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O T T A W A August 7th, 1944.

R E P O R T

of the

ORE DRESSING AND METALLURGICAL LABORATORIES.

Investigation No. 1697.

Investigation of the Influence of Pouring Temperature on the Properties of Magnesium Alloy Cast Test Bars.

(Copy No. 10 .)

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Investigation of the Influence of Pouring Temperature on the Properties of Magnesium Alloy Cast Test Bars.

Origin of Material and Object of Investigation:

On July 5th, 1944, forty (40) magnesium alloy test bars were received from Light Alloys, Limited, Renfrew, Ontario, for metallurgical examination. Thirty-two of the bars had been cast in standard D.T.D. moulds.

The remaining eight bars had been cast using the method of gating and risering indicated on Page 144 of "Technology of Magnesium and Its Alloys" (by Adolf Beck)*. The illustration shown on that page is reproduced in this report (see Figure 1). Four of these bars were chilled, while four were not.

Pouring temperatures had been noted and were listed in an accompanying letter. It was reported that the

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* Published by F. A. Hughes & Co. Ltd., Abbey House, London, N.W.1, 1940.

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

bars had been radiographed and that, on inspection of the radiographs, Bars B43B1, B43B2, B43C, B45A, B46A, B47C2, B48A, B48C, B49C2, B43S2 and B45S2 were found to be relatively free of porosity. Bars B46B2 and B49A were found to be poor in this respect. It was also reported that there was a marked tendency towards greater porosity at the lower end of the test bars.

It was requested that mechanical tests be performed on the bars and that the grain size be determined.

Results:

The results of the mechanical tests were previously reported in P.M. Lab. Report No. 7235, issued on July 15th, 1944, and are repeated here for the sake of completeness.

The grain size was determined using the chart, based on the A.S.T.M. standard austenitic grain sizes, published by Basic Magnesium Incorporated. The samples were etched in 1 per cent nital. Figures 2, 3 and 4, respectively, show the largest, average, and smallest grain sizes encountered.

Grain size determinations were also made on several samples cut from light sections of castings poured at the same time as the test bars.

TABLE I. - Grain Size of Light Sections.

No.		Grain Size
B42	-	13
B43	-	14
B44	-	14-15
B45	-	15
B46	-	14

(Continued on next page)

(Results, cont'd) -

TABLE II.

Bar No.	Pouring Temp. °C.	Pouring Temp. °F.	Ultimate Stress, p.s.i.	Proof Stress, p.s.i. 0.1%	Proof Stress, p.s.i. 0.2%	Proof Stress, p.s.i. 0.5%	Elongation in 2 inches, per cent	Grain Size
B42A1	760	1400	22,800	9,600	12,400	16,200	3.0$^{\Phi\Phi}$	11-12
B42A2	760	1400	22,800	11,700	13,400	16,000	3.0	12
B42B	715	1320	25,600	10,600	12,800	16,000	4.5	12
B42C	688	1270	24,600	11,000	13,200	16,400	4.5	13
B43A	765	1410	22,000	11,200	13,200	16,500	3.0	12
B43B1	704	1300	25,200	11,600	13,600	16,800	3.5	12-13
B43B2	704	1300	26,600	11,600	13,800	16,600	4.5$^{\Phi}$	14
B43C	691	1275	27,600	11,200	13,200	16,400	4.0$^{\Phi}$	12-13
B44A	749	1380	26,100	11,600	13,600	16,400	4.0$^{\Phi}$	11-12
B44B	710	1310	25,600	10,400	12,800	16,300	4.5	13-14
B44C1	688	1270	23,600	9,500	11,400	14,800	3.5	11-12
B44C2	688	1270	21,200	9,600	11,600	15,400	3.0	11-12
B45A	760	1400	24,400	10,600	13,200	16,600	3.5	13
B45B1	732	1350	24,400	11,000	13,200	16,000	5.0	13
B45B2	732	1350	27,200	11,200	13,200	16,000	5.0$^{\Phi\Phi}$	13-14
B45C	693	1280	23,200	10,800	12,800	15,900	3.5$^{\Phi\Phi}$	12
B46A	771	1420	25,400	9,200	11,000	14,800	4.0$^{\Phi}$	11-12
B46B1	743	1370	25,600	12,400	14,000	16,600	5.0	14
B46B2	743	1370	23,000	10,400	12,500	15,400	5.0	14
B46C	677	1250	22,200	8,800	11,200	15,000	4.0	12
B47A	771	1420	26,000	9,600	12,000	15,600	4.0$^{\Phi}$	14
B47B	732	1350	24,400	8,800	11,000	15,600	4.0	15
B47C1	688	1270	24,800	9,400	11,500	15,000	4.5	11
B47C2	688	1270	26,400	9,680	11,700	15,200	4.5	12-13
B48A	782	1440	26,100	12,160	14,000	16,800	5.0	15
B48B1	682	1360	24,400	11,200	13,400	17,000	3.0$^{\Phi}$	13-14
B48B2	682	1360	25,600	12,000	14,000	16,200	3.5$^{\Phi}$ $\not$	14-15
B48C	699	1290	25,600	11,600	13,800	16,800	3.0$^{\Phi}$	14
B49A	777	1430	21,800	9,000	11,000	14,400	3.5	13
B49B	732	1350	23,400	10,000	12,000	15,600	4.0	13
B49C1	660	1220	22,600	11,200	13,000	16,000	4.0	13
B49C2	660	1220	23,200	10,000	12,000	15,400	4.0	12
B43S1	677	1250	25,000	11,200	13,400	16,400	3.5	14
B43S2	677	1250	17,400	9,360	11,280	14,100	1.5$^{\Phi}$	13-14
B45S1	727	1340	20,000	11,400	13,200	15,800	4.0	14
B45S2	727	1340	23,600	12,800	14,800	17,300	2.0$^{\Phi}$	14
B46S1	710	1310	22,400	10,400	12,400	15,300	2.0$^{\Phi}$	13
B46S2	710	1310	27,200	12,000	14,000	17,000	5.0$^{\Phi}$	13
B48S1	699	1290	23,200	10,000	12,400	15,900	3.5	13
B48S2	699	1290	26,800	12,600	14,800	17,600	3.5$^{\Phi}$	13

$^{\Phi\Phi}$ Broke outside middle third of gauge length.
$\not$ Flaw in fracture. $^{\Phi}$ Broke outside gauge marks.

Note: Last eight bars horizontally cast; S1 - not chilled, S2 - chilled.

Discussion:

A statistical analysis was made of the results of the mechanical tests and grain size determinations, in an attempt to observe any variation in properties with varying pouring temperature. It was shown that the pouring temperature has very little effect on the properties observed. There was an indication that the range of 1300-1350° F. might be the optimum with regard to tensile properties. Further experimentation within this range appears warranted and would be necessary before any conclusions can be drawn.

The grain size was practically unaffected by the pouring temperature. There was a tendency for the higher temperatures to produce a slightly finer grain. Thinner sections also tend to produce a slightly finer grain size. Chilling, as practiced in the horizontally cast bars, had no effect on the grain size. The chilled bars, however, tend to have slightly higher mechanical properties than the unchilled bars.

Conclusions:

Reported pouring temperatures had very little influence on the grain size and mechanical properties of the submitted cast magnesium alloy test bars. There appears to be a range of temperatures between 1300 and 1350° F. at which optimum properties are obtained, but further experimentation in this range is necessary.

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Figure 1.

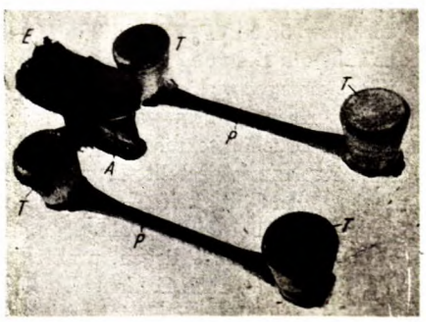

Fig. 197. Separately cast sand-cast test bars, 0·5 in. diameter (in some cases 0·8 in. diameter). *E* downgate, *A* gate, *P* test bars, *T* risers.

DIAGRAM SHOWING METHOD OF GATING AND RISERING HORIZONTALLY CAST TEST BARS.

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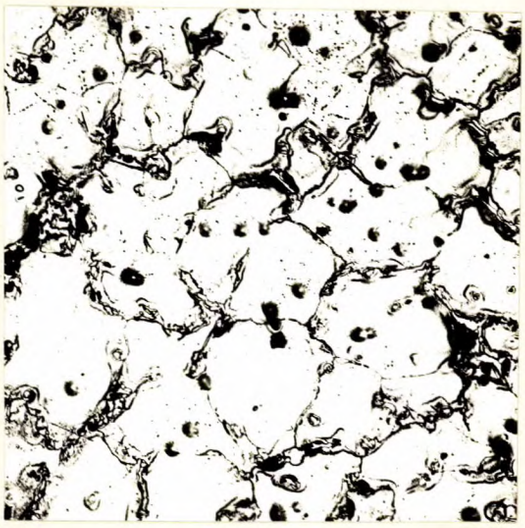
Figure 2.



X100, 1 per cent nital etch.
MAGNESIUM GRAIN SIZE NO. 11.
Largest grain size observed.

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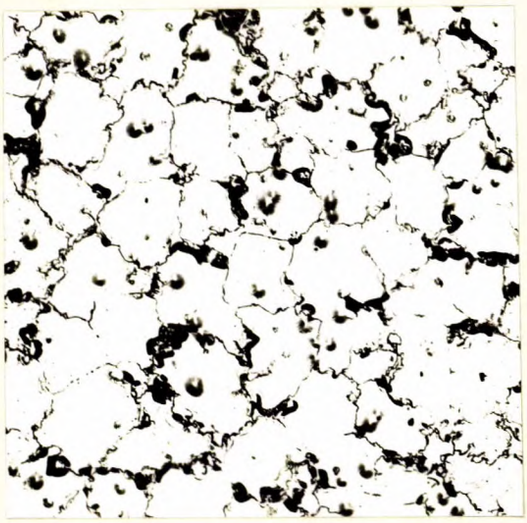
Figure 3.



X100, 1 per cent nital etch.
MAGNESIUM GRAIN SIZE NO. 13.
Average grain size observed.

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Figure 4.

X100, 1 per cent nital etch.
MAGNESIUM GRAIN SIZE NO. 15.
Finest grain size observed.

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