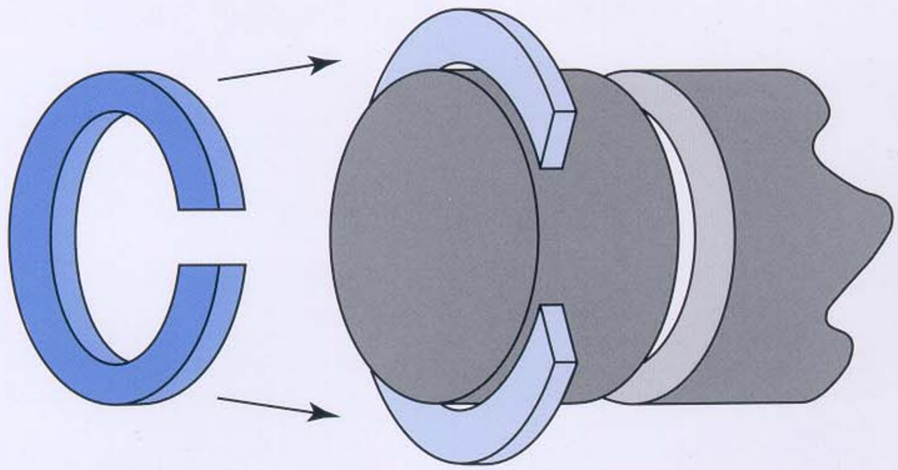
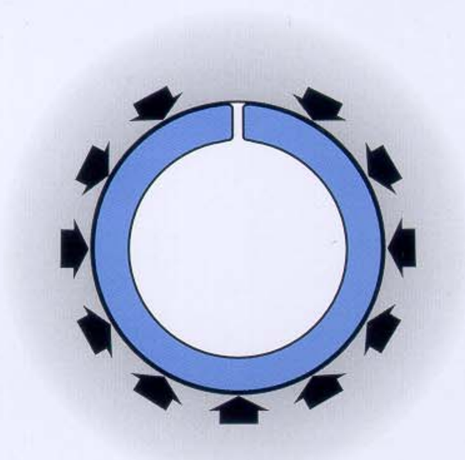
PISTON RING DESIGN

OUTSPRINGERS

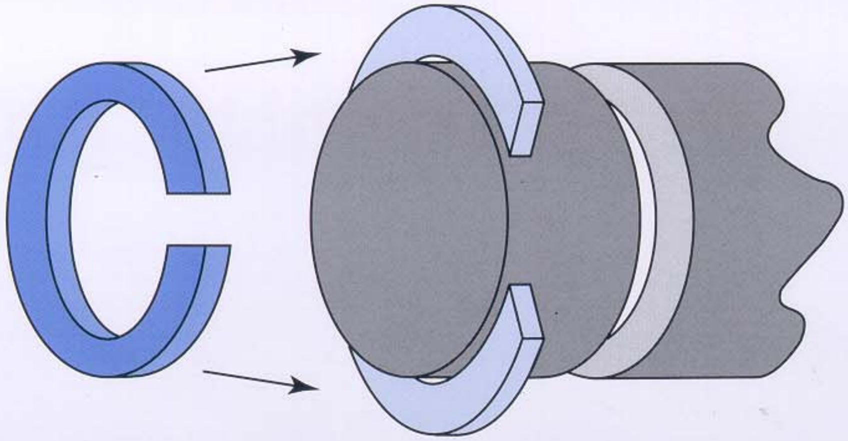


Will this piston ring overstress when fitted?

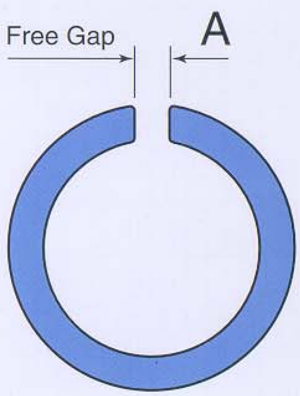


What is the radial pressure between the piston ring and the cylinder?

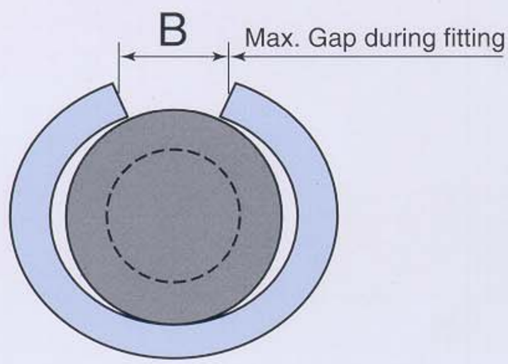
CROSS MANUFACTURING Co. (1938) LTD

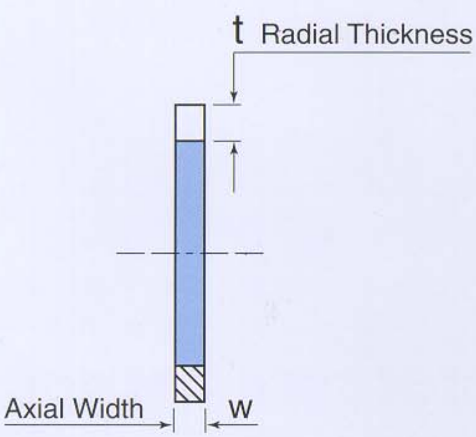


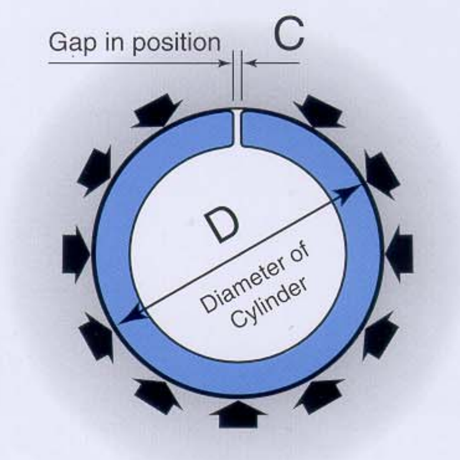
RING IN FREE STATE



RING AT MAX. STRESS DURING FITTING







CROSS

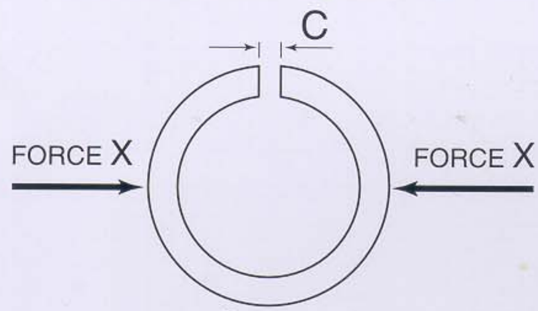
E = MODULUS OF ELASTICITY (YOUNG'S MODULUS)

$$\left.\begin{array}{r}\text{MAX}\\ \text{FITTING}\\ \text{STRESS}\end{array}\right\} = \frac{(B-A) \times E}{2.356 \times t \times \left[\frac{D}{t} - 1\right]^2}$$

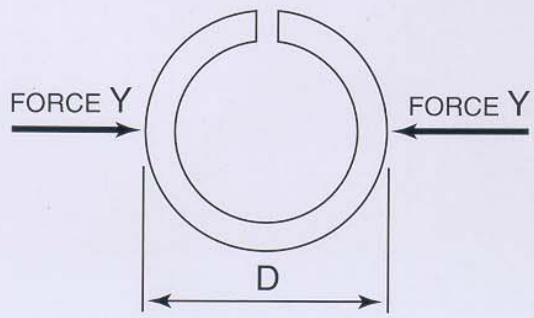
$$\left.\begin{array}{r}\text{RADIAL}\\ \text{PRESSURE}\\ \text{RING ONTO}\\ \text{CYLINDER}\end{array}\right\} = \frac{(A-C) \times E}{7.07 \times D \times \left[\frac{D}{t} - 1\right]^3}$$

$$\left.\begin{array}{r}\text{MAX STRESS}\\ \text{TO GIVE}\\ \text{THIS RADIAL}\\ \text{PRESSURE}\end{array}\right\} = \frac{(A-C) \times E}{2.356 \times t \times \left[\frac{D}{t} - 1\right]^2}$$

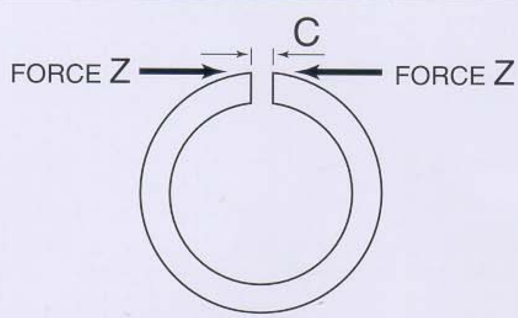
WAYS OF MEASURING RADIAL PRESSURE



$$\left.\begin{array}{r}\text{RADIAL}\\ \text{PRESSURE}\end{array}\right\} = \frac{0.76 \times X}{D \times w}$$



$$\left.\begin{array}{r}\text{RADIAL}\\ \text{PRESSURE}\end{array}\right\} = \frac{0.88 \times Y}{D \times w}$$



$$\left.\begin{array}{r}\text{RADIAL}\\ \text{PRESSURE}\end{array}\right\} = \frac{2 \times Z}{D \times w}$$

CROSS

RING MATERIALS

Cross piston rings are usually made from forged alloys by the process originally invented by Roland Cross. These rings are tough and can be made to large diameters and slender sections because they are not brittle. Most standard piston rings are made from cast alloys and Cross can produce cast alloy rings if required.

The materials listed below are in nine basic groups and the details are typical of that group.

MATERIAL GROUP (Related Specifications)	TYPICAL COMPOSITION	'E' ELASTIC MODULUS TYPICAL DETAILS AT ROOM TEMP		
COBALT ALLOYS Haynes® 25, L.605, BS.HR.40, UNS.R.30605, XSH, KC.20WN, Stellite® 6B, Stellite® 31, X.40, Haynes 188 XM.011	Co 50% Cr 20% Wi 15% Ni 10%	30×10^6 PSI	207,000 M Pa 207 GPa	Cobalt alloys have good rubbing, heat and corrosion resistance properties at high temperatures.
NICKEL ALLOYS Nimonic® 75, 80A, 90, C.263, 901, Inco® 718, X-750, 625, 600, Waspaloy, XM.004	Ni 75% Cr 20% Co, Al, Mo etc	30×10^6 PSI	207,000 M Pa 207 GPa	Nickel alloys have good heat and corrosion resisting properties. The rubbing properties generally are not as good as Cobalt Alloys.
BRONZES Phosphor Bronze PB.102, Aluminium Bronze CA.104, XM.013, XM.014	Cu 90+% P, Al	16×10^6 PSI	110,000 M Pa 110 GPa	Bronzes rub well against steel when lubricated.
HIGH SPEED STEELS M.2, 14% Tungsten H.SS, XM.003, 1.3343	Fe 80% W, Mo, Cr V, C etc	30×10^6 PSI	207,000 M Pa 207 GPa	Can be very hard and run at high temperatures with marginal lubrication. Corrosion resistance is poor.
CARBON STEELS S.203, AISI 1080, XM.005, 0773	Fe 98% C, Cr, Mn etc	30×10^6 PSI	207,000 M Pa 207 GPa	Can be hard but run at lower temperatures than the high speed steels. Corrosion resistance is poor.
STAINLESS STEELS				
AUSTENITIC 18/8 Austenitic: 321, 316, S.521, DTD.734, Nitronic® 60, XM.010, 1.4304	Fe 74% Cr 18% Ni 8% etc	28×10^6 PSI	193,000 M Pa 193 GPa	Good corrosion resistance but poor rubbing properties. Can only be hardened by cold work.
MARTENSITIC / FERRITIC Martensitic: 420.S.45, DTD.326.A, S.80, XM.001, XM.009, 1.4112	Fe 85% Cr 12.17% C, Ni etc	30×10^6 PSI	207,000 M Pa 207 GPa	Corrosion resistance not as good as austenitic alloys but can be hardened by heat treatment.
CAST IRON				
GREY CAST IRON	Fe 96% C 3%+ Si, Mn, P, Cr	15×10^6 PSI	103,000 M Pa 103 GPa	Cast Iron is the commonest alloy used in engines, but it is brittle and corrosion resistance is poor.
HIGH CHROMIUM CAST IRON	Fe 80% C 2% Cr 15%	28×10^6 PSI	193,000 M Pa 193 GPa	Better heat and corrosion resistance than grey cast iron.

Cross Manufacturing Co. (1938) Ltd.

Head Office & Factory:
Midford Road
Bath, BA2 5RR, England
Tel: 01225 837000 Fax: 01225 834115
bathsales@crossmanufacturing.com

Devizes Factory:
Hopton Park
Devizes, SN10 2EY, England
Tel: 01380 722421 Fax: 01380 722405
mail@cross-devizes.com

Web Site: www.crossmanufacturing.com

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CMR No. 535/1