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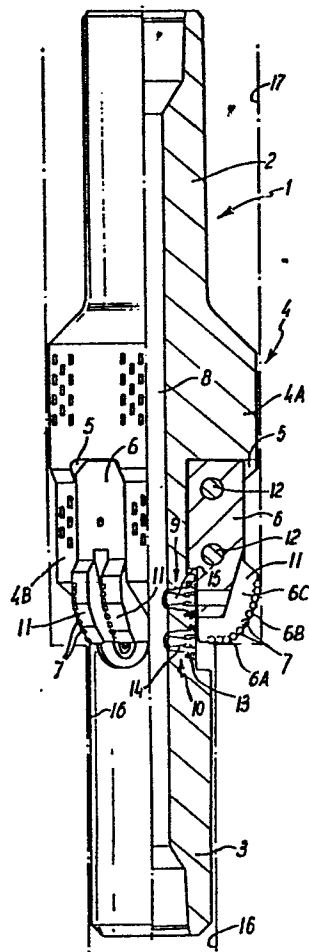
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54 **Hole opener.**

57 A tool for enlarging well bores, comprising  
a tubular housing (1)  
a cutter (6) extending outwardly of the housing and  
having a cutting edge (6A, B, C) engaging a well bore wall,  
and a passageway (8) through the housing for delivery  
of pressurised fluid, the housing wall being apertured (9, 10)  
to direct fluid from the passageway in a direction lateral of  
the housing and at generally the same level on the housing  
as said cutting edge.



**FIG. 2**

Hole Opener

This invention relates to a tool for enlarging well bores.

5 In the process of drilling wells for hydrocarbon minerals or geothermal energy, there are many situations where an existing well bore has to be enlarged. This can be achieved in a variety of different ways. For example a larger drill bit can be run. This has disadvantages in  
10 that, for example, the hydraulics have been designed to be efficient in a blind hole and not with a pilot hole ahead, and cuttings and debris are not all removed at the time cutting is taking place; much will fall down the pilot hole to be redrilled at a later stage in the operation.

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A second method of hole enlarging would be to use a conventional hole enlarger. In this case the hydraulics though improved are not as efficient as they could be.

20 In conventional hole-opening operations also, the hole-opening tool is stabilised by having its lower diameter the same as the pilot hole so as to bear against the pilot hole in use, but the pilot hole tends to be non-uniform and rough-walled and severe vibration of the tool can result.

According to the present invention there is provided a tool for enlarging well bores, comprising

a tubular housing,

a cutter extending outwardly of the housing and having  
5 a cutting edge for engaging a well bore wall,

and a passageway through the housing for delivery of pressurised fluid, the housing wall being apertured to direct fluid from the passageway in a direction lateral of the housing and at generally the same level on the housing as  
10 said cutting edge.

Preferably a plurality of cutters are arranged around the housing. Preferably also a plurality of apertures are provided for the passageway.

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The aperture is preferably in the form of a nozzle for providing a jet of fluid from the passageway laterally outwardly against the well bore. In this way localised pressure is exerted on the borehole wall in the area of  
20 cutting, increasing locally the pore pressure. The provision of the aperture at the same level as the cutting edge maximises this effect and also ensures that cuttings are immediately caught in the flow of fluid, keeping the cutting edge clear of debris.

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Further according to the invention there is provided a tool for enlarging well bores, comprising

a tubular housing,

a cutter extending outwardly of the housing and having  
30 a cutting edge for enlarging a well bore wall,

and a passageway through the housing for delivery of pressurised fluid to the well bore, wherein the housing above the cutter has at least a portion whose diameter is substantially the same as the diameter proscribed by the  
35 outer extremity of the cutter on rotation of the housing.

Preferably a plurality of cutters are provided at spaced intervals around the housing and the diameter of the housing above the cutter is at its maximum substantially the same as the diameter of the enlarged well bore produced by the  
5 cutters on rotation of the housing.

An embodiment of this invention will now be described by way of example with reference to the accompanying drawings, in which:

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Fig. 1 is a side view of a tool for enlarging well bores in accordance with the invention;  
Fig. 2 is a part-sectional angled side view of the tool of Fig. 1;

15

and

Fig. 3 is a sectional view on the line A-A of Fig. 1.

Referring to the drawings, the tool of this embodiment of  
20 the invention has a housing generally indicated at 1 of which top and bottom cylindrical sections 2, 3 of 241 mm outside diameter and a middle cylindrical section 4 is of 444 mm outside diameter at its upper portion 4A. The housing 1 has an overall length of 2121 mm.

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A lower portion 4B of the middle section is of reduced outside diameter and has three equispaced slots 5 cut into it, the slots receiving cutters 6 having cutting edges 6A, 6B and 6C which have synthetic polycrystalline Compax,  
30 Stratax or Diapax diamond wafers 7 along them to provide hardness and wear resistance. On rotation of the housing the outermost cutting edges 6C describe a circle having a diameter of 444 mm, i.e. the same as the diameter of the upper portion 4A of the housing middle section.

Each cutter 6 is secured within its slot 5 by means of two  
screwed pins 12 passing through the cutter 6 and screwing  
into the portion 4B of the housing 1 (see Fig. 3) which  
forces the cutter 6 against a side face of the slot 5,  
5 thereby preventing vibration of the cutter 6 in the slot.  
Each screwed pin is prevented from loosening by means of an  
eccentric locking disc 12A.

At their lower portion the cutters 6 are forked at 11, the  
10 cutting edges 6 being provided on each fork.

A through bore 8 extends axially through the housing and  
apertures 9, 10 open from the bore 8 radially outwardly into  
the slots 5 between the forks 11 of each cutter 6. The  
15 apertures 9, 10 are disposed at the same level on the  
housing 1 as the cutting edges 6C, 6A respectively.

The apertures 10 are directed along the cutting edges 6A.

20 Located within the apertures 9, 10 are removable sleeves 14  
which are aligned with the bore 8 by dowel pins 13.  
Nozzles 15 are disposed within the sleeves 14 and sealed  
against their inner faces to provide a reducing cross-  
sectional area for the apertures 9, 10 as they emerge from  
25 the bore 8. The nozzles 15 are removable and  
interchangeable, and their total area at their outer ends is  
0.9 cm<sup>2</sup>.

In use, the tool of this embodiment of the invention is  
30 screwed at its upper and lower ends into a drill string, so  
that the bore 8 communicates with fluid passageways above  
and below it. The string carries at its lower end a drill  
bit (not shown) which forms a pilot hole 16 (Fig. 2) in the  
sea bed on rotation of the string, or a bullnose which will  
35 follow an existing pilot hole.

Drilling fluid is pumped through the drill string and passes through the bore 8 to the drill bit and, being under pressure, is forced in part through the nozzles 15, emerging from them at a velocity of 60-100 metres per sec. The pressure drop across the nozzles 15 is around 70 kg per cm<sup>2</sup>. The rate of fluid flow through the nozzles is 5455 litres per minute.

As the fluid is jetted through the nozzles 15 it forces debris away from the cutting edges 6A, 6B, 6C, with direct action along the edge 6A. Cuttings are then entrained in the upward flow of fluid from the drill bit, which is joined by the fluid from the nozzles 15. Further, the high velocity of the fluid from the nozzles 15 against the wall of the well bore assists the cutting action of the cutters by causing initial weakening and breakage of the wall; as the fluid flow from the nozzles is lateral of the well bore it acts directly against the bore wall generally in the plane of rock strata, thus producing a disruptive effect on the wall. The localised high pressure created by the fluid from the nozzles also reduces the "chip hold-down" effect of a substantially downwardly-directed jet, thus reducing wear on the cutting edges 6A, 6B, 6C.

Thus the pilot hole 16 is opened to a wider diameter by the cutters 6, providing a drill hole 17 (Fig. 2) of about 444 mm diameter. As the tool rotates, therefore, the upper portion 4A of the housing's middle section bears against the wall of the drill hole 17, providing stabilisation for the tool. The face of the newly-formed drill hole 17 is smoother and has more integrity than that of the pilot hole 16, and therefore provides better stabilisation for the tool than conventional arrangements in which the stabilisation is effected against the pilot hole.

There are several reasons for the high level of performance achieved by the tool of this embodiment:

- 5 1) The impact of the high velocity jet was breaking down the ledge.
- 10 2) The lateral jet was carrying away the cutting effectively as it only had to turn  $90^{\circ}$  to be travelling up the hole as opposed to  $180^{\circ}$  as in normal jet nozzle bits or hole openers.
- 15 3) Creating a wash-out situation relieved the cutters of much of their work.
- 15 4) Creating localised high formation pressure reduced the chip hold down effect.

It is a well-known fact that chip hold down is affected greatly by over-balance and if the lateral jetting is causing formation pressure to be increased to a level above the hydrostatic pressure of the mud column, then a substantial increase in rate of penetration will certainly take place.

25 This now remains to be proved under laboratory conditions.

Increases in ROP have been achieved in the past using nozzles to reduce bottom hole pressure but this method of increasing the ROP has been accompanied with the increased risk of causing an influx by reducing or removing the over-balance excited by the mud column. In the case of lateral jetting in the present invention this is not the case as the formation pressure is being increased locally at the point of cutting which would effectively reduce the risk of an influx but still reduce or remove the over-balance

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exerted by the mud column.

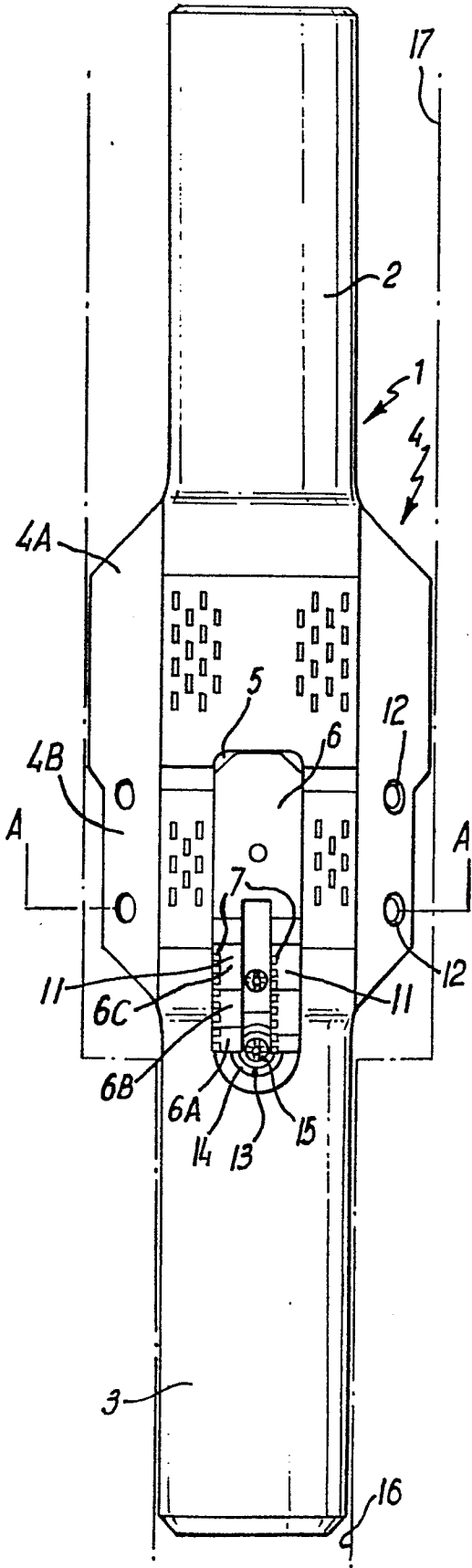
Modifications and improvements may be made without departing from the scope of the invention.

CLAIMS

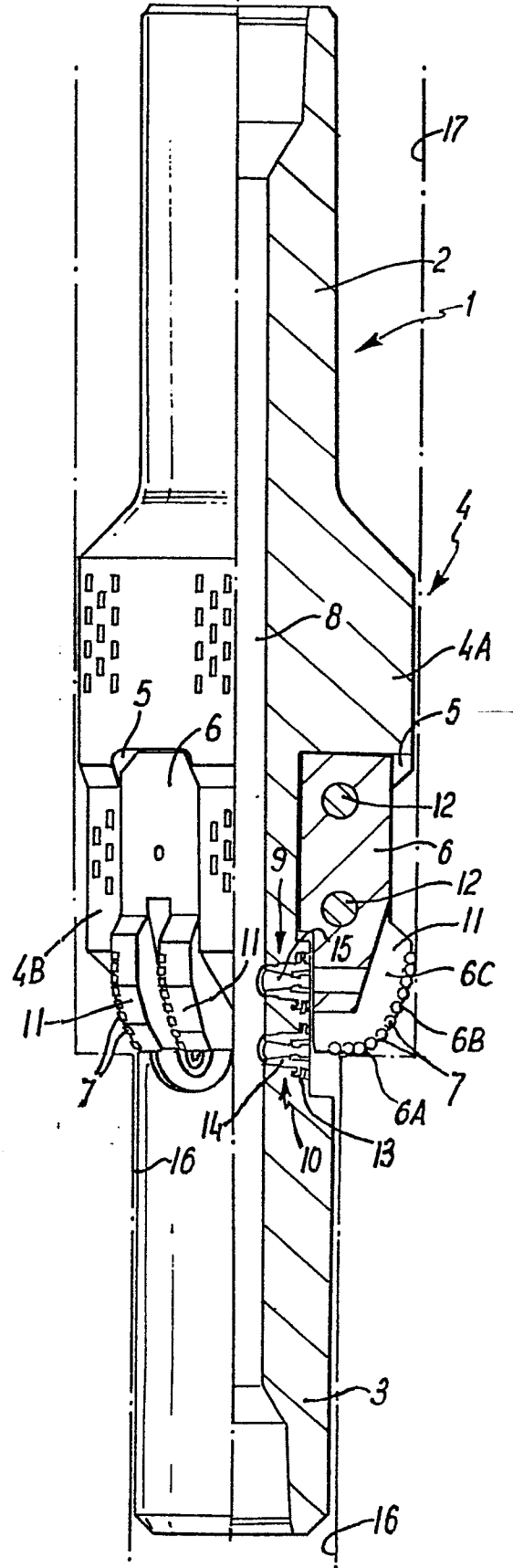
1. A tool for enlarging well bores, comprising  
a tubular housing,  
5 a cutter extending outwardly of the housing and having  
a cutting edge for engaging a well bore wall,  
and a passageway through the housing for delivery of  
pressurised fluid, the housing wall being apertured to direct  
fluid from the passageway in a direction lateral of the  
10 housing and at generally the same level on the housing as  
said cutting edge.
2. A tool as claimed in Claim 1, wherein the aperture  
through the housing wall is directed perpendicular to the  
15 main axis of the housing.
3. A tool as claimed in Claim 1 or 2, wherein the aperture  
through the housing wall is in the form of a nozzle for  
providing a jet of fluid from the passageway.
- 20 4. A tool as claimed in any one of the preceding Claims,  
wherein the cutter has circumferentially-spaced cutting  
edges and the aperture through the housing wall emerges  
between the cutting edges.
- 25 5. A tool as claimed in Claim 4, wherein the cutting edges  
extend along a portion of the length of the housing and the  
aperture emerges at the level of the lower extremity of the  
cutting edges.
- 30 6. A tool as claimed in Claim 5, wherein a further  
aperture is provided through the housing wall to emerge  
axially spaced above the first aperture and between the  
cutting edges.

7. A tool as claimed in any one of the preceding Claims, wherein a plurality of cutters are provided around the housing.
- 5 8. A tool as claimed in any one of the preceding Claims, wherein a plurality of apertures are provided at spaced intervals around the housing.

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**FIG. 1**



**FIG. 2**

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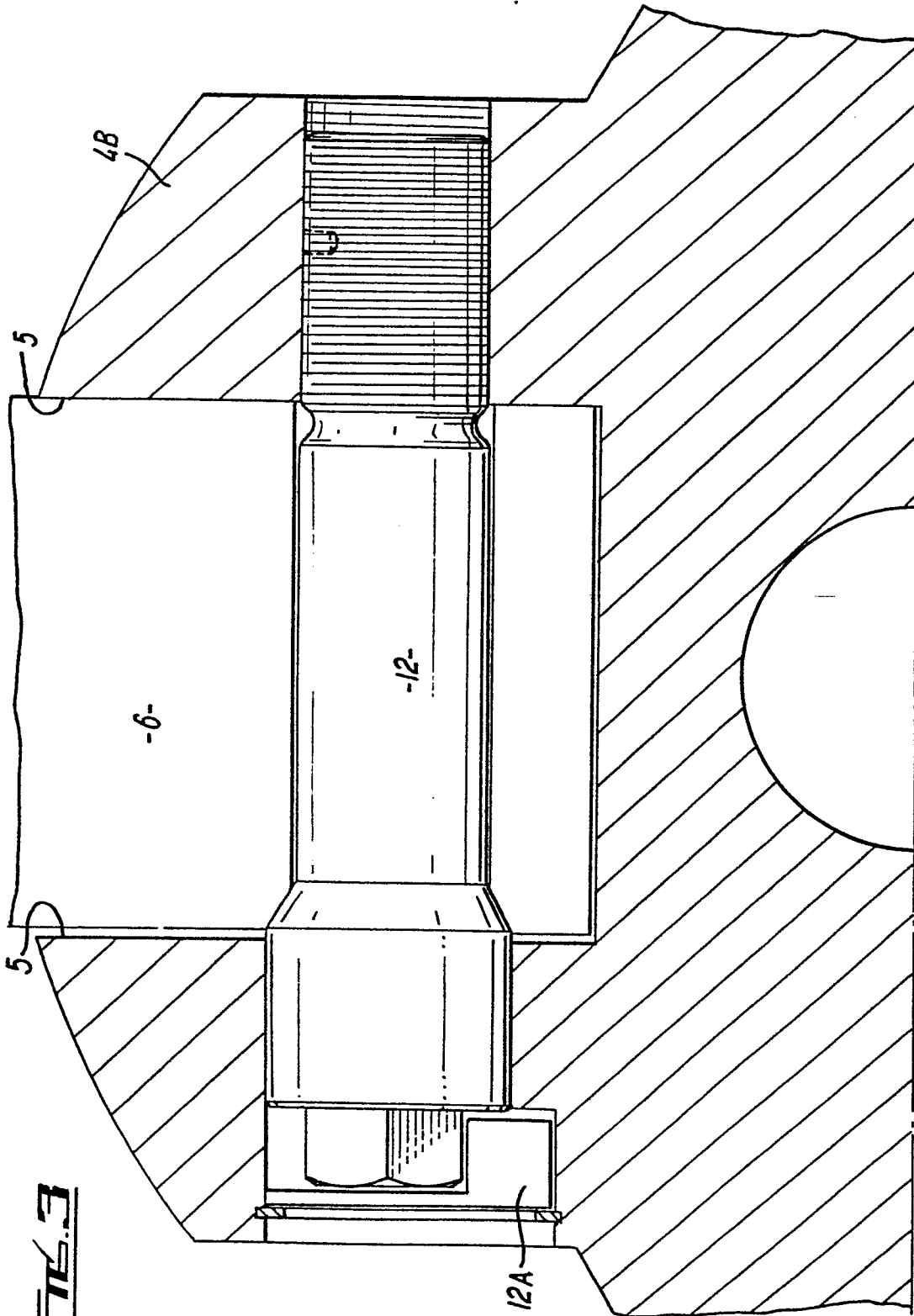


FIG. 3



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.4)
X	US-A-3 237 705 (WILLIAMS) * Column 2, line 64 - column 4, line 30; figures 2,4 *	1,2,4	E 21 B 10/26 E 21 B 10/60
Y	---	3,5-8	
Y	US-A-3 908 771 (GARRETT) * Column 3, line 29 - column 4, line 29; figures 1-4 *	3,5-8	
X	US-A-2 028 910 (REAMER) * Page 1, column 1, line 39 - page 1, column 2, line 19; page 2, column 2, lines 23-32; figures 1,2 *	1,7,8	
A	---	4-6	TECHNICAL FIELDS SEARCHED (Int. Cl.4)
X	US-A-2 249 732 (GREEN) * Page 1, column 1, line 36 - page 1, column 2, line 29; figures 1,2 *	1	E 21 B
A	---	5,6	
A	US-A-3 324 957 (GOODWIN et al.) * Figures *	1-3,5-8	
	---	-/-	
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 05-11-1985	Examiner RAMPPELMANN J.
<p><b>CATEGORY OF CITED DOCUMENTS</b></p> <p>X : particularly relevant if taken alone  Y : particularly relevant if combined with another document of the same category  A : technological background  O : non-written disclosure  P : intermediate document</p> <p>T : theory or principle underlying the invention  E : earlier patent document, but published on, or after the filing date  D : document cited in the application  L : document cited for other reasons  &amp; : member of the same patent family, corresponding document</p>			



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. 4)
	US-A-4 445 580 (SAHLEY)		
A	US-A-2 140 417 (CONKLIN)		
A	GB-A- 788 104 (MODERN HARDMETALS)		
A	US-A-2 149 798 (STARKEY)		
A	US-A-2 607 562 (PHIPPS)		
			TECHNICAL FIELDS SEARCHED (Int. Cl. 4)
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 05-11-1985	Examiner RAMPELMANN J.
<b>CATEGORY OF CITED DOCUMENTS</b> X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	