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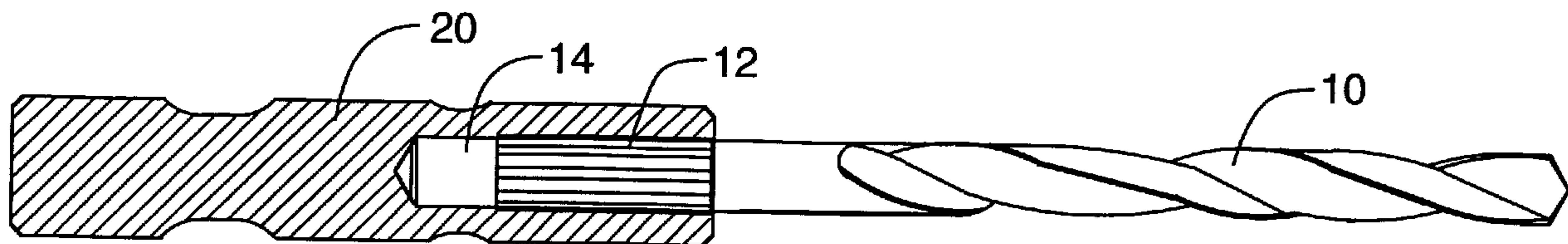
(72) Inventeur/Inventor:
VASUDEVA, KAILASH C., CA

(73) Propriétaire/Owner:
MAXTECH MANUFACTURING INC., CA

(74) Agent: BORDEN LADNER GERVAIS LLP

(54) Titre : TREPANS DEUX PIECES

(54) Title: TWO-PIECE DRILL BITS



(57) **Abrégé/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.

ABSTRACT

5 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
10 shank.

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

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:

(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.

(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.

(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.

5

- (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.

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

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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.

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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.

30

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, roll-peening, or differential expansion in heating and cooling.

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

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

Fig. 1A is a partially sectioned side view of a first embodiment of a drill bit according to the invention,

Fig. 1B is a side view of the drill bit according to Fig. 1A,

Fig. 1C is a side view of a drill portion according to Fig. 1A,

Fig. 1D is an end view of the drill according to Fig. 1C, showing the knurled end of the drill,

Fig. 1E is a side view of a variation of the first embodiment of the drill portion,

Fig. 1F is a sectional side view of the variation of the first embodiment of the drill portion,

Fig. 2A is a partially sectioned side view of a second embodiment of a drill bit according to the invention,

Fig. 2B is a side view of the drill bit according to Fig. 2A,

Fig. 2C is a side view of a drill portion according to Fig. 2A,

Fig. 2D is an end view of the drill according to Fig. 2C, showing the knurled end of the drill,

Fig. 3A is a side view of the hex shaft according to Fig. 1A,

- Fig. 3B is a sectioned side view of the hex shaft according to Fig. 3A,
- Fig. 3C is an end view of the hex shaft according to Fig. 3B, as seen from the
5 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,
- Fig. 3D is a side view of the hex shaft according to Fig. 3A, showing the outlines
of the finished axial hole,
- 10 Fig. 3E is a sectioned side view of the hex shaft according to Fig. 3D,
- Fig. 3F is an end view of the hex shaft according to Fig. 3D, as seen from the
distal end, showing the hex shaft after the axial hole has been bored,
- 15 Fig. 4A is a side view of a third embodiment of a drill according to the invention,
- Fig. 4B is an end view of the drill according to Fig. 4A, showing the knurled end
of the drill,
- 20 Fig. 5A is a side view of a fourth embodiment of a drill according to the invention,
- Fig. 5B is an end view of the drill according to Fig. 5A, showing the knurled end
of the drill,
- 25 Fig. 6A is a partially sectioned side view of a fifth embodiment of a drill according
to the invention,
- Fig. 6B is a side view of the drill according to Fig. 6A,
- 30 Fig. 7A is a side view of a sixth embodiment of a drill according to the invention,
- Fig. 7B is an end view of the drill according to Fig. 7A, showing the winged end of
the drill,

Fig. 8A is a partially sectioned side view of a seventh embodiment of a drill according to the invention,

5 Fig. 8B is a side view of the drill according to Fig. 8A,

Fig. 8C is an end view of the drill according to Fig. 8B, showing the polygon shaped end of the drill,

10 Fig. 9A is a side view of an eighth embodiment of a drill bit according to the invention,

Fig. 9B is a partially sectioned side view of the drill bit according to Fig. 9A,

15 Fig. 10A is a sectional side view of a shank having a tapered axial hole,

Fig. 10B is a distal end view of the shank of Fig. 10A,

Fig. 10C is a partially sectional side view of the assembled drill bit,

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Fig. 10D is a side view of the assembled drill bit,

Fig. 10E is a side view of the drill portion,

25 Fig. 11A is a sectional side view of a shank having a tapered axial hole, and knurling,

Fig. 11B is a distal end view of the shank of Fig. 11A,

30 Fig. 11C is a partially sectional side view of the assembled drill bit,

Fig. 11D is a side view of the assembled drill bit,

Fig. 11E is a side view of the drill portion,

Fig. 12A is a sectional side view of a shank having a tapered axial hole, and an alternative form of knurling, and

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Fig. 12B is a side view of the drill portion of Fig. 12A.

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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.

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In the preferred embodiment, illustrated in Figs. 1A-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.

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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.

25

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.

30

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.

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.

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

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.

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.

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

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

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 **18**, 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.

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.

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).

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.

10 In Figs. 8A to 8C, a seventh embodiment of a drill according to the invention is shown. The proximal end **19** 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.

15 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.

20 In a ninth embodiment, shown in Figs. 10A to 10E, 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.

30 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.

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 having a shank tightly compressed against 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 drill portion further comprising:

two knurled portions separated by an unknurled portion at the proximal end of said drill portion.

2. The two-piece drill bit of claim 1, wherein a number of wings extend radially outwardly from the unknurled portion.

3. 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;

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

inserting said proximal end section of said drill portion into said axial hole; and,

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.

4. The method of claim 3, wherein said axial hole and said proximal end section of said drill portion are correspondingly tapered.

5. The two-piece drill bit of claim 1, wherein said axial hole is tapered, and said proximal end section of said drill portion is correspondingly tapered.

6. The method of claim 3, wherein the step of mechanically deforming includes rolling, peening, roll-peening, and pressing.

7. The method of claim 3, wherein the step of forming a knurled portion includes forming a cross-hatched pattern.

8. The method of claim 3, wherein the step of forming includes forming wings extending radially outwardly on the portion of said proximal end section of said drill portion.

9. The two-piece drill bit of claim 1, wherein said shank has a proximal portion having one cross-sectional dimension, and a distal portion having a large cross-sectional dimension, said distal portion accommodating 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 having a shank tightly compressed against 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, comprising:

wings extending radially outwardly from said proximal end section of said drill portion.

11. The two-piece drill bit of claim 10, wherein said wings include barbed wings.

12. The method of claim 3, wherein the step of forming includes forming barbed wings extending radially outwardly on the portion of said proximal end section of said drill portion.

13. A two-piece drill bit having a shank tightly compressed against 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 drill portion comprising:

a knurled portion at said tapered proximal end of said drill portion; and,
an unknurled portion adjacent said tapered proximal end section of said drill portion.

14. The two-piece drill bit of claim 13, wherein the knurled portion has cross-hatched pattern.

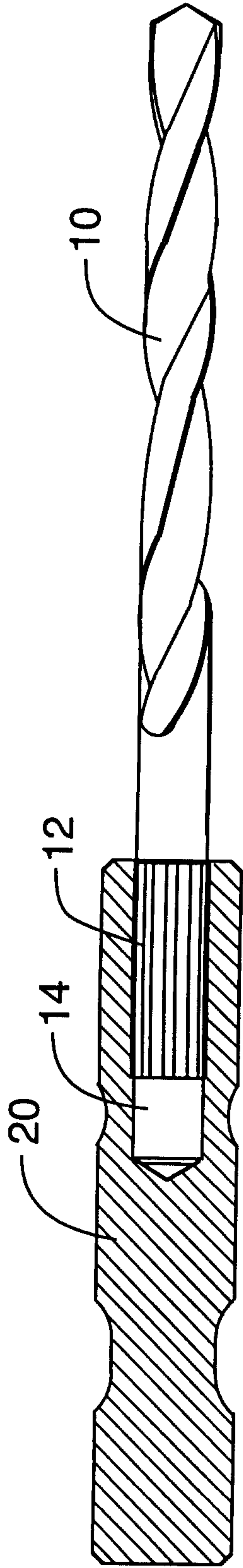


FIG. 1A

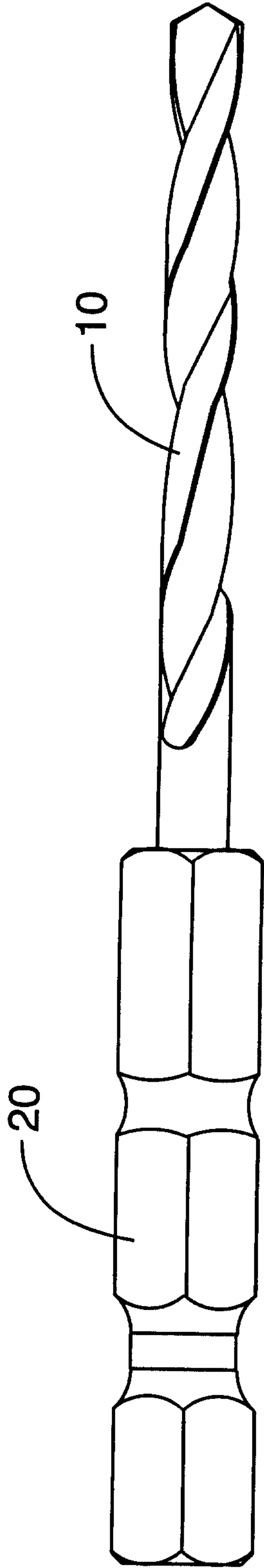


FIG. 1B

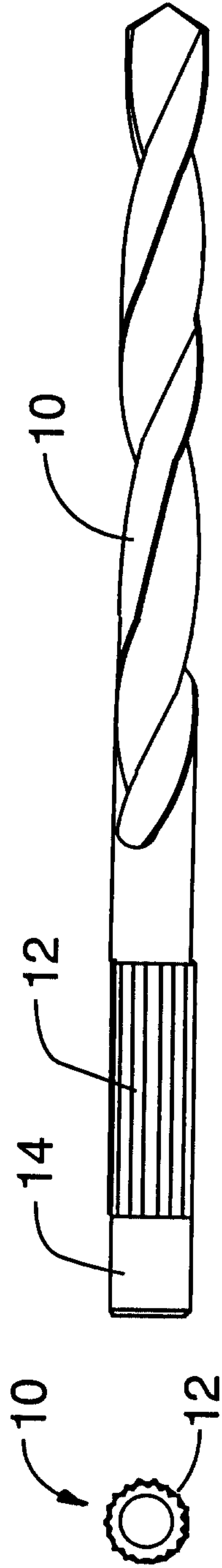


FIG. 1C

FIG. 1D



FIG. 1E

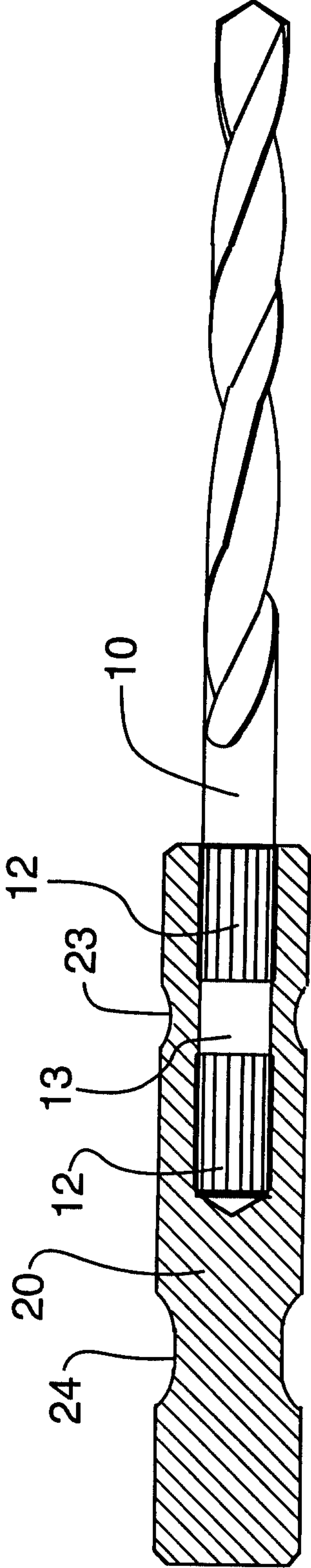


FIG. 1F

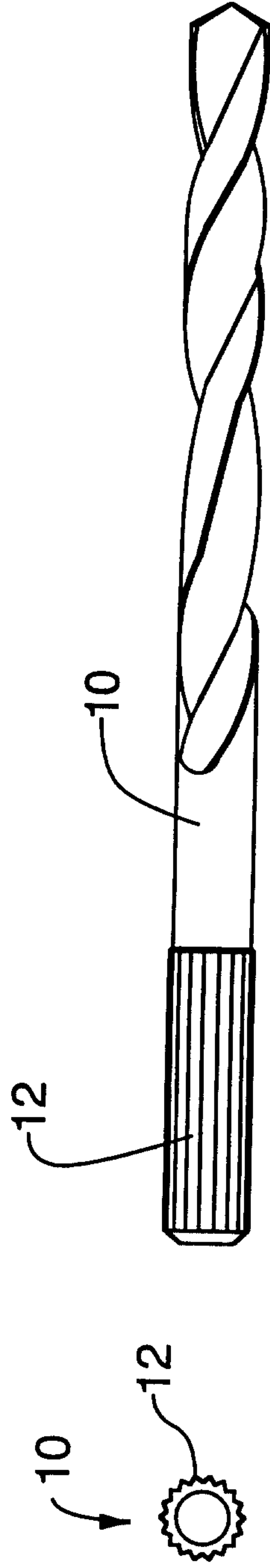
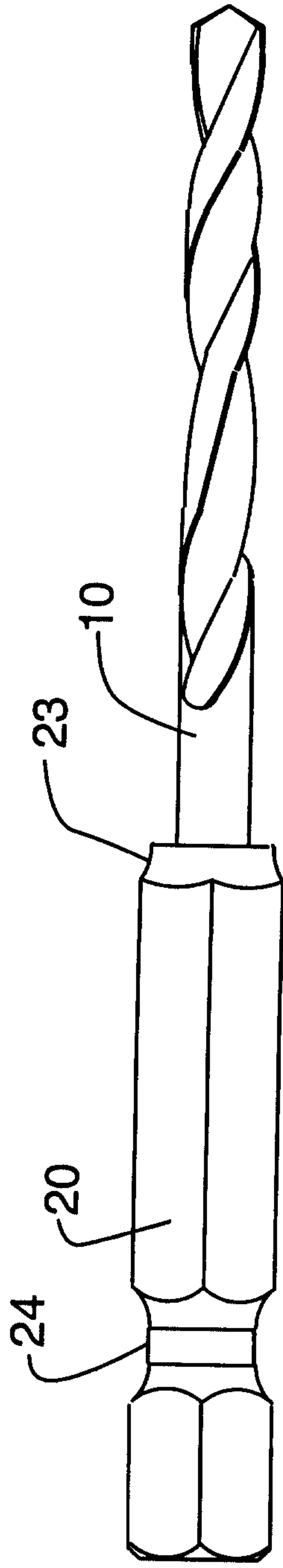
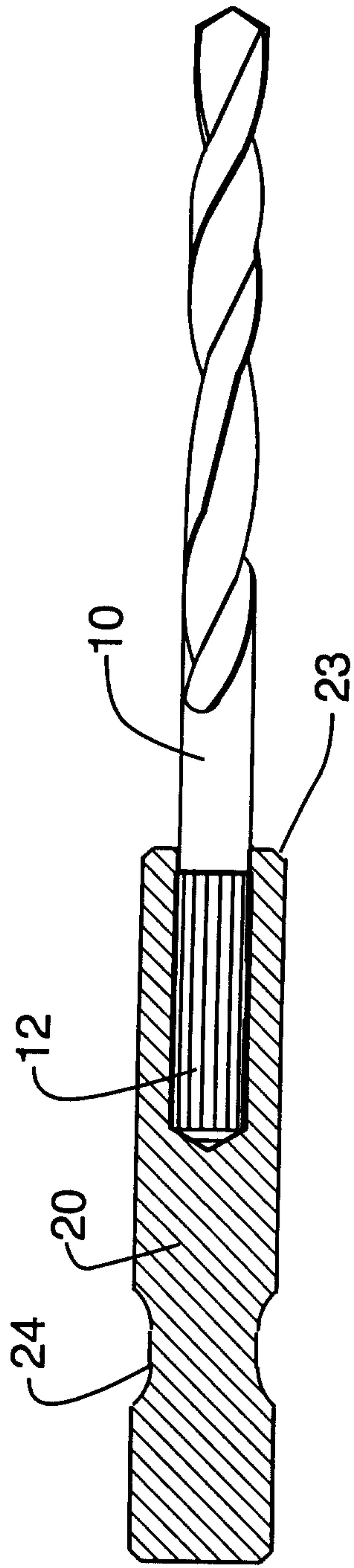


FIG. 2D

FIG. 2C

FIG. 2B

FIG. 2A

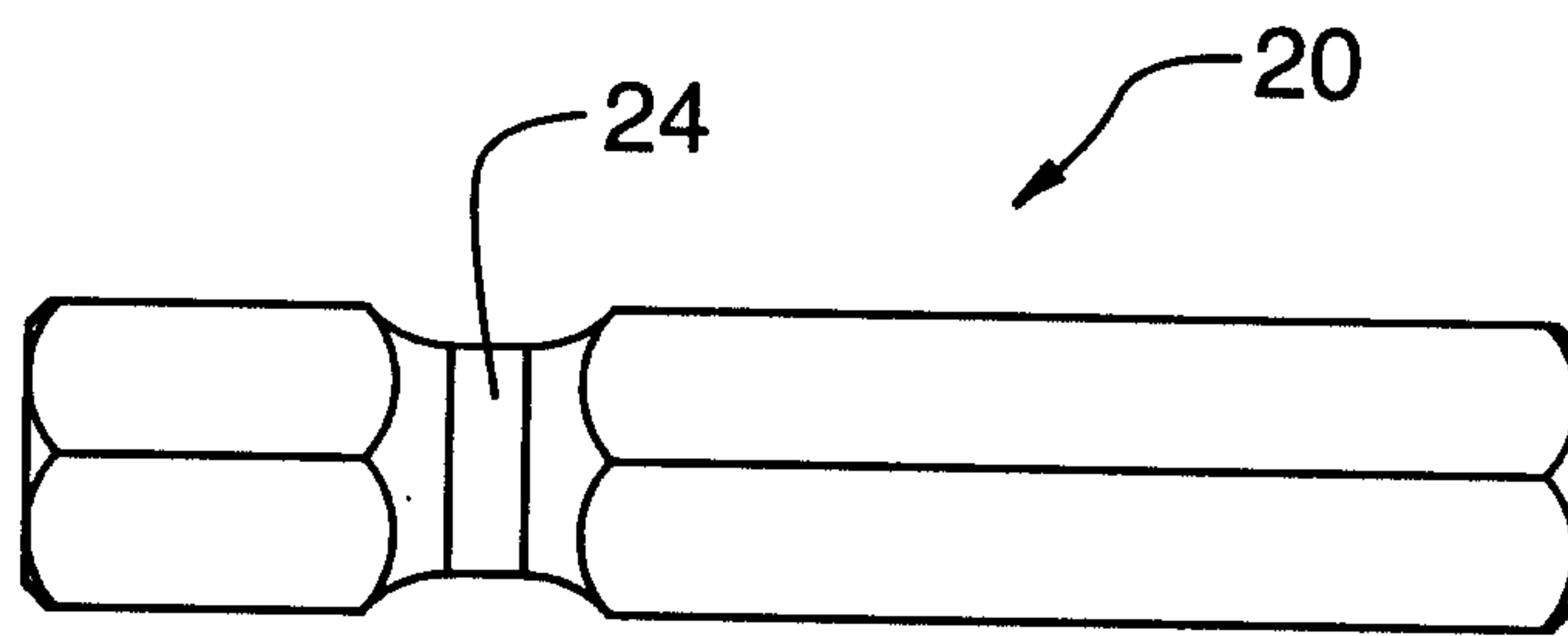


FIG. 3A

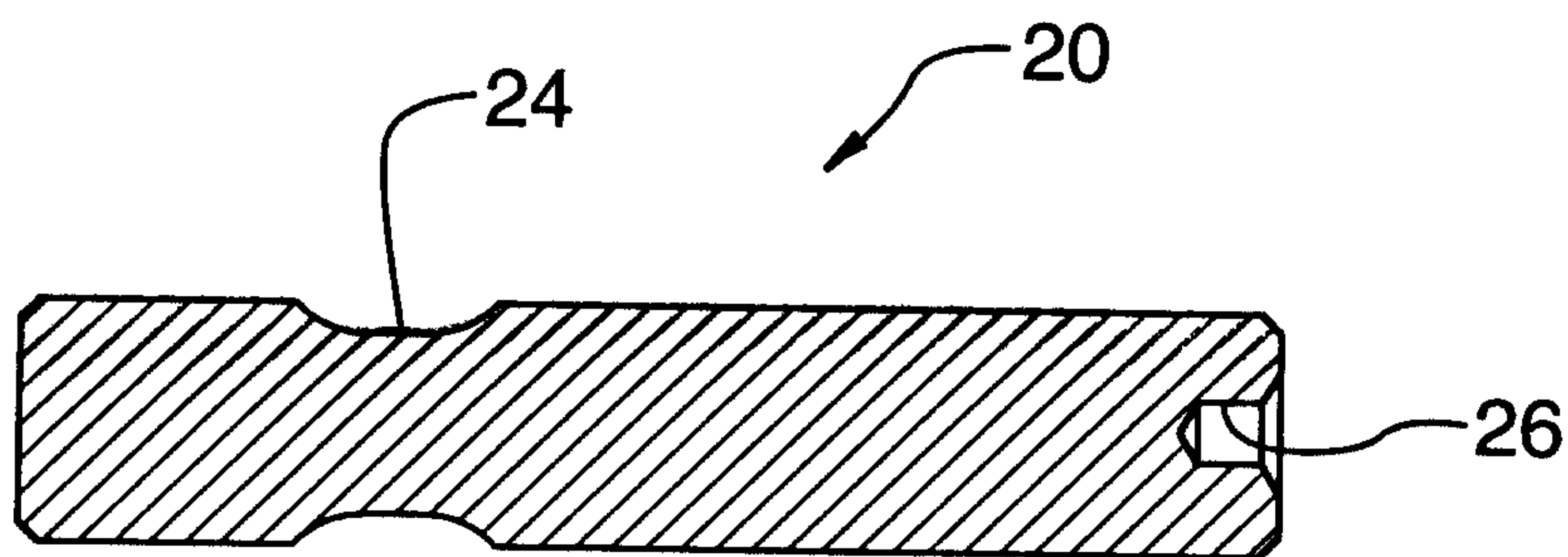


FIG. 3B

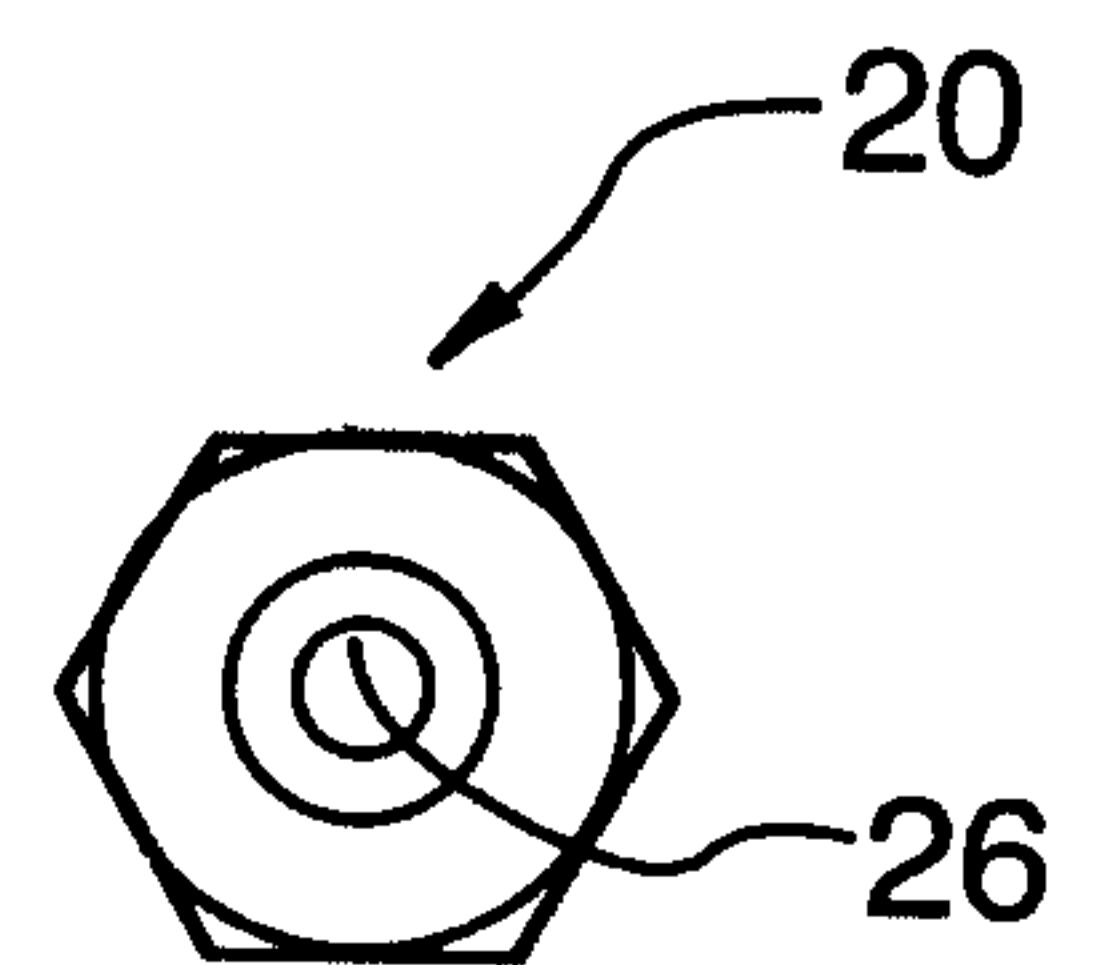


FIG. 3C

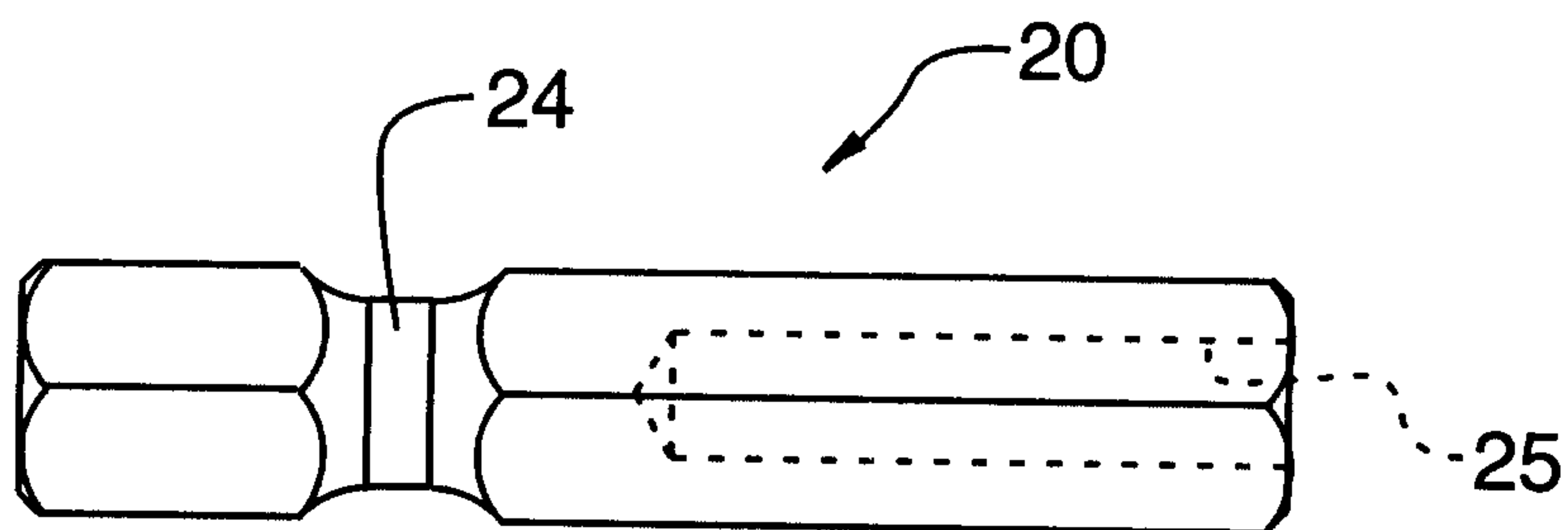


FIG. 3D

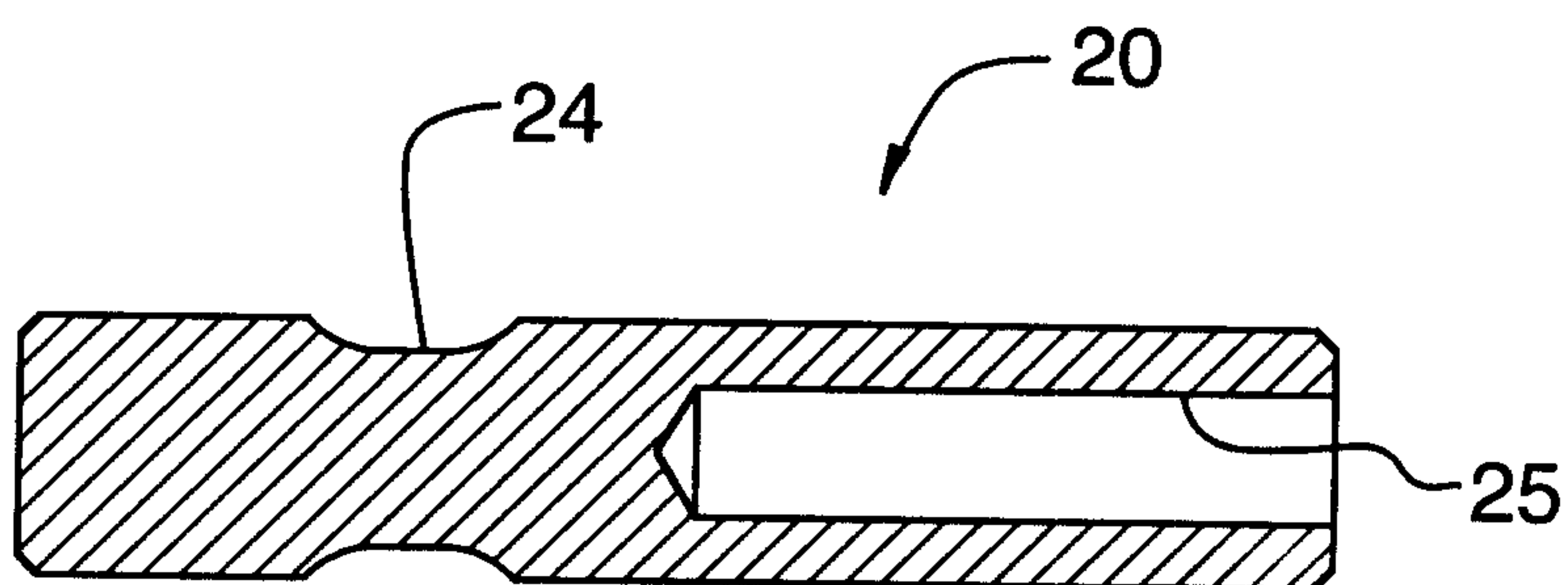


FIG. 3E

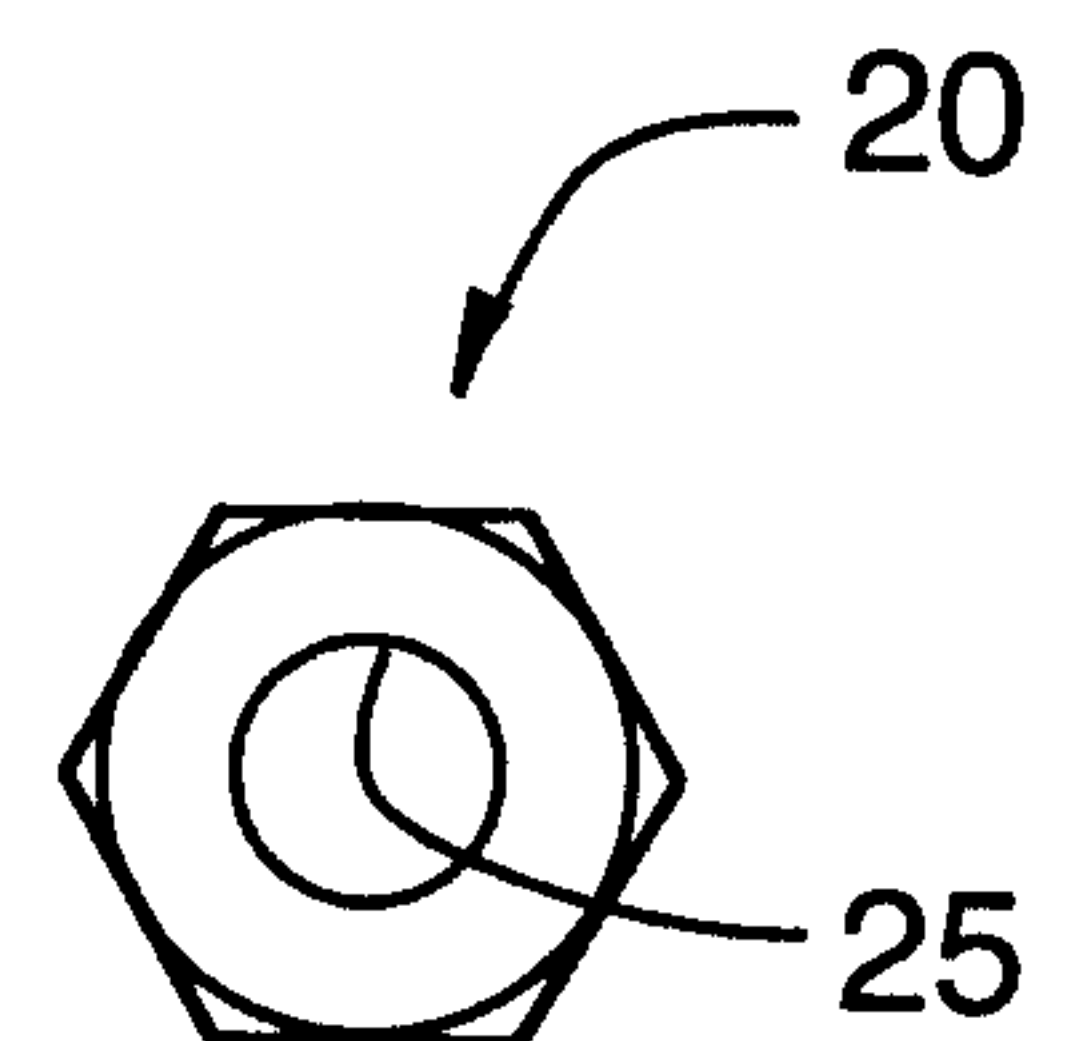


FIG. 3F

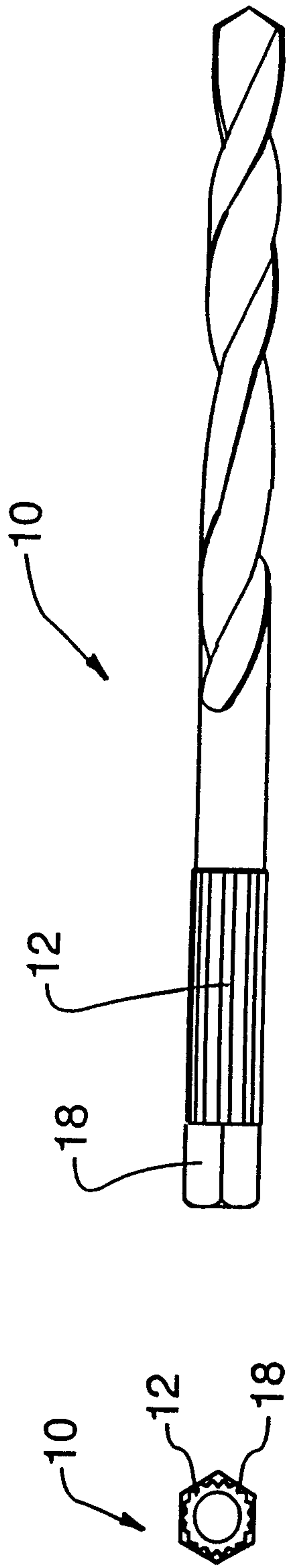


FIG. 4B

FIG. 4A

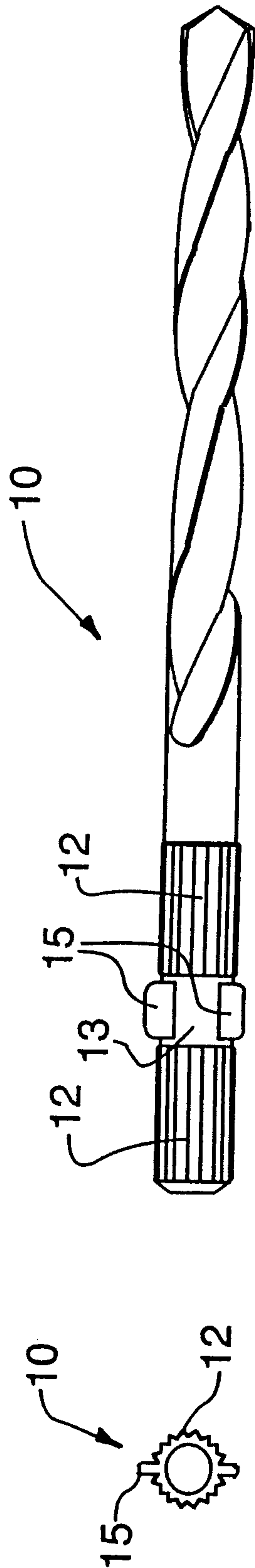


FIG. 5B

FIG. 5A

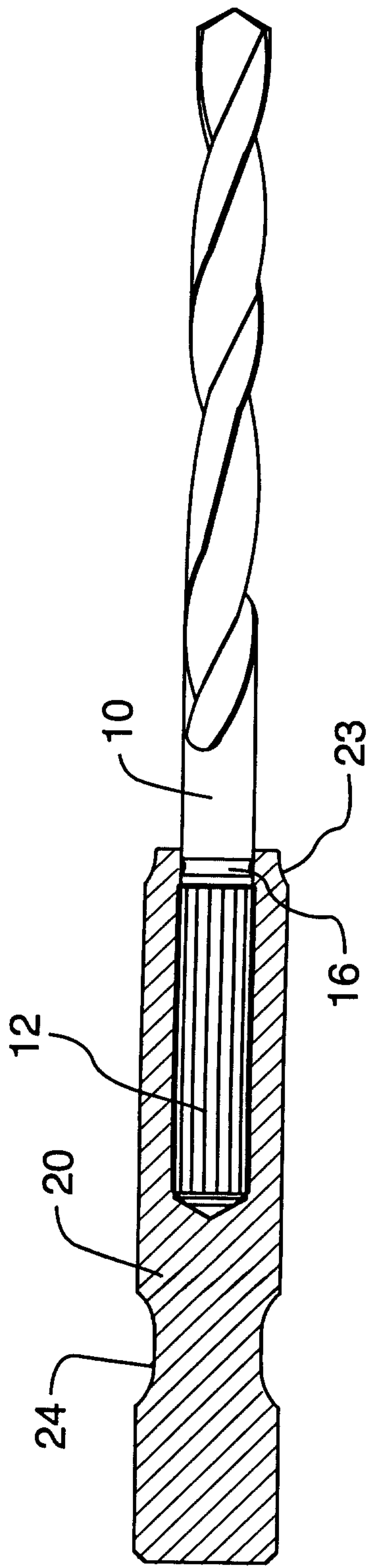


FIG. 6A



FIG. 6B

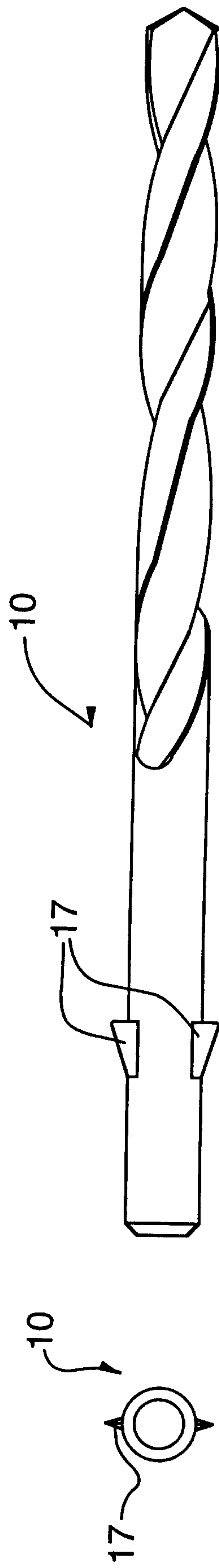


FIG. 7A

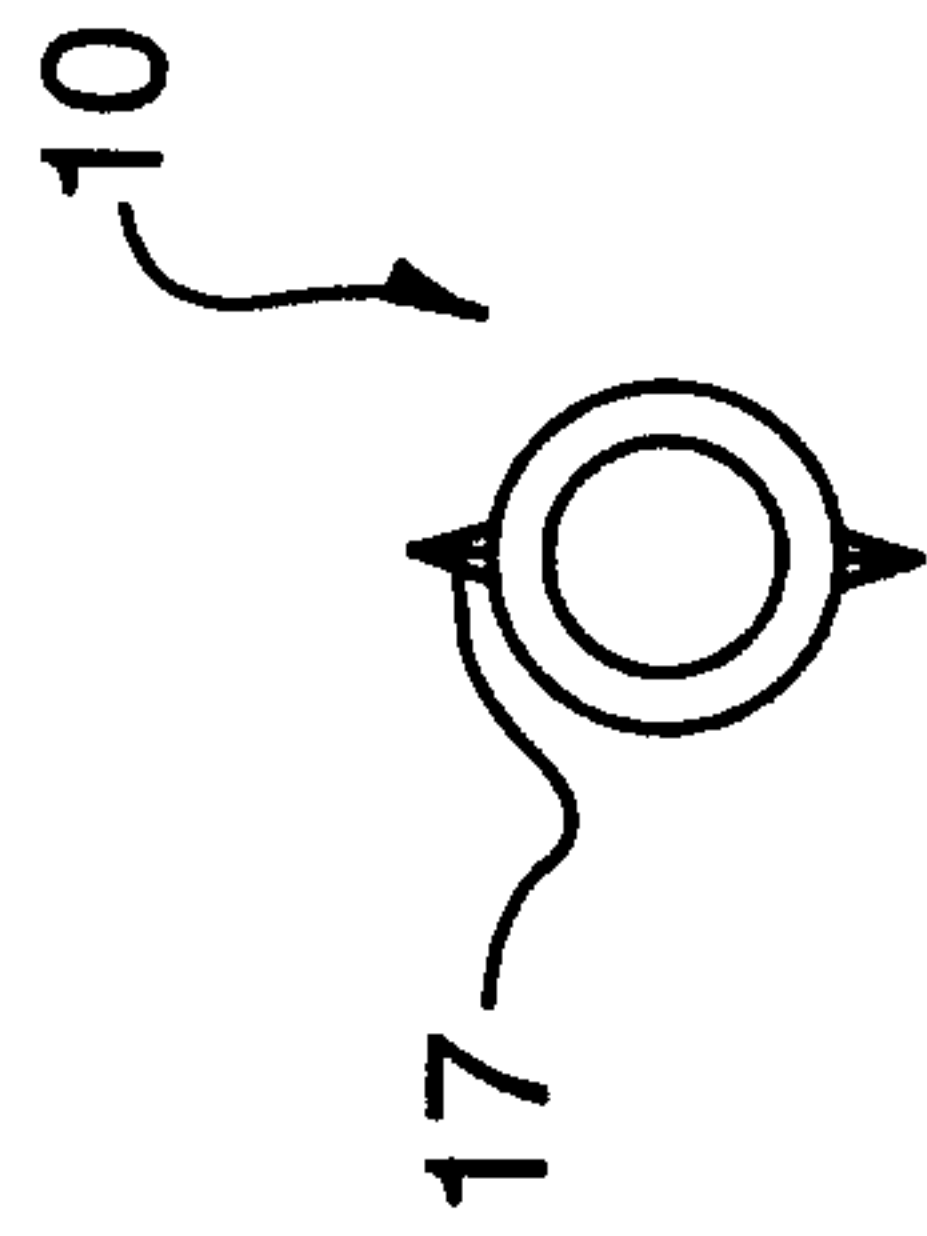


FIG. 7B

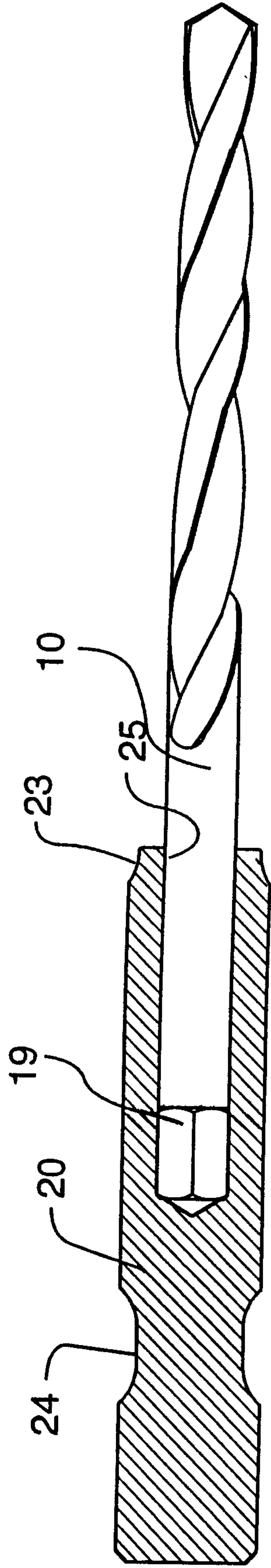


FIG. 8A

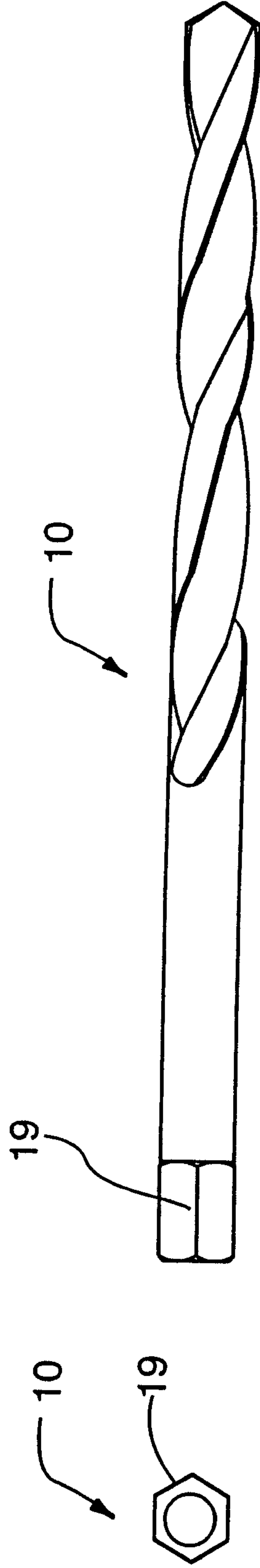


FIG. 8B

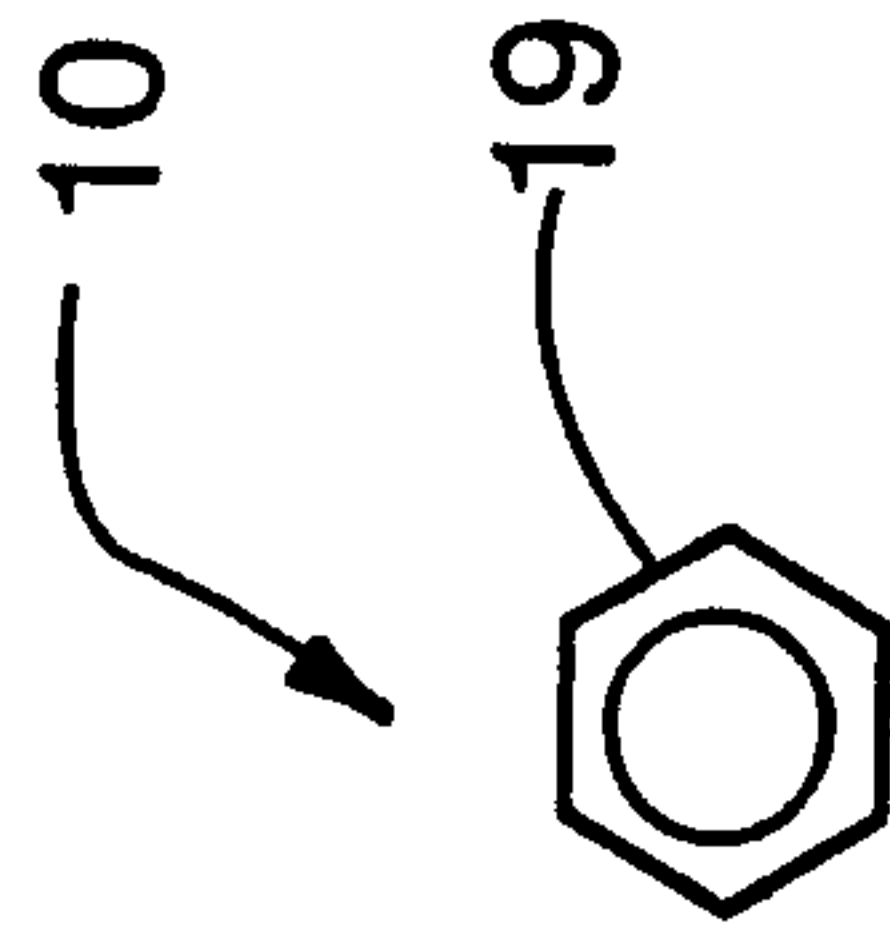


FIG. 8C

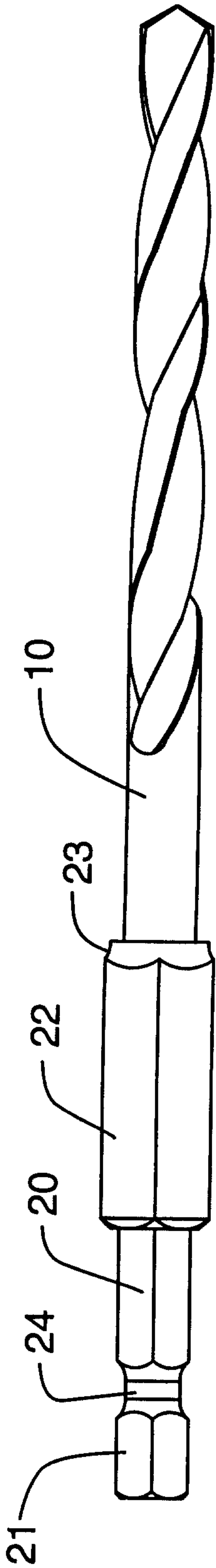


FIG. 9A

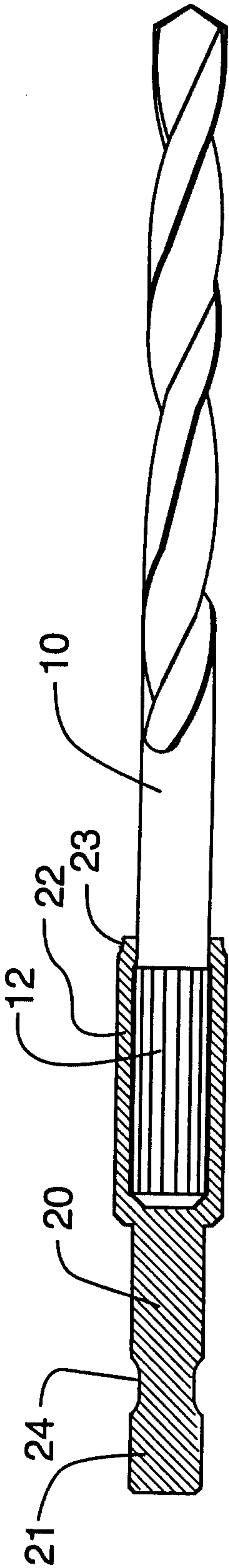


FIG. 9B

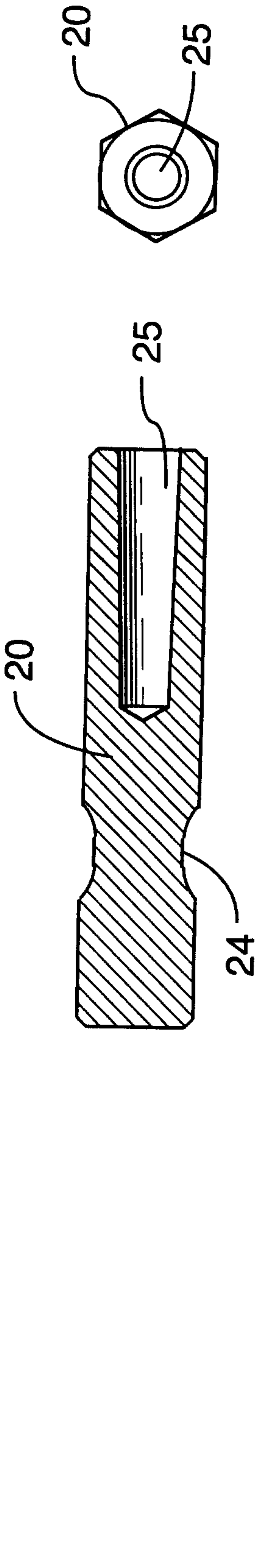


FIG. 10A

FIG. 10B

FIG. 10C

FIG. 10D

FIG. 10E

FIG. 10F

FIG. 10G

FIG. 10H

FIG. 10I

FIG. 10J

FIG. 10K

FIG. 10L

FIG. 10M

FIG. 10N

FIG. 10O

FIG. 10P

FIG. 10Q

FIG. 10R

FIG. 10S

FIG. 10T

FIG. 10U

FIG. 10V

FIG. 10W

FIG. 10X

FIG. 10Y

FIG. 10Z

FIG. 10AA

FIG. 10AB

FIG. 10AC

FIG. 10AD

FIG. 10AE

FIG. 10AF

FIG. 10AG

FIG. 10AH

FIG. 10AI

FIG. 10AJ

FIG. 10AK

FIG. 10AL

FIG. 10AM

FIG. 10AN

FIG. 10AO

FIG. 10AP

FIG. 10AQ

FIG. 10AR

FIG. 10AS

FIG. 10AT

FIG. 10AU

FIG. 10AV

FIG. 10AW

FIG. 10AX

FIG. 10AY

FIG. 10AZ

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FIG. 10BB

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FIG. 10BQ

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FIG. 10BS

FIG. 10BT

FIG. 10BU

FIG. 10BV

FIG. 10BW

FIG. 10BX

FIG. 10BY

FIG. 10BZ

FIG. 10CA

FIG. 10CB

FIG. 10CC

FIG. 10CD

FIG. 10CE

FIG. 10CF

FIG. 10CG

FIG. 10CH

FIG. 10CI

FIG. 10CJ

FIG. 10CK

FIG. 10CL

FIG. 10CM

FIG. 10CN

FIG. 10CO

FIG. 10CP

FIG. 10CQ

FIG. 10CR

FIG. 10CS

FIG. 10CT

FIG. 10CU

FIG. 10CV

FIG. 10CW

FIG. 10CX

FIG. 10CY

FIG. 10CZ

FIG. 10DA

FIG. 10DB

FIG. 10DC

FIG. 10DD

FIG. 10DE

FIG. 10DF

FIG. 10DG

FIG. 10DH

FIG. 10DI

FIG. 10DJ

FIG. 10DK

FIG. 10DL

FIG. 10DM

FIG. 10DN

FIG. 10DO

FIG. 10DP

FIG. 10DQ

FIG. 10DR

FIG. 10DS

FIG. 10DT

FIG. 10DU

FIG. 10DV

FIG. 10DW

FIG. 10DX

FIG. 10DY

FIG. 10DZ

FIG. 10EA

FIG. 10EB

FIG. 10EC

FIG. 10ED

FIG. 10EE

FIG. 10EF

FIG. 10EG

FIG. 10EH

FIG. 10EI

FIG. 10EJ

FIG. 10EK

FIG. 10EL

FIG. 10EM

FIG. 10EN

FIG. 10EO

FIG. 10EP

FIG. 10EQ

FIG. 10ER

FIG. 10ES

FIG. 10ET

FIG. 10EU

FIG. 10EV

FIG. 10EW

FIG. 10EX

FIG. 10EY

FIG. 10EZ

FIG. 10FA

FIG. 10FB

FIG. 10FC

FIG. 10FD

FIG. 10FE

FIG. 10FF

FIG. 10FG

FIG. 10FH

FIG. 10FI

FIG. 10FJ

FIG. 10FK

FIG. 10FL

FIG. 10FM

FIG. 10FN

FIG. 10FO

FIG. 10FP

FIG. 10FQ

FIG. 10FR

FIG. 10FS

FIG. 10FT

FIG. 10FU

FIG. 10FV

FIG. 10FW

FIG. 10FX

FIG. 10FY

FIG. 10FZ

FIG. 10GA

FIG. 10GB

FIG. 10GC

FIG. 10GD

FIG. 10GE

FIG. 10GF

FIG. 10GG

FIG. 10GH

FIG. 10GI

FIG. 10GJ

FIG. 10GK

FIG. 10GL

FIG. 10GM

FIG. 10GN

FIG. 10GO

FIG. 10GP

FIG. 10GQ

FIG. 10GR

FIG. 10GS

FIG. 10GT

FIG. 10GU

FIG. 10GV

FIG. 10GW

FIG. 10GX

FIG. 10GY

FIG. 10GZ

FIG. 10HA

FIG. 10HB

FIG. 10HC

FIG. 10HD

FIG. 10HE

FIG. 10HF

FIG. 10HG

FIG. 10HH

FIG. 10HI

FIG. 10HJ

FIG. 10HK

FIG. 10HL

FIG. 10HM

FIG. 10HN

FIG. 10HO

FIG. 10HP

FIG. 10HQ

FIG. 10HR

FIG. 10HS

FIG. 10HT

FIG. 10HU

FIG. 10HV

FIG. 10HW

FIG. 10HX

FIG. 10HY

FIG. 10HZ

FIG. 10IA

FIG. 10IB

FIG. 10IC

FIG. 10ID

FIG. 10IE

FIG. 10IF

FIG. 10IG

FIG. 10IH

FIG. 10II

FIG. 10IJ

FIG. 10IK

FIG. 10IL

FIG. 10IM

FIG. 10IN

FIG. 10IO

FIG. 10IP

FIG. 10IQ

FIG. 10IR

FIG. 10IS

FIG. 10IT

FIG. 10IU

FIG. 10IV

FIG. 10IW

FIG. 10IX

FIG. 10IY

FIG. 10IZ

FIG. 10JA

FIG. 10JB

FIG. 10JC

FIG. 10JD

FIG. 10JE

FIG. 10JF

FIG. 10JG

FIG. 10JH

FIG. 10JI

FIG. 10JJ

FIG. 10JK

FIG. 10JL

FIG. 10JM

FIG. 10JN

FIG. 10JO

FIG. 10JP

FIG. 10JQ

FIG. 10JR

FIG. 10JS

FIG. 10JT

FIG. 10JU

FIG. 10JV

FIG. 10JW

FIG. 10JX

FIG. 10JY

FIG. 10JZ

FIG. 10KA

FIG. 10KB

FIG. 10KC

FIG. 10KD

FIG. 10KE

FIG. 10KF

FIG. 10KG

FIG. 10KH

FIG. 10KI

FIG. 10KJ

FIG. 10KK

FIG. 10KL

FIG. 10KM

FIG. 10KN

FIG. 10KO

FIG. 10KP

FIG. 10KQ

FIG. 10KR

FIG. 10KS

FIG. 10KT

FIG. 10KU

FIG. 10KV

FIG. 10KW

FIG. 10KX

FIG. 10KY

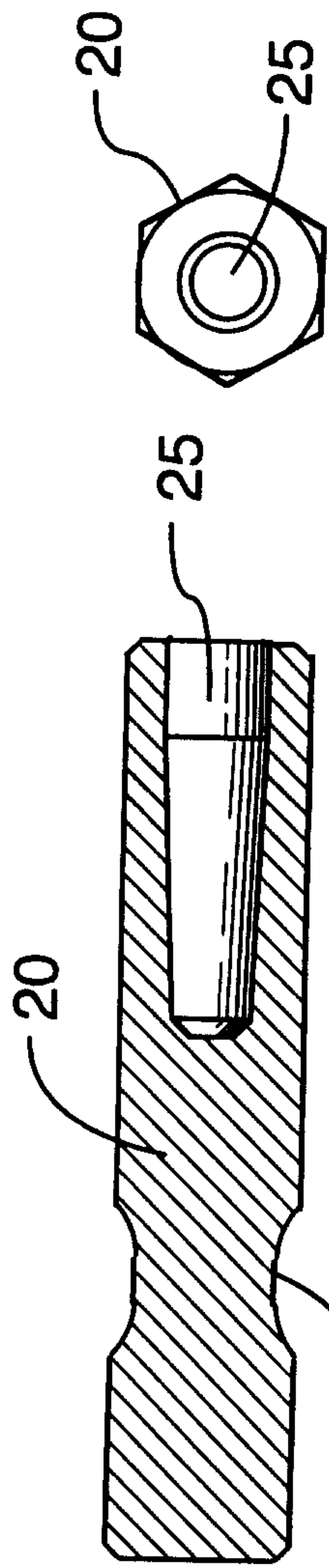


FIG. 11B

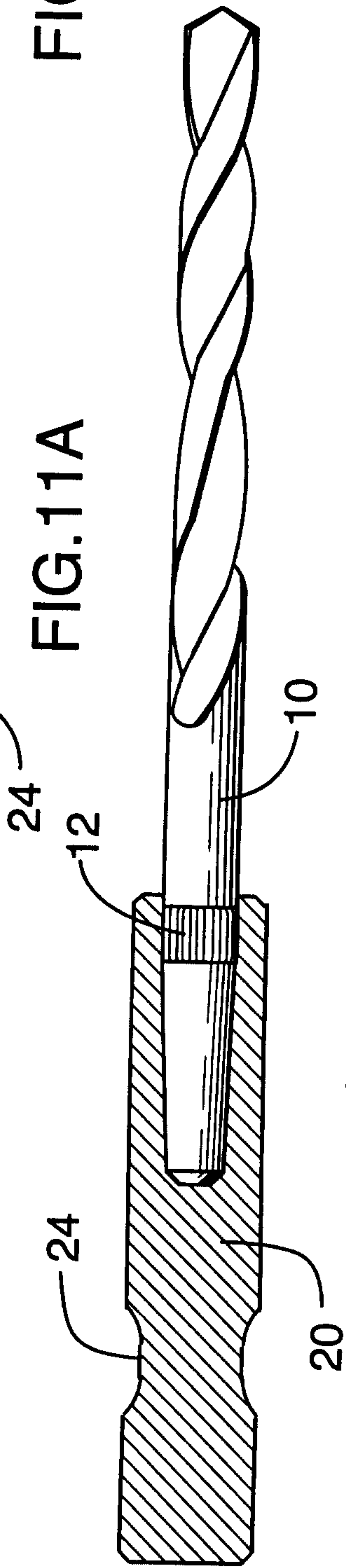


FIG. 11C

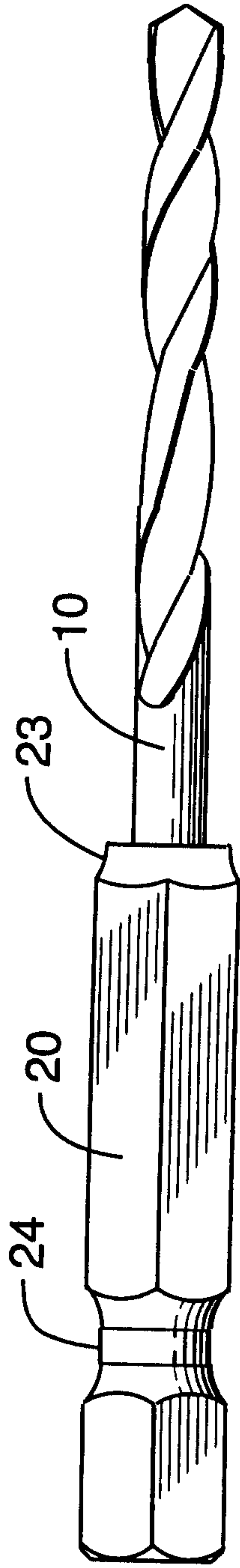


FIG. 11D

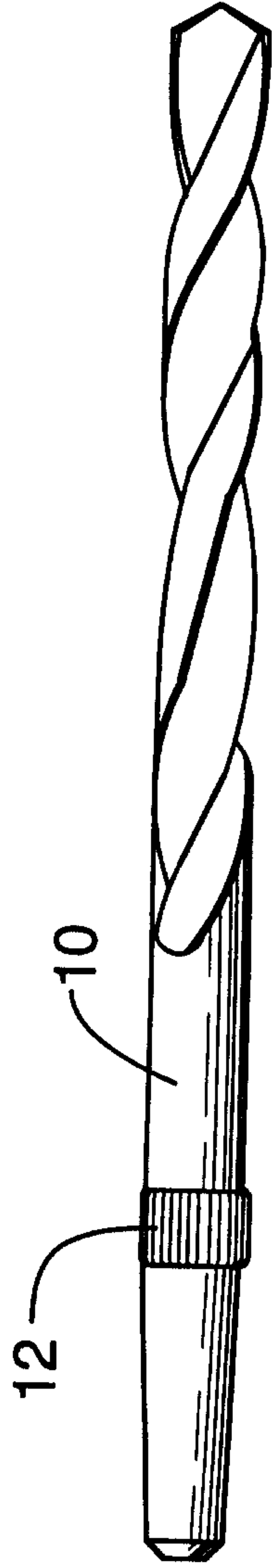


FIG. 11E

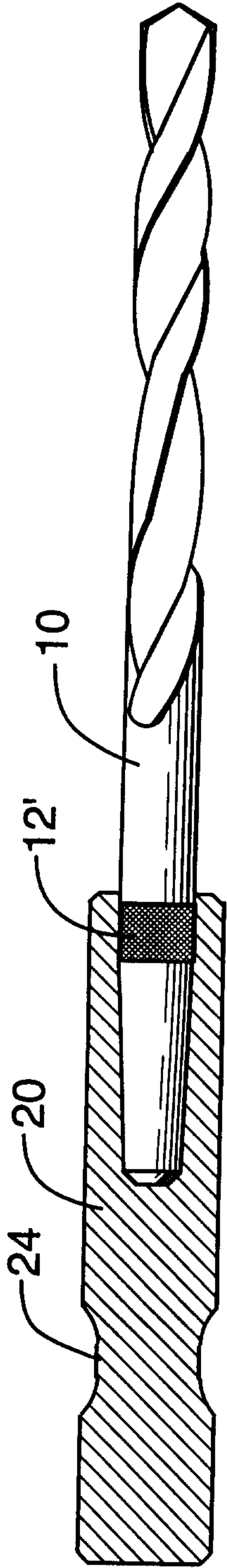


FIG. 12A

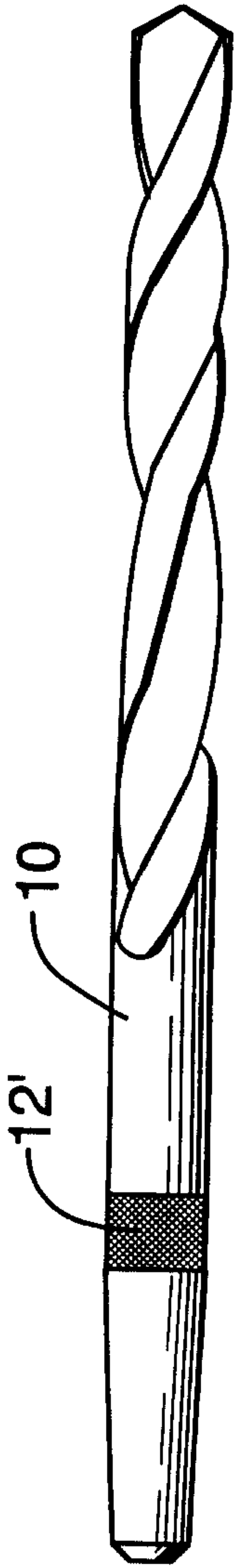


FIG. 12B

