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(54) Knife and holder assembly for use in sheet material processing mechanisms

(57) A cutter cartridge assembly (20) for holding a cutting tool (22) includes an outer casing having an axial bore (32) extending through it. At least two radial bearings (38,40) are positioned in the axial bore and have a predetermined gap (42) between them for receiving a resilient annular member (43). The resilient annular member engages the inner races (46) of the bearings and the cutting tool, thereby exerting a force on the inner races as well as aiding in the retention of the cutting tool while allowing the cutting tool to freely rotate.

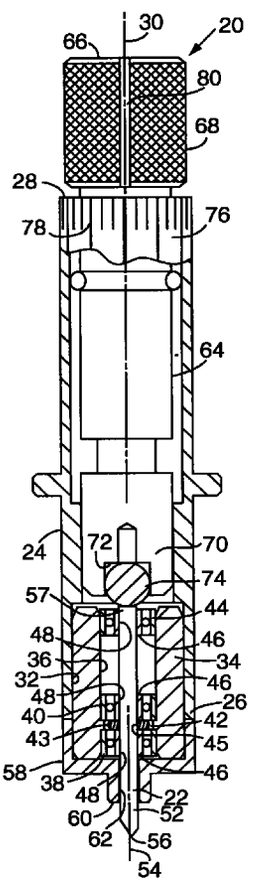

FIG. 2

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Description

Field Of The Invention

The present invention relates generally to the cutting of sheet-type work material with X-Y sheet material cutting mechanisms, and deals more particularly with a cutter cartridge assembly mounted on such mechanisms for performing cutting operations on the sheet-type work material.

Background Of The Invention

Plotters are often used to cut graphic images from sheets of elongated work material. The work material is fed longitudinally of itself through the plotter and under a tool holder carrying a cutting tool mounted on a support for movement across the sheet material's width. A known cutting tool used to perform cutting operations of the type described herein is referred to by those skilled in the art, as a drag knife. Typically, a drag knife consists of an elongated rotatable blade having a sharpened edge, supported in a housing which in turn is carried by the tool holder.

To cut a graphic image from a sheet of work material, the drag knife engages the work material and is pulled or dragged along its surface by the tool holder in response to commands issued from a controller. To ensure well defined lines of cut are made in the work material, the sharpened edge of the blade must align itself with the direction in which the blade is being dragged. Accordingly, the blade must pivot about its longitudinal axis in response to changes in the cutting direction.

In known drag knives the blade is typically mounted in a single radial bearing supported by the aforementioned housing. A problem often arise due to the construction of typical radial bearings. Inherent in the construction of radial bearings is a small amount of clearance between the rolling elements and the inner and outer race of the bearing. During a cutting operation, this clearance can cause detrimental amounts of vibration in the cutting tool, an effect known to those skilled in the art as tool chatter. Tool chatter causes premature wear and dulling of the cutting tool and diminishes cutting accuracy.

To counter these effects, prior art drag knives have attempted to employ mechanisms to reduce the radial clearance in the bearing by shifting the bearing's inner bearing race relative to its outer race, thereby forcing the races against the rolling elements, and reducing or eliminating the above-described radial clearance. This technique is referred to by those familiar with the manufacture of bearings, as preloading a bearing. In the past, radial bearings in drag knives have been preloaded by placing a stationary spring or other resilient member between the bearing's inner race and a non-rotating surface or bearing seat. However, because the inner race of the bearing must rotate to maintain the proper blade alignment, this method produced an inordinate amount of friction between the bearings inner race and the resilient member severely restricting the ability of the blade to align itself with the direction of cut.

Based on the foregoing, it is the general object of the present invention to provide a cutter assembly that attenuates vibration and tool chatter in the blade.

It is a further object of the present invention to provide a cutter assembly that allows the blade to freely rotate during operation.

Summary Of The Invention

The present invention meets these and other objects by providing in one aspect, a cutter cartridge assembly for use with an X-Y sheet material cutting mechanism. The cutter cartridge removably receives and holds, for rotation about its central axis, an elongated cutting tool having a sharpened cutting edge at a forward end portion inclined to, and having a tip point spaced from, the central tool axis. The cutter cartridge assembly comprises an outer casing having first and second ends and an axial bore extending at least part way into the outer casing from the first end. At least two radial bearings are received within the axial bore and are spaced apart to thereby define a predetermined gap between them. Each of the radial bearings includes an inner bearing race rotatable about the aforementioned central axis, and a bore for removably receiving the tool, such that the forward end portion of the tool protrudes from the casing. A resilient annular member is positioned in the previously described gap and is in engagement with the inner bearing races, thereby exerting a force on each of the inner bearing races.

The cutter cartridge assembly includes means for adjusting the amount by which the cutting edge of a cutting tool extends from the outer casing. In one embodiment of the present invention, the axial bore extends through the outer casing and a shaft having a knob portion and an end portion is adjustably received in the axial bore at the outer casing's second end. Means carried by the end portion of the shaft engage an end of the cutting tool opposite the front end portion, such that rotation of the knob portion causes the cutter to extend or retract relative to the first end of the outer casing.

In a related aspect, the aforementioned outer casing axial bore extends only part way into the outer casing from its first end, thereby defining a bottom surface. A cap is threaded onto the first end of the outer casing adjacent to the two radial bearings described above. The cap includes a reference surface and also defines a bore extending from the reference surface through the cap for receiving the front end portion of the cutting tool. Means are carried by the bottom surface for engaging an end of the cutter opposite the cutting edge, such that rotation of the cap causes the cutter to extend or retract relative to the cap's reference surface.

Brief Description Of The Drawings

Other objects and advantages of the present invention will become apparent with reference to the following detailed description, appended claims, and reference figures wherein:

FIG. 1 is a perspective view of an X-Y sheet material cutting mechanism;

FIG. 2 is a partly in section front elevational view of the cutter cartridge assembly of the present invention;

FIG. 3 is a partly in section front elevational view of an alternate embodiment of the cutter cartridge assembly of FIG. 2; and

FIG. 4 is a partly in section front elevational view of an alternate embodiment of the cutter cartridge assembly of FIG. 2.

Detailed Description of The Preferred Embodiment

Turning to the drawings and first referring to FIG. 1, a plotter there shown, generally designated as 10, is used for performing work operations on a sheet-type work material 12. The plotter 10 includes a drive (not shown) for feeding the work material 12 back and forth in a direction longitudinal of itself, through the plotter. A tool holder 14 is pivotally and slidably mounted on a support 16 fixed to a frame 18, such that as the work material 12 is advanced, the tool holder can traverse the width of the work material 12 in response to commands issued from a controller 13. A cutter cartridge assembly 20 carrying a cutter 22 is mounted on the tool holder 14 for movement between a lowered working position where the cutter is pressed against the work material 12, and a raised non-working position perpendicular to the work material.

Turning to FIG. 2, the cutter cartridge assembly 20 includes an outer casing 24 having first and second ends 26 and 28 respectively, a central casing axis 30, and an axial bore 32 extending through the outer casing. A bearing sleeve 34 defining a bore 36 is preferably pressed into the axial bore 32 from the first end 26. A pair of radial bearings 38 and 40 are received in the bore 36 adjacent to the outer casing first end 26 and define a predetermined gap 42 between them. A resilient annular member 43 preferably in the form of an O-ring is compressively positioned in the gap 42 and in engagement with the inner races 46 of the radial bearings 38 and 40, thereby urging the inner races of the bearings away from each other and preloading the bearings. A third radial bearing 44 is also received in the bore 36 and is spaced apart from the pair of bearings 38 and 40. All of the radial bearings 38, 40 and 44 have inner bearing races 46 rotatable about the outer casing central axis 30, and define bores 48 for removably receiving and retaining an elongated cutting tool 22. The cutting tool 22 has a forward end portion 52 sharpened to provide a cutting edge inclined to a central tool axis 54, a tip point 56 spaced away from the central tool axis, and an opposite end portion 57. In addition to preloading the bearings 38 and 40, the above-described resilient annular member 43 defines an aperture 45 having an inner diameter for frictionally yieldingly engaging the cutting tool 22. While the resilient annular member 43 is described above, as an O-ring, the present invention is not limited in this regard as other resilient annular members, such as, but not limited to springs, elastomeric washers, or gaskets may be substituted without departing from the broader aspects of the present invention.

Still referring to FIG. 2, the cutter cartridge assembly further includes a cap 58 having a reference surface 60 and defining a bore 62 extending from the reference surface through the cap. The cap 58 is positioned over the bearing sleeve 34 adjacent to the pair of radial bearings 38 and 40, and abuts the first end 26 of the outer casing 24 with the forward end portion 52 of the cutting tool 22 received within the bore 62.

The preferred embodiment of the present invention also includes a shaft generally designated as 64, shown in FIG. 2, having a knob portion 66 defining a knurled outer periphery 68, and an opposite end portion 70 received in the axial bore 32 of the outer casing 24 at the second end 28, and defining a recess 72. A ball 74, made of a suitable material, such as, but not limited to metal, is received in the recess 72 and engages the opposite end portion 57 of the cutting tool 22. The second end of the outer casing 24 includes a peripheral surface 76 defining angular indicia 78 extending there around, and the knob portion 66 includes reference mark 80 alignable with the angular indicia 78. During operation, when the knob portion 66 is rotated, the shaft 64 moves either up or down, depending on the direction of rotation, causing the ball 74 to engage or retract away from the opposite end 57 of the cutting tool 22, thereby extending or retracting the cutting tool forward end portion 52 relative to the reference surface 60. The final position of the reference mark 80 relative to the angular indicia 78 indicates the amount by which the cutting tool 22 extends past the reference surface 60.

Referring to FIG. 3, the outer casing axial bore 32' rather than extending from the first end 26' through the outer casing 24', extends only part way through the outer casing, thereby defining a bottom surface 82 against which abuts the bearing sleeve 34'. In this embodiment, the bottom surface 82, instead of the shaft 64, FIG. 2, defines the recess 72' for receiving the ball 74'. An adjustable cap 84 is threadedly engaged with the first end 26' of the outer casing 24' and includes a reference surface 86 that defines a bore 88 extending from the reference surface through the cap, the forward end portion 52' of the cutting tool 22' being received within the bore. The outer casing 24' also includes a peripheral surface 90 defining angular indicia 92 extending there around, and the adjustable cap 84

includes reference mark 94 alignable with the angular indicia 92. During operation, depending on the direction of rotation of the adjustable cap 84, the cap will move toward or away from the outer casing first end 26', thereby causing the ball 74' to engage or retract away from the opposite end 57' of the cutting tool 22', extending or retracting the cutting tool forward end portion 52' relative to the reference surface 86. The final position of the reference mark 94 relative to the angular indicia 92 indicates the amount by which the cutting tool 22' extends past the reference surface 86.

While the foregoing embodiments have been shown and described as including a combination of three bearings two of which are preloaded by a resilient annular member, the invention is not limited in this regard. Other combinations of bearings and resilient members are possible, one such combination being shown in FIG. 4 where two pairs of bearings 38" and 40", and 96 and 98 are shown. Each pair of bearings being preloaded by resilient annular member 43" and 100 respectively.

Referring back to FIGS. 1 and 2, the operation of the cutter cartridge assembly 20 installed in a plotter or similar mechanism will be explained. As the tool holder 14 traverses the width of the work material 12, the cutting tool 22 selectively engages the work material in response to commands issued from the controller 13. Since the work material 12 is being fed back and forth longitudinally of itself as the tool holder 14 traverses its width, the cutting path of the cutting tool 22 will vary causing the cutting tool to rotate in the radial bearings 38, 40, and 44 thereby aligning the sharpened edge with the direction of cut. In addition, the engagement of the annular resilient member 43 with the cutting tool 22 as well as the inner bearing races as described above, damps vibrations induced in the cutting tool 22 resulting from the tool's interaction with the work material 12.

While preferred embodiments have been shown and described, various modifications and substitutions may be made without departing from the spirit and scope of the invention. Accordingly, it is to be understood that the present invention has been described by way of example, and not by limitation.

Claims

1. A cutter cartridge assembly (20) for use with an X-Y sheet material cutting mechanism and for removably receiving and holding, for rotation about its central axis, an elongated cutting tool (22) having a forward end portion (52) sharpened to provide a cutting edge inclined to said central tool axis (54) and having a tip point (56) spaced from said central tool axis, said cartridge assembly characterized by:

   an outer casing (24) having a central casing axis (30), first and second ends (26,28), and an axial bore (32) extending at least part way into said outer casing from said first end;

   at least two radial bearings (38,40) received within said axial bore and defining a predetermined gap (42) therebetween, each of said radial bearings having an inner bearing race (46) rotatable about said casing central axis and having a bore for removably receiving said cutting tool with said forward end portion of said cutting tool protruding from said casing; and

   a resilient annular member (43) positioned in said gap and in engagement with said inner bearing races, thereby exerting a force on each of said inner bearing races.

2. A cutter cartridge assembly (20) as defined by claim 1, further characterized by a bearing sleeve (34) positioned in said axial bore (32) for receiving said at least two radial bearings (38,40).

3. A cutter cartridge assembly (20) as defined by claim 1 or 2, wherein:

   said resilient member (43) defines an aperture (45) having an inner diameter for frictionally yieldingly engaging said outer diameter of said cutting tool (22).

4. A cutter cartridge assembly (20) as defined by anyone of claims 1 to 3 further characterized by means for adjusting the amount by which said front end portion of said cutting tool (22) extends from said first end of said outer casing (24).

5. A cutter cartridge assembly (20) as defined by claim 4 wherein said axial bore (32) extends through said outer casing (24) from said first to said second end, and wherein said means for adjusting is characterized by:

   a shaft (64) having a knob portion (66) and an opposite end portion (70) adjustably received in said axial bore at said second end of said outer casing; and

   means carried by said opposite end portion of said shaft for engaging an end of said cutting tool (22) opposite said forward end portion, such that rotation of said knob portion causes said cutting tool to extend or retract relative to said first end of said outer casing.

6. A cutter cartridge assembly (20) as defined by claim 5 wherein said end portion defines a recess (72) and said means carried by said end portion comprises a ball (74) receivable in said recess; and wherein said end of said cutting tool (22) engages said ball.

7. A cutter cartridge assembly (20) as defined by claim 6, further comprising a third radial bearing interposed between said at least two radial bearings (38,40) and said ball (74), said third radial bearing defining a bore for rotatably receiving said end of said cutting tool (22).

8. A cutter cartridge assembly (20) as defined by anyone of claims 5 to 7 further characterized by:

a cap (58) coupled to said first end of said outer casing (24) adjacent to said at least two radial bearings (38,40), said cap having a reference surface and a bore for receiving said cutting tool (22), said bore extending from said reference surface through said cap; and wherein
said outer casing includes a peripheral surface defining angular indicia (78) extending there around; and
said knob portion includes a reference mark (80) alignable with said angular indicia, such that when said knob portion is rotated, the position of said reference mark relative to said angular indicia indicates the amount by which said cutting tool extends past said reference surface.

9. A cutter cartridge assembly (20) as defined by anyone of claims 4 to 8 wherein said axial (32) bore extends part way into said outer casing (24) from said first end thereby defining a bottom surface (82), and said means for adjusting the amount by which said cutting edge extends from said outer casing comprises:

a cap (58) threadedly engaged with said first end of said outer casing adjacent to said at least two radial bearings (38,40), said cap including a reference surface and defining a bore for receiving said cutter (22), said bore extending from said reference surface through said cap; and
means carried by said bottom surface for engaging an end of said cutting tool opposite said forward end portion, such that rotation of said cap causes said cutting tool to extend or retract relative to said reference surface.

10. A cutter cartridge assembly (20) as defined by claim 9 wherein said bottom surface (82) defines a recess (72') and said means carried by said shaft comprises a ball (70) receivable in said recess; and wherein

said end of said cutting tool (22) engages said ball.

11. A cutter cartridge assembly (20) as defined by claim 9 or 10, further characterized by:

said outer casing (24) including a peripheral surface defining angular indicia (78) extending there around; and
said cap (58) includes a reference mark (80) alignable with said angular indicia (78), such that when said cap is rotated the position of said reference mark relative to said angular indicia indicates the amount by which said cutting tool extends past said reference surface.

12. A cutter cartridge assembly (20) as defined by anyone of the foregoing claims wherein said resilient member (43) is an o-ring.

13. A cutter cartridge assembly (20) for use with an X-Y sheet material cutting mechanism and for removably receiving and holding, for rotation about its central axis (54), an elongated cutting tool (22) having a forward end portion (52) sharpened to provide a cutting edge inclined to said central tool axis and having a tip point (56) spaced from said central tool axis, said cartridge assembly characterized by:

an outer casing (24) having a central casing axis (30), first and second ends (26,28), and an axial bore (32) extending at least part way into said outer casing from said first end;
two radial bearing pairs (38",40" and 96,98) received within said axial bore, each pair defining a predetermined gap between the bearings in said pair, each of said radial bearings having an inner bearing race rotatable about said casing central axis and having a bore for removably receiving said cutting tool with said forward end portion of said cutting tool protruding from said casing; and
two resilient annular members (43",100) one positioned in each of said gaps and in engagement with said bearing pair inner bearing races , thereby exerting a force on each of said inner bearing races.

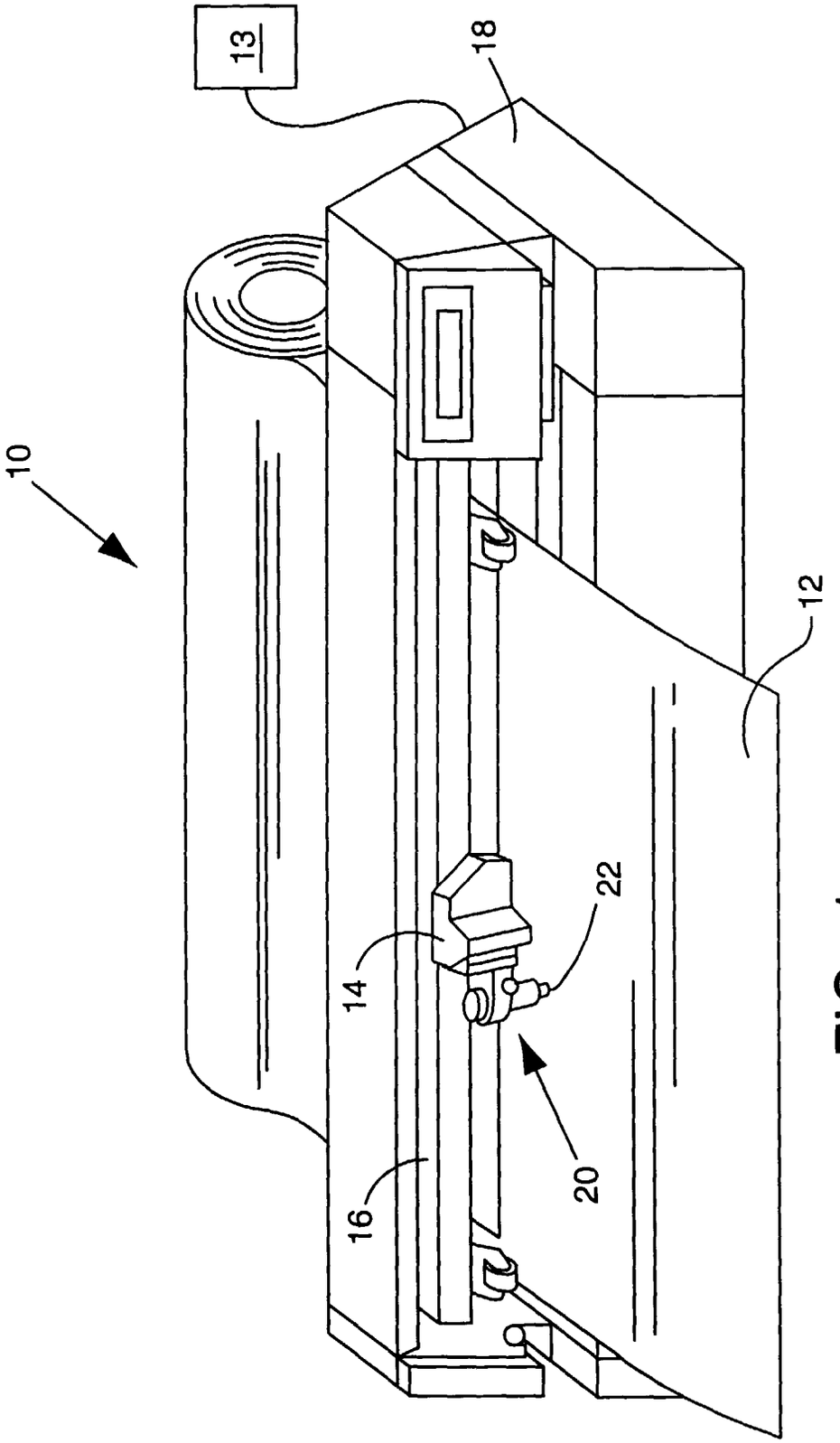

FIG. 1

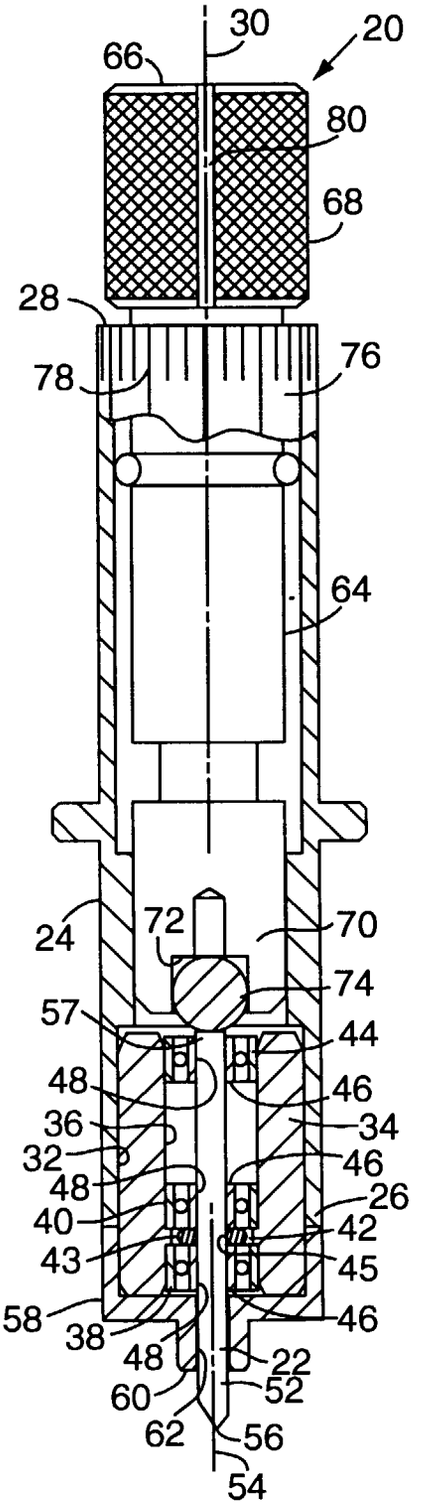
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FIG. 2

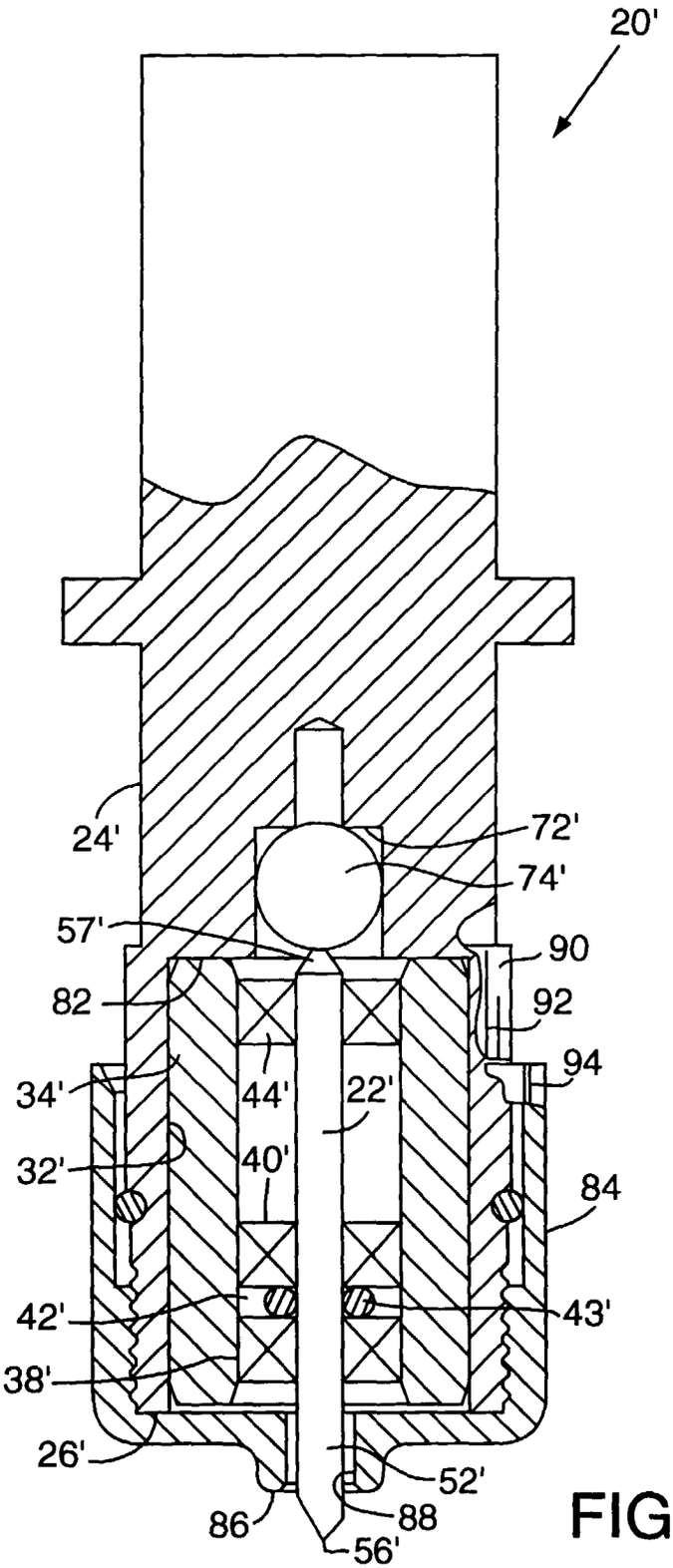
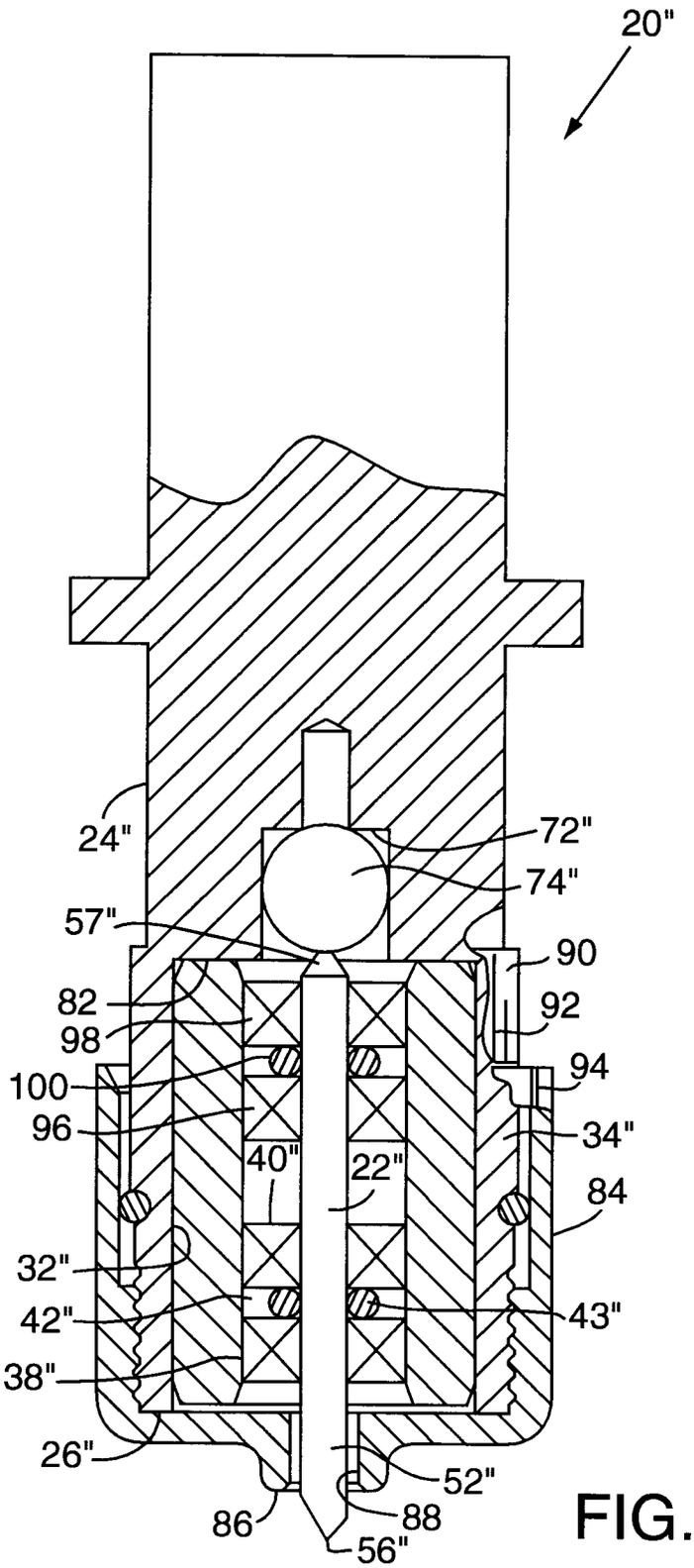


FIG. 3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86
88
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FIG. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 98 10 5974

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US 5 094 134 A (MIZUKOSHI TOSHIYA) 10 March 1992 * column 1, line 50 - line 56 * * column 2, line 63 - column 3, line 10 * * column 3, line 34 - line 38 * * column 3, line 39 - line 43; figure 3 *	1,3-6,12	B26F1/38 B26D7/26
Y		2,7,9,10	

Y	PATENT ABSTRACTS OF JAPAN vol. 096, no. 006, 28 June 1996 & JP 08 052685 A (ROLAND D G KK), 27 February 1996, * abstract *	2	

Y	PATENT ABSTRACTS OF JAPAN vol. 096, no. 008, 30 August 1996 & JP 08 090486 A (ROLAND D G KK), 9 April 1996, * abstract *	7,9,10	

			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B26F B26D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	9 June 1998	Huggins, J

CATEGORY OF CITED DOCUMENTS

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