File

O T T A W A August 18, 1945.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1919.

Corrosion Resistance, Composition and Hardness of Clasp Knife Parts.

(Copy No. 10.)

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Background:

A letter* was received on May 31, 1945, from W/C P. W. Webb, Director, Inter-Service Research and Development (Clothing and Equipment), Department of National Defence, Army, 299 Bank Street, Ottawa, Ontario, requesting tests on five pocket knives brought to these Laboratories by F/L Hewson. Enclosed with the letter was a copy of the Marine Corps Specification - Knife, Pocket, Utility.

The tests were to be performed in order to obtain data for writing specifications for the corrosion resistance, chemical composition and hardness of the knife parts.

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*(File No. DIRD-(P)-105-11).

Identification of Knives Examined:

The knives were numbered and photographed as received, to identify each throughout the tests (see Figure 1).

	Mark	Location
Knife 1. -	SSP 1944 ↑	Stamped on handle.
Knife 2. -	Whittingslowe Opener 15737 Pat. Appn. Adelaide	Stamped on handle.
Knife 3. -	G. Bberson & Co. Sheffield, 1943	Stamped on can opener.
Knives 4 and 5. -	M.S. Ltd. XX	Stamped on blade.

TESTS PERFORMED:

Hardness.

Table I gives hardness of various parts of the five knives and, where given, hardness from the Marine Corps specification.

TABLE I. - Hardness of Knife Parts

	Knife 1	Knife 2	Knife 3	knife 4	Knife 5	Marine Corps Specification
Blade, Rockwell "C"	48-50	58	55-53	53-54	47-56	56-61
Can Opener, Rockwell "C"	48	47.51	48-53	53-54	23-59*	42-52
Springs, Rockwell "C"	41-43	50-56	40-42	41-50	50-54	45-51
Separator	48-51 Rockwell "C".	90-93 Rockwell "B".	99-100 Rockwell "B".	32-35 Rockwell "C".	39-50 Rockwell "C".	
Handle, Rockwell "B"	69-76	36-42	90-94	94-96	92-97	

* High value obtained near cutting edge. Low value obtained near back of the part.

Corrosion Resistance.

All parts were cleaned and degreased by washing in trichlorethylene, and then were exposed in a salt spray

(Corrosion Resistance, cont'd) -

cabinet at 95° F. using a 20 per cent salt (sodium chloride) solution. The results were:

After 6 hours: No. 1 had no corrosion on the clevis and two sides of the handle. Local areas corroded on all other parts.

No. 2 had some corrosion along the cutting edge of the blade, around all holes and a few other localized spots, probably where the plating was damaged.

No. 3 had begun to rust in certain small areas.

Nos. 4 and 5 had all parts covered with fine specks of rust.

After 24 hours: No. 1 had no corrosion on the clevis and two sides of the handle. Corrosion on blade and can opener still localized. That on springs and separator general but light.

No. 2 blade had local corrosion on edge and around the hole. Corrosion general on remainder of knife.

Nos. 3, 4 and 5 had fairly heavy general corrosion over entire surface.

After 72 hours: Corrosion quite severe on most parts except handle and clevis of No. 1.

The appearance of the various parts after 72 hours in the salt spray cabinet is shown in Figure 2, with the corrosion product not removed.

Chemical Composition

Tables II to VI give the chemical composition of the knife blades, can openers, knife springs, knife separators and knife handles, respectively.

TABLE II. - Chemical Composition of Knife Blades.

	Knife 1	Knife 2	Knife 3	Knife 4	Knife 5
	- Per Cent -				
Carbon -	0.34	0.55	0.80	0.78	1.08
Manganese -	0.61	0.75	0.55	0.41	0.42
Silicon -	0.21	0.23	0.18	0.15	0.25
Nickel -	0.15	Nil.	●●	Trace.	Trace.
Chromium -	11.07	0.04	Nil.	Nil.	0.10
Molybdenum -	0.08	Trace.	Trace.	Trace.	Trace.
Vanadium -		Nil.	Nil.	Nil.	Nil.

TABLE III. - Chemical Composition of Can Openers.

	Knife 1	Knife 2	Knife 3	Knife 4	Knife 5
	- Per Cent -				
Carbon -	0.34	0.56	0.44	0.78	0.70
Manganese -	0.58	0.75	0.54	0.40	0.70
Silicon -	0.10	0.19	0.14	0.15	0.16
Nickel -	0.10	Nil.	Trace.	Nil.	Trace.
Chromium -	11.94	0.29	Nil.	Nil.	Nil.
Molybdenum -	0.06	Trace.	Trace.	Trace.	Trace.
Vanadium -		Nil.	Nil.	Nil.	Nil.

TABLE IV. - Chemical Composition of Knife Springs.

	Knife 1	Knife 2	Knife 3	Knife 4	Knife 5
	- Per Cent -				
Carbon -	0.36	0.54	0.50	0.75	0.79
Manganese -	0.51	0.67	0.71	0.39	0.36
Silicon -	0.09	●●	0.18	0.15	0.15
Nickel -	0.20	0.30	Trace.	Trace.	Trace.
Chromium -	12.11	Trace.	Nil.	0.12	0.06
Molybdenum -	0.07	0.01	Trace.	0.05	0.06
Vanadium -		Nil.	Nil.	Nil.	Nil.

●● Insufficient sample for determination.

(Chemical Composition, cont'd) -

TABLE V. - Chemical Composition of Knife Separators.

	Knife 1	Knife 2	Knife 3	Knife 4	Knife 5
	- Per Cent -				
Carbon -	0.35	0.63	0.82	0.83	0.86
Manganese -	0.64	0.86	0.79	0.30	0.24
Silicon -	0.09	0.14	0.17	0.13	0.14
Nickel -	**	Nil.	Nil.	Trace.	Trace.
Chromium -	11.80	0.05	Nil.	0.10	0.05
Molybdenum -	**	Trace.	Trace.	Trace.	Trace.
Vanadium -		Nil.	Nil.	Nil.	Nil.

TABLE VI. - Chemical Composition of Knife Handles.

	Knife 1	Knife 2	Knife 3	Knife 4	Knife 5
	- Per Cent -				
Carbon -	0.15	0.06	0.24	0.37	0.36
Manganese -	0.41	0.38	1.10	0.53	0.50
Silicon -	0.09	Nil.	0.09	0.11	0.10
Nickel -	0.23	Nil.	Trace.	Trace.	Trace.
Chromium -	14.62	Nil.	Nil.	Nil.	Nil.
Molybdenum -	0.09	Nil.	Trace.	Trace.	Trace.
Vanadium -		Nil.	Nil.	Nil.	Nil.

(** Insufficient sample for determination.)

Conclusions:

The low chromium content of all knives, with the exception of Knife No. 1, accounts for the poor corrosion resistance. In the case of Knife No. 1 the parts with a bright finish had quite good resistance to corrosion, while the section of the blade, can opener and springs that were not so well finished corroded more readily.

An enquiry was sent to Atlas Steels Limited, Welland, Ontario, requesting their opinion of the suitability of 0.60 per cent carbon, 14 per cent chromium steel for this purpose, and whether the International Silver Co., at Niagara Falls, Ont., could make the blades. The following reply was received:

"We have your letter of July 5th regarding stainless steel for clasp knife blades and wish to advise that we

(Conclusions, cont'd) -

do manufacture a .60% carbon, 17% chromium steel, known as No-Kor-O 18-H-60, which should be suitable. The grade to select depends entirely on the hardness required for the cutting edge. The above grade will develop a Rockwell hardness as high as C 58. The standard cutlery grade is .35% carbon, 14% chromium, which will develop a hardness as high as C 53. Naturally, the toughness depends on the degree of hardness. The harder the blade, the more brittle, which may also be a factor in your problem.

The International Silver Company at Niagara Falls should be able to handle the manufacturing end of this job."

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The steel suggested by Atlas Steels Limited is very similar to the "Modified Cutlery Type" listed in page 538 of the 1939 edition of the "Metals Handbook", published by the American Society for Metals. The chemical composition of this Modified Cutlery Type is given in Table VII, below, and the physical properties are listed in Table VIII.

TABLE VII. - Nominal Chemical Composition of Modified Cutting Type. (Per Cent)

Carbon	Silicon	Manganese	Chromium	Molybdenum
0.55-0.75	0.40	0.45	15.0-18.0	0.50 (optional)

TABLE VIII. - Typical Physical Properties (from ASM Metal Handbook, 1939)

	Oil-quenched at 1850° F., Tempered 450° F.	Oil-quenched at 1850° F., Tempered 1250° F.	Annealed, 1650° F.
Yield point, p.s.i.	245,000	100,000	54,000
Tensile strength, p.s.i.	270,000	130,000	95,000
Elongation, per cent in 2 inches	2.0	12.0	27.0
Reduction in area, per cent	3.5	30.0	45.0
Izod impact, ft-lb.	3	6	14.0
Brinell hardness	545	286	185
Rockwell hardness	55 "C"	105 "B"	91 "B"

It is suggested that useful handles, and possibly separators, could be made from Aluminium Alloy 75ST, which has good corrosion resistance and lightness in addition to

(Conclusions, cont'd) -

unusually high strength for an aluminium alloy, namely, ultimate strength, 88,000 p.s.i., and yield strength, 80,000 p.s.i.

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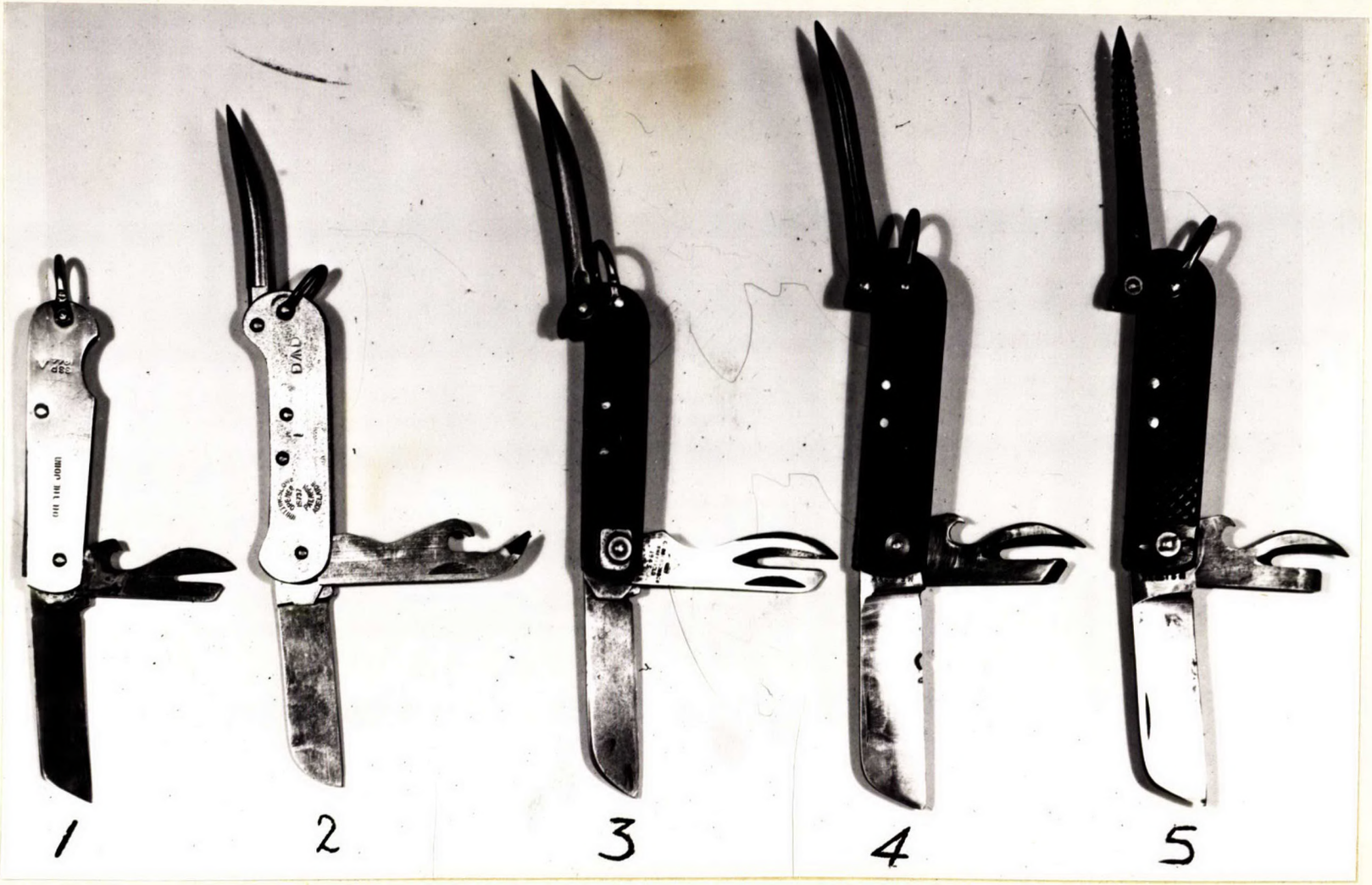

Figure 1.

GENERAL APPEARANCE OF THE FIVE CLASP KNIVES AS RECEIVED.

(Approximately 1/2 size).

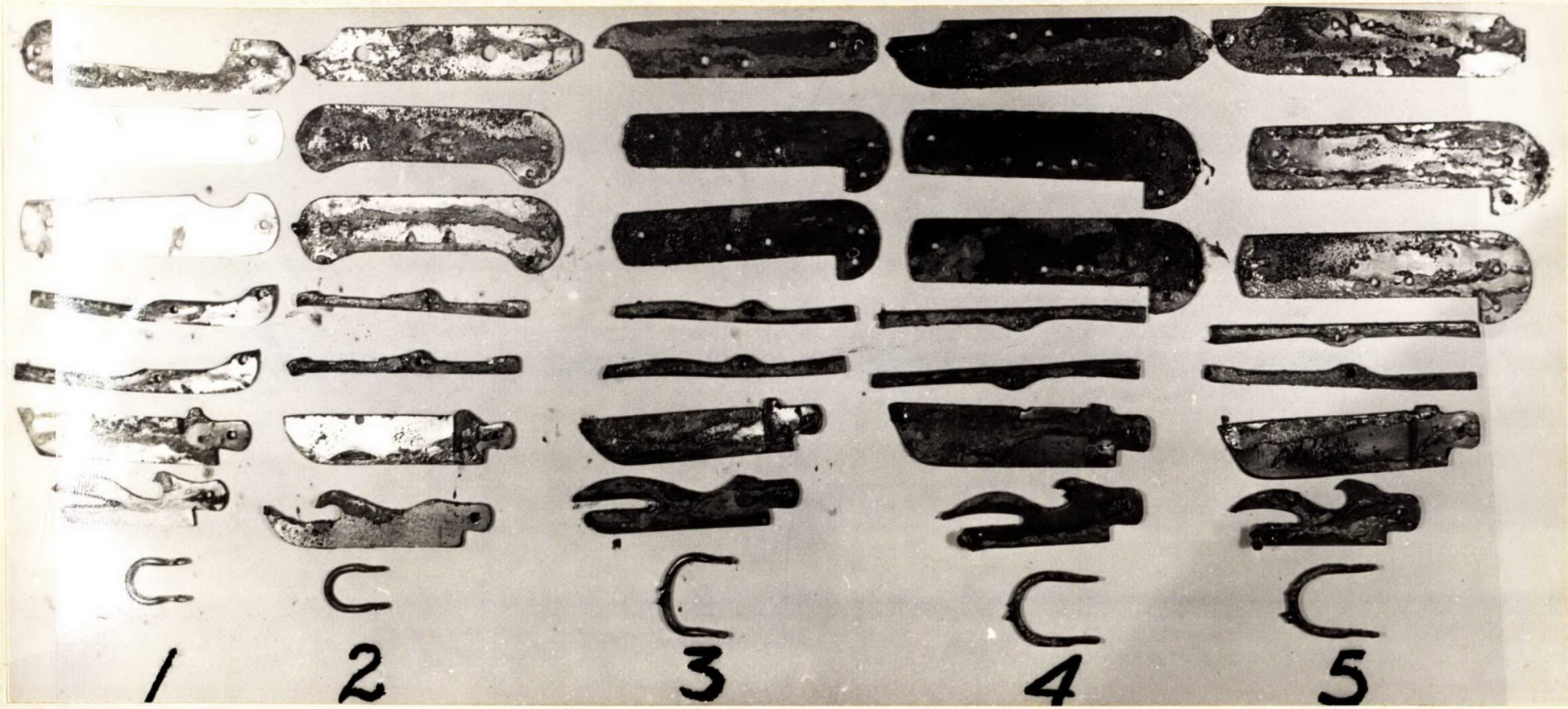

Figure 2.

APPEARANCE OF THE KNIFE PARTS AFTER 72 HOURS IN SALT SPRAY.

Corrosion product not removed.

(Approximately 1/2 size).

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