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THE COLLEGE OF AERONAUTICS

DEPARTMENT OF MATERIALS

High temperature creep properties of Mo T.Z.M. Alloy

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Introduction

This memorandum reports a series of experiments to determine some tensile creep properties of Mo T.Z.M. alloy at elevated temperatures in the range 1200°C to 1800°C, the material being in sheet form.

A subsequent memorandum will report some creep properties of W-ThO_2 alloy.

Experimental

The furnace and associated control apparatus used for these tests is that developed to investigate the high temperature properties of graphite and is fully described in the College of Aeronautics Report No. F.T.R. No. 1.

Some modifications were carried out on the loading and measuring mechanism, the torsional system was removed and a new gripping and loading mechanism substituted enabling dead weight tensile loading to be employed.

Details of this system are shown in figure 1. Specimens with a $\frac{1}{2}''$ gauge length and a $\frac{1}{4}''$ gauge width were machined from the 0.020" thick material supplied. The specimen was supported on tungsten pins into carbon rods, the lower rod pinned onto a nimonic rod extension. The upper grip being fixed to the furnance body and the lower grip extension supporting a lead weight.

A simple screw jack, initially supporting the weight, was used to apply the load when required, the specimen, specimen grips and loading system was under vacuum for the duration of the test.

Creep strain was recorded by means of a travelling microscope focussed through a vacuum-tight window onto the lower specimen grip extension.

The specimens were loaded in such a way that the gauge length was contained within the furnace hot zone throughout the test.

Results

The following series of experiments have been completed and the results are shown tabulated in figures 2, 3, 4 and 5 with series 1, 2 and 3 plotted to a base of log time in figures 6 and 7.

Series 1

Soak for 1 hour at testing temperatures: 1400°C, 1500°C, 1600°C and 1800°C. Load to 4 tons/in^2.

Series 2

Soak for 1 hour at temperatures: 1800°C, 1600°C, 1400°C.
Load to 4 tons/in^2 at 1400°C.

Series 3

Soak for 1 hour at testing temperature 1200°C. Load to 10 tons/in^2.

NB. For this test the gauge area was reduced to enable the same lead weight to be used.

Series 4

Soak for 1 hour at testing temperatures: 1400°C, 1500°C, 1600°C. Load to 4 tons/in^2 and remove load when approximately 3 m.m. extension recorded.

For experiments 1, 2 and 3 an unloaded portion of the same material was attached to the specimen such that it was contained within the hot zone of the furnace, these together with the specimens have been returned to the sponsors.

Figure 2

Creep Tests on Mo T.Z.M. Alloy - Series 1

Test No. 1 Temp. 1400°C		Test No. 2 Temp. 1500°C		Test No. 3 Temp. 1600°C		Test No. 4 Temp. 1600°C		Test No. 5 Temp. 1800°C	
Time (mins)	C.S. (mm)	Time (mins)	C.S. (mm)	Time (mins)	C.S. (mm)	Time (mins)	C.S. (mm)	Time (mins)	C.S. (mm)
1	2.05	1	2.13	0.5	2.53	1	2.76	1	4.47
2	2.06	1.5	2.23	1	2.67	1.5	2.99	1.25	4.94
3	2.06	2	2.28	1.5	2.76	2	3.19	1.50	5.39
5	2.065	3	2.33	2	2.83	3	3.48	1.75	5.88
10	2.16	4	2.41	3	2.93	4	3.79	2.0	6.27
15	2.22	5	2.48	4	3.04	5	4.06		
20	2.26	10	2.80	5	3.10	5.5	4.25		
25	2.30	15	3.15	10	3.72	6	4.59		
30	2.36	20	3.58			6.5	4.80		
45	2.51					7	5.13		
60	2.68					7.5	5.68		
75	2.80								
90	3.03								
105	3.08								
120	3.21								
135	3.41								

Figure 3

Creep tests on Mo T.Z.M. Alloy - Series 2

Test No. 6 - Soak at 1800°C Test at 1400°C		Test No. 7 - Soak at 1600°C Test at 1400°C		Test No. 8 - Soak at 1500°C Test at 1400°C	
Time (Mins)	Creep Strain (mm)	Time (Mins)	Creep Strain (mm)	Time (Mins)	Creep Strain (mm)
0.5	2.19	1	2.24	0.5	1.77
1	2.20	2	2.24	1	1.77
2	2.20	5	2.24	2	1.80
3	2.20	15	2.24	3	1.84
5	2.20	30	2.35	4	1.86
10	2.20	35	2.41	5	1.89
15	2.20	40	2.48	10	1.97
20	2.20	45	2.56	15	2.08
30	2.20	50	2.66	20	2.19
45	2.20	55	2.82	25	2.29
60	2.20	57	2.85	30	2.45
75	2.20	60	2.92	35	2.54
90	2.20	65	3.05	40	2.66
120	2.30	70	3.19	45	2.90
125	2.33	75	3.48	50	3.05
130	2.38	80	3.78	55	3.18
135	2.46	81	3.96	60	3.31
140	2.53			65	3.48
145	2.59			70	3.75
150	2.68			71.25	4.06
155	2.82				
156	2.93				

Figure 4

Creep tests on Mo T.Z.M. Alloy - Series 3

Test No. 9

Temperature 1200°C Load 10 t.s.i.

Time mins.	Creep Strain mm.
0.5	1.64
1	1.75
2	1.78
3	1.86
4	1.92
5	2.00
6	2.09
8	2.21
10	2.41
11	2.63

Figure 5

Creep tests on Mo T.Z.M. Alloy - Series 4

Test No. 10 Temp. 1400°C		Test No. 11 Temp. 1500°C		Test No. 12 Temp. 1600°C	
Time (mins)	C.S. (mm)	Time (mins)	C.S. (mm)	Time (mins)	C.S. (mm)
0.5	1.77	0.5	2.09	0.5	1.4
1	1.77	1	2.09	1	2.75
2	1.79	2	2.11	1.6	3.00
3	1.80	3	2.15		
4	1.81	4	2.18		
5	1.82	5	2.21		
10	1.86	7	2.31		
15	1.90	9	2.36		
20	1.93	10	2.41		
30	1.96	12	2.51		
45	2.03	15	2.63		
60	2.10	18	2.76		
75	2.20	20	2.86		
90	2.30	22.5	3.00		
105	2.40				
120	2.55				
135	2.68				
150	2.84				
160	3.00				

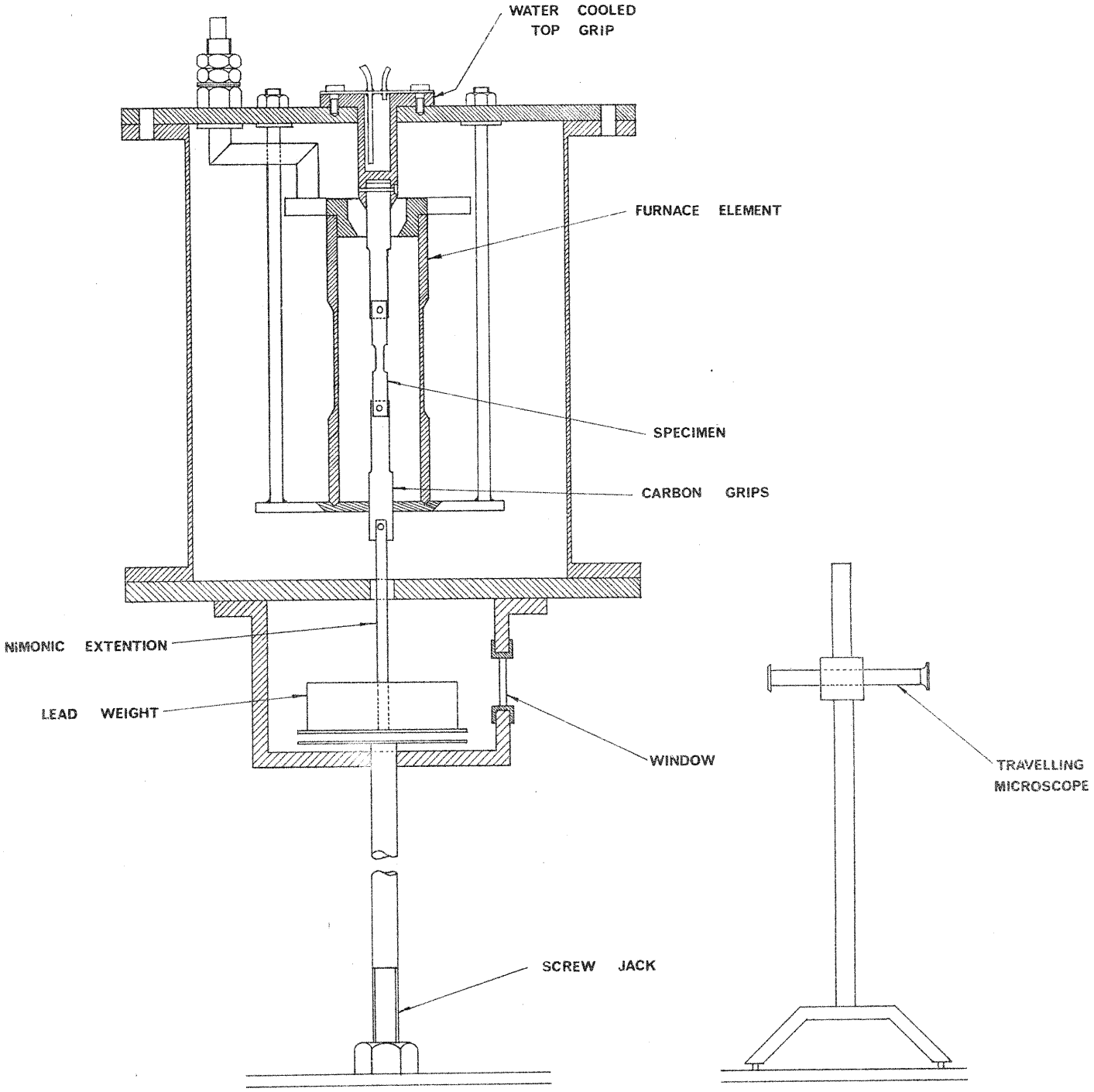

FIGURE 1 LAYOUT OF FURNACE, AND LOADING SYSTEM

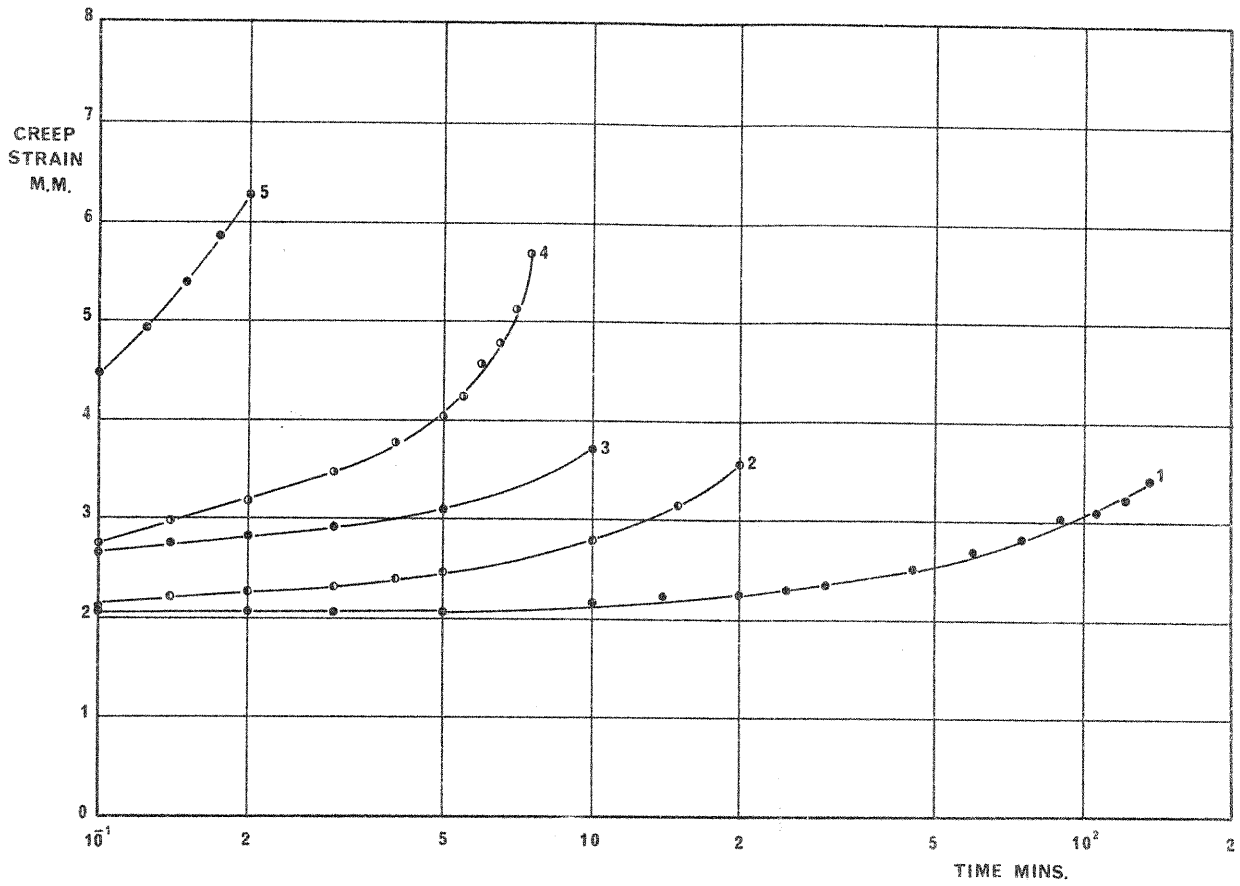

FIGURE 6 SERIES 1

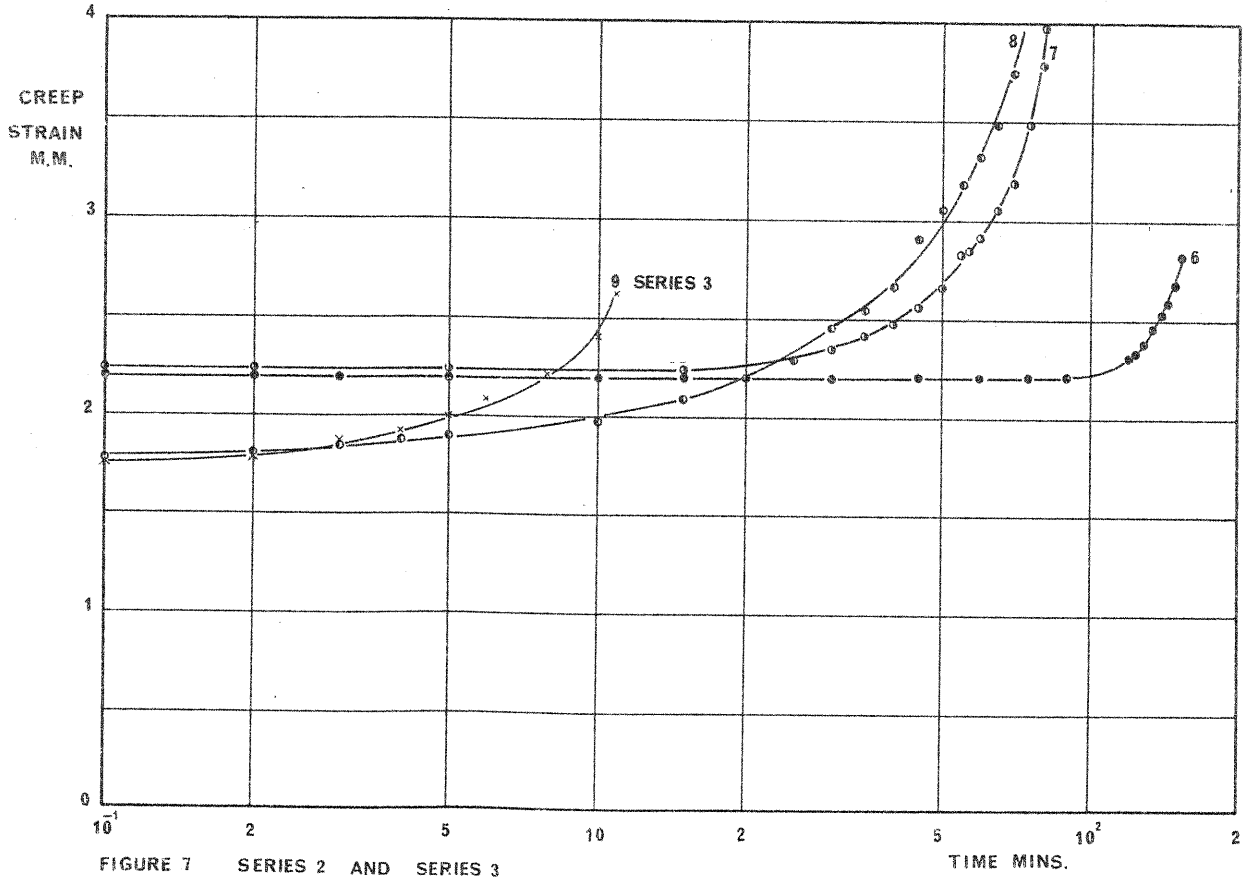

FIGURE 7 SERIES 2 AND SERIES 3