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- (71) Applicant: CODMAN & SHURTLEFF, INC. [US/US];
325 Paramount Drive, Raynham, MA 02767-0350 (US).
- (72) Inventors: MCDOWELL, Christopher; 519 Orchard
Street, Raynham, MA 02767 (US). KENNEFICK,
William; 47 Cabot Circle, Plymouth, MA 02360 (US).
ROGERS, Laurel; 121 Metcalf Rd., N. Attleboro, MA
02760 (US).
- (74) Agents: JOHNSON, Philip, S. et al.; Johnson & Johnson
Corp, One Johnson & Johnson Plaza, New Brunswick, NJ
08933 (US).

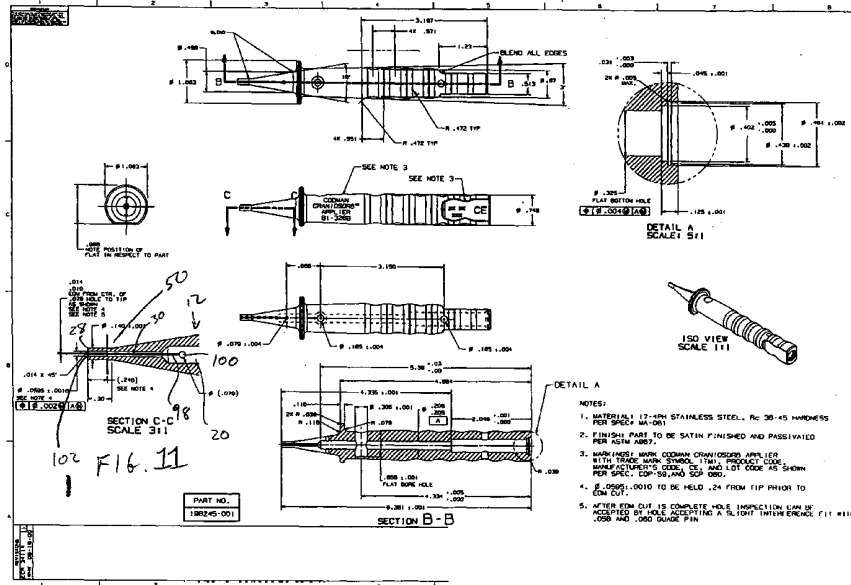
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(54) Title: SELF CENTERING BONE DRILL



(57) Abstract: A self-centering bone drill comprises a drill bit having a proximal end and a distal end, a cutting surface at the distal end, and a first radially extending flange. A tubular housing coaxially receives the drill bit and a spring is coaxially received within the housing, and coaxially receives the drill bit. The spring is compressed between the first radially extending flange and an interior abutment surface on the housing distal of the first radially extending flange to urge the housing distally along the drill bit. A chamfered surface on a distal end of the housing engages a chamfered surface on a work piece to center the drill bit.



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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

SELF CENTERING BONE DRILL5 Field of the Invention

The present invention relates to an apparatus for drilling into bone, and in one particular aspect to such an apparatus which self centers about an aperture through a work
10 piece.

Background

It is known in the art to apply fasteners for attaching
15 sutures, bone plates, and connective tissue. The fastener is inserted into a hole in a bone and generally through some application of force is caused to expand. One particular method for driving a fastener is disclosed in U.S. Patent No. 5,398,861 by Green which discloses a spring loaded retractable
20 piston and a pivotable trigger device for releasing the piston and allowing it to drive forward and drive home a fastener. The fasteners are received through holes in a bone plate into holes in the skull. It would be desirable to have a drill for drilling the skull which self centers through the holes in the
25 bone plate.

Summary of the Invention

A self-centering bone drill according to the present
30 invention comprises a drill bit having a proximal end and a distal end, a cutting surface at the distal end, and a first radially extending flange. A tubular housing coaxially receives the drill bit and a spring is coaxially received within the housing, and coaxially receives the drill bit. The
35 spring is compressed between the first radially extending

flange and an interior abutment surface on the housing distal
of the first radially extending flange to urge the housing
distally along the drill bit. A chamfered surface on a distal
end of the housing engages a chamfered surface on a workpiece
5 to center the drill bit.

Preferably, the housing comprises a second abutment
proximal of the first radially extending flange to inhibit
proximal movement of the drill bit out of the housing. It can
10 also comprise a second annular flange, proximal of the first
annular flange and an exterior abutment surface exterior of
the housing such that abutment of the second annular flange
against the exterior abutment surface limits distal movement
of the drill bit out of the housing to thereby control the
15 depth of a hole drilled thereby. Preferably, the housing
comprises a two-piece collar assembled over the drill bit
between the first annular flange and the second annular flange
and received coaxially into the housing, the exterior abutment
surface being on the collar.

20

Preferably, the housing has a first bore of a diameter to
slidably receive the first annular flange of the drill bit and
a second smaller diameter bore to slidably receive the drill
bit distal end and the abutment surface comprises an annular
25 surface formed at the transition between the first bore and
the second bore.

Brief Description of the Drawings

30

FIG. 1 is a top plan view of an instrument for applying
surgical;

FIG. 2 is a section view taken along lines 2--2 of FIG. 1;

FIG. 3 is a perspective detail view of a release button for the instrument of FIG. 1;

FIG. 4 is perspective view of a fastener for using in the instrument of FIG. 1;

FIG. 5 is a section view taken along lines 5--5 of FIG. 4;

FIG. 6 is a top plan view of a plate to be applied using the fastener of FIG. 4;

FIG. 7 is a top plan view of a tray holding a plurality of the fasteners of FIG. 4;

FIG. 8 is a sectional view taken along lines 8--8 of FIG. 7;

FIG. 9 is a detail sectional view taken along lines 9--9 of FIG. 7;

FIG. 10 is a perspective view of the tray of FIG. 7;

FIG. 11 is a sectional view taken along lines 11--11 of FIG. 1;

FIG. 12 is top plan view of a drill according to the present invention for drilling holes in a skull to receive the fastener of FIG. 4;

FIG. 13 is a sectional view taken along lines 13--13 of FIG. 12;

FIG. 14 is an exploded perspective view of an alternate
5 embodiment of a drill according to the present invention;

FIG. 15 is a top plan view of the drill of FIG. 14; and

FIG. 16 is a section view taken along lines 16--16 of
10 FIG. 15.

Detailed Description

15 Referring now to the drawings, FIGS. 1 and 2 illustrate a rivet applier 10 according to the present invention. It comprises in general an elongated cylindrical body 12, a piston 14 restrained by a spring 16 and a release mechanism 18. An axial bore 20 passes through the body 12 and has
20 varying diameters. At a proximal end 22 of the body 12 a first portion 24 of the bore 20 has a relatively large diameter to accommodate the spring 16 which is coiled about the piston 14 within the first portion 24. Intermediate portion 26 of the bore 20 has an intermediate diameter closely
25 matched to the diameter of the piston 14.

At a distal end 28 of the body 12 a distal portion 30 of the bore 20 has a narrow diameter to accommodate a hardened setting pin 32 which projects axially from a distal end 34 of
30 the piston 14. Preferably, the setting pin 32 is an integral part of the piston 14, but can alternatively be a separate piece affixed to the piston 14.

The spring 16 is caged between a flange or retaining clip 36 about the piston 14, and a washer 38 and retaining clip 40 at the body proximal end 22. The piston 14 passes outwardly of the body 12 through the washer 38 and retaining clip 14.

5

At a proximal end 42 of the piston 14 a handle 44 is provided for manual retraction of the piston 14. The proximal half of the body 12 is provided with flutes 46 for enhancing gripability and an axial flange 48 is provided near the body 10 distal end 28 also to enhance gripability and maneuverability of the rivet applier 10. A flat 49 on the flange 48 inhibits rotation of the rivet applier 10, thereby reducing the likelihood that it will roll off of a surface upon which it is placed. The body distal end 28 tapers to a narrow tip 50 to 15 allow more precise direction of the instrument 10. The set pin 32 is fixed within a coaxial bore 52 in the piston distal end 34.

A circumferential groove 54 surrounds the piston 14 near 20 its distal end 34. A radial bore 56 passes into the body 12 adjacent the groove 54 and extends beyond the bore 20 but does not completely penetrate the body 12. Turning also to FIG. 3 the release mechanism 18 comprises a release button 58 received within the bore 56 and a the coil spring 60 between 25 an end of the bore 56 and the button 58 which biases the button outwardly of the bore 56. The button 58 has a radial bore 62 through which passes the piston 14. A radial flange 64 within the bore 62 is adapted to engage the circumferential groove 54 on the piston 14.

30

When the handle 44 is retracted, causing the piston 14 to retract proximally, the flange 64 rides over the surface of the piston 14 until it encounters the circumferential groove 54 into which the spring 60 causes the flange 64 to slip.

This action locks the piston 14 in a retracted position as its distal motion is restrained by the abutment of the flange 64 and groove 54. Inward pressure applied to the button 58 causes the flange 64 to disengage from the circumferential groove 54 and allows the spring 16 to drive the piston 14 forward or distally. This causes the setting pin 32 to move distally to a position flush with the distal end of the body 12.

10 FIGS. 4 and 5 illustrate a rivet 66 for use with the instrument 10. The rivet 66 comprises a round head 68 from which extends axially 3 leaves 70. A cylindrical plug 72 extends axially from the head 68 in the opposite direction and is frangible connected to the head 68 through a frangible
15 connection 74. The surfaces of the leaves 70 are curved so that the combination of the three leaves 70 provides an overall tubular configuration. Application of force in the axial direction applied to the plug 72 breaks its frangible connection 74 with the head 68 and allows it to drive axially
20 into a position between the leaves 70 thus causing the leaves 70 to spread.

FIG. 6 shows a cranial plate 76 for placement on a skull of an patient, either human or animal (not shown). It
25 comprises a flat planar body 78 having a plurality of circular extensions 80 therefrom, each of which has a countersunk bore 82 therethrough. A tag 84 extends from the plate 76 and serves several functions. The tag 84 may contain model number, size, material, date and other pertinent information
30 as well as showing which side of the plate 76 is to face upwards away from the patient's skull (not shown). It also provides a purchase location for a user's hand to hold and manipulate the plate 76 during placement. A frangible connection 86 between the tag 84 and the remainder of the

plate 76 allows easy removal of the tag 84 from the plate 76 after placement of the plate 76. Many other configurations of plates will be apparent to those of skill in the art.

5 Turning to FIGS. 7 to 10, the rivets 66 are disposed for use in a tray 88. The tray 88 comprises a base 90 having a downwardly extending peripheral wall 92 and a plurality of wells 94 therein. Preferably, the wells 94 penetrate the base 90. A plurality of the rivets 66 reside within the plurality
10 of the wells 94 with their plugs 72 facing upwardly out of the wells 94. A film cover 96 adheres to the base 90 over at least the area of the base 90 comprising the wells 92 to hold the rivets 66 within the wells 92. The film cover 96 preferably has slits 97, scorings or some other weakness at
15 each of the wells 92 to allow access to the rivets 66 through the film cover 96 by the instrument 10 (not shown in FIGS. 8 to 10), although a suitable material allowing access therethrough without slits or the like may be employed.

20 FIG. 11 illustrates the distal tip 50 of the instrument body 12. It comprises at least one axial slit 98 extending proximally from the distal end 28 and terminating in an aperture 100. A chamfer 102 is also provided at the distal end of the bore 20. In one preferred embodiment, the plugs 72
25 of the rivets 66 (FIG. 4) have an outside diameter of 0.0590 inches (1.50 mm), the bore distal portion 30 has an inside diameter of .0595 inches (15.1 mm) and the outside diameter of the tip 50 is 0.140 inches (3.56 mm). The slit 98 allows the material of the tip 50 to contract slightly thus reducing the
30 effective internal diameter of the bore distal portion 30 and the aperture 100 reduces stress risers during flexing.

Preferably the rivet 66 and plate 76 are formed of a bioabsorbable material such as a polylactide, such as an 85:15

(mol/mol) poly(lactide-co-glycolide) copolymer. More preferably, the rivet 66 is formed of PLLA and the plates are formed of 50/50 D, LPLA blended with 95/5 PCL/PDO in a 91:9 ratio as more fully described in US Patents Nos. 5,641,501 and 5,705,181, incorporated herein by reference. Preferably the instrument body 12 is formed of a sturdy material such as stainless steel, however, many other materials, including polymers, would be suitable. Preferably, the instrument body 12 weighs considerably more than the piston 14 so as to minimize kick-back as the piston 14 is released. The setting pin 32, and especially if the setting pin 32 and piston 14 are integral, is preferably formed of a hardened steel or stainless steel, but of course many other hardy materials would be suitable for such service. The tray 88 preferably is formed of a suitable polymer, but can also be formed of other materials.

To use the instrument 10, a user grasps the handle 42 and retracts the piston 14 until the flange 64 of the release mechanism 18 engages the annular groove 54 of the piston 14 and holds the piston 14 in a retracted position. The tip 50 of the instrument 10 is inserted through one of the slits 97 to capture the plug 72 of one of the rivets 66 within the bore distal portion 30. The chamfer 102 eases entry of the plug 72 into the bore distal portion 30 and contraction of the tip 50 due to the slit 98 helps the tip 50 grip the plug 72. The rivet 66 is then placed through one of the plate apertures 82 and into a hole in the skull (not shown) and the rivet applicator 10 is held thereagainst with some force, say 2 pounds force. Pressing the button 58 releases the engagement of the piston 14 and flange 64 allowing the setting pin 32 to move distally to push against the plug 72 breaking its frangible connection to the head 68 and driving it between the leaves 70 thereby spreading the leaves and setting the rivet 66.

FIGS. 12 and 13 illustrate a bone drill 110 which provides a simple and elegant solution to the problem of centering and boring holes in a patient's skull into which the rivets 66 (not shown in FIG. 12) are received when applying the cranial plate 76 (also not shown in FIG. 12). The drill 110 comprises an elongated drill bit 112 having a proximal end 114 with an attachment surface 116 for attachment to a drill chuck (not shown). Any appropriate attachment surface can be substituted therefor. A distal end 118 of the drill bit 112 carries helical cutting edges 120, but other forms of cutting surfaces as appropriate can be substituted therefor. A first radial flange 122 extends radially outwardly from the drill bit 112 and a second larger radial flange 124 extends radially outwardly from the drill bit 112 proximal of the first radial flange 122. A pair of windows 123 allow debris from the drilling to exit the drill 110 and are arranged so as to release the debris before it can reach and possibly interfere with operation of the spring 140.

20

A tubular housing 126 having an axial bore 128 therethrough coaxially receives the drill bit 112 through the axial bore 128. A proximal end 130 of the housing 126 abuts the second radial flange 124 and thereby limits distal movement of the drill bit 112 through the housing 126. A first diameter 132 of the bore 128 at the housing proximal end 130 closely matches the diameter of the drill bit 112 for sliding engagement. A central diameter 134 of the bore 128 closely matches the diameter of the first radial flange 122 for sliding engagement. A distal diameter 136 of the bore 128 closely matches the diameter of the drill bit 112 for sliding engagement, and the change in diameter of the bore 128 between the central diameter 134 and distal diameter 136 forms a radial abutment 138. A coil spring 140 encircles the drill

30

bit 112 and operates between the abutment 138 and the first radial flange 122 to urge the housing distally along the drill bit 112.

5 A distal end 142 of the housing 126 carries a chamfer 144 of matching angle to the chamfer of the holes 82 in the cranial plate 76 (see FIG. 6). By pressing the distal end 142 into the chamfered hole 82 the drill bit 112 is centered within the hole 82 allowing accurate drilling. Abutment of
10 the second radial flange 124 and the housing proximal end 130 limits travel of the drill bit 112 out of the housing 126 and thus limits the depth of a hole created by the drill bit 112.

 The housing 126 can be formed of two pieces glued
15 together along joints (not shown) running longitudinally along the housing to form the cylindrical shaped housing 126 with the drill bit 112 captured therein. FIGS. 14 to 16 illustrate an alternative construction in which a two-piece collar 200 having an annular flange 202 is assembled over the drill bit
20 112 between the first and second radial flanges 122 and 124. The collar 200 is then glued into a housing 204, similar to the housing 126, except that it is adapted to receive the collar 200, with the collar taking over the function of trapping the drill bit 112 within the housing 204 which was
25 previously provided by the diameter 132 on the housing 126. The housing 204 can then be sturdier as it is not glued together along its length.

 While the invention has been described with regard
30 to a particular embodiment thereof, those skilled in the art will understand, of course, that the invention is not limited thereto since modifications can be made by those skilled in the art, particularly in light of the foregoing teachings. Reasonable variation and modification are possible within the

foregoing disclosure of the invention without the departing from the spirit of the invention.

IN THE CLAIMS

1. A self-centering bone drill comprising:
a drill bit having:
5 a proximal end and a distal end;
a cutting surface at the distal end; and
a first radially extending flange;
a tubular housing coaxially receiving the drill bit;
a spring coaxially received within the housing, and
10 coaxially receiving the drill bit, the spring being compressed
between the first radially extending flange and an interior
abutment surface on the housing distal of the first radially
extending flange whereby to urge the housing distally along
the drill bit; and
15 a chamfered surface on a distal end of the housing for
engaging a chamfered surface on a workpiece.

2. A bone drill according to claim 1 wherein the
housing comprises a second abutment proximal of the first
20 radially extending flange whereby to inhibit proximal movement
of the drill bit out of the housing.

3. A bone drill according to claim 1 wherein the drill
bit further comprises a second annular flange, proximal of the
25 first annular flange and an exterior abutment surface exterior
of the housing whereby abutment of the second annular flange
against the exterior abutment surface limits distal movement
of the drill bit out of the housing to thereby control the
depth of a hole drilled thereby.

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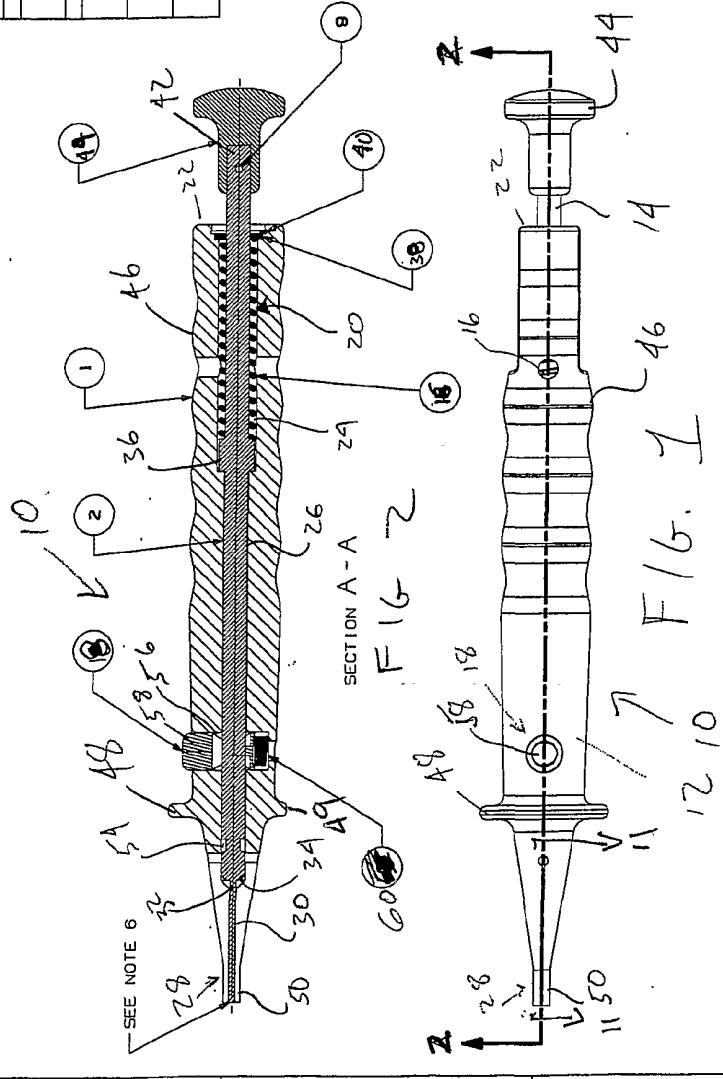
4. A bone drill according to claim 3 wherein the
housing comprises a two-piece collar assembled over the drill
bit between the first annular flange and the second annular

flange received and coaxially into the housing, the exterior abutment surface being on the collar.

5 5. A bone drill according to claim 1 wherein the housing has a first bore of a diameter to slidably receive the first annular flange of the drill bit and a second smaller diameter bore to slidably receive the drill bit distal end and the abutment surface comprises an annular surface formed at the transition between the first bore and the second bore.

10

ITEM NO.	PART NO.	QTY.	DESCRIPTION	DRAWING NO.
1	198245-001	1	BODY	198245
2	198246-001	1	ADVANCE SHAFT	198246
3	198248-001	1	PULL KNOB	198248
4	198249-001	1	BUTTON TRIGGER	198249
5	SPEC# 035-17505 OR EQUIV.	1	SPRING, FIRING	N/A
6	198259-001	1	END WASHER	198259
7	KAMAN# N5000-43H OR EQUIV.	1	RETAINING RING	N/A
8	SPEC# C0240-020-02505 OR EQUIV.	1	SPRING, BUTTON	N/A
9	PIC DESIGN# D15-312 OR EQUIV.	1	DOWEL PIN L=.312 X .0626 +.0002/-.0000	N/A



- NOTES:
1. ASSEMBLE ITEMS 5, 6, 7, TO ITEM 2 PRIOR TO PRESS FIT, PIN AND PEEN OF ITEM 3 TO ITEM 2
 2. ASSEMBLE ITEM 8 AND 4 TO ITEM 1 AND POSITION TO ACCEPT ITEM 2.
 3. SECURE ITEMS 2, 5, 6, TO ITEM 1 WITH ITEM 7.
 4. ITEM 2 TO PASS THRU ITEM 4 FREELY WHEN ITEM 4 IS DEPRESSED.
 5. ENTIRE ASSY TO FREELY ACTUATE WITHOUT BINDING AND FIRE REPEATEDLY.
 6. PIN PORTION OF ITEM 2 TO BE FLUSH WITH ITEM 1.

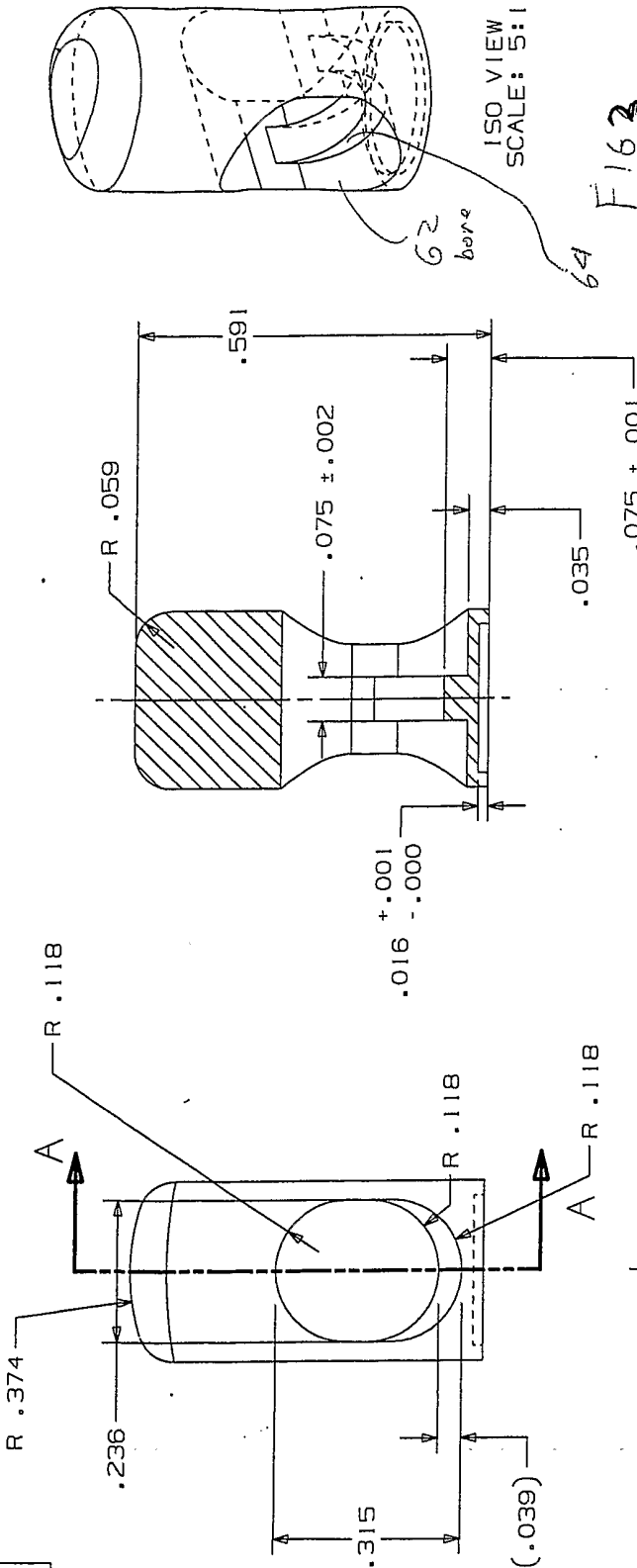
PRODUCT CODE	PART NUMBER
BI-3268	198244-001

ANY CHANGES TO THIS PRODUCT REQUIRES PRIOR APPROVAL OF CODMAN

REV	DATE	DESCRIPTION
1	05/16/00	WHK
1	05/16/00	ECR 34114

PRELIMINARY

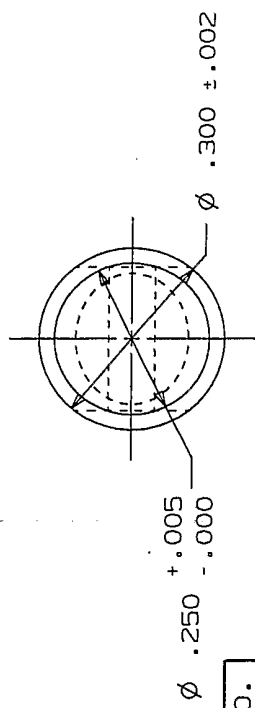
PROPRIETARY
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SECTION A - A

NOTES:

- 1. MATERIAL: 17-4PH STAINLESS STEEL HARDENED RC 38-45 PER SPEC# MA-061
- 2. FINISH: PART TO BE SATIN FINISHED AND PASSIVATED PER ASTM A967.



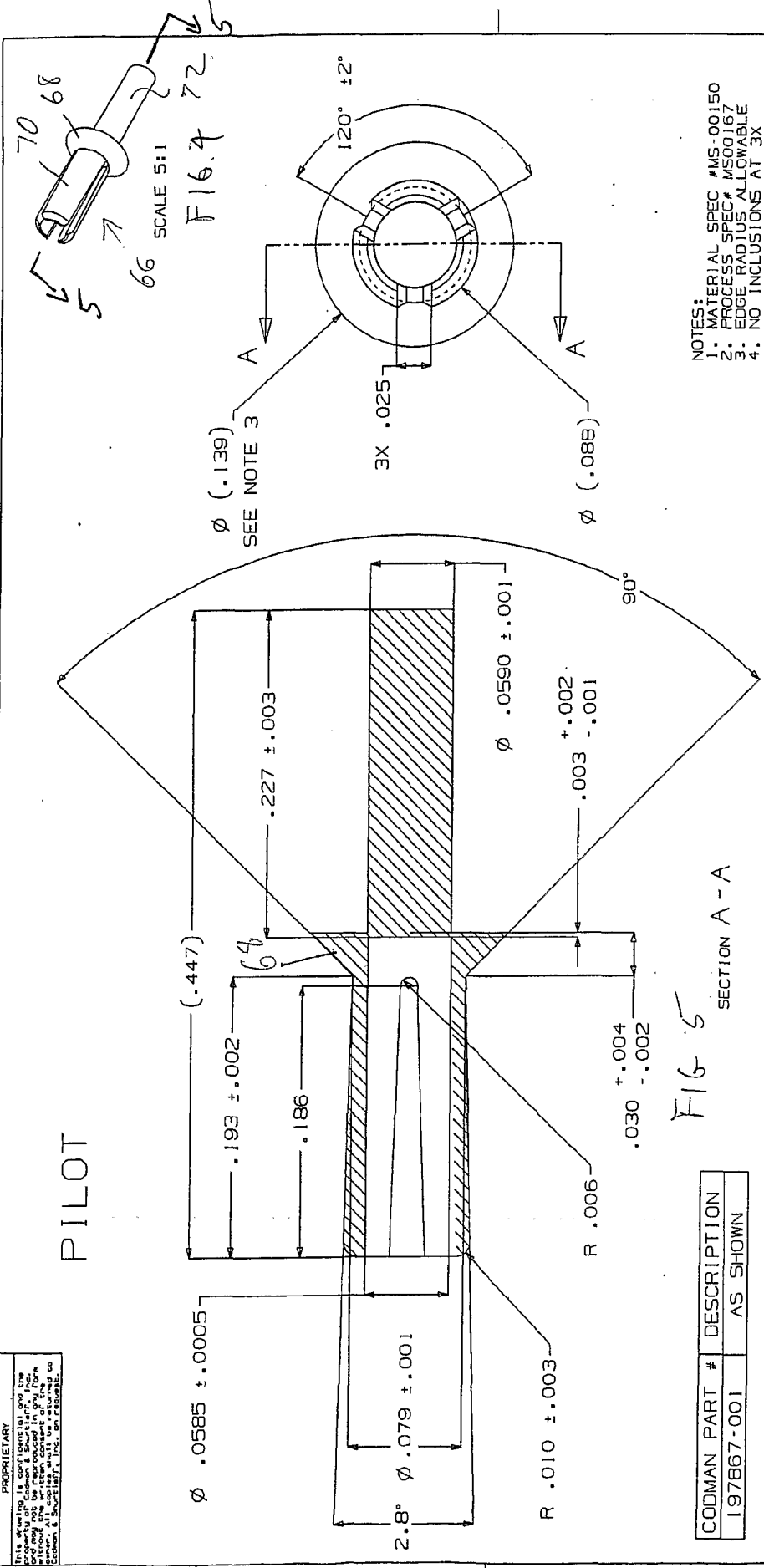
PART NO.
 198249-001

REVISIONS	ECR 3414	WHR 05-17-00
1		
PRELIMINAR		
	NEXT ASSY	APPL

C:\EPR\197867.2

PROPRIETARY
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PILOT



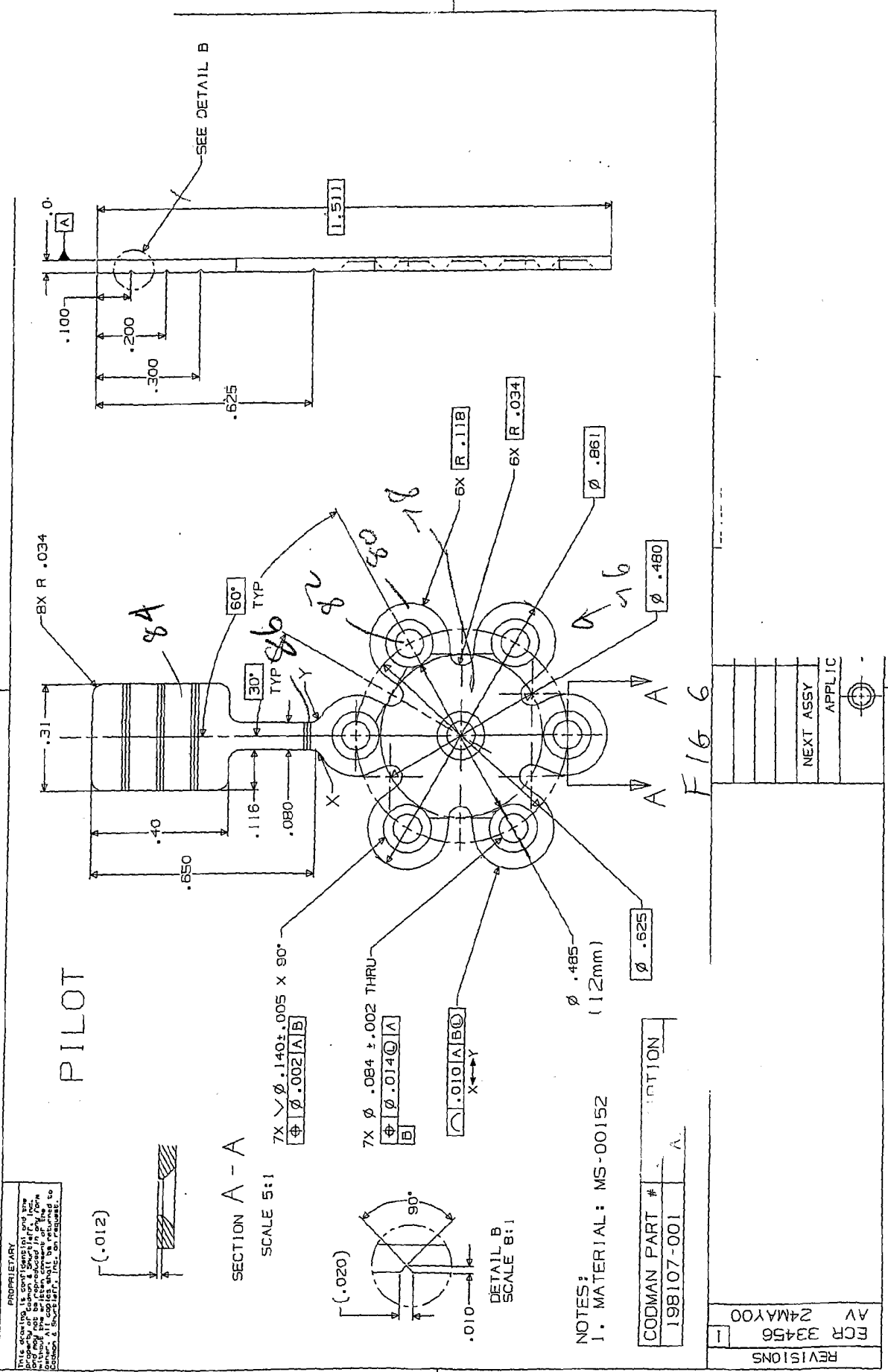
- NOTES:
1. MATERIAL SPEC #MS-00150
 2. PROCESS SPEC #MS00167
 3. EDGE RADIUS ALLOWABLE
 4. NO INCLUSIONS AT 3X

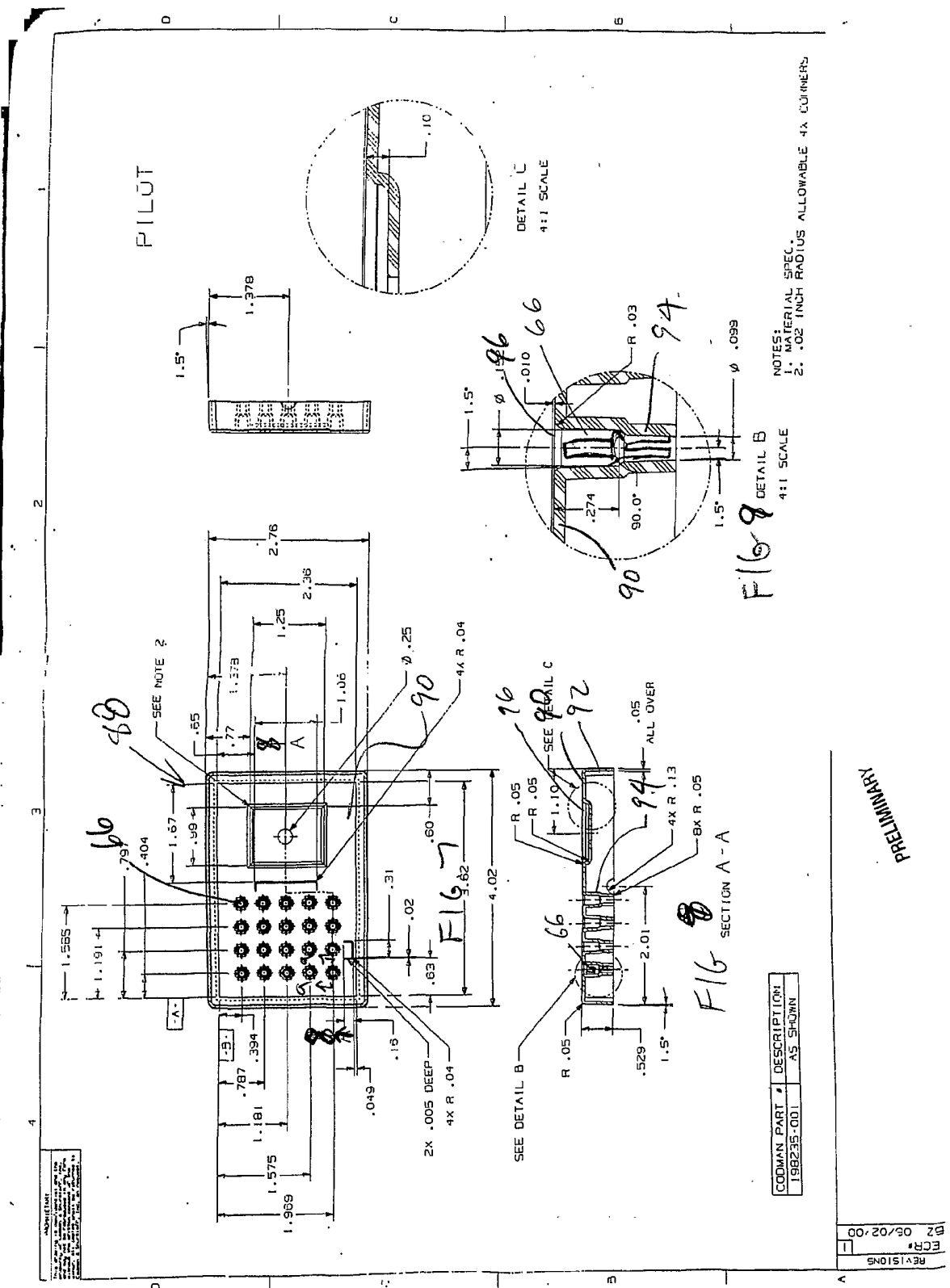
FIG 5 SECTION A-A

CODMAN PART #	DESCRIPTION
197867-001	AS SHOWN

REVISIONS	
1	DEVELOPMENTAL RELEASE E82 1/21/00
2	ECR #35644 RELEASE TO PILOT LEVEL E82 3/21/00
NEXT ASSY APPLICA	

C:\EPR\198107.1





NOTES:
 1. MATERIAL SPEC.
 2. .02 INCH RADIUS ALLOWABLE 4X CORNERS

FIG 16
 DETAIL B
 4:1 SCALE

FIG 16
 SECTION A-A

CODMAN PART #	DESCRIPTION
198235-001	AS SHOWN

REV	DESCRIPTION
1	ECR# 05/02/00

PRELIMINARY

PRELIMINARY

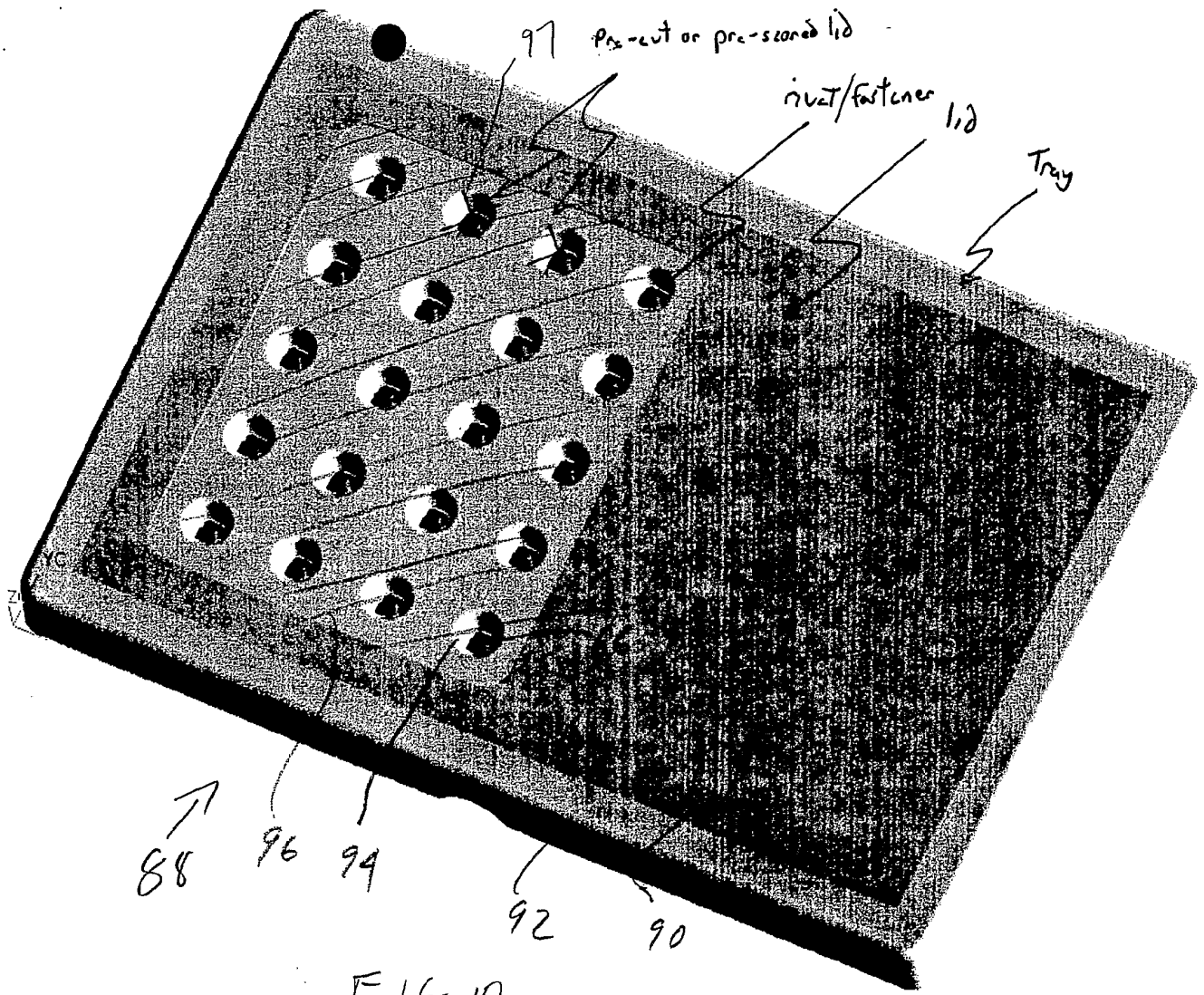
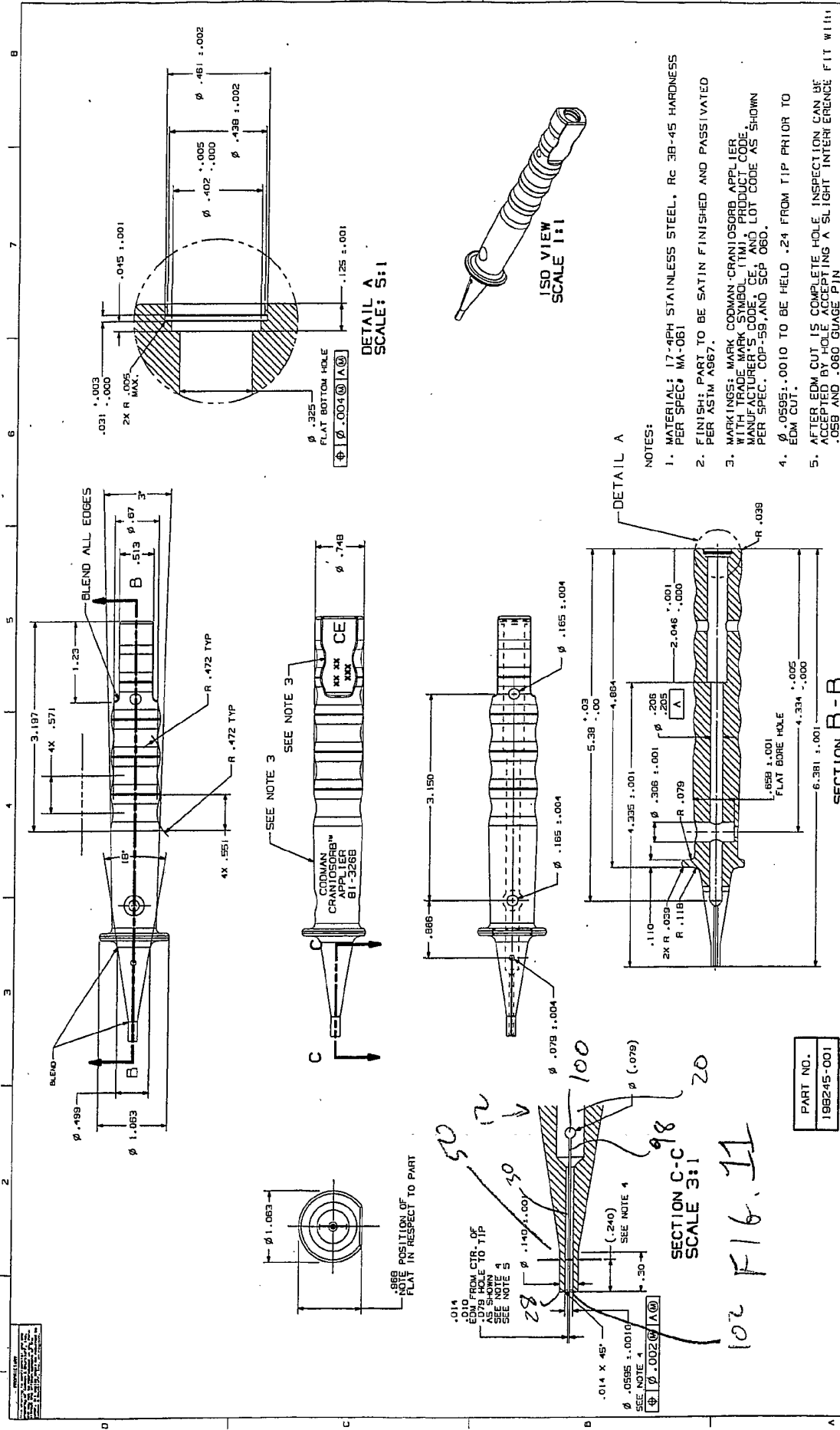
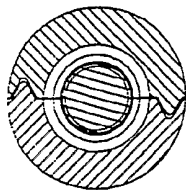


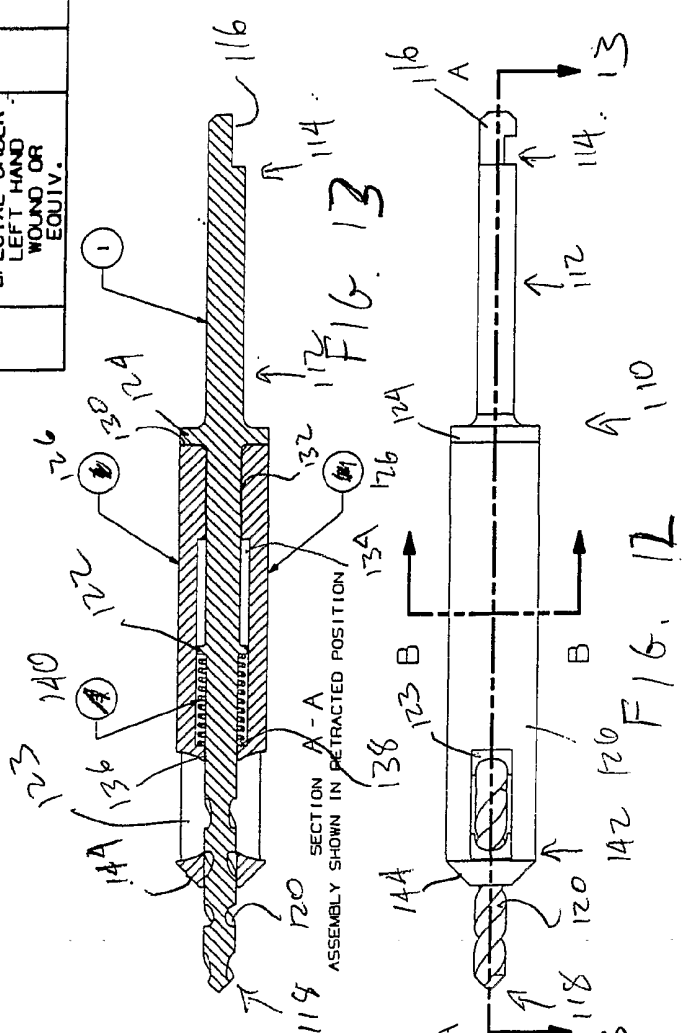
FIG 10



ITEM NO.	PART NO.	QTY.	DESCRIPTION	DRAWING NO.
1	198302-001	1	DRILL BIT, SAW STOP, STANDARD LOW SPEED	198302
2	198304-001	2	SAW DRILL HOUSING	198304
3	SPEC P/N CO120-010-06905 SPECIAL ORDER LEFT HAND WOUND OR EQUIV.		SPRING	N/A



SECTION B-B
SCALE 10:1



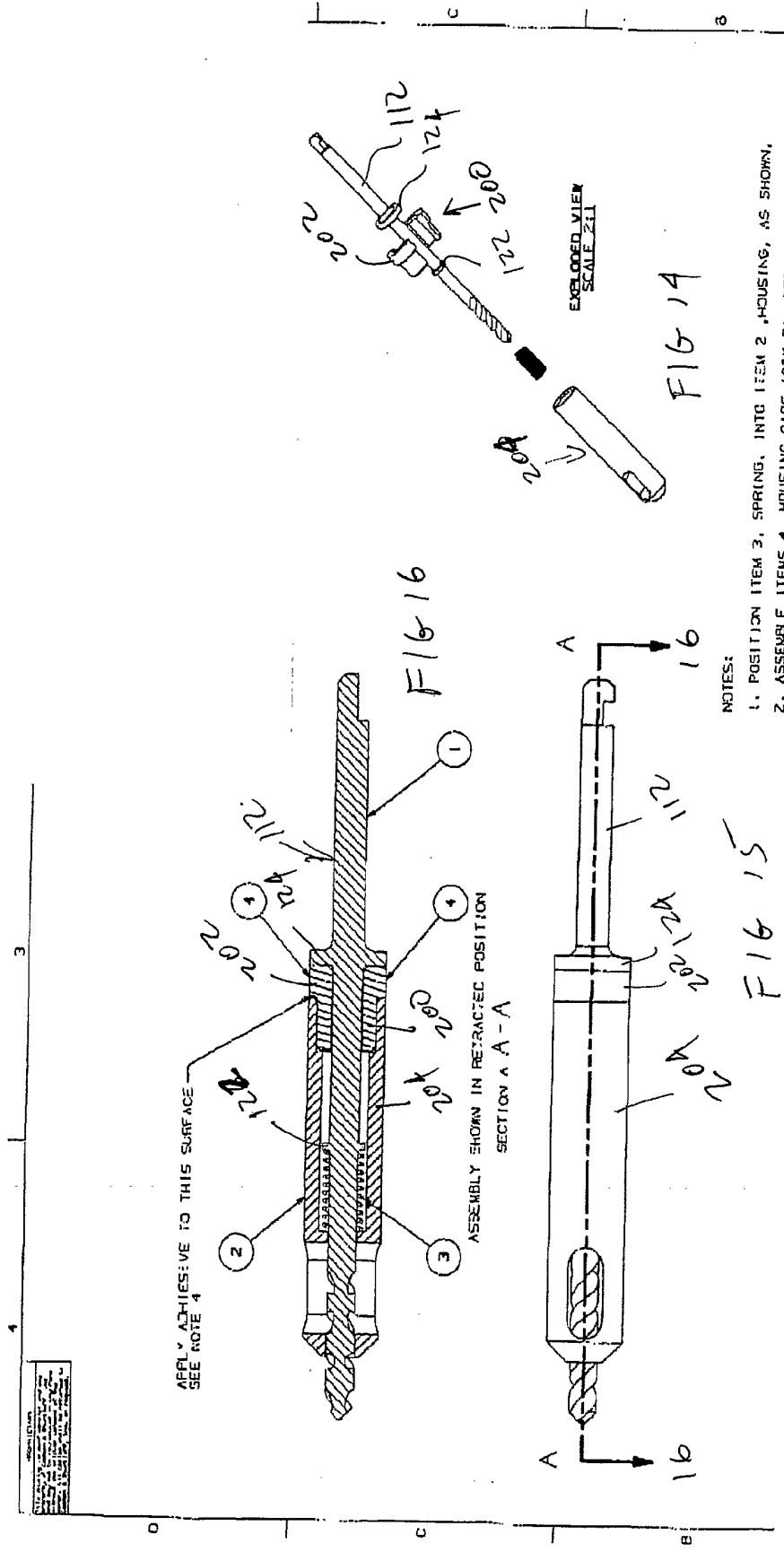
NOTES:

1. SLIDE ITEM 3 SPRING ONTO ITEM 1 DRILL BIT AS SHOWN.
2. POSITION ITEMS 1 & 3 WITHIN APPROPRIATE CHANNELS OF ITEM 2 HOUSING.
3. BOND THE TWO ITEM 2 HOUSINGS USING ADHESIVE. CAPE MUST BE TAKEN TO AVOID EXCESS ADHESIVE RESIDUE ON BOTH THE INSIDE AND OUTSIDE OF ASSEMBLY.
4. THE TWO ITEM 2 HOUSINGS MUST BE BONDED FLUSH AT CHAMFERED END.
5. AFTER CURE AND SET TIME HAS OCCURRED THE HOUSING PORTION OF ASSEMBLY MUST BE ABLE TO SPIN AND ACTUATE ITS FULL RANGE FREELY.

PRODUCT CODE
BI-3258

PROPERTY
 2012/13
 3

:10-17- 0 ; 3:56PM ; J&J PROFESSI



NOTES:

1. POSITION ITEM 3, SPRING, INTO ITEM 2 HOUSING, AS SHOWN.
2. ASSEMBLE ITEMS 4. MOVING CAPS (PART 3) BETWEEN THE TWO HOUSINGS.

REVISIONS

NO.	DATE	DESCRIPTION

INTERNATIONAL SEARCH REPORT

International Application No
PC1/US 01/29538

A. CLASSIFICATION OF SUBJECT MATTER IPC 7 A61B17/16		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) IPC 7 A61B		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 261 242 A (MO NII MICROCHIRURG) 30 March 1988 (1988-03-30) page 3, line 34 -page 4, line 6; figure 1 ---	1,2
X	US 5 993 453 A (WALDRON STEPHEN H ET AL) 30 November 1999 (1999-11-30) column 3, line 7 - line 17; figure 1 ---	1-3,5
Y	US 5 628 751 A (SANDER THOMAS W ET AL) 13 May 1997 (1997-05-13) column 3, line 1 - line 28; figures 2,7,8 ---	1-3
Y	US 5 810 828 A (MICKEL THOMAS J ET AL) 22 September 1998 (1998-09-22) column 7, line 55 -column 8, line 9; figures 1A,1B ----- -/--	1-3
<input checked="" type="checkbox"/> Further documents are listed in the continuation of box C. <input checked="" type="checkbox"/> Patent family members are listed in annex.		
° Special categories of cited documents :		
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Date of the actual completion of the international search 5 February 2002		Date of mailing of the international search report 13/02/2002
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer Ducreau, F

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International Application No
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