Technical Information

Issue 7
Updated: **21 September 2009 2:42 PM**

Alder Works		Tel	+44(0)1483 415444
Catteshall Lane		Fax	+44(0)1483 426891
Godalming		Email	GSValves@aol.com
Surrey GU7 1JS		Web	www.gsvalves.co.uk

G&S

Contents

Company Profile

Established 1946

G&S Valves Ltd. specialises in manufacturing a wide range of valves, from 'one off' prototypes for engine development, up to ongoing scheduled contracts for larger companies. We have received approved supplier status from many of the major OEM and high performance manufacturers.

- Cosworth 'Approved Supplier Scheme'
- Rolls Royce Motor Cars 'Supplier Assessments'
- Varity Perkins 'Approved Supplier'
- Various Vintage Motor Car & Motorcycle Clubs

General Overview

G&S Valves Ltd. can offer you a complete valve, from start to finish. We hold a comprehensive stock of high quality valve steel and can upset forgings from a vast range of die forms to produce suitably close limit forgings to suit most applications.

We have the facilities to perform various types of heat treatments, bi-metal valves and hard stellite seat facing.

Our manufacturing prºCess starts life as a plain steel rod which is then electrically upset to form a bunt, then forged into a close limit forging.

After being forged the valve goes through a number of machining and grinding operations.

Before final inspection in our quality department.

After final inspection, we can offer a pulsed plasma treatment (in house) as well as various other treatments. Surface Hardness is then checked in our metallurgy lab.

Company History

G&S Valves Ltd. was founded on July 13th 1946 by Mr. Harry Grenside and his partner Mr. Ralph Saunders, the company was originally known as G&S Motors lºCated in a small factory in Milford, Surrey, England.

In 1947 G&S Valves acquired its first major customer, Petters of Staines. By 1959 the work load had increased so much that new premises had to be found. This was to be a purpose built factory in Catteshall Lane, Godalming, when the name changed to G&S Valves.

Over the next few years the range of valves produced was increased to include those for competition engines and racing cars as well as for the English motor cycle industry. During this time they earned a reputation as a high quality engine valve manufacturer, supplying the likes of:

- Cosworth Racing
- Lotus
- Ford Competition Department
- and many others.

In 1974 Mr. Robert Grenside & Mr. Neville Nichols took over control of G&S Valves Ltd. and continued to improve quality of the valves produced. 1980 saw the purchase of a Forge, based in the West Midlands, which Mr. Trevor Abbotts, formally from TRW, took control of this new acquisition allowing us to make purpose made forgings for the ever increasing valve business.

Due to the increasing complexity of some of the shapes required by some of our racing customers, G&S Valves had to purchase a number of CNC Lathes and Grinders to produce these new designs. With this came the need to install a CAD system to create the drawings needed.

In 1991 Mr. Andrew Grenside joined the company and used his knowledge in computers to set up this new system. This new set-up has improved the production techniques and quality of all of valves produced at G&S, and is looking forward to new challenges in the forthcoming years.

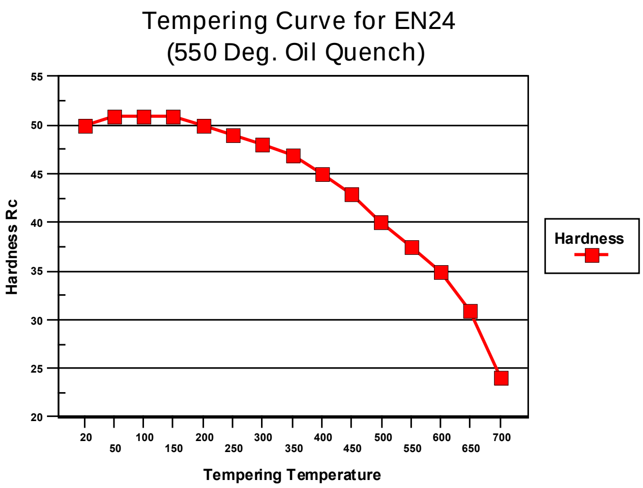
Material Cross Reference

	ENGLAND		SWEDEN	USA	GERMANY		FRANCE	BELGIUM	ITALY	SPAIN	JAPAN
G&S Valves	British Std.	EN	SS	AIS/SAE	W.-nr	DIN	AFNOR	NBN		UNF	JISwww
EN18	530M40	EN18		5140	1.7035	41Cr4	42C4	41Cr4	41Cr4	42Cr4	SCr44 (H)
EN24	817M40	EN24	2451	5340	1.6582	34CrNiMo6	35NCD6	35NiCrMo6	35NiCrMo6		
EN31	534A99	EN31	2258	52100N	1.3505	100Cr6	100C6		100Cr6	F.131	SUJ2
EN52	401S45	EN52		HW3	1.4718	X45CrSi93	Z45CS9		X45CrSi8	F.322	SUH1
EN54A	331S42	EN54A	S		1.2731	X80CrNiSi20					
EN59	443S65	EN59		HNV6	1.4747	X80CrNiSi20	Z80CSN20.02		X80CrSiNi20	F.320B	SUH4
214N	349S52	214N		EV8	1.2731	X53CrMnNi219	Z55CMN21.09		X53CrMnNiN	F.3551	SUH35
X21RB	352S52	214MNC			1.4747	X50CrMnNiNb219	Z50CMNNb21.09				
1.4882		214MNCW			1.4882	X50CrMnNiNbN219					
1.4731					1.4731	X40CrSiMo102	Z40CSD10				SUH3
1.3343	BM2		2272		1.3343	S6-5-2	HS6-5-2				SKIH51
Nimonic 80A	3076	2188		HEV5	2.4952	17742	NC20TA				SUH751
Incolnel 751											
316S11					1.4404	X2CrNiMo17132	Z2CND1712		X2CrNiMo17		
AMS6514D				C300							
In.Titanium	6A1-4V				3.7165						
Ex.Titanium	6242										
6082 Alloy	6082		4242		3.3215	AlMgSil					
7075 Alloy	7075 (T6)					AlZnMgCul,5					
Die Steel	BH13		2242	H13A							

Heat Treatment (EN24)

a. This material is hardenable and the hardening can be adjusted to suit customer's requirements, therefore the heat treatment can vary according to hardness requirements. Where the customer has no particular requirement, the heat treatment shall be as in code HTP 11.

b. Miscellaneous Notes applying to this grade. Overheating can result in retained austenite and high crack frequency.



HTP 1

No heat treatment

HTP 12: Harden & Temper

Harden from 820°C., 1 hour soak and oil quench to give 50 HRc. min. Followed by tempering at 620°C., 1 hour soak and air cool to give 30-40 HRc.

HTP 16: Harden & Temper (Charts & Graphs)

Harden from 820°C., 1 hour soak and oil quench to give 50 HRc. min. Followed by tempering at 620°C., 1 hour soak and air cool to give 30-40 HRc.

HTP 11: Stress Relieve

Stress relieve at 620°C., 1 hour soak and air cool.

HTP 11: Stellite Seat

Stress relieve at 620°C., 1 hour soak and air cool, this treatment to be performed within 8 hours of stelliting or coining.

HTP 13: Bi-Metal (214N/1.4882/Nimonic 80A) / EN24 & Full Welded Ends

Harden from 820°C., 1 hour soak and oil quench to give 50 HRc. min. Temper at 620°C., 1 hour soak and air cool to give 30-40 HRc., this operation to be carried out within 8 hours of welding.

HTP 13: Stellite Seat Bi-Metal (214N/1.4882/Nimonic 80A) / EN24 & Full Welded Ends

Harden from 820°C., 1 hour soak and oil quench to give 50 HRc. min.

Temper at 620°C., 1 hour soak and air cool to give 30-40 HRc., this operation to be carried out within 8 hours of stelliting or coining.

HTP 19

Customer hardness requirements other than that listed above, consult tempering curve.

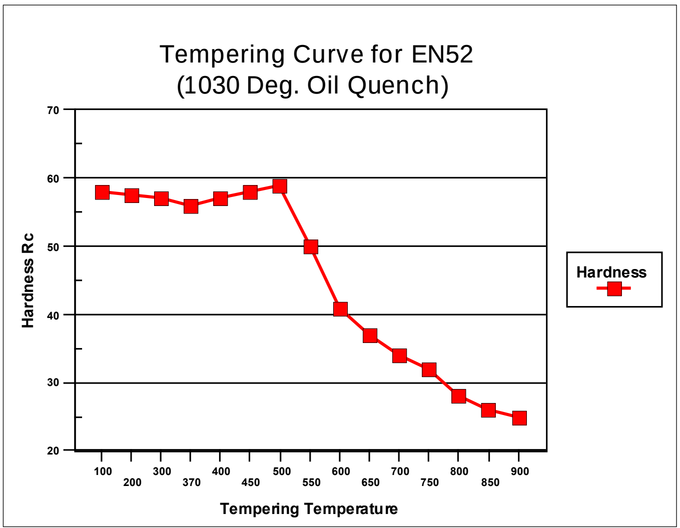
GSHTP 1: Tip & Seat Hardening

Hardening should be carried out at the minimum temperature above 820°C. which may vary considerably, dependent upon equipment used, time and quench medium, to produce the required hardness and depth.

Heat Treatment (EN52)

a. This material is hardenable and the hardening can be adjusted to suit customer's requirements, therefore the heat treatment can vary according to hardness requirements. Where the customer has no particular requirement, dependent upon plant the heat treatment shall be as in code HTP 5

b. Miscellaneous Notes applying to this grade. It must be noted that this material will work harden during stem straightening, the amount depending upon the pressure applied, however for guidance it has been found in practice that the stem hardness will normally increase by 2-5 HRc. on the surface layers, after stem rolling. The stress relieving temperature given in Code no. HTP 5 is not to be exceeded as this material can be susceptible to critical strain grain grown when stress relieving treatments in excess of 750ºC. are employed.



HTP 1

No heat treatment

HTP 5: Stress Relieve

Temper at 750ºC., 1 hour soak and air cool to give 40 HRc. (Head) & 25 HRc (Stem).

HTP 6: Full Temper

Temper at 750ºC., 4 hour soak and air cool to give 40 HRc. (Head) & 25 HRc (Stem).

HTP 8: Std. Harden & Temper

Harden from 1050ºC., 30 Min., soak then air cool followed by tempering at 750ºC., 1 hour soak and air cool to give 40 HRc. (Head) & 25 HRc (Stem).

HTP 7: Full Harden & Temper

Harden from 1050ºC., 30 Min., soak then air cool followed by tempering at 750ºC., 4 hour soak and air cool to give 40 HRc. (Head) & 25 HRc (Stem).

HTP 9: Bi-Metal 214N or Nimonic 80A / EN52 & Full Welded Ends

Harden from 1050ºC., 30 Min., soak then air cool followed by tempering at 750ºC., 1 hour soak and air cool to give 40 HRc. (Head) & 25 HRc (Stem). This operation to be carried out within 8 hours of welding.

HTP 17: Bi-Metal 1.4882 / EN52 & Full Welded Ends

Stress relieve from 800ºC., 1 2 hour soak then air cool, after friction welding temper at 750ºC., 1 hour soak and air cool to give 40 HRc. (Head) & 25 HRc (Stem). This operation to be carried out within 8 hours of welding.

HTP 5: Stellite Seat EN52

Stress relieve at 750ºC., 1 hour soak and air cool to be performed after stelliting or coining within 2 hours.

HTP 9: Stellite Seat, Bi-Metal 214N or Nimonic 80A / EN52 & Full Welded Ends

Harden from 1050ºC., 30 Min., soak then air cool followed by tempering at 750ºC., 1 hour soak and air cool to give 40 HRc. (Head) & 25 HRc (Stem). This operation to be carried out within 8 hours of stelliting or coining.

HTP 17: Stellite Seat, Bi-Metal 1.4882 / EN52 & Full Welded Ends

Stress relieve from 800ºC., 1 2 hour soak then air cool, after friction welding temper at 750ºC., 1 hour soak and air cool to give 40 HRc. (Head) & 25 HRc (Stem). This operation to be carried out within 8 hours of stelliting or coining.

HTP 20

Customer hardness requirements other than that listed above, consult tempering curve.

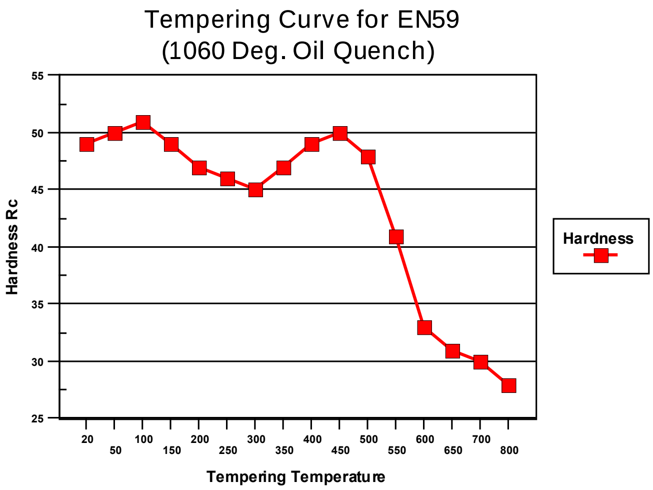
GSHTP 2: Tip & Seat Hardening

Hardening should be carried out at the minimum temperature above 1030ºC. which may vary considerably, dependent upon equipment used, time and quench medium, to produce the required hardness and depth.

Heat Treatment (EN59)

a. This material is hardenable and the hardening can be adjusted to suit customer's requirements, therefore the heat treatment can vary according to hardness requirements. Where the customer has no particular requirement, dependent upon plant the heat treatment shall be as in code HTP 3

b. Miscellaneous Notes applying to this grade. This material exhibits a hardening peak therefore over heating will result in softening. The characteristics of this material eliminate fast heating rates and high thermal gradients.



HPT 1

No heat treatment.

HTP 3

Stress relieve at 780°C., 1 2 hour soak and air cool to give 28-36 HRc.

HTP 21

Customer hardness requirements other than listed above, consult tempering curve and choose a low temperature and progressively increase temperature until the required hardness is achieved.

GSHTP 3: Tip & Seat Hardening -

Hardening should be carried out at the minimum temperature above 1050°C.

This material exhibits a hardening peak therefore over heating will result in softening. The characteristics of this material eliminate fast heating rates and High thermal gradients. Hardness requirements 45 HRc. min.

Heat Treatment (214N)

a. This material is austenitic and can be precipitation hardened after a suitable solution treatment. Valves in this material are supplied in the as forged condition as in code HTP 1.

b. Material Approval Test: The material shall be capable of maintaining a hardness of 32 HRc. min. After the following heat treatment 1160-1190oC. oil or water quench and precipitation hardened within the range 750-850oC. for a time not exceeding 15 hours.

c. Miscellaneous Notes Applying to this grade: It must be noted that this material will work harden during stem straightening, the amount depending upon the pressure applied, however for guidance it has been found in practice that the stem hardness will normally increase by 5-10 HRc. on the surface layers, after stem rolling.

HTP 1

No heat treatment

HTP 2: Stress Relieve

Stress relieve at 800ºC., 1 2 hour soak and air cool to give 32 HRc.

HTP 13: Bi-Metal 214N / EN24 & Full Welded Ends

Harden from 820ºC., 1 hour soak and oil quench to give 50 HRc. min. Temper at 620ºC., 1 hour soak and air cool to give 30-40 HRc., this operation to be carried out within 8 hours of welding.

HTP 9: Bi-Metal 214N /EN52 & Full Welded Ends

Harden from 1050ºC., 30 Min., soak then air cool followed by tempering at 750ºC., 1 hour soak and air cool to give 40 HRc. (Head) & 25 HRc (Stem). This operation to be carried out within 8 hours of welding.

HTP 18: Bi-Metal 214N/1.3343 & Full Welded Ends

Stress relieve at 680ºC., 2 hour soak and air cool, this treatment to be performed immediately after welding.

HTP 4: Stellite Seat

Stress relieve at 800ºC., 1 hour soak and air cool to give 30 HRc.

HTP 13: Stellite Seat, Bi-Metal 214N / EN24 & Full Welded Ends

Harden from 820ºC., 1 hour soak and oil quench to give 50 HRc. min.

Temper at 620ºC., 1 hour soak and air cool to give 30-40 HRc., this operation to be carried out within 8 hours of stelliting or coining.

HTP 9: Stellite Seat, Bi-Metal 214N/EN52 & Full Welded Ends

Harden from 1050ºC., 30 Min., soak then air cool followed by tempering at 750ºC., 1 hour soak and air cool to give 40 HRc. (Head) & 25 HRc (Stem). This operation to be carried out within 8 hours of stelliting or coining.

HTP 18: Stellite Seat, Bi-Metal 214N/1.3343 & Full Welded Ends

Stress relieve at 680ºC., 2 hour soak and air cool, this treatment to be performed immediately after stelliting or coining.

GSHTP 3: Stabilised

Stabilised at 600ºC., 2 hour soak and oil quench

HTP 15 - Solution treat & Age (Charts & Graphs) -

Solution treat at 1175ºC., 2 hour soak and oil quench followed by ageing at 780ºC., 10 hour soak and air cool to give a hardness of 32 HRc. min

HTP 22

Customer hardness requirements other than listed above.

Heat Treatment (1.4882)

a. This material is austenitic and can be precipitation hardened after a suitable solution treatment. Valves in this material are supplied in the as forged condition as in code HTP 2.

b. Material Approval Test

The material shall be capable of maintaining a hardness of 32 HRc. min. After the following heat treatment 1160-1190ºC. oil or water quench and precipitation hardened within the range 750-850ºC. for a time not exceeding 15 hours.

c. Miscellaneous Notes Applying to this grade. It must be noted that this material will work harden during stem straightening, the amount depending upon the pressure applied, however for guidance it has been found in practice that the stem hardness will normally increase by 5-10 HRc. on the surface layers, after stem rolling.

HTP 1

No heat treatment

HTP 2: Stress Relieve

Stress relieve at 800ºC., 1 hour soak and air cool to give 30 HRc

HTP 13: Bi-Metal 1.4882 / EN24 & Full Welded Ends

Harden from 820ºC., 1 hour soak and oil quench to give 50 HRc. min.

Temper at 620ºC., 1 hour soak and air cool to give 30-40 HRc., this operation to be carried out within 8 hours of welding.

HTP 17 - Bi-Metal 1.4882 / EN52 & Full Welded Ends -

Stress relieve from 800ºC., 1 2 hour soak then air cool, after friction welding temper at 750ºC.,

1 hour soak and air cool to give 40 HRc. (Head) & 25 HRc (Stem). This operation to be carried out within 8 hours of welding.

HTP 18 - Bi-Metal 214N / 1.3343 & Full Welded Ends -

Stress relieve at 680ºC., 2 hour soak and air cool, this treatment to be performed immediately after welding.

HTP 4: Stellite Seat

Stress relieve at 800ºC., 1 hour soak and air cool to give 30 HRc, this operation to be carried out within 8 hours of stelliting or coining

HTP 13: Stellite Seat, Bi-Metal 1.4882 / EN24 & Full Welded Ends

Harden from 820ºC., 1 hour soak and oil quench to give 50 HRc. min Temper at 620ºC., 1 hour soak and air cool to give 30-40 HRc., this operation to be carried out within 8 hours of stelliting or coining.

HTP 17: Stellite Seat, Bi-Metal 1.4882 / EN52 & Full Welded Ends

Stress relieve from 800ºC., 1 2 hour soak then air cool, after friction welding temper at 750ºC., 1 hour soak and air cool to give 40 HRc. (Head) & 25 HRc (Stem). This operation to be carried out within 8 hours of stelliting or coining.

HTP 18: Stellite Seat, Bi-Metal 1.4882 / 1.3343 & Full Welded Ends

Stress relieve at 680ºC., 2 hour soak and air cool, this treatment to be performed immediately after stelliting or coining.

GSHTP 3: Stabilised

Stabilised at 600ºC., 2 hour soak and oil quench

HTP 15: Solution treat & Age (Charts & Graphs)

Solution treat at 1175ºC., 2 hour soak and oil quench followed by ageing at 780ºC., 10 hour soak and air cool to give a hardness of 32 HRc. min

HTP 23

Customer hardness requirements other than listed above.

Heat Treatment (Nimonic 80A)

a. Valves in this material are supplied as in code HTP 10.

HTP 1

No heat treatment

HTP 10: Stress Relieve

Stress relieve at 750°C., 4 2 hour soak and air cool to give 30-40 HRc

HTP 13: Bi-Metal Nimonic 80A / EN24 & Full Welded Ends

Harden from 820°C., 1 hour soak and oil quench to give 50 HRc. min.

Temper at 620°C., 1 hour soak and air cool to give 30-40 HRc., this operation to be carried out within 8 hours of welding.

HTP 9: Bi-Metal 214N or Nimonic 80A / EN52 & Full Welded Ends

Harden from 1050°C., 30 Min., soak then air cool followed by tempering at 750°C., 1 hour soak and air cool to give 40 HRc. (Head) & 25 HRc (Stem). This operation to be carried out within 8 hours of welding.

HTP 18: Bi-Metal Nimonic 80A / 1.3343 & Full Welded Ends

Stress relieve at 680°C., 2 hour soak and air cool, this treatment to be performed immediately after welding.

HTP 13 - Stellite Seat Bi-Metal Nimonic 80A / EN24 & Full Welded Ends -

Harden from 820°C., 1 hour soak and oil quench to give 50 HRc. min.

Temper at 620°C., 1 hour soak and air cool to give 30-40 HRc., this operation to be carried out within 8 hours of stelliting or coining.

HTP 9: Stellite Seat, Bi-Metal Nimonic 80A / EN52 & Full Welded Ends

Harden from 1050°C., 30 Min., soak then air cool followed by tempering at 750°C., 1 hour soak and air cool to give 40 HRc. (Head) & 25 HRc (Stem). This operation to be carried out within 8 hours of stelliting or coining.

HTP 18: Stellite Seat, Bi-Metal Nimonic 80A / 1.3343 & Full Welded Ends

Stress relieve at 680°C., 2 hour soak and air cool, this treatment to be performed immediately after stelliting or coining.

HTP 24

Customer hardness requirements other than listed above.

Heat Treatment (316S11)

a). Valves in this material are supplied as in code HTP 1.

HTP 1

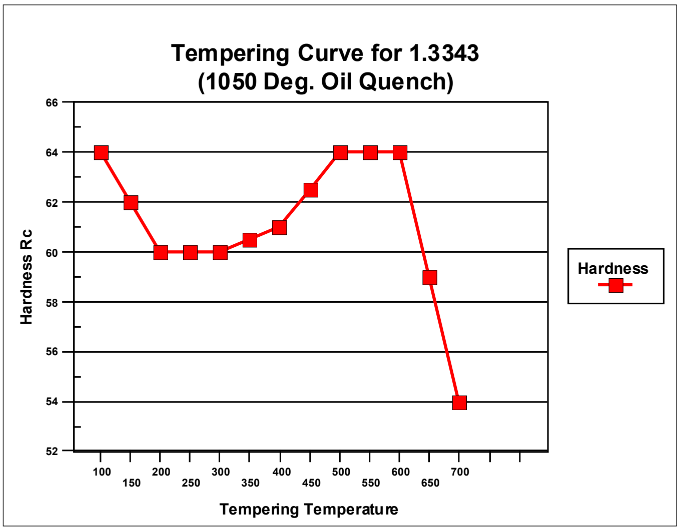
No heat treatment

HTP 25

Customer hardness requirements other than listed above.

Heat Treatment (1.3343)

a. This material is hardenable and the hardening can be adjusted to suit customer's requirements, therefore the heat treatment can vary according to hardness requirements. Where the customer has no particular requirement, dependent upon plant the heat treatment shall be as in code HTP 18



HTP 1

No heat treatment

HTP 18: Bi-Metal (214N, 1.4882, Nimonic 80A) & Full Welded Ends

Stress relieve at 680°C., 2 hour soak and air cool, this treatment to be performed immediately after welding.

HTP 18: Stellite Seat, Bi-Metal (214N, 1.4882, Nimonic 80A) & Full Welded Ends

Stress relieve at 680°C., 2 hour soak and air cool, this treatment to be performed immediately after stelliting or coining.

HTP 26

Customer hardness requirements other than listed above.

Heat Treatment (Inconel 751)

a. Valves in this material are supplied as in code HTP 1.

HTP 1

No heat treatment

HTP 27: Solution treat & Age

Solution treat at 1175°C., 1 hour soak and air cool followed by age harden at 871°C., 4 hour soak and air cool followed by aging at 750°C. for 4 hours and air cool

HTP 28: Age

Age at 750°C.,

4 hours soak and air cool

HTP 29: Full Age

Age at 750°C.,

8 hours soak and air cool

HTP 30

Customer hardness requirements other than listed above.

Heat Treatment (Inconel 751)

a Valves in this material are supplied as in code HTP 1.

HTP 1

No heat treatment

HTP 27: Solution treat & Age

Solution treat at 1175 °C., 1 hour soak and air cool followed by age harden at 871 °C., 4 hour soak and air cool followed by aging at 750 °C. for 4 hours and air cool.

HTP 28: Age

Age at 750 °C., 4 hours soak and air cool.

HTP 29: Full Age

Age at 750 °C.,

8 hours soak and air cool.

HTP 30

Customer hardness requirements other than listed above.

Mechanical Properties

Tensile Strength, Proof Stress & Creep Strength

Material	**Tensile Strength (N/ sq. mm)**	**0.2% Proof Stress (Yield Strength) N/sq. mm**	**Creep Strength (after 1000 h) N/sq. mm**
214N - (349S52)	500 oC. 650 550 Deg.C. 600 600 Deg.C. 550 650 Deg.C. 500 700 Deg.C. 450 750 Deg.C. 370 800 Deg.C. 300	500 Deg.C. 350 550 Deg.C. 330 600 Deg.C. 300 650 Deg.C. 270 700 Deg.C. 250 750 Deg.C. 230 800 Deg.C. 200	650 Deg.C. 200 725 Deg.C. 110 800 Deg.C. 50
1.4882	500 Deg.C. 680 550 Deg.C. 650 600 Deg.C. 610 650 Deg.C. 550 700 Deg.C. 480 750 Deg.C. 410 800 Deg.C. 340	500 Deg.C. 350 550 Deg.C. 330 600 Deg.C. 310 650 Deg.C. 285 700 Deg.C. 260 750 Deg.C. 240 800 Deg.C. 220	650 Deg.C. 220 725 Deg.C. 120 800 Deg.C. 55
352S52	500 Deg.C. 680 550 Deg.C. 650 600 Deg.C. 600 650 Deg.C. 510 700 Deg.C. 450 750 Deg.C. 380 800 Deg.C. 320	500 Deg.C. 340 550 Deg.C. 320 600 Deg.C. 310 650 Deg.C. 280 700 Deg.C. 260 750 Deg.C. 235 800 Deg.C. 220	650 Deg.C. 215 725 Deg.C. 115 800 Deg.C. 50
316S11			
EN24 - (817M40)	1180 – 1380	980	
EN31 - (534A99)			
1.3343			
EN52 - (401S45)	500 Deg.C. 500 550 Deg.C. 360 600 Deg.C. 250 650 Deg.C. 170 700 Deg.C. 110 Not use above 700 Deg.C.	500 Deg.C. 400 550 Deg.C. 300 600 Deg.C. 240 650 Deg.C. 120 700 Deg.C. 80 Not use above 700 Deg.C.	500 Deg.C. 190 650 Deg.C. 40 Not use above 700 Deg.C.
EN59 - (443S65)	20 Deg.C. 1080 600 Deg.C. 400 700 Deg.C. 175 800 Deg.C. 115	20 Deg.C. 900 600 Deg.C. 300 700 Deg.C. 150 800 Deg.C. 75	
EN54A (331S42)	Ultimate Strength 20 Deg.C. 818 - 926 600 Deg.C. 463 - 494 700 Deg.C. 417 - 448 800 Deg.C. 247 - 262 1000 Deg.C. 77 - 92	Yield Point 20 Deg.C. 509 - 556 600 Deg.C. 278 - 309 700 Deg.C. 216 - 231 800 Deg.C. 123 - 139 1000 Deg.C. 38 - 46	
Nimonic (80A) * Note: Nimonic has an undesirable operating range of between 750-775 °C (top end of sulphur corrosion overlapping into the bottom end of the oxidation corrosion)	500 Deg.C. 1050 550 Deg.C. 1030 600 Deg.C. 1000 650 Deg.C. 930 700 Deg.C. 820 750 Deg.C. * 680 * 800 Deg.C. 500	500 Deg.C. 700 550 Deg.C. 650 600 Deg.C. 650 650 Deg.C. 600 700 Deg.C. 600 750 Deg.C. * 500 * 800 Deg.C. 450	650 Deg.C. 500 725 Deg.C. 290 800 Deg.C. 150
Inconel 751	20 Deg.C. 1310 649 Deg.C. 1100 732 Deg.C. 860 816 Deg.C. 554	20 Deg.C 976 649 Deg.C. 889 732 Deg.C. 783 816 Deg.C. 526	
Titanium (6AL/4V)	20 Deg.C. 1000 300 Deg.C. 730 500 Deg.C. 540	20 Deg.C 830	
Titanium (6242)	550 Deg.C. 1030	860	
Stellite No. 6	600 Deg.C. 1000		
Stellite SF12	99 kg/mm^2		

Mechanical Properties

Modulas of Elasticity, Elongation and Reduction in Area

Material	Modulus of Elasticity @20 Deg.C. kN/sq. mm	Elongation after Fracture (L=5d)^2 E %	Reduction in Area after Fracture RA %
214N(349S52)	205	8	10
1.4882	205	12	15
352S52	205	8	10
EN52(401S45)	210	14	40
EN59(443S65)	200	15	15
EN54A(331S42)	203	20°C. 25-32 600°C. 20-25 700°C. 24-28 800°C. 35-40 1000°C. 60-65	20-25
EN24(817M40)	210	159	40
1.3343	217		
Nimonic(80A)	215	15	25
Inconel 751	214	20 649 732 816	
316S11			
Titanium (6AL/4V)	105-120	10-18	
Titanium (6242)		8-18	
Stellite No.6	210		
Stellite SF12	204		

Tensile Strength The maximum load applied in breaking a tensile test piece divided by the original cross-sectional area of the test piece. (The maximum stress value obtained on a stress-strain curve).

Ultimate Strength Is the maximum stress value obtained on a stress-strain curve.

Yield Strength The maximum stress that can be applied without permanent deformation.

Yeild Point Is a point on the stress-strain curve at which there is a suden incease in strain without a corresponding increase in stress.

Creep Strength Continuing changes in dimensions of a stressed material over time, a constant tensile load is applied under a specified temperature. (This is not Creep Rupture - which is when the material fails).

Modulas of Elasticity The ratio of unit stress to unit strain within the proportional limit of a material in shear.

Chemical Properties

% Chemical Composition

Material	C Carbon	Si Silicon	Mn Manganese	Ni Nickel	Cr Chromium	N Nitrogen	S Sulfur	P Phosphorus	Cu Copper	Fe Iron	Ti Titanium	Al Aluminium	Co Cobalt	B Boron	Zr Zirconium	Pb Lead	Nb Niobium	W Tungsten	Mo Molybdenum	O2 Oxygen	V Vanadium	H2 Hydrogen	Sn Tin

Austinetic Stainless Steel

Material	C	Si	Mn	Ni	Cr	N	S	P	Cu	Fe	Ti	Al	Co	B	Zr	Pb	Nb	W	Mo	O2	V	H2	Sn
214N (349S52)	0.48 0.58	0.25 Max	8 10	3.25 4.50	20 22	0.35 0.50	0.03 Max	0.045 Max		Bal													
352S52	0.48 0.58	0.45 Max	8 10	3.25 4.50	20 22	0.38 0.50	0.035 Max	0.04 Max		Bal							2.00 3.00						
1.4882	0.45 0.55	0.45 Max	8 10	3.50 5.50	20 22	0.40 0.60	0.030 Max	0.045 Max		Bal							1.80 2.50	0.80 1.50					

Stainless Steel

Material	C	Si	Mn	Ni	Cr	N	S	P	Cu	Fe	Ti	Al	Co	B	Zr	Pb	Nb	W	Mo	O2	V	H2	Sn
316S11	0.3	1.0	2.0	11 14	16.5 18.5		0.03	0.045		Bal									2.00 2.50				

Wrought Steel (EN Series)

Material	C	Si	Mn	Ni	Cr	N	S	P	Cu	Fe	Ti	Al	Co	B	Zr	Pb	Nb	W	Mo	O2	V	H2	Sn
EN24 (817M40)	0.35 0.44	0.10 0.35	0.45 0.70	1.30 1.70	1.00 1.40		0.04 Max	0.04 Max		Bal									0.20 0.35				
EN52 (401S45)	0.40 0.50	2.70 3.30	0.60 Max	0.50 Max	8 10		0.03 Max	0.04 Max		Bal													
EN59 (443S65)	0.75 0.85	1.75 2.25	0.30 0.75	1.20 1.70	19 21		0.40 Max	0.40 Max		Bal													
EN54A (331S42)	0.45	1.37 1.45	1.37 1.45	0.59 0.96	13.52 13.70	13.58 14.40				Bal								2.17 2.42					
1.3343	0.90	0.23	0.20		4.15					Bal								6.35	4.95		1.85		

Nimonic Alloys

Material	C	Si	Mn	Ni	Cr	N	S	P	Cu	Fe	Ti	Al	Co	B	Zr	Pb	Nb	W	Mo	O2	V	H2	Sn
Nimonic (80A)	0.04 0.10	1.0 Max	1.0 Max	65 Min	18 21		0.015 Max	0.020 Max	0.2 Max	3 Max	1.8 2.7	1.0 1.8	2 Max	0.008 Max	0.15 Max	0.0025 Max							
Inconel 751	0.010 Max	0.5 Max	1.0 Max	70.0 Min	14.0 17.0		0.01 Max			5.0 9.0	2.0 2.6	0.90 1.50					0.70 1.20						Cu 0.50

Titanium Alloys

Material	C	Si	Mn	Ni	Cr	N	S	P	Cu	Fe	Ti	Al	Co	B	Zr	Pb	Nb	W	Mo	O2	V	H2	Sn
5AL/4V	<0.08					<0.05				<0.25	Bal	5.5 6.76								<0.2	3.5 4.5	<0.01	
5242	<0.10	0.06 0.10				<0.50				<0.25	Bal	5.5 6.5			3.6 4.4				1.8 2.2	<0.15		<0.12	1.8 2.2

Colbalt Based Alloys

Material	C	Si	Mn	Ni	Cr	N	S	P	Cu	Fe	Ti	Al	Co	B	Zr	Pb	Nb	W	Mo	O2	V	H2	Sn
Stellite No. 6	1.1			<0.30	28					<3.0			Bal					5.0					
Stellite SF12	0.9	2.5		13	19					<3.0			Bal	1.8				9.0					

Chemical Properties

Proof Stress & Creep Strength

Material	Melting Point	Corrosion at @900°C with Lead Oxide (g/dm^2/h)
214N (349S52)	1,420°C	18
1.4882	1,420°C	
352S52	1,420°C	
EN52 (401S45)	1,457°C	54
EN54A (331S42)		
EN59 (443S65)	1,408°C	51
EN24 (817M40)		
1.3343		
Nimonic (80A)	1,343°C	3
Inconel 751	1390-1430°C	4.31
316S11		
Titanium (6AL/4V)	1,660°C	
Titanium (6242)	1,700°C	
Stellite 6 (Seats)	1,290°C	
Stellite SF12 (Tips)	1061-1104°C	

The initial assessment of any group of steel is by chemical analysis and the main alloys used in Valve Steels are,

Chromium: (Cr)

The most valuable element for improving the corrosion and oxidation resistance of steel, particularly against sulphur in any form, or in combination with hydrogen or with organic compounds. It is considered that under oxidising conditions, a thin tenacious surface layer of chromium oxide is formed which provides a skin impervious to further oxidation. This protective surface remains constant, preventing any penetration of the general body of the steel. As an alloying element, chromium has advantages over others, such as silicon and aluminium, both of which improve oxidation resistance but are less satisfactory in the presence of reducing atmospheres and/or sulphur attack. For this purpose, it is required to be 15% at minimum. When the amount of Cr is too large, an austenite phase becomes unstable and brittle phases such as an .alpha.-phase, .sigma.-phase and the like are precipitated to degrade high temperature strength, toughness and ductility so that the Cr amount is limited to not more than 25%.

Nickel: (Ni)

In the higher additions, nickel improves oxidation resistance, especially in the presence of chromium, but has little effect when present at values below 2%. This element has a considerable effect on toughness and depth of hardening of the martensitic steels. High nickel steels are prone to attack by sulphurous atmospheres due to intergranular formation of nickel sulphide. Nickel is required for stabilizing austenite and provide high-temperature strength by precipitation of a .gamma.'-phase {Ni.sub.3 (Al, Ti, Nb)} through aging treatment. Further, Nickel is important as an element enhancing the resistance to the attack of Lead Oxides. When the amount of Ni is less than 53%, the resistance to the attack of Lead Oxides is insufficient, so that the addition of not less than 53% is necessary. However, when the amount of Ni is too large, the material cost increases and also Ni is apt to be attacked by Sulfur if the valve is used in an atmosphere containing sulfur (S), so that the Ni amount is limited to not more than 65%.

Silicon: (Si)

This element leads to improvement in strength and resistance to oxidation but is on occasions responsible for manipulation difficulties and brittleness due to grain coarsening. In certain ranges of composition, silicon contributes to lack of uniformity in mechanical properties. Silicon is necessary in High nickel steels as a deoxidizing element. When the amount of Silicon is too large, not only are the strength, toughness and ductility degraded but also the resistance to the attack of Lead Oxides is degraded, so that the amount of Silicon is limited to not more than 2.0%.

Molybdenum: (Mo)

An element generally regarded as an additive to promote fine grain and to confer an increase in resistance to temper brittleness. It has a beneficial effect on high temperature strength.

Vanadium: (V)

This is a grain refining and toughening element, which also contributes towards high temperature strength.

Tungsten: (W)

This element has a beneficial effect on high temperature strength and was one of the first elements used for this purpose.

Continued from: "Chemical Composition" on page 18

Nitrogen: (N)

This element has a beneficial effect on improving hardness.

Niobium: (Nb)

This element has a beneficially effect on refining the grain size. Niobium is an element effective for enhancing high temperature strength by the formation of a carbide or .gamma.'-phase. In order to provide such an effect, it is necessary to add Nb in an amount of at least 0.3%. When the addition amount is too large an, .delta.-phase (Ni.sub.3 Nb) and a Laves phase (Fe.sub.2 Nb) are precipitated to degrade not only high-temperature strength, toughness and ductility but also acid resistance and corrosion resistance. Therefore, the upper limit is 3.0%.

Titanium: (Ti)

Titanium is an element mainly forming an .gamma.'-phase and is important for maintaining high temperature strength. When the Ti amount is too small, the precipitating amount of the .gamma.'-phase is less and high temperature strength is not obtained sufficiently, while when it is too large, an .eta.-phase (Ni.sub.3 Ti) is precipitated to reduce the strength. Therefore, the Ti amount is limited to a range of 2.0.about.3.5%.

Aluminium: (Al)

Aluminum is an element mainly forming an .gamma.'-phase like Ti and Nb. However, when the Al amount is too small, the .gamma.'-phase becomes unstable and an .eta.-phase is precipitated to decrease strength. In order to prevent the precipitation of the .eta.-phase, it is necessary to add Al in an amount of not less than 0.2%. On the other hand, when the Al amount is too large, the alignment between the .gamma.'-phase and the matrix is enhanced to reduce the aligning strain and the sufficient strength can not be obtained in a short time. Furthermore, excessive addition of Al considerably reduces the productivity. From these facts, the upper limit is 1.5%.

Manganese: (Mn)

On High nickel steels Manganese acts as a deoxidizing element like Si. When the amount of Mn is too large, the oxidation resistance at high temperature lowers, so that the amount of Mn is limited to not more than 2.5%.

Boron: (B)

Boron acts not only to enhance the creep strength by segregation into the crystal grain boundaries but also to suppress the precipitation of the .eta.-phase into the crystal grain boundaries. In order to provide such an action, it is necessary to add B in an amount of not less than 0.0010%. However, when the amount of B is too large, the hot workability is extremely deteriorated, so that the upper limit is 0.020%.

Carbon: (C)

On High nickel steels Carbon is an effective element for bonding with Cr, Nb or Ti to form a carbide and enhance high-temperature strength. In order to provide such an effect, it is necessary to add carbon in an amount of at least 0.01%. However, when the amount is too large, the high-temperature strength, toughness and ductility lower, so that the amount of C is limited to not more than 0.15%

Physical Properties

Hot Forming Temperature, Thermal Conductivity, Specific Heat Capacity & Coefficient of Thermal Expansion

Material	Hot Forming Temperature	Thermal Conductivity W/(m.C)	Specific Heat Capacity J/Kg. C	Mean coefficient of Thermal Expansion * 10 exp(-6).K(-1)
214N (349S52)	1150-950°C	14.5	500	100 °C 15.5 300 °C 17.5 500 °C 18.5 700 °C 18.8
1.4882	1150-950°C	14.5	500	100 °C 15.5 300 °C 17.5 500 °C 18.5 700 °C 18.8
352S52	1150-980°C	14.5	500	100 °C 15.5 300 °C 17.5 500 °C 18.5 700 °C 18.8
316S11				
EN24 (817M40)		37.7	460	
EN31 (534A99)	1050-850°C			
EN52 (401S45)	1100-900°C	21	500	100 °C 10.9 300 °C 11.2 500 °C 11.5 700 °C 11.8
EN54A (331S42)	1200-950°C			
1.3343	1100-900°C	19	460	100 °C 11.5 300 °C 12.2 500 °C 12.7 700 °C 12.9
EN59 (443S65)				
Titanium 6AL4V	Rough Forge 982°C Finish Forge 968°C	20°C 6.7	20°C 515	0-200°C 8.9
Titanium 6242	Rough Forge 1066-1038°C Finish Forge 982-954°C			
Nimonic (80A)	1150-1050°C	13	460	100 °C 11.9 300 °C 13.1 500 °C 13.7 700 °C 14.5
Inconel 751	980-1205°C	12	431	21-93°C 12.6
Stellite No. 6			0.101 cal/g. C	50-600°C 15.3
Stellite SF12			0.098 cal/g. C	50-600°C 14.1

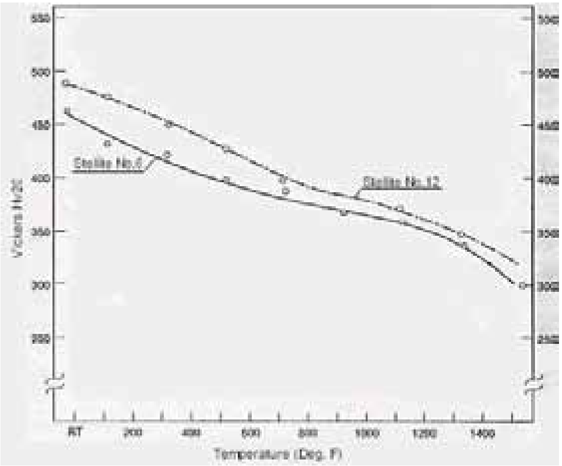
Specific Heat is the ratio of heat required to raise the temperature of a certain weight of material by 1°C to that required to raise the temperature of the same weight of water by 1°C.

Coefficients of Thermal Expansion for Valve Guide Material (between 0 and 200°C, in 10 exp(-6).K(-1)) Cast Iron 11, Phosphor Bronze 18, Aluminum Bronze 18.

Note: To find the expansion at 300 Deg C of a valve with a stem diameter of 0.275" in 214N material. (Assuming the stem diameter was measured at 20°C) the temperature difference is (300°C-20°C) = 280°C stem diameter x temperature difference x coefficient of thermal expansion = Expansion of Valve ie: 0.275"x280x0.0000175 = 0.0013".

Physical Properties

High Temperature Hardness (Stellite No.6 & 12)



Volumetric Weight

Material +/- 0.5 Grams	Volumetric Weight
214N - (349S52)	7.74 g/cc x (16.38706 x Volume)
1.4882	7.81 g/cc x (16.38706 x Volume)
352S52	
Nimonic (80A)	8.19 g/cc x (16.38706 x Volume)
Inconel 751	8.22 g/cc x (16.38706 x Volume)
Titanium (6AL/4V)	4.42 g/cc x (16.38706 x Volume)
Titanium (6242)	4.54 g/cc x (16.38706 x Volume)
EN59 (443S65)	7.74 g/cc x (16.38706 x Volume)
EN52 (401S45)	7.61 g/cc x (16.38706 x Volume)
EN24 (817M40)	7.84 g/cc x (16.38706 x Volume)
1.3343	8.10 g/cc x (16.38706 x Volume)
316S11	
6082	2.71 g/cc x (16.38706 x Volume)

Hardness

Material's (Valve Steels & Tips)	Rockwell 'C' Scale	Vicker's '30'
214N (349S52)	30 HRc	318 Vicker's
1.4882	30 HRc	385 Vicker's
352S52		
EN52 (401S45)	25 - 31 HRc	437 - 395 Vicker's
EN59 (443S65)	28 - 36 HRc	283 - 353.5 Vicker's
EN54A (331S42)		
EN24 (817M40)	22 - 30 HRc	248 - 302 Vicker's
1.3343	63 - 66 HRc	Vicker's
Nimonic (80A)	32 HRc	Vicker's
Inconel 751		
316S11		
Titanium (6AL/4V)	36 HRc	349 Vicker's
Titanium (6242)	32 HRc	318 Vicker's
Stellite 6 (Seats)	38 - 42 HRc	371 - 412.5 Vicker's
Stellite SF12 (Tips)	46 - 50 HRc	Vicker's
EN24 (welded tips)	52 - 54 HRc	541 - 576 Vicker's
EN31 (welded tips)	Approx. 64 HRc	Vicker's

Surface Treatments

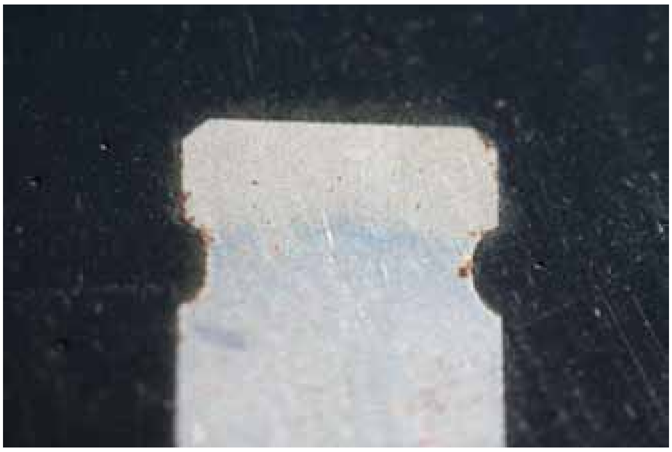
Various treatments are available to enhance the life and performance of your valves, these include the following:

Stellite Tipping

Process for placing a Stellite SF12 Hard tip on an Austinetic Stainless Steel Valve.

1. The valve is ground to finished length +0.001”
2. Using a special profiled solid carbide drill, we drill the tip of the valve until the outer edge of the countersunk hole is at the +0.005” on finished stem diameter.
3. Then using an Induction hardening machine with a vibratory depositing system, we heat the valve up in various stages to keep the right conditions to stop cross contamination during heating.
4. Stellite SF12 Powder with a flux additive is deposited into the countersunk hole and meted @1060 degrees C.
5. The valve is now ground to finished length and checked for porosity and hardenss.

Friction Welded Hard Tip



Process for placing a Friction Welded Hard tip on an Austinetic Stainless Steel Valve.

1. This operation is done at the forging stage of production.
2. The length of the forging is ground to allow for the correct amount of burn-off to ensure the weld position is in the correct position relative to the collet groove.
3. At a later stage during the production cycle the friction welded tip will be hardened using a induction hardening method depending on the relevant material used for the tip.
4. The valve is now ground to finished length and checked for hardness.

Continued from "Surface Treatments" on page 22

Diamond like Carbon DLC (Process 30)

This a Plasma Assisted Chemical Vapour Deposition process (PACVD) which gives a hard layer of 4500 Hk over the complete valve of 3 - 5 microns in depth, the anti-friction qualities are greatly improved as the coefficient of friction (Al2O3) is 0.1, this process is applied at a relativity low temperature of between 200-300 °C. This process is applied after the valve has been Plasma Nitrided, the plasma process gives the valve a substrate that is sufficient to give the DLC coating enough strength to be able to withstand the high contact stresses, and an increase in wear life.

Pulsed Plasma Nitriding (Process 6 or 7)

Valves for internal combustion engines must have high resistance to thermal stress caused by frequent temperature changes. They must remain ductile but acquire good anti-friction properties to reduce wear in the area of the valve guide. The valve seat must be able to resist the corrosive effects of hot exhaust gases from the engine.

Pulsed Plasma Nitriding (Furnace supplied by Eltropuls) improves the resistance to wear and the anti-friction qualities by increasing the surface hardness along the valve stem, while retaining the inherent corrosion resistance of the material at the valve seat. Pulsed Plasma Nitriding allows high temperature metallurgical reactions to occur at low work surface temperatures, plasma is produced by applying high voltage through a low pressure gas (a mixture of hydrogen and nitrogen) causing it to ionise, using this high energy (but thermally low temperature), plasma will diffuse nitrogen into the surface of the valve.

Some of the advantages of Pulsed Plasma Nitriding are:

1. This process is applied at low temperature so it does not affect the original core properties of the substrate material.
2. The nitride layer is more uniform and there is less deviation from mean values, when compared to salt bath or gas nitriding.
3. The anti-friction qualities between the valve stem and the valve guide have been substantially improved.
4. Plasma Nitrided surfaces offer better protection against adhesive and abrasive wear
5. Due to the low temperature process the dimensional stability of the valve is improved.
6. Valves can be masked to allow specific parts to be treated
7. Using this process it is possible to allow other treatments to be applied to further enhance the properties of the valve
8. By using this process it is also possible to produce a case structure without an Iron Nitride compound (White) layer and this allows the deposition of a subsequent surface coating onto the nitrided surface, to produce a multi layer coating.

eg: TiAlCrYN (PVD Coating) and DLC - (PACVD Coating)

Pulsed Plasma Nitriding (Process 113)

The basic procedure for Pulsed Plasma Nitriding valves are as follows:

The valves are washed to remove any traces of oil and machining residues, they are then placed inside the vacuum chamber in a manner that will permit the plasma to gain access to all of its important surfaces. The furnace is then closed, the atmosphere in the chamber is evacuated to give a vacuum. A number of purges and evacuations of the furnace atmosphere are made to ensure that there is no residual air inside the chamber. A voltage is then applied with a controlled gas mixture to produce a plasma. This plasma is first used to sputter cleaned and remove any passive layers on the surface. During these stages the furnace load is heated by both the furnace wall heaters and the plasma until the nitriding temperature is reach at which stage the load is held for a specific amount of time to allow the plasma to produce required nitride. At the end of the nitriding cycle the valves the are then cooled down in a vacuum giving a slight grey appearance on the nitrided areas of the valve.

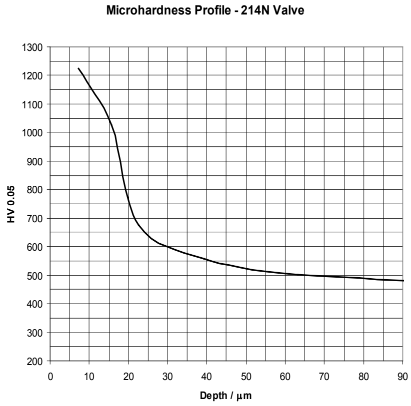
Example of Process Procedure:

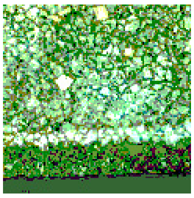
1. Initial heating
2. Sputter Cleaning
3. Nitriding
4. Cool down cycle

The table below shows the case depth and surface hardness achieved on different valve steels from pulsed plasma.

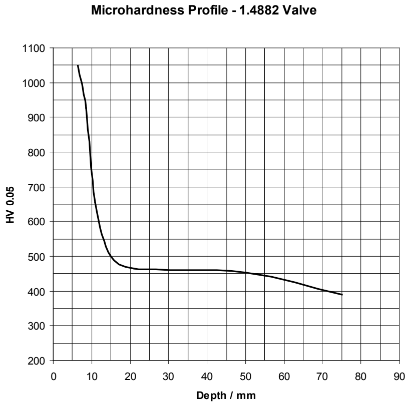
Materials (Valve Steels)	Minimum Surface Hardness (@50g load)	Minimum Case Depth Microns
214N (349S52)	1,000 HV0.10	5 Micron
1.4882	1,000 HV0.10	5 Microns
	1,000 HV0.10	10 Microns
	600 HV0.10	10 Microns
	700 HV0.10	5 Microns
Inconel 751		

Microhardness Profile 214N Valve

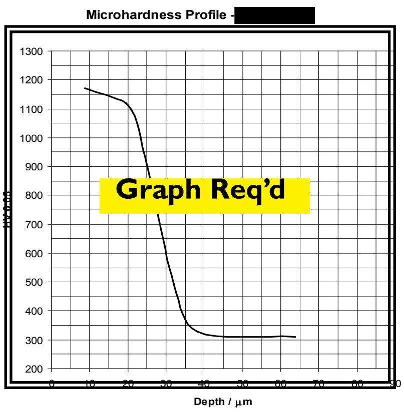


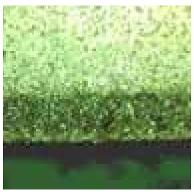


Micrograph of 1.4882

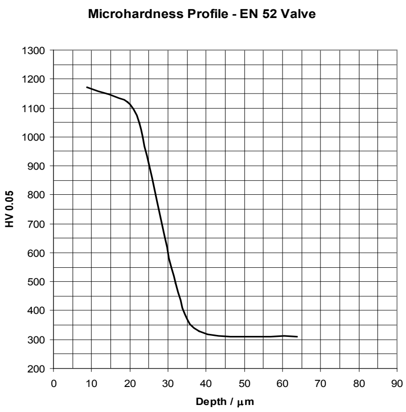


Micrograph of Nimonic 80A





Microhardness Profile EN52 Valve



Continued from "Pulsed Plasma Nitriding (Process 113)" on page 23

Trufftride (AB1 or TF1)

The process used depends upon the specification of the valve

Gives a hard layer of between 72 to 74 Rockwell 'C' over the complete valve of between 10-20 microns in depth, and gives excellent wear properties in a cast iron or bronze guide with the added benefit of stress relieving the valve. This type of treatment gives a black mottled finish all over the valve.

Tufftride Process

TF1	AB1
De-Grease	De-Grease
Process in air circulated furnace @350/250 Deg's C	Process in air circulated furnace @350/250 Deg's C
Process in (TFI) for 40 Min.@600°C	Process in (TFI) for 40 Min.@600°C
Quench in Oil	Process in salt bath (AB1) @380°C
Wash Components in hot water then warm water	Quench in cold water
Oil components	Wash Components in hot water then warm water
	Oil components

Hard Chrome Plating

Gives the stem added durability by depositing chrome on the stem to guide area of the valve of between 32 - 7 2 microns in thickness, this gives good compatibility if the valve is made in 214N (Stainless) and is to be used in a cast iron guides. This type of treatment is only on the valve stem,

Note: Nickel layer gives corrosion protection, but the chromium layer must be at least 13 micron's (0.0005") thick for adequate wear resistance. Maximum thickness of chrome is 0.3 - 0.4mm (0.012" to 0.015"), deposits in excess go brittle.

Stellite Seats (see Stellite Seat Section)

A stellite 6 deposit is placed on the exhaust valve seat face which enhances the seat hardness (Rockwell'C' of between 38 to 42 HRc) which enables it to be used with unleaded fuel or highly stressed engines e.g.: turboed, supercharged or engines that are generally hard on valve seats.

Sodium Filled Exhaust Valves

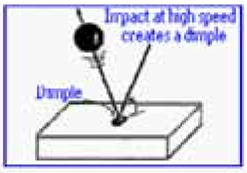
1. Hole 60% filled with Sodium, three types of specifications:
2. One piece, drilled from the head then plugged
3. Two piece, drilled from the stem then friction welded
4. Two piece, drilled from the stem then swaged closed, then friction welded

Shot Peening

Shot S230H, Intensity 007-009A, Coverage 200%, Spec MIL-S-13165C (Impact Finishers)

Shot peening is a cold working process in which the surface of a part is bombarded with small spherical media called shot. Each piece of shot striking the material acts as a tiny peening hammer, imparting to the surface a small indentation or dimple. In order for the dimple to be created, the surface fibers of the material must be yielded in tension. Below the surface, the fibers try to restore the surface to its original shape, thereby producing below the dimple, a hemisphere of cold-worked material highly stressed in compression.

Overlapping dimples develop a uniform layer of residual compressive stress in the metal. It is well known that cracks will not initiate or propagate in a compressively stressed zone. Since nearly all fatigue and stress corrosion failures originate at the surface of a part, compressive stresses induced by shot peening provide considerable increases in part life. The maximum compressive residual stress produced at or under the surface of a part by shot peening is at least as great as one half the yield strength of the material being peened. Many materials will also increase in surface hardness due to the cold working effect of shot peening.



Benefits obtained by shot peening are the result of the effect of the compressive stress and the cold working induced. Compressive stresses are beneficial in increasing resistance to fatigue failures, corrosion fatigue, stress corrosion cracking, hydrogen assisted cracking, fretting, galling and erosion caused by cavitation. Benefits obtained due to cold working include work hardening, intergranular corrosion resistance, surface texturing, closing of porosity and testing the bond of coatings. Both compressive stresses and cold working effects are used in the application of shot peening in forming metal parts.

Surface Treatments (Thickness & Hardness)

Materials (Valve Steels)	Min. Surface Hardness (@50g load)	Minimum Case Depth Microns
214N (349S52)	1,000 HV0.10	5 microns
1.4882	1,000 HV0.10	5 microns
EN52 (401S45)	1,000 HV0.10	10 microns
EN24 (817M40)	600 HV0.10	10 microns
Nimonic (80A)	700 HV0.10	5 microns
Inconel 751		

Stellite Seat: Unleaded Use

Stellite Seat

The whole unleaded question regarding valves is a bit tricky to explain. To begin with certain 'older style' engines can run perfectly satisfactorily on plain 214N material, due to the fact that they are not a modern day 'lean' burn, high revving engines, expected to do modern day mileage and service intervals.

Unfortunately every engine is different. What we have found is that if the cylinder heads have had modern day 'unleaded' hardened seat inserts fitted the seat insert will most probably be too hard for the valve which could excessively wear the valve seat. In this particular case we would recommend a stellite seated exhaust valve.

For racing use unless the engine is a very heavily loaded engine or has forced induction you could usually get away with 214N or 1.4882 material as the valve will not be in service as long as a standard road going valve.

As a rule of thumb any exhaust valve running on modern day fuels should NOT be magnetic, if so, it is a martensitic (magnetic) steel which nowadays is used as inlet valve material. 214N which is an austenitic (non magnetic) stainless steel developed in the 60's and designed to run on leaded fuel. Some older style engines pre 60's used EN54 (non magnetic) steel some with a stellite 6 seat or EN59 / EN52 both of which are magnetic materials. Any of these materials would not be as good as a plain 214N exhaust valve. The addition of stellite seats has been implemented due to the demise of leaded fuel leading to excessive seat wear.

The other thing to note is that 214N (austenitic stainless steel) is not compatible to run in cast iron guides without a surface treatment on the stem e.g.: plasma nitride, chrome or tufftride, where EN52 or inlet (magnetic) material without a treatment is acceptable. Nimonic 80A is also not compatible to run with cast iron guides without a surface treatment on the stem e.g.: plasma nitride or chrome, but is acceptable to use unleaded fuel without a stellite seat

The basic procedure for a Stellite Seat Valve Forging is as follows:

1.

1. Forge a forging as per normal procedure.

2.

2. Traking of forging (to be able to deposit a layer of Stellite No.6) .

3.

3. Welding of the Stellite Deposit on the forging.

4.

4. Coining of forging (drives the stellite in to the base material)and removes any porosity in the stellite layer.

5.

5. Section sample forging to determine correct position of the stellite.

Valve Steel

Various steels are available, these include the following:

EN52

For many years the standard exhaust valve steel was EN52, this steel was first introduced over 70 - 75 years ago. But since then improved engine design including increased compression and higher operating temperatures, and improved fuels with an increased octane rating and addition of tetra-ethyl-lead have lead to an increasing tendency to prematurely burnout the valve. This steel is classed as "semi" corrosion resistant as they are attacked by Chlorine and Sulphur compounds. As a result this material is no longer considered suitable for exhaust valves, although it is still perfectly satisfactory for inlet valves.

EN54, KE965 & Jessops G2 (No longer available)

Developed to replace EN52 as an exhaust grade steel, this steel possesses excellent creep strength and impact values at high temperature, and has good scaling and corrosion resistance, except in the presence of sulphur, and its resistance to oxidation extends to temperatures above 900 °C. EN54A was expensive to manufacture (in its time) due to the high Nickel content so a new material was developed which was EN59.

EN59 (No longer available)

This material had a lower thermal expansion rate and good heat conductivity properties which gives much better resistance to high temperature scaling. This steel is resistant to Chlorine compounds but not Sulphur. It is suitable for use where resistance to high octane rated fuels and oils containing tetra-ethyl-lead.

214N

About 1960 a new steel, 214N was developed. This steel retains its hardness even up to temperatures of 800 °C and possesses excellent rupture strength under high temperature conditions combined with good creep and impact values, The high Chromium content gives good scaling resistance, and has greater corrosion resistance against Chlorine although is still not immune to sulphurous attack.

1.4882

This material has the same properties as 214N (349S52) but with addition of Ta (Tantalum), Nb (Niobium) and W (Tungsten). This gives it greater elongational properties, improved tensile, yield and creep strength.

Note: This material is available in stem sizes of (7.44mm - 9/32") or less.

Nimonic 80A

Nimonic 80A has an increased operating temperature over 214N and higher corrosion resistance. Note: Nimonic has an undesirable operating range of between 750-775 °C where it can suffer corrosion (top end of sulphur corrosion overlapping into the bottom end of the oxidation corrosion)

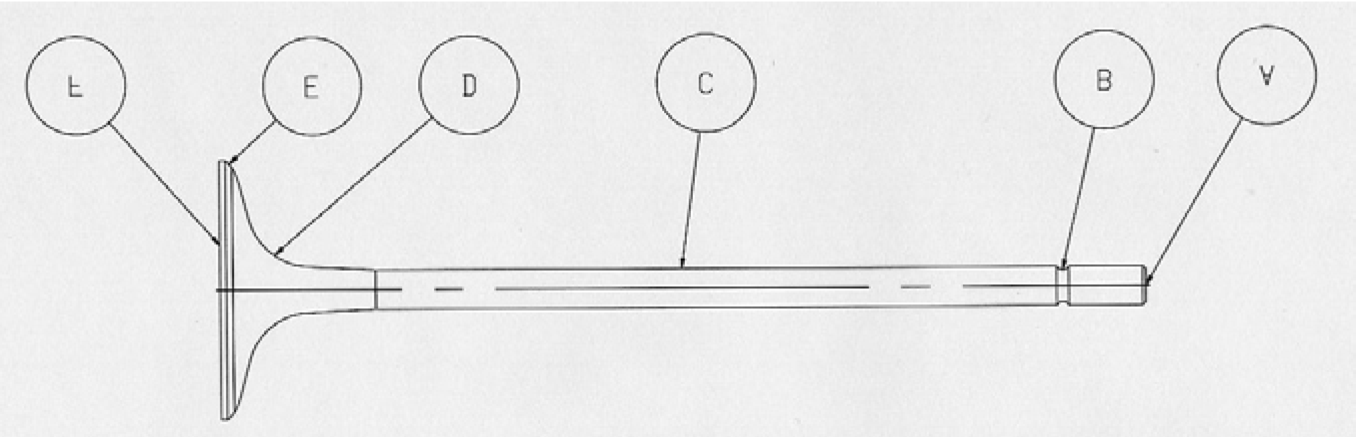
Inconel 751

Inconel 751 is a precipitation hardenable nickel-chromium alloy used for high temperature exhaust valves

General Information

Heat flow is through the Back-of-Head (piston side) by radiation during combustion and by conduction through the Back-of-Head, Seat and Stem during the exhaust stroke. Valves pass 75 % of their heat through the valve seat to the seat insert and 25 % from the valve stem to the valve guide.

Typical Requirements for Valves in High-performance Engines



A. Valve Tip

Tribological contact pressures (up to 2000 Mpa), at temperatures of 150 °C. (Max.)

B. Collet Groove

Low wear, at temperatures of 150 °C.

C. Valve Stem

Wear resistance in contact with valve guides, at temperatures ranging from 150 to 300 °C.

D. Underhead Area (Stem/Neck)

Sufficient fatigue strength at temperatures ranging from (Inlet 600 °C.) / (Exhaust 850-950 °C.) and in an oxidizing/corrosive environment.

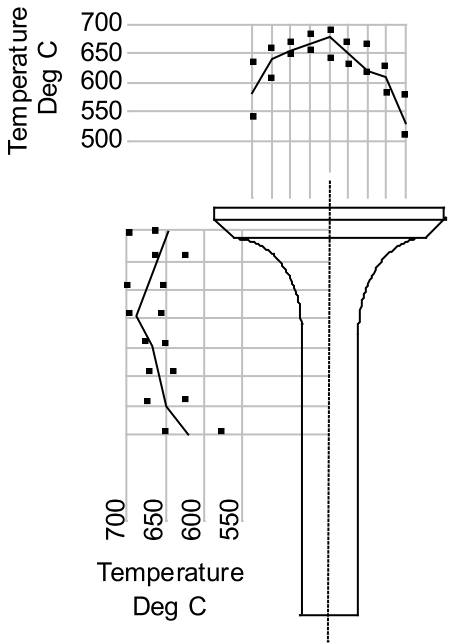
E. Valve Seat

Wear resistance in contact with valve seats at high surface pressings, at temperatures ranging from

(Inlet 400 °C.) / (Exhaust 700 °C.) and in an oxidizing/ corrosive environment.

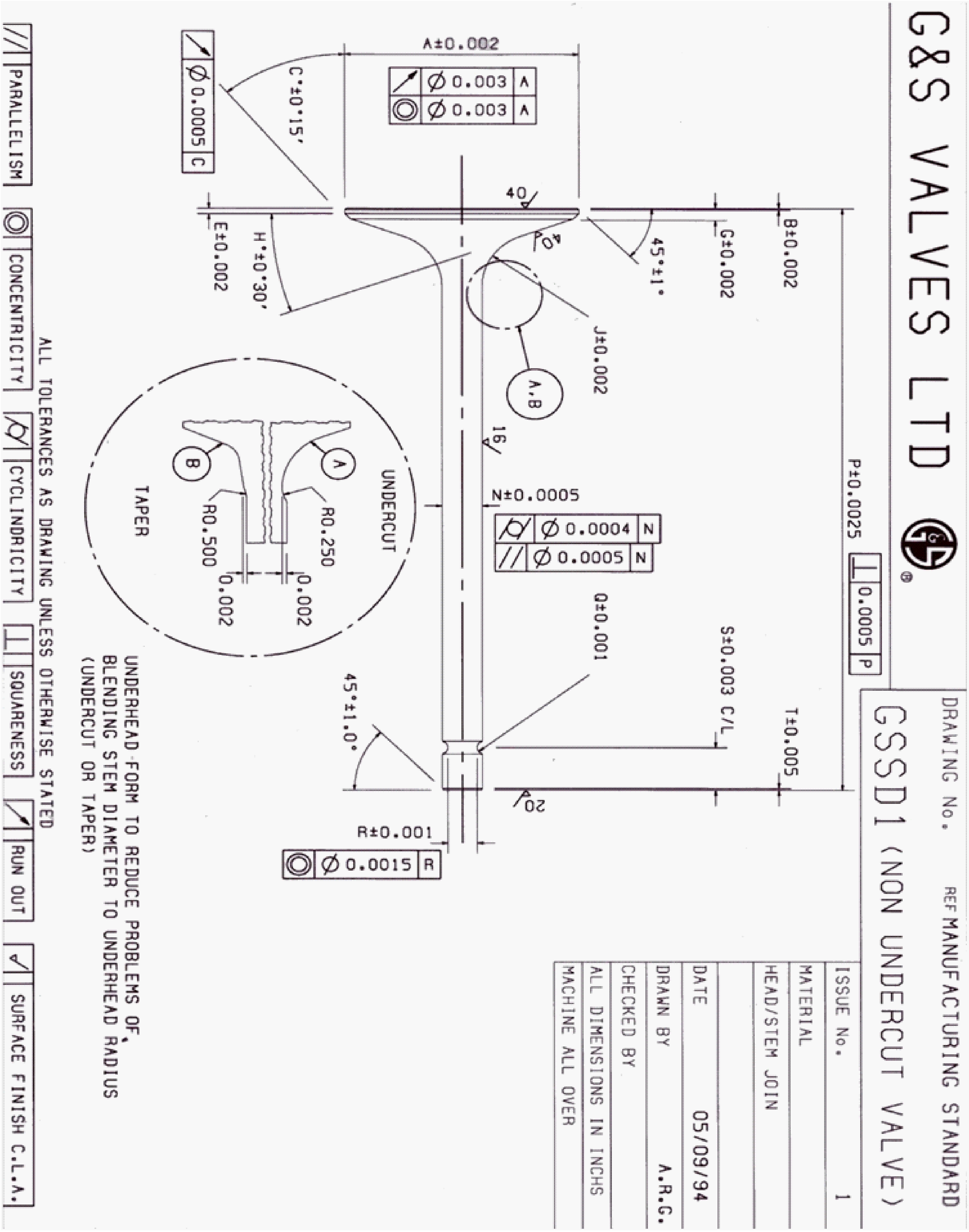
F. Back of Head

Resistance against an oxidizing/corrosive environment at temperatures ranging from (Inlet 600 °C.) / (Exhaust 850-950 °C.).

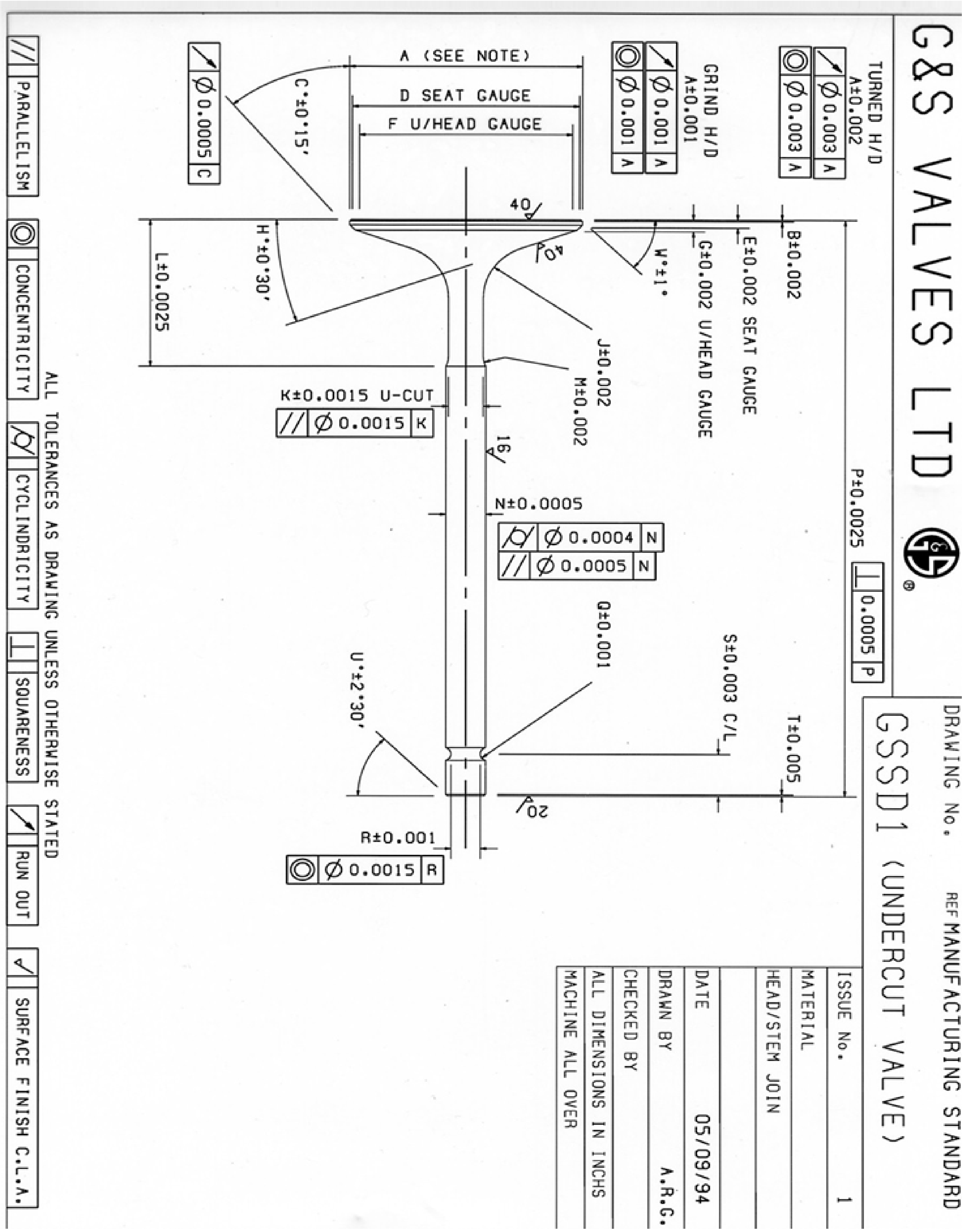


Typical Exhaust Valve Operating Temperature

Standards Drawing



Standards Drawing 2



General Valve Failures

Fault Detection

There are many possible fundamental causes of valve failure and it is the purpose of this site to examine these and trace some of the more common failures which can be attributed to operating conditions beyond the control of G&S Valves.

Head Fractures, Breakage's and Serious Distortion

Effect:

A piece broken away from the valve head roughly in the shape of the chord of a circle.

Cause:

Very high cylinder pressure and valve temperatures; incorrect valve material; etc. This problem is nearly always confined to exhaust valves.

Effect:

Concavity or tuliping of the back of the valve head (piston side)

Cause:

Very high cylinder pressures and valve temperatures incorrect valve material.

Effect:

A piece broken away from the valve head roughly segmental in shape, or a radial rim crack propagating inwards.

Cause:

Excessive valve temperature together with unequal cooling or cyclic engine loading.

Example:

Exhaust gas leaks past the valve seat, causing it to expand into an oval shape, this creates Hoop Stresses in the valve head. After a few cycles of uneven expansion and contraction stress cracks form at the outer edge of the seat, these cracks progress inwards towards the center of the valve until they are approx. 1/4" inch long then turn 90 degrees and grow around the valve head, when two cracks meet a piece of the seat breaks off.

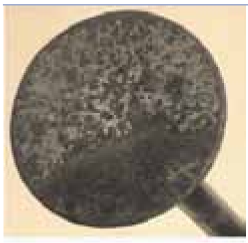
Valve Seat & Face Burning, Pitting, Guttering and Corrosion

Effect:

Valve burnt out locally in a deep channel or gutter.

Cause:

Poor seating due to cold sticking; lack of tappet clearance; excessive carbon buildup; misalignment; worn valve guides; pre-ignition; etc.



Effect:

Wide areas of valve face burnt and blowing but no guttering.

Cause:

Poor valve seating in affected areas; worn guides; excess material removed from and during previous re-facing operations.

Effect:

Badly pitted valve and valve seat faces, discovered on early overhaul due to power loss or a burn out.

Cause:

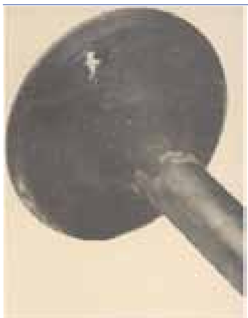
Excessive oil consumption, incorrect mixture setting producing a high level of solid particles or long periods of low power cold running.

Effect:

Exhaust valve underhead or back of head surface corrosion.

Cause:

Excessive overload and overheating or incorrect fuel.



Effect:

A hole burnt through the back of head in the underhead radius, just behind the seating face.

Cause:

This is another form of the radial rim crack (Head Fractures) or thermal fatigue, burning through beyond the hard seat face.

Mechanical

Effect:

Valve head to stem breakage in the region of the junction of the underhead radius with the stem.

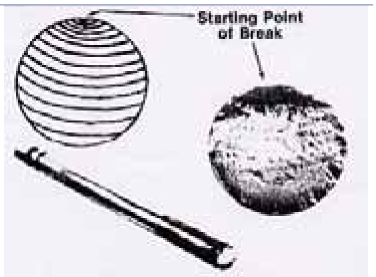
Cause:

Excessive cyclic stem stresses brought about by one or more of the following, valve bounce due to overspeed or weak valve springs, seating velocity too high due to excessive tappet clearance or loss of valve retainer. Piston to valve collision due to overspeed or incorrectly set valve timing or sticking.

Examples of breakages

Effect:

Fatigue break.



Cause:

This is fatigue type failure caused by a gradual breakdown of the material due to excessive cyclic stresses, high cylinder pressure and excessive valve temperature.

Example:

A fatigue break normally shows lines of progression (see picture).

Effect:

Impact break.

Cause:

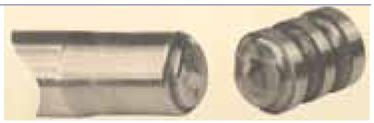
This is a impact type failure (mechanical breakage of the valve).

Example:

A impact break normally shows radial lines (see picture).

Effect:

Valve stem breakage through collet groove.



Cause:

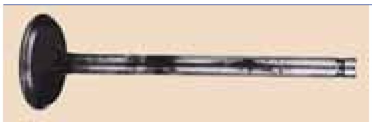
This type of valve is usually hardened through the cotter grooves and is susceptible to failure due to overspeeding or valve bounce.

Effect:

Excessive valve stem and guide wear.

Cause:

To much valve stem to guide clearance; poor stem lubrication; poor stem to guide alignment.



Effect:

Valve stem sticking or seizing.

Cause:

A lack of lubrication; not enough stem to guide clearance; bent valve stem; carbon build up at the bottom of the valve stem, incompatible valve to guide material.

Effect:

Exhaust valve seat wear.

Cause:

Incorrect fuel; valve seat misalignment; weak valve springs worn guides.

Valve Retainers

G&S Valves is now able to produce a wide range of valve retainers to the same high standards as the valves we manufacture. From 'one off' prototypes, for engine development, up to larger batchs sizes. We can change the existing collet and manufacture a 'new' design retainer arrangement to give a better taper lock on the valve assembly to enable it to withstand the new breed of high RPM engines.

Various materials are available, these include the following:

Example of various types of retainers

EN24

EN24 is a nickel chromium molybdenum steel recognised for its high tensile strength and toughness.

6082 T6 Alloy

6082 Alloy is a high strength alloy with good toughness and corrosion resistance.

7075 T6 Alloy

7075 Alloy is used in the aerospace industry for highly stressed components. Characteristic properties of this material are a very high fatigue strength.

6Al-4V (Grade 5) Titanium

Titanium 6Al-4V is a high-strength, alpha-beta alloy which is fully heat-treatable and is the most versatile of the titanium industry. Titanium is extensively used in the aerospace industry and increasingly used in the automotive industry in applications where weight or space are factors or corrosion is a problem.

AMS 6514D Maraging

Maraging AMD6514D belongs to the family of iron-based alloys, and is strengthend by a process of martensitic transformation followed by ageing. This material works well where ultra-high strength is required and has good dimensional stability. Due to the fact that this material has such good mechanical properties and is nearly the same volumetric weight as steel it is therefore possible to manufacture a small/thinner sectioned retainer (ie: similar weight to a retainer manufacture from titanium) but with the benefits of steel or where titanium is banned.

Some of the desirable properties of this material are:

1. Ultra-high strength.
2. Minimum distortion.
3. Superior fracture toughness compared to quenched and tempered steel of similar strength.
4. Low carbon content, which precludes decarburization problems.

Mechanical Properties

Tensile Strength, Proof Stress & Creep Strength

Material	Tensile Strength	0.2% Proof Stress (Yield Strength) (N/sq. mm)	Elongation after Fracture (L=5d)^2 E %	Creep Strength (after 1000 h) (N/sq. mm)	Hardness
EN24- (817M40)	980	870	13		248 - 302 Brinell (HB)
6082 - (T6)	340	270	11	200	95 Brinell (HB)
7075 - (T6)	572	503	10	245	150 Brinell (HB)
6Al-4V (Grade 5)	900	830	10 - 18		36 HrC
AMS 6514 Maraging	2027	1,999	11		52 HrC

Thermal Conductivity

Material	Thermal Conductivity W/(m.K)	Mean Coefficient of Thermal Expansion 10 exp(-6).K(-1)	Melting Point
EN24 - (817M40)	37.7		
6082 - (T6)	172	20 Deg C 23.1	575 - 650 Deg C
7075 - (T6)	130	20 Deg C 23.4	532 - 635 Deg C
6Al-4V (Grade 5)	6.7		
AMS 6514 Maraging		482 Deg C 10.1	

% Chemical Composition

Material	C	Si	Mn	Ni	Cr	N	S	P	Cu	Fe	Ti	Al	Mo	O2	V	H2	Mg	Zn	Co	Ca	Zr
	Carbon	Silicon	Manganese	Nickel	Chromium	Nitrogen	Sulfur	Phosphorus	Copper	Iron	Titanium	Aluminium	Molybdenum	Oxygen	Vanadium	Hydrogen	Magnesium	Zinc		Calcium	Zirconium

Wrought Steel (EN Series)

Material	C	Si	Mn	Ni	Cr	N	S	P	Cu	Fe	Ti	Al	Mo	O2	V	H2	Mg	Zn	Co	Ca	Zr
EN24 (817M40)	0.35 0.44	0.10 0.35	0.45 0.70	1.30 1.70	1.00 1.40		0.04 Max	0.04 Max.		Bal.			0.20 0.35								

Titanium Alloys

Material	C	Si	Mn	Ni	Cr	N	S	P	Cu	Fe	Ti	Al	Mo	O2	V	H2	Mg	Zn	Co	Ca	Zr
6Al-4V	<0.08					<0.05				<0.25	Bal.	5.5 6.76		<0.2	3.5 4.5	<0.01					

Aluminum Alloys

Material	C	Si	Mn	Ni	Cr	N	S	P	Cu	Fe	Ti	Al	Mo	O2	V	H2	Mg	Zn	Co	Ca	Zr
6082 - (T6)		7.00 1.3	0.40 1.00		0.25				0.10	0.50	0.10	Bal.					0.60 1.2	0.20			
7075 - (T6)		0.40	0.30		0.18 0.28				1.20 2.00	0.50	0.20	Bal.					2.10 2.90	5.10 6.10			

Maraging Steel

Material	C	Si	Mn	Ni	Cr	N	S	P	Cu	Fe	Ti	Al	Mo	O2	V	H2	Mg	Zn	Co	Ca	Zr
AMS6514D	0.03	0.10	0.10	18 19	0.50		0.01	0.01	0.50	Bal.		0.50 0.80	0.05 0.15	4.70 5.10					8.00 9.50	0.05	0.03

Continued from: “Mechanical Properties” on page 36

Volumetric Weight

Material +/- 0.5 Grams	Volumetric Weight
6AL/4V (Grade 5) – Titanium -	4.42 g/cc x (16.38706 x Volume)
EN24 (817M40)	7.84 g/cc x (16.38706 x Volume)
6082 - (T6)	2.70 g/cc x (16.38706 x Volume)
7075 - (T6)	2.80 g/cc x (16.38706 x Volume)
225XE (Metal Matrix)	2.88 g/cc x (16.38706 x Volume)
AMS6514D	8.04 g/cc x (16.38706 x Volume)

Surface Treatments

Various treatments are available to enhance the life and performance of your retainers, these include the following:

Titanium - Plasma Nitriding (Process 1001)

Pulsed Plasma Nitriding allows high temperature metallurgical reactions to occur at low work surface temperatures. Plasma is produced by applying high voltage through a low presure gas causing it to ionise, using this high energy (but thermally low temperature), plasma will diffuse nitrogen into the surface of the retainer. This process gives a hard case with a surface hardness of >700 HV0.05 over the exposed surface of between 10-30 microns at 0.050mm over core in depth, incorporated in this nitrided layer is a TiN layer of between 1-3 microns, therefore there is not any adhesion problems possibly associated with TiN as a hard coating.

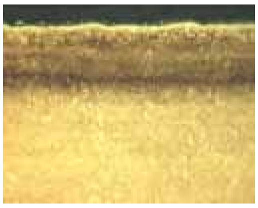
The basic procedure for Pulsed Plasma Nitriding retainers are as follows:

The retainers are washed to remove any traces of oil and machining residues, they are then placed inside the vacuum chamber in a manner that will permit the plasma to gain access to all of its important surfaces. The furnace is then closed, the atmosphere in the chamber is evacuated to give a vacuum. A number of purges and evacuations of the furnace atmosphere are made to ensure that there is no residual air inside the chamber. A voltage is then applied with a controlled gas mixture to produce a plasma. This plasma is first used to sputter cleaned and remove the passive layer on the surface of the titanium. During these stages the furnace load is heated by both the furnace wall heaters and the plasma until the nitriding temperature is reach at which stage the load is held for a specific amount of time to allow the plasma to produce the required nitride case depth. At the end of the nitriding cycle the retainers are then cooled down in a vacuum. This type of treatment produces a characteristic gold TiN color in the nitrided areas on the retainer.

Example of Process Procedure:

1. Initial heating
2. Sputter Cleaning
3. Nitriding
4. Cool down cycle

Maraging Steel-Age & Plasma Nitriding (Process 11)



Typical Micrograph (500x)

Pulsed Plasma Nitriding allows high temperature metallurgical reactions to occur at low work surface temperatures. Plasma is produced by applying high voltage through a low presure gas causing it to ionise, using this high energy (but thermally low temperature), plasma will diffuse nitrogen into the surface of the retainer. This process gives a hard case with a surface hardness of >900 HV0.05 over the exposed surface of 0.10mm over core in depth.

The basic procedure for Pulsed Plasma Nitriding retainers are as follows:

The retainers are washed to remove any traces of oil and machining residues, they are then placed inside the vacuum chamber in a manner that will permit the plasma to gain access to all of its important surfaces. The furnace is then closed, the atmosphere in the chamber is evacuated to give a vacuum. A number of purges and evacuations of the furnace atmosphere are made to ensure that there is no residual air inside the chamber. A voltage is then applied with a controlled gas mixture to produce a plasma. This plasma is first used to sputter cleaned and remove any passive layers on the surface of the maraging. During these stages the furnace load is heated by both the furnace wall heaters and the plasma until the ageing temperature is reached, at which stage the load is held for a specific amount of time to allow the required aged properties to be achived. After the ageing process, the furnace then proceeds to the nitriding temperature and is held for a specific amount of time to allow the plasma to produce the required nitride case.

Note: Maraging shrinks per liner inch on aging and grows per surface at a rate of approx 3/4 of diffusion zone

Maraging Steel - Age & Plasma Nitriding (Process 11) – continued -

At the end of the nitriding cycle the retainers are then cooled down in a vacuum. This type of treatment produces a slightly grey appearance in the nitrided areas on the retainer.

Example of Process Procedure:

1. Initial heating
2. Sputter Cleaning
3. Aging
4. Nitriding
5. Cool down cycle

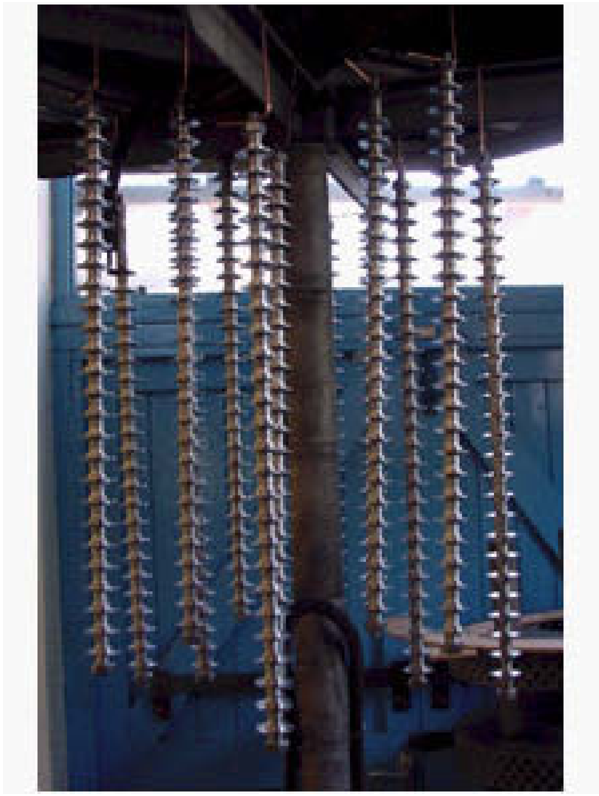
EN24 - Plasma Nitriding (Process 12)

Pulsed Plasma Nitriding allows high temperature metallurgical reactions to occur at low work surface temperatures. Plasma is produced by applying high voltage through a low presure gas causing it to ionise, using this high energy (but thermally low temperature), plasma will diffuse nitrogen into the surface of the retainer.

Continued from: "Surface Treatments" on page 38

The basic procedure for Pulsed Plasma Nitriding retainers are as follows:

The retainers are washed to remove any traces of oil and machining residues, they are then placed inside the vacuum chamber in a manner that will permit the plasma to gain access to all of its important surfaces. The furnace is then closed, the atmosphere in the chamber is evacuated to give a vacuum. A number of purges and evacuations of the furnace atmosphere are made to ensure that there is not residual air inside the chamber. A voltage is then applied with a controlled gas mixture to produce a plasma. This plasma is first used to sputter cleaned and remove any passive layers on the surface. During these stages the furnace load is heated by both the furnace wall heaters and the plasma until the nitriding temperature is reach at which stage the load is held for a specific amount of time to allow the plasma to produce the required nitride case. At the end of the nitriding cycle the retainers are then cooled down in a vacuum giving a slightly grey appearance in the nitrided areas on the retainer. This process gives a hard case with a surface hardness of >600 HV0.05 over the exposed surface of 0.10mm over core in depth.



Example of Process Procedure:

1. Initial heating
2. Sputter Cleaning
3. Nitriding
4. Cool down cycle

Alloy - Hard Anodizing

Sub-Contract Process

Valve Guides

Various material is available, these include the following:

Cast Iron

Grey 12 cast iron is normally used for valve guides

Colsibro

Is a copper-nickel-silicon alloy ideally suited for valve guides for internal combustion engines requiring high thermal conductivity, wear resistance and strength at varying engine temperatures.

Trojan

Is a copper-nickel-silicon alloy ideally suited for high performance valve guides for internal combustion engines requiring high thermal conductivity, wear resistance and improved mechanical properties over Colsibro.

Tensile Strength, Proof Stress & Creep Strength

Material	Tensile Strength (N/sq. mm)	0.2% Proof Stress (Yield Strength) (N/sq. mm)	Elongation after Fracture (L=5d)^2 E %	Creep Strength (after 1000 h) (N/sq. mm)
Cast Iron (Grey 12)				
Colsibro				
	20 °C 650	20 °C 570	20 °C 10	200 °.C 340
	200 °C 605	200 °C 530	200 °C 11	300 °C 105
	300 °C 535	300 °C 470	300 °C 7.5	450 °C 30
	450 °C 380	450 °C 330	450 °C 4.5	
	600 °C 260	600 °C 220	600 °C 30	
Trojan	20 °C 800	20 °C 750	20 °C 10	

% Chemical Composition

Material	Ni	Si	Cu
Cast Iron (Grey 12)			
Colsibro	1.6 - 2.5	0.4 - 0.8	Balance
Trojan	3	1	Balance

Valve Collet Infomation

Task and function

Valve collets have the task of attaching the valve spring retainer to the valve, so that the valve spring always holds the valve in the required position. While turned collets were used earlier, cold formed collets are state of the art today for valve stem diameters up to 12.7 mm {1/2 in.). TRW Motorkomponenten has standardized valve collets, to limit the number of types. The precise forming method guarantees uniform quality and ensures interchangeability.

Material grades C 10 or SAE 1010 are used.

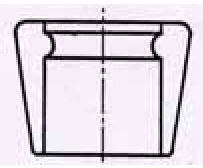
Valve collets are subdivided into two groups, according to their function:

- clamping types, where the frictional connection between valve, collet and spring retainer is obtained in any operating situation;
- the non-clamping types, which allow free rotation of the valve.

Clamping designs:

Types

These include the types KK and LK, with a cone angle of 14 Deg. 15'(corresponds to 1 :4 cone) and the collets RK and SK, with a cone angle of 10 Deg. (corresponds to 1 :5.715 cone). RK and SK collets produce a more powerful clamping effect, because of the smaller cone angle. They are therefore particularly suitable for engines with the highest speeds. Clamping collets transmit the force through a friction connection. A gap between the collet halves is necessary for this to happen. It is recommended that heavily stressed clamping attachments are made with casehardened or nitrided collets.



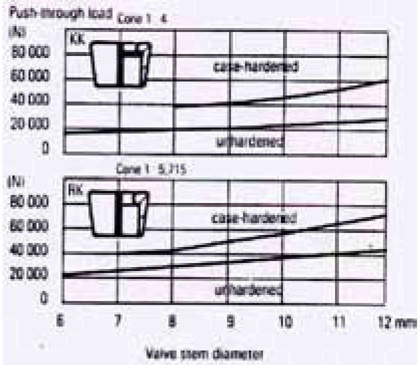
Hardness data

480-610 HV1 with casehardening, >= 400 HV 1 with nitriding (only with SK collets).

Comparison of push-through forces of unhardened and case-hardened valve collets

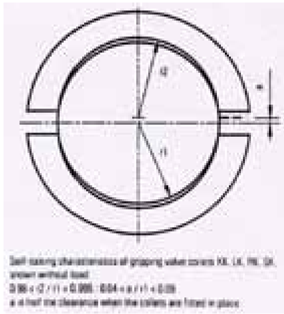
The diagram shows the difference between unhardened collets and those which have-been case-hardened. There is roughly an increase of push-through loads of 25 to 100%.

Performance of the test: The unlubricated valve collets were pressed along with the corresponding valve stem end on a press arrangement until the beads were sheared through a hardened mounting with internal cone.



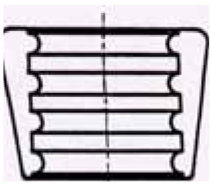
Gripping Collets

Under unfavorable operating conditions, e.g. in overspeed or exhaust braking operation, there is a risk that the clamping attachment is loosened and the collets will spring out of the spring retamer. To counter this possibility, TRW Motorkomponenten has developed special collets. A feature of this type is that they remain fixed to the stem by positive self-locking in the critical situations outlined. The way in which they work is shown.



Non-clamping designs

A non-clamping assembly is obtained by the use of MK collets with a cone angle of 14 Deg. 15' (corresponding to 1 :4 cone). Due to the fact that the collet halves support one another along the flat faces, they produce a clearance between the collets and the valve stem, allowing valve rotation under specific conditions. Among these are stimulation of the valve to rotate through resonances, eccentric action of the rocker arm on the end of the valve stem and impulses from rotation of the cup tappet.



Rotation speed and direction cannot be specified. Negative effects on rotation are:

- oil carbon deposits on the stem,
- valve stem sealing,
- heavy lateral forces of the valve springs.

In contrast to the clamping collets (with friction locking on the stem), forces are transmitted in the MK attachment via the 3 or 4 collet beads. For this reason, it is essential that MK collets are case-hardened.

Continued from: “Valve Collet Infomation” on page 41

Comparison of the most important collet characteristics

	Stem dia. range	Number of beads	Cone angle	Collet height	Bead radius
KK	6 - 12.7	1	14° 15'	10	1.250
LK	5 - 7	1	14° 15'	7	1.250
RK	6 - 12.7	1	10°	9.5	1.530
SK	4 - 6	1	10°	4.7	0.762
MK	6	3	14° 15'	5	0.520
	7 - 9	3	14° 15'	7.5	0.740
	10 - 12	4	14° 15'	10	0.700

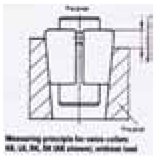
Functionally correct measurements

Measuring arrangement

Tip dimension, cone angle, valve stem diameter and the cone of the valve spring retainer determine the mounting length both for clanping and non-clamping valve collets. The tip dimension (S) is the theoretically maximum cone diameter of the fitted pair of collets. that measurements can be made functionally correct, i.e. in accordancewith the fitted condition, a plug gauge similar to the stem end is used along with a conical ring representing the valve spring retainer.

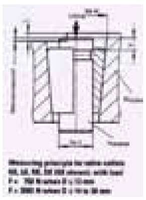
Function testing of clamping types KK, LK, RK, SK

- Testing in the unloaded condition



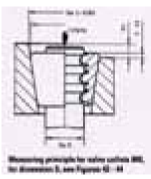
Collets are mounted on a plug gauge and inserted manually into a ring gauge without axial force. When this is done, the dimension Eo should be measured as a record of clamping action reserve.

- Testing under preload



The measurement corresponds to the state when installed in the engine and is made with the standardised force of 750 N (up to 1/2 in.). Here, interest is in the distance E between the plug gauge and the ring gauge. The fitting test corresponds to the position tolerances of the spring retainer in relation to the valve stem in the engine and thus to variations in valve spring preload.

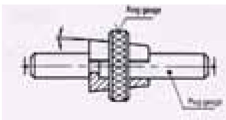
- Function testing of the non-clamping type MK



In contrast to the clamping collets, only the installed condition is relevant to the freely rotating MK attachment. Inspection in the ring gauge is carried out in a similar way to the measurement under preload with the clamping components, at a load of 750 N. Reference face for the depth of assembly is the upper surface of the collet. The collet is functionally satisfactory if its upper surface is within the ring gauge step of 0 to 0.5 mm and the plug gauge can turn freely.

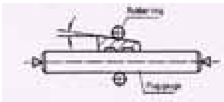
Measurement of cone angle

- Clamping types KK, LK, RK, SK



A collet is mounted on a plug gauge made for the particular collet type with the correct stem end groove and is inserted in a clamping ring with a force of 750 N. This combination is put in the centre cradle of a measuring microscope. The angle is measured 90” to the parting line.

- Non-clamping type MK



Only one collet half is clamped on a cylindrical plug gauge by means of a sealing ring, so that the beads of the collet form the reference plane. This combination is put on the microscope, between two centres. At 10 times magnification and at 90” to the parting face.

Manufacturing methods

Valve collets are stamped out of profiled strip steel.

Multi-groove valve collets are generally case-hardened and ground on their parting faces. KK, LK and RK can alternatively be supplied unhardened or case-hardened. SK is nitrided. Subject to production, the outer surface can be made concave by up to 0.06 mm, depending on the type, in the region of the middle of the height. A convex outer surface is not allowed.

Design recommendations for valve stem and valve spring retainer

Valve Stem

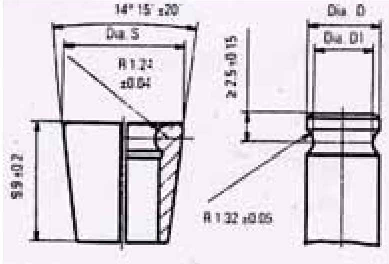
Clamping valve collets of types KK, LK, RK and SK require valve sten ends with a diameter of 0.01 - 0.11 mm below the nominal diameter Adequate clamping or functioning cannot be guaranteed if the stem end diameter is not in this range.

With the freely rotating multi-groove collets MK, satisfactory clearance from the valve stem is obtained by a diameter 0.06 mm less than the nominal. Recommended tolerance is -0.04. Figures 38 - 44 contain the necessary data for manufacturing the grooves. VKR 57.186 and 57.187 contain data on hardening of the groove region.

Valve spring retainer

The conical length of the spring retainer must be such that the collets do not protrude at either side when fixed in position. The bases of design for the cone diameter are the tip dimensions given in the tables, which should be converted appropriately when the diameter of the plug gauge is different. The conical surface may in no case be convex and should be used as reference surface for the shape and position tolerances of the valve spring retainer

KK Collets

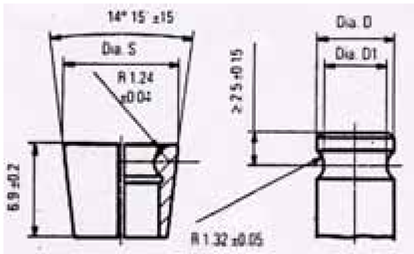


Single groove collet KK, cone 1 : 4

Short Designation	Dimensions of valve stem end								Weight	1mm
Un-Hardened or Case Hardened	Dia. S * +/- 0.06	Dia. D nominal size	Preferred range Dia. D Metric From	Metric To	Imperal From	Imperal To	Dia. D1		Weight (g)	1mm Min. Dia.
KK 6 / KK 6H	10	6	5.99	5.89	0.2358	0.2319	4.85 +/-0.05	0.193/0.189	1.17	0.2883
KK 7 / KK 7H	11	7	6.99	6.89	0.2752	0.2713	5.85 +/-0.05	0.232/0.228	1.37	0.3277
KK 8 / KK8H	12	8	7.99	7.89	0.3146	0.3106	6.83 +/-0.07	0.271/0.266	1.55	0.3671
KK 9 / KK9H	13	9	8.99	8.89	0.3539	0.3500	7.80 +/-0.1	0.311/0.303	1.73	0.4064
KK 10 / KK10H	14	10	9.99	9.89	0.3933	0.3894	8.80 +/-0.1	0.350/0.342	1.90	0.4458
KK 11 / KK 11H	15	11	10.99	10.89	0.4327	0.4288	9.80 +/-0.1	0.390/0.382	2.00	0.4852
KK 12 / KK12H	16	12	11.99	11.89	0.4721	0.4681	10.80 +/-0.1	0.429/0.421	2.24	0.5245

*Related to plug gauge diameter = nominal diameter -0.07

LK Collets

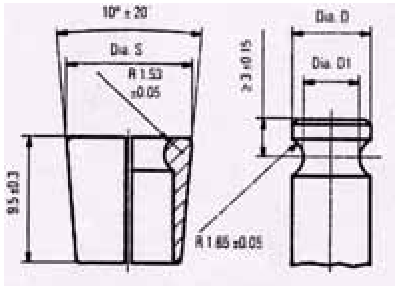


Single groove collet LK, cone 1 : 4

Short Designation	Dimensions of valve stem end								Weight	1mm
Un-Hardened or Case Hardened	Dia. S * +/- 0.06	Dia. D nominal size	Preferred range Dia. D Metric From	Metric To	Imperal From	Imperal To	Dia. D1		Weight (g)	1mm Min. Dia.
LK 5 / LK 5H	8	5	4.99	4.89	0.1964	0.1925	3.85 +/-0.05	0.153/0.150	0.53	0.2386
LK 5.5 / LK5.5H	8.5	5.5	5.49	5.39	0.2161	0.2122	4.35 +/-0.05	0.273/0.169	0.58	0.2583
LK 6 / LK 6H	9	6	5.99	5.89	0.2358	0.2319	4.85 +/-0.05	0.193/0.189	0.64	0.2780
LK 6.5 / LK 6.5H	9.5	6.5	6.49	6.39	0.2555	0.2515	5.35 +/-0.05	0.213/0.209	0.69	0.2976
LK 7 / LK7H	10	7	6.99	6.89	0.2752	0.2713	5.85 +/-0.05	0.232/0.228	0.73	0.3259

*Related to plug gauge diameter = nominal diameter -0.07
*Add 0.155 to outer spring seat for groove C/L from tip

RK Collets

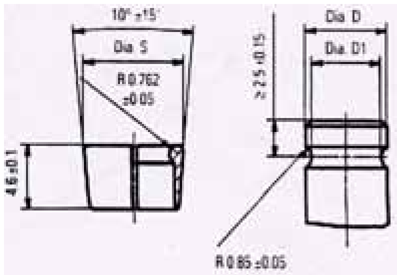


Single groove collet RK, cone 1 : 5.715

Short Designation	Dimensions of valve stem end									
Un-Hardened or Case Hardened	Dia. S * +/- 0.06	Dia. D nominal size	Preferred range Dia. D Metric From	To	Imperal From	To	Dia. D1		Weight (g)	1mm Min. Dia.
RK 6 / RK 6H	8.79	6	5.99	5.89	0.2358	0.2319	4.15 +/-0.05	0.165/0.161	0.77	0.2737
RK 7 / RK 7H	9.79	7	6.99	6.89	0.2752	0.2713	5.15 +/-0.05	0.205/0.200	0.91	0.3131
RK 8 / RK 8H	10.79	8	7.99	7.89	0.3146	0.3106	6.13 +/-0.07	0.244/0.239	1.09	0.3525
RK 9 / RK 9H	11.79	9	8.99	8.89	0.3539	0.3500	7.10 +/-0.1	0.284/0.276	1.19	0.3918
RK 10 / RH 10H	12.79	10	9.99	9.89	0.3933	0.3894	8.10 +/-0.1	0.323/0.315	1.30	0.4312
RK 11 / RK 11H	13.79	11	10.99	10.89	0.4327	0.4288	9.10 +/-0.1	0.362/0.354	1.46	0.4706
RK 12 / RK 12H	14.79	12	11.99	11.89	0.4721	0.4681	10.10 +/-0.1	0.402/0.394	1.58	0.5100

*Related to plug gauge diameter = nominal diameter -0.07

SK Collets

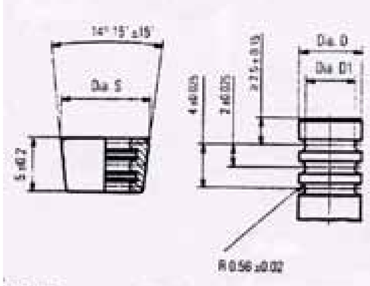


Single groove cotter SK, cone 1 : 5.715

Short Designation	Dimensions of valve stem end									
Un-Hardened or Case Hardened	Dia. S * +/- 0.06	Dia. D nominal size	Preferred range Dia. D Metric From	To	Imperal From	To	Dia. D1		Weight (g)	1mm Min. Dia.
RK 6 / RK 6H	8.79	6	5.99	5.89	0.2358	0.2319	4.15 +/-0.05	0.165/0.161	0.77	0.2737
RK 7 / RK 7H	9.79	7	6.99	6.89	0.2752	0.2713	5.15 +/-0.05	0.205/0.200	0.91	0.3131
RK 8 / RK 8H	10.79	8	7.99	7.89	0.3146	0.3106	6.13 +/-0.07	0.244/0.239	1.09	0.3525
RK 9 / RK 9H	11.79	9	8.99	8.89	0.3539	0.3500	7.10 +/-0.1	0.284/0.276	1.19	0.3918
RK 10 / RH 10H	12.79	10	9.99	9.89	0.3933	0.3894	8.10 +/-0.1	0.323/0.315	1.30	0.4312
RK 11 / RK 11H	13.79	11	10.99	10.89	0.4327	0.4288	9.10 +/-0.1	0.362/0.354	1.46	0.4706
RK 12 / RK 12H	14.79	12	11.99	11.89	0.4721	0.4681	10.10 +/-0.1	0.402/0.394	1.58	0.5100

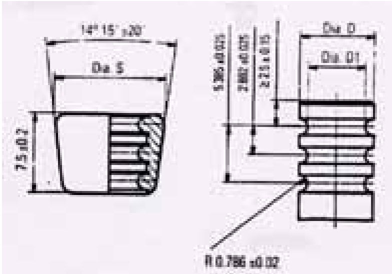
*Related to plug gauge diameter = nominal diameter -0.07

MK Collets



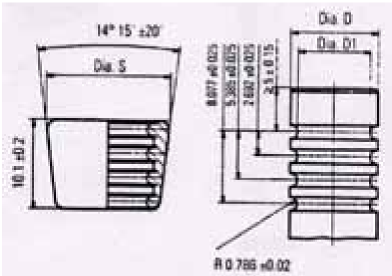
Multi-groove collet MK 6,
cone 1 : 4

Type	Dia. D No. of Beads	Dia. S +/- 0.04	Metric From	Metric To	Imperal From	Imperal To	Dia. D1		Weight (g)	1mm Min. Dia.
MK5	3	7.0	4.94	4.90	0.1945	0.1929	3.91 +/-0.07	0.156/0.151	0.31	0.2176
MK6	3	8.5	5.94	5.90	0.2338	0.2323	4.59 +/-0.05	0.183/0.178	0.49	0.2766



Multi-groove collets MK 7 - 9,
cone 1 : 4

Type	Dia. D No. of Beads	Dia. S +/- 0.04	Metric From	Metric To	Imperal From	Imperal To	Dia. D1		Weight (g)	1mm Min. Dia.
MK7	3	10.5	6.94	6.90	0.2732	0.2717	5.25 +/-0.05	0.208/0.204	1.12	0.3554
MK8	3	11.5	7.94	7.90	0.3126	0.3110	6.23 +/-0.07	0.248/0.242	1.27	0.3947
MK9	3	12.5	8.94	8.90	0.3520	0.3504	7.20 +/-0.10	0.287/0.279	1.40	0.4341



Multi-groove collets MK 10 - 12,
cone 1 : 4

Type	Dia. D No. of Beads	Dia. S +/- 0.04	Metric From	Metric To	Imperal From	Imperal To	Dia. D1		Weight (g)	1mm Min. Dia.
MK10	4	13.8	9.94	9.90	0.3914	0.3898	8.20 +/-0.10	0.327/0.319	2.04	0.4853
MK11	4	14.8	10.94	10.90	0.4307	0.4292	9.20 +/-0.10	0.366/0.358	2.19	0.5247
MK12	4	15.8	11.94	11.90	0.4701	0.4685	10.20 +/-0.10	0.405/0.398	2.82	0.5640

Contact Information

Address

Alder Works
Catteshall Lane
Godalming
Surrey GU7 1JS
England

+44(0)1483 415444
+44(0)1483 426891

Sales

Ian Barraclough
Andrew Grenside
GSValves@aol.com

Technical

Andrew Grenside
Ian Barraclough
GSValves@aol.com

Accounts

Ameia Reids
GSValvesacc@aol.com

Directions

From M25 (J10, A3) travel south towards Portsmouth (approx. 11 miles) pas Guildford, exit Compton (B3000), through Compton to a mini roundabout (approx. 2 miles). Turn right (A3100) to Godalming. Turn left after approximately a mile and a half into Catteshall Road. Turn left at mini roundabout into Catteshall Lane. G&S Valves can be found on the right, just around the corner.