the fastener head until the plug bottoms out in the threaded bore;

applying a torque to the fastener head sufficient to shear the neck of the shearing fastener to separate the shank from the plug;

removing the shank from the threaded bore; and

retaining the plug within the threaded bore to make the sealed bore.

8. The repaired work piece of claim 7, wherein:

before the step of threading the shearing fastener into the threaded bore, inserting a bottoming tap into the threaded bore; and

cutting additional threads into the threaded bore along a lower end thereof.

9. The repaired work piece of claim 7, further including:

applying an anaerobic thread locker material to the threaded outer surface of the plug before the step of threading the shearing fastener into the threaded bore.

10. The repaired work piece of claim 7, wherein the neck of the shank is disposed within a recess along the upper surface of the plug and the step of applying torque to the fastener head sufficient to shear the neck creates a fracture surface within the recess and below an upper extent of the plug.

11. The method of claim 7, wherein the shearing fastener further includes a radius extending around a periphery of the neck at the intersection between the transition section and the upper surface of the plug.

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