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Piston Rings

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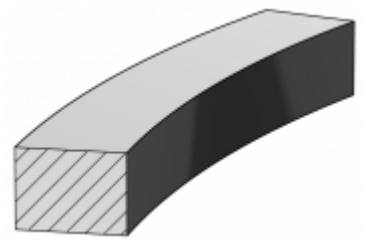
Piston Ring Types
Compression Rings

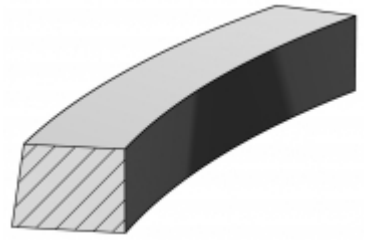
The main functions of compression rings are to seal the combustion chamber from the crankcase and transfer heat from the piston to the cylinder. However, they also play an important part in controlling engine oil consumption.

There are the following types:



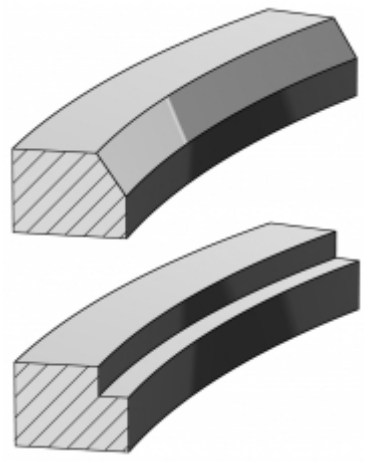
Rectangular Ring:

A piston ring with a rectangular cross section. This ring with its geometrically simple shape performs the necessary sealing functions under normal operating conditions. With a peripheral coating and appropriate barrel face the rectangular ring is today used mainly in the top groove in passenger car gasoline and diesel engines. Besides service in internal combustion engines, rectangular rings are commonly used as rotary shaft seals, e.g. transmission seals.



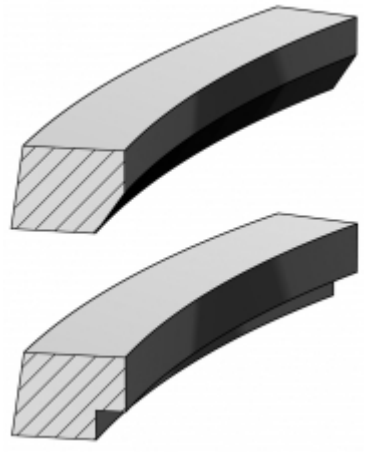
Taper Faced Ring:

Owing to the tapered running face the ring contacts the cylinder bore with its bottom outer edge. This shortens running-in and improves oil scraping. The gas forces acting initially at the running face provide a degree of pressure relief (especially when used in the top groove). Taper faced rings are chiefly installed in the second groove in passenger car gasoline and passenger car and truck diesel engines. In passenger car gasoline engines they are also used in the top groove.



Internally Bevelled or Stepped Ring:

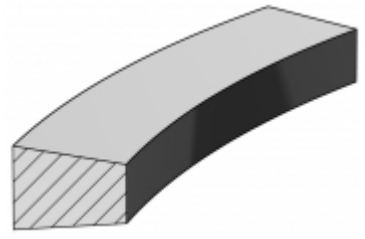
By providing an edge relief on the top side of rectangular and taper faced rings a twist effect is achieved which, in all operating phases without gas pressure loading, brings the ring into bore contact only with its bottom outer edge while the inner edge contacts the bottom groove side (positive twist). This helps to improve oil consumption control. Under operating conditions the gas pressure forces the ring flat against the piston groove, creating an additional dynamic behavior of the ring. Rings of this kind are used in the top and second groove of passenger car gasoline and passenger car and truck diesel engines.



Taper Faced Ring with Inside Bottom Bevel or Step:

In the installed condition this edge relief causes a negative twist, i.e. in the opposite direction to a ring with the relief on the top side. The taper must be larger than on a taper faced ring without twist or with positive twist so that the top outer edge is prevented from contacting the cylinder wall.

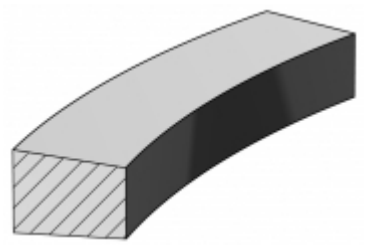
The effect of the negative twist is to make the ring contact the groove and create a seal with its outer bottom side and its inner top side. This type of ring is installed in the second groove in passenger car gasoline and passenger car and truck diesel engines.



Keystone Ring:

A compression ring with a wedge cross section. With its tapered sides, radial movement of the ring in engine operation will cause the axial clearance in the groove to increase and decrease. This greatly reduces ring sticking, as the ring continuously works its way free of

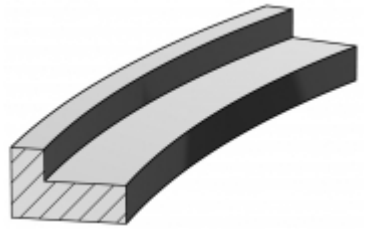
the combustion residues. These rings are designed with an overall side angle of 6° bzw. 15°, the larger angle being more effective against the tendency to coking. The keystone ring is used in the top groove in passenger car and truck diesel engines where ring sticking must be expected.



Half Keystone Ring:

A compression ring with only the top side tapered. Like on the keystone ring, the tapered side (keystone angle 7°) causes the axial clearance to vary as the ring moves radially, and thus reduces ring sticking. Owing to its asymmetrical cross section the ring has a positive twist when installed.

A half keystone ring is used in the top groove of passenger car and truck diesel engines when a rectangular ring is no longer adequate in regard to ring sticking but a keystone ring is not yet warranted. Another application is in 2-stroke gasoline engines, e.g. for snowmobiles and ultralight aircraft.



L-Shaped Compression Ring:

This ring is used mainly in small 2-stroke gasoline engines as a "head land" ring, the vertical arm of the L being flush with the top edge of the piston crown. With gas pressure acting behind the vertical arm, this ring will also seal when in contact with the top side of the piston groove.

Besides being used in 2-stroke engines, in some cases it has been installed in automotive diesel engines in order to minimize crevice volume in the combustion chamber.

Piston Ring Types
Scraper Rings

Practically all of the scraper rings used are rings with a step recessed into the bottom outer face. This assures extremely effective oil scraping.

The efficient scraping can be explained by a number of features. The step increases the unit pressure. Additionally, the step relief causes a positive twist which, without gas pressure, brings the periphery into bore contact only with the very edge of the step.

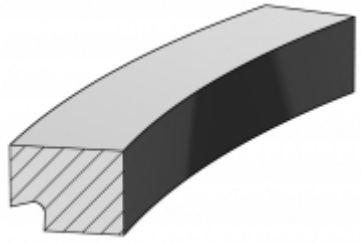
The volume created by the step is beneficial in allowing large amounts of oil to be stored there. This means that the favorable characteristics of a ring with a stepped bottom outer edge can be adjusted by varying the size of the step.

The step can be produced in a rectangular or undercut (Napier) design. An advantage of the undercut step is that, when the ring twists, a sharp downward scraping edge will still be available to conduct the oil quickly from the outer edge of the ring into the reservoir of the step and thus prevent oil from gathering at the scraping edge and diminishing the scraping effect.

If necessary, the benefit of the oil storage volume can be enhanced by the provision of an additional recess on the outer diameter of the bottom piston groove side.

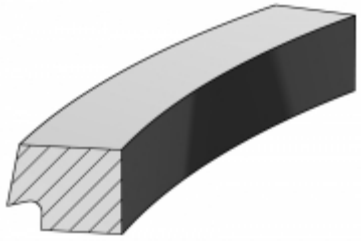
Rings with a step have a higher oil scraping effect than taper faced rings, but this is usually coupled with higher blow by.

The following types exist:



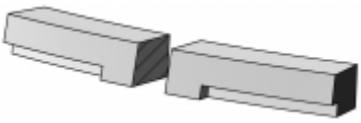
Napier Ring:

This can be installed in the second groove in passenger car gasoline and passenger car and truck diesel engines, but has been almost entirely replaced by the taper faced Napier ring. It is now occasionally used only in the compressors of air brake systems.



Taper Faced Napier Ring:

Like on the taper faced ring, the periphery of this ring is designed with a taper in order to improve oil scraping and quicken running-in. These rings are used on the same applications as Napier rings.



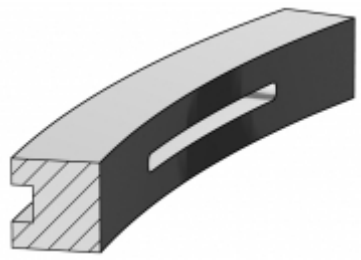
Taper Faced Closed Gap Scraper Ring::

On this ring the step runs out at the gap and is designed without an undercut. It seals better against blow by than the Napier and taper faced Napier rings with a continuous step. The applications for this ring are the same as for Napier and taper faced Napier rings.

Oil Control Rings

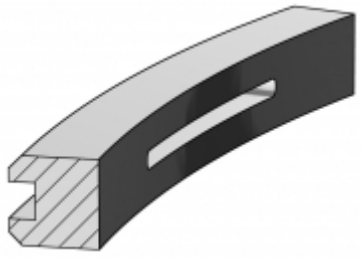
Single-Piece Oil Control Rings

Single-piece oil control rings - like for example compression rings - derive their tangential force from their inherent inner tension. There are the following types:



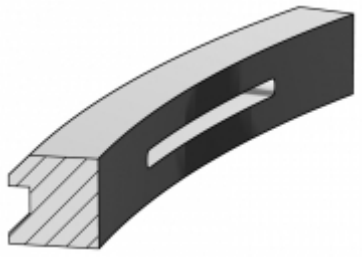
Slotted Oil Control Ring:

A slotted oil control ring with two outer lands, the sides of which are parallel to one another. As the width of the lands is smaller than the overall width a higher unit pressure can be obtained than with a rectangular ring.



Bevelled Edge Oil Control Ring:

To obtain still higher unit pressures than with a slotted oil control ring, this type of ring has the outer lands chamfered on the outer edge.



Double Bevelled Oil Control Ring:

On this type both lands are chamfered on the edge facing the combustion chamber. While the unit pressure is the same, oil consumption is reduced through the improved oil scraping effect.

In modern passenger car production engines single-piece rings are generally no longer used as they fail to meet today's performance requirements.

Oil Control Rings

Multi-Piece Oil Control Rings

Another characteristic of oil control rings that is at least as important as the contact pressure at the running face is their ability to conform to the bore distortions of an engine. Given the prevailing trend towards lightweight engines, higher levels of bore distortion must be expected. To assure oil economy in such engines, highly flexible rings (i.e. rings with a low moment of inertia across the wall thickness) with sufficient unit pressure are needed.

The usual way of combining these two requirements is to use multi-piece oil control rings. These have an additional, self-supporting spring which presses the optimized ring against the cylinder wall. The types of spring that are supported on the base of the piston groove are now scarcely ever used as with such springs the piston rings must also transmit the lateral forces of the piston.

Multi-piece rings are produced in two-piece and three-piece designs:

Multi-Piece Oil Control Rings

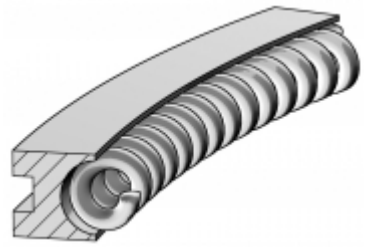
Two-Piece Oil Control Rings

Two-piece oil control rings consist of a cast iron or profiled steel ring and a coil spring. The spring is a cylindrical coil spring made from heat-set resistant spring steel and it acts uniformly around the whole of the ring circumference.

The retaining groove for the coil spring may be semicircular or V-shaped. The coil spring groove has the effect of reducing the moment of inertia. Where greater durability is required, such as in diesel engines, the springs are center less ground, sometimes additionally wound

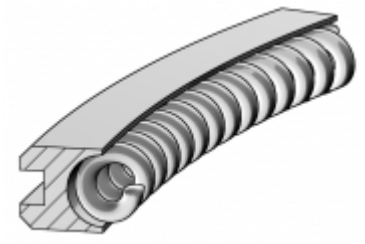
more tightly at the ring gap and in many cases sheathed in a Teflon tube in the ring gap region. These features have the purpose of reducing secondary wear between the spring and ring.

In order to prevent oil from accumulating between the two outer lands, drainage holes are provided. These can be either circular or slotted. For a long time the slotted hole was preferred but today round holes are again being used increasingly. The drilled rings have better breaking strength than the slotted type, offering greater safety in assembly especially for narrow width rings. Additionally, drilled rings have a more even outer contour, which assures better oil scraping. The cast iron rings described below can all be produced optionally with drilled or slotted holes.



Coil Spring Loaded Slotted Oil Control Ring::

A slotted oil control ring with two outer lands, the sides of which are parallel to one another. Compared to the slotted oil control ring described above, this ring additionally has a groove on the inside diameter to accommodate the coil spring.

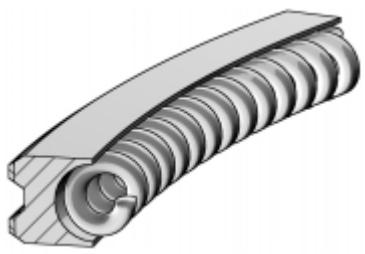


Coil Spring Loaded Bevelled Edge Oil Control Ring::

Consists of a ring similar to the bevelled edge ring, but has an additional groove for the coil spring.

Coil Spring Loaded Double Bevelled Oil Control Ring::

Like the double bevelled ring, but with a groove to hold the coil spring.



Coil Spring Loaded Bevelled Edge Oil Control Ring with Chromed, Profile Ground Lands::

The wear coating gives the ring high long-time stability and makes it particularly suitable for operation mainly in diesel engines. The profile grinding of the lands allows close tolerances to be achieved on these critical working surfaces.

Nitrided Profiled Steel Ring::

A bevelled edge ring made from a high-chromium profiled steel. Wear protection is provided by nitriding the ring all over. Like the chromed bevelled edge ring, this ring is chiefly used in diesel engines. Oil drainage is provided by means of punched holes.

Piston Ring Coatings

We can do one of the following coatings on the piston rings as per the requirement:

- Chrome
- Copper
- Molybdenum
- Phosphate