

REVISED: MARCH 1963

NONFERROUS ALLOYS

1. **GENERAL**
This member of the family of age hardening nickel base alloys is used in form of bar, forgings and sheet for various heat resisting parts in engines at temperatures up to 1600 F. In this write-up properties for the alloy J-1500 are also included, which has a slightly higher titanium content, 3.0 percent, than M-252. A further development of these alloys is René 41.

- 1.01 Commercial Designations, M-252 (and J-1500).
1.02 Alternate Designations, None.
1.03 Specifications, None.
1.04 Composition, Table 1.04.

Source Alloy	TABLE 1.04 Universal Cyclops (1)	
	M-252	
	Percent	
	Min	Max
Carbon	0.10	0.20
Manganese	-	0.50
Silicon	-	0.50
Sulfur	-	0.015
Chromium	18.0	20.0
Cobalt	9.00	11.0
Molybdenum	9.00	10.50
Titanium	2.25	2.75
Aluminum	0.75	1.25
Boron	0.001	0.010
Zirconium	0.02	0.15
Iron	-	5.00
Nickel	Balance	

- 1.05 Heat Treatment
1.051 Anneal, 1925 to 2125 F, 4 hr, oil or water quench for maximum formability, (1)(9).
1.052 Solution treat, 1925 to 2125 F, 4 hr air cool. 2075 to 2125 F develops higher creep rupture strength, (1)(9).
1.053 Age, 1375 to 1425 F, 16 hr, (9).
1.06 Hardenability, Alloy retains most of the hardening elements in solid solution on air cooling and develops full hardening on subsequent aging, (1).
1.07 Forms and Conditions Available
1.08 Melting and Casting Practice, Induction and consumable electrode vacuum melts.
1.09 Special Considerations
2. **PHYSICAL AND CHEMICAL PROPERTIES**
2.01 Thermal Properties
2.011 Melting range, 2470 to 2500 F, (1).
2.012 Transformation temperature
2.013 Thermal conductivity, Fig. 2.013.
2.014 Thermal expansion, Fig. 2.014.
2.015 Specific heat
2.02 Other Physical Properties
2.021 Density, 0.298 lb per cu in. 8.25 gr per cu cm, (1).
2.022 Electrical properties
2.023 Magnetic properties
2.03 Chemical Properties
2.031 Corrosion resistance, Solution treated condition provides the best corrosion resistance, (1).
2.032 Oxidation resistance is good for continuous service in engines up to about 1900 F, for intermittent service up to 1600 F, (1).

- 2.04 Nuclear Properties

3. **MECHANICAL PROPERTIES**

- 3.01 Specified Mechanical Properties
3.02 Mechanical Properties at Room Temperature, See 3.03 also.
3.021 Hardness, Solution treated, 20 to 25 RC. Aged, 35 to 40 RC, (1).
3.03 Mechanical Properties at Various Temperatures
3.031 Short time tension properties
3.0311 Effect of test temperature on tensile properties of J-1500 sheet and bar, Fig. 3.0311.
3.0312 No loss in strength is observed when exposed up to 5000 hr at 1250 F.
3.032 Short time properties other than tension
3.033 Static stress concentration effects
3.04 Creep and Creep Rupture Properties
3.041 Creep rupture curves for M-252 and J-1500 bar at 1200 to 1600 F, Fig. 3.041.
3.042 Creep rupture curves for J-1500 sheet at 1200 to 1600 F, Fig. 3.042.
3.043 Master curves for total strain, creep and creep rupture of M-252 bar, Fig. 3.043.
3.044 Master curves for creep rupture of J-1500 sheet and bar, Fig. 3.044.
3.05 Fatigue Properties
3.051 Stress range diagrams for M-252 bar at 1350 and 1500 F, Fig. 3.051.
3.06 Elastic Properties
3.061 Modulus of elasticity at room and elevated temperatures, Fig. 3.061.
3.062 Modulus of rigidity at room and elevated temperatures, Fig. 3.062.

4. **FABRICATION**

- 4.01 Forming and Casting
4.011 General, This alloy is difficult to form at room temperature. The annealed condition strain hardens rapidly and all but the simplest parts require intermediate anneals, (1).
4.012 Forging, Starting temperature 2150 F maximum, finishing temperature 1800 F minimum. Low finishing temperatures may result in cracking or, on subsequent solution treating, in coarse grain structure, (1).
4.02 Machining, This alloy is machined most readily in a partly aged condition. Solution treated material, however, is more suitable for drilling and tapping. Equipment must be very rigid, tools very sharp and positive cuts must be taken. Grinding is preferred for many applications, using carborundum wheels, (1).
4.03 Welding, Information on welding this alloy is not available.
4.04 Heating and Heat Treating, Neutral or slightly oxidizing atmospheres are recommended to minimize oxidation, (1).
4.05 Surface Treating

	Ni
19	Cr
10	Co
10	Mo
2.5	Ti
1	Al

M-252

	Ni
19	Cr
10	Co
10	Mo
2.5	Ti
1	Al

M-252

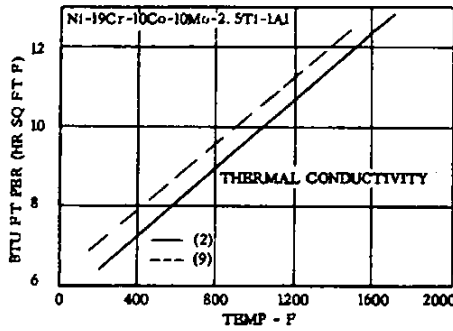


FIG. 2.013 THERMAL CONDUCTIVITY (2)(9)

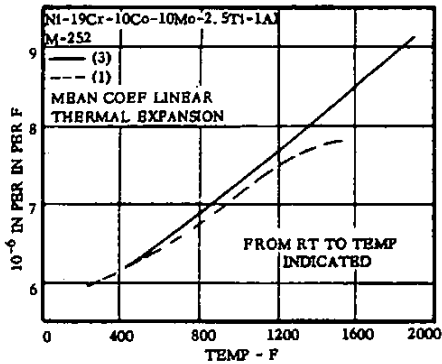


FIG. 2.014 THERMAL EXPANSION (1)(3)

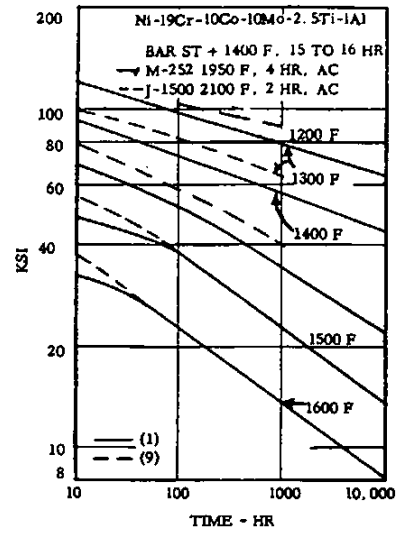


FIG. 3.041 CREEP RUPTURE CURVES FOR M-252 AND J-1500 BAR AT 1200 TO 1600 F (1)(9)

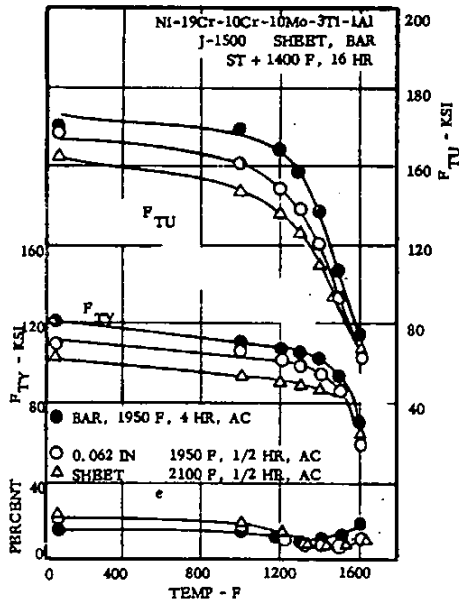


FIG. 3.0311 EFFECT OF TEST TEMPERATURE ON TENSILE PROPERTIES OF J-1500 SHEET AND BAR (9)

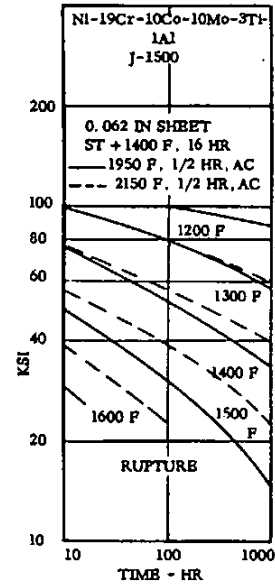


FIG. 3.042 CREEP RUPTURE CURVES FOR J-1500 SHEET AT 1200 TO 1600 F (9)

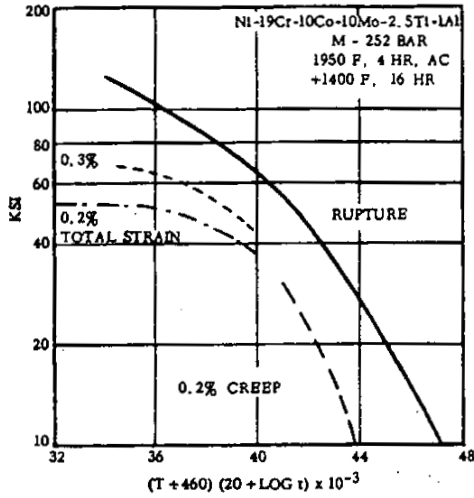


FIG. 3.043 MASTER CURVES FOR TOTAL STRAIN CREEP AND CREEP RUPTURE OF M-252 BAR. (4)(5)(6)

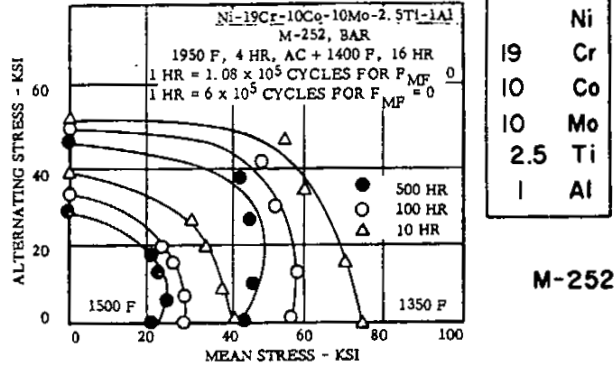


FIG. 3.051 STRESS RANGE DIAGRAMS FOR M-252 BAR AT 1350 AND 1500 F (7)(8)

Ni
19 Cr
10 Co
10 Mo
2.5 Ti
1 Al

M-252

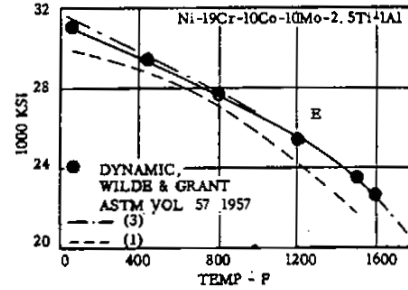


FIG. 3.061 MODULUS OF ELASTICITY AT ROOM AND ELEVATED TEMPERATURES (1)(3)

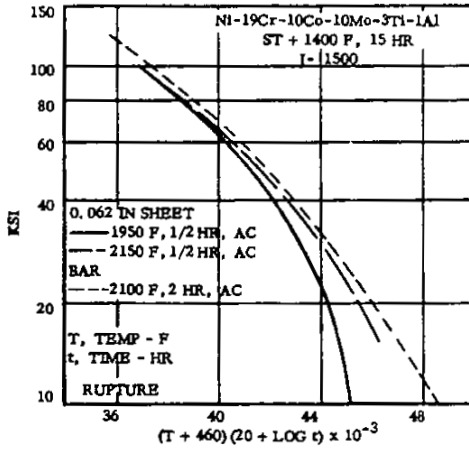


FIG. 3.044 MASTER CURVES FOR CREEP RUPTURE OF J-1500 SHEET AND BAR (9)

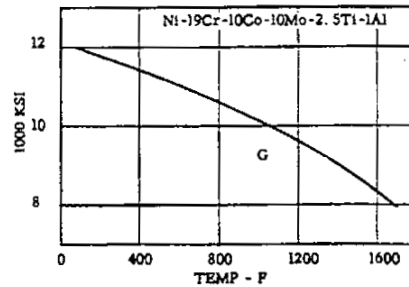


FIG. 3.062 MODULUS OF RIGIDITY AT ROOM AND ELEVATED TEMPERATURES (2)

	Ni
19	Cr
10	Co
10	Mo
25	Ti
1	Al

M-252

REFERENCES

- 1 Universal Cyclope Steel Corp., "High Temperature Metals-Properties and Processing Data," HTM 300, 1 59-5M, (1958)
- 2 General Electric Co., "M252 Physical Properties," A4012220-482, (Dec. 16, 1958)
- 3 General Electric Co., "M252 Physical Properties," A4012220-134R1, (Dec. 15, 1958)
- 4 General Electric Co., "M252 Master Rupture," A4012220-136R1, (June 5, 1958)
- 5 General Electric Co., "V. M. M252 Master Relaxation," A4012220-220, (Nov. 9, 1956)
- 6 General Electric Co., "M252 0.2% Plastic Creep," A4012220-137, (Oct. 6, 1956)
- 7 General Electric Co., "M252 Bar Stress Range Diagram, 1350°F," A4012220-255, (Feb. 28, 1957)
- 8 General Electric Co., "M252 Bar Stress Range Diagram, 1500°F," A4012220-256, (Feb. 28, 1957)
- 9 General Electric Co., "Engineering Data, VM 105, J1500," (Dec. 1957)

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