United States Patent [19]

Yamaya et al.

[11] **3,798,009**

[45] **Mar. 19, 1974**

[54] **HARD SINTERED COMPOSITION**

[75] Inventors: **Susumu Yamaya**, Tokyo; **Takeshi Sadahiro**, Yokohama, both of Japan.

[73] Assignee: **Tashiba Tungaloy Co. Ltd.**, Isukagoshi, Kawasaki-shi, Japan

[22] Filed: **Dec. 15, 1971**

[21] Appl. No.: **208,064**

[30] **Foreign Application Priority Data**

Oct. 1, 1971 Japan 46-76313

[52] **U.S. Cl.** **29/182.7**, 29/182.8, 75/203, 75/204

[51] **Int. Cl.** **G22c 29/00**, B22f 3/12

[58] **Field of Search** 29/182.7, 182.8; 75/203, 75/204

[56] **References Cited**

UNITED STATES PATENTS

3,490,901	1/1970	Hachisuka	29/182.7
R25,815	7/1965	Humenik et al.	29/182.7

FOREIGN PATENTS OR APPLICATIONS

4,321,879	9/1968	Japan	29/182.7
719,896	12/1954	Great Britain	29/182.7

OTHER PUBLICATIONS

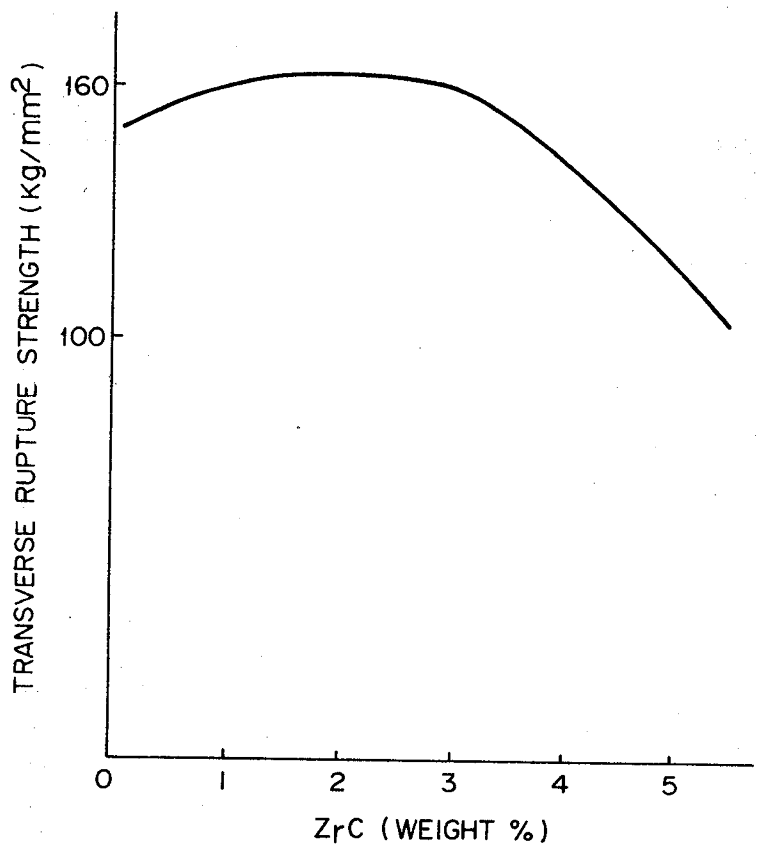
Schwarzkopf et al., Cemental Carbides, MacMillan, N. Y., 1960, pg. 205, TP 770 53.

Primary Examiner—Carl D. Quarforth
Assistant Examiner—R. E. Schafer
Attorney, Agent, or Firm—Kemon, Palmer & Estabrook

[57] **ABSTRACT**

The addition of up to 5 wt.% of zirconium carbide to hard sintered compositions of the titanium carbide type used in cutting tools for machining metals reduces cratering and plowing when machining metals at high speeds.

3 Claims, 1 Drawing Figure



TRANSVERSE RUPTURE STRENGTH (kg/mm²)
160
100
0
1
2
3
4
5
ZrC (WEIGHT %)

HARD SINTERED COMPOSITION

This invention relates to hard sintered compositions which are particularly highly resistant to cratering and plowing in machining metals at high speeds.

The hard sintered compositions, the chief ingredient of which is titanium carbide, have been widely used. These previous compositions are highly resistant to cratering, but are poorly resistant to plowing when employed for cutting bits, which is the important field of the application of the compositions.

It is the object of this invention to provide the hard sintered TiC compositions improved with respect to the plowing defect of previous compositions.

According to the present invention, there are provided hard sintered compositions consisting essentially of: (i) 5 percent maximum by weight of at least one metal carbide selected from the group consisting of zirconium carbide and vanadium carbide; (ii) 10 to 50 percent by weight of binding alloys comprising 25 to 70 percent by weight based on the binding alloy of at least one material selected from the group consisting of molybdenum and molybdenum carbide, and 75 to 30% by weight based on the binding alloy of at least one metal selected from the group consisting of iron, cobalt and nickel; and (iii) the balance of titanium carbide. Titanium carbide can be substituted by tantalum carbide to the extent that the amount of the tantalum carbide weighs less than that of the titanium carbide.

The appended drawing depicts relationships between the amount of ZrC and the transverse rupture strength of sintered compact containing ZrC.

An example of the methods of manufacturing the compositions of this invention is as follows.

A titanium carbide powder substantially free of oxides and nitrides was chosen. The binding alloy powder was prepared by milling fifty percent of approximately five microns nickel powder and fifty percent of approximately one micron molybdenum powder. Together with the binding alloy powder and titanium carbide powder, there were mixed minus 325 mesh powderous materials such as zirconium carbide, vanadium carbide, cobalt, iron or tantalum carbide to manufacture various compositions as shown in the Table 1, wherein compositions of this invention are indicated as A, B, C, D, E, F, G and H and the compositions I and H are shown for a comparison purpose. These compositions refer to the compositions of the compact prior to reaction which may occur during sintering.

TABLE 1

	TiC	Ni	Mo	Co	Fe	ZrC	VC	TaC
	The compositions of this invention							
A	65	17	17			1		
B	59	10	10	5		1		15
C	67	16	16			1		
D	59	15	15			1		10
E	57	16	16			1		10
F	61	14	14			1		10
G	59	10	10		5		1	15
H	67	16	16			0.5	0.5	
	The compositions for comparison							
I	66	17	17					
J	58	16	16					10

The milling operation was conducted in a stainless steel mill containing cemented tungsten carbide balls, acetone being added to inhibit oxidation of the charge during the one hundred twenty hour milling period. After milling the acetone was evaporated and four percent wax binder dissolved in benzene was added to the compositions. Upon drying, each powderous mixture was pressed in a steel die at a pressure of about 1.5 tons/cm^2.

The cold pressed compacts were presinterd in a hydrogen furnace at 650° Centigrade for one hour to dewax the specimens. Final sintering was performed on an inert stool and in an inert atmosphere at 1350° Centigrade for one hour in an induction furnace. An absolute pressure of about 0.1 to 0.3 micron was maintained in the furnace. The final sintering may be conducted in any suitable inert atmosphere, e.g. in an atomosphere of dry hydrogen, argon or helium. The period of sintering time depends on the sintering temperature. As the temperature is raised the sintering period may be shortened. In any event, however, the sintering temperature should not exceed 1,480° Centigrade in order to avoid substantial grain growth. The time end temperature of sintering must be adjusted so that the grain size of titanium carbide in the finished article is not substantially larger than that of the starting powder.

Table 2 shows the properties and cutting performances of the compositions shown in the Table 1. The hardness represents the Rockwell A hardness, and the unit of the transverse rupture strength is a kilogram per square millimeter. The width of plowing, presented by the unit of millimeter, was obtained by cutting a rod of JIS S55C steel at a Brinell hardness of 303 with a feed of 0.1 millimeter per revolution and a depth of cut of 1.0 millimeter at a surface speed of 30 meter per minute for one minute. The cutting conditions as described above are generally severe for a cutting bit, and render the bit subject to cratering and plowing at low speeds.

TABLE 2

	Hardness	Transverse rupture strength	Width of plowing
A	90.9	150	0.44
B	91.7	179	0.50
C	91.9	161	0.47
D	92.2	162	0.47
E	92.0	164	0.40
F	91.8	133	0.50
G	92.0	171	0.53
H	92.0	160	0.49
I	90.9	142	0.55
J	92.0	160	0.57

It is clear particularly by comparing the resembling compositions such as A with I, and E with J, that the cutting tools of the compositions of this invention are less affected by plowing, and have superior performance.

The appended drawing is presented to show the effect of varying amount of zirconium carbide in the compositions on the transverse rupture strength of the sintered compacts. With the exception of zirconium carbide, the remainders of the compositions were constantly composed of 60 percent of titanium carbide, 15 percent of nickel, 15 percent of molybdenum, and 10 percent of tantalum carbide. As shown in the drawing, when the amount of zirconium carbide exceeds five percent, the depression of the transverse rupture strength, namely that of the toughness of the compositions is remarkable. When zirconium carbide was replaced partly or wholly by vanadium carbide, approximately the same effect resulted. Therefore, the sum of zirconium carbide and vanadium carbide in compositions of this invention should not exceed five percent.

It is essential that the binding alloy contain 25 percent to 70 percent of molybdenum and/or molybdenum carbide to take advantage of the ability of these materials to cause alloys containing them to wet the surface of the hard titanium carbide particles. A deficiency of the amount of molybdenum and molybdenum carbide makes said advantage insufficient, and an excess of them depresses the toughness of the composition. Molybdenum carbide may be applied in the state of a solid solution with titanium carbide before sintering.

Among the iron group metals, nickel is preferred as a component of the binding alloy. However, any iron group metals or their alloys, may be employed. It is essential that the compositions contain ten percent to 50 percent of the binding alloy. A deficiency of the amount of the binding alloy depresses the toughness of the composition, and an excess depresses the hardness of the composition.

It is possible to substitute tantalum carbide for titanium carbide to the extent that the amount of titanium carbide weighs always more than tantalum carbide. An excess of tantalum carbide depresses the faculty of the composition for cutting bits. Tantalum carbide may take a form of solid solution with titanium carbide before sintering.

It is, of course, essential that all of the steps in the production of the finished tool be carried out so that the final product is free of detrimental amount of oxides and nitrides.

What we claim is:

1. Hard sintered compositions consisting essentially of:

i. 5 percent maximum by weight of zirconium carbide,

ii. 10 to 50 percent by weight of binding alloy which comprises,

a. 25 to 70 percent by weight based on the binding alloy of at least one material selected from the group consisting of molybdenum and molybdenum carbide and,

b. 75 to 30 percent by weight based on the binding alloy of at least one metal selected from the group consisting of iron, cobalt and nickel, and

iii. the balance of titanium carbide.

2. Hard sintered compositions according to claim 1 wherein said titanium carbide is replaced by tantalum carbide to the extent that the amount of the tantalum carbide weighs less than that of the titanium carbide.

3. Hard sintered compositions according to claim 1 wherein part of said zirconium carbide is replaced by vanadium carbide.

* * * * *