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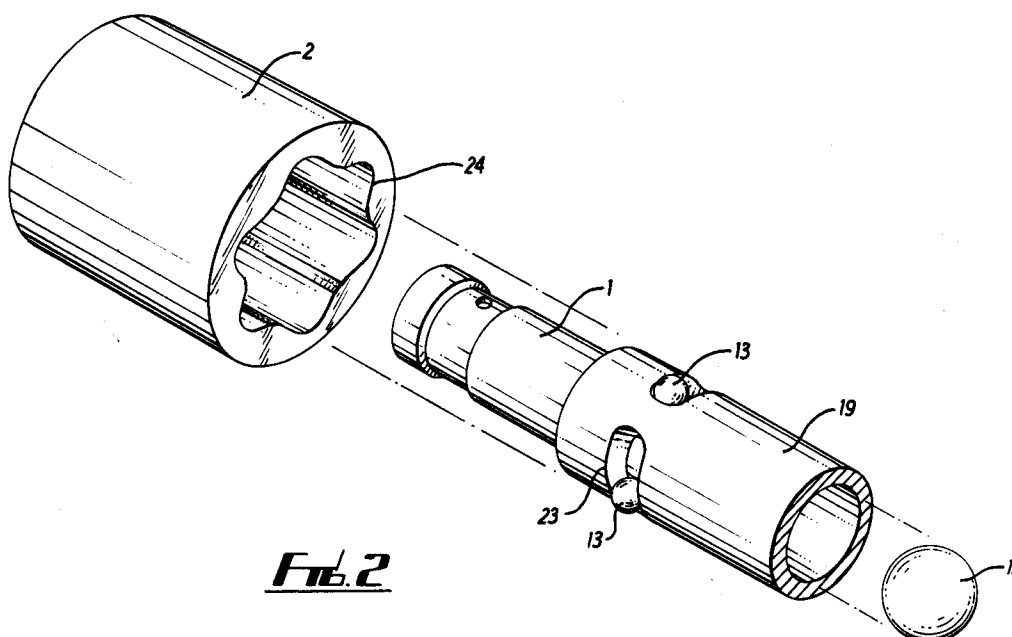
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(54) **A device for applying torque to a fastener.**

(57) A device for applying torque to a fastener, comprising a first member (1) adapted to be coupled to a fastener, and a second member (3) coupled to the first member (1) by a releasable coupling (2, 13, 19) adapted to transmit torque applied to the second member (3) to the first member (1) and to de-couple the second member (3) from the first member (1) when the torque applied to the second member (3) exceeds a predetermined magnitude; characterised in that the releasable coupling comprises a lost-motion device (2, 13, 19).

**Fig. 2****EP 0 532 289 A1**

The invention relates to a device for applying torque to a fastener such as a screw or bolt.

Conventional screw-drivers for applying a pre-determined torque level to a fastener, such as a screw or bolt, generally comprises a coupling mechanism which includes one or more spherical balls which are located in close-fitting recesses and which are biased against a cam by means of a spring bias device.

5 When the torque applied through the handle of the screw-driver to the fastener exceeds a predetermined level, then the cam overcomes the biasing force of the biasing device and the balls are forced further into their recesses. This enables the balls to move relative to the cam and to de-couple the handle from the fastener.

10 In accordance with the present invention, a device for applying torque to a fastener comprises a first member adapted to be coupled to a fastener and a second member coupled to the first member by a releasable coupling which transmits torque applied to the second member to the first member, and whereby the releasable coupling is adapted to de-couple the second member from the first member when the torque applied to the second member exceeds a predetermined magnitude, and the releasable coupling comprising a lost motion device to couple the second member to the first member. Preferably, the lost motion
15 device comprises a lost motion member and a movable member mounted on the lost motion member which is movable between an engaged position in which the second member is coupled to the first member and a disengaged position in which the second member is de-coupled from the first member.

Typically, the lost motion member includes a recess and the dimensions of the movable member and recess are chosen to permit relative movement of the movable member in the recess, preferably in both a
20 radial direction and a circumferential direction. In the preferred embodiment, the movable member comprises a spherical shaped member and the recess may be radially and circumferentially extending slots in which the spherical member moves.

Preferably, the releasable coupling further comprises biasing means and a counter-biasing means and the movable member is biased into engagement with the counter biasing means by the biasing means and
25 typically, the biasing means may be adjustable in order to vary the biasing force applied to the movable member. In the preferred embodiment, the counter biasing means comprises a cam device.

Preferably, when the movable member is in the disengaged position, the movable member and the lost motion member move relative to the counter-biasing means.

In the preferred embodiment, the counter-biasing means is mounted on the second member and the
30 lost motion member and movable member are mounted on the first member.

Typically, where the device is a screw-driver the first member may comprise a shaft of the screw-driver and the second member may comprise a handle. Typically, in this example, the releasable coupling comprises three recesses in the lost motion member and three corresponding movable members. Preferably, the lost motion member and the movable members are mounted on the first member and the counter
35 biasing means is mounted on the second member. Typically, where the counter biasing means comprises a cam device, then this is in the form of a cam ring mounted on the second member.

Preferably, the biasing means comprises a helical spring and may further comprise a spherical member which transmits the biasing force from the spring to the movable member. Typically, where the device is a screw-driver and the biasing means is a helical spring, the central axis of the spring is parallel to the central
40 axis of the shaft of the screw-driver and typically, is coincident with the central axis of the shaft.

The term "lost motion device" as used herein means a device which permits a limited movement of one member relative to the other member, without a corresponding movement of the other member.

An example of a device for applying torque to a fastener in accordance with the invention will now be described with reference to the accompanying drawings, in which:-

45 Fig 1 is a cross-sectional view of a screw-driver;

Fig 2 is an exploded perspective view of parts of the screwdriver of Fig 1;

Fig 3 is a cross-sectional view through a spring housing for use with the screw-driver along the line AA in Fig 1 with the other components omitted;

Fig 4 is a cross-sectional view through a cam ring for use with the screw-driver along the line AA in Fig 1 with the other components omitted;

50 Figs 5A and 5B are detail views of parts of cam profiles which may be used; and

Fig. 6 illustrates certain dimensions referred to in the description.

Fig 1 shows a screw-driver 20 which comprises a shaft 1 which is fixed to a spring housing 19 at one end. At the other end of the shaft 1 is $\frac{1}{4}$ inch square drive 21 which has a blind bore 22 in which is
55 mounted a steel ball 14 with a diameter of approximately $\frac{1}{8}$ inch (3.175mm) and a spring 10 to bias the steel ball 14 towards the position shown in Fig 1. The ball 14 is retained by light deformation of the mouth of the bore 22.

Within the spring housing 19 is located an adjusting screw 4 which is rotationally locked to the spring housing 19 by means of a nylon ball 17 which has a diameter of approximately 3/32 inch (2.38mm). A spring 6 is located within the spring housing 19 and abuts against the inner side of the adjusting screw 4 at one end and against a spring pad 16 at its other end. The spring pad 16 rests on a steel ball 12 of approximately 1/2 inch (12.7mm) diameter which transmits the biasing force from the spring 6 to three steel balls 13 (only one shown) which are mounted in apertures 23 in the spring housing 19. Each of the steel balls 13 has a diameter of approximately 7/32 inch (5.56mm).

The spring housing 19 is mounted within a handle assembly which comprises a handle 3, a cam ring 2 mounted at the lower end of the handle 3. The handle 3 has an aperture 24 in its upper end which is screened by a threaded plug 9.

The shaft 1 and spring housing 19 are rotationally mounted on the handle assembly by means of a radial bearing 15 mounted between the cam ring 2 and shaft 1 which is held in position by a retaining ring 11, and a thrust washer assembly which comprises two outer thrust washers 7 and a central thrust washer 8 which are located between the upper end of the spring housing 19 and the inside of the handle 3. The thrust washer assembly has a central aperture 25 which permits access to engagement recesses 26 in the adjusting screw 4.

Fig 3 is a cross-sectional view through the spring housing 19 along the line AA in Fig 1, with the other components removed. As shown in Fig 3 there are 3 apertures 23 equi-spaced circumferentially around the spring housing 19. Hence, the centres of the apertures 23 are mutually spaced circumferentially by 120°. As shown in Fig 3 each aperture 23 has a slot profile so that each steel ball 13 may move circumferentially, by about 40° in the embodiment, within its corresponding aperture 23. Each ball 13 may also move radially within its respective aperture 23.

Fig 4 is a cross-sectional view of the cam ring 2 also along the line AA in Fig 1 and with the other components omitted. As shown in Fig 4 the cam ring 2 has six recesses 24 formed in its internal surface 25. Each recess 24 is equi-spaced around the internal circumference of the surface 25 and so the centre of each recess 24 is mutually spaced from the other recesses 24 by 60°. Hence, when one of the steel balls 13 is located in a recess 24 the other steel balls 13 are also located in their respective recesses 24. Alternatively, three recess mutually spaced by 120° may be used.

In use, a fastener coupling (not shown) is attached to the square drive 21 of the shaft 1 and is engaged with a fastener, such as a screw or bolt (not shown). An operator then grips the handle 3 with his hand and applies a rotational torque to the handle 3. At this time the spring 6 forces the steel balls 13 outwards via the spring pad 16 and the 1/2 inch steel ball 12, the steel balls 13 are forced into the recesses 24 in the cam ring 13. Hence, rotational movement of the handle 3 which rotates the cam ring 2, as the cam ring 2 is fixed to the handle 3, forces rotation of the steel balls 13 and hence rotation of the housing 19 and shaft 1. Therefore, the torque applied to the handle 3 by the operator is transmitted to the square drive 21 and the fastener in order to tighten or loosen the fastener.

When the torque applied by an operator to the handle 3 exceeds a pre-determined threshold level, then the side walls of the recesses 24 apply sufficient biasing force against the steel balls 13 to force the steel balls 13 into the apertures 23 against the biasing force of the spring 6. Hence, the steel balls 13 may move circumferentially relative to the cam ring 2 against the internal surface 25 of the cam ring 2. Thus, when the torque applied by the operator to the handle 3 exceeds the predetermined threshold level, the spring housing 19 is rotationally de-coupled from the handle 3 and so the operator knows that a predetermined torque has been applied to the fastener.

With conventional torque limiting screw-drivers, continued rotation of the handle 3 causes the steel balls 13 to re-engage in the next available recess 24, and such re-engagement could theoretically cause the fastener to have a reverse torque applied to it. However, by use of the apertures 23 which permit circumferential movement of the steel balls 13 relative to the spring housing 19 the likelihood of the theoretically possible reverse torque being applied to the fastener is eliminated, as the motion of the handle 3 when the steel balls 13 re-engage the recesses 24 is lost by circumferential movement of the steel balls 13 in the apertures 23.

The threshold torque level of the screw-driver 20 may be increased or decreased as described by an appropriate choice of the strength of the spring 6. In addition, for any given spring the threshold may be adjusted by removing the plug 9 and moving the adjustable screw 4 up or down the inside of the housing 19 by using an appropriate tool engaged with the recesses 26 through the aperture 25. The threshold is increased by compression of the spring 6 and decreased by allowing the spring to extend.

Fig 5 illustrates possible cam profiles in detail. In Fig 5A, the recess 24 has a central radiused portion 30 of radius R1 bounded by two flat portions 31 which are each inclined at 45° to the median plane. The radius R1 is slightly larger than the radius of the balls 13. The flat portions 31 join the inner cam face 32 via

radiused portions 33 of radius R2. This cam profile is similar to that used in prior art screwdrivers.

In the cam profile of Fig. 5B the flat portions 31 are omitted. The recess 24 consists of a radiused portion 30 of radius R1 and the joining radiused portions 33 of radius R2, R2 suitably being equal to R2 of Fig. 5A and R1 being equal to the radius of the balls 13. We have established experimentally that the cam profile of Fig 5B gives better results (in terms of lower reverse torque) in the device of the present invention than that of Fig 5A.

Fig 6 illustrates the form of the slots 23 in greater detail. The circumferential extent of each slot can be defined in terms of a nominal angle α between the centre of the ball when at its end positions. This dimension can also be defined in terms of the path length X taken along the mean diameter of the sleeve and expressed as a proportion of the ball diameter D. Table I summarises experiments carried out on different slot sizes, which indicate that longer slots are more effective in reducing reverse torque. The reverse torque figures in Table I are given for a spring setting for a nominal forward torque of 90 cN.m.

TABLE I

Nominal angle α	Slot length X	Typical reverse torque (cN.m)	
		Cam of Fig 5A	Cam of Fig 5B
0	D (circular hole)	63	26
10°	1.235D	83	85
20°	1.477D	31	18
30°	1.710D	15	10
40°	1.943D	12	n/d
n/d = not detectable.			

This invention thus provides an improved torque-applying device which reduces the risk of reverse torque being inadvertently applied. It has also been found that the device of the invention reduces the risk of repetitive strain injury to the operator.

Claims

1. A device for applying torque to a fastener, comprising a first member (1) adapted to be coupled to a fastener, and a second member (3) coupled to the first member (1) by a releasable coupling (2, 13, 19) adapted to transmit torque applied to the second member (3) to the first member (1) and to decouple the second member (3) from the first member (1) when the torque applied to the second member (3) exceeds a predetermined magnitude; characterised in that the releasable coupling comprises a lost-motion device (2, 13, 19).
2. A device according to Claim 1, in which the lost-motion device (2, 13, 19) comprises a lost-motion member (19) and a movable member (13) mounted on the lost-motion member (19), the movable member (13) being movable between an engaged position in which the second member (3) is coupled to the first member (1) and a disengaged position in which the second member (3) is de-coupled from the first member (1).
3. A device according to Claim 1 or Claim 2, in which the lost-motion member (19) includes a recess (23), and the movable member (13) and the recess (23) are dimensioned to permit relative movement of the movable member (13) in the recess (23).
4. A device according to Claim 3, in which the movable member (13) is relatively movable in the recess (23) both radially and circumferentially.
5. A device according to Claim 3 or Claim 4, in which the movable member comprises a sphere (13) and the recess comprises a slot (23) within which the sphere (13) is movable.
6. A device according to Claim 5, in which the slot (23) has a radial dimension in the range 1.2D to 2.0D, where D is the diameter of the sphere (13).

7. A device according to Claim 6, in which said radial dimension is 1.943D.
8. A device according to any of Claims 2 to 7, in which the releasable coupling (2, 13, 19) further includes
5 biasing means (6, 12) and counter-biasing means (2), the biasing means (6, 12) acting to urge the
movable member (13) into engagement with the counter-biasing means (2).
9. A device according to Claim 8, in which the biasing means (6, 12) is adjustable to vary the biasing
force applied to the movable member (13).
10. A device according to Claim 8 or Claim 9, in which the counter-biasing means comprises a cam device
10 (2).
11. A device according to Claim 10, in which the cam device is in the form of a cam ring (2) secured to the
second member (3), the lost-motion member (19) is mounted on the first member (1), and there are
15 provided three movable members (13) housed in respective slots (23) in the lost-motion member (19).
12. A device according to Claim 11, in which the biasing means comprises a coil spring (6) and thrust
means (12) transmitting the thrust of the coil spring (6) to the three movable members (13).
13. A device according to Claim 12, in which the thrust means is a ball (12).
14. A device according to Claim 12 or Claim 13, in which the coil spring (6) is adjustable to vary the thrust
on the movable members (13).
15. A device according to any of Claims 11 to 14, the device being in the form of a screwdriver, the second
25 member comprising a handle (3) for gripping and turning by an operator, the first member comprising a
shaft (1) extending from the handle (3) for connection to a fastener, and the coil spring (6) being axially
disposed within the handle (3).

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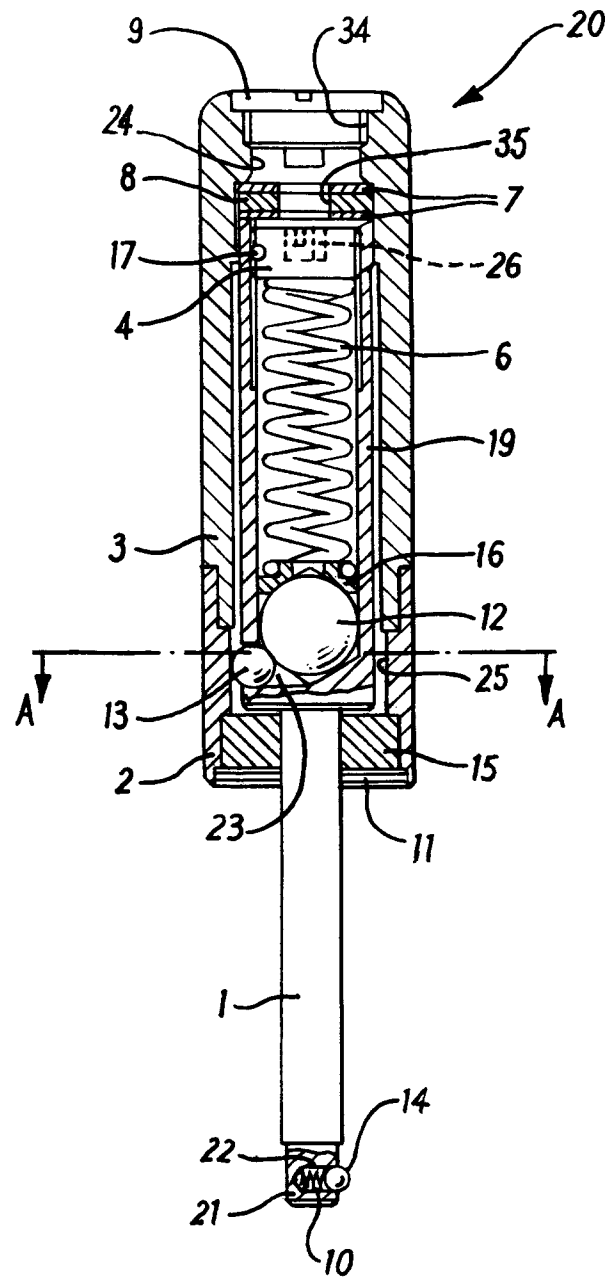
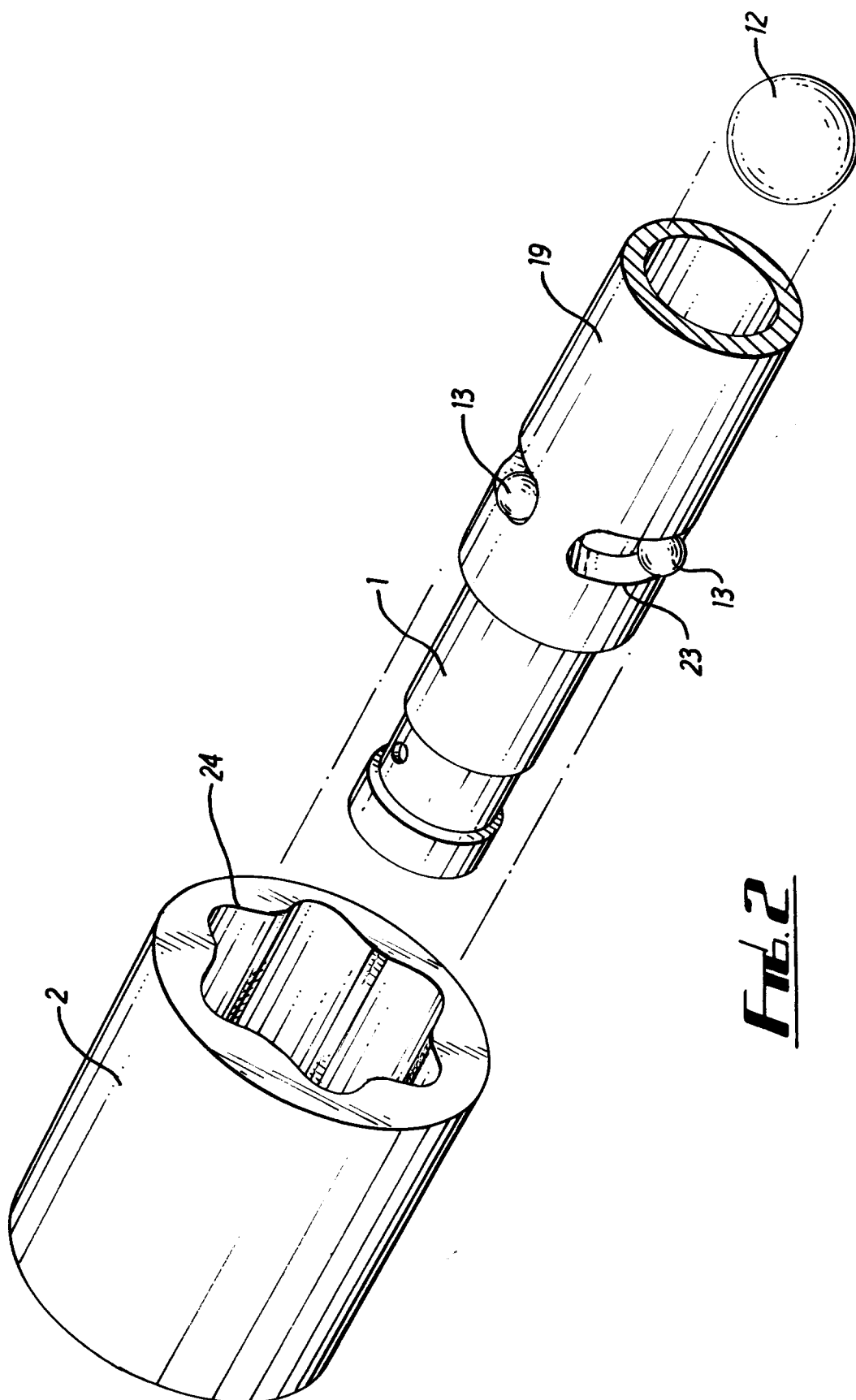


Fig. 1



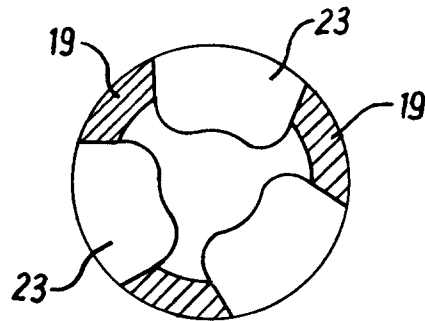


FIG. 3

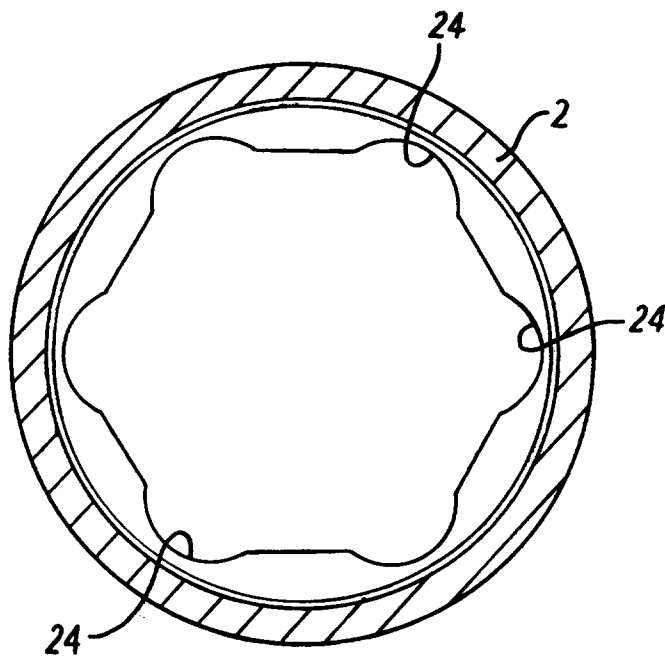
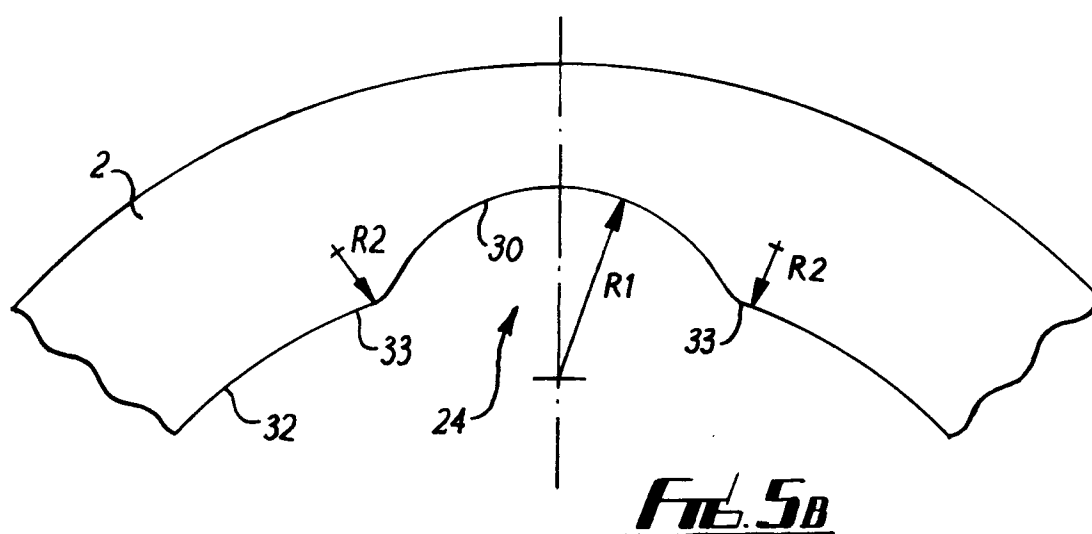
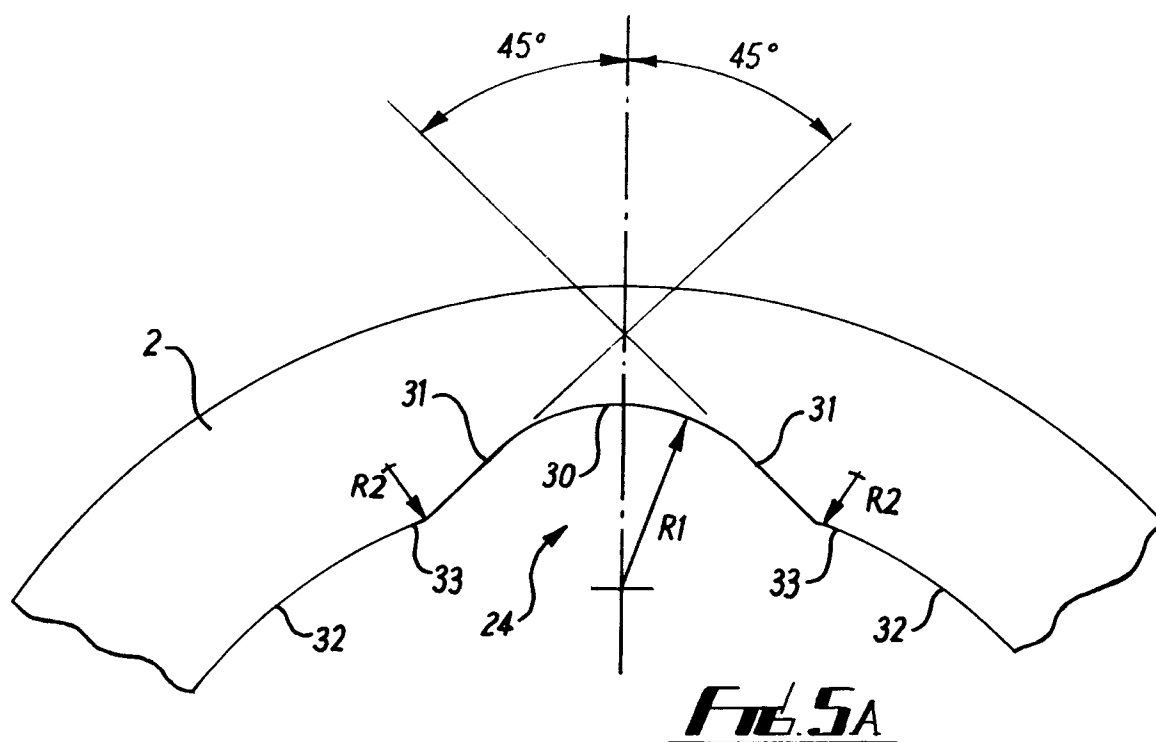


FIG. 4



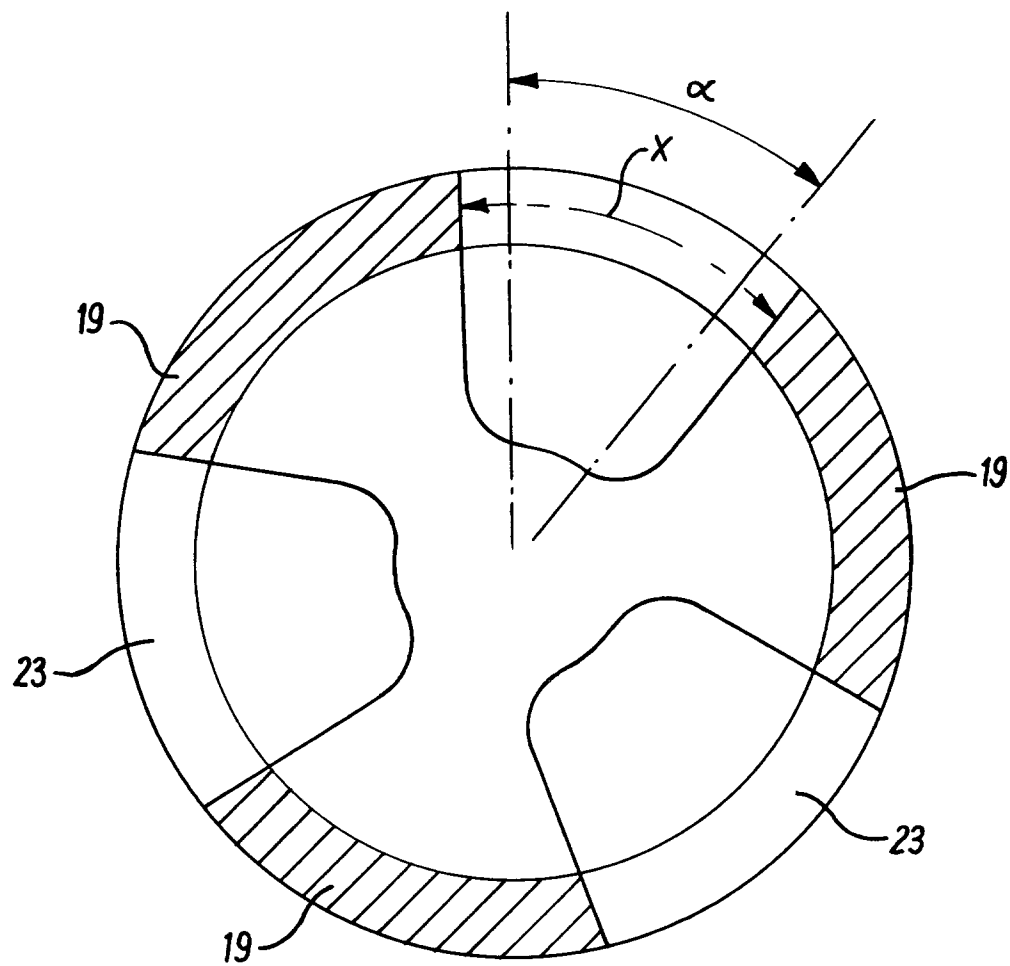


FIG. 6



European Patent
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EUROPEAN SEARCH REPORT

Application Number

EP 92 30 8171

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.5)
Y	DE-A-3 140 288 (SALTUS WERK MAX FORST GMBH & CO) * the whole document * ---	1-15	B25B23/14
Y	FR-A-1 569 991 (FACOM) * page 3, line 37 - page 4, line 12; figures * ---	1-15	
A	DE-A-2 819 226 (G.HOLLAND-LETZ) -----		
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			B25B B23P
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 03 DECEMBER 1992	Examiner MAJERUS H.M.P.
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