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DEPARTMENT OF MATERIALS

Stress redistribution due to creep in Nimonic 90

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Report for the period June, 1965 to July, 1966

- by -

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Introduction

Part I of this report, dated September 1965, deals mainly with the design and construction of the special apparatus to simulate the stress redistribution occurring during the creep of a cooled turbine blade. It reported some preliminary experiments using aluminium alloy test specimens.

During the past year, the period covered by this report, a series of experiments have been completed using specimens machined from nimonic 90 alloy.

Experience gained in operating the apparatus, have resulted in several modifications both to the apparatus and the associated instrumentation. These are detailed within this report.

2. Modification to apparatus

2.1 Mand extensometers

The original extensometers as received from Mand Precision Engineering Co. were of sufficient length to permit the use of the furnaces as constructed and detailed in Part I section 2.3. They have been lengthened by inserting a nimonic rod into each arm of the extensometer.

The two pairs of arms comprising the unit are held together at the lower end by a system of springs and rods which trap hardened steel rollers between the arms and the lower specimen grip. Due to the increased ratio of specimen to pivot and pivot to spring distance caused by the above modification it was difficult to maintain contact between the extensometer grooves and the specimen ridges. Thin nimonic strips were therefore welded to each of the extensometer arms adjacent to the grooves so that each pair of arms could be wired into position onto the specimen gauge length.

2.2 Transducers

In the original design it was considered adequate to use only one strain measuring transducer per specimen. Subsequent experiments, however, have shown that during the initial loading some bending takes place leading to an incorrect strain reading. Two transducers are now used per specimen: they are electrically coupled to read the average strain, computed from readings taken from either side of the gauge length. All tests, after and including No. 38 were carried out using this modification.

2.3 Load Transfer

The flexible tubes interconnecting the load drums, (ref. Part I, section 2.2), have been replaced by tubes of a larger diameter allowing an increased rate of load transfer during the initial part of the experiment,

after which the throttling valve is adjusted to minimise the effect of hunting during the steady conditions.

This modification is effective after and including test No. 57.

2.4 Load cutout device

Throughout the majority of tests prior to No. 51, an intermittent fault occurred when the indicator was programmed to select the standard transducer and thus set and lock the position of the automatic uniselectors, (Ref. Part I, Appendix 2).

The fault resulted in an incorrect reading being indicated. In the majority of cases, the error was .0001", and occurred perhaps once per 25 to 30 readout cycles.

With the uniselectors locked in a different position to that at the start of the test, load transfer occurred triggered by the fault and not by an error signal generated by a difference in strain reading.

Various attempts were made both by the College and the manufacturers, to cure this fault, with very little success. Consequently it was decided to accept an occasional error and design a device to reject resulting information.

Fig. 1 shows the circuit employed. The indicator bridge is balanced by shifting the tap on each of four cascaded auto-transformers the position of which when at rest is indicated by neon number tubes.

The circuit is such that the anode of individual number tubes is supplied with a positive dc voltage and the particular number selected by grounding the respective cathode to the negative rail, via a segment on the automatic uniselectors.

A separate isolated d.c. supply was constructed with negative rail grounded and positive rail connected to one side of three relays coils, RL_1, RL_2, and RL_3.

The circuit to each coil was completed by connection to the wipers of three, ten-way single pole switches S_1, S_2, and S_3, and then to the indicator bank on the indicator uniselectors US_1, US_2, US_3.

Thus when a particular number is selected on the ten way switches the associated relay is energised only when that number is indicated, earth continuity to the relay coil being through the switch and through the uniselector bank.

Three normally open contacts, one on each relay, are connected in series and used to control the operation of the pumping mechanism.

If a false standard is indicated no pumping will occur until a further sequence is initiated by the programmer, and the correct standard is set up.

3. Results

A number of single and combined tests have been completed and are tabulated in figures 2 to 41.

These include a series of single-specimen creep tests designed to provide short term creep data at relevant temperatures and loads, and combined two-specimen tests, at various initial loads distributed equally at the start of the test, and various temperature combinations of the same mean temperature.

In the above series the transducers were balanced when a stable temperature was achieved and the tabulated results include instantaneous plastic strain.

A further series of tests have been completed at the same mean temperature but with different combinations of initial stress: (a) to simulate the thermal stress problem and (b) to set up at the start of a test the final redistributed stresses occurring at the completion of an 'equal starting load' experiment.

The instantaneous extension occurring at the initial load was computed using a modulus of 22×10^6 lb/in^2 and the extensometers set such that the zero setting was at the start of creep and not at the start of loading.

One preliminary experiment has been carried out in which the temperature of one specimen was adjusted during the experiment.

Two batches of nomonic 90 have been used:

(1) Material obtained from N.G.T.E. was used for tests up to and including 51.

(2) Material obtained direct from Henry Wiggin, from a billet put aside for N.G.T.E., was used for the remaining experiments.

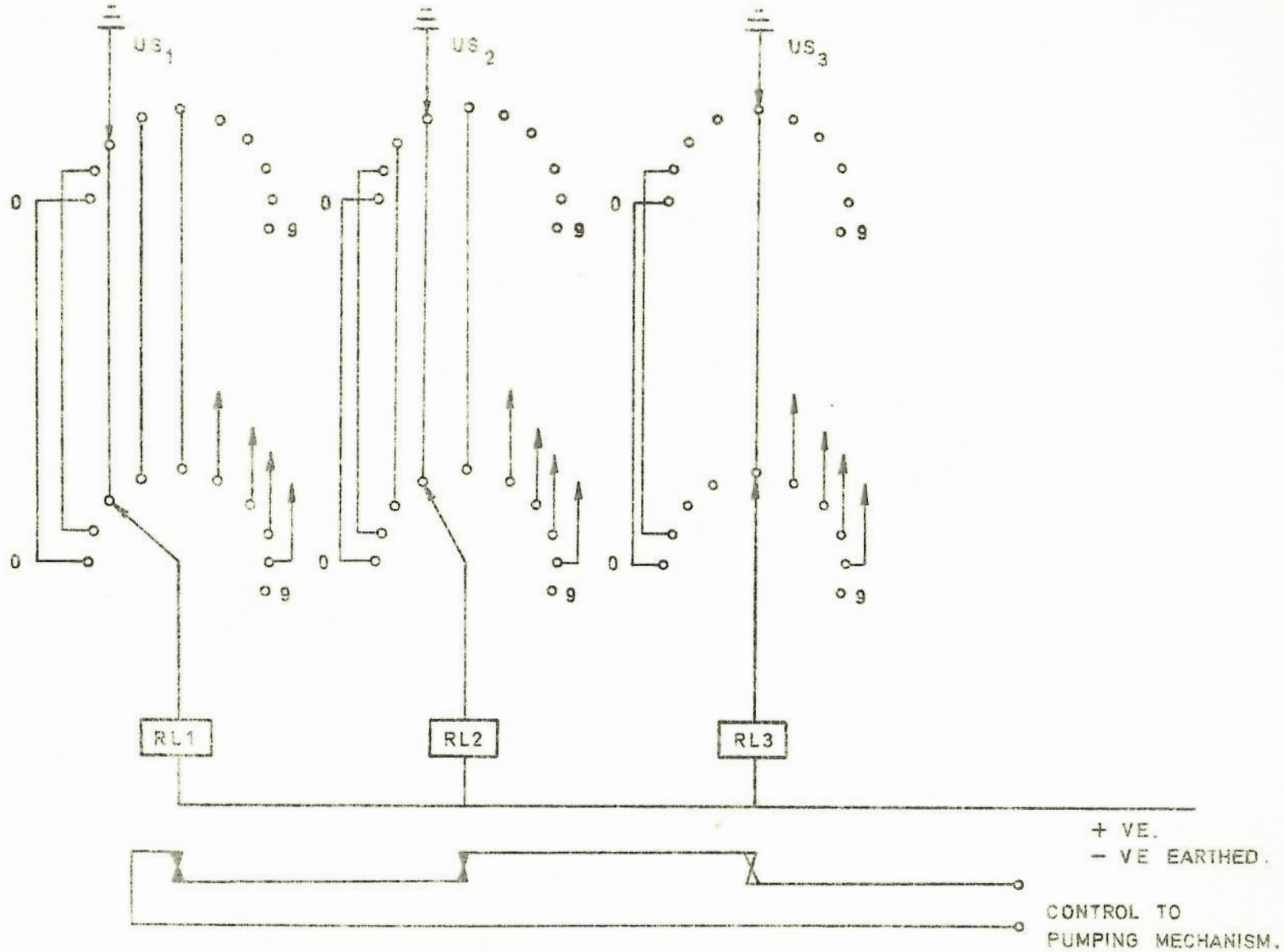

FIG. 1 CIRCUIT DIAGRAM OF LOAD CUT-OUT MECHANISM

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Single Specimen Creep Test
Temperature 875°C, 10 t.s.i.
Specimen Size 0.175" dia. G.L.1"

Test No. 38

Time	Ext.ins.
0	0
20 sec	.00134
1 min	.00142
2	.001425
3	.001445
4	.001455
5	.00146
10	.001455
15	.001465
20	.00149
25	.001485
30	.001465
35	.00147
40	.00150
45	.00154
50	.00161
55	.001575
60	.00156
2 hrs	.00170
3	.001785
4	.00184
5	.00188
6	.00191
7	.00197
8	.001975
9	.00205
10	.002095
11	.002175
12	.002215
13	.00228
14	.002345
15	.00241
16	.00251
17	.002585
18	.002695
19	.00279

Time	Ext.ins.
20	.00285
21	.00293
22	.003165
23	.00329
24	.003485
25	.00365
26	.003865
27	.00411
28	.004385
29	.00462
30	.004905
31	.005235
32	.005555
33	.005965
34	.00643
35	.006915
36	.00750
37	.00819
38	.00894
39	.009815
40	.01079
41	.011865
42	.013055
43	.01440
44	.01509
45	.01767
46	.01953
47	.02151
48	.02392
49	.02655
50	.02936
51	.03280
52	.03670
53	.04088
54	.04546
55	.05045

Figure 2.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Single Specimen Creep Test
Temperature 875°C, 10 t.s.i.
Specimen size 0.175" dia. G.L.1"

Test No. 39

Time	Ext.ins.
1 min	.00106
2	.001105
3	.001165
4	.001205
5	.00122
10	.001315
15	.001355
20	.001335
25	.00133
30	.001365
35	.00138
40	.00140
45	.00139
50	.00141
55	.00138
60	.001425
2 hrs	.00147
3	.001395
4	.00143
5	.001255
6	.00129
7	.001265
8	.001235
9	.00125
10	.00144
11	.00143
12	.00146
13	.001445
14	.00147

Time	Ext.ins.
15	.001475
16	.001465
17	.001475
18	.00149
19	.001495
20	.001505
21	.001515
22	.00157
23	.00171
24	.001715
25	.00173
26	.001705
27	.001735
28	.00168
29	.00164
30	.001675
31	.001625
32	.001645
33	.001645
34	.00168
35	.001665
36	.00159
37	.00159
38	.001585
39	.001595
40	.001595
41	.00161
42	.001625
43	.00165

Time	Ext.ins.
44	.00165
45	.00166
46	.001635
47	.00165
48	.00167
49	.001665
50	.00167
51	.001665
52	.001665
53	.001665
54	.001665
55	.00159
56	.001695
57	.00171
58	.001695
59	.00150
60	.001495
61	.001495
62	.00150
63	.001505
64	.00150
65	.00151
66	.00151
67	.00152
68	.001545
69	.00156
70	.001575
71	.001555
72	.00156

Time	Ext.ins.
73	.001605
74	.001625
75	.001625
76	.001625
77	.001635
78	.00163
79	.00164
80	.001645
81	.001645
82	.001645
83	.001645
84	.00163
85	.00165
86	.001685
87	.00168
88	.00169
89	.00168
90	.00170
91	.001725
92	.00175
93	.001715
94	.00176
95	.001825
96	.00168
97	.001865
98	.001875
99	.001845
100	.001755

Figure 3

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Single Specimen Test
Temperature 825°C, 12 t.s.i.
Specimen size 0.166" dia. G.L.1" Test No. 40

Time	Ext.ins.	Time	Ext.ins.	Time	Ext.ins.	Time	Ext.ins.
1 min	.00120	15	.00137	44	.00150	73	.00162
2	.00119	16	.00135	45	.00154	74	.00166
3	.00116	17	.00134	46	.00159	75	.00157
4	.00116	18	.00134	47	.00158	76	.00168
5	.00118	19	.00147	48	.00154	77	.00165
10	.00116	20	.00144	49	.00155	78	.00166
15	.00117	21	.00141	50	.00156	79	.00167
20	.00125	22	.00140	51	.00149	80	.00167
25	.00123	23	.00143	52	.00153	81	.00168
30	.00115	24	.00142	53	.00151	82	.00168
35	.00113	25	.00147	54	.00154	83	.00168
40	.00120	26	.00144	55	.00155	84	.00167
45	.00123	27	.00143	56	.00154	85	.00170
50	.00118	28	.00145	57	.00154	86	.00172
55	.00116	29	.00143	58	.00154	87	.00174
60	.00117	30	.00146	59	.00156	88	.00172
2 hrs	.00126	31	.00144	60	.00155	89	.00173
3	.00121	32	.00145	61	.00155	90	.00175
4	.00128	33	.00145	62	.00155	91	.00173
5	.00126	34	.00145	63	.00156	92	.00172
6	.00128	35	.00145	64	.00157	93	.00173
7	.00131	36	.00146	65	.00157	94	.00178
8	.00132	37	.00144	66	.00160	95	.00179
9	.00131	38	.00145	67	.00164	96	.00180
10	.00132	39	.00144	68	.00165	97	.00177
11	.00132	40	.00144	69	.00166	98	.00176
12	.00132	41	.00145	70	.00164	99	.00179
13	.00132	42	.00143	71	.00164	100	.00182
14	.00133	43	.00143	72	.00164		

Figure 4.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Combined Test Specimen dia. 0.166"
Specimen A - 825°C 10 t.s.i. (484 lbs.)
Specimen B - 875°C 10 t.s.i. (484 lbs.) Test No. 41.

Time	Ext.	Load A	Load B
0	0	484	484
1 min	.00080	423	545
2	82	430	538
3	82	435	533
4	82	437	531
5	82	434	534
10	86	467	511
15	86	453	515
20	86	465	502
25	88	468	500
30	89	465	503
35	90	468	500
40	87	442	526
45	84	457	511
50	94	469	499
55	95	457	511
1 hr	94	453	515
2	.00100	465	503
3	102	484	484
4	102	476	492
5	104	446	522
6	111	484	504
7	113	492	476
8	118	500	468
9	121	511	457
10	122	518	450
11	126	520	448
12	127	526	442

Time	Ext.	Load A	Load B
13	.00128	522	446
14	132	530	438
15	135	538	430
16	138	552	416
17	137	541	427
18	141	563	405
19	178		
20	178	484	484
21	180	507	461
22	184	508	460
23	196	518	450
24	196	526	442
25	195	526	442
26	199	543	425
27	202	550	418
28	203	554	414
29	197	546	422
30	202	546	422
31	204	550	418
32	203	550	418
33	202	563	405
34	208	552	416
35	208	561	407
36	209	558	410
37	211	565	403
38	213	575	393
39	214	575	393
40	214	583	385

Figure 5

Test No. 41 continued.

Time	Ext.	Load A	Load B
41	.00216	585	383
42	217	587	381
43	219	588	380
44	220	593	375
45	221	588	380
46	221	595	373
47	220	600	368
48	222	601	367
49	225	602	366
50	227	596	372
51	225	602	366
52	231	604	364
53	230	604	364
54	231	613	355
55	231	618	350
56	234	615	353
57	234	617	351
58	236	622	346
59	236	622	346
60	237	624	344
61	238	622	346
62	241	625	343
63	242	620	348
64	239	620	348
65	242	620	348
66	242	620	348
67	238	620	348
68	241	619	349
69	243	619	349

Time	Ext.	Load A	Load B
70	.00242	619	349
71	244	620	348
72	244	620	348
73	246	620	348
74	245	620	348
75	247	620	348
76	247	620	348
77	250	620	348
78	252	619	349
79	253	619	349
80	250	619	349
81	250	619	349
82	255	619	349
83	258	619	349
84	259	619	349
85	261	619	349
86	262	619	349
87	260	619	349
88	261	618	350
89	262	618	350
90	261	618	350
91	263	618	350
92	264	618	350
93	284	706	262
94	286	688	280
95	284	682	286
96	287	688	280
97	312	593	375
98	317	596	372

Figure 6.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Combined Test
Specimen A - 825°C 11.5 t.s.i. (557 lbs)
Specimen B - 675°C 11.5 t.s.i. (557 lbs)

Specimen dia. 0.166"
Test No. 42

Time	Ext.	Load A	Load B
0	0	557	557
1 min	.00074	477	637
2	71	495	619
3	71	496	615
4	71	507	607
5	73	512	602
10	71	499	615
15	72	511	603
20	73	512	602
25	76	504	610
30	77	500	614
35	82	498	616
40	82	498	616
45	83	496	618
50	80	492	622
55	86	461	653
1 hr	92	472	642
2	.00105	508	606
3	114	532	582
4	121	544	570
5	129	584	530
6	140	609	505
7	142	602	512
8	143	596	518
9	143	612	502
10	153	619	495
11	153	622	492
12	154	629	485
13	155	630	481
14	172	674	440
15	173	673	441
16	169	639	475
17	193	682	432
18	173	639	475
19	173	647	467
20	192	695	419
21	183	656	458
22	187	674	440
23	190	665	449
24	193	656	458

Time	Ext.	Load A	Load B
25	.00203	700	414
26	193	663	451
27	201	677	437
28	203	675	439
29	203	688	426
30	209	675	439
31	208	691	423
32	212	700	414
33	213	700	414
34	213	700	414
35	213	700	414
36	213	707	407
37	220	708	406
38	222	708	406
39	223	708	406
40	223	708	406
41	223	708	406
42	233	716	398
43	233	717	397
44	238	713	401
45	239	716	398
46	242	715	399
47	243	717	397
48	252	717	397
49	252	717	397
50	254	717	397
51*	258	761	353
52*	273	677	437
53	283	717	397
54	283	708	406
55	283	717	397
56	289	717	397
57	293	726	388
58	293	726	388
59	293	726	388
60	302	734	380
61	302	733	381
62	303	726	388
63	303	734	380
64	310	734	380

Figure 7.

Test No. 42 continued.

Time	Ext.	Load A	Load B
65	.00313	734	380
66	313	734	380
67	322	734	380
68	323	734	380
69	323	734	380
70	333	734	380
71	333	743	371
72	333	741	373
73	340	743	371
74	343	734	380
75	343	742	372
76	352	743	371
77	354	734	380
78	354	743	371
79	359	741	373
80	363	734	380
81	372	743	371
82	373	734	380
83	383	741	373
84	383	743	371
85	391	734	380
86	393	734	380
87	402	734	380
88	403	734	380
89	423	761	353
90	423	726	388
91	423	734	380
92	433	734	380
93	439	735	379
94	443	735	379
95	454	734	380
96	454	734	380
97	460	734	
98	472	734	
99	482	734	
100	483	734	
101	493	734	
102	502	734	
103	512	734	
104	513	734	
105	523	734	

Time	Ext.	Load A	Load B
106	.00533	734	
107	543	733	381
108	552	734	380
109	556	734	
110	573	734	
111	583	734	
112	592	734	
113	602	734	
114	613	734	
115	623	726	388
116	633	726	
117	651	726	
118	661	726	
119	683	726	
120	703	734	380
121	713	726	388
122	723	734	380
123	733	734	380
124	753	733	381
125	769	726	388
126	783	727	387
127	802	726	388
128	813	726	388
129	833	726	388
130	854	726	
131	784	726	
132	889	726	
133	907	724	390
134	934	726	388
135	953	725	389
136	973	717	387
137	.01000	717	387
138	1023	726	388
139	1050	725	389
140	1073	717	397
141	1103	717	397
142	1131	717	397
143	1191	717	397
144	1191	717	397
145	1220	717	397
146	1244	717	397

Figure 8.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Combined test
Specimen A. 825°C at 11.5 t.s.i.
Specimen B. 900°C - 875°C - 850°C - 875°C

Specimen dia. 0.166"

Test No. 43

Time	Ext.	Load A	Load B
0	0	557	557
1 min	.00127	583	531
2	131	600	514
3	136	615	499
4	137	610	504
5	140	614	500
10	146	611	503
15	150	606	508
20	152	612	502
25	154	609	505
30	156	615	499
35	156	624	490
40	157	621	493
45	159	628	486
50	159	633	481
55	161	629	485
1 hr.	160	635	479
2	172	654	460
3	178	662	452
4	188	688	426
5	188	700	414
10	205	743	371
21	249	760	354
22	255	761	353
23	258	772	342
24	267	770	344
25	270	780	334
26	272	785	329
27	279	782	332
28	280	790	324
29	287	784	330
47	352	800	314

TEMP. CHANGED TO 875°C.

Time	Ext.	Load A	Load B
48 hrs	.00368	820	294
48.5 m	369	831	283
10	372	845	269
15	372	837	277
20	372	845	269
25	372	835	279
30	372	817	297
35	378	847	267
40	379	854	260
45	372	832	282
50	380	844	270
55	378	819	295
49 hrs	381	845	269
52	391	808	306
70	440	751	363
93	572	717	397
94	570	720	394
95	579	713	401
96	590	720	394
97	601	727	387
98	606	735	379
99	619	731	383
100	627	720	394
101	636	737	377
102	648	740	374
117	841	716	398
118	849	723	391
119	872	697	417

TEMP. CHANGED TO 850°C.

Figure 9.

Test No. 43 continued

Time	Ext.	Load A	Load B
120 hrs	.00880	700	414
120 hrs 5 mins	882	709	405
10 "	886	712	402
15 "	882	701	413
20 "	886	714	400
25 "	888	694	420
30 "	887	677	437
35 "	888	698	416
40 "	889	716	398
45 "	892	714	400
50 "	891	696	418
55 "	892	686	428
121 hrs	892	696	418
122	903	699	415
123	907	687	427
124	916	671	443
125	924	688	426
126	933	670	444
127	943	673	441
128	948	681	433
129	958	679	435
130	965	675	439
131	975	681	433
132	983	674	440
133	997	668	446
134	.01004	674	440
135	1018	670	444
136	1028	664	450
137	1040	658	456
138	1052	664	450
139	1062	662	452
140	1077	662	452
141	1087	664	450
142	1099	675	439
143	1120	656	458
TEMP. CHANGED TO 875°C			

Time	Ext.	Load A	Load B
144 hrs	.01132	657	457
144 hrs 5 mins	.01132	682	432
10 "	.01132	678	436
15 "	1138	664	450
20 "	1141	670	444
25 "	1142	682	432
30 "	1146	686	428
35 "	1150	681	433
40 "	1149	688	426
45 "	1152	688	426
50 "	1152	676	438
56 "	1158	678	436
145 hrs	1161	679	435
146	1192	695	419
147	1222	694	420
148	1257	707	407
149	1289	688	426
150	1322	697	417
165	2032	678	436
166	2062	683	432
167	2122	689	425
168	2189	683	431

Figure 10.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Combined Test
Specimen A - 825 11.5 t.s.i.
Specimen B - 875 11.5 t.s.i.

Specimen dia. 0.1875"

Test No. 44

Time	Ext.	Load A	Load B
0	0	711	711
1 min	.00104	754	668
2	104	772	650
3	103	793	629
4	104	811	611
5	105	813	609
10	105	826	596
15	109	842	580
20	109	832	590
25	112	839	583
30	116	842	580
35	116	851	571
40	116	857	565
45	120	858	564
50	119	846	576
55	122	860	562
1 hr.	124	867	555
2	130	836	586
3	133	824	598
4	140	844	578
5	139	840	582
6	146	862	560
7	154	853	569
24	192	867	555
25	195	861	561
26	197	850	572
27	200	865	557
28	200	858	564
29	204	863	559
30	209	866	556
31	214	890	532
32	215	874	548
33	216	877	545
34	220	877	545
35	222	885	537
36	226	886	536

Time	Ext.	Load A	Load B
37	.00226	885	537
38	230	898	524
39	234	890	532
40	236	908	514
41	236	906	516
42	242	911	511
43	245	909	513
44	245	895	527
45	246	907	515
46	251	897	527
47	256	913	509
48	254	897	527
49	256	890	532
50	261	891	531
51	263	896	526
52	266	892	530
53	266	894	528
54	274	895	527
55	280	897	525
56	276	891	531
57	283	896	526
58	286	888	534
59	285	889	533
60	290	890	532
61	296	891	531
62	296	896	526
63	297	894	528
64	297	890	532
65	301	890	532
66	306	886	536
67	312	891	531
68	315	881	541
69	321	903	519
70	326	899	523
71	326	897	525
72	334	913	509

Figure 11.

Test No. 44 continued.(1)

Time	Ext.	Load A	Load B
73	.00335	903	519
74	336	879	543
75	344	895	527
76	346	893	529
77	351	889	533
78	359	903	519
79	360	899	523
80	363	888	534
81	366	886	536
82	374	895	537
83	376	879	543
84	391	880	542
85	397	903	519
86	394	891	531
87	395	880	542
88	399	891	531
89	403	887	535
90	412	893	529
91	416	894	528
92	425	892	530
93	430	881	541
94	436	892	530
95	442	895	527
96	446	877	545
97	456	898	524
99	468	884	538
100	473	872	550
101	483	900	522
102	482	889	533
103	490	877	545
104	497	886	536
105	502	887	535
106	512	883	539
107	518	879	543
108	526	881	541
109	535	877	545

Time	Ext.	Load A	Load B
110	.00546	888	534
111	554	887	535
112	561	876	546
113	570	882	540
114	581	885	537
115	586	880	542
116	597	876	546
117	606	879	543
118	616	879	543
119	626	885	537
120	640	888	534
121	646	880	542
122	660	888	534
123	673	887	535
124	684	888	534
125	697	883	539
126	705	887	535
127	720	881	541
128	734	876	546
129	746	882	540
130	761	890	532
1	772	881	541
2	786	880	542
3	802	876	546
4	816	882	540
5	834	884	538
6	846	877	545
7	866	876	546
8	882	879	543
9	898	882	540
140	911	880	542
1	928	876	546
2	950	877	545
3	968	876	546
4	990	880	542
5	.01006	879	543

Figure 12.

Test No. 44 continued. (2)

Time	Ext.	Load A	Load B
146	.01032	887	535
7	1051	880	542
8	1073	869	553
9	1094	876	546
150	1116	874	548
1	1141	876	546
2	1165	871	551
3	1191	869	553
4	1214	880	542
5	1236	876	546
6	1266	877	545
7	1294	884	538
8	1316	868	554
9	1346	868	554
160	1376	814	558
1	1412	867	555
2	1430	863	559
3	1483	870	552
4	1516	873	549
5	1546	865	557
6	1586	871	551
7	1625	870	552
8	1664	871	551
9	1702	863	559
170	1754	874	548
1	1797	874	548
2	1843	872	550
3	1886	867	555
4	1937	869	553
5	1988	858	554
6	2036	865	557
7	2086	863	559
8	2146	862	560
9	2199	864	558
180	2266	861	561
1	2325	865	557

Time	Ext.	Load A	Load B
182	.02385	867	555
3	2454	860	562
4	2524	863	559
5	2586	859	563
6	2666	859	563
7	2736	855	567
8	2816	857	565
9	2895	859	563
190	2977	859	563
1	3056	856	566
2	3146	855	567
3	3246	865	557
4	3336	858	564
5	3436	856	566
6	3546	857	565
7	3646	856	566
8	3766	854	568
199	3876	852	570

Figure 13.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Combined Test
Specimen A - 800°C 11.5 t.s.i. (711 lbs)
Specimen B - 900°C 11.5 t.s.i. (711 lbs)

Specimen dia. .1875"
5 min to balance
Test No. 45

Time	Ext.	Load A	Load B
0	0	711	711
5 min	.00160	1011	411
10	161	1004	418
15	164	1007	415
20	164	1006	416
25	165	1006	416
30	168	1012	410
35	169	1023	399
40	168	1032	390
45	170	1018	404
50	172	1026	396
55	172	1023	399
1 Hr.	173	1024	398
2	176	1029	393
3	184	1044	378
4	190	1054	368
5	193	1056	366
6	197	1078	344
7	201	1081	341
8	204	1088	334
9	206	1086	336
10	209	1090	332
11	211	1094	328
12	214	1098	324
13	215	1096	326
14	218	1108	314
15	220	1098	324
*16	223	1110	312
17	255	1257	165
18	231	1111	311
19	199	1118	304
20	236	1128	294
21	238	1126	296
22	241	1138	284
23	242	1135	287
24	244	1138	284
25	246	1151	271
26	247	1145	277
27	248	1150	272
28	249	1145	277

Time	Ext.	Load A	Load B
29 Hrs	.00251	1144	278
30	253	1145	277
31	254	1150	272
32	256	1143	279
33	257	1151	271
34	259	1150	272
35	261	1160	262
36	265	1152	270
37	269	1159	263
38	265	1154	268
39	267	1161	261
40	268	1163	259
41	270	1168	254
42	288	1157	265
43	273	1155	267
44	273	1161	261
45	276	1160	262
46	280	1163	259
47	281	1157	265
48	283	1163	259
49	286	1170	252
50	287	1165	257
51	289	1165	257
52	282	1170	252
53	292	1170	252
*54	304	1165	257
55	354	1375	47
56	314	1120	302
57	317	1133	289
58	320	1139	283
59	320	1154	268
60	323	1151	271
61	325	1158	264
62	325	1165	257
63	328	1160	262
64	330	1164	258
65	332	1165	257
66	332	1168	254
67	334	1169	253
68	338	1172	249

*Wrong standard. Test stopped after 150 hours.

Figure 14.

Test No. 45 continued...

Time	Ext.	Load A	Load B
69 hrs	.00339	1160	262
70	385	1266	156
71	340	1163	259
72	348	1168	254
73	353	1166	256
74	351	1175	247
75	353	1170	252
76	356	1175	247
77	357	1171	251
78	359	1176	246
79	361	1182	240
80	362	1182	240
*81	365	1176	246
82	405	1206	136
83	381	1128	294
84	387	1146	273
*85	387	1148	274
86	396	1194	228
87	390	1152	270
88	393	1161	261
89	396	1160	262
*90	397	1165	257
91	396	1141	281
92	404	1175	247
93	407	1175	247
94	408	1184	238
95	412	1166	256
96	414	1165	257
97	416	1166	256
98	420	1166	256
99	422	1161	261
100	426	1166	256
101	428	1166	256
102	431	1168	254
103	435	1168	254
104	437	1159	263
*105	439	1166	256
106	458	1196	226
*107	451	1149	273
108	505	1265	157
109	480	1034	328

Time	Ext.	Load A	Load B
110 hrs	.00483	1106	316
111	486	1111	311
112	489	1121	301
113	493	1128	294
114	496	1127	295
115	500	1136	286
*116	504	1136	284
117	529	1204	218
118	518	1114	308
119	521	1125	297
120	525	1136	286
121	526	1131	291
122	532	1137	285
123	538	1148	274
124	540	1136	286
125	544	1134	288
126	550	1138	286
127	555	1136	286
128	560	1133	289
129	562	1136	286
130	567	1134	288
131	572	1150	272
132	576	1141	281
133	581	1136	286
134	584	1133	289
135	591	1129	293
136	595	1124	298
137	601	1127	295
138	608	1126	296
139	615	1121	301
140	619	1123	299
141	625	1100	322
142	634	1123	299
143	641	1120	302
144	647	1124	298
145	656	1120	302
146	661	1127	295
147	667	1119	303
148	675	1119	303
149	681	1114	308
150	687	1119	303

*Wrong standard. Test stopped after 150 hrs.

Figure 15.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Combined Test
Specimen A - 840°C 11.5 t.s.i. (711 lbs)
Specimen B - 860°C 11.5 t.s.i. (711 lbs)
Specimen dia. .1875"
1 min. to balance
Test No. 46

Time	Ext.	Load A	Load B
0	0	711	711
1 min	.00102	737	685
2	103	738	684
3	103	729	693
4	105	727	695
5	104	728	694
10	107	721	701
15	109	731	691
20	114	736	686
25	113	732	690
30	115	743	679
35	116	750	672
40	116	754	668
45	115	747	675
50	114	734	688
55	115	738	684
1 Hr.	117	743	679
2	121	741	681
3	129	754	668
4	134	764	658
5	137	774	648
6	140	769	653
7	145	767	655
8	147	776	646
9	151	779	643
10	154	777	645
11	157	783	639
12	159	790	632
13	161	794	628
14	164	792	630

Time	Ext.	Load A	Load B
15	.00166	796	626
16	170	799	623
17	172	806	616
18	174	804	618
19	175	803	619
20	178	815	607
21	177	813	609
22	182	806	616
23	183	805	617
24	187	807	615
25	187	808	614
26	192	812	610
27	194	812	610
*28	196	807	615
49	246	893	529
50	250	868	554
51	254	855	567
52	256	847	575
53	258	849	573
54	263	844	578
55	265	841	581
56	267	836	586
57	269	841	581
73	323	838	584
74	327	836	586
75	332	829	593
76	337	836	586
77	340	829	593
78	347	838	584
79	349	832	590
80	357	836	586

*Wrong standard. Thread stripped in grip at 81 hrs. Rig in balanced position 28-49 hrs. and 57 - 73 hrs. (over-night).

Figure 16.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Combined Test
Specimen A - 840°C 11.5 t.s.i. (711 lbs)
Specimen B - 860°C 11.5 t.s.i. (711 lbs)
Specimen dia..1875"
30 sec.to balance
Test No. 47

Time	Ext.	Load A	Load B
0	0	711	711
1 min	.00136	710	712
2	144	696	726
3	148	696	726
4	153	692	730
5	157	696	726
10	163	709	713
15	169	700	722
20	171	710	712
25	172	705	717
30	173	694	728
35	173	715	707
40	177	703	719
45	178	712	710
50	176	722	700
55	177	719	703
1 hr.	180	733	689
2	189	735	687
3	197	732	690
4	200	730	692
5	203	750	672
6	209	739	683
7	210	762	660
8	217	755	667
9	219	766	656
10	216	713	709
11	220	729	693
12	225	777	645
13	226	784	638
14	234	795	627
15	237	800	622
16	239	791	631
17	243	789	633
18	246	784	638
19	249	795	627
20	264	831	591

Time	Ext.	Load A	Load B
21 hrs.	.00258	783	639
22	261	777	645
23	267	773	649
24	273	820	602
25	282	833	589
26	288	853	569
27	287	822	600
28	290	807	615
29	290	799	623
30	299	798	624
31	303	824	598
32	311	806	616
*33	320	798	624
34	371	967	485
35	343	744	678
36	348	756	666
37	354	774	648
38	347	786	636
*39	352	799	623
40	416	919	503
41	463	736	686
42	387	752	670
43	394	761	661
44	425	790	632
45	402	774	648
46	407	777	645
*47	417	800	622
48	430	760	662
49	439	771	651
50	448	821	601
51	453	798	624
52	459	806	616
53	459	815	607
54	469	794	628
55	469	783	639
56	473	804	618

Figure 17.

TEST NO. 47 continued....

Time	Ext.	Load A	Load B
57 hrs	.00480	788	634
58	481	790	632
59	489	802	620
60	493	811	611
61	501	811	611
62	512	817	605
63	515	807	615
64	521	804	618
*65	529	799	623
66	617	802	620
67	601	746	676
*68	609	777	645
69	718	879	543
70	699	720	702
71	711	784	638
72	720	766	656
73	728	800	622
74	736	777	645
75	747	796	626
76	756	775	647
77	767	795	627
78	777	777	645
79	788	790	632
80	799	793	629
81	812	796	626
82	823	801	621
83	836	786	636
84	851	781	641
85	864	805	617
86	878	798	624
87	892	792	630
88	909	792	630
*89	926	783	639
90	989	804	618
91	993	780	642

Time	Ext.	Load A	Load B
92 hrs	.01011	783	639
93	1030	783	639
94	1054	790	632
95	1073	784	638
96	1101	789	633
*97	1123	782	640
98	1233	796	626
99	1244	779	643
100	1302	780	642
101	1293	777	645
102	1323	792	630
103	1348	781	641
104	1378	790	632
105	1404	7-0	652
106	1426	771	651
*107	1464	781	641
108	1584	784	638
109	1605	766	656
110	1645	782	640
111	1691	778	644
112	1728	785	637
113	1783	757	665
114	1838	778	644
115	1880	753	669
116	1935	770	652
117	1992	776	646
118	2061	774	648
119	2151	775	647
120	2171	766	656
121	2261	784	638
122	2334	780	642
123	2416	775	647
124	2499	783	639
125	2593	777	645
126	2685	773	649

*Wrong standard. Test stopped after 126 hrs.

Figure 18.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 80

Combined Test
Speciman A - 840°C 11.5 t.s.i. (711 lbs)
Specimen B - 860°C 11.5 t.s.i. (711 lbs)

Specimen dia. .1875
1 min to balance
Test No. 48

Time	Ext.	Load A	Load B
0	0	711	711
2 min.	.00097	796	626
3	96	820	602
4	93	826	596
5	93	831	591
10	98	814	608
15	.00101	804	618
20	103	798	624
25	102	788	634
30	107	806	616
35	108	800	622
40	110	811	611
45	111	806	616
50	112	806	616
55	113	802	620
1 hr.	114	799	623
2	127	771	651
3	126	753	669
4	134	761	661
5	136	783	639
6	138	759	663
7	141	751	671
8	139	737	685
9	141	747	675

Time	Ext.	Load A	Load B
10 hr.	.00143	759	663
11	145	751	671
12	146	761	661
13	153	763	659
14	151	756	666
15	153	774	648
16	156	760	662
17	157	758	664
18	161	748	674
19	163	748	674
20	168	742	680
21	169	737	685
22	174	747	675
23	177	733	689
24	178	761	661
25	181	749	673
26	191	760	662
27	188	772	650
28	196	747	675
29	192	772	650
30	200	765	657
31	197	733	689
32	201	756	666
33	202	774	648

Thread stripped after 33 hrs.

Figure 19.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Combined Test
Specimen A - 840°C 11.5 t.s.i.(711 lbs.) Specimen dia. .1875"
Specimen B - 860°C 11.5 t.s.i. (711 lbs.) 45 sec. to balance
Test No. 49.

Time	Ext.	Load A	Load B
0	0	711	711
1 min	.00100	756	666
2	.00098	760	662
3	97	827	595
4	98	769	653
5	97	751	671
10	93	751	671
15	99	767	655
20	98	764	658
25	.00101	777	645
30	104	776	646
35	107	764	658
40	106	762	660
45	106	740	682
50	103	748	674
55	107	768	654
1 hr.	108	772	650
2	119	760	662
3	121	769	653
4	127	774	648
5	126	783	639
6	130	755	667
7	129	765	657
8	129	761	661
9	129	762	660
10	133	750	672
11	139	744	678
12	137	726	696
13	140	732	690
14	140	740	682
15	144	747	675
16	147	744	678
17	149	744	678
18	152	751	671
19	156	762	660
20	159	775	647
21	159	786	636
22	164	766	646
23	172	797	625

Time	Ext.	Load A	Load B
24 hr	.00179	798	624
25	182	784	638
26	185	795	627
27	183	802	620
28	187	805	617
29	186	784	638
30	185	785	637
31	190	782	640
32	191	790	632
33	195	783	639
34	193	793	629
35	194	779	643
36	197	752	670
37	196	759	663
38	196	751	671
39	198	767	655
40	199	766	656
41	203	772	650
42	205	772	650
43	206	756	666
44	211	781	641
45	210	786	636
46	219	805	617
47	225	791	631
48	225	805	617
49	233	805	617
50	236	802	620
*51	239	801	621
*52	405	994	428
53	335	633	789
*54	337	674	748
*55	372	803	619
*56	381	818	604
*57	385	824	598
*58	385	814	608
*59	379	780	642
*60	375	745	677
*61	374	739	683
*62	369	726	696

Figure 20.

Test No. 49 continued.....

Time	Ext.	Load A	Load B
*63 hr	.00376	746	676
*64	376	736	686
*65	379	737	685
66	381	735	687
67	385	746	676
68	391	757	665
69	392	769	653
70	398	755	667
71	403	772	650
72	406	783	639
73	416	774	648
74	421	783	639
75	422	795	627
76	428	786	636
77	429	792	630
78	433	783	639
79	437	764	658
80	441	756	656
81	439	770	652
82	446	769	653
83	451	770	652
84	456	794	628
85	459	791	631
86	461	790	632
87		794	628
88	472	779	643
89	479	786	636
90	483	780	642
91	489	781	641
92	497	795	627
*93	782	935	487
94	740	709	713
95	750	783	639
96	764	765	657
97	772	780	642
98	780	789	633
99	790	795	627
100	796	783	639
101	802	791	631

Time	Ext.	Load A	Load B
102 hr.	.00809	781	641
103	817	758	664
104	829	766	656
105	834	772	650
106	845	788	634
107	852	788	634
108	862	791	631
109	872	789	633
110	882	782	640
111	893	783	639
112	902	778	644
113	911	780	642
114	923	783	639
115	934	780	642
116	951	772	650
117	967	779	643
118	984	791	631
119	998	792	630
120	.01013	787	635
121	1036	778	644
122	1047	784	638
123	1063	788	634
124	1071	785	637
125	1098	777	645
126	1106	785	637
127	1124	778	644
*128	1212	613	609
129	1265	784	638
130	1224	777	645
131	1242	784	638
132	1257	775	647
133	1276	783	639
134	1298	784	638
135	1318	782	640
136	1339	778	644
137	1365	779	443
138	1391	783	639
139	1415	761	641
140	1446	780	642
141	1477	812	610

*Wrong standard: Test stopped after 141 hrs.

Figure 21.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Combined Test
Specimen A - 840°C 11.5 t.s.i. (711 lbs.)
Specimen B - 860°C 11.5 t.s.i. (711 lbs.)
Specimen dia. .1875
45 sec. to balance
Test No. 50

Time	Ext.	Load A	Load B
0	0	711	711
1 min.	.00101	750	672
2	98	767	655
3	95	775	647
4	93	792	630
5	91	799	623
10	100	756	666
15	106	764	658
20	105	768	654
25	108	784	638
30	108	796	626
35	108	781	641
40	111	765	657
45	110	769	653
50	113	784	638
55	118	745	677
1 hr	118	742	680
2	121	748	674
3	123	739	683
4	132	724	698
5	132	722	700
21	181	756	666
22	183	748	674
23	186	748	674
24	188	763	659
25	200	750	672
26	198	764	658
27	204	741	681
28	203	777	645
29	208	774	648
45	251	790	632
46	262	784	638
47	263	785	637
48	262	794	628

Time	Ext.	Load A	Load B
49 hrs	.00283	794	628
50	281	767	655
52	280	798	624
53	315	777	645
54	324	777	645
55	296	783	639
56	299	783	639
57	205	784	638
58	208	790	632
59	209	784	638
60	315	795	627
61	319	786	636
62	322	787	633
63	325	787	635
64	331	789	633
65	336	785	637
66	343	790	632
67	349	787	635
68	354	786	636
69	360	781	641
70	366	785	637
71	371	783	639
72	381	783	639
73	388	774	648
74	397	781	641
75	402	781	641
76	412	779	643
77	419	767	655
78	431	795	627
79	437	789	635
80	444	794	628
81	449	786	636
82	455	793	629
83	464	790	632

Figure 22.

Test No. 50 continued.....

Time	Ext.	Load A	Load B
84 hrs	.00472	799	623
85	478	789	633
86	490	788	634
87	497	785	637
88	506	791	631
89	516	783	639
90	527	778	644
91	542	794	628
92	550	774	648
93	550	784	638
94	575	788	634
95	591	772	650
96	608	769	653
97	620	789	633
98		785	637
99	645	783	639
100	656	778	644
101	672	784	638
102	685	784	638
103	693	782	640
104	698	784	638
105	715	785	637
106	723	785	637
107	742	775	647
108	759	787	635
109	777	772	650
110	788	787	635
111	868	708	714
112	901	766	656
113	950	702	720
114	.01075	727	695
115	1098	763	659
116	1120	776	646

Time	Ext.	Load A	Load B
117 hrs	.01143	772	650
118	1165	769	653
119	1196	769	653
120	1224	771	651
121	1251	788	634
122	1280	769	653
123	1313	782	640
124	1349	774	648
125	1381	787	635
126	1416	776	646
127	1451	771	651
128	1486	787	635
129	1523	776	646
130	1562	785	637
131	1600	776	646
132	1642	779	643
133	1689	782	640
134	1734	780	642
135	1783	782	640
136	1828	781	641
137	1880	775	647
138	1932	768	654
139	1992	774	648
140	2053	779	643
141	2115	764	658
142	2182	774	648
143	2262	783	639
144	2330	773	649
145	2412	776	646
146	2501	803	619
147	2578	771	651
148	2667	768	654
149	2767	782	640
150	2861	771	651

Test stopped after 150 hrs.
Rig in balanced position 5-21 hrs. 29-45 hrs. (overnight)

Figure 23

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Combined Test
Specimen A - 825°C 12 t.s.i. (742 lbs)
Specimen B - 875°C 12 t.s.i. (742 lbs)

Specimen dia. .1875
4.5 mins to balance
Test No. 51.

Time	Ext.	Load A	Load B
0	0	742	742
5 min.	.00094	963	521
6	94	963	521
7	94	951	533
8	93	941	543
9	93	943	541
10	93	938	546
15	95	946	538
20	95	939	545
25	.00100	930	554
30	102	939	545
35	103	942	542
40	100	911	573
45	102	941	543
50	103	923	561
55	104	927	557
1 hr	106	923	561
2	115	946	538
3	116	910	574
4	121	914	570
5	125	967	517
6	134	934	550
7	138	943	541
8		920	564
9	142	921	563
10	143	932	552
11	149	937	547
12	151	934	550
13	148	939	545
14	151	944	540
15	153	934	550
16	157	913	571
17	159	937	547
18	162	926	558
19	167	925	559
20	172	937	547

Time	Ext.	Load A	Load B
21 hrs	.00177	933	551
22	182	957	527
23	182	932	552
24	186	955	529
25	186	932	552
26	191	931	553
27	193	916	568
28	196	918	566
29	205	926	558
30	202	920	564
31	205	930	554
32	207	930	554
33	210	941	543
34	213	931	553
35	216	931	553
36	212	931	553
37	219	942	542
38	223	934	550
39	227	946	538
40		940	544
41	233	937	547
42	238	939	545
43		935	549
44	250	922	562
45	254	926	558
46	259	922	562
47	261	938	546
48	264	936	548
49	267	938	546
50	271	939	545
51	278	944	540
52	279	930	554
53	288	952	532
54	293	939	545
55	301	913	571

Figure 24.

Test No. 51 continued....

Time	Ext.	Load A	Load B
56 hrs	.00304	931	553
57	311	921	563
58	316	935	549
59	321	926	558
60	323	938	546
61	329	934	550
62	333	953	531
63	338	941	543
64	348	948	536
65	351	938	546
66	363	942	542
67		923	561
68	375	931	553
69	379	934	550
70	389	931	553
71	398	959	525
72	406	927	557
73	411	926	558
74	421	930	554
75	428	944	540
76	442	959	525
77	447	946	538
78	455	948	536
79	464	941	543
80	476	927	557
81	481	932	552
82	492	942	542
83	506	930	554
84	517	927	557
85	527	938	546
86	537	932	552
87	549	944	540
88	561	928	556
89	575	934	550
90	587	926	558

Time	Ext.	Load A	Load B
91 hrs	.00602	931	553
92	613	937	547
93	627	935	549
94	642	940	544
95	658	926	558
96	672	926	558
97	690	919	565
98	709	931	553
99	727	941	543
100	745	930	554
101	767	929	555
102	785	940	544
103	804	922	562
104	827	923	561
105	852	931	553
106	876	925	559
107	899	937	547
108	925	926	558
109	953	928	556
110	981	932	552
111	.01009	931	553
112	1039	930	554
113	1070	921	563
114	1105	919	565
115	1144	923	561
116	1188	926	558
117	1218	925	559
118	1259	919	565
119	1306	926	558
120	1349	911	573
121	1395	916	568
122	1446	919	565
123	1509	937	547
124	1542	913	571
125	1599	911	563
126	1649	923	561

Figure 25.

Test stopped after 126 hrs.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

(New material)

Combined Test
Specimen A - 825°C — 12.5 t.s.i. (773 lbs.)
Specimen B - 875°C — 12.5 t.s.i. (773 lbs.)

Specimen dia. .1875"
2½ mins to balance
Test No. 52.

Time	Ext.	Load A	Load B
0	0	773	773
3 min	.00129	865	681
4	132	865	681
5	134	842	704
10	133	857	689
15	133	878	668
20	134	881	665
25	134	879	667
30	137	885	661
35	141	892	654
40	140	886	660
45	143	889	657
50	144	906	640
55	146	903	643
1 hr	145	904	642
2	163	894	652
3	173	900	646
4	169	890	656
5	182	916	630
6	186	896	650
7	192	924	622
8	205	910	636
9	213	930	616
10	218	928	618
11	225	928	618
12	228	931	615
13	235	943	605
14	239	960	586
15	247	966	580
16	253	953	593
17	260	963	583
18	263	938	608
19	278	958	588
20	288	944	602
21	296	953	593
22	302	961	585
23	309	970	576
24	321	956	590
25	325	974	572
26	339	972	574
27	346	972	574
28	358	969	577
29	359	962	584
30	376	977	569
31	383	996	550
32 hrs	.00398	973	573
33	409	978	568
34	417	973	573
35	425	991	555
36	436	977	569
37	445	980	566
38	455	975	571
39	469	968	578
40	483	972	574
41	499	972	574
42	514	974	572
43	530	979	567
44	548	951	595
45	574	957	589
46	591	972	574
47	609	977	569
48	637	952	594
49	653	962	584
50	682	964	582
51	698	975	571
52	723	964	582
53	747	968	578
54	771	971	575
55	792	970	576
56	826	950	596
57	859	966	580
58	890	958	588
59	925	970	576
60	959	972	574
61	995	966	578
62	.01030	971	575
63	1074	950	596
64	1117	977	569
65	1165	955	591
66		967	579
67	1279	943	603
68	1340	950	596
69	1402	950	596
70	1471	956	590
71	1549	951	595
72	1625	955	591
73	1707	949	597
74	1800	967	579
75	1891	945	601
76	1996	939	607

Test stopped after 76 hrs.

Figure 26.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Combined Test
Specimen A 800°C — 12.5 t.s.i.
Specimen B 900°C — 12.5 t.s.i.

Specimen Dia. .1875"
2½ mins. to balance
Test No. 53

Time	Ext.	Load A	Load B
0	0	773	773
3 mins	.00133	906	640
4	135	900	646
5	138	889	657
10	142	878	668
15	146	903	643
20	149	896	650
25	151	907	639
30	154	911	635
35	156	934	612
40	159	946	601
45	160	949	597
50	163	950	587
55	166	955	591
1 hr.	166	952	594
2	188	1003	543
3	200	1046	500
4	207	1046	500
5	211	1062	484
6	221	1074	472
7	223	1078	468
8	241	1087	459
9	247	1093	453
10	257	1113	433
11	261	1108	438
12	267	1125	421
13	273	1127	419
14	279	1137	409
15	281	1147	399
16	285	1154	392
17	286	1151	395
18	.00292	1166	380
19	297	1160	386
20	307	1166	380
21	315	1164	382
22		1149	397
23	327	1168	378
24	324	1148	398
25	347	1163	383
26	349	1170	376
27	365	1210	336
28	372	1163	383
29	366	1151	395
30	379	1198	348
31	379	1156	390
32	394	1214	332
33	.402	1122	369
34	413	1191	355
35	419	1187	359
36	422	1176	370
37	434	1184	362
38	439	1200	346
39	442	1190	356
40	449	1183	363
42	458	1181	365
42	.464	1190	356
43	474	1204	342
44	488	1186	360
46	502	1191	355
46	514	1170	375
47	530	1194	352
48	529	1172	347

Figure 27.

Test No. 53 continued.

Time	Ext.	Load A	Load B
49	.00546	1175	371
50	551	1166	380
51	561	1175	371
52	581	1179	367
53	586	1195	351
54	609	1229	317
55	617	1184	362
56	646	1180	366
57	659	1176	370
58	676	1185	361
59	689	1172	374
60	707	1170	376
61	724	1184	362
62	737	1172	374
63	752	1175	371
64	768	1177	369
65	783	1171	375
66	804	1175	371
67	824	1171	375
68	847	1157	389
69	872	1152	394
70	899	1157	389
71	925	1172	374
72	954	1158	388
73	973	1169	377
74	1004	1162	384
75	1038	1180	366
76	1057	1166	380
77	1097	1158	388
78	1137	1160	386
79	1172	1149	379

Time	Ext.	Load A	Load B
80	.01204	1138	408
81	1232	1141	405
82	1269	1151	395
83	1327	1154	392
84	1369	1154	392
85	1412	1141	405
86	1463	1137	409
87	1509	1143	403
88	1563	1141	405
89	1622	1143	403
90	1682	1141	405
91	1747	1145	401
92	1822	1142	404
93	1898	1139	407
94	1980	1137	409
95	2069	1130	416
96	2163	1131	415
97	2257	1132	414
98	2363	1131	415
99	2473	1131	415
100	2592	1140	406
101	2720	1132	414
103	3008	1122	424
104	3167	1131	415
105	3338	1130	416
106	3531	1120	426
107	3734	1120	426
108	3996	1123	423
109	4217	1122	424
110	4500	1119	427
111	4864	1103	443

12 to 17 hours - standard incorrect therefore no load transfer.

Figure 28.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Combined Test
Specimen A - 840°C 12.5 t.s.i.
Specimen B - 860°C 12.5 t.s.i.

Specimen dia. .1875"
1½ min to balance
Test No. 54.

Time	Ext.	Load A	Load B
0	0	773	773
2	.00125	711	835
3	127	710	836
4	128	710	836
5	125	701	845
10	133	732	814
15	140	737	809
20	138	758	788
25	141	740	806
30	142	766	780
35	145	754	792
40	149	785	761
45	146	761	785
50	152	792	754
55	153	780	766
1 hr.	162	799	747
2	170	818	728
3	175	772	774
4	188	808	738
5	182	756	790
6	200	822	724
7	203	815	731
8	217	851	695
9	225	844	702
10	231	839	707
11	234	855	691
12	241	847	699
13	246	846	700
14	254	852	694
15	258	865	681
16	265	861	685
17	270	852	694
18	279	869	677
19	284	870	676
20	288	870	676
21	296	867	679
22	304	872	674
23	311	862	684
24	317	861	685
25	318	873	673
26	335	862	684
27	338	895	651
28	353	874	672
29	357	820	726
30	374	874	672
31	392	885	661

Time	Ext.	Load A	Load B
32	.00399	876	670
33	410	881	665
34	419	884	662
35	430	882	664
36	443	884	662
37	454	875	671
38	464	891	655
39	473	881	665
40	487	877	669
41	498	877	669
42	513	876	670
43	526	873	673
44	546	877	669
45	571	870	676
46	586	877	669
47	610	876	670
48	630	877	669
49	653	887	659
50	665	872	674
51	692	869	677
52	719	891	655
53	744	893	653
54	774	872	674
55	797	873	673
56	835	878	668
57	867	870	676
58	901	867	679
59	934	877	669
60	968	868	678
61	.01008	873	673
62	1044	873	673
63	1083	877	669
64	1128	869	677
65	1176	867	679
66	1233	860	686
67	1288	868	678
68	1356	859	687
69	1426	870	676
70	1493	870	676
71	1576	870	678
72	1659	868	678
73	1753	870	678
74	1845	864	682
75	1931	844	702
76	2058	867	679
77	2170	865	681
78	2292	862	684

Figure 29.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Combined Test
Specimen A 840°C 12 t.s.i. (742 lbs.)
Specimen B 860°C 12 t.s.i. (742 lbs.)

Specimen dia. .1875
1 min. to balance
Test No. 55.

Time	Ext.	Load A	Load B
0	0	742	742
1 min	.00104	743	741
2	106	729	755
3	108	719	765
4	109	713	771
5	111	709	775
10	113	709	775
15	113	728	756
20	115	724	760
25	116	722	762
30	122	733	751
35	123	747	737
40	121	733	751
45	124	724	760
50	126	743	741
55	127	743	741
60	130	745	739
2 hrs	144	755	729
3	150	753	731
4	159	755	729
5	167	756	728
6	173	763	721
7	178	766	718
8	181	769	715
9	188	774	710
10	197	787	697
11	203	785	699
12	202	789	695
13	216	789	695
14	220	789	695
15	227	789	695
16	232	789	695
17	237	789	695
18	255	839	645
19	260	818	660
20	272	818	660
21	274	826	658
22	282	815	669
23	299	834	650
24	302	829	655
25	305	840	644
26	315	829	655
27	326	832	652
28	333	826	658
29	343	829	655
30	.00352	833	651
31	359	825	659
32	366	831	653
33	374	827	657
34	385	829	655
35	394	825	659
36	410	833	651
37	420	832	652
38	437	838	646
39	450	839	645
40	461	836	648
41	472	832	652
42	488	834	650
43	503	829	655
44	520	836	648
45	539	833	651
46	556	840	644
47	571	830	654
48	594	832	652
49	612	835	649
50	633	834	650
51	653	834	650
52	676	833	651
53	700	820	664
54	724	832	652
55	745	826	658
56	770	830	654
57	798	832	652
58	828	824	660
59	859	823	661
60	893	823	661
61	935	832	652
62	980	834	650
63	.01019	829	655
64	1062	818	666
65	1109	827	657
66	1160	824	660
67	1217	831	653
68	1273	830	654
69	1328	818	666
70	1391	832	652
71	1447	825	659
72	1521	823	661
73	1594	823	661
74	1680	823	661

Figure 30.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Combined Test
Specimen A 800°C 12 t.s.i. (742 lbs)
Specimen B 900°C 12 t.s.i. (742 lbs)

Specimen dia. .1875
7½ min. to balance
Test No. 56

Time	Ext.	Load A	Load B
0	0	742	742
8 mins	.00114	1093	401
9	116	1089	395
10	117	1086	398
15	116	1080	404
20	116	1058	426
25	121	1063	421
30	125	1058	426
35	126	1056	428
40	126	1056	428
45	127	1058	426
50	128	1057	427
55	129	1055	429
60	129	1043	441
2 hrs.	136	1077	407
3	144	1073	411
4	157	1059	425
5	166	1054	430
6	170	1057	437
7	168	1059	425
8	173	1053	431
9	175	1053	431
10	178	1067	417
11	182	1072	412
12	186	1074	410
13	190	1084	400
14	192	1084	400
15	197	1082	402
16	203	1090	394
17	213	1092	392
18	219	1100	384
19	224	1108	376
20	228	1116	368
21	238	1118	366
22	239	1118	366
23	247	1132	352
24	251	1124	360
25	259	1121	363
26	260	1122	362
27	264	1118	366
28	267	1126	358
29	269	1111	373
30	272	1116	368
31	276	1120	364
32	280	1112	372
33	281	1114	370
34	287	1130	354
35	289	1139	345
36	291	1125	359
37	.00289	1136	348
38	296	1140	344
39	300	1134	350
40	304	1134	350
41	314	1133	351
42	319	1144	340
43	327	1146	338
44	332	1140	344
45	338	1145	339
46	346	1137	347
47	349	1131	353
48	355	1137	347
49	362	1138	346
50	366	1135	349
51	368	1151	333
52	367	1170	314
53	378	1129	355
54	385	1141	343
55	387	1144	340
56	392	1138	346
57	396	1141	343
58	405	1141	343
59	409	1144	340
60	413	1138	346
61	420	1151	333
62	425	1141	343
63	429	1140	344
64	437	1137	347
65	449	1133	351
66	448	1143	341
67	455	1123	361
68	472	1134	350
69	477	1133	351
70	484	1145	339
71	492	1140	344
72	496	1147	337
73	509	1147	337
74	517	1139	345
75	514	1151	333
76	524	1146	338
77	539	1118	366
78	550	1134	350
79	555	1125	359
80	563	1134	350
81	571	1120	364
82	579	1124	360
83	590	1131	353
84	597	1128	356
85	607	1125	359

Figure 31.

Test No. 56 continued. . . . .

Time	Ext.	Load A	Load B
86	.00615	1123	361
87	629	1125	359
88	638	1126	358
89	654	1130	354
90	667	1120	364
91	672	1133	351
92	686	1157	327
93	705	1120	364
94	718	1120	364
95	730	1123	361
96	742	1120	364
97	755	1124	360
98	768	1118	366
99	780	1121	363
100	800	1111	373
101	814	1110	374
102	828	1108	376
103	843	1114	370
104	857	1108	376
105	872	1110	374
106	890	1113	371
107	905	1108	376
108	924	1110	374
109	942	1107	377
110	963	1102	382
111	983	1106	378
112	1005	1104	380
113	1031	1099	385
114	1056	1106	378
115	1080	1106	378
116	1103	1100	384
117	1127	1099	385
118	1153	1101	383
119	1163	1098	386
120	1208	1091	393

Time	Ext.	Load A	Load B
121	.01234	1092	392
122	1264	1092	392
123	1295	1098	386
124	1332	1092	392
125	1367	1086	398
126	1399	1090	394
127	1434	1092	392
128	1475	1084	400
129	1509	1082	402
130	1552	1081	403
131	1600	1080	404
132	1645	1076	408
133	1693	1076	408
134	1753	1075	409
135	1812	1074	410
136	1875	1069	415
137	1953	1064	420
138	2041	1055	429
139	2148	1046	438
140	2355	1005	479

Figure 32.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Combined Test
Specimen A — 15.11 t.s.i. (934 lbs)
Specimen B — 8.89 t.s.i. (550 lbs)

Specimen Dia. . 1875"
15 seconds to balance
Test No. 57

Time	Ext.	Load A	Load B
0	0	934	550
1	.00157	914	570
2	161	903	581
3	166	895	589
4	167	886	598
5	169	891	593
10	171	878	606
15	172	875	609
20	176	870	614
25	179	875	609
30	179	873	611
35	179	870	614
40	179	870	614
45	182	877	607
50	183	877	607
55	184	885	599
60	186	894	590
2 hrs.	188	914	570
3	202	898	586
4	212	869	615
5	217	893	591
6	223	893	591
7	228	908	576
8	232	913	571
9	239	906	578
10	245	906	578
11	249	920	564
12	253	930	554

Time	Ext.	Load A	Load B
13	.00259	931	553
14	265	937	547
15	269	940	544
16	268	959	525
17	276	927	557
18	279	929	555
19	286	929	555
20	293	937	547
21	304	937	547
22	309	937	547
23	314	967	517
24	314	950	534
25	324	956	528
26	325	950	534
27	331	952	532
28	345	941	543
29	351	937	547
30	355	925	559
31	362	936	548
32	369	950	534
33	375	948	536
34	379	948	536
35	387	948	536
36	395	948	536
37	405	948	536
38	413	948	536
39	419	948	536
40	421	948	536

Figure 33.

Test No. 57 continued.

Time	Ext.	Load A	Load B
41	.00446	950	534
42	455	956	528
43	468	963	521
44	478	962	522
45	492	937	547
46	499	950	534
47	511	948	536
48	524	950	534
49	533	963	521
50	552	946	538
51	564	945	539
52	593	950	534
53	582	937	547
54	596	944	540
55	609	950	534
56	625	943	541
57	644	943	541
58	659	942	541
59	676	946	538
60	695	945	539
61	714	941	543
62	737	937	547
63	761	924	560
64	787	924	560
65	807	913	571
66	832	913	571
67	853	913	571
68	879	913	571

Time	Ext.	Load A	Load B
69	.00904	943	541
70	930	947	537
71	955	934	550
72	989	932	552
73	1019	935	549
74	1051	934	550
75	1081	936	548
76	1110	936	548
77	1137	934	550
78	1176	930	554
79	1218	926	558
80	1262	927	557
81	1312	925	559
82	1359	929	555
83	1419	927	557
84	1473	888	596
85	1531	888	596
86	1603	889	595
87	1669	888	596
88	1747	889	545
89	1831	889	545
90	1923	889	545
91	2009	889	545
92	2105	889	545
93	2204	889	545
94	2304	933	551
95	2424	930	554

Figure 34.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 80

Combined Test
Specimen A 825°C
Specimen B 875°C

18 t.s.i. (1112 lbs)
7 t.s.i. (434 lbs)

Specimen dia. .1875
3 secs to balance
Test No. 58.

Time	Ext.	Load A	Load B
0	0	1112	434
1 min	.00201	1125	421
2	203	1134	432
3	206	1108	438
4	206	1104	442
5	208	1101	445
10	215	1086	460
15	218	1081	465
20	218	1075	471
25	224	1063	483
30	224	1047	499
35	223	1059	487
40	226	1062	484
45	227	1055	491
50	225	1047	499
55	227	1053	493
60	228	1057	489
2 hrs	234	1023	523
3	248	999	547
4	253	1000	546
5	262	1000	546
6	265	1003	543
7	266	1014	532
8	274	1010	536
9	278	1011	535
10	286	1003	543
11	293	1002	544
12	298	1002	544
13	303	1000	546
14	308	991	555
15	310	985	561
16	323	1005	541
17	327	991	555
18	338	991	555
19	349	973	573
20	358	998	548
21	360	974	572
22	370	1011	535
23	378	1006	540
24	380	985	561
25	390	985	561
26	391	985	561
27	403	980	566
28	415	985	561
29	420	985	561
30	428	991	555

Time	Ext.	Load A	Load B
31	.00434	995	551
32	444	986	560
33	453	993	553
34	461	995	551
35	468	984	562
36	476	985	561
37	490	987	559
38	501	984	562
39	515	980	566
40	530	979	567
41	545	973	573
42	558	962	584
43	575	962	584
44	600	963	583
45	616	963	583
46	630	962	584
47	645	967	579
48	662	979	567
49	678	974	572
50	688	946	600
51	721	951	595
52	741	952	594
53	763	952	594
54	783	952	594
55	806	951	595
56	828	952	594
57	853	952	594
58	881	952	594
59	907	952	594
60	938	952	594
61	968	952	594
62	998	952	594
63	1033	952	594
64	1070	952	594
65	1109	952	594
66	1146	952	594
67	1184	952	594
68	1228	952	594
69	1277	952	594
70	1325	952	594
71	1377	952	594
72	1428	952	594
73	1493	952	594
74	1555	952	594
75	1622	952	594
76	1695	963	583

from 51 hrs. to 75 hrs load transducer sticking.

Figure 35.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 90

Combined Test
Specimen A 825°C 14.4 t.s.i. (890 lbs)
Specimen B 875°C 8.6 t.s.i. (532 lbs)

Specimen Dia. .1875
10 seconds to balance
Test No. 52

Time	Ext.	Load A	Load B
0	0	890	532
1 min	.00156	932	490
2	163	928	494
3	163	891	531
4	164	890	532
5	166	888	534
10	171	868	554
15	173	882	540
20	176	881	541
25	177	875	547
30	180	871	551
35	180	865	557
40	182	877	545
45		868	554
50	179	863	559
55	177	863	559
1 hr	181	864	558
2	188	864	558
3	197	858	564
4	200	838	584
5	206	842	580
6	208	848	574
7	212	837	585
8	214	835	587
9	215	821	601
10	219	829	593
11	224	837	585
12	227	838	584
13	230	837	585
14	233	841	581
15	238	846	576
16	241	838	584
17	247	848	574
18	247	832	590
19	255	844	578
20	262	865	557
21	265	871	551
22	269	870	552
23	274	884	538
24	263	826	596
25	277	870	552
26	280	865	557
27	289	891	531
28	294	868	554
29	297	867	555

Time	Ext.	Load A	Load B
30 hrs	.00298	875	547
31	300	868	554
32	303	873	549
33	311	873	549
34	314	872	550
35	320	874	548
36	320	876	546
37	324	879	543
38	329	875	547
39	334	873	549
40	348	886	536
41	351	889	533
42	356	893	529
43	363	900	522
44	366	885	537
45	374	903	519
46	382	909	513
47	387	892	530
48	391	866	556
49	398	875	547
50	403	892	530
51	414	895	527
52	420	915	507
53	423	897	525
54	428	903	519
55	434	875	547
56	441	891	531
57	446	894	528
58	450	891	531
59	459	885	537
60	467	897	525
61	468	898	524
62	480	898	524
63	491	878	544
64	497	883	539
65	509	887	535
66	521	896	526
67	533	903	519
68	540	899	523
69	550	889	533
70	560	895	527
71	570	889	533
72	578	891	531
73	589	891	531
74	594	898	524

Figure 36

Test No. 59 continued. . . . . .

Time	Ext.	Load A	Load B
75 hrs	.00604	887	535
76	623	879	543
77	620	878	544
78	633	885	537
79	642	885	537
80	653	874	548
81	666	886	536
82	679	889	533
83	693	893	529
84	708	885	537
85	719	884	538
86	733	882	540
87	751	880	542
88	764	882	540
89	784	885	537
90	803	890	532
91	818"	881	541
92	838	885	537
93	855	885	537
94	873	882	540
95	893	885	537
96	910	887	535
97	929	885	537
98	949	885	537
99	965	887	535
100	987	882	540
101	1015	875	547
102	1025	873	549
103	1046	873	549
104	1070	878	544
105	1094	882	546
106	1122	878	544
107	1147	877	545
108	1174	881	541
109	1202	875	547

Figure 37.

Time	Ext.	Load A	Load B
110 hrs	.01233	875	547
111	1267	870	552
112	1302	863	559
113	1338	866	556
114	1371	864	556
115	1410	865	557
116	1450	881	541
117	1492	864	558
118	1529	865	557
119	1576	867	555
120	1616	868	554
121	1662	862	560
122	1709	868	554
123	1764	870	552
124	1813	863	559
125	1862	874	548
126	1916	870	552
127	1972	870	552
128	2032	854	568
129	2097	860	562
130	2164	862	560
131	2234	859	563
132	2308	864	558
133	2384	858	564
134	2469	859	563
135	2560	855	567
136	2652	854	568
137	2751	857	565
138	2856	866	556
139	2981	864	558
140	3104	859	563
141	3232	858	564

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 80

Combined Test
Specimen A 800°C — 18.45 t.s.i. (1141 lbs)
Specimen B 900°C — 6.56 t.s.i. (405 lbs)

Specimen Dia. .1875"
2 seconds to balance
Test No. 60

Time	Ext.	Load A	Load B
0	0	1141	405
1 min.	.00181	1145	401
2	197	1209	337
3	194	1191	355
4	197	1198	348
5	200	1198	348
10	206	1179	367
15	207	1160	386
20	209	1153	393
25	211	1149	397
30	216	1161	385
35	222	1168	378
40	221	1170	376
45	221	1160	386
50	224	1167	379
55	224	1151	395
1 hr.	226	1151	395
2	236	1165	381
3	244	1140	406
4	255	1151	395
5	264	1160	386
6	269	1147	399
7	274	1140	406
8	277	1141	405
9	286	1148	398
10	289	1142	404
11	294	1142	404
12	298	1146	400
13	302	1156	390
14	304	1152	394
15	306	1154	392
16	316	1155	391
17	319	1158	388
18	327	1159	387
19	332	1150	396
20	341	1154	392
21	346	1154	392
22	350	1154	392
23	359	1154	392
24	362	1154	392
25	366	1154	392
26	372	1108	438
27	375	1163	383
28	386	1134	412
29	391	1124	422
30	399	1140	406

Time	Ext.	Load A	Load B
31 hrs.	.00405	1135	411
32	409	1147	399
33	415	1135	411
34	422	1147	399
35	425	1159	387
36	430	1140	406
37	440	1160	386
38	448	1168	378
39	455	1182	364
40	463	1181	365
41	466	1170	376
42	473	1161	385
43	483	1168	378
44	494	1176	370
45	503	1184	362
46	512	1168	378
47	516	1163	383
48	521	1197	349
49	528	1189	357
50	543	1165	381
51	557	1149	397
52	566	1167	379
53	572	1187	359
54	586	1165	381
55	596	1166	380
56	606	1159	387
57	618	1163	383
58	630	1173	373
59	641	1164	382
60	651	1159	387
61	666	1175	371
62	673	1152	394
63	683	1133	413
64	704	1185	361
65	716	1154	392
66	731	1168	378
67	748	1175	371
68	763	1158	388
69	778	1164	382
70	796	1162	384
71	812	1165	381
72	831	1173	373
73	846	1149	397
74	864	1153	393
75	882	1167	379
76	904	1156	390

From 20 to 25 hrs. load transducer sticking - changed to B load cell.

Figure 38.

Test No. 60 continued. . . . . .

Time	Ext.	Load A	Load B
77 hrs.	.00927	1151	395
78	946	1151	395
79	972	1140	406
80	992	1151	395
81	.01016	1147	399
82	1040	1140	406
83	1063	1142	404
84	1092	1151	395
85	1116	1149	397
86	1137	1140	406
87	1171	1158	388
88	1207	1142	404
89	1241	1140	406
90	1281	1140	406
91	1316	1139	407
92	1359	1160	386
93	1396	1130	416
94	1449	1137	409
95	1495	1146	400
96	1539	1148	398
97	1590	1148	398

Time	Ext.	Load A	Load B
98 hrs.	.01641	1134	412
99	1696	1131	415
100	1751	1138	408
101	1815	1140	406
102	1884	1132	414
103	1955	1133	413
104	2029	1122	424
105	2108	1133	413
106	2192	1137	409
107	2283	1123	423
108	2375	1133	413
109	2482	1129	417
110	2594	1130	416
111	2715	1131	415
112	2844	1128	418
113	2986	1128	418
114	3137	1124	422
115	3301	1122	424
116	3484	1124	422
117	3696	1114	432

Figure 39.

STRESS REDISTRIBUTION DUE TO CREEP IN NIMONIC 80

Combined Test
Specimen A 23.5 t.s.i. (1453 lbs)
Specimen B 1.5 t.s.i. (93 lbs)

Specimen Dia. .1878"
2 seconds to balance
Test No. 61

Time	Ext.	Load A	Load B
0	0	1453	93
1 min	.00244	1465	81
2	237	1464	82
3	237	1442	104
4	237	1441	105
5	237	1434	112
10	243	1405	141
15	247	1380	166
20	247	1349	197
25	251	1359	187
30	257	1374	172
35	263	1365	181
40	263	1359	187
45	266	1341	205
50	267	1341	205
55	267	1338	208
1 hr.	267	1331	215
2	277	1305	241
3	284	1292	254
4	287	1257	289
5	296	1252	294
6	300	1236	310
7	306	1223	323
8	316	1204	342
9	321	1215	331
10	323	1224	322
11	327	1211	335
12	334	1198	348
13	337	1198	348
14	343	1194	352

Time	Ext.	Load A	Load B
15	.00347	1209	337
16	355	1216	330
17	357	1196	350
18	357	1179	367
19	366	1209	337
20	372	1189	357
21	377	1183	363
22	377	1186	360
23	384	1195	351
24	386	1214	332
25	395	1195	351
26	394	1153	393
27	400	1215	331
28	404	1205	341
29	414	1205	341
30	417	1176	370
31	422	1159	387
32	437	1162	384
33	437	1158	388
34	446	1170	376
35	452	1180	366
36	455	1188	358
37	464	1181	365
38	467	1157	389
39	471	1160	386
40	477	1176	370
41	486	1180	366
42	493	1178	368
43	496	1167	379
44	503	1178	368

Figure 40.

Test No. 61 continued . . . . . .

Time	Ext.	Load A	Load B
45 hrs	.00514	1172	374
46	523	1185	361
47	527	1181	365
48	587	1167	379
49	547	1172	374
50	557	1202	344
51	573	1167	379
52	577	1192	354
53	584	1155	391
54	593	1178	368
55	602	1176	370
56	615	1171	375
57	631	1140	406
58	640	1151	395
59	649	1162	384
60	655	1175	371
61	670	1163	383
62	677	1160	386
63	693	1172	374
64	705	1176	370
65	715	1156	390
66*	730	1182	364
67	766	1182	364
68	767	1182	364
69	790	1182	364
70	810	1182	364
71*	830	1182	364
72	843	1167	379
73	867	1156	390
74	890	1148	398

Time	Ext.	Load A	Load B
75	.00901	1182	364
76	920	1155	391
77	944	1158	388
78	963	1175	371
79	987	1179	367
80	.01008"	1167	379
81	1031	1149	397
82	1056	1132	414
83	1078	1165	381
84	1100	1154	392
85	1125	1169	397
86	1145	1157	389
87	1177	1152	394
88	1200	1157	389
89	1227	1149	397
90	1261	1159	387
91	1296	1148	398
92	1337	1160	386
93	1380	1144	402
94	1415	1144	402
95	1457	1149	397
96	1513	1142	404
97	1557	1146	400
98	1606	1149	397
99	1654	1161	385
100	1704	1149	397
101	1757	1147	399.
102	1811	1151	395
103	1866	1158	388

*66-71 HRS NO TRANSFER OF LOAD. Standard transducer incorrect.

Figure 41.