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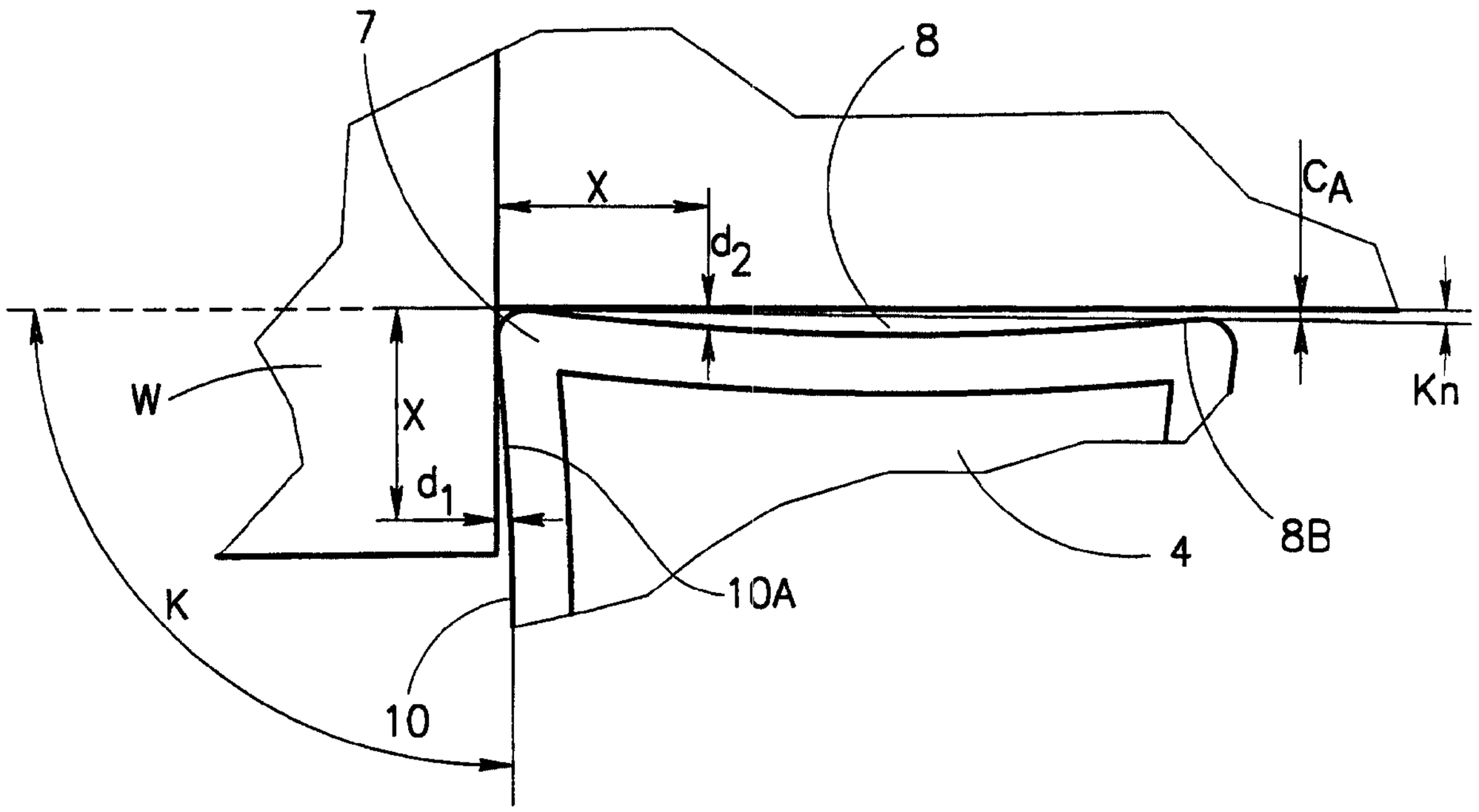

(57) Abrégé/Abstract:
A cutting tool assembly (1, 1') for turning a stepped square shoulder on a workpiece of a limited maximum depth of cut, the cutting tool assembly (1, 1') including a toolholder for replaceably receiving a substantially square cutting insert (13) with concave side edges (13) and acute insert cutting corners (17).

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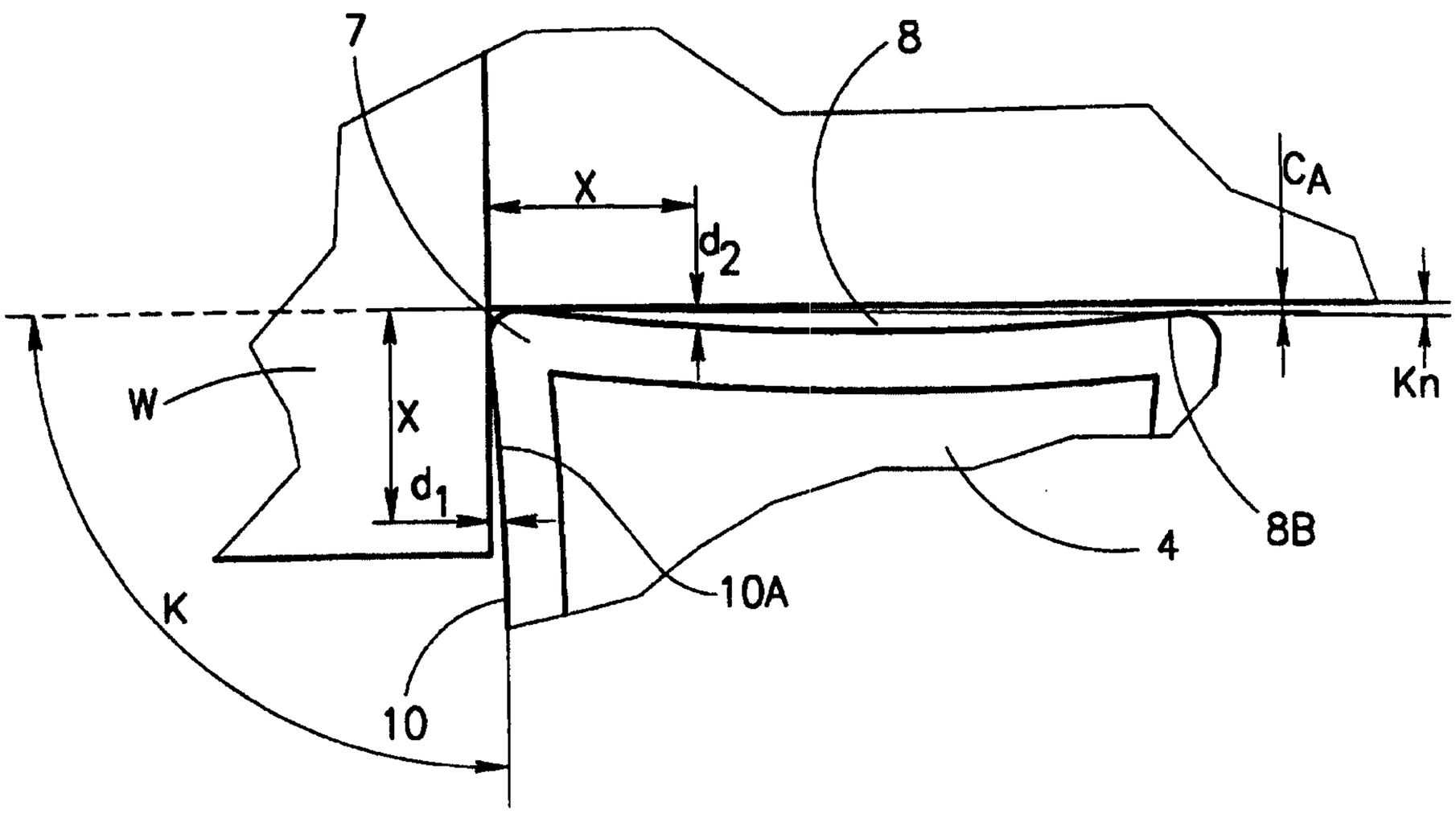


(57) Abstract

A cutting tool assembly (1, 1') for turning a stepped square shoulder on a workpiece of a limited maximum depth of cut, the cutting tool assembly (1, 1') including a toolholder for replaceably receiving a substantially square cutting insert (13) with concave side edges (13) and acute insert cutting corners (17).

CUTTING TOOL ASSEMBLY AND CUTTING INSERT THEREFOR

FIELD OF THE INVENTION

The invention is in the field of cutting tool assemblies for turning operations. In particular, the invention relates to cutting tool assemblies and cutting inserts therefor for turning stepped square shoulders.

BACKGROUND OF THE INVENTION

For turning a stepped square shoulder on a workpiece, a cutting tool assembly requires a cutting insert with an acute operative insert cutting corner, a tool back clearance angle κ_n along its inoperative cutting edge and an obtuse entering angle κ along its operative cutting edge. Such an entering angle enables an outwardly directed feed out movement to square out a shoulder, in particular, an outwardly directed radial feed out movement in the case of external longitudinal turning operations and an outwardly directed axial feed out movement in the case of external radial turning operations.

In view of these restrictions, cutting inserts for turning stepped square shoulders are either rhomboidal or triangular, thereby having respectively two or three indexable insert cutting corners when single-sided. Such cutting inserts are, for example, as illustrated and described in EP 0 162 029 A2, each insert cutting corner being formed as a protruding nose portion at the juncture between centrally depressed insert sides. The cutting inserts are preferably double sided so as to be respectively formed with four or six indexable insert cutting corners.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a cutting tool assembly for turning stepped square shoulders, the cutting tool assembly being adapted for use with a cutting insert formed with more indexable insert cutting corners.

In accordance with a broad aspect of the present invention, there is provided a cutting tool assembly for turning a stepped square shoulder on a workpiece, the cutting tool assembly comprising a toolholder for replaceably receiving a cutting insert presenting an acute insert cutting corner at the juncture of substantially concave operative and inoperative cutting edges,

characterized in that

said cutting insert is substantially square shaped and is so disposed in a top view of the cutting tool assembly that a clearance between said operative cutting edge and a first surface of the stepped square shoulder is less than a clearance between said inoperative cutting edge and a second surface of the stepped square shoulder at equal distances along said cutting edges whereby the location along the operative cutting edge whereat there is a minimal clearance from said first surface limits the maximal depth of cut of the cutting tool assembly to less than the length of the cutting insert's side.

The present invention is based on the realization that a fully indexable substantially square cutting insert with concave side edges can be employed for turning a stepped square shoulder on a workpiece in such cases where a maximum desired depth of cut in a direction substantially transverse to an initial feed direction of the cutting tool assembly is less than the length of the cutting insert's side.

In accordance with a further aspect of the present invention, there is provided a cutting insert comprising a substantially square upper surface, a lower surface and side surfaces intersecting with said upper surface at four substantially concave side edges each having a central portion between adjacent lateral portions, each pair of adjacent lateral portions meeting at an acute insert cutting corner,

characterized in that each of said central portions is substantially straight and the angle of each of said acute insert cutting corners is in the range of about 83° ±5°.

A cutting insert according to the pre-characterizing portion of Claim 4 has been illustrated and described with reference to Figure 3 of US Patent 5,503,509, however, for drilling applications which require that the entire length of a cutting edge be operative. As shown, the side edges of the cutting insert do not have substantially straight central portions and, moreover, the angle of each of its acute insert cutting corners denoted "c" is in the region of 70°.

The cutting insert of the present invention is characterized by virtue of each of its side edges having a substantially straight central portion and the angle of each of its acute insert cutting corners being in the region of 83° ±5°. This construction ensures that, on the one hand, the strength of the cutting insert is maximized both at its insert cutting corners and at its weakest portion where its cross section area is minimal, namely, at its throughgoing bore and, on the other hand, the angle of an operative insert cutting corner remains acute when the cutting insert is suitably mounted in a toolholder.

The cutting insert is preferably double sided, thereby being formed with a total of eight indexable insert cutting corners. The cutting insert can be of either a negative or a double positive relief flank geometry. Alternatively, the cutting insert can be single sided and of a positive relief flank geometry.

BRIEF DESCRIPTION OF THE DRAWINGS

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

Fig. 1 is a plan view of a cutting tool assembly for external longitudinal turning of a stepped square shoulder on a workpiece in accordance with a first embodiment of the present invention;

Fig. 2 is a close-up view of the operative insert cutting corner of the cutting tool assembly of Figure 1;

Figs. 3 and **4** are respectively side and end views of the cutting tool assembly of Figure 1;

Fig. 5 is a plan view of a cutting tool assembly for external face turning of a stepped square shoulder on a workpiece in accordance with a second embodiment of the present invention;

Fig. 6 is a close-up view of the operative insert cutting corner of the cutting tool assembly of Figure 5;

Fig. 7 is a plan view of a cutting insert for use in the cutting tool assemblies of Figures 1 and 5; and

Figs. 8-10 are various possible cross sections of the cutting insert of Figure 7 along line E-E.

DETAILED DESCRIPTION OF THE DRAWINGS

Turning now to Figures 1-4, a cutting tool assembly 1 is adapted for external longitudinal turning of a stepped square shoulder S on a workpiece W rotatable about an axis of rotation A up to a limited radial depth of cut as described hereinbelow.

The cutting tool assembly 1 includes a double negative rake toolholder 2 having an insert receiving pocket 3 at its leading end for replaceably receiving a double sided cutting insert 4 secured via a clamping device 5 (not shown), the cutting insert 4 being of the type shown in Figures 7-9.

The cutting tool assembly 1 presents an acute operative insert cutting corner 7 to the workpiece W, the operative insert cutting corner 7 being at the juncture of an inoperative concave cutting edge 8 and an operative concave cutting edge 10, the cutting edge 10 having a lateral portion 10A adjacent the operative insert cutting corner 7.

As shown in Figure 2, the cutting insert 4 is so disposed that a clearance d_1 between the cutting edge 10 and the shoulder's end face is less

than a clearance d_2 between the cutting edge 8 and the shoulder's cylindrical face at equal distances X along the cutting edges 8 and 10, the square shoulder's end and cylindrical faces respectively constituting its first and second surfaces.

Thus, in this arrangement, the inoperative cutting edge's trailing end 8B has a back clearance C from the shoulder's cylindrical face whilst the operative cutting edge's lateral portion 10A delimits an obtuse entering angle κ which enables an outwardly directed radial feed out movement P.

As shown in Figures 1 and 2, due to the concavity of the operative cutting edge 10, there is a location therealong at which there is a minimal clearance from the shoulder's end face. This limits the maximal radial depth of cut of the cutting tool assembly 1 to less than the length of the cutting insert's side when squaring out a stepped shoulder in the direction P.

As shown in Figures 3 and 4 respectively, typical rake angles imparted by the toolholder 2 are a so-called "negative back rake angle" α_1 to provide relief along an exposed side surface 9 of the cutting edge 8 and a so-called "negative side rake angle" α_2 to provide relief along an exposed side surface 11 of the cutting edge 10 from the workpiece. Typical values of the rake angles are as follows: $\alpha_1 \approx \alpha_2 \approx 6°$.

Turning now to Figures 5 and 6, a cutting tool assembly 1' with the same cutting insert 4 is adapted for external face turning of a stepped square shoulder S' on a workpiece W' rotatable about an axis of rotation B. In this arrangement, the cutting insert 4 is so disposed that a clearance d_3 between the operative cutting edge 8' and the shoulder's cylindrical face is less than a clearance d_4 between the inoperative cutting edge 10' and the shoulder's end face at equal distances X along the cutting edges 8' and 10', the square shoulder's cylindrical and end faces respectively constituting its first and second surfaces.

As a consequence, as shown in Figure 6, the cutting edge's trailing end 10'B has a clearance C' from the shoulder's end face whilst the operative cutting edge's lateral portion 8'A adjacent the operative insert cutting corner

7' delimits an obtuse entering angle κ which enables an outwardly directed axial feed out movement Q.

Thus, in this case, as shown in Figure 5, due to the concavity of the operative cutting edge 8', there is a location therealong at which there is a minimal clearance from the shoulder's cylindrical face. This limits the maximal axial depth of cut of the cutting tool assembly 1' to less than the length of the cutting insert's side when squaring out a stepped shoulder in the direction Q.

Turning now to Figure 7, a generally square cutting insert 13 has a central throughgoing bore 14 and an upper surface 15 having four side edges 16, each pair of adjacent side edges 16 meeting at an insert cutting corner 17.

Each side edge 16 is recessed with respect to an imaginary line 19 of a length l constituting one side of an imaginary square 20 in which the cutting insert 13 is inscribed in its plan view.

Each side edge 16 has a straight central portion 21 between adjacent lateral portions 22, a lateral portion 22 constituting the lateral portions 10A and 8'A respectively of the cutting tool assemblies 1 and 1'. The juncture of adjacent lateral portions 22 define an acute insert cutting corner angle B of 83°.

Each central portion 21 is coextensive with the throughgoing bore 14 and tangential to an imaginary central inscribed circle 23.

The cutting insert 13 can be a double sided cutting insert, thereby being formed with a total of eight insert cutting corners, and of a negative relief flank geometry 13A (see Figure 8) or a double positive relief geometry 13B (see Figure 9) for use in either of the cutting tool assemblies 1 or 1' with suitable adapted pocket therefor.

Alternatively, the cutting insert 13 can be a single sided positive cutting insert 13C (see Figure 10), thereby being formed with four insert cutting corners, and built in relief flank geometry for mounting in a neutral toolholder having $\alpha_1 \approx \alpha_2 \approx 0°$ and adapted for turning stepped square shoulders of either limited maximum radial or axial depth of cut.

Alternatively, such an insert can possess a large relief angle whereby it can be mounted on a positive type toolholder.

While the invention has been described with respect to a limited number of embodiments, it will be appreciated that many variations, modifications and other applications of the invention can be made. Thus, in addition to external operations as shown and described hereinabove, similar cutting tool assemblies can be adapted for internal boring of stepped square shoulders. In addition, the same cutting insert can be equally employed in both right and left hand directions in turning operations. Whilst, the cutting insert can be modified such that its acute insert cutting corner angle β lies in the range $83° \pm 5°$.

CLAIMS:

1. A cutting tool assembly for turning a stepped square shoulder on a workpiece, the stepped square shoulder having perpendicularly disposed first and second surfaces, the cutting tool assembly comprising a tool holder for replaceably receiving a cutting insert presenting an acute insert cutting corner at the juncture of substantially concave operative and inoperative cutting edges respectively co-directional and transversely directed to a feed out direction of the cutting tool assembly relative to the workpiece, the cutting tool assembly having a tool back clearance angle κ_n along said inoperative cutting edge and an obtuse entering angle κ along said operative cutting edge such that in a top view of the cutting assembly, the cutting insert is so disposed that a clearance between an inoperative portion of said operative cutting edge and the first surface of the stepped square shoulder is less than a clearance between said inoperative cutting edge and the second surface of the stepped square shoulder at equal distances along said cutting edges,

characterized in that

said cutting insert is substantially square shaped and in a top view thereof is inscribed in an imaginary square of a side length *"l"* whereby the cutting tool assembly has a maximum depth of cut in said feed out direction less than the length *"l"*.

2. A cutting tool assembly according to Claim 1 wherein the square shoulder's end and cylindrical faces respectively constitute its said first and second surfaces and whereby the cutting tool assembly is adapted for turning stepped square shoulders of a limited maximum radial depth of cut.

3. A cutting tool assembly according to Claim 1 wherein the square shoulder's cylindrical and end faces respectively constitute its said first and second surfaces and whereby the cutting tool assembly is adapted for turning stepped square shoulders of a limited maximum axial depth of cut.

4. A cutting insert having a substantially square upper surface, a lower surface and side surfaces intersecting with said upper surface at four substantially concave side edges each having a central portion between adjacent lateral portions, each pair of adjacent lateral portions meeting at an acute insert cutting corner,

characterized in that each of said central portion is substantially straight and the angle of each of said acute insert cutting corners is in the range of about 83° ±5°.

5. A cutting insert according to Claim 4 wherein the cutting insert has a central throughgoing bore transversing said upper and lower surfaces and each central portion is at least co-extensive with said throughgoing bore.

6. A cutting insert according to Claim 4 wherein the cutting insert is double sided and of a negative relief flank geometry.

7. A cutting insert according to Claim 4 wherein the cutting insert is double sided and of a double positive relief flank geometry.

8. The cutting insert according to Claim 4 wherein the cutting insert is single sided and of a positive relief flank geometry.

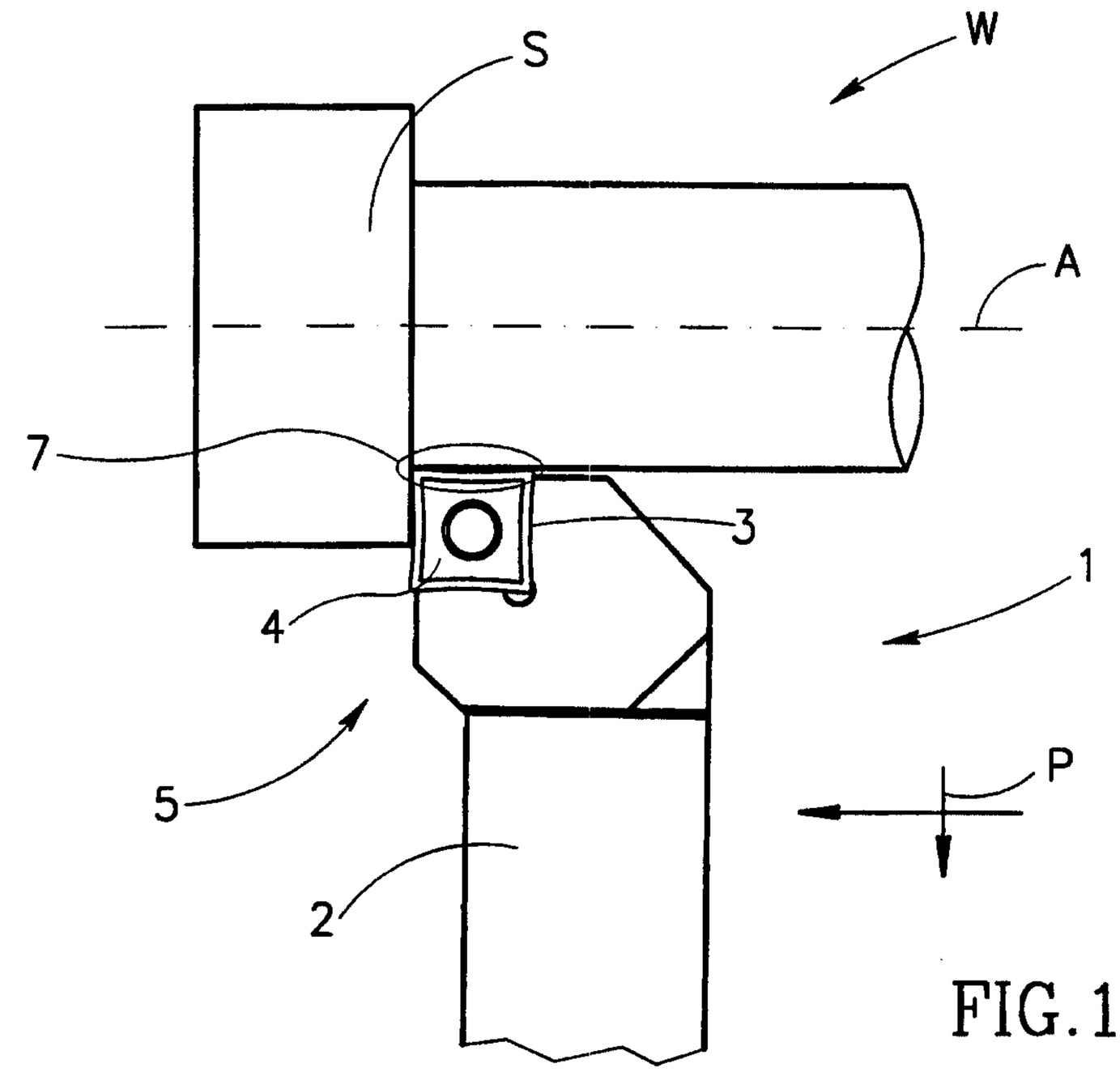


FIG.1

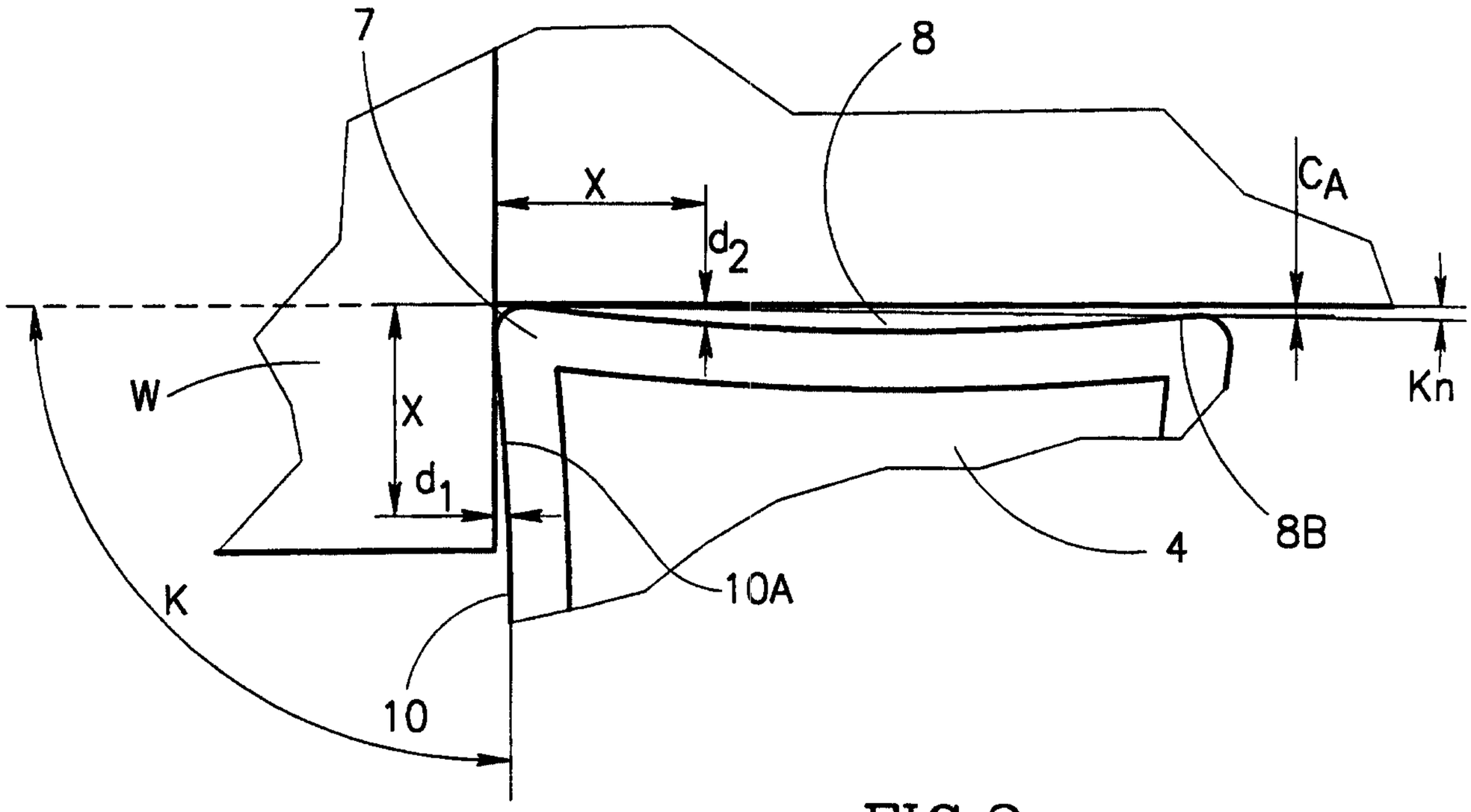


FIG.2

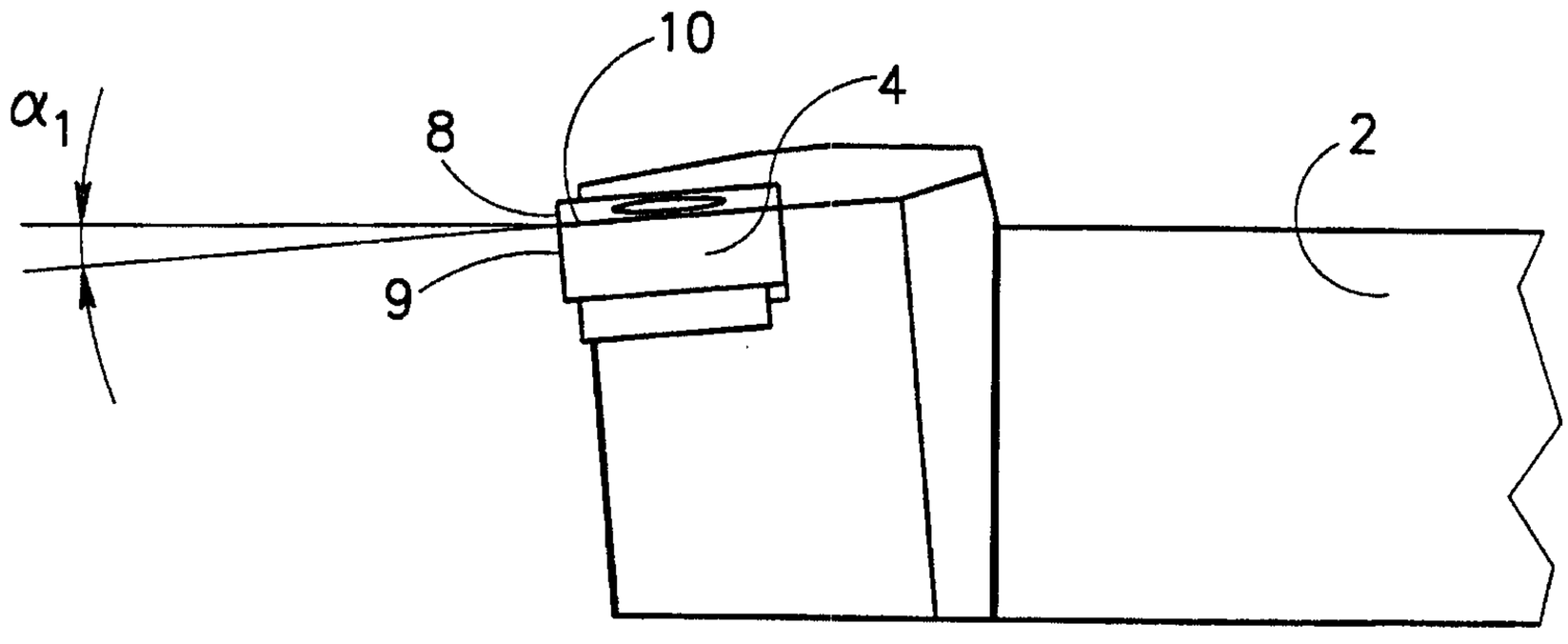


FIG.3

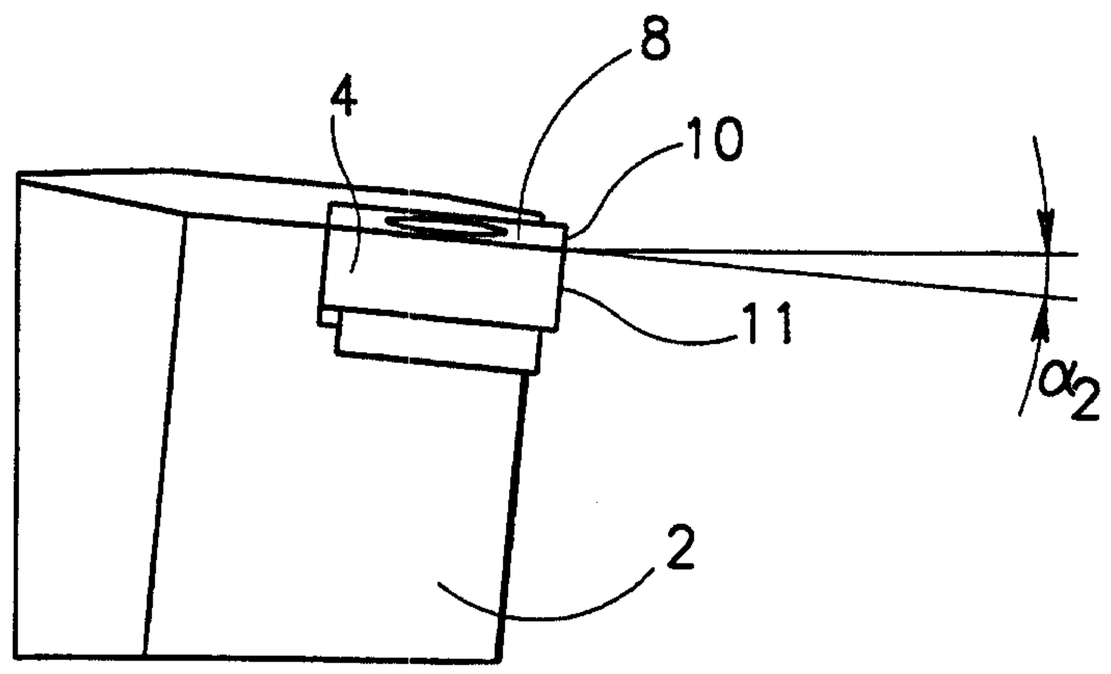


FIG.4

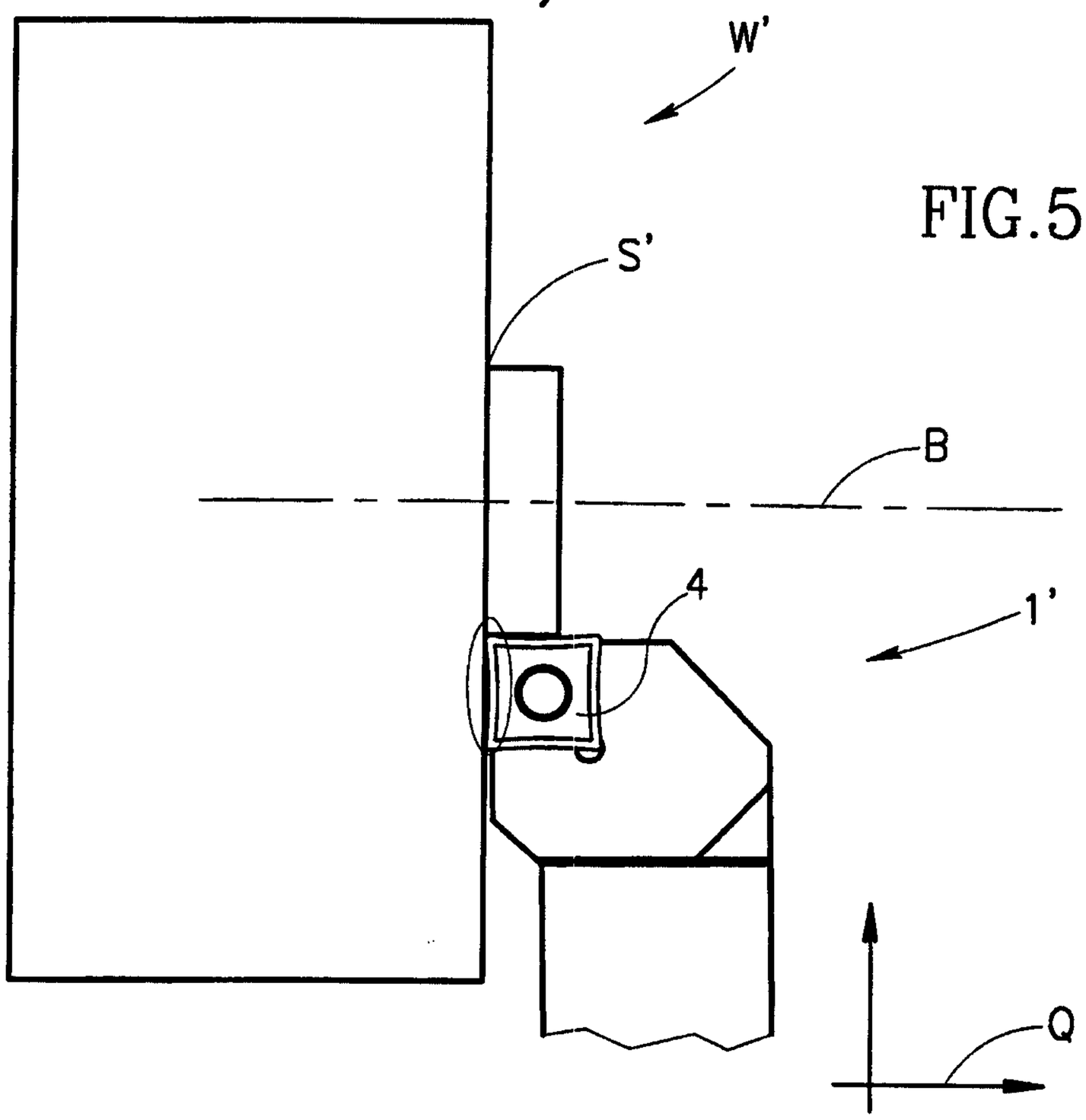


FIG.5

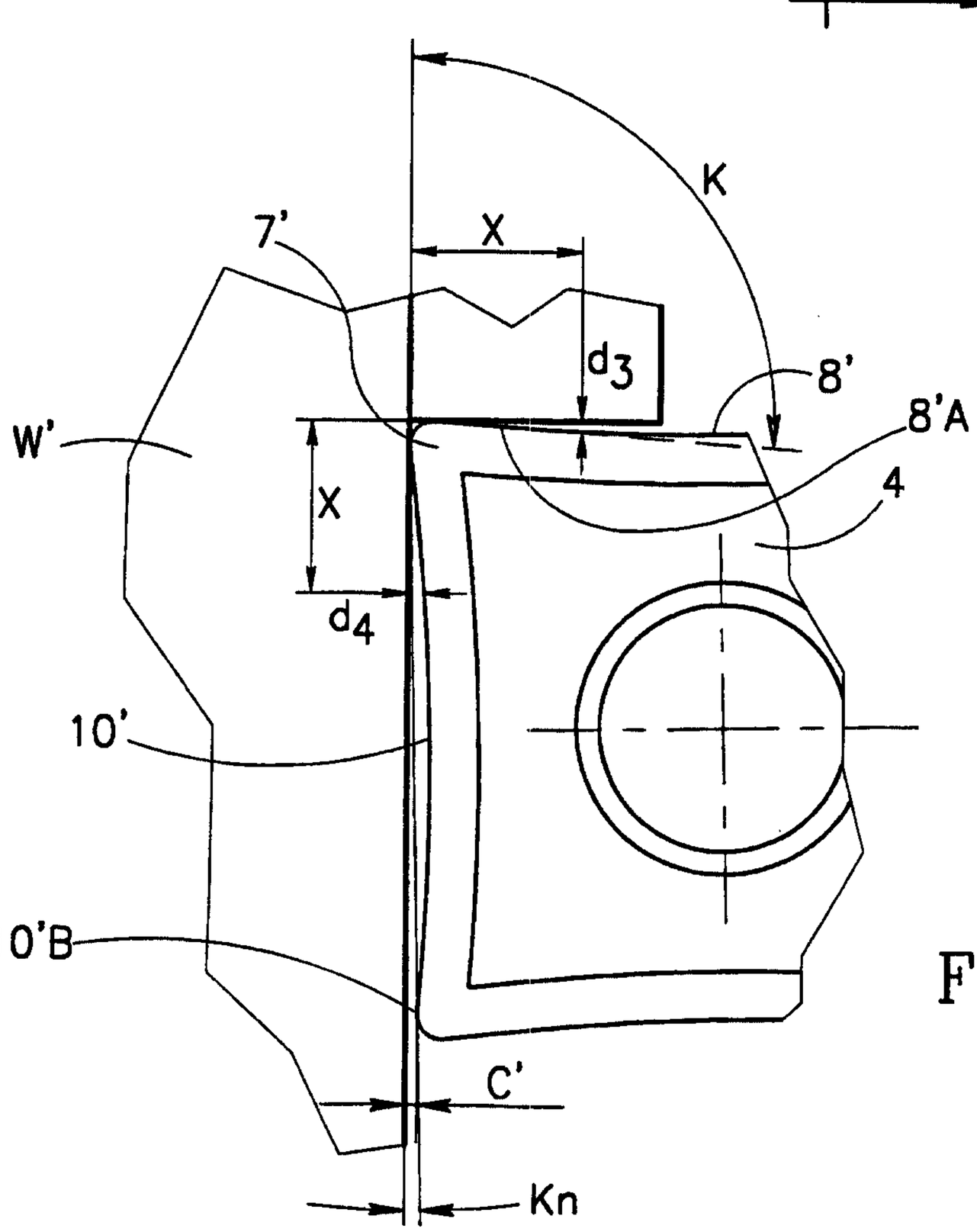


FIG.6

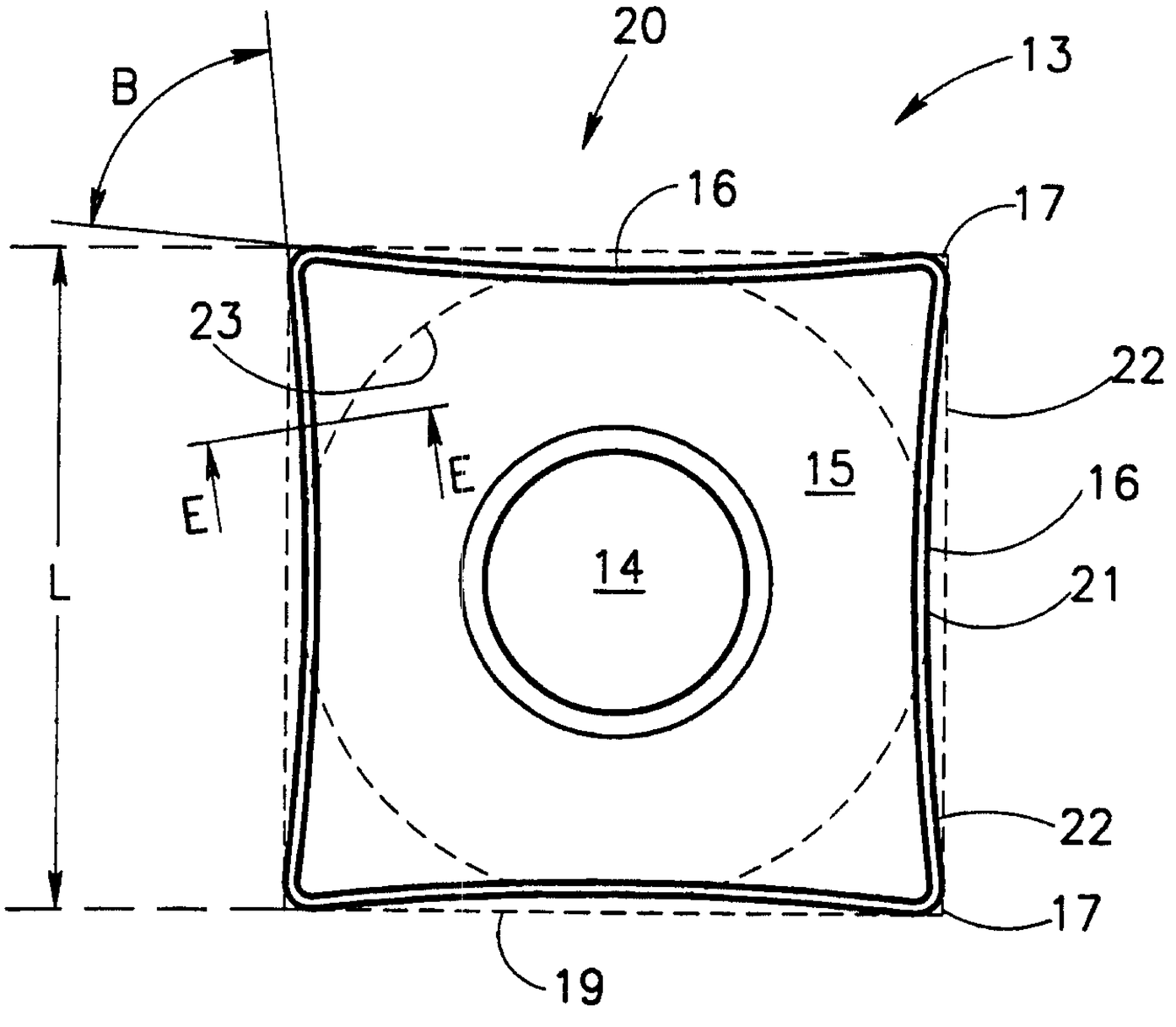


FIG.7

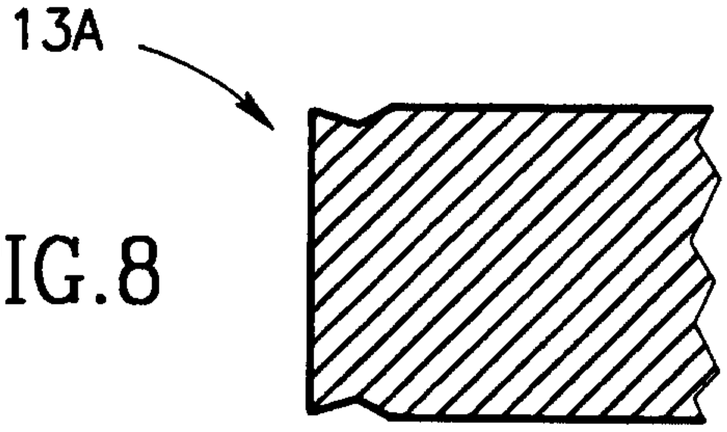


FIG.8

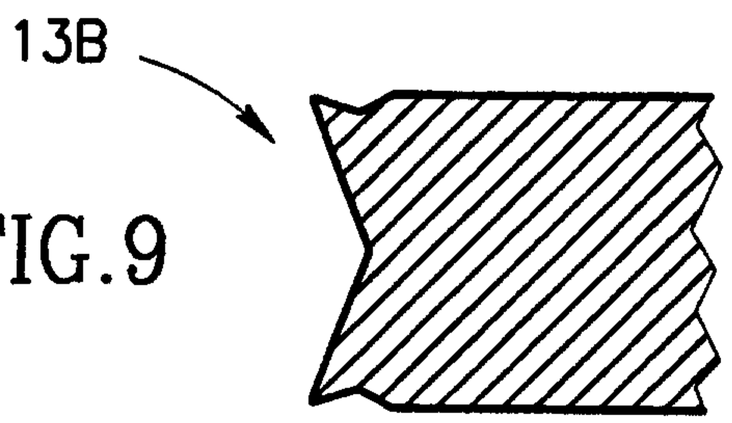


FIG.9

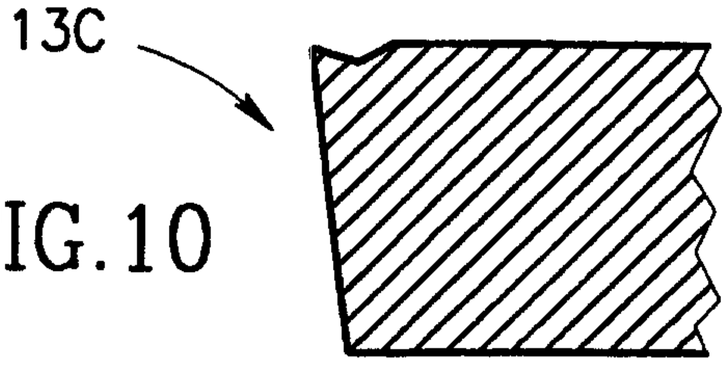
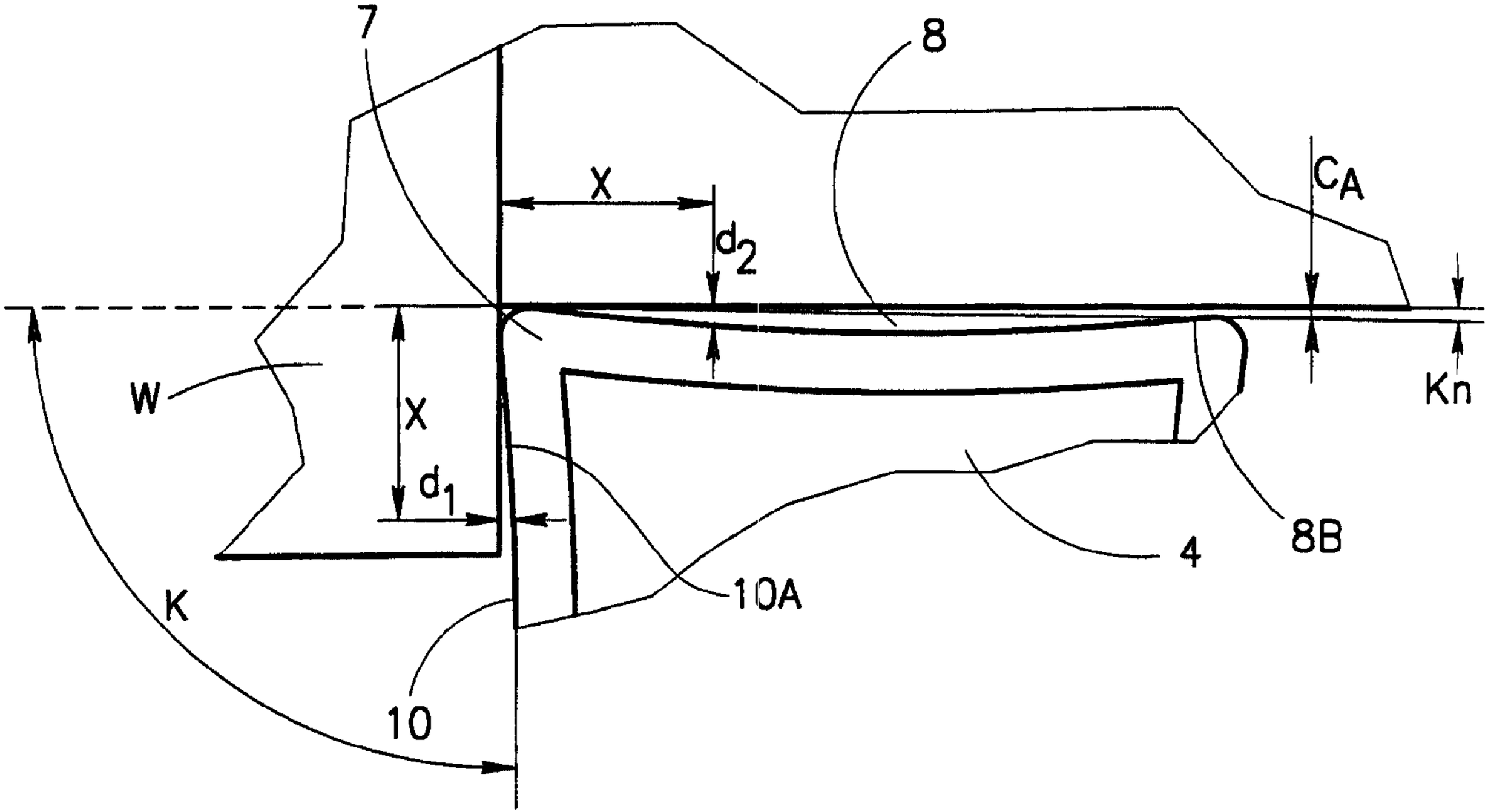


FIG.10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