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OTTAWA February 9th, 1944.

REPORT

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1592.

Examination of a New Cutting Tool Material
As to Possible Special Armour-Piercing Properties.

(Copy No. 13.)

Bureau of Mines
Division of Metallic Minerals

Ore Dressing and Metallurgical Laboratories

CANADA
DEPARTMENT OF MINES AND RESOURCES
Mines and Geology Branch

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Source of Material and Object of Investigation:

On January 26th, 1944, Col. H. N. Sowdon, for Military Technical Adviser, Department of Munitions and Supply, Ottawa, Ontario, submitted two samples of cutting tool material. In his accompanying letter (File 279-039) Colonel Sowdon stated it was claimed this material will cut hard armour plate better than tungsten carbide tools will. It was requested that the samples be examined and that a report be made as to what the material is and whether it has any special properties which would be of interest for A/P projectiles.

In a letter dated January 28th, 1944, C. A. Meadows, Chief Engineer, of Armstrong, Wood & Co., Industrial Engineers, Temple Building, 62 Richmond Street W., Toronto, Ontario, (Source of Material and Object of Investigation, cont'd) -

supplied the following further information regarding these materials:

MEMORANDUM RE NEW CUTTING TOOL MATERIAL.

1. The material is moulded by heating and pouring, not by compressing metal powder.

2. It is a non-ferrous and non-magnetic alloy, and is acid-proof.

3. Specific gravity - 8.77.

4. Hardness - 61-62 Rockwell 'C' scale, as poured.

5. The alloy should be poured in moulds at a temperature of about 3100° F. It can reach approximately that temperature when cutting metal without undue damage.

6. So far graphite moulds have been used; the alloy leaves the moulds in a smooth condition and requires only a few thousandths of an inch grind to finish it to size.

7. Grinding: For tools and tool tips it can be ground on any general purpose wheel in use in shop, provided ordinary precautions are taken. For best results and finish a soft silicon carbide wheel should be used.

8. Regarding toughness as compared with tungsten carbide, it is a true alloy, whereas tungsten carbide is a cemented mixture. Therefore it is not as brittle and is tougher in every way. It can be used for cutting tools in shapers and planers - tungsten carbide will not stand that shock.

9. By actual tests it has proven superior to other cutting tools on the following points:

   (a) With respect to cost;
   (b) Ease of manufacture;
   (c) No special grinding equipment necessary;
   (d) Superiority on heavy machine cuts - 200 to 300 per cent increased production;
   (e) Intermittent cutting (shock);
   (f) Less time taken to set up tools.

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Macro-Examination and Magnetic Tests, Etc.:

One of the samples submitted had been made into a cutting tool. The alloy sample appeared to be free from porosity and shrinkage cavities. The material was found to be

(Macro-Examination and Magnetic Tests, Etc., cont'd) -

non-magnetic. It appeared to unattacked by hydrochloric acid or aqua regia.

Specific Gravity:

A specific gravity determination was carried out by the Loss in Weight in Water method. A value of 8.505 was obtained.

Hardness Tests:

The material was found to have a Rockwell hardness of 61 'C' scale.

Spectrographic Analysis:

A qualitative spectrographic analysis showed the following elements to be present:

Major Elements - Cobalt, chromium, tungsten.

Minor Elements - Manganese, iron, silicon.

Faint Traces - Copper, nickel, magnesium.

Chemical Analysis:

A sample of the new cutting tool material was analysed chemically and the following results were obtained:

		Per Cent
Cobalt	-	47.25
Chromium	-	32.15
Tungsten	-	13.14
Manganese	-	2.27
Iron	-	2.86
Silicon	-	0.79
Carbon	-	Not determined.

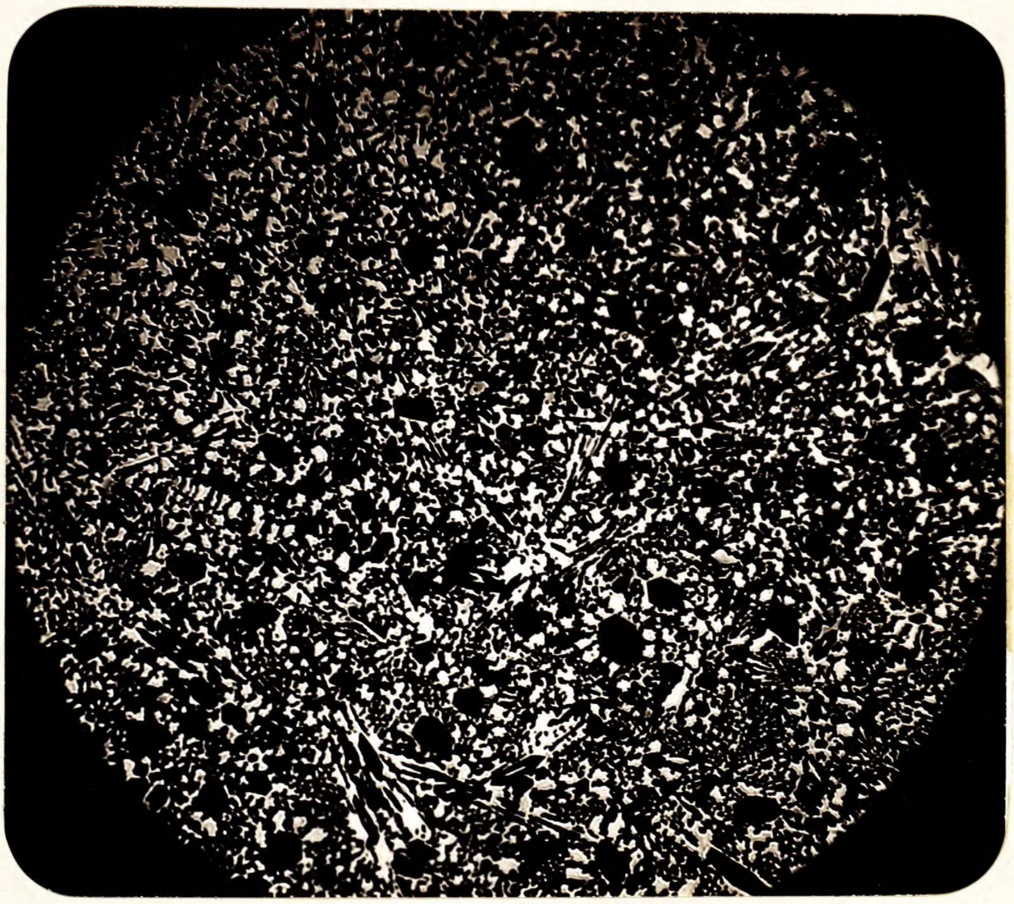
Microscopic Examination:

A sample of the material was given a metallographic polish, etched in alkaline ferricyanide solution, and examined under the microscope. The etched structure is shown in Figure 1, a photomicrograph at X500 magnification. The structure shows carbides embedded in what is most probably a cobalt solid solution.

(Continued on next page)

(Microscopic Examination, cont'd) -

Figure 1.



X500, etched in
alkaline-ferricyanide solution.

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Machining Tests:

Comparative machining tests were carried out with the new cutting material submitted, against a number of cutting tools in use in our machine shops. These tests indicated that the new cutting tool was able to withstand heat better than ordinary grades of tungsten tool steel. A test against #90 Deloro Stellite indicated that the new bit had properties somewhat similar to this latter cutting tool. Tests against Carboloy seem to indicate that in certain applications the new bit was superior; however, more tests would have to be carried

(Machining Tests, cont'd) -

out before any definite statement can be made. It would appear, however, to have better ductility than Carboloy and therefore would have higher impact properties.

Remarks:

The alloy used in making these bits was found to contain cobalt, chromium and tungsten as the major constituents. The material was found to have substantially the properties given in the memorandum that accompanied Mr. Meadows' letter, with the exception of the density, which was found to be slightly lower.

It is of interest that the structure does not show any dendrites, usually associated with a cast material. There also are no acicular constituents present, which should render it tougher.

The machining tests, although only of a qualitative nature, indicated that the material has merit. In the light of the rather crude tests conducted, we feel that the material would perform similarly to stellite. It would appear to be useful in applications where higher bit hardnesses are required, i.e., in heavy cuts, etc.

With regard to possible armour-piercing properties, it is worthy of note that the density of ferrous metals is around 7.85, while the density of the material examined was 8.50, as compared with tungsten carbide at 14 and up. All other properties being equal it is not thought that it would offer any advantage over A/P projectiles made from steel alloys.

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