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(54) **TWO-PIECE DRILL BITS**

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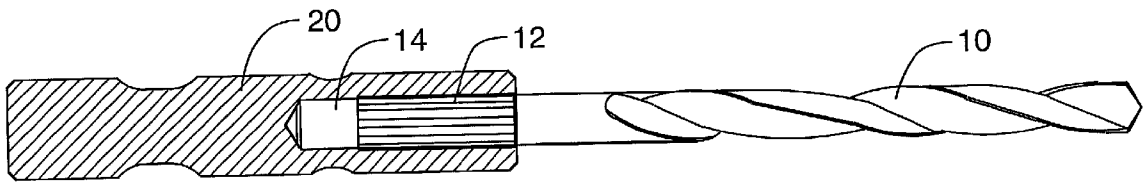
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(52) **U.S. Cl.** ..... **408/226**; 408/227; 408/239 A; 76/108.6

(57) **ABSTRACT**

Two-piece drill bits and methods of manufacturing same provide a preferably hexagonal shank, and a drill portion having a proximal end inserted into an axial hole in a distal end of the shank. In a preferred embodiment, at least part of the area adjacent the proximal end of the drill portion is knurled. Alternative embodiments have wings, polygons, tapers or other irregular shapes, or combinations of same. A variety of means may be employed to mechanically capture the drill portion in the shank.



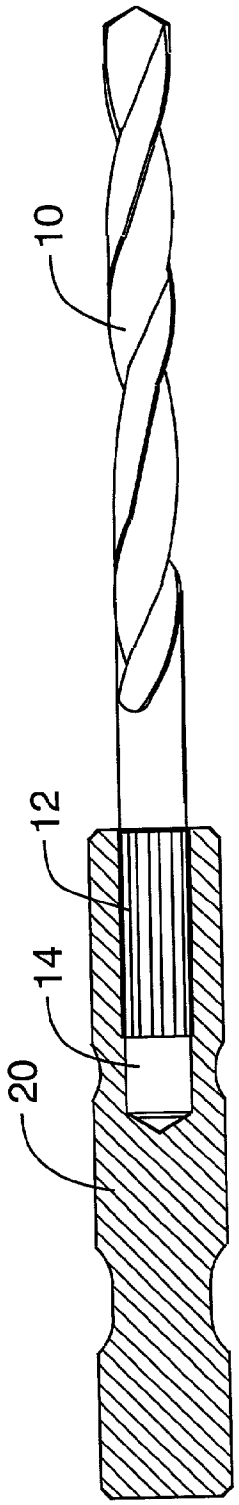


FIG.1A

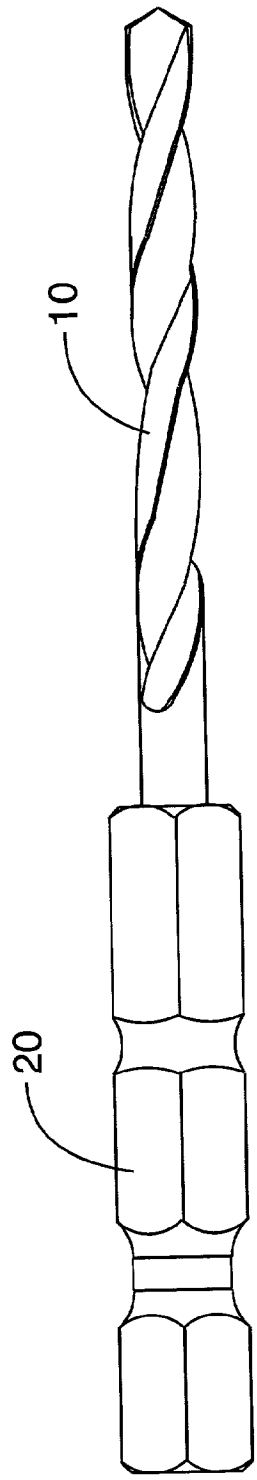


FIG.1B

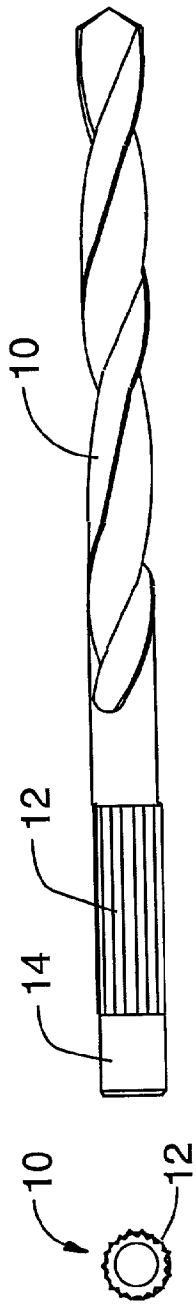


FIG.1C

FIG.1D

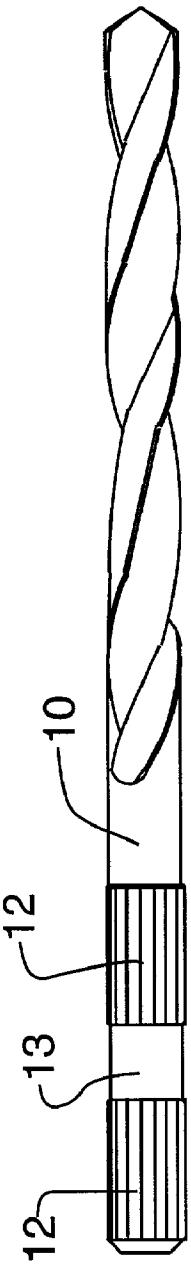


FIG.1E

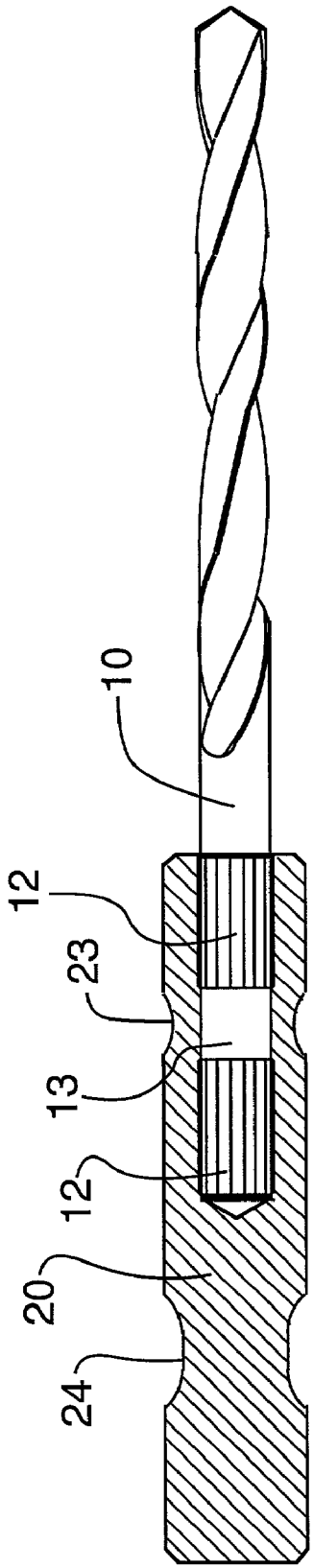


FIG.1F

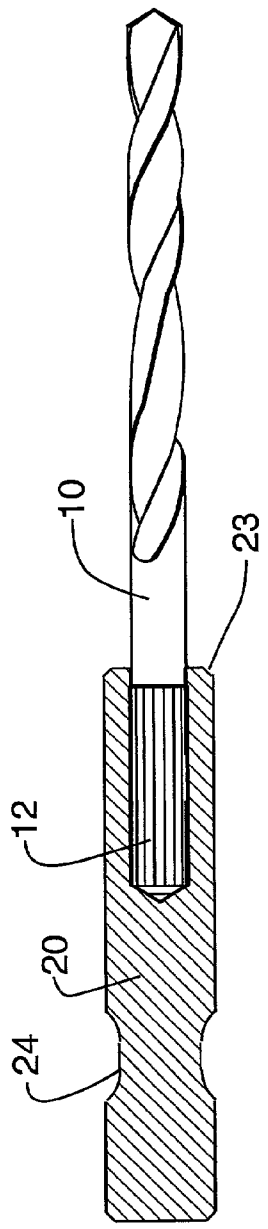


FIG.2A

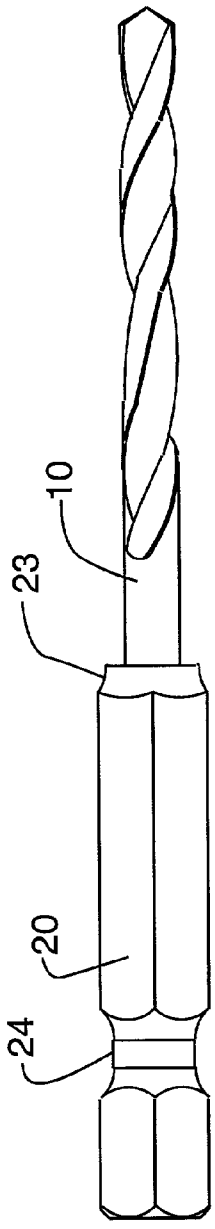


FIG.2B

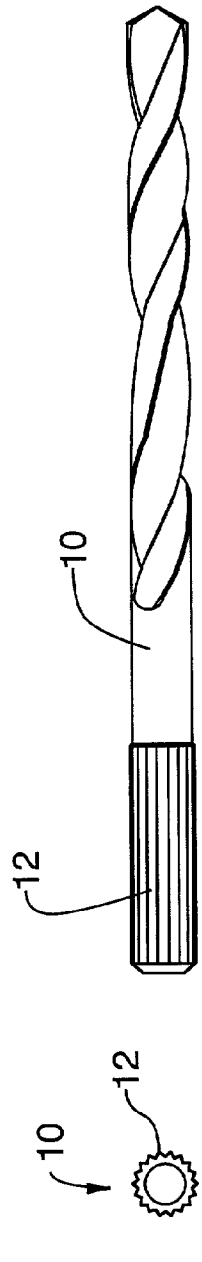


FIG.2C

FIG.2D

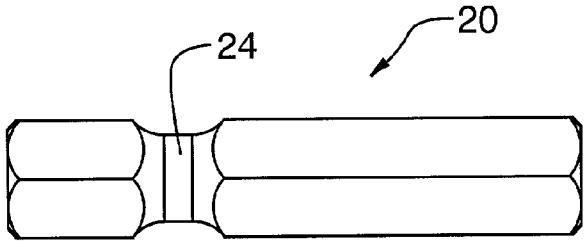


FIG.3A

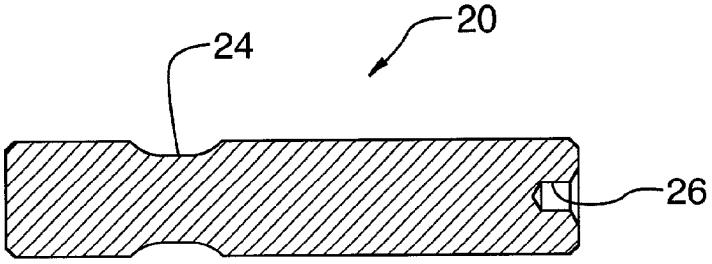


FIG.3B

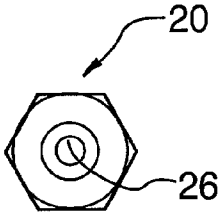


FIG.3C

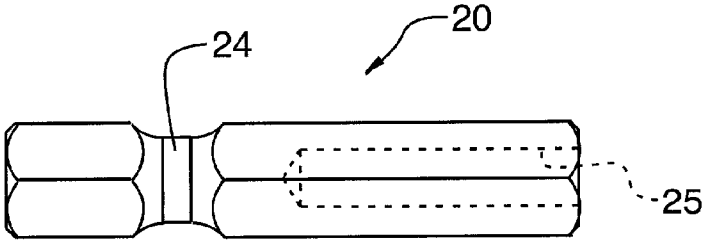


FIG.3D

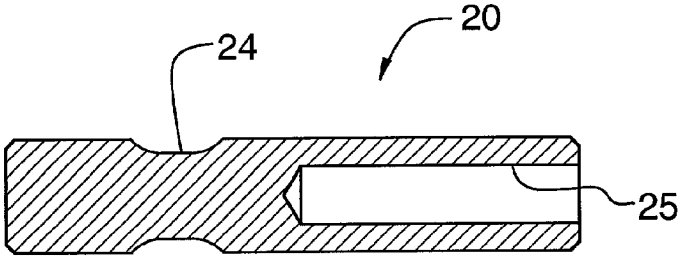


FIG.3E

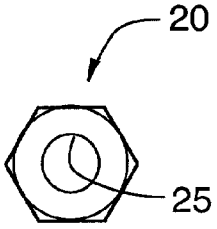


FIG.3F

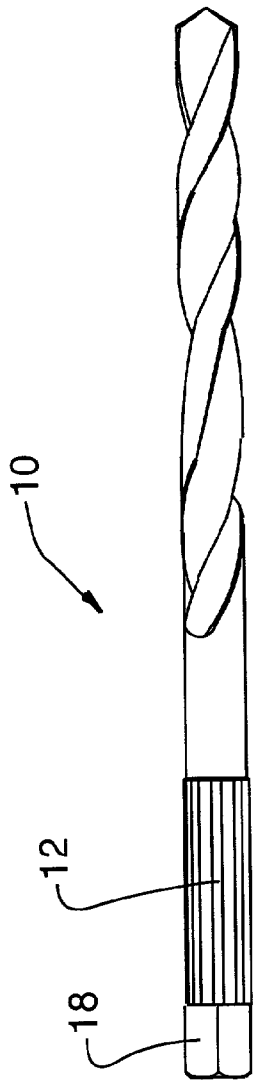


FIG.4A

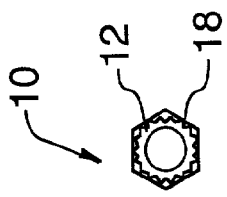


FIG.4B

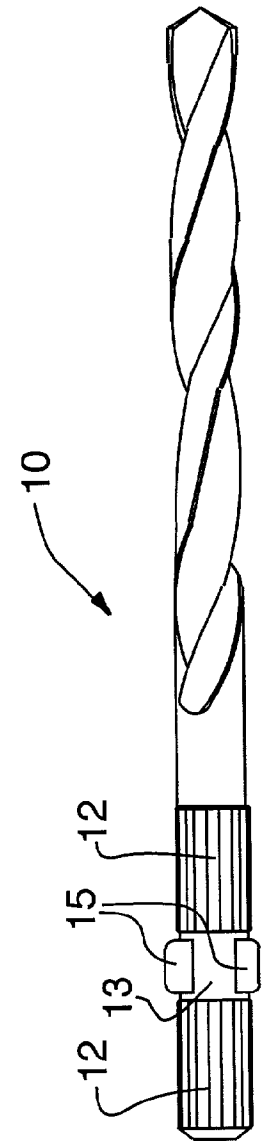


FIG.5A

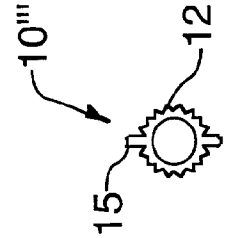


FIG.5B

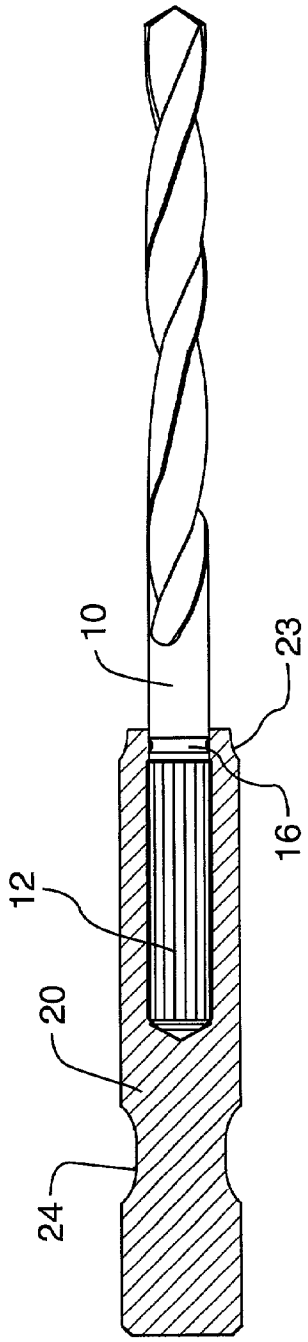


FIG.6A



FIG.6B

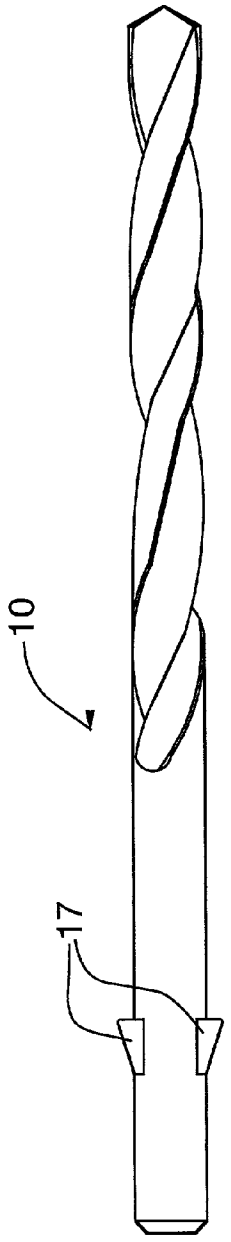


FIG.7A

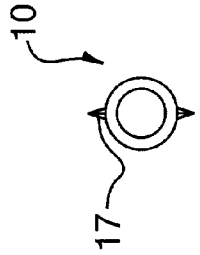


FIG.7B

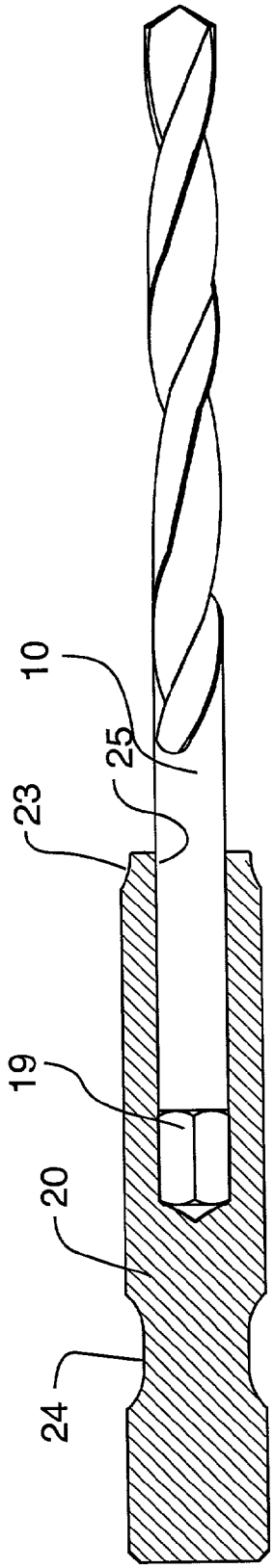


FIG.8A

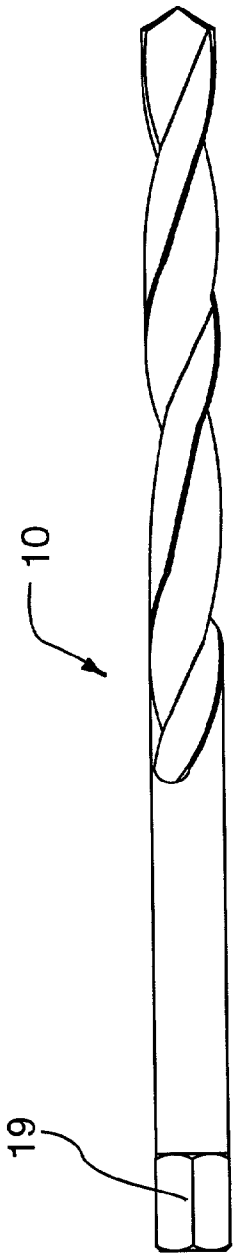


FIG.8A

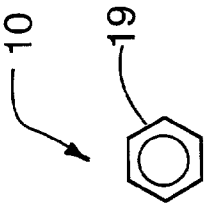


FIG.8C

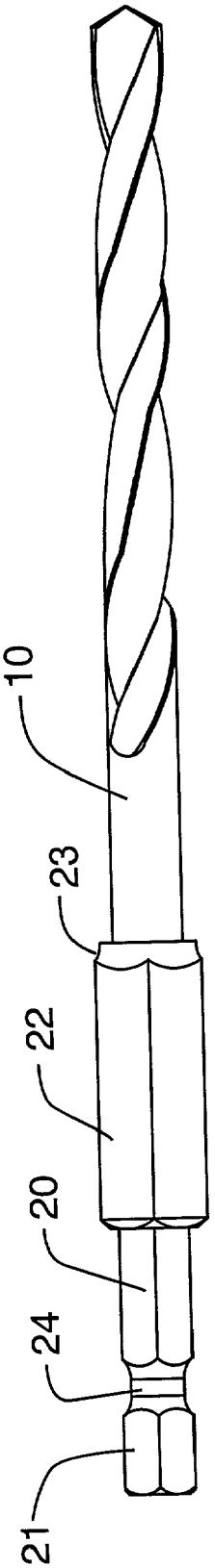


FIG.9A

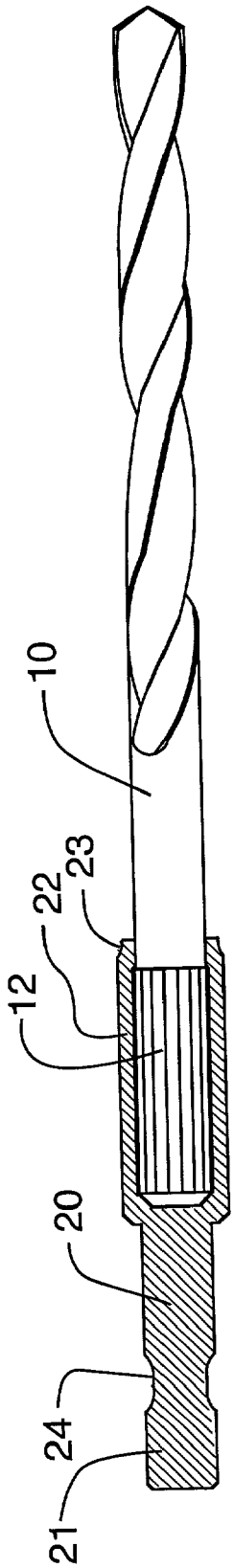


FIG.9B

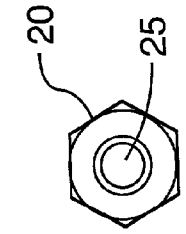


FIG.10B

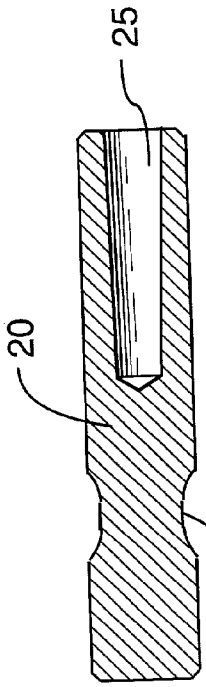


FIG.10A

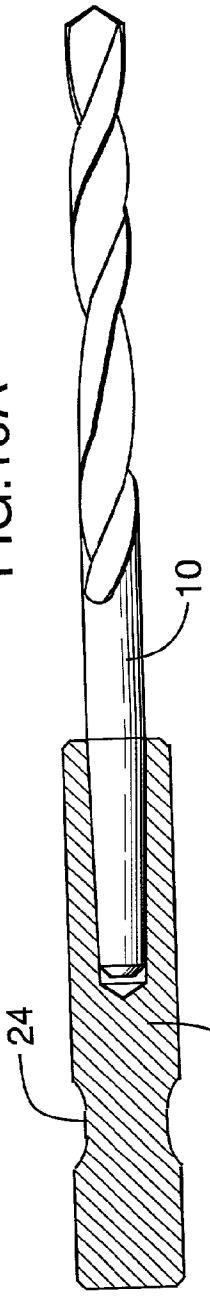


FIG.10C

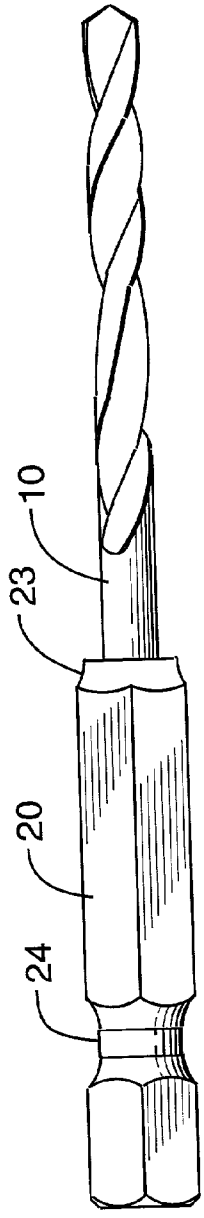


FIG.10D



FIG.10E

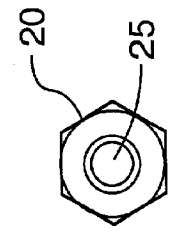


FIG.11B

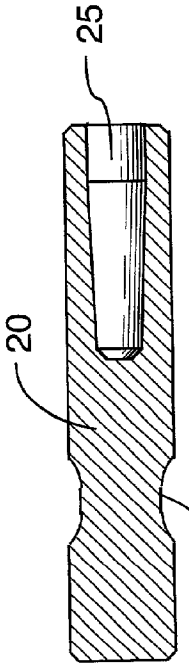


FIG.11A

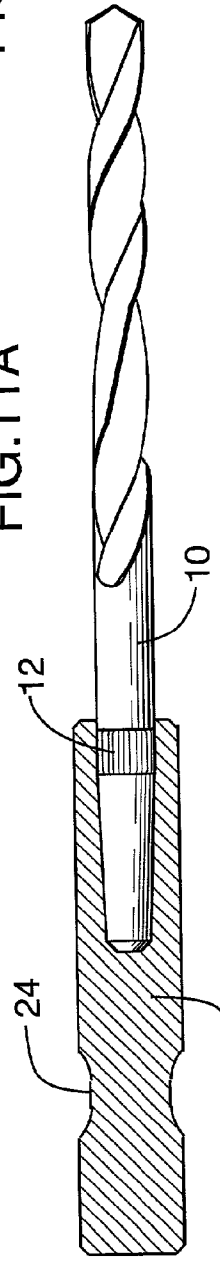


FIG.11C

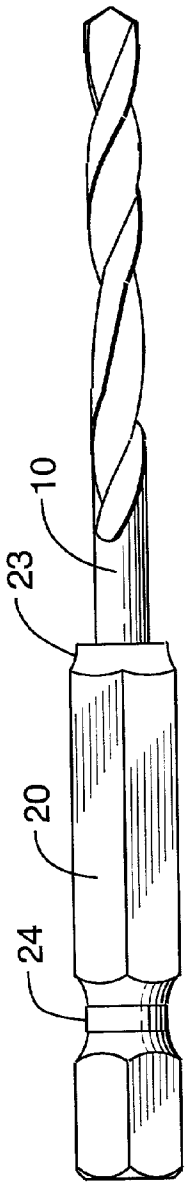


FIG.11D



FIG.11E

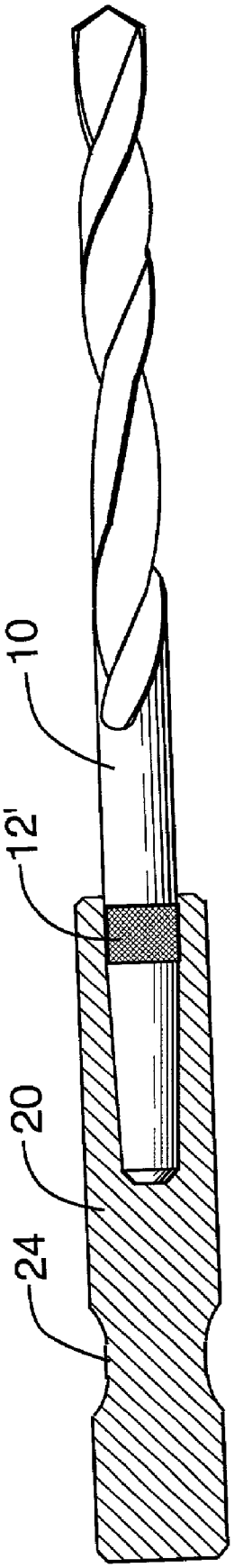


FIG.12A

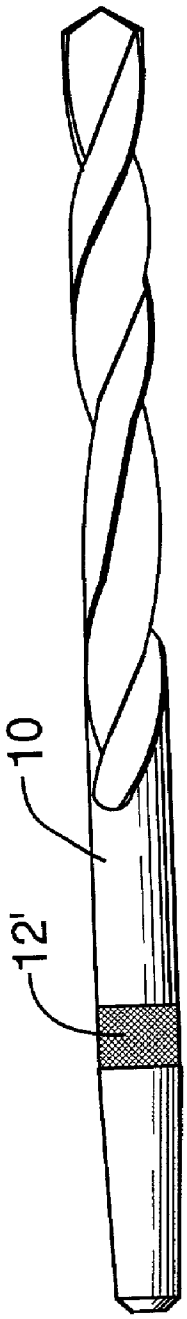


FIG.12B

TWO-PIECE DRILL BITS

BACKGROUND OF THE INVENTION

[0001] This invention relates to two-piece drill bits, having a shank portion and a drill portion.

[0002] Two-piece drill bits are known in the prior art, and commonly have a hexagonal shank for mounting in a suitable holder or chuck. Several different structures and methods of manufacture are known. For example:

[0003] (1) Cutting a hex shaft to length and drilling an axial hole at a distal end. A flat is ground/machined onto the shank of the drill part, which is inserted into the drilled hole of the hex shaft. The shaft is then swaged at the position where the flat is, so that the displaced material is lodged against the flat of the drill shank to secure it inside the hole of the hex shaft. There are at least two perceived disadvantages with this method. To enable insertion, the hole has to be drilled over-size to accept the drill shank. After swaging, the shank is shifted to one side, there is thus a loss of concentricity of the drill with respect to the hex shaft. Furthermore, after swaging again, one side of the hex shaft is flattened, resulting in loss of the hex profile at that part of the hex shaft. This may make it difficult for the drill bit assembly to be inserted into ordinary hex-shank holder tools available in the market.

[0004] (2) Cutting a hex shaft to length and drilling an axial hole at a distal end. Introducing adhesive in the drilled hole and inserting a drill shank by pressing and letting the adhesive dry. This method may not provide a drill bit having the required strength for most applications, because during heavier use, the drill shank may spin around inside the drilled hole of the hex shaft.

[0005] (3) Drill shanks are arranged and held in a die having cavities that are of the same shape as regular hex shafts. The shank of the drill bit is then cast (usually of Zinc/Zinc alloy) around the drill shanks and left to cool. Because the cast material is softer than the drill shanks, the shank of the drill bit wears prematurely and cannot maintain its shape after repeated use. Also the centring of the drill shank in the hex shaft can become disturbed after wearing out the shank material. Furthermore, after casting and removal of the die, there is usually left some extra material at the die parting line (usually on both sides of the hex shaft). These imperfections may cause improper positioning of the drill bit in drill chucks or tool hex mounts, with the subsequent run-out and concentricity problems during use.

[0006] (4) Cutting a hex shaft to length and drilling an axial hole at a distal end. The drill shank is then pressed into the hole and the shank is cross-drilled (radially through the shank) and a pin inserted through the radial hole to secure the drill shank. In case a smaller diameter drill is used, the radial hole is tapped so a set-screw may be used to retain the drill shank in the hex shaft. This method is time-consuming and expensive because of all the steps involved. Also, the method yields drill bit assemblies which are non-concentric and difficult to insert into hex tool holders, especially when the ends of the pin or set-screw are not flush with the outer flat surface of the hex shaft.

SUMMARY OF THE INVENTION

[0007] It is an object of the invention to provide economical and effective alternative structures and methods of manufacturing two-piece drill bits.

[0008] In the invention, an axial hole is drilled into the distal end of a preferably hexagonal shank. The proximal end of the drill portion is inserted in the axial hole and is secured in the hole by one or more of a variety of mechanical means as described in greater detail below.

[0009] In the preferred embodiment, at least a portion of the proximal end section of the drill portion is knurled, and the shank is compressed tightly against the proximal end section of the drill portion, for example by rolling or roll-peening.

[0010] In the method of the invention, a knurled portion is formed on at least a portion of the proximal end section of the drill portion, shanks of a suitable length are drilled with an axial hole at a distal end, the proximal end section of the drill portion is inserted into the axial hole, and at least a portion of the shank is mechanically deformed to symmetrically compress the shank onto the drill portion, for example by rolling, rollpeening, or differential expansion in heating and cooling.

[0011] Additional features of the invention will be described or will become apparent in the course of the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The invention will now be described in detail, with reference to the accompanying drawings by way of example only, in which:

[0013] **FIG. 1A** is a partially sectioned side view of a first embodiment of a drill bit according to the invention,

[0014] **FIG. 1B** is a side view of the drill bit according to **FIG. 1**A,

[0015] **FIG. 1C** is a side view of a drill portion according to **FIG. 1**A,

[0016] **FIG. 1D** is an end view of the drill according to **FIG. 1**C, showing the knurled end of the drill,

[0017] **FIG. 1E** is a side view of a variation of the first embodiment of the drill portion,

[0018] **FIG. 1F** is a sectional side view of the variation of the first embodiment of the drill portion,

[0019] **FIG. 2A** is a partially sectioned side view of a second embodiment of a drill bit according to the invention,

[0020] **FIG. 2B** is a side view of the drill bit according to **FIG. 2**A,

[0021] **FIG. 2C** is a side view of a drill portion according to **FIG. 2**A,

[0022] **FIG. 2D** is am end view of the drill according to **FIG. 2**C, showing the knurled end of the drill,

[0023] **FIG. 3A** is a side view of the hex shaft according to **FIG. 1**A,

[0024] **FIG. 3B** is a sectioned side view of the hex shaft according to **FIG. 3**A,

[0025] **FIG. 3C** is an end view of the hex shaft according to **FIG. 3**B, as seen from the distal end, showing the hex shaft after it has received a spot/centre drill for marking the location of the axial hole to be bored,

[0026] **FIG. 3D** is a side view of the hex shaft according to **FIG. 3**A, showing the outlines of the finished axial hole,

[0027] **FIG. 3E** is a sectioned side view of the hex shaft according to **FIG. 3**D,

[0028] **FIG. 3F** is an end view of the hex shaft according to **FIG. 3**D, as seen from the distal end, showing the hex shaft after the axial hole has been bored,

[0029] **FIG. 4A** is a side view of a third embodiment of a drill according to the invention,

[0030] **FIG. 4B** is an end view of the drill according to **FIG. 4**A, showing the knurled end of the drill,

[0031] **FIG. 5A** is a side view of a fourth embodiment of a drill according to the invention,

[0032] **FIG. 5B** is an end view of the drill according to **FIG. 5**A, showing the knurled end of the drill,

[0033] **FIG. 6A** is a partially sectioned side view of a fifth embodiment of a drill according to the invention,

[0034] **FIG. 6B** is a side view of the drill according to **FIG. 6**A,

[0035] **FIG. 7A** is a side view of a sixth embodiment of a drill according to the invention,

[0036] **FIG. 7B** is an end view of the drill according to **FIG. 7**A, showing the winged end of the drill,

[0037] **FIG. 8A** is a partially sectioned side view of a seventh embodiment of a drill according to the invention,

[0038] **FIG. 8B** is a side view of the drill according to **FIG. 8**A,

[0039] **FIG. 8C** is an end view of the drill according to **FIG. 8**B, showing the polygon shaped end of the drill,

[0040] **FIG. 9A** is a side view of an eighth embodiment of a drill bit according to the invention,

[0041] **FIG. 9B** is a partially sectioned side view of the drill bit according to **FIG. 9**A,

[0042] **FIG. 10A** is a sectional side view of a shank having a tapered axial hole,

[0043] **FIG. 10B** is a distal end view of the shank of **FIG. 10**A,

[0044] **FIG. 10C** is a partially sectional side view of the assembled drill bit,

[0045] **FIG. 10D** is a side view of the assembled drill bit,

[0046] **FIG. 10E** is a side view of the drill portion,

[0047] **FIG. 11A** is a sectional side view of a shank having a tapered axial hole, and knurling,

[0048] **FIG. 11B** is a distal end view of the shank of **FIG. 11**A,

[0049] **FIG. 11C** is a partially sectional side view of the assembled drill bit,

[0050] **FIG. 11D** is a side view of the assembled drill bit,

[0051] **FIG. 11E** is a side view of the drill portion,

[0052] **FIG. 12A** is a sectional side view of a shank having a tapered axial hole, and an alternative form of knurling, and

[0053] **FIG. 12B** is a side view of the drill portion of **FIG. 12A**.

DETAILED DESCRIPTION

[0054] The two-piece drill bit has a drill portion **10** and a hexagonal shank **20**. The proximal end of the drill portion is installed in an axial hole **25** in the distal end of the shank. Although some applications could be envisioned where a shape other than hexagonal could be used, i.e. for a chuck or holder designed to receive other shapes, the hexagonal shape is preferred, for installation in a hexagonal holder or conventional chuck. As is well-known, the holder may include a spring-loaded ball cooperating with a detent groove **24** in the shank, to retain the drill bit in the holder.

[0055] In the preferred embodiment, illustrated in FIGS. **1**A-1D, a section of the drill bit portion near its proximal end is provided with knurling **12**. Preferably a lead-in portion **14** immediately adjacent the proximal end is unknurled, to facilitate starting the drill portion into the axial hole and to ensure proper concentricity as it is inserted. The shank preferably has a circumferential groove **24**, to cooperate with retaining means (not shown) of the holder, such as the previously-mentioned spring-loaded ball. The distal end of the drill portion has spiral grooves and a cutting head forming a traditional drill.

[0056] In a variation on the preferred embodiment, shown in **FIGS. 1E and 1F**, the proximal end of the drill portion has two knurled portions **12**, separated by an unknurled portion **13**. After the drill has been inserted fully into the axial hole of the hex shaft, a crimped drill retention groove **23** is formed on the shank by roll-crimping in place. The drill retention groove preferably is located directly around the unknurled portion **13**. Alternatively, the roll-crimping or roll-peening **23** could be immediately adjacent the distal end of the shank, as illustrated in **FIG. 2B**.

[0057] In manufacturing the drill bit, pre-made drills, i.e. the drill portions are fed into a knurling machine, where the shanks are knurled (splined). Shanks are cut from a coil or standard hex bars, for example using a high-speed saw, a single-spindle machine or a press at standard lengths, for example 1.26 inch (32 mm). Optionally, the cut hex shafts are placed in a tumbler and processed to eliminate burrs and sharp edges. The cut shafts are then loaded into a hopper or vibratory bowl feeder and fed into a combination chamfering/notching machine, which automatically loads and chucks each shaft in turn for machining. The circumferential groove **24** is formed on the shafts in this machine. The circumferential groove is optional, but is a "standard" feature of many hex bit tools. If present, the circumferential grooves should be made according to ANSI/ASME standards (B107.4M-1995). The machining operations, though not necessarily in this order, are chamfering, facing and

notching. The drill retention groove **23** is preferably formed in advance so that it can subsequently be rolled into the unknurled portion **13** of the drill portion **10**. The shank **20** is first spot/centre-drilled with a hole **26**, to define the starting point of the axial hole **25**. Thereafter the axial hole is formed by drilling to correct depth (possibly in two or more stages and possibly with increasing diameter drills). The proximal end of the drill portion **10** is inserted into the axial hole, and the hex shaft is roll-crimped around the drill, by rolling the drill retention groove as described above. The diameter of the axial hole is preferably sized to an optimum diameter for press-fitting the drill in the axial hole before roll-crimping.

[**0058**] Advantageously, the hex shaft is heated before inserting the drill shank, to expand the diameter of the axial hole to facilitate fitting the drill. Optionally, the drill shank may be cooled to decrease the diameter of the drill for the same purpose. A combination of both heating the hex shaft and cooling the drill shank may be employed.

[**0059**] The machining and assembly operations for all embodiments of the invention may be performed on a multi-head/spindle machine.

[**0060**] The manufacturing methods according to the invention eliminate common problems of the hex-shank drill assemblies in that they ensure the integrity of the mating parts. The roll-crimped portion of the hex shaft, whether it is in the centre or at the end, retains the drill bit firmly and prevents removal in an axial direction. The drill bits cannot rotate in the hex shafts because the knurls/splines prevent this, and the drill bits run true relative the rotational axis of the driving tool because there is no swaging or other operation that requires heavy impact to retain the drill bits in the shafts. The high impact easily causes deflection and bending of the components.

[**0061**] Conventional methods of manufacturing and assembly requires the hex shafts to be chucked/re-chucked at each stage of the process. This may cause concentricity and run-out problems. Since the manufacturing processes of the invention integrate the manufacturing at one multi-function station, the need for removal/replacing from chuck to chuck is eliminated. This ensures consistency of concentricity and eliminates any problems associated with run-out.

[**0062**] In **FIGS. 2A** to **2**D, a second embodiment is shown, in which the knurling **12** extends the length of that portion of the the proximal end of the drill portion **10** which is within the shank **20**.

[**0063**] **FIGS. 3A** to **3**F show the shank **20** and its manufacture, including the preferred initial step of drilling a starting hole **26**.

[**0064**] In **FIGS. 4A and 4B**, a third embodiment of a drill bit according to the invention is shown. The distal end of the drill portion has a tip **13**, which has a polygonal cross-section. The polygonal tip further enhances the resistance against rotation of the drill in the axial hole after the roll-crimping process.

[**0065**] In **FIGS. 5A and 5B**, a fourth embodiment of a drill bit according to the invention is shown. The distal area of the drill bit has an unknurled portion **13**, which has a number of protruding wings **15**. The wings further enhance the resistance against rotation of the drill in the axial hole after the roll-crimping process.

[**0066**] In **FIGS. 6A and 6B**, a fifth embodiment of a drill bit according to the invention is shown. The distal area of the drill portion has a groove **16**, which cooperates with the roll-crimped portion of the shank **20**, allowing material from the shank to flow into the groove to thereby securely hold the drill in the shank (after roll-crimping).

[**0067**] In **FIGS. 7A and 7B**, a sixth embodiment of a drill according to the invention is shown. The distal area of the drill portion has a number of sharp edged barbed wings **17**. The wings enhance the resistance against rotation and prevents removal of the drill in the axial hole after the roll-crimping process, but permit easy insertion of the drill before roll-crimping.

[**0068**] In **FIGS. 8A** to **8**C, a seventh embodiment of a drill according to the invention is shown. The proximal end of the drill portion has a polygonal shape, which enhances the resistance against rotation of the drill in the axial hole after the roll-crimping process, but permit easy insertion of the drill before roll-crimping.

[**0069**] In **FIGS. 9A and 9B**, an eighth embodiment of a drill bit according to the invention is shown. The shank **20** has a standard size portion **21** and an oversized portion **22**, for accommodating a larger size drill **10**, compared to earlier embodiments described. The proximal end of the drill portion has a polygonal shape, which enhances the resistance against rotation of the drill in the axial hole after the roll-crimping process, but permit easy insertion of the drill before roll-crimping.

[**0070**] In a ninth embodiment, shown in **FIGS. 10A** to **10**E, the axial hole **25** can be seen to be tapered, and the proximal end of the drill portion **10** is correspondingly tapered. The drill portion may be captured by any previously-mentioned means, including for example contraction of a heated shank, but preferably a knurled portion **12** is provided as in the previous embodiments.

[**0071**] In all embodiments, as shown in **FIGS. 12A and 12B** by knurling **12'**, the knurling need not be longitudinally oriented. It could be, for example, in a cross-hatched pattern as shown in **FIGS. 12A and 12B**.

[**0072**] The above description relates to preferred embodiments by way of example only. However, it should be apparent to those knowledgeable in the field that many variations are possible, without departing from the spirit of the invention. Such variations are intended to be within the scope of the invention as claimed, whether or not expressly described above.

claims:

1. A two-piece drill bit, comprising a shank and a drill portion, said shank having a proximal end for mounting and a distal end having an axial hole for receiving a proximal end section of said drill portion, characterized by at least a portion of said proximal end section of said drill portion being knurled, said shank being compressed tightly against said proximal end section of said drill portion.

2. A drill bit as in claim 1, further characterized by there being two said knurled portions, separated by an unknurled portion.

3. A drill bit as in claim 1, further characterized by an unknurled portion adjacent said proximal end of said drill portion.

4. A drill bit as in claim 1, characterized by said shank being compressed tightly against said proximal end section of said drill portion by a process selected from the group consisting of rolling, peening, roll-peening, pressing, and compression by differential heating and cooling.

5. A drill bit as in claim 1, characterized by said axial hole being tapered, and said proximal end section of said drill portion being correspondingly tapered.

6. A drill bit as in claim 5, further characterized by there being two said knurled portions, separated by an unknurled portion.

7. A drill bit as in claim 5, further characterized by an unknurled portion adjacent said proximal end of said drill portion.

8. A drill bit as in claim 5, characterized by said shank being compressed tightly against said proximal end section of said drill portion by a process selected from the group consisting of rolling, peening, roll-peening, pressing, and compression by differential heating and cooling.

9. A drill bit as in claim 1, characterized by said shank having a proximal portion having one cross-sectional dimension, and a distal portion having a larger cross-sectional dimension, whereby said distal portion may accommodate drill portions of a larger diameter than if said distal portion was of the same cross-sectional dimension as said proximal portion.

10. A two-piece drill bit, comprising a shank and a drill portion, said shank having a proximal end for mounting and a distal end having an axial hole for receiving a proximal end section of said drill portion, characterized by at least a portion of said proximal end section of said drill portion having an irregular cross-section, said shank being compressed tightly against said proximal end section of said drill portion.

11. A drill bit as in claim 10, wherein said irregular cross-section is selected from the group consisting of wings extending radially outwardly, barbs extending radially outwardly, and a polygon.

12. A drill bit as in claim 11, characterized by said shank being compressed tightly against said proximal end section of said drill portion by a process selected from the group consisting of rolling, peening, roll-peening, pressing, and compression by differential heating and cooling.

13. A two-piece drill bit, comprising a shank and a drill portion, said shank having a proximal end for mounting and a distal end having an axial hole for receiving a proximal end section of said drill portion, characterized by said axial hole being tapered, and said drill portion having a correspondingly tapered proximal end, said shank being compressed tightly against said proximal end section of said drill portion.

14. A drill bit as in claim 13, further characterized by at least a portion of said proximal end section of said drill portion being knurled.

15. A method of manufacturing a two-piece drill bit, said two-piece drill bit comprising a shank and a drill portion, said shank having a proximal end for mounting and a distal end having an axial hole for receiving a proximal end section of said drill portion, said method comprising the steps of:

forming a knurled portion on at least a portion of said proximal end section of said drill portion;

providing shanks of a suitable length;

drilling an axial hole at a distal end of said shank; and

inserting said proximal end section of said drill portion into said axial hole.

16. A method as in claim 15, comprising the further step of mechanically deforming at least a portion of said shank to symmetrically compress said shank onto said drill portion after said insertion of said proximal end section of said drill portion into said axial hole.

17. A method as in claim 15, wherein said axial hole and said proximal end section of said drill portion are correspondingly tapered.

18. A method as in claim 17, comprising the further step of mechanically deforming at least a portion of said shank to symmetrically compress said shank onto said drill portion after said insertion of said proximal end section of said drill portion into said axial hole.

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