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[54] **RUTHENIUM OR OSMIUM ON HARD METALS**

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[58] **Field of Search**..... 29/182.3, 182.7, 187.8; 117/160 R

[56] **References Cited**

UNITED STATES PATENTS

2,039,822	5/1936	McKenna	29/187.8
2,672,426	3/1954	Grubel et al.	29/182.8
3,171,192	3/1965	Ortner et al.	75/203
3,264,222	8/1966	Carpenter et al.	75/203

FOREIGN PATENTS OR APPLICATIONS

1,309,634	3/1973	United Kingdom
2,011,082	9/1970	Germany

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[57] **ABSTRACT**

The life of cutting tools is increased by providing on the cutting surface thereof a deposited layer of osmium, ruthenium or an alloy of osmium and ruthenium.

4 Claims, No Drawings

RUTHENIUM OR OSMIUM ON HARD METALS

The present application is a continuation-in-part of U.S. application Ser. No. 256,889 filed on May 25, 1972.

The present invention is concerned with articles which present one or more working surfaces subject to wear in use. As is well known, the most common articles of this kind are cutting tools having at least one cutting edge between rake and flank faces, the actual cutting edge and parts of these faces being working surfaces subjected to considerable wear, which limits the cutting life. The whole of the tool may be made of sintered hard metal consisting essentially of a metal carbind and a metal binder of the iron group, but usually only the tip of the tool is made of hard metal and is carried by a steel or other support.

Other articles which are subjected to wear and become heated in use are wire-drawing dies, powder-compacting and metal-forming dies and some journal bearings, the bores and surfaces of which become worn in use.

As is well known, sintered carbide is a product of powder metallurgy made of finely divided, hard particles of a carbide of a refractory metal sintered with one or more metals of the iron group. The hard particles are, most advantageously, tungsten carbide, usually in combination with lesser amounts of other carbides. The additional carbides are those of titanium and tantalum with some occasional specialized use being made of the carbides of niobium, molybdenum, vanadium, chromium, zirconium and hafnium. For most commercial purposes, the binder metal is cobalt.

The carbides are present as individual grains and also as a finely dispersed network resulting from the precipitation during cooling of carbide dissolved in the cobalt during sintering. Table I sets forth in percent by weight the composition of certain types of carbide compositions to which the present invention is applicable.

TABLE I

Carbide Group	% Co	% TaC +	% WC
1	2.5–6.5	0–3	Bal.
2	6.5–15	0–2	Bal.
3	15–30	0–5	Bal.
4*	3–7	20–42	Bal.
5*	7–10	10–22	Bal.
6*	1–12	8–15	Bal.
7**	4.5–8	16–25	Bal.
8**	8–10	12–20	Bal.
9***	5.5–16	18–30	Bal.

*Added carbide is predominantly TiC
**Added carbide is predominantly TaC
***Added carbide is exclusively TaC

The carbide groups set forth in Table I are generally used for cutting purposes for various types of metal. The carbides of group 3 are especially useful for high-impact die applications and the carbides of group 9 are specifically applicable for wear-resistant applications particularly involving heat. One common hard metal used for cutting tips consists of 94% tungsten carbide and 6% cobalt, and another of 82% tungsten carbide, 13% titanium carbide and 5% cobalt or, more precisely 82.5% tungsten carbide, 13% titanium carbide and 4.5% cobalt, known to the trade as grades C–1 and C–6 respectively.

It is an object of the present invention to provide novel wear-resistant articles, particularly cutting tools, having improved resistance to wear.

Other objects and advantages will become apparent from the following description.

It has been found that the provision on cutting tools, whether made of hard metal (i.e., sintered carbide) or of other materials commonly used for this purpose (e.g., high-speed tool steel), of a surface coating of ruthenium or osmium or an alloy of these two elements gives the tool a longer life or enables it to be worked at a higher speed without loss of life.

According to the invention, therefore, a cutting tool has a coating of ruthenium or osmium or an alloy of these two elements on at least the surfaces adjacent to the cutting edge or each such edge.

The tool may be made of hard metal (consisting essentially of carbide and a binder metal of the iron group, usually cobalt), high-speed steel or any other suitable material. The coating can be formed in any convenient way, for example, by electrodeposition, plasma-spraying or vapour deposition; or by applying a slurry of power and sintering; or by applying liquid-bright (a ruthenium-bearing liquid) and subsequently decomposing this to metal by heating, or by applying ruthenium as a powder at the pressing stage.

The coating can be very thin, say 2 or 3 microns thick or less, but the thickness is in part dependent on the way in which the coating is produced. When it is produced electrolytically it is found that the quality tends to be inconsistent when the thickness is greater than 6 microns. However, so far as improvement is life is concerned coatings of equal quality from 2 to 30 microns in thickness gave substantially the same improvement and the preferred thickness is from 2 to 10 microns. Coatings applied by plasma spraying are inevitably thicker by nature of the process and may be, for example, as great as 125 microns thick.

If the coating is formed by the application of a 'liquid-bright' (a ruthenium-bearing liquid produced by the reaction of a ruthenium halide with an ether), a single application followed by drying and heating at say 600°C. yields a coating about 0.5 microns thick, and it is desirable to repeat the process several times in order to produce a thicker final coating.

Most electrolytic baths from which ruthenium or osmium can be deposited are so acidic as to attack the binder in the hard metal, and when such a bath is used a flash coating of a resistant metal, which may be gold or palladium, should first be applied.

The invention is primarily useful in prolonging the life of cutting tips, and numerous tests have been made on tips having a base of the hard metal composed nominally of 82% tungsten carbide, 13% titanium carbide and 5% cobalt or, more precisely of 82.5% to tungsten carbide, 13% titanium carbide and 4.5% cobalt. In these tests the conditions were severe, the tips being used to cut bars of EN30B steel (an alloy steel containing 0.3% carbon, 4% nickel, 1.25% chromium and 0.3% molybdenum) hardened and tempered to 500 Hv. The majority of the tests were carried out without cutting lubricant and coolant. The angle of approach of the tip to the work was 75°, the cut being made by one edge of the tip. The feed was 0.3 mm/rev. and the depth of cut was 1.3 mm. The life was determined when the tool tip broke off or 0.4 mm. average flank wear was observed or 0.8 mm. localized flank wear was observed

or the tip was observed to be no longer making a cut to a given diameter.

EXAMPLE 1

Sintered carbide cutting tips made of 82% tungsten carbide, 13% titanium carbide and 5% cobalt or, more precisely, of 82.5% tungsten carbide, 13% titanium carbide and 4.5% cobalt were coated electrolytically with ruthenium in an aqueous electrolyte containing 30 g/l $(NH_4)_3[Ru_2NCl_8\ (H_20)_2]$ and 10 g/l ammonium sulphate, at a pH adjusted to 1.5 by the addition of sulphamic acid, the temperature of the electrolyte being 70°C. and the current density from 1 to 2 amp/dm². Prior to ruthenium plating the hard metal was given an initial flash coating of gold in an alkaline gold cyanide bath to avoid attack of the cobalt by the acid electrolyte. Ruthenium coatings of different thicknesses were produced. Tips having coatings 6 microns and 10 microns thick had lives three times longer than the initial uncoated tips when the machining speed was 92 meters per minute.

EXAMPLE 2

Tips similar to those treated in Example 1 were electrolytically coated with osmium in an aqueous electrolyte containing 10 g/l potassium hexachlorosmate, 15 g/l potassium chloride and 60 g/l potassium hydrogen sulphate, adjusted into the pH range of 1.2 to 1.5 by potassium hydroxide. The temperature of the electrolyte was 70°C., the cathode current density from 1 to 2 amps/dm² and the anode current density less than 0.5 amp/dm. This electrolyte also attacks hard metal, so all the tips were initially flash-coated with gold. The improvement in life given by an osmium coating 3 microns thick at a machining speed of 67 meters per minute was three times compared to an uncoated tip.

EXAMPLE 3

A hard metal tip consisting of 82% tungsten carbide, 13% titanium carbide and 5% cobalt or, more precisely 82.5% tungsten carbide, 13% titanium carbide and 4.5% cobalt was electrolytically coated with ruthenium 6 microns thick as in Example 1. When used as in Example 1 to machine EN30B at a speed of 61 meters per minute the tip had a life three times that of a similar uncoated tip.

EXAMPLE 4

A cutting tool of high-speed steel having the nominal composition 0.8% carbon, 21% tungsten, 11% cobalt, 5% chromium, 1.5% vanadium, 0.5% molybdenum, balance iron, was coated with ruthenium 4 microns thick as in Example **1.** To coat such steel satisfactorily is difficult, and the steel was pretreated in the same way as stainless steel to be coated with nickel. After this pretreatment a flash coating of gold was applied before the steel was coated with the ruthenium. When the coated tip was used to machine EN30B steel of 500 Hv. at 15 meters per minute, the feed at each revolution being 0.25 mm. and the depth of cut at 1.3 mm., the life was 4 times that of a similar uncoated tip.

Although the present invention has been described in conjunction with preferred embodiments, it is to be understood that modifications and variations may be resorted to without departing from the spirit and scope of the invention, as those skilled in the art will readily understand. Such modifications and variations are considered to be within the purview and scope of the invention and appended claims.

We claim:

1. A cutting tool having deposited, at least on a portion of the surface thereof, a layer of metal from the group of osmium and ruthenium and mixtures and alloys thereof.

2. A cutting tool as in claim **1** in which the surface layer is an electrolytic deposit and is from 2 to 10 microns thick.

3. A cutting tool as in claim 2 comprising a base of cobalt-bonded, sintered carbide.

4. A cutting tool as in claim 2 comprising a base of high-speed steel.

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