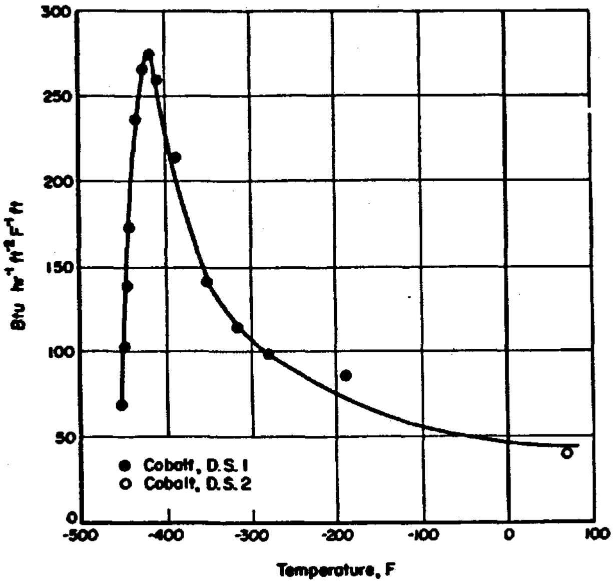
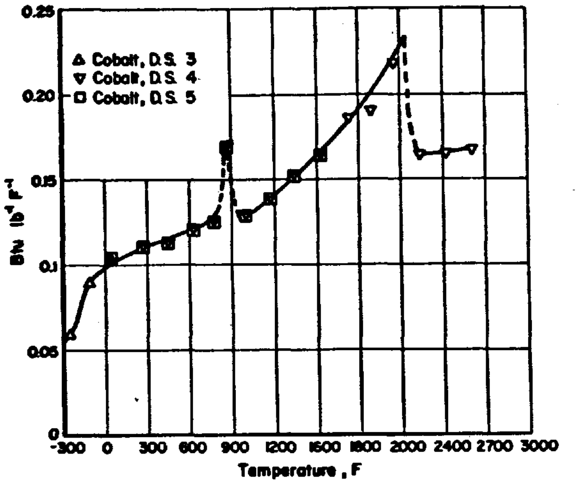
STP296-EB/Apr. 1961

COBALT AND ITS ALLOYS

COBALT



THERMAL CONDUCTIVITY OF COBALT



SPECIFIC HEAT OF COBALT

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

1

MATERIAL	Cobalt	HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Co: 99.9	
FORM		
HEAT TREATMENT	Annealed.	
REFERENCE	White, G. K., Woods, S. B., Canadian Journal of Physics, 35, (1957) pp. 656-665; *as found in* "A Compendium of Properties of Materials at Low Temperatures, Phase I", Part II, edited by Victor J. Johnson, NBS Cryogenic Engineering Laboratory, Boulder, Colorado (December, 1959).	

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
-453	69.9	-433	237	-388	214	-190	86.1
-449	104	-424	266	-352	142	-100	--
-445	139	-417	272	-316	113		
-442	173	-406	260	-280	90		
Values interpolated from graph.							

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

2

MATERIAL	Cobalt	HEAT NUMBER
CHEMICAL COMPOSITION PER CENT	Co: 99.9	
FORM		
HEAT TREATMENT		
REFERENCE	"Materials in Design Engineering", Materials Selector, edited by H. R. Clauser, Vol 46, No. 4 (Sept. 57), p 84.	
REMARKS	Melting point, F: 2723.	

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F-1 X 10⁶	TEMP RANGE, F	F-1 X 10⁶	TEMP RANGE, F	F-1 X 10⁶	TEMP RANGE, F	F-1 X 10⁶
Room	6.8						
Data assumed to be at room temperature and instantaneous coefficients.							

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
Room	40						
Data assumed to be at room temperature.							

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.322						
Data assumed to be at room temperature.							

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

3

MATERIAL	Cobalt					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Co	Fe	Cu	Ni	S	Mn			
	96.95	2.50	0.26	0.20	0.08	0.01			
FORM									
HEAT TREATMENT									
REFERENCE	Clusine, Keans, Schachinger, and Liselotte, "Results of Low-Temperature Research IX. The Atomic Heat of Cobalt Between 15 and 270 K", Z. Naturforsch, Vol 7a, pp. 185-91 (Germany); as found in WADC Technical Report 58-476.								
REMARKS									

SPECIFIC HEAT

TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1
-280	0.058	-100	0.089	80	0.102		

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

4

MATERIAL	Cobalt					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Co	Fe							
	99.95	0.01-0.05							
FORM									
HEAT TREATMENT									
REFERENCE	Jaeger, F. M., Rosenbahm E., and Auithoff, A. J., "Exact Determination of Specific Heats at High Temperatures. XII. Specific Heat, Electrical Resistance and Thermoelectric Power of Cobalt", Rec. Tran. Chim., Vol 59, pp. 831-56 (France); as found in WADC Technical Report 58-476.								

SPECIFIC HEAT

TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1
260	0.112	865	0.168 *	1520	0.164	2240	0.166**
440	0.116	980	0.128	1700	0.177	2420	0.167
620	0.121	1160	0.139	1880	0.190	2600	0.168
800	0.125	1340	0.152	2060	0.220		
* Discontinuity due to $\alpha \longrightarrow \beta$ transformation.							
** Discontinuity due to Curie point.							

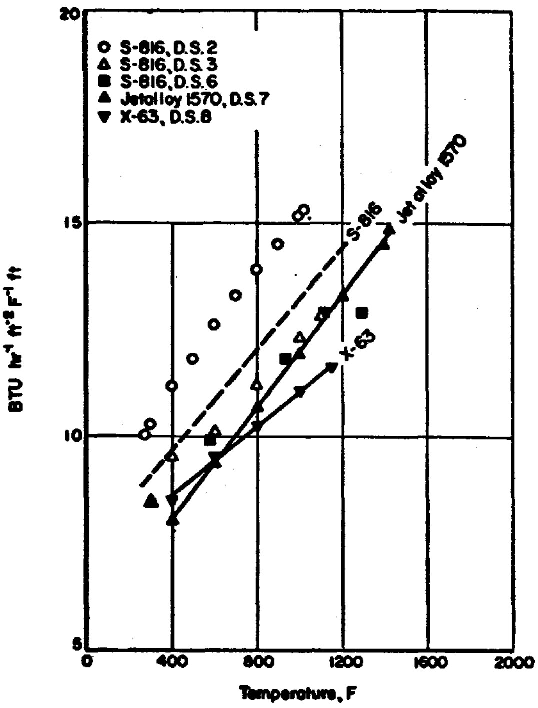
ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

5

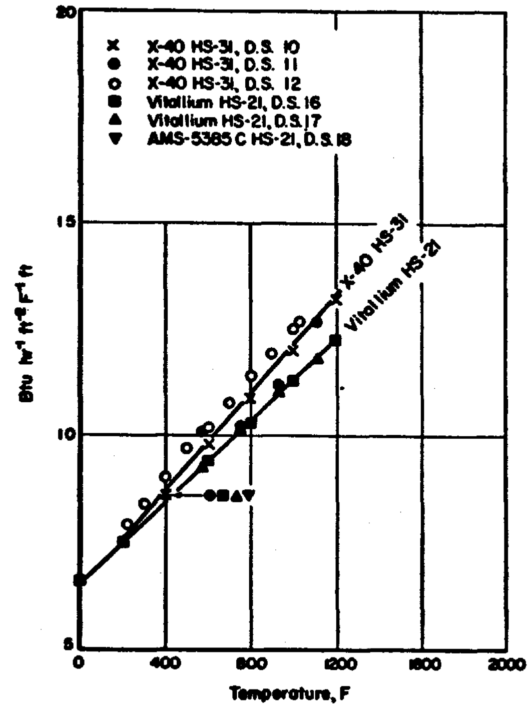
MATERIAL	Cobalt--Electrolytic					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Impur.	Co							
	<0.01	Bal							
FORM									
HEAT TREATMENT									
REFERENCE	Armstrong, L. D., and Grayson-Smith, H., "High-Temperature Calorimetry. I-A new Adiabatic Calorimeter. II-Atomic Heats of Chromium, Manganese, and Cobalt between 0 and 800°", Am. Jour. Research, Vol 28A, p 44-50, 51-59 (Canada). Data found in WADC Technical Report 58-476.								

SPECIFIC HEAT

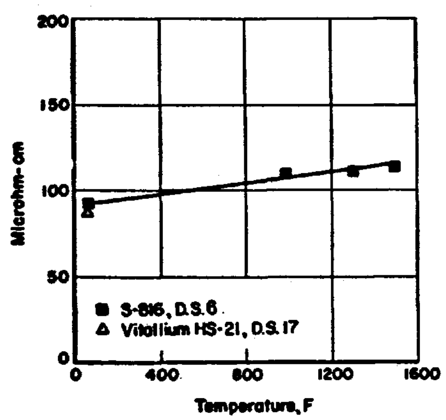
TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1	TEMP., F	BTU LB-1 F-1
80	0.102	620	0.121	980	0.128	1340	0.152
260	0.112	800	0.125	1160	0.139	1520	0.164
440	0.116	865	0.168*				
*Discontinuity due to $\alpha \longrightarrow \beta$ transformation.							



THERMAL CONDUCTIVITY OF COBALT BASE ALLOYS



THERMAL CONDUCTIVITY OF COBALT BASE ALLOYS



ELECTRICAL RESISTIVITY OF COBALT BASE ALLOYS

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

(1)

MATERIAL	Haynes Alloy No. 36					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	W	Ni	Fe	C	Co			
	18.5	15	10	max. 2.0	0.40	Bal			
FORM									
HEAT TREATMENT									
REFERENCE	Haynes Stellite Company								

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.326						

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

(2)

MATERIAL	Cobalt--S 816					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	W	Cb	Fe	Mn	Si	C
	20	20	4	4	4	3	1.2	0.1	0.38
	Co								
	Bal								
FORM									
HEAT TREATMENT									
REFERENCE	Evans, E., Jr., "Thermal Conductivity of 14 Metals and Alloys Up to 1100 F", Lewis Flight Propulsion Laboratory, NACA Research Memorandum Rm E 50L07 (March, 1951).								
REMARKS	Nominal composition found in DMIC Memo 42.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
275	10	500	11.8	800	13.9	1000	15.2
300	10.2	600	12.6	900	14.5	1025	15.3
400	11.1	700	13.3				
Interpolated data taken from a heat curve.							

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

(3)

MATERIAL	Cobalt--S 816					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Ni	Cr	Mo	W	Cb	Fe	Mn	Si	C
	20	20	4	4	4	3	1.2	0.4	0.38
	Co								
	Bal								
FORM									
HEAT TREATMENT									
REFERENCE	Materials Data Book No. 1, General Electric Company.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT	TEMP., F	BTU HR-1 FT-2 F-1 FT
300	8.4	600	10.1	1000	12.2	1100	12.8
400	9.5	800	11.2				

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

(4)

MATERIAL	Cobalt--S 816					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Co	Ni	Cr	Cb	Mo	W	Fe	Mn	Si
	43.70	20.23	19.5	4.06	3.93	3.45	2.95	0.58	0.54
	C								
	0.47								
FORM	1/2" dia. bar.								
HEAT TREATMENT									
REFERENCE	U. S. Naval Engineering Experiment Station.								
REMARKS	Absolute method, Leitz Dilatometer, heating rate: 5.0 or 5.6 F per minute.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6
100-500	7.6	100-1000	8.8	100-1600	8.8		

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

(5)

MATERIAL	Cobalt and Mixed Base Alloys--S 816					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Ni	Cr	Mo	W	Cb	Fe	Mn	Si	C
	20	20	4	4	4	3	1.2	0.4	0.38
	Co								
	Bal								
FORM									
HEAT TREATMENT									
REFERENCE	Materials and Methods Manual No. 115, "Metals for Short Time Service at High Temperatures", by A. Levy (April 1955), p 121.								
REMARKS	Melting point--2400° F. Nominal composition taken from DMIC Memo 42.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6	TEMP RANGE, F	F-1 x 10^6
70-600	6.6	70-1000	7.1	70-1400	7.7	70-1800	8.3
70-800	6.9	70-1200	7.4	70-1600	8.0		

DENSITY

TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1	TEMP., F	LB CU IN-1
Room	0.313						
Data assumed to be at room temperature.							

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

(6)

MATERIAL	Cobalt--S 816					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Co	Ni	Cr	W	Cb	Mo	Fe	Mn	Si
	41.71	20.65	19.88	4.20	4.13	3.76	3.38	1.32	0.56
	C								
	0.38								
FORM									
HEAT TREATMENT									
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS	Rolled or forged from 2100-2250 F. Solution: 2150-2250 1hr W.Q. Aged 1400-1500 F - 16 hr air. Excellent corrosion resistance to 1500 F.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
302	8.42	932	11.8	1112	12.9	1292	12.9
572	9.92						

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
68-572	6.6	68-932	7.1	68-1292	7.5	68-1652	8.0
68-752	6.9	68-1112	7.2	68-1472	7.8	68-1832	8.3

SPECIFIC HEAT

TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1
77-572	0.09-0.10	77-932	0.10	77-1292	0.12		

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
81	93.0	990	109.3	1302	111.4	1505	113.0

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.313						

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

7

MATERIAL	Jetalloy 1570						HEAT NUMBER		
CHEMICAL COMPOSITION PER CENT	Ni	Cr	W	Ti	Fe	C	Co		
	28	20	7	4	2	0.2	Bal		
FORM									
HEAT TREATMENT									
REFERENCE	Research Lab, General Electric Company.								
REMARKS	Nominal composition found in DMIC Memo 42.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
400	8.08	800	10.65	1200	13.25	1425	14.87
600	9.37	1000	11.96	1400	14.54		

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
300	7.883	600	7.932	1000	8.130	1400	8.725
400	7.895	800	7.999	1200	8.373	1575	9.145
Assumed to be instantaneous coefficients.							

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

8

MATERIAL	Cobalt Alloy--X-63					HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Co	Cr	Ni	Mo	Fe	Al	C		
	58.50	22.00	10.00	6.00	2.00	1.25	0.40		
FORM	Cast								
HEAT TREATMENT									
REFERENCE	Materials Data Bk I, General Electric Company, Thompson Lab.								
REMARKS	Nominal composition found in DMIC Memo 42.								

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
400	8.48	800	10.27	1000	11.07	1150	11.65
600	9.47						

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

9

MATERIAL	Cobalt Alloy--Y-36						HEAT NUMBER		
CHEMICAL COMPOSITION PER CENT	Co	Cr	Ni	Mo	W	Cb&Ta	Fe	Mn	Si
	43.00	25.00	20.00	4.00	2.30	2.00	2.00	0.90	0.40
	C	S	P						
	0.30	0.02	0.02						
FORM									
HEAT TREATMENT									
REFERENCE	Allegheny Ludlum Steel Corporation.								
REMARKS	Rolled or forged from 1800 to 2250 F.								

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
122-212	6.7	122-752	7.9	122-1472	8.8	122-1832	8.9
122-392	7.1	122-1112	8.5				
Heat treatment: 2250 F--1 hr W.Q.; 2250F--1 hr W.Q. + 1400--16 hr air.							

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
122-212	6.1	122-752	7.8	122-1472	8.8	122-1832	9.3
122-392	7.2	122-1112	8.1				
Heat treatment: 2250 F--1 hr W.Q.; 2250--1 hr W.Q. + 1400--16 hr air.							

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.303						
Data assumed to be at room temperature. Heat treatment solution: 2250-2275 - water quenched - age 1400 F - 16 hour - air.							

(10)

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

MATERIAL	Cobalt Alloy--X-40 (Stellite 31)				HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Mo	Fe	Co			
	23.00	10.00	7.00	1.00	Bal			
FORM	Cast							
HEAT TREATMENT								
REFERENCE	Materials Data Bk. I, General Electric Company, Thomson Lab.							
REMARKS	Nominal composition obtained from DMIC Memo 42.							

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
400	8.62	800	10.90	1000	12.03	1200	13.17
600	9.77						
Interpolated data from curve.							

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
200	21.5	600	24.2	1000	26.8	1400	29.4
400	22.9	800	25.5	1200	28.1		
Values interpolated from curve and assumed to be instantaneous coefficients.							

(11)

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

MATERIAL	Cobalt Alloy--X-40 (Stellite 31)				HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	W	C	Co			
	25.5	10.5	7.5	0.05	Bal			
FORM								
HEAT TREATMENT								
REFERENCE	Haynes Stellite Company.							
REMARKS	Investment cast alloy. As cast - Rockwell C 34 maximum Aged 50 hrs at 1500 F - Rockwell C 42 maximum.							

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
392	8.58	752	10.2	932	11.2	1112	12.7
572	10.1						

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-600	7.84	70-1000	8.39	70-1500	9.19	70-1600	9.19
70-800	8.08	70-1200	8.75				

SPECIFIC HEAT

TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1	TEMP, F	BTU LB-1 F-1
Room	0.0981						
Data assumed to be at room temperature.							

DENSITY

TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1	TEMP, F	LB CU IN-1
Room	0.315						
Data assumed to be at room temperature.							

(12)

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

MATERIAL	Cobalt Alloy--X-40 (Stellite 31)				HEAT NUMBER			
CHEMICAL COMPOSITION PER CENT	Cr	Ni	Fe	C	Co			
	25.5	10.5	2.0	0.53	Bal			
FORM								
HEAT TREATMENT								
REFERENCE	Jessy E. Evans, Jr., "Thermal Conductivity of 14 Metals and Alloys up to 1100 F", Lewis Flight Propulsion Lab. NACA Research Memorandum RME 50L07 (March 51).							

THERMAL CONDUCTIVITY

TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT	TEMP, F	BTU HR-1 FT-2 F-1 FT
220	7.9	500	9.7	800	11.4	1000	12.5
300	8.4	600	10.2	900	11.9	1030	12.65
400	9.1	700	10.8				

(13)

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS

MATERIAL	Cobalt Alloy--HS-23					HEAT NUMBER		
CHEMICAL COMPOSITION PER CENT	Co	Cr	W	Mn	Fe	Si	C	Mo
	65.12	26.57	5.08	0.94	0.71	0.68	0.56	0.39
FORM								
HEAT TREATMENT								
REFERENCE	U. S. Naval Engineering Experiment Station.							
REMARKS	Absolute method, Leitz Dilatameter. Heating rate: 5.0° or 5.6° per minute.							

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	7.6	100-1000	8.3	100-1600	9.1		

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (14)

MATERIAL: Cobalt Alloy--HS-27 HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Co	Ni	Cr	Mo	Mn	Si	Fe	C
	33.85	30.91	26.40	6.14	1.02	1.0	0.97	0.5

FORM

HEAT TREATMENT

REFERENCE: U. S. Naval Engineering Experiment Station.

REMARKS: Absolute method, Leitz Dilatometer. Heating rate: 5.0° or 5.6° per minute.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	7.3	100-1000	7.7	100-1600	8.7		

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (15)

MATERIAL: Cobalt Alloy--HS-27 HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Co	Ni	Cr	Mo	Mn	Si	C	Fe
	32.0	32.0	25.0	6.5	1.0	0.4	0.2	Bal

FORM

HEAT TREATMENT

REFERENCE: U. S. Naval Engineering Experiment Station.

REMARKS: Absolute method, Leitz Dilatometer, heating rate: 5.0 or 5.6 F per minute.

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
100-500	7.7	100-1000	8.1	100-1600	9.1		

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (16)

MATERIAL: Cobalt Alloy--Vitallium (HS-21) HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Mo	Fe	N	C	Co
	27	5.5	3.0	2.75	0.25	Bal

FORM

HEAT TREATMENT

REFERENCE: Thomson Lab Data, General Electric Company.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
0	6.58	400	8.50	800	10.34	1200	12.24
200	7.52	600	9.40	1000	11.30		

ASTM-ASME JOINT COMMITTEE ON EFFECT OF TEMPERATURE ON PROPERTIES OF METALS (17)

MATERIAL: Cobalt Alloy--Vitallium (Stellite 21) HEAT NUMBER

CHEMICAL COMPOSITION PER CENT	Cr	Mo	Fe	N	C	Co
	27	5.5	3.0	2.75	0.25	Bal

FORM: Investment Cast Alloy.

HEAT TREATMENT

REFERENCE: Haynes Stellite Company.

REMARKS: As cast Rockwell C 34 maximum.
Aged 50 hrs. at 1475 F - Rockwell C 45 maximum.

THERMAL CONDUCTIVITY

TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP, F	BTU HR^{-1} FT^{-2} F^{-1} FT
392	8.42	752	10.1	932	11.0	1112	11.8
572	9.45						

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
70-600	7.83	70-1000	8.18	70-1500	8.68	70-1600	8.72
70-800	7.96	70-1200	8.38				

SPECIFIC HEAT

TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}	TEMP, F	BTU LB^{-1} F^{-1}
Room	0.1006						

Data assumed to be at room temperature.

ELECTRICAL RESISTIVITY

TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM	TEMP, F	MICROHM-CM
Room	34.4						

Data assumed to be at room temperature.

DENSITY

TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}	TEMP, F	LB CU IN^{-1}
Room	0.299						

Data assumed to be at room temperature.

MATERIAL	Cobalt Alloy--AMS 5385C (Stellite 21) HEAT NUMBER								
CHEMICAL COMPOSITION PER CENT	Cr	Mo	Fe	Ni	Si	Mn	C	B	Co
	25-30	4.5-6.5	max. 2.0	1.5-3.5	max. 1.0	max. 1.0	0.20-0.35	max. 0.07	Bal
FORM									
HEAT TREATMENT									
REFERENCE	"Materials in Design Engineering " Materials Selector, edited by H. R. Clauser, Vol 46, No. 4 (September, 1957), p. 84.								
REMARKS	Melting point: 2465 F; Annealing temperature: 2175-2200 F; Hardening temperature: 1475-1500 F.								

THERMAL CONDUCTIVITY

TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT	TEMP., F	BTU HR^{-1} FT^{-2} F^{-1} FT
392	8.4						

COEFFICIENT OF LINEAR THERMAL EXPANSION

TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$	TEMP RANGE, F	$F^{-1} \times 10^6$
Room	7.8						
Data assumed to be at room temperature and instantaneous coefficients.							

DENSITY

TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}	TEMP., F	LB CU IN^{-1}
Room	0.299						
Data assumed to be at room temperature.							