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(19) **United States**(12) **Patent Application Publication**
Corbett et al.(10) **Pub. No.: US 2018/0111184 A1**(43) **Pub. Date: Apr. 26, 2018**(54) **FASTENER AND FASTENING SYSTEM**(71) Applicant: **Arconic Inc.**, Pittsburgh, PA (US)(72) Inventors: **Robert J. Corbett**, Woodway, TX (US); **Joseph Z. Leavelle**, Lorena, TX (US)(73) Assignee: **Arconic Inc.**, Pittsburgh, PA (US)(21) Appl. No.: **15/785,526**(22) Filed: **Oct. 17, 2017****Related U.S. Application Data**

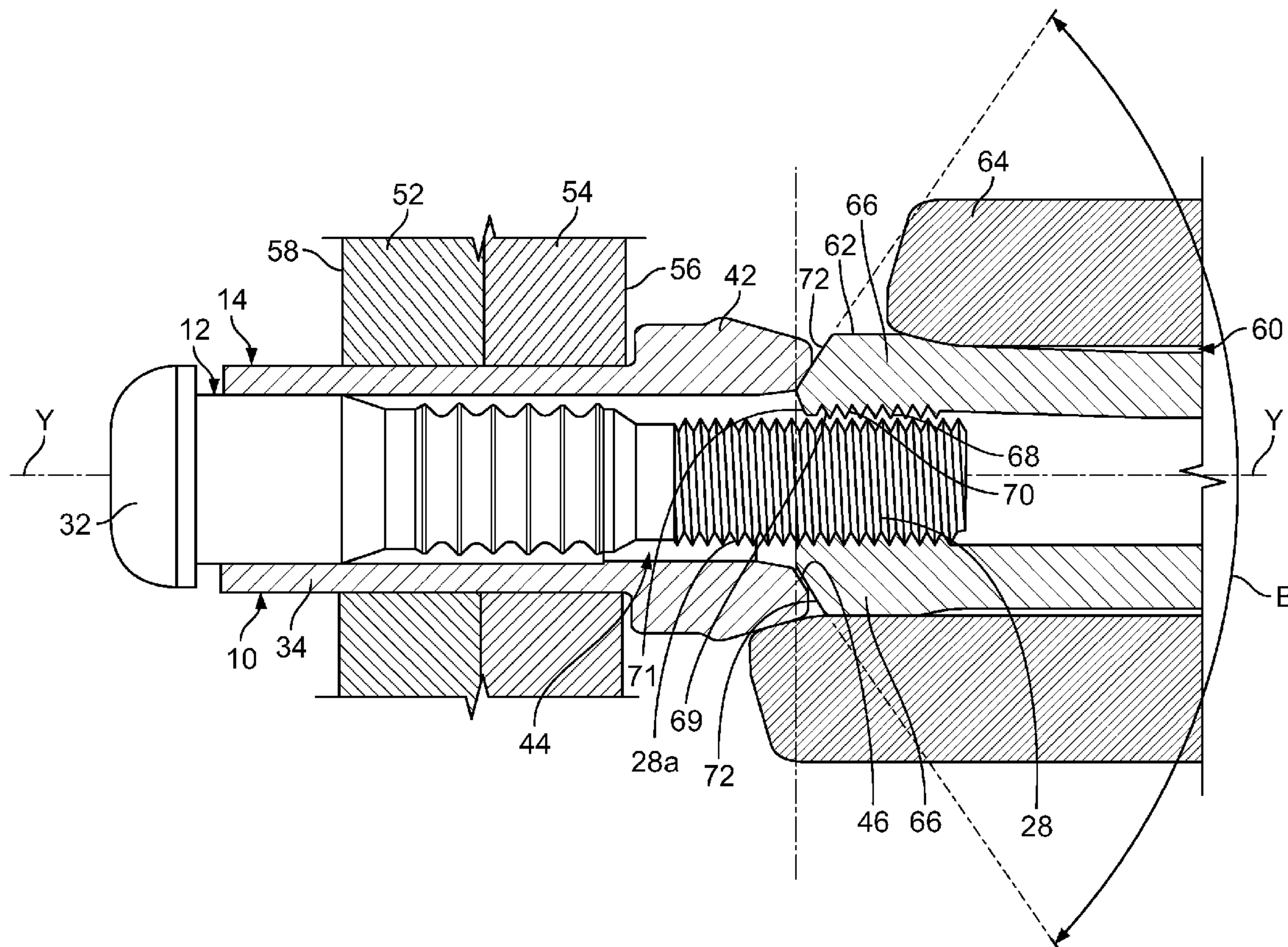
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(57)

ABSTRACT

A fastening system includes a fastener having a bolt with a pull portion having at least one pull groove, and an outer sleeve having a head with an inner face, the bolt being inserted within the sleeve. The fastening system includes a fastener installation tool having a puller with at least one tooth and a front face. The inner face of the head of the sleeve is angled at an included angle measured transverse to a longitudinal axis of the fastener, while the front face of the puller of the fastener installation tool is angled at an included angle measured transverse to a longitudinal axis of the puller. The included angles are chosen to match or be substantially the same. The front face of the puller of the fastener installation tool is adapted to engage the inner face of the outer sleeve of the fastener when the fastener installation tool engages the fastener, and the inner face of the outer sleeve facilitates the receipt of the front face of the puller and the alignment of the at least one tooth of the puller with the at least one pull groove of the bolt by allowing the puller to shift forward or backward to facilitate such alignment.



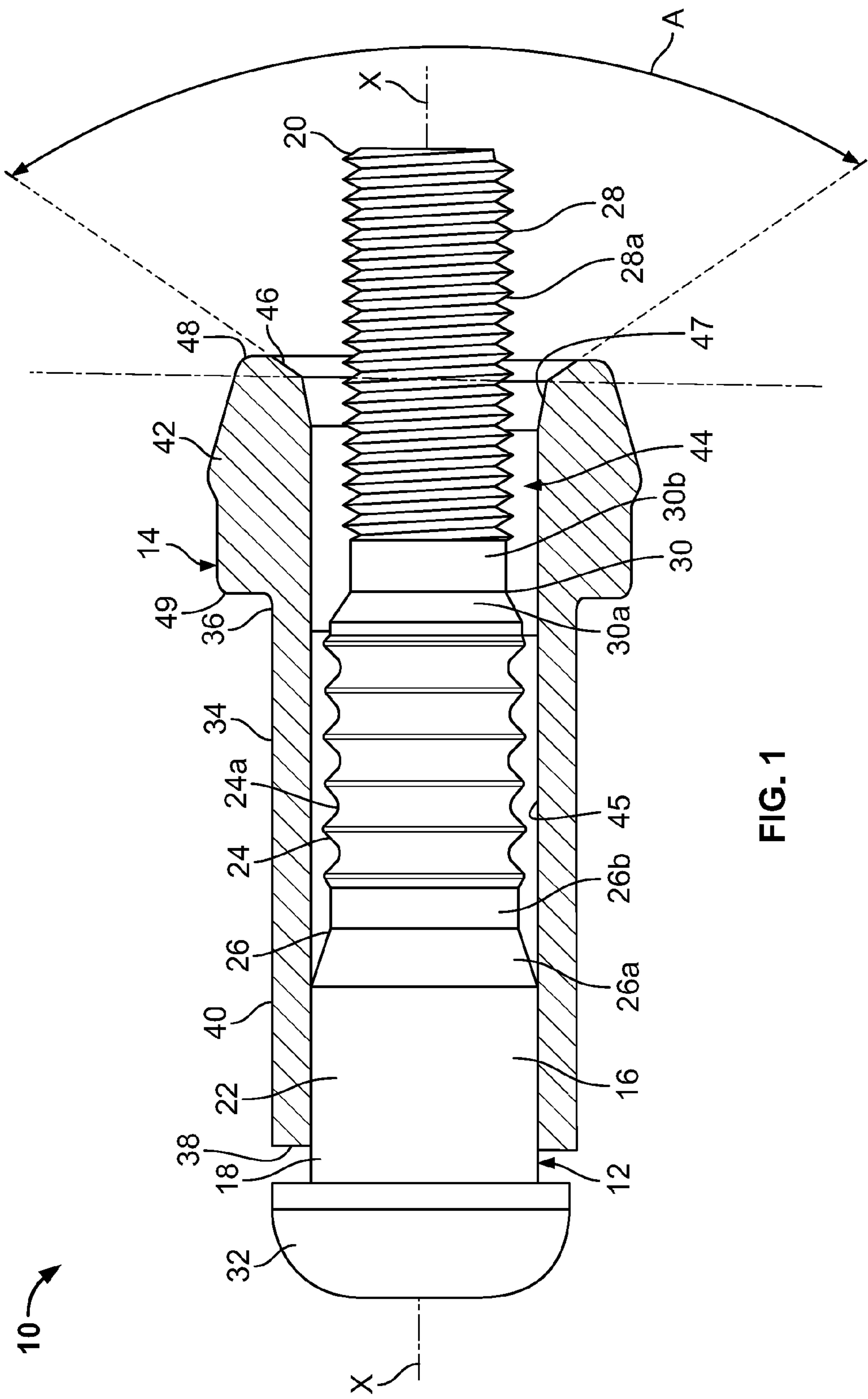
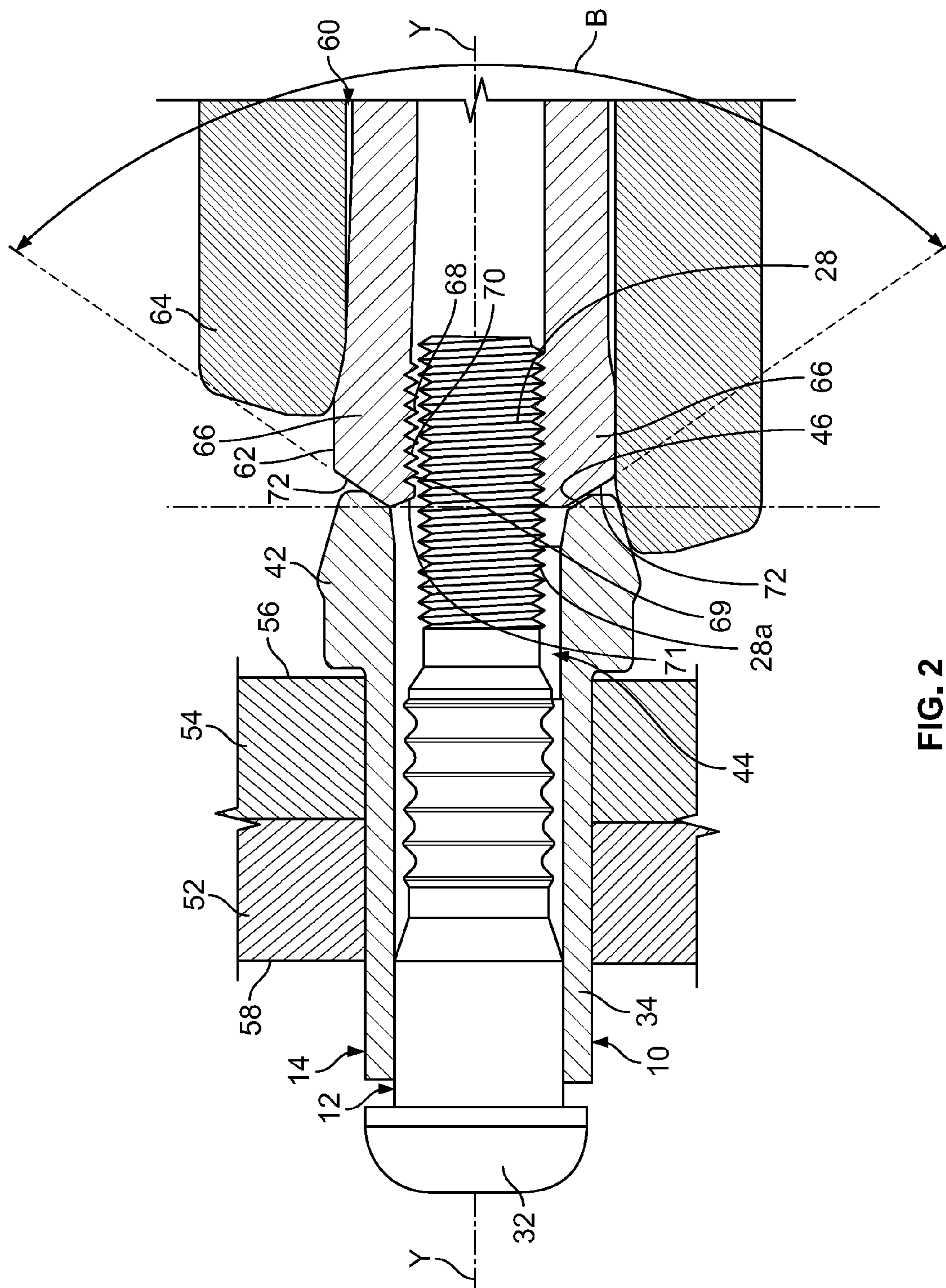


FIG. 1



FASTENER AND FASTENING SYSTEM**CROSS-REFERENCE TO RELATED APPLICATION**

[0001] This application is a § 111(a) application that relates to and claims the benefit of commonly-owned, co-pending U.S. Provisional Patent Application Ser. No. 62/410,497, filed Oct. 20, 2016, entitled “BLIND FASTENER,” the entirety of which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to a fastening system and, more particularly, a fastener and a fastener installation tool for securing work pieces together.

BACKGROUND OF THE INVENTION

[0003] Fasteners, and in particular blind fasteners, are commonly used to secure a plurality of work pieces together when it is difficult or impossible to access the blind side of one of the work pieces. Certain fasteners include a pull portion having pull grooves, while associated fastener installation tools include a puller (e.g., collet) having teeth that engage the pull grooves of the pull portion of the fastener. Alignment of the teeth of the puller and the pull grooves of the fastener is desired.

SUMMARY OF THE INVENTION

[0004] In an embodiment, a fastening system includes a fastener including a bolt having a shank and a pull portion extending from a first end of the shank and including at least one pull groove, and a sleeve adapted to receive the bolt, wherein the sleeve includes a body having a first end and a head located at the first end, wherein the head includes a first end having an inner face; and a fastener installation tool including a puller having a front face and at least one tooth that is adapted to engage the at least one pull groove of the pull portion of the bolt, wherein the inner face of the sleeve is adapted to receive and engage the front face of the puller of the fastener installation tool when the puller is engaged with the pull portion of the bolt, and wherein when the puller of the fastener installation tool is engaged with the fastener, the front face of the puller is adapted to stop against the inner face of the head of the sleeve of the fastener and the puller is adapted to shift toward or away from the sleeve and align the at least one tooth of the puller with a corresponding one of the at least one pull groove of the pull portion of the bolt.

[0005] In an embodiment, the inner face of the head of the sleeve of the fastener extends obliquely at a first included angle measured transversely from a longitudinal axis of the fastener. In an embodiment, the front face of the puller of the fastener installation tool is angled at a second included angle measured transversely from a longitudinal axis of the puller of the fastener installation tool. In an embodiment, each of the first included angle and the second included angle is about 60 degrees. In an embodiment, each of the first included angle and the second included angle is about 70 degrees. In an embodiment, each of the first included angle and the second included angle is about 80 degrees. In an embodiment, each of the first included angle and the second included angle is about 90 degrees. In an embodiment, each of the first included angle and the second included angle is about 100 degrees. In an embodiment, each of the first

included angle and the second included angle is about 110 degrees. In an embodiment, each of the first included angle and the second included angle is about 120 degrees. In an embodiment, each of the first included angle and the second included angle is about 130 degrees. In an embodiment, each of the first included angle and the second included angle is about 140 degrees. In an embodiment, each of the first included angle and the second included angle is about 150 degrees. In an embodiment, each of the first included angle and the second included angle is about 160 degrees. In an embodiment, each of the first included angle and the second included angle is about 170 degrees. In an embodiment, each of the first included angle and the second included angle is about 180 degrees. In an embodiment, each of the first included angle and the second included angle is within a range of about 60 degrees to about 180 degrees. In an embodiment, the front face is concave in shape. In an embodiment, the front face is conical in shape. In an embodiment, the at least one pull groove includes a plurality of pull grooves, and wherein the at least one tooth includes a plurality of teeth. In an embodiment, each of the plurality of pull grooves is an annular groove. In an embodiment, the at least one pull groove is a helical groove.

[0006] In an embodiment, a fastener includes a bolt having a shank and a pull portion extending from a first end of the shank and including at least one pull groove; and a sleeve adapted to receive the bolt, wherein the sleeve includes a body having a first end and a head located at the first end, wherein the head includes a first end having an inner face, wherein the inner face of the sleeve is adapted to receive and engage a front face of a puller of a fastener installation tool when the puller is engaged with the pull portion of the bolt, and wherein when the puller of the fastener installation tool is engaged with the fastener, the front face of the puller is adapted to stop against the inner face of the head of the sleeve of the fastener and the puller is adapted to shift toward or away from the sleeve and align the at least one tooth of the puller with a corresponding one of the at least one pull groove of the pull portion of the bolt.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] FIG. 1 is a side elevational view of a blind fastener constructed in accordance with an embodiment, with an outer sleeve employed by the blind fastener being shown in cross-section; and

[0008] FIG. 2 is a side elevational view of the blind fastener shown in FIG. 1 positioned within work pieces and engaged by a fastener installation tool, with the outer sleeve, the tool, and the work pieces being shown in cross-section.

DETAILED DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 illustrates an embodiment of a fastener 10. In an embodiment, the fastener 10 includes a bolt 12 and an outer sleeve 14 that is sized and shaped to receive the bolt 12. In an embodiment, the outer sleeve 14 is of one-piece construction. In another embodiment, the outer sleeve 14 is constructed with a plurality of components. In an embodiment, the bolt 12 includes an elongated shank 16 having a first end 18 and a second end 20 opposite the first end 18, the shank 16 being sized and shaped to extend through the outer sleeve 14. In an embodiment, the shank 16 includes a cylindrical-shaped smooth portion 22 located proximate to the first end 18, a grooved portion 24 located intermediate

the first and second ends **18**, **20**, and a first transition portion **26** located intermediate the smooth portion **22** and the grooved portion **24**. In an embodiment, the first transition portion **24** includes a frusto-conical shaped portion **26a** located adjacent to the smooth portion **22** and a cylindrical-shaped portion **26b** located intermediate the frusto-conical shaped portion **26a** and one end of the grooved portion **24**. In an embodiment, the grooved portion **24** includes a plurality of grooves **24a**. In an embodiment, each of the plurality of grooves **24a** is an annular groove. In another embodiment, each of the plurality of grooves **24a** is a helical groove. In another embodiment, the grooved portion **24** includes a single helical groove. In an embodiment, the grooved portion **24** includes a diameter that is less than a diameter of the smooth portion **22**. In an embodiment, the cylindrical-shaped portion **26b** of the transition portion **26** includes a diameter that is less than a diameter of the smooth portion **22**. In an embodiment, the frusto conical-shaped portion **26a** of the transition portion **26** tapers towards the cylindrical-shaped portion **26b**. In an embodiment, the shank **16** of the bolt **12** includes a pull portion **28** located at the second end **20** of the shank **16**, and a second transition portion **30** located intermediate the grooved portion **24** and the pull portion **28**. In an embodiment, the second transition portion **30** includes a frusto-conical shaped portion **30a** located adjacent to an opposite end of the grooved portion **24** and a cylindrical-shaped portion **30b** located intermediate the portion **30a** and one end of the pull portion **28**. In an embodiment, the cylindrical-shaped portion **30b** of the second transition portion **30** includes a diameter that is less than a diameter of the grooved portion **24**. In an embodiment, the frusto conical-shaped portion **30a** of the second transition portion **30** tapers towards the cylindrical-shaped portion **30b**. In an embodiment, the pull portion **28** includes a plurality of pull grooves **28a**. In an embodiment, each of the plurality of pull grooves **28a** is an annular groove. In another embodiment, the pull portion **28** includes a single pull groove **28a**. In another embodiment, the pull portion **28** includes at least one pull groove **28a**. In another embodiment, the pull portion **28** includes a helical groove. In an embodiment, the bolt **12** includes a head **32** located at the first end **18** of the shank **16** and adjacent to the smooth portion **22**. In an embodiment, the head **32** is an enlarged head.

[0010] Still referring to FIG. 1, in an embodiment, the outer sleeve **14** includes an elongated body **34** having a first end **36** and a second end **38** opposite the first end **36**. In an embodiment, the body **34** has a cylindrical shape and a smooth exterior surface **40**. In an embodiment, the body **34** includes an outer diameter that provides for a clearance fit through openings of work pieces, which shall be described below. In an embodiment, the body **34** includes an outer diameter that provides for a press fit or interference fit through the openings of the work pieces. In an embodiment, the outer sleeve **14** includes a head **42** located at the first end **36** of the body **34**. The head **42** includes a first end **48** and a second end **49** opposite the first end **48**. In an embodiment, the head **42** is enlarged. In an embodiment, the outer sleeve **14** includes an internal aperture **44** that extends through the head **42** from the first end **48** to the second end **49** and through the body **34** from the first end **36** to the second end **38** thereof. In an embodiment, the aperture **44** includes an elongated portion **45** that extends from the second end **38** to a location proximate to the first end **48** of the head **42**, and

a tapered portion **47** located adjacent to one end of the elongated portion **45** proximate to the first end **48** of the head **42**. In an embodiment, the tapered portion **47** tapers outwardly towards the first end **48** of the head **42**. In an embodiment, the head **42** of the sleeve **14** includes an inner face **46** located adjacent to the tapered portion **47** at the end **48** thereof and is in communication with the aperture **44**. In an embodiment, the inner face **46** is concave in shape. In another embodiment, the inner face **46** is conical in shape. In an embodiment, the inner face **46** extends obliquely at an included angle A measured transversely from a longitudinal axis X-X of the fastener **10**. In an embodiment, the included angle A is about 60 degrees. In an embodiment, the included angle A is about 70 degrees. In an embodiment, the included angle A is about 80 degrees. In an embodiment, the included angle A is about 90 degrees. In an embodiment, the included angle A is about 100 degrees. In another embodiment, the included angle A is about 110 degrees. In another embodiment, the included angle A is about 120 degrees. In another embodiment, the included angle A is about 130 degrees. In another embodiment, the included angle A is about 140 degrees. In another embodiment, the included angle A is about 150 degrees. In another embodiment, the included angle A is about 160 degrees. In another embodiment, the included angle A is about 170 degrees. In an embodiment, the included angle A is about 180 degrees. In another embodiment, the included angle A is within a range of about 60 degrees to about 180 degrees.

[0011] Referring to FIG. 2, in an embodiment, the fastener **10** is adapted to secure a plurality of work pieces **52**, **54** together. In an embodiment, the bolt **12** is inserted within the aperture **44** of the sleeve **14** such that the head **32** of the bolt **12** is adapted to sit on and be juxtaposed with the second end **38** of the sleeve **14**, and at least a portion of the pull portion **28** of the bolt **12** extends outwardly from the head **42** of the sleeve **14**. In an embodiment, the entire pull portion **28** of the bolt **12** extends outwardly from the head **42** of the sleeve **14**. In an embodiment, the fastener **10** is inserted through holes of the work pieces **52**, **54**, with the head **42** of the sleeve **14** abutting one side **56** of the work piece **54**, and at least a portion of the elongated body **34** of the sleeve **14** extending outwardly from one side **58** (i.e., the blind side) of the work piece **52**.

[0012] Still referring to FIG. 2, in an embodiment, a fastener installation tool **60** includes a puller **62** and a swage anvil **64**. In an embodiment, the puller **62** includes chuck jaws **66** having internal teeth **68** and pull grooves **70** that are sized, shaped and adapted to grip the pull grooves **28a** of the pull portion **28** of the bolt **12**. In an embodiment, the internal teeth **68** includes at least one tooth **69** proximate to an engagement end **71** of the puller **62** and having a first inner diameter, while the remainder of the teeth **68** each have a second inner diameter which is less than the first inner diameter. By opening up the first inner diameter of the at least one tooth **69**, as shown, chipping of the tooth **69** is resisted. In an embodiment, the pull grooves **70** of the puller **62** are helical grooves. In another embodiment, the pull grooves **70** of the puller **62** are annular grooves. In another embodiment, the pull grooves **70** of the puller **62** match the pull grooves **28a** of the pull portion **28** of the bolt **12**. In another embodiment, the puller **62** includes at least one pull groove **70**. In another embodiment, the puller **62** includes a single pull groove **70**. In an embodiment, the pull grooves **70** of the puller **62** are formed by tapping. In an embodiment,

the puller **62** is a split collet. In an embodiment, the chuck jaws **66** of the puller **62** include a front face **72**. In an embodiment, the front face **72** is angled at an included angle B measured transverse to a longitudinal axis Y-Y of the puller **62**. In an embodiment, the included angle B is chosen to match or be substantially the same as the included angle A of the inner face **46** of the head **42** of the sleeve **14**. In an embodiment, the included angle B is about 60 degrees. In an embodiment, the included angle B is about 70 degrees. In an embodiment, the included angle B is about 80 degrees. In an embodiment, the included angle B is about 90 degrees. In an embodiment, the included angle B is about 100 degrees. In another embodiment, the included angle B is about 110 degrees. In another embodiment, the included angle B is about 120 degrees. In another embodiment, the included angle B is about 130 degrees. In another embodiment, the included angle B is about 140 degrees. In another embodiment, the included angle B is about 150 degrees. In another embodiment, the included angle B is about 160 degrees. In another embodiment, the included angle B is about 170 degrees. In an embodiment, the included angle B is about 180 degrees. In another embodiment, the included angle B is within a range of about 60 degrees to about 180 degrees.

[0013] Referring to FIG. 2, in an embodiment, the fastener **10** is positioned within the holes of the work pieces **52**, **54** as described above. In an embodiment, the jaws **66** of the puller **62** are split and spread to an open position in order to clear and slip over the pull portion **28** of the bolt **12**. In an embodiment, the teeth **68** and the pull grooves **70** of the puller **62** engage the pull grooves **28a** of the pull portion **28** of the bolt **12**. In an embodiment, the face **72** of the jaws **66** of the puller **62** stops against the inner face **46** of the head **42** of the sleeve **14** to align the puller **62** properly with the pull portion **28** of the bolt **12**. Along these lines, the inner face **46** of the head **42** of the sleeve **14** permits the puller **62** to shift forward toward the sleeve **14** at distance or backward away from the sleeve **14** at another distance, depending on how the teeth **68** of the puller **62** engage initially the pull grooves **28a** of the pull portion **28** of the bolt **12** while closing, and align the teeth **68** of the puller **62** with the pull grooves **28a** of the pull portion **28** of the bolt **12**. The puller **62** can then slide downward and inward towards the face **46** at a distance as the puller **62** is driven forward when engaging the pull portion **28**. Once the puller **62** is aligned with the pull portion **28**, namely, the teeth **68**, grooves **70** and pull grooves **28a** are aligned properly, the jaws **66** of the puller **62** are then moved inwardly to a closed position and clamp down on the pull portion **28** and provide an axial force on the bolt **12** and close any gap between the work pieces **52**, **54**. The anvil **64** then engages and swages the sleeve **14**.

[0014] Referring to FIG. 2, the puller **62** continues to provide an axial force on the bolt **12**. In embodiments, the sleeve **14** can form various expanded blind side shapes as the bolt **12** is pulled into or against the outer sleeve's **14** blind side. In an embodiment, a portion of the elongated body **34** of the outer sleeve **14** is compressed and swaged into the grooved portion **24** of the bolt **12**. In an embodiment, the pull portion **28** remains as part of the shank **16** after installation of the fastener **10**. In another embodiment, the pull portion **28** is broken off from the shank **16** after installation of the fastener **10** (not shown in the Figures).

[0015] It should be understood that the embodiments described herein are merely exemplary and that a person skilled in the art may make many variations and modifica-

tions without departing from the spirit and scope of the invention. For instance, the fastener **10** is a blind fastener. In other embodiments, the fastener **10** can comprise other types of fasteners known in the art. All such variations and modifications are intended to be included within the scope of the claims.

What is claimed is:

1. A fastening system, comprising:

a fastener including a bolt having a shank and a pull portion extending from a first end of the shank and including at least one pull groove, and a sleeve adapted to receive the bolt,

wherein the sleeve includes a body having a first end and a head located at the first end, wherein the head includes a first end having an inner face; and

a fastener installation tool including a puller having a front face and at least one tooth that is adapted to engage the at least one pull groove of the pull portion of the bolt,

wherein the inner face of the sleeve is adapted to receive and engage the front face of the puller of the fastener installation tool when the puller is engaged with the pull portion of the bolt, and

wherein when the puller of the fastener installation tool is engaged with the fastener, the front face of the puller is adapted to stop against the inner face of the head of the sleeve of the fastener and the puller is adapted to shift toward or away from the sleeve and align the at least one tooth of the puller with a corresponding one of the at least one pull groove of the pull portion of the bolt.

2. The fastening system of claim 1, wherein the inner face of the head of the sleeve of the fastener extends at a first included angle measured transversely from a longitudinal axis of the fastener.

3. The fastening system of claim 2, wherein the front face of the puller of the fastener installation tool is angled at a second included angle measured transversely from a longitudinal axis of the puller of the fastener installation tool.

4. The fastening system of claim 3, wherein the first included angle is within a range of about 60 degrees to about 180 degrees.

5. The fastening system of claim 4, wherein the second included angle is within a range of about 60 degrees to about 180 degrees.

6. The fastening system of claim 2, wherein the front face is concave in shape.

7. The fastening system of claim 2, wherein the front face is conical in shape.

8. The fastening system of claim 1, wherein the at least one pull groove includes a plurality of pull grooves, and wherein the at least one tooth includes a plurality of teeth.

9. The fastening system of claim 8, wherein each of the plurality of pull grooves is an annular groove.

10. The fastening system of claim 1, wherein the at least one pull groove is a helical groove.

11. A fastener, comprising:

a bolt having a shank and a pull portion extending from a first end of the shank and including at least one pull groove; and

a sleeve adapted to receive the bolt,

wherein the sleeve includes a body having a first end and a head located at the first end, wherein the head includes a first end having an inner face, wherein the inner face of the sleeve is adapted to receive and engage

a front face of a puller of a fastener installation tool when the puller is engaged with the pull portion of the bolt, and

wherein when the puller of the fastener installation tool is engaged with the fastener, the front face of the puller is adapted to stop against the inner face of the head of the sleeve of the fastener and the puller is adapted to toward or away from the sleeve and align the at least one tooth of the puller with a corresponding one of the at least one pull groove of the pull portion of the bolt.

12. The fastener of claim **11**, wherein the inner face of the head of the sleeve of the fastener extends at a first included angle measured transversely from a longitudinal axis of the fastener.

13. The fastener of claim **12**, wherein the front face of the puller of the fastener installation tool is angled at a second included angle measured transversely from a longitudinal axis of the puller of the fastener installation tool.

14. The fastener of claim **13**, wherein the first included angle is within a range of about 60 degrees to about 180 degrees.

15. The fastener of claim **14**, wherein the second included angle is within a range of about 60 degrees to about 180 degrees.

16. The fastener of claim **11**, wherein the front face is concave in shape.

17. The fastener of claim **11**, wherein the front face is conical in shape.

18. The fastener of claim **11**, wherein the at least one pull groove includes a plurality of pull grooves, and wherein the at least one tooth includes a plurality of teeth.

19. The fastener of claim **18**, wherein each of the plurality of pull grooves is an annular groove.

20. The fastener of claim **11**, wherein the at least one pull groove is a helical groove.

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