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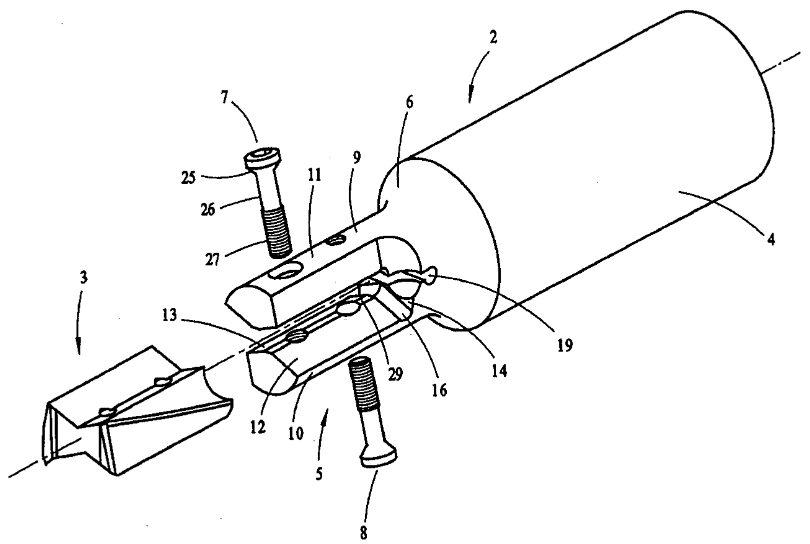

(57) Abstract

A cutting tool assembly (1) rotatable about an axis of rotation having a tool (2) in which a replaceable insert (3) is mountable. The tool (2) has two clamping jaws (9, 10) spaced apart by an insert receiving slot (28). The insert (3) has top (34) and bottom (35) surfaces each of which has two abutting surfaces (43, 44). The abutting surfaces (43, 44) have a rear abutting portion and a front abutting portion and in accordance with one embodiment the insert is thicker at its rear abutting portion than at its front abutting portion. This structure of the insert provides positive axial locking of the insert, ensuring no axial movement of the insert relative to the tool during machining. The abutting surfaces of the top surface slope towards each other and inwardly towards a central portion ot the insert. Similarly, the abutting surfaces of the bottom surface slope towards each other and inwardly towards the central portion of the insert. The insert is thereby effectively radially clamped by the clamping jaws in a double dove-tail manner.

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Cutting Tool Assembly and Cutting Insert Therefor

FIELD OF THE INVENTION

The present invention relates to a cutting tool assembly having a replaceable insert for use in rotary machining operations in general and in finishing applications in particular.

BACKGROUND OF THE INVENTION

In known end milling cutters having indexable inserts, the inserts are arranged on the periphery of the tool and fastened thereto by means of clamping screws. When machining a surface whose height is greater than the height presented by the cutting edge of a single insert, an extended flute milling cutter is used whereby several inserts are arranged along the periphery of the tool in such an arrangement so as to effectively constitute a single long cutting edge.

The extended flute milling cutter, which is efficient for rough end milling operations, has several disadvantages when performing finishing operations: (i) radial mismatch between the inserts, on the same flute or on different flutes, causes unevenness of the machined surface, (ii) the angular pitch between the inserts decreases web thickness and thereby tool strength, (iii) the reliability of the entire tool depends on many components thereby increasing the chance for failure.

When performing finishing applications with tools having replaceable inserts at high speeds, e.g. in the range of 10,000 to 30,000 rpm, stability problems limits the use of conventional clamping systems.

In view of the foregoing, it should be apparent that there exists a need to provide a cutting tool that will eliminate, or reduce to within acceptable limits, the above mentioned problems and disadvantages.

SUMMARY OF THE INVENTION

In accordance with the present invention there is provided a cutting tool assembly, rotatable about an axis of rotation A, comprising a tool, a replaceable insert mountable therein and at least one clamping screw, said tool comprises two substantially equal clamping jaws spaced apart by an insert receiving slot, each of said clamping jaws is provided with at least one screw bore and comprises a peripheral surface, peripheral abutment surface and central abutment surface, said peripheral abutment surface and said central abutment surface being substantially parallel to said axis of rotation,

said insert is of a generally prismatic shape having an axis of rotation B and comprising a central portion, a front surface, a rear surface, top and bottom surfaces having at least one through bore aligned with said at least one screw bore, and side surfaces on opposite sides of said axis of rotation, said side surfaces merging with said top and bottom surfaces at edges, at least one of said edges being a cutting edge,

each of said top and bottom surfaces comprising first and second abutting surfaces, each of said first and second abutting surfaces terminating in a front abutting portion having, respectively, central and peripheral front edge lines, and in a rear abutting portion having, respectively, central and peripheral rear edge lines, said peripheral front edge lines being parallel to said peripheral rear edge lines, and said central front edge lines being parallel to said central rear edge lines, said first and second abutting surfaces of said top surface slope towards each other and inwardly towards the central portion of said insert and said first and second abutting surfaces of said bottom surface slope towards each other and inwardly towards the central portion of said insert.

There is also provided in accordance with the present invention an insert for clamping in a clamping tool between clamping jaws, said insert being of a generally prismatic shape having an axis of rotation B and comprising a central portion, a front surface, a rear surface, top and bottom surfaces and side surfaces on opposite sides of said axis of rotation, said side surfaces merging with said top and bottom surfaces at edges, at least one of said edges being a cutting edge,

each of said top and bottom surfaces comprising first and second abutting surfaces, each of said first and second abutting surfaces terminating in a front abutting portion having, respectively, central and peripheral front edge lines and in a rear abutting portion having, respectively, central and peripheral rear edge lines,

said first and second abutting surfaces of said top surface slope towards each other and inwardly towards said central portion of said insert and wherein said first and second abutting surfaces of said bottom surface slope towards each other and inwardly towards said central portion of said insert.

Preferably, said insert is thicker at its rear abutting portion than at its front abutting portion

Typically, said first and second abutting surfaces follow an elastic bending curve of said clamping jaws.

If desired, said first and second abutting surfaces are flat.

Preferably, said cutting edge follows a spiral path about the axis of rotation B.

Further preferably, said insert has two through bores.

Generally, said first and second abutting surfaces of said top surface are connected by a first intermediate surface and said first and second abutting surfaces of said bottom surface are connected by a second intermediate surface.

Preferably, said first and second intermediate surfaces are located on either side of a vertical plane V passing through the axis of rotation of the insert when the insert is oriented horizontally.

Further preferably, said first and second intermediate surfaces are located at equal distances from said vertical plane.

In accordance with one embodiment of the invention, said first and second intermediate surfaces are lines.

In accordance with another embodiment of the invention, said first and second intermediate surfaces have straight cross-sections in a plane perpendicular to the axis of rotation B.

In accordance with another embodiment of the invention, said first and second intermediate surfaces have curved cross-sections in a plane perpendicular to the axis of rotation B.

In accordance with the present invention, said peripheral and central abutment surfaces form between them an angle α.

Further in accordance with the present invention, said first and second abutting surfaces of said insert top surface form between them an angle α` and wherein said first and second abutting surfaces of said insert bottom surface form between them an angle $\alpha$`.

Preferably, said angle α` is smaller than said angle α.

If desired, said insert receiving slot terminates in an intermediate slot.

Further if desired, said intermediate slot terminates in a stress equalizing flexibilizing bore.

Preferably, said at least one through bore is provided in said top and bottom surfaces.

In accordance with one embodiment of the invention there is provided a cutting tool assembly rotatable about an axis of rotation A comprising a tool, a replaceable insert mountable therein and at least one clamping screw, said tool comprises two substantially equal clamping jaws spaced apart by an insert receiving slot having at least one rear abutment surface, each of said clamping jaws is provided with at least one screw bore slanted at an angle δ with respect to a line perpendicular to the axis of rotation of the cutting tool assembly and having at least one screw bore tapered portion, each of said clamping jaws comprises a peripheral surface, peripheral abutment surface and central abutment surface, said peripheral abutment surface and said central abutment surface being substantially parallel to said axis of rotation;

said insert is of a generally prismatic shape having an axis of rotation B and comprising a central portion, a front surface, a rear surface, top and bottom surfaces having at least one through bore substantially aligned with said at least one screw bore, and side surfaces on opposite sides of said axis of rotation, said side surfaces merging with said top and bottom surfaces at edges, at least one of said edges being a cutting edge,

each of said top and bottom surfaces comprising first and second abutting surfaces, each of said first and second abutting surfaces terminating in a front abutting portion having, respectively, central and peripheral front edge lines, and in a rear abutting portion having, respectively, central and peripheral rear edge lines, said peripheral front edge lines being parallel to said peripheral rear edge lines, and said central front edge lines being parallel to said central rear edge lines,

said first and second abutting surfaces of said top surface slope towards each other and inwardly towards the central portion of said insert and said first and second abutting surfaces of said bottom surface slope towards each other and inwardly towards the central portion of said insert.

said clamping screw (307) has an axis E, a screw head tapered portion (325), a screw cylindrical portion (326) slanted at an angle δ with respect to the axis E and a screw threaded portion (327),

in an assembled position the insert rear abutment surface (33) abuts the at least one rear abutment surface (14, 15), the screw cylindrical portion (326) abuts the at least one insert through bore (38, 39), the screw head tapered portion (325) abuts the screw bore tapered portion (331) and the peripheral abutment surfaces (12) and central abutment surfaces (13) of the clamping jaws (9, 10) abut the first and second abutting surfaces (43, 43`, 44, 44`) of the insert.

There is yet further provided in accordance with the present invention a tool rotatable about an axis of rotation A comprising two substantially equal parallel clamping jaws spaced apart by an insert receiving slot, each of said clamping jaws is provided with at least one screw bore and comprises a peripheral surface, peripheral abutment surface and central abutment surface, said peripheral abutment surface and said central abutment surface being substantially parallel to said axis of rotation.

BRIEF DESCRIPTION OF THE DRAWINGS

For a better understanding of the present invention and to show how the same may be carried out in practice, reference will now be made to the accompanying drawings, in which

Fig. 1 is a perspective view of a cutting tool assembly according to the present invention;

Fig. 2 is an exploded view of the cutting tool assembly shown in Fig. 1;

Fig. 3 is a partial side view of the tool shown in Fig. 2;

Fig. 4 is a partial top view of the tool shown in Fig. 2;

Fig. 5 is a front view of the tool shown in Fig. 2;

Fig. 6 is a cross-sectional view of the tool shown in Fig. 3 taken along line VI-VI;

Fig. 7 is a perspective view of an insert according to the present invention;

Fig. 8 is a side view of the insert shown in Fig. 7;

Fig. 8A is a rear view of the insert shown in Fig. 8 viewed from direction A-A;

Fig. 8B is a cross-sectional view of the insert shown in Fig. 8 taken along line B-B;

Fig. 9 is a front view of the insert shown in Fig. 7;

Fig. 10 is a top view of the insert shown in Fig. 7;

Fig. 10A is a cross-sectional partial view of the insert shown in Fig. 10 taken along line A-A;

Fig. 10B is a cross-sectional partial view of the insert shown in Fig. 10 taken along line B-B;

Fig. 11 is a schematic enlarged front view of an insert according to a first preferred embodiment of the present invention;

Fig. 12A is a schematic drawing illustrating the bending of a fixed beam;

Fig. 12B is a schematic partially sectioned side view showing the clamping of a flat insert before clamping;

Fig. 12C is a schematic partially sectioned side view showing the clamping of a flat insert after clamping;

Fig. 12D is a schematic partially sectioned side view of the tool shown in Fig. 12C clamping an insert according to the present invention;

Fig. 13A is a schematic partial cross-section of the cutting tool assembly shown in Fig. 1 taken in a plane perpendicular to axis A through a region of abutment between the insert and the clamping jaws of the tool, wherein the intermediate surfaces are lines;

Fig. 13B is a schematic partial cross-section of the cutting tool assembly shown in Fig. 1 taken in a plane perpendicular to axis A through a region of abutment between the insert and the clamping jaws of the tool, wherein the intermediate surfaces have straight cross sections;

Fig. 13C is a schematic partial cross-section of the cutting tool assembly shown in Fig. 1 taken in a plane perpendicular to axis A through a region of abutment between the insert and the clamping jaws of the tool, wherein the intermediate surfaces have curved cross sections;

Fig. 14A is a perspective view of an insert with a single cutting edge in accordance with the present invention;

Fig. 14B is a front view of the insert shown in Fig. 14A;

Fig. 14C is a top view of the insert shown in Fig. 14A;

Fig. 15 is a schematic enlarged partial cross section of a cutting tool assembly according to the present invention, with a different clamping arrangement, showing a first stage of tightening of a clamping screw;

Fig. 16 is a schematic enlarged partial cross section of a cutting tool assembly according to the present invention, with a different clamping arrangement, showing a second stage of tightening of a clamping screw; and

Fig. 17 is a schematic enlarged partial cross section of a cutting tool assembly according to the present invention, with a different clamping arrangement, showing a third stage of tightening of a clamping screw.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Attention is first drawn to Figs. 1 and 2 showing a cutting tool assembly **1** rotatable about an axis of rotation **A**, comprising a tool **2**, a replaceable insert **3** and clamping screws **7** and **8**. Each clamping screw consists of screw head tapered portion **25**, screw cylindrical portion **26** and screw threaded portion **27**. The tool **2** consists of a body portion **4**, clamping portion **5** and intermediate portion **6** therebetween. Clamping portion **5** is formed by two spaced apart substantially equal parallel clamping jaws **9** and **10**. As can be seen in Figs. 2 to 6, each clamping jaw consists of a peripheral surface **11**, preferably cylindrical, peripheral abutment surface **12** and central abutment surface **13**, all of which are parallel to the axis of rotation **A**. On each clamping jaw, peripheral abutment surface **12** and central abutment surface **13** are joined by connecting surface **29**. It should be noted that connecting surface **29** can be of several shapes and does not generally constitute an abutment surface. Both connecting surfaces **29** are preferably parallel to each other and to axis **A**. In an extreme case, either one, or both of connecting surfaces **29** can be reduced to a line at which a peripheral abutment surface **12** and a central abutment surface **13** meet. Both clamping jaws **9** and **10** are formed with front and rear screw bores. Clamping jaw **9** is provided, near its front end **24** with a front screw bore **20** aligned co-axially with front threaded screw bore **21** provided near front end **24`** of clamping jaw **10**, and, with rear threaded screw bore **23** aligned co-axially with rear screw bore **22** provided in clamping jaw **10**. Clamping screws **7** and **8** are screwed into the clamping portions from opposite directions thereby providing substantially the same stress on the peripheral surfaces of the clamping jaws, when clamped.

Clamping jaws **9** and **10** are provided therebetween with an insert receiving slot **28**, directed parallel to the axis of rotation **A**. Clamping jaw **10** is provided with stress relief channel **16** which merges with first rear abutment surface **14**. Clamping jaw **9** is provided with stress relief channel **17** which merges with second rear abutment surface **15**. Adjacent the rear end of insert receiving slot **28** is intermediate slot **18** directed parallel to the axis of rotation **A**. The rear end of intermediate slot **18** terminates in a stress equalizing flexibilizing bore **19** located at the base **30** of the clamping jaws. Stress equalizing flexibilizing bore **19** terminates at the intermediate portion **6** of tool **2** and is directed transversely to axis **A**, passes therethrough, and being remote from the clamping jaws adds flexibility to their gripping action.

As can be best seen in Fig. 5, peripheral abutment surfaces **12** on both clamping jaws are parallel but not co-planar and do not cross axis **A**. Similarly, central abutment surfaces **13** on both clamping jaws are parallel but not co-planar and do not cross axis **A**. On each clamping jaw, peripheral and central abutment surfaces **12** and **13** form between them an angle α. As can be seen in Fig. 6, front screw bore **20** has a tapered portion **31** serving as an abutment surface for screw head tapered portion **25** of clamping screw **7** shown in Fig. 2. A similar construction applies for the rear screw bore **22** and clamping screw **8**.

As can be seen in Figs. 7 to 10, the insert **3** is of a generally prismatic shape with 180° rotational symmetry about an axis of rotation **B** and consists of front surface **32**, rear surface **33**, identical top and bottom surfaces **34** and **35**, respectively, and identical side surfaces **36** and **37** which include relief surfaces **63** and **63`**, respectively. Front and rear through bores **38** and **39**, respectively, are disposed so as to be aligned, when the insert is mounted in the tool, with front and rear screw bores of the clamping jaws and capable to freely receive therethrough clamping screws **7** and **8**, respectively. In a different arrangement between the screws and the through bores of the insert the through bores do not freely receive therethrough the clamping screws as will be described later. When the insert is clamped in the tool its axis of rotation **B** coincides with the axis of rotation **A** of the tool.

Top surface **34** merges with side surface **36** at cutting edge **40** which terminates, at its front end at cutting corner **41** followed by wiper **61**. Similarly, bottom surface **35** merges with side surface **37** at cutting edge **40`** which terminates, at its front end at cutting corner **41`** followed by wiper **61`**. Top surface **34** comprises first and second abutting surfaces **43** and **44**, respectively, connected by an intermediate surface **45**, which, in the present embodiment, is reduced to a line, and rake surface **42** extending from cutting edge **40** along the entire length of the insert top surface and merging with first abutting surface **43**. Similarly, bottom surface **35** comprises first and second abutting surfaces **43`** and **44`**, respectively, connected by an intermediate surface **45`**, which, in the present embodiment, is also reduced to a line, and rake surface **42`** extending from cutting edge **40`** along the entire length of the insert bottom surface and merging with first abutting surface **43`**.

First and second abutting surfaces **43** and **44** of insert top surface **34** form between them an angle α` and slope inwardly towards intermediate surface **45**.

Similarly, first and second abutting surfaces **43`** and **44`** of insert bottom surface **35** form between them an angle α` and slope inwardly towards intermediate surface **45`**. The angle α` is preferably smaller than the angle α between the clamping jaws' peripheral and central abutment surfaces **12** and **13**, respectively. In view of this construction of the insert and the clamping jaws, the insert is effectively radially clamped in a double dove-tail manner with peripheral abutment surface **12** and central abutment surface **13** of clamping jaw **9** abutting second abutting surface **44** and first abutting surface **43** of the insert, respectively, and with peripheral abutment surface **12** and central abutment surface **13** of clamping jaw **10** abutting second abutting surface **44`** and first abutting surface **43`** of the insert, respectively.

As can be seen in front and rear views in Figs. 9 and 8A, respectively, for top surface **34**, first and second abutting surfaces **43** and **44** terminate, at their front portion, in respective central and peripheral front edge lines **46** and **47**, and, in their rear portion, in respective central and peripheral rear edge lines **48** and **49**. Similarly, for bottom surface **35**, first and second abutting surfaces **43`** and **44`** terminate, at their front portion, in respective central and peripheral front edge lines **46`** and **47`**, and, at their rear portion, in respective central and peripheral rear edge lines **48`** and **49`**. Central front edge lines **46** and **46`**are parallel to each other, as are peripheral front edge lines **47** and **47`**. Similarly, central rear edge lines **48** and **48`**are parallel to each other as are peripheral rear edge lines **49** and **49`**.

Figs. 10A and 10B are cross-sectional views of the cutting edge **40** taken along lines **A-A** and **B-B** in Fig. 10. Cutting edge **40** follows a spiral path about the axis B and rake angle β preferably remains substantially constant along the length of the cutting edge, so that $\beta_A \approx \beta_B$, where β_A and β_B are the rake angles measured at cross sections **A-A** and **B-B**, respectively.

In accordance with a first preferred embodiment of the present invention, and as will be described in greater detail below, the insert 3 is thicker at its rear abutting portion than at its front abutting portion. In accordance with a second preferred embodiment of the present invention, the insert 3 has the same thickness at its rear abutting portion as it does at its front abutting portion.

Therefore, in accordance with the first preferred embodiment the rear edge lines of the insert should be seen in Fig. 9. However, in practice, in a front view of the insert of the first preferred embodiment, respective central and peripheral rear edge lines **48** and **49** almost overlap with respective central and peripheral front edge lines **46** and **47**, respectively, and therefore cannot be seen. Similarly, respective central and peripheral rear edge lines **48`** and **49`** almost overlap with respective central and peripheral front edge lines **46`** and **47`**, respectively, and therefore cannot be seen. The non-overlapping of these edge lines, in a front view, for an insert of the first preferred embodiment, will be discussed in detail below with reference to Fig. 11.

Fig. 11 shows schematically, in exaggeration, the disposition of the respective central and peripheral front edge lines **46, 46`** and **47, 47`** with respect to the respective central and peripheral rear edge lines **48, 48`** and **49, 49`**, respectively. As can be seen, central front edge lines **46** and **46`** are parallel to central rear edge lines **48** and **48`**, and, peripheral front edge lines **47** and **47`** are parallel to peripheral rear edge lines **49** and **49`**. For the insert top surface **34**, central and peripheral front edge lines **46** and **47**, respectively, meet at a front intersection point **50**. Similarly, central and peripheral rear edge lines **48** and **49**, respectively, meet at a rear intersection point **51**. For the insert bottom surface **35**, central and peripheral front edge lines **46`** and **47`**, respectively, meet at a front intersection point **50`**. Similarly, central and peripheral rear edge lines **48`** and **49`**, respectively, meet at a rear intersection point **51`**. The diameter of a first circle **72** passing through the two front intersection points **50** and **50`** is denoted by **d1** and the diameter of a second circle **73** passing through the two rear intersection points **51** and **51`** is denoted by **d2**. By means of this construction insert top surface **34** and insert bottom surface

35 slope towards each other, from rear surface **33** towards front surface **32** so that the diameter **d2** at the rear abutting portion **57** of the insert is greater than the diameter **d1** at the front abutting portion **58** of the insert (see Fig. 10). Hence, in this respect insert **3** is thicker at its rear abutting portion than at its front abutting portion. As will be described below, this property of the insert provides positive axial locking of the insert in the tool. The first and second circles lie on a conical surface defining therein a central portion **74** of the insert.

As also described herein, for the insert top surface **34** first and second abutting surfaces **43** and **44**, respectively, slope towards each other and inwardly towards the intermediate surface **45** with which they merge. Similarly, for the insert bottom surface **35**, first and second abutting surfaces **43`** and **44`**, respectively, slope inwardly towards the intermediate surface **45`** with which they merge. This property can conveniently be phrased alternatively in the following manner: for the insert top surface **34** first and second abutting surfaces **43** and **44**, respectively, slope towards each other and inwardly towards the central portion **74** of the insert. Similarly, for the insert bottom surface **35**, first and second abutting surfaces **43`** and **44`**, respectively, slope towards each other and inwardly towards the central portion **74** of the insert. As will be described below, this property of the insert provides effective radial clamping of the insert in the tool.

Although intermediate surfaces **45** and **45`** can be located substantially on the vertical plane **V**, which passes through the axis of rotation of the insert, it is preferable that they be located on either side of the vertical plane when the insert is oriented horizontally as shown in Fig. 11. For a given distance between the intermediate surfaces, an insert having intermediate surfaces on either side of the vertical plane will be stronger than an insert having intermediate surfaces located substantially on the vertical plane. It is further preferable that the intermediate surfaces **45** and **45`** be located at equal distances from the vertical plane.

Reference will now be made to Figs. 12A-12D. As can be seen in Fig. 12A, a beam **52** of a length **L** is fixed perpendicularly to a rigid support **53**. A force **F** applied perpendicularly on the free end **54** of the beam deflects the beam by an increasing amount, starting from zero deflection at the fixed end **55** of the beam and terminating in maximum deflection Δ_{max} at the free end **54** of the beam. The beam deflection follows an elastic bending curve, which for small deflections is approximately a parabolic path **56**.

The deflection of clamping jaws **9** and **10** is analogous in general to the beam deflection described above. Figs. 12B and 12C illustrate the clamping of a flat insert **103** using one clamping screw only. The figures show a tool **102** in accordance with the present invention, similar in construction to the tool **2** shown in Fig. 2 but using one clamping screw only. The tool **102** has clamping jaws **109** and **110** and stress equalizing flexibilizing bore **119**. The insert **103** is similar to the insert **3** of the present invention but has the same thickness at its rear and front abutting portions in the sense described above. Fig. 12B shows the situation before clamping the insert **103**. The base **130** of the clamping jaws serves as a base of deflection. In order to slide an insert into the insert receiving slot **128**, a certain primary clearance Δ_0 should be provided between the insert abutting surfaces and the abutment surfaces of the clamping jaws. It should be appreciated that the primary clearance Δ_0 is shown greatly exaggerated for illustrative purposes. Fig. 12C shows the insert clamped in the tool. The screw **107** exerts a clamping force Fc on the clamping jaws **109** and **110** and hence presses them against the insert **103**. As can be seen, the insert is clamped just in a small area adjacent the screw whereas most of its abutting surface remains non-abutted.

In accordance with the present invention an insert having a shape that will fill the entire gap between the deflected clamping jaws is used, thereby providing maximum clamping contact area and hence greater stability and less stress concentration. The required insert is, as described above, thicker at its rear abutting portion than at its front abutting portion. Fig. 12D shows a schematic disposition of an insert **203** according to the present invention when clamped according to the above description. The insert **203** is similar in structure to insert **3**, however, it only has one through bore. The clamping jaws abut the insert along the whole length of the insert abutting surfaces.

Only one screw bore is used in Figs. 12B to 12D for illustrational purposes. However, in practice two screw bores are used (see, for example, Fig. 1). The longitudinal profile of the insert preferably follows the elastic bending curve of the clamping jaws of the tool. By way of this construction positive axial locking of the insert is obtained, ensuring no axial movement of the insert relative to the tool during machining. Positive axial locking refers to the situation wherein the axial component of the clamping force applied on the insert abutting surfaces along, at least, a portion thereof is directed towards the rear-abutting portion of the insert.

Fig. 13A shows an insert **3a**, similar to insert **3** described above, clamped between clamping jaws **9a** and **10a**. Abutment surfaces **43a** and **44a** of the top surface of the insert meet at an intermediate surface **45a** which, in this case, is a line. The bottom surface of the insert is of a similar construction. The intermediate surface is not, however, restricted to a line. Figs. 13B and 13C show two other possible forms for the intermediate surface. In Fig. 13B the intermediate surface **45b**, of insert **3b**, has a straight cross-section. The thickness of the insert is defined in a similar manner to the way that it is defined for insert **3** with reference to Fig. 11. However, since in the present case neither the abutment surfaces of the top surface of the insert, nor the abutment surfaces of the bottom surface thereof meet at a line, a generalized definition for the thickness of the insert has to be used. The following generalization of the definition of the thickness of an insert, based on the definition given for insert **3**, is used. For the top surface of the insert, imaginary planes are drawn through, and parallel to, the abutment surfaces **43b** and **44b**. The intersection of the imaginary planes defines an imaginary line analogous to line **45** in Fig. 11. In a similar manner an imaginary line of intersection for the abutment surfaces of the bottom surface of the insert is constructed. The thickness of the insert at any point along the axis of the insert is given by the diameter of a circle tangent to the two imaginary lines, with the plane of the circle being perpendicular to the axis of the insert and including the point along the axis at which the thickness is being determined. The diameter of the circle is not greater than the distance between the two imaginary lines at the point along the axis at which the thickness is being determined. Since the actual thickness of the insert at a given point along the axis varies across the cross section of the insert taken at that given point, it will be appreciated that the definition used herein serves the sole purpose of conveying the fact that the rear of the insert is in some sense thicker than the front of the insert, as illustrated by insert **203** in Fig. 12D.

Fig. 13C shows yet another form of intermediate surface. Insert **3c** has an intermediate surface **45c** which has a curved cross-section. The thickness of the insert in this case is defined in a similar manner to the definition given above with reference to insert **3b**.

As shown in Figs. 7 and 9, the construction of the insert according to the invention, and, in particular, the relative disposition of first abutting surfaces **43** and **43`** and second abutting surfaces **44** and **44`**, is such that the side surfaces **36** and **37** are relatively thick thereby enabling the construction of the long peripheral spiral cutting edges **40** and **40`**. Hence, such an insert is suitable, *inter alia*, for end milling finishing operations.

Although the present invention has been described to a certain degree of particularity, it should be understood that various alterations and modifications can be made without departing from the spirit or scope of the invention as hereinafter claimed. In particular, as shown in Figs. 14A to 14C, the insert may have only one cutting edge **40**. This is particularly useful if the cutting edge has a complex contour, in which case it may be difficult to reproduce the same contour precisely on two cutting edges. In this case top surface **34** of the insert will not be identical to bottom surface **35**. As shown, top surface **34** merges with side surface **36** at cutting edge **40**, whereas bottom surface **35** merges with side surface **37** along edge **40``** that does not constitute a cutting edge. It should be noted that the edge **40``** does not necessarily have to be a line and can be a region of any convenient cross section connecting bottom surface **35** with side surface **37**.

In general, the front surface **32** of the insert of the invention is not restricted to the shape shown in the figures, but can be of any required shape and can include a cutting edge.

Any of the above mentioned modifications are acceptable provided that the general shape and orientation of abutting surfaces **43**, **43`**, **44** and **44`** are of the form described and illustrated. This being the case, there will be positive axial locking of the insert in the tool and effective radial clamping in a double dove-tail manner.

Attention is now drawn to Figs. 15 to 17, showing an arrangement between a clamping screw and a through bore of the insert, whereby the screw causes positive axial locking of the insert. Fig. 15 shows an insert **3** having an axis of rotation **B** that is mounted into an insert receiving slot **28** of a tool **2** having an axis of rotation **A**. When the insert **3** is mounted in the tool **2** its axis of rotation **B** coincides with the axis of rotation **A** of the tool **2**. The insert receiving slot **28** has respective first and second rear abutment surfaces **14** and **15**, intermediate slot **18** and stress equalizing flexibilizing bore **19**. The insert **3** has a through bore **39** and a rear surface **33**. A clamping screw **307** has an axis **E**, a screw head tapered portion **325**, screw conical portion **326** and screw threaded portion **327**. The tool **2** has clamping jaws **9** and **10**. A screw bore **322** in the clamping jaw **9** has a tapered portion **331** and is aligned with a threaded screw bore **323** in the clamping jaw **10**.

The screw conical portion **326** is slanted at an angle δ of about 2.5° with respect to the axis **E**. The axis **E** is slanted at the same angle δ with respect to a radial direction **P** perpendicular to the axis **A**. The screw conical portion **326** has a forwardly facing portion **326A** and a rearwardly facing portion **326B**. The term rearwardly refers to a direction from the open side of the insert receiving slot **28** towards the rear abutment surfaces **14** and **15**. The rearwardly facing portion **326B** is perpendicular to the axis **A** and parallel to the through bore **39** of the insert **3**.

The tightening of the screw **307** is described as a three stage process. In the first stage, as shown in Fig. 15, the screw threaded portion **327** is engaged into the threaded screw bore **323**. At this stage, the rearwardly facing portion **326B** touches the rear side of the through bore **39**, and the rear surface **33** of the insert **3** is not yet in abutment with the rear abutment surfaces **14** and **15** of the insert receiving slot **28**. In the second stage, as shown in Fig. 16, the screw **307** is further tightened. Due to the angle δ by which the screw **307** is slanted with respect to the radial direction **P**, the rearwardly facing portion **326B** pushes the insert **3** rearwardly till the rear surface **33** of the insert firmly abuts against the rear abutment surfaces **14** and **15**. In the third stage, as shown in Fig. 17, the screw **307** is further tightened till the screw head tapered portion **325** firmly abuts against the tapered portion **331** of the screw bore **322**. In this position, the clamping jaws **9** and **10** approach each other thus abutting the insert **3** along its length.

By way of the above description the insert **3** is positively axially locked by the screw. It should be understood that if applied to the cutting tool shown in Fig. 2, the positive axial locking can be similarly applied with either screw 7 or screw **8**.

CLAIMS:

1. A cutting tool assembly (1) rotatable about an axis of rotation A comprising a tool (2) and a replaceable insert (3) mountable therein, said tool comprises two substantially equal clamping jaws (9, 10) spaced apart by an insert receiving slot (28), each of said clamping jaws is provided with at least one screw bore (20, 21, 22, 23) and comprises a peripheral surface (11), peripheral abutment surface (12) and central abutment surface (13), said peripheral abutment surface and said central abutment surface being substantially parallel to said axis of rotation;

said insert is of a generally prismatic shape having an axis of rotation B and comprising a central portion (74), a front surface (32), a rear surface (33), top and bottom surfaces (34, 35) having at least one through bore (38, 39) aligned with said at least one screw bore, and side surfaces (36, 37) on opposite sides of said axis of rotation, said side surfaces merging with said top and bottom surfaces at edges (40, 40`), at least one of said edges being a cutting edge,

each of said top and bottom surfaces comprising first and second abutting surfaces (43, 43`, 44, 44`), each of said first and second abutting surfaces terminating in a front abutting portion (58) having, respectively, central (46, 46`) and peripheral (47, 47`) front edge lines, and in a rear abutting portion (57) having, respectively, central (48, 48`) and peripheral (49, 49`) rear edge lines, said peripheral front edge lines being parallel to said peripheral rear edge lines, and said central front edge lines being parallel to said central rear edge lines,

said first and second abutting surfaces (43, 44) of said top surface (34) slope towards each other and inwardly towards the central portion (74) of said insert and said first and second abutting surfaces (43`, 44`) of said bottom surface (35) slope towards each other and inwardly towards the central portion (74) of said insert.

2. An insert (3) according to claim 1, wherein said insert is thicker at its rear abutting portion than at its front abutting portion

3. A cutting tool assembly (1) according to claim 2, wherein said first and second abutting surfaces follow an elastic bending curve of said clamping jaws.

4. A cutting tool assembly (1) according to either of claims 1 or 2, wherein said first and second abutting surfaces are flat.

5. A cutting tool assembly (1) according to either of claims 1 or 2, wherein said cutting edge follows a spiral path about the axis of rotation B.

6. A cutting tool assembly (1) according to either of claims 1 or 2, wherein said insert has two through bores (38, 39).

7. A cutting tool assembly (1) according to either of claims 1 or 2, wherein said first and second abutting surfaces of said top surface are connected by a first intermediate surface (45) and wherein said first and second abutting surfaces of said bottom surface are connected by a second intermediate surface (45`).

8. A cutting tool assembly (1) according to claim 7, wherein said first and second intermediate surfaces are located on either side of a vertical plane V passing through the axis of rotation of the insert when the insert is oriented horizontally.

9. A cutting tool assembly (1) according to claim 8, wherein said first and second intermediate surfaces are located at equal distances from said vertical plane.

10. A cutting tool assembly (1) according to claim 7, wherein said first and second intermediate surfaces are lines.

11. A cutting tool assembly (1) according to claim 7, wherein said first and second intermediate surfaces have straight cross-sections in a plane perpendicular to the axis of rotation B.

12. A cutting tool assembly (1) according to claim 7, wherein said first and second intermediate surfaces have curved cross-sections in a plane perpendicular to the axis of rotation B.

13. A cutting tool assembly (1) according to either of claims 1 or 2, wherein said peripheral and central abutment surfaces form between them an angle α.

14. A cutting tool assembly (1) according to claim 13, wherein said first and second abutting surfaces of said insert top surface form between them an angle α`

and wherein said first and second abutting surfaces of said insert bottom surface form between them an angle α`.

15. A cutting tool assembly (1) according to claim 14, wherein said angle α` is preferably smaller than said angle α.

16. A cutting tool assembly (1) according to either of claims 1 or 2, wherein said insert receiving slot terminates in an intermediate slot (18).

17. A cutting tool assembly (1) according to claim 16, wherein said intermediate slot terminates in a stress equalizing flexibilizing bore (19).

18. An insert (3) for clamping in a clamping tool between clamping jaws, said insert being of a generally prismatic shape having an axis of rotation B and comprising a central portion (74), a front surface (32), a rear surface (33), top and bottom surfaces (34, 35) and side surfaces (36, 37) on opposite sides of said axis of rotation, said side surfaces merging with said top and bottom surfaces at edges (40, 40`), at least one of said edges being a cutting edge,

each of said top and bottom surfaces comprising first and second abutting surfaces (43, 43`, 44, 44`), each of said first and second abutting surfaces terminating in a front abutting portion (58) having, respectively, central (46, 46`) and peripheral (47, 47`) front edge lines and in a rear abutting portion (57) having, respectively, central (48, 48`) and peripheral (49, 49`) rear edge lines,

said first and second abutting surfaces of said top surface slope towards each other and inwardly towards said central portion of said insert and wherein said first and second abutting surfaces of said bottom surface slope towards each other and inwardly towards said central portion of said insert.

19. An insert (3) according to claim 18, wherein said insert being thicker at its rear abutting portion than at its front abutting portion.

20. An insert (3) according to claim 18, wherein said peripheral front edge lines are parallel to said peripheral rear edge lines, and said central front edge lines are parallel to said central rear edge lines.

21. An insert (3) according to claim 19, wherein said first and second abutting surfaces follow an elastic bending curve of said clamping jaws.

22. An insert (3) according to either of claims 18 or 19, wherein said first and second abutting surfaces are flat.

23. An insert (3) according to either of claims 18 or 19, wherein said at least one cutting edge follows a spiral path about the axis of rotation B.

24. An insert (3) according to either of claims 18 or 19, wherein said first and second abutting surfaces of said top surface are connected by a first intermediate surface (45) and wherein said first and second abutting surfaces of said bottom surface are connected by a second intermediate surface (45`).

25. An insert (3) according to claim 24, wherein said first and second intermediate surfaces are located on either side of a vertical plane V passing through the axis of rotation of the insert when the insert is oriented horizontally.

26. An insert (3) according to claim 25, wherein said first and second intermediate surfaces are located at equal distances from said vertical plane.

27. An insert (3) according to claim 24, wherein said first and second intermediate surfaces are lines.

28. An insert (3) according to claim 24, wherein said first and second intermediate surfaces have straight cross-sections in a plane perpendicular to the axis of rotation B.

29. An insert (3) according to claim 24, wherein said first and second intermediate surfaces have curved cross-sections in a plane perpendicular to the axis of rotation B.

30. An insert (3) according to either of claims 18 or 19, wherein said insert is further provided with at least one through bore (38, 39).

31. An insert (3) according to claim 30, wherein said at least one through bore is provided in said top and bottom surfaces.

32. A tool (2) rotatable about an axis of rotation A comprising two substantially equal parallel clamping jaws (9, 10) spaced apart by an insert receiving slot (28), each of said clamping jaws is provided with at least one screw bore (20, 21, 22, 23) and comprises a peripheral surface (11), peripheral abutment surface (12) and central abutment surface (13), said peripheral abutment surface and said central abutment surface being substantially parallel to said axis of rotation.

33. A tool (2) according to claim 32, wherein said peripheral and central abutment surfaces form between them an angle α.

34. A tool (2) according to claim 32, wherein said insert receiving slot terminates in an intermediate slot (18).

35. A tool (2) according to claim 34, wherein said intermediate slot terminates in a stress equalizing flexibilizing bore (19).

36. A cutting tool assembly (1) rotatable about an axis of rotation A comprising a tool (2), a replaceable insert (3) mountable therein and at least one clamping screw (307), said tool comprises two substantially equal clamping jaws (9, 10) spaced apart by an insert receiving slot (28) having at least one rear abutment surface (14, 15), each of said clamping jaws is provided with at least one screw bore (20, 21, 22, 23) slanted at an angle δ with respect to a line (P) perpendicular to the axis of rotation of the cutting tool assembly and having at least one screw bore tapered portion (331), each of said clamping jaws comprises a peripheral surface (11), peripheral abutment surface (12) and central abutment surface (13), said peripheral abutment surface and said central abutment surface being substantially parallel to said axis of rotation;

said insert is of a generally prismatic shape having an axis of rotation B and comprising a central portion (74), a front surface (32), a rear surface (33), top and bottom surfaces (34, 35) having at least one through bore (38, 39) substantially aligned with said at least one screw bore, and side surfaces (36, 37) on opposite sides of said axis of rotation, said side surfaces merging with said top and bottom surfaces at edges (40, 40`), at least one of said edges being a cutting edge,

each of said top and bottom surfaces comprising first and second abutting surfaces (43, 43`, 44, 44`), each of said first and second abutting surfaces terminating in a front abutting portion (58) having, respectively, central (46, 46`) and peripheral (47, 47`) front edge lines, and in a rear abutting portion (57) having, respectively, central (48, 48`) and peripheral (49, 49`) rear edge lines, said peripheral front edge lines being parallel to said peripheral rear edge lines, and said central front edge lines being parallel to said central rear edge lines,

said first and second abutting surfaces of said top surface slope towards each other and inwardly towards the central portion of said insert and said first and second abutting surfaces of said bottom surface slope towards each other and inwardly towards the central portion of said insert.

said clamping screw (307) has an axis E, a screw head tapered portion (325), a screw cylindrical portion (326) slanted at an angle δ with respect to the axis E and a screw threaded portion (327),

in an assembled position the insert rear abutment surface (33) abuts the at least one rear abutment surface (14, 15), the screw cylindrical portion (326) abuts the at least one insert through bore (38, 39), the screw head tapered portion (325) abuts the screw bore tapered portion (331) and the peripheral abutment surfaces (12) and central abutment surfaces (13) of the clamping jaws (9, 10) abut the first and second abutting surfaces (43, 43`, 44, 44`) of the insert.

37. A cutting tool assembly (1) according to claim 36, wherein said insert is thicker at its rear abutting portion than at its front abutting portion.

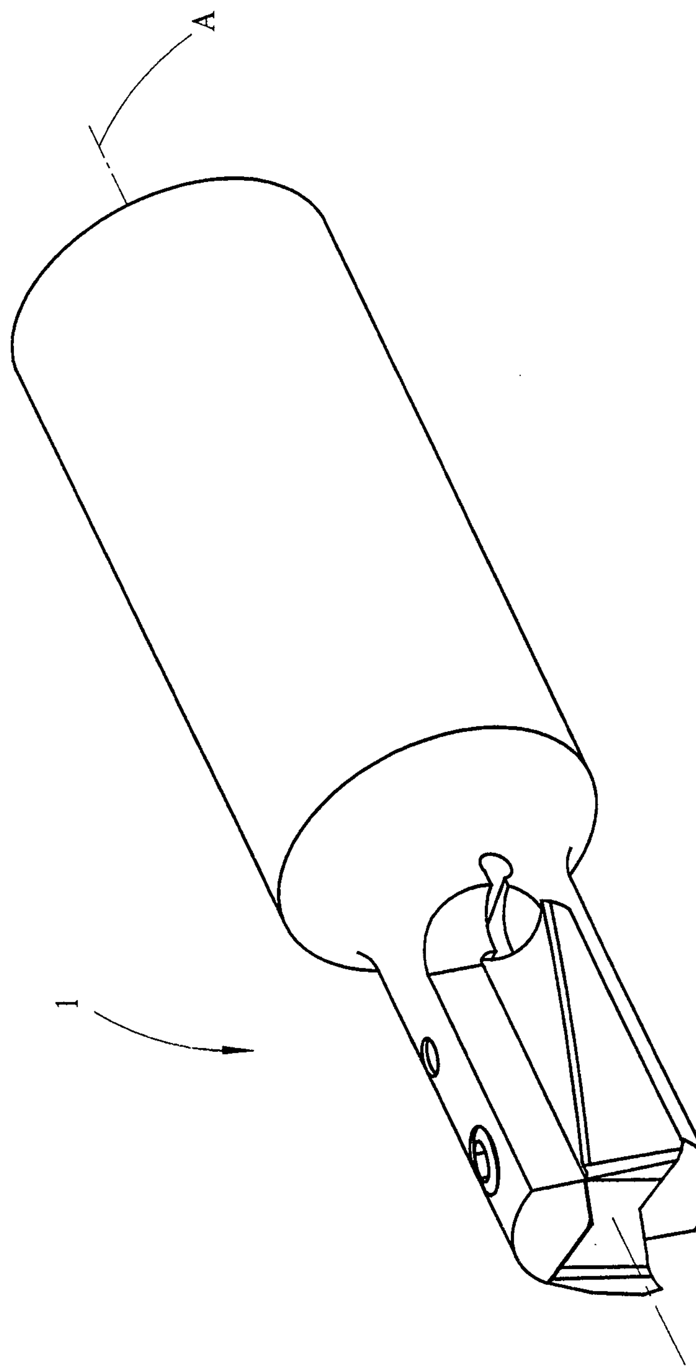

Fig. 1

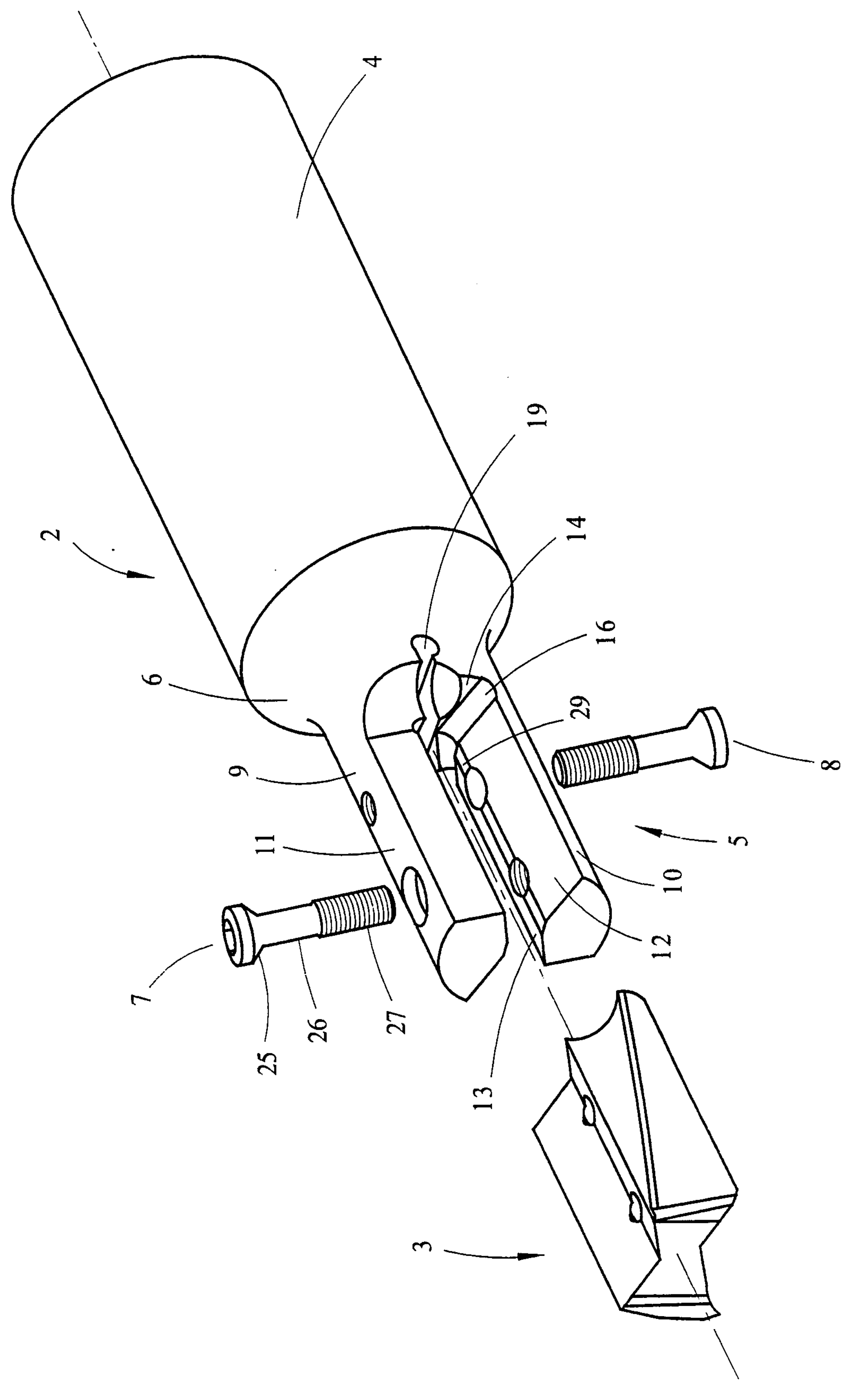

Fig. 2

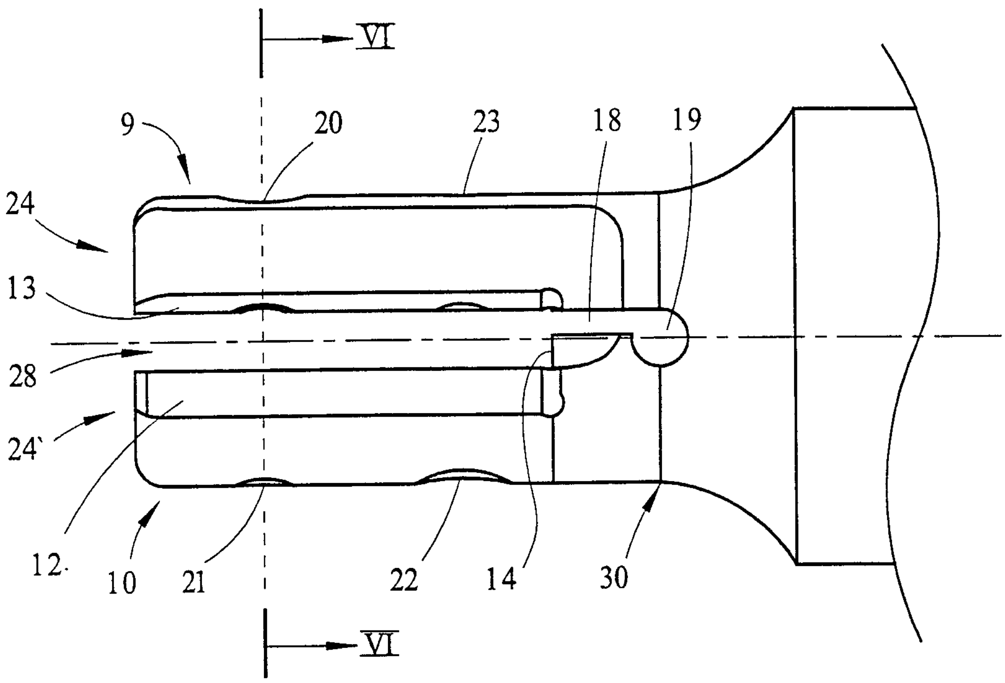

Fig. 3

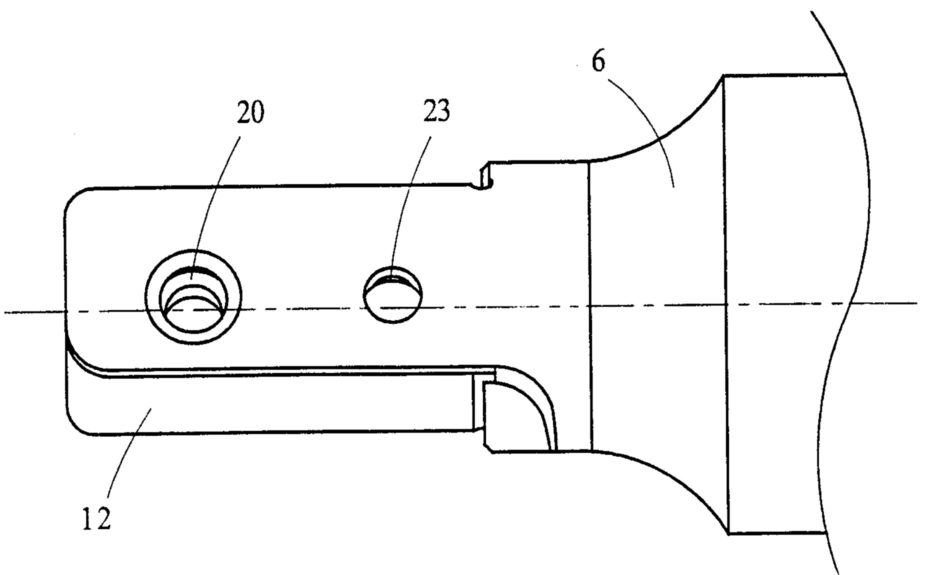

Fig. 4

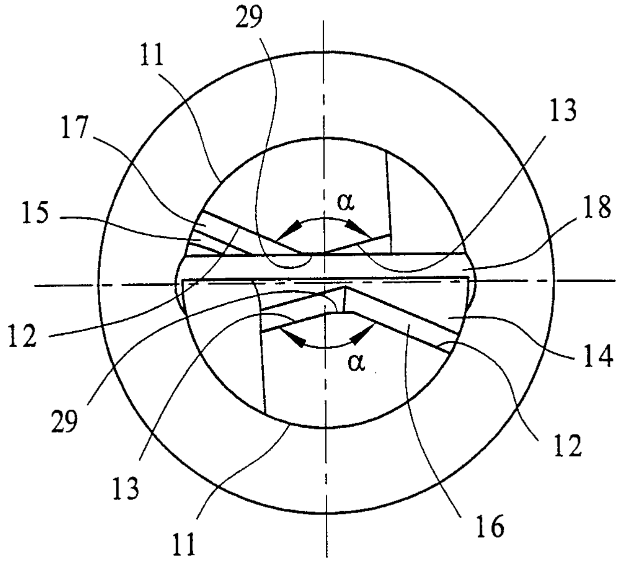

Fig. 5

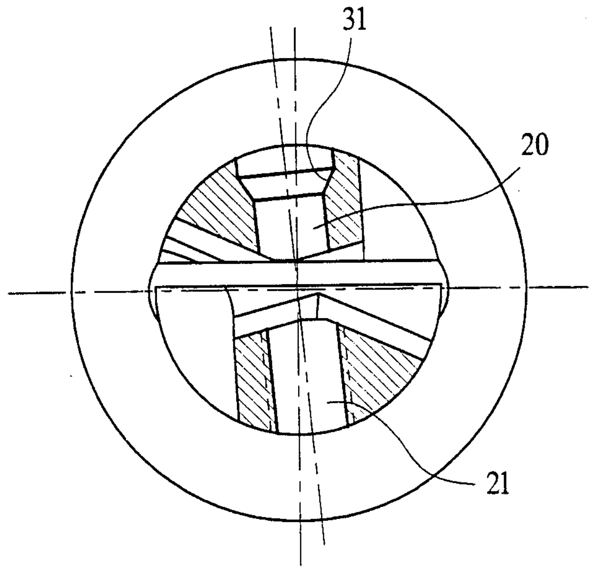

Fig. 6

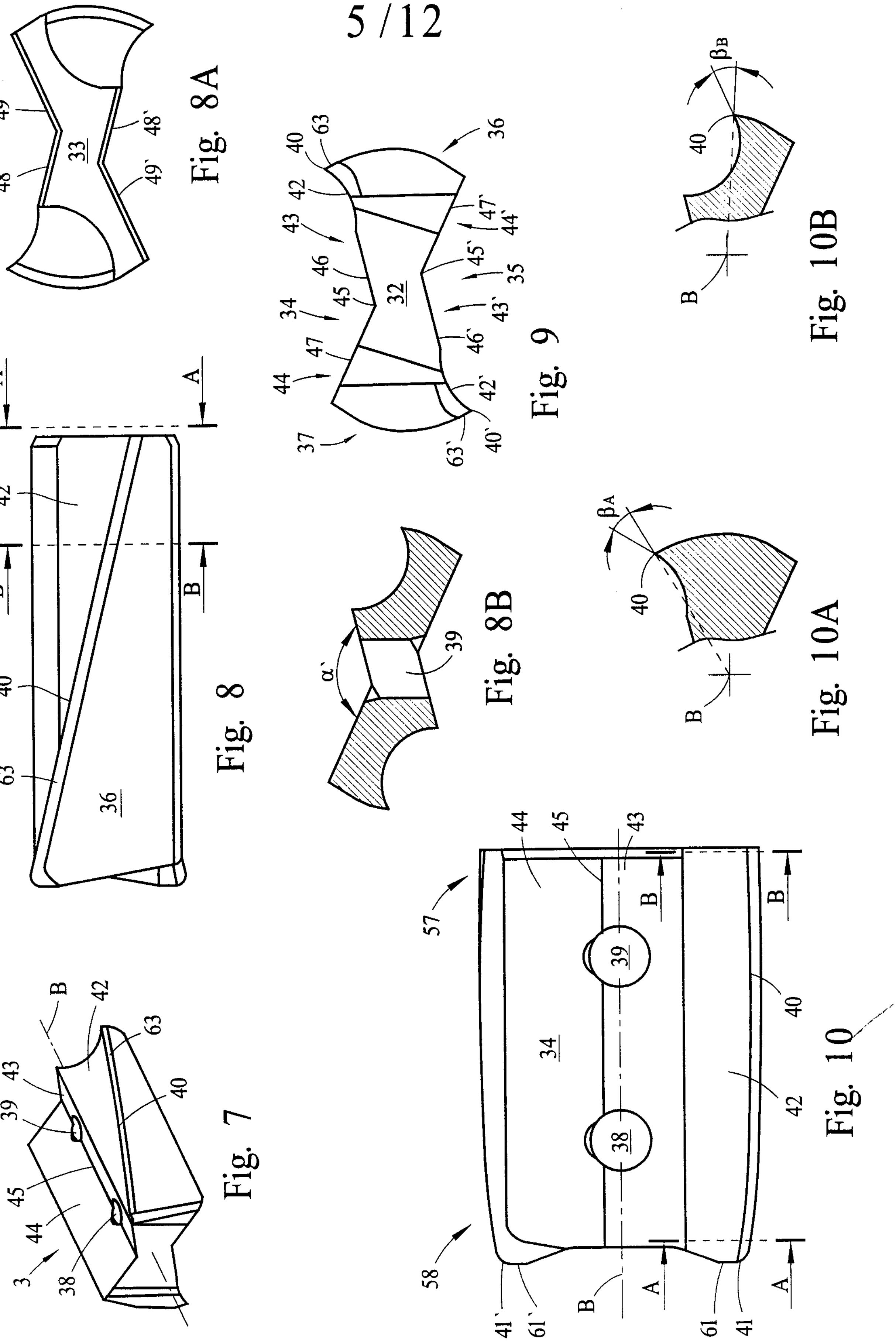

Fig. 8A Fig. 9 Fig. 10B Fig. 8 Fig. 8B Fig. 10A Fig. 7 Fig. 10

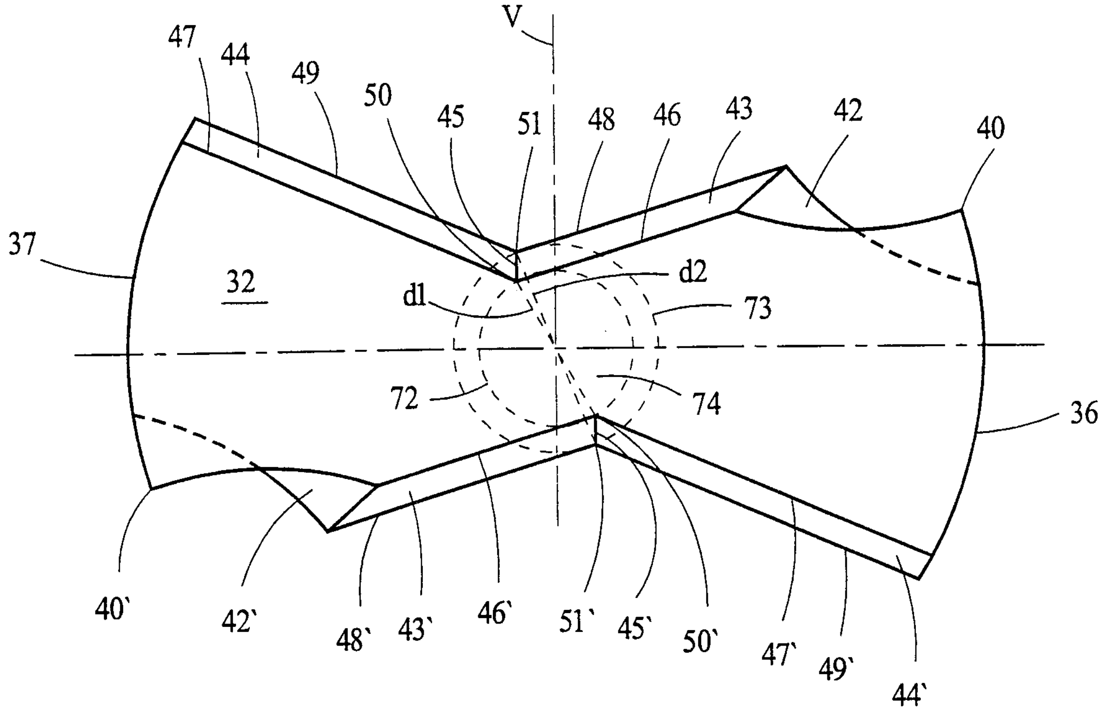

Fig. 11

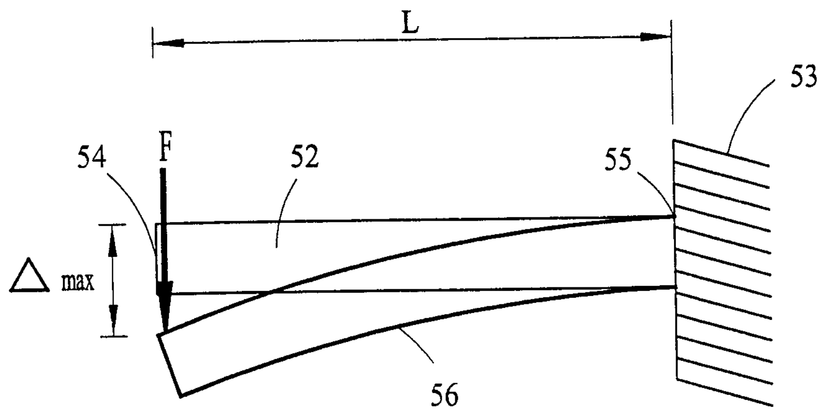

Fig. 12A

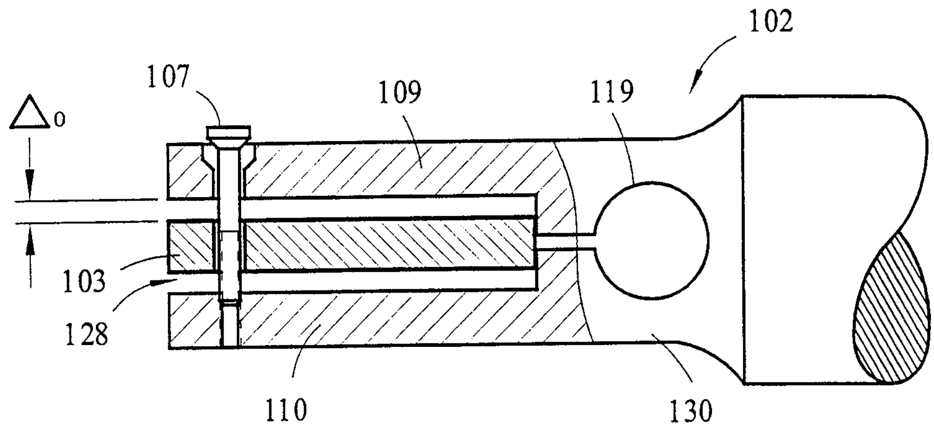

Fig. 12B

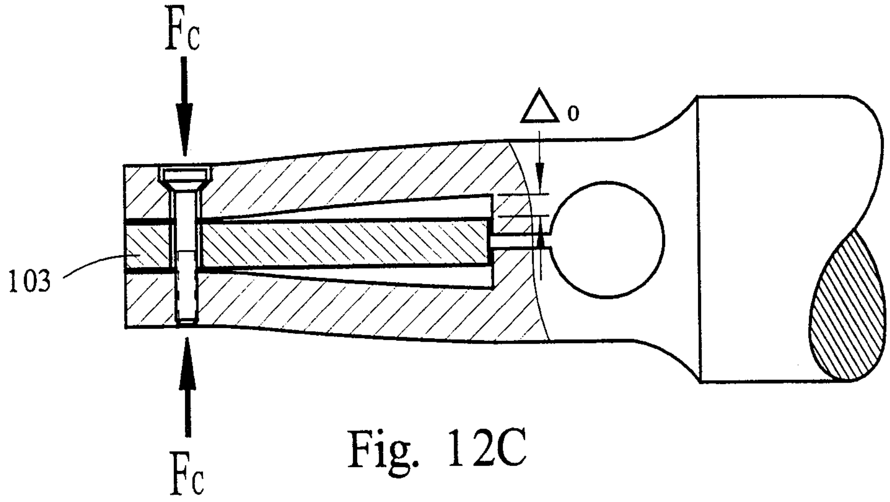

Fig. 12C

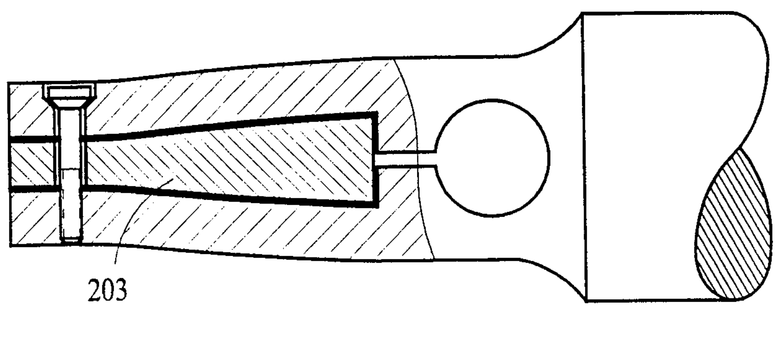

Fig. 12D

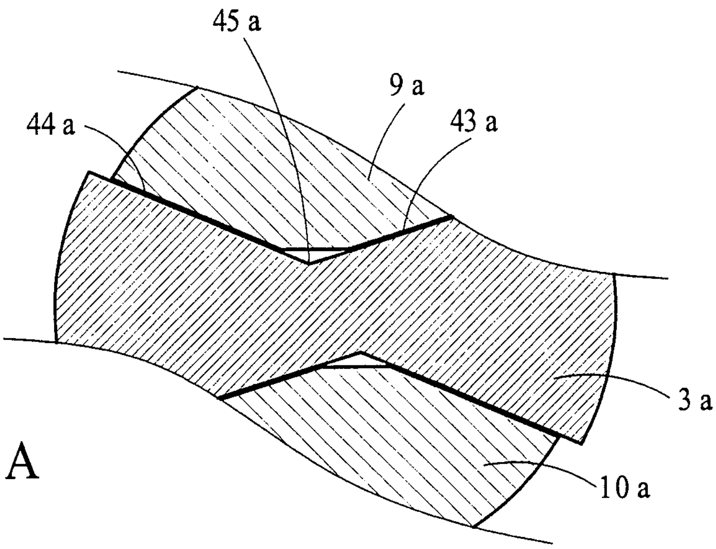

Fig. 13A

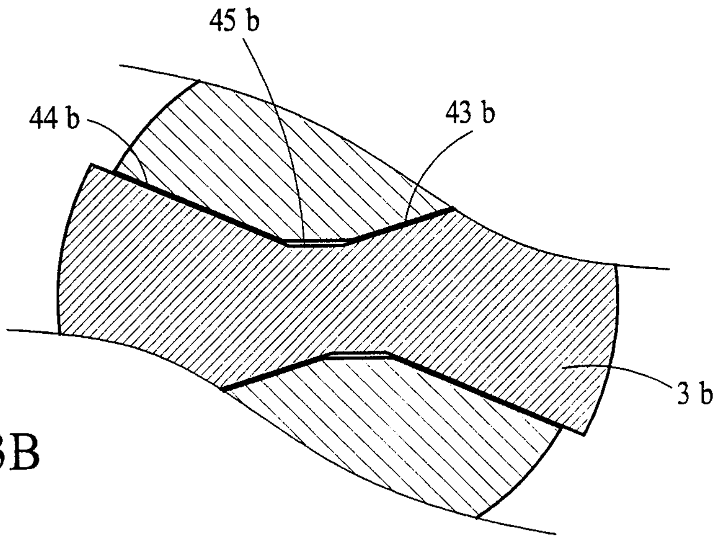

Fig. 13B

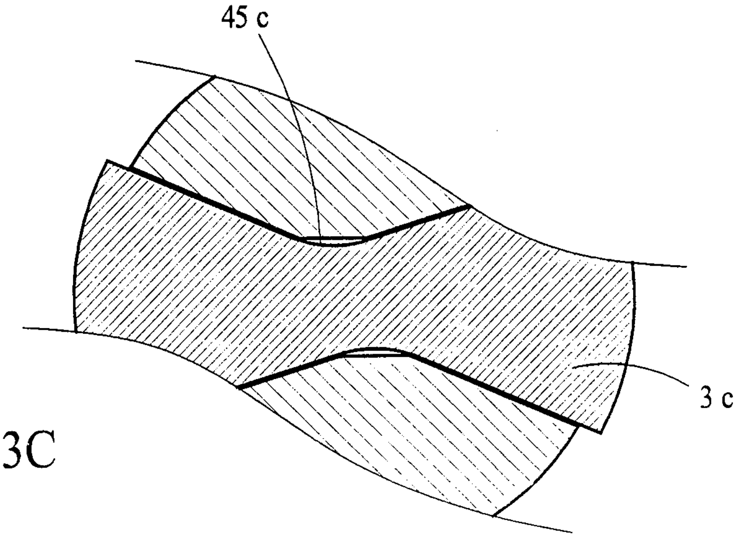

Fig. 13C

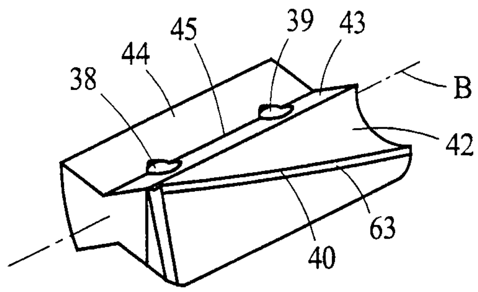

Fig. 14A

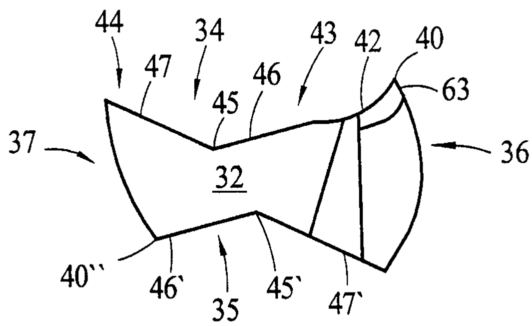

Fig. 14B

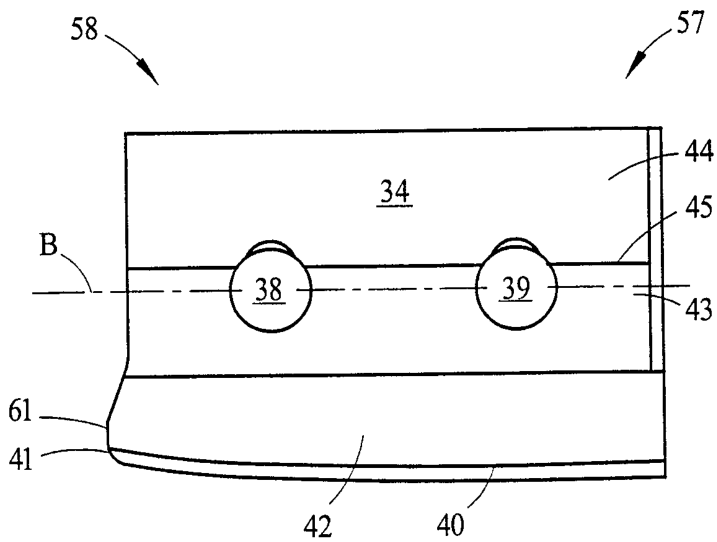

Fig. 14C

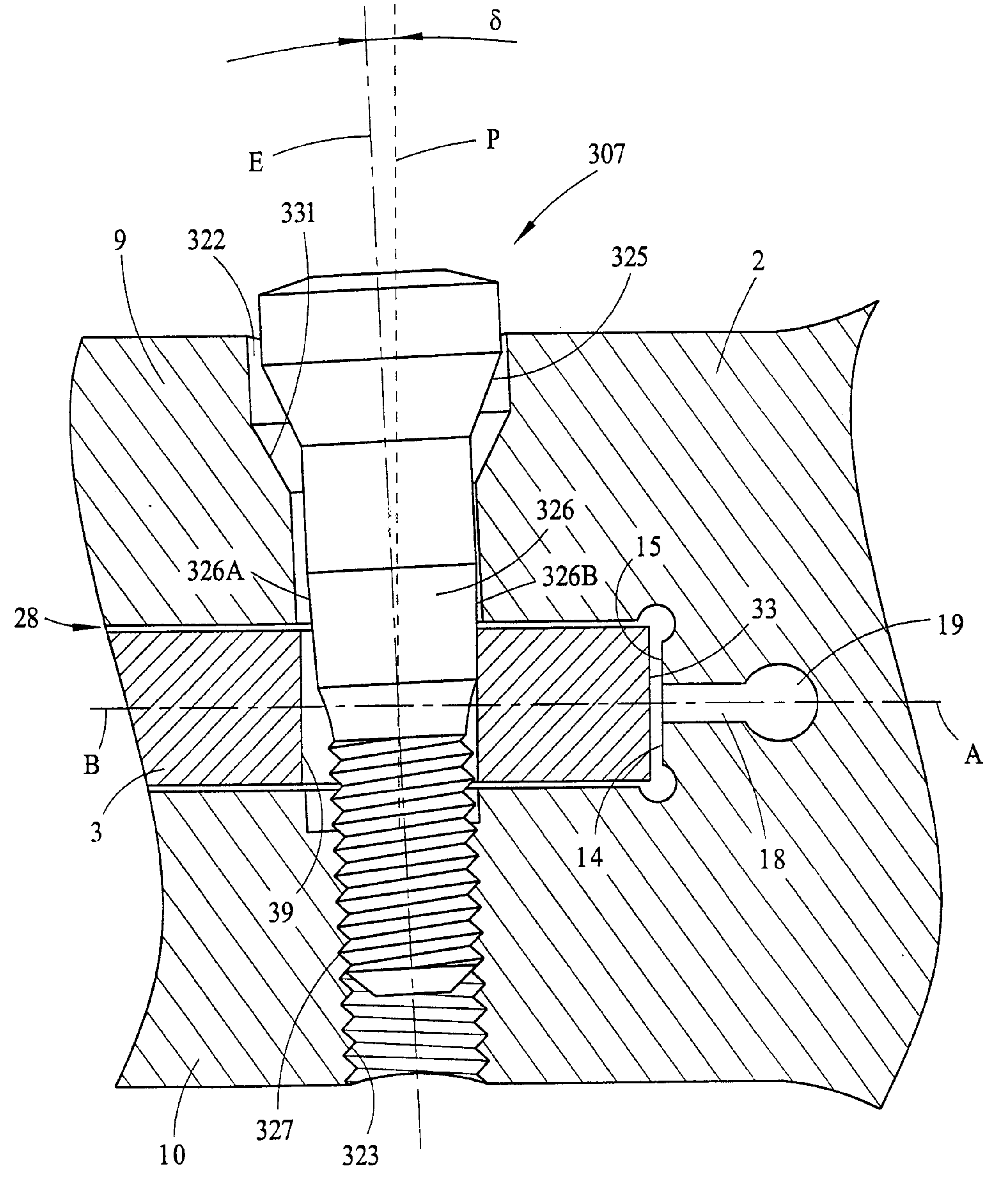
δ
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Fig. 15

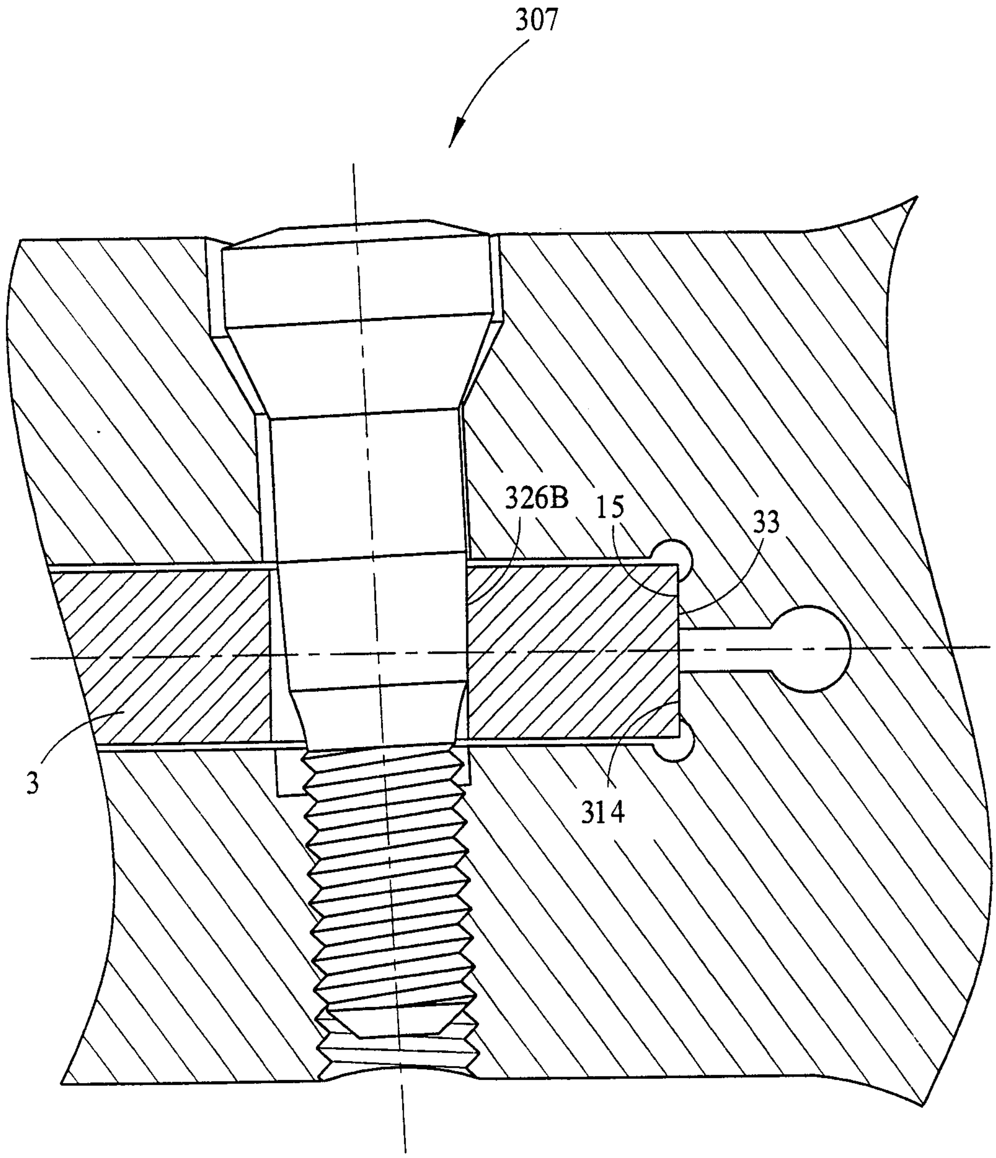

Fig. 16

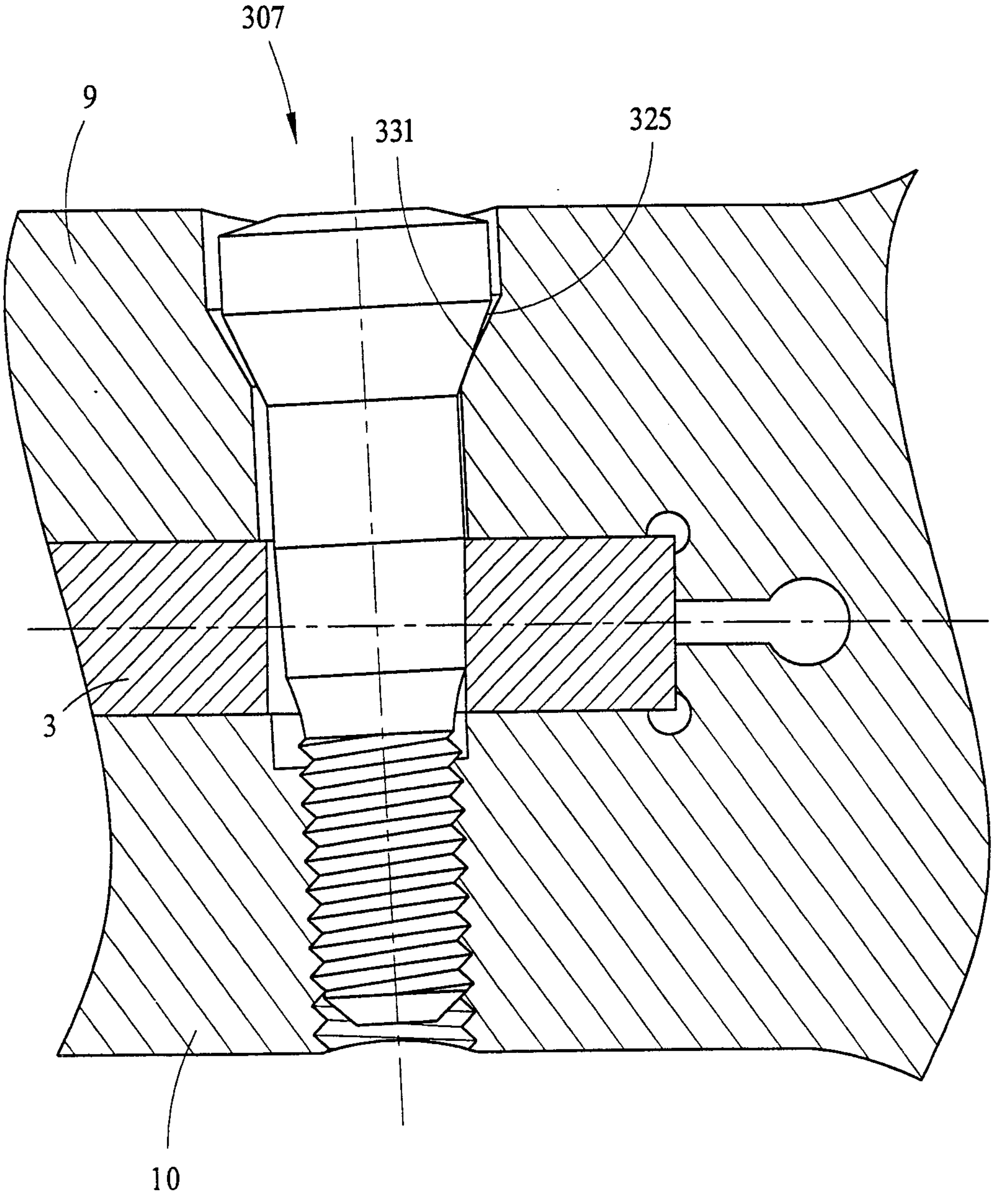

Fig. 17

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IL 99/00207

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B23C5/10 B23B51/00

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 6 B23C B23B

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)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	DE 35 29 620 A (KIENINGER) 19 February 1987 see column 4, line 5 - line 25; figures 5-8	1,18,32, 36
A	DE 32 04 210 A (STELLRAM) 18 August 1983	
A	GB 172 820 A (VAN DE RAADZT) 12 January 1922	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 June 1999	05/07/1999

Name and mailing address of the ISA	Authorized officer
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	Bogaert, F

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/IL 99/00207

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 3529620 A	19-02-1987	EP 0216064 A	01-04-1987
DE 3204210 A	18-08-1983	US 4493596 A	15-01-1985
GB 172820 A		NONE	