O T T A W A March 14th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1179.

(Subsequent to Investigation No. 1153, dated February 5th, 1942.)

Examination of Extruded Aluminium Alloy Shapes. (II)

(Copy No. 6.)

BUREAU OF MINES
DIVISION OF METALLIC MINERALS

ORE DRESSING AND
METALLURGICAL LABORATORIES

CANADA
DEPARTMENT
OF
MINES AND RESOURCES
MINES AND GEOLOGY BRANCH

O T T A W A March 14th, 1942.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1179.

(Subsequent to Investigation No.
(1153, dated February 5th, 1942.)

Examination of Extruded Aluminium Alloy Shapes. (II)

Origin of Problem and Object of Investigation:

In a letter dated February 12th, 1942, Mr. K. S. Rawlins, Assistant Chief Inspector (Materials), British Air Commission, Washington, D. C., requested the examination of two further samples of aluminium alloy extrusions similar to those that were submitted on January 13th and covered in

(Origin of Problem and Object of Investigation, cont'd) -

Report of Investigation No. 1153, dated February 5th, 1942.

For the present investigation, two samples were submitted.[*] One of them, marked "H," was heat-treated by the contractor who normally machines and heat-treats the wing fittings of which these extrusions form a part. The other was received as extruded (without heat treatment).

It was requested that an investigation similar to No. 1153 (macro- and micro-examination), and also tensile tests with determinations of 0.1 per cent and 0.2 per cent proof stresses, ultimate stress, and elongation on 4D, be made on these samples. It was also requested that after macro-examination of the non-heat-treated sample it be heat-treated at a temperature as close to but not exceeding 930° F., quenched, aged, and the mechanical properties tested.

It was further requested that the compositions be determined, both chemically and spectroscopically, with special attention to traces of nickel, titanium, zinc, chromium, and tin.

The shape of the extrusions was the same as shown in Figure 1 of the Report of Investigation No. 1153.

In the present report the sample submitted "as heat-treated" is designated No. 3 and that submitted "as extruded" is designated No. 4.

X-Ray Examination:

X-ray examination carried out by L. W. Ball, of the National Research Laboratories, Ottawa, showed that the submitted extrusions have a generally sound structure, except for apparent flaws in the section adjacent to the

---

[*] Received on February 10th.

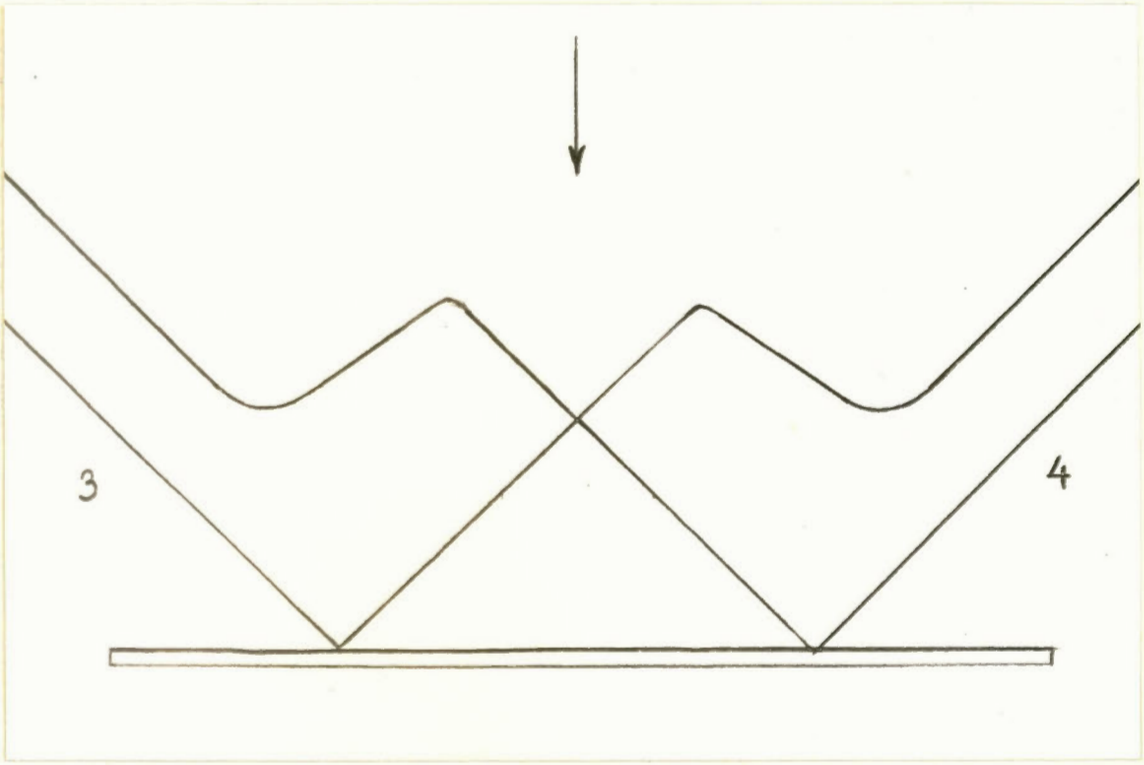
(X-Ray Examination, cont'd) -

bottom edge of the heavy portion of the extrusion.

The location of this area is shown in Figure 1.

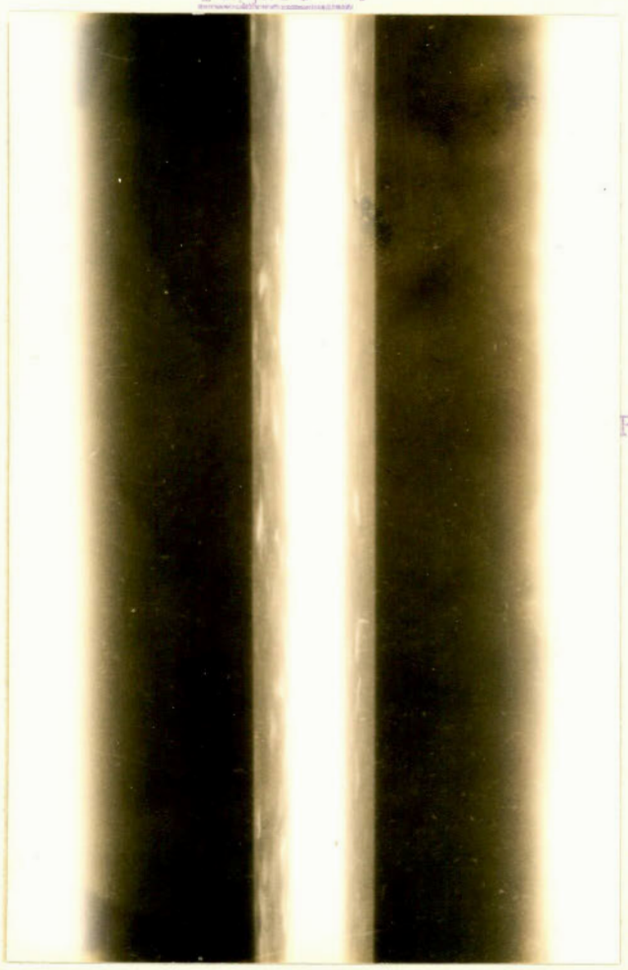
The character of the detected flaws is shown in Figure 2.

Figure 1.



Showing the manner of taking the radiograph.
Natural size.

Figure 2.



RADIOGRAPH.

Macro-Examination:

Macro-examination of both samples gave no indications of any defects and showed structures similar to those of previously submitted samples (see Figure 2 of Report of Investigation No. 1153).

Heat Treatment:

Sample No. 4 (submitted "as extruded") was given the following heat treatment:

45 minutes at 925° F. in a salt bath;
quenched in cold water; and
aged 5 days at room temperature.

Chemical Analysis:

a) Wet Analysis -

	Sample No. 3	Sample No. 4	SAE Spec. AMS-4152
	-(Per cent)-		
Copper -	4.28	4.27	3.8-4.9
Magnesium -	1.61	1.60	1.2-1.8
Manganese -	0.60	0.61	0.3-0.9
Silicon -	0.16	0.16	0.5 max.
Iron -	0.20	0.20	0.5 "
Titanium -	trace	trace	-
Zinc -	trace	trace	0.03 max.
Chromium -	trace	trace	0.025 max.
Nickel -	none	none	-
Tin -	none	none	-

b) Spectrographic Analysis (qualitative only) -

Sample No. 3:

Essential	-	Al, Cu, Mg
Strong traces	-	Mn, Fe, Si
Faint traces	-	Ti, Ni, Be
Nil	-	Zn, Sn, Cr

Sample No. 4:

Essential	-	Al, Cu, Mg
Strong traces	-	Mn, Fe, Si
Faint traces	-	Ti, Ni, Be, Zn, Sn
Nil	-	Cr

Mechanical Properties:

TENSILE TESTS -

Figure 3 shows the locations where the specimens for tensile testing were taken from both submitted extrusions.

Sample No. 3 (received as heat treated) - Test Specimens A, B, C, and D were obtained for examination.

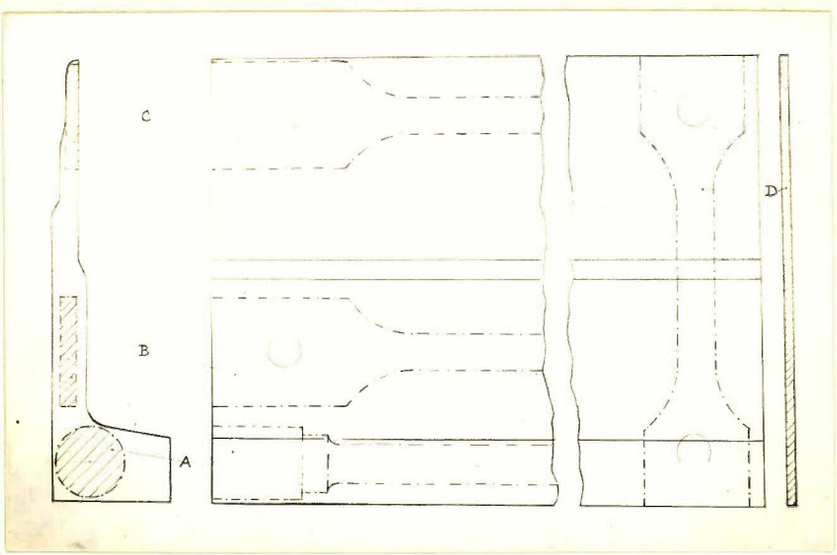
Sample No. 4 (after heat treatment in these laboratories) - Test Specimens A, B, and C were obtained for examination.

Table No. 1 gives the results of the tensile tests. The gauge length of "4D" means four times the diameter of the round test bar or four times the diameter of a circle of an area equal to the cross-sectional area of the flat test specimen.

All fractures of the test specimens showed sound material.

For purposes of comparison, Table No. 2 shows the S.A.E. specifications for this type of aluminium-alloy extrusion.

Figure 3.



Locations of tensile test specimens.
(Approximately 1/3 size).

(Continued on next page)

(Mechanical Properties, cont'd) -

Table No. 1.

Results of Tensile Tests.

Sample No.	Size of sample, inches	0.1% P.S., p.s.i.	0.2% P.S., p.s.i.	U.T.S., p.s.i.	ELONGATION In 2 in., %	ELONGATION In 4D, %
3 A	.564 diam.	53,000	54,000	78,600	15	15
B	.249 x .501	43,600	44,800	70,300	17.5	18
C	.158 x .500	43,700	45,000	67,800	16.5	16.8
D	.068 x .501	45,400	47,000	69,900	15	16.6
4 A	.564 diam.	53,400	54,400	79,000	17.5	16.8
B	.224 x .500	49,000	50,300	71,100	18	20.5
C	.167 x .501	43,000	45,000	69,200	20	20

Table No. 2.

S.A.E. Specification AMS-4152 for Al-Alloy Extrusions.

Thickness, in inches	Yield Point, p.s.i. min.	Ult. Tens. Strength, p.s.i. min.	Elongation in 2 inches, % min.
0.050-0.249	42,000	57,000	12
0.250-1.499	44,000	60,000	12
1.500 and greater	52,000	70,000	10

HARDNESS -

Hardness was determined by the Vickers method, using a 10-kilogram load.

Sample No. 3, As heat-treated - 130-140 V.H.N.

Sample No. 4, As extruded - 60-65 V.H.N.

After heat treatment - 130-140 V.H.N.

Micro-Examination:

The examination of the microstructure showed it to be very similar in all respects to the previously submitted samples, the structures of which are shown in Figures 3 to 8

(Micro-Examination, cont'd) -

of Report of Investigation No. 1153.

No traces whatsoever of any defects in structure could be detected to check the apparent flaws shown in the X-ray examination.

Conclusions:

The submitted aluminium alloy extrusions have a generally sound material as shown by the X-ray, macro, and micro examinations. X-ray examination reveals only minor imperfections in one corner of the heavy section. Micro-examination showed no defects in the portion of the extrusions that the X-ray examination indicated may have been defective. It may be concluded, then, that what appear to be cavities or defects are in reality areas in which an element of a lower atomic number than aluminium has segregated. This cannot, for all practical purposes, be regarded as a defect.

The mechanical properties obtained are considerably higher than the average, especially in the transverse direction.

oooooooooooo
oooooo
oo

JWM:PES.