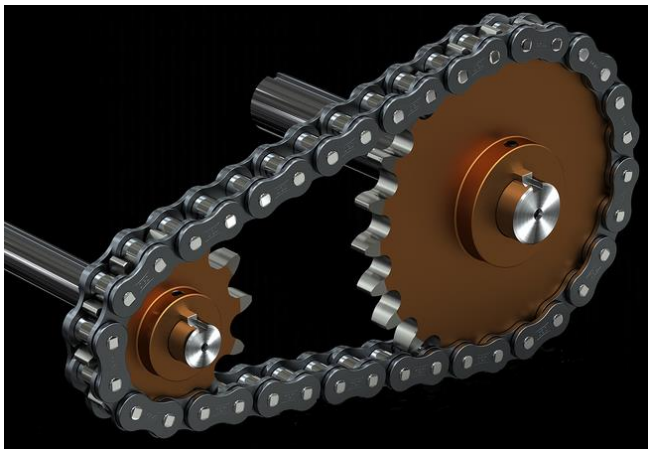
Chains & Sprockets

A chain is two or more connected links which are typically made of metal. Chains are usually made in one of two styles, according to their intended use:

Firstly, those which are made up of *torus* shaped links. These are mostly used for pulling, lifting, securing etc. as with a block and tackle hoist or like a bicycle lock. Torus type links means that the chain is flexible in two dimensions, the third and fixed dimension being the chain's length!

Secondly, there are *roller chains* types designed for transferring power in machines. They have links designed to mesh with the teeth of the sprockets of machine shafts and they are flexible in one dimension only. There are also non-rolling type chains, such as block chains to be found, but this *fact-sheet* will concentrate from here out on the roller chains normally used for power transmission and positioning accuracy.



Roller chains are to be found on many different kinds of domestic, industrial and agricultural machinery, commercial lawn mowers, cars, motorcycles and bicycles. They consist of a series of short cylindrical rollers held together by side links. They are either driven or they drive a toothed wheel called a *sprocket*. They are a simple, reliable, and efficient means of transferring power between two or more shafts, where slippage is not permissible. They can be run at high speed and some designs are so constructed to be relatively noiseless at speed.

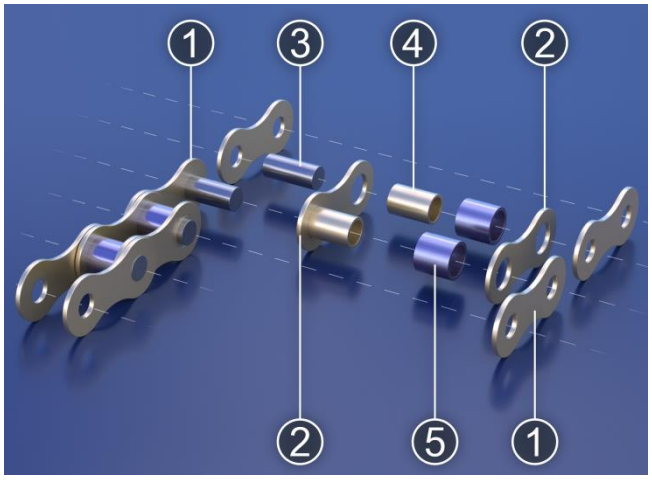
A *sprocket* or *sprocket-wheel* is a profiled wheel with teeth that mesh with a roller chain. The name *sprocket* applies generally to any wheel that has radial projections that engage a chain passing over them, for example, the mechanism in a block and tackle hoist uses a chain and sprocket as shown on the left. Sprockets are distinguished from gears, in that sprockets are never meshed together directly, and differ from a pulley in that sprockets have teeth, whilst pulleys are smooth.

The roller chain design reduces friction compared to simpler designs, resulting in higher efficiency and less wear. The original power transmission chain varieties lacked rollers and bushings, with both the inner and outer plates held by pins which directly contacted the sprocket teeth, however this configuration exhibited extremely rapid wear of both the sprocket teeth, and the plates where they pivoted on the pins. This problem was partially solved by the development of bushed chains, with the pins holding the outer plates passing through bushings or sleeves connecting the inner plates. This distributed the wear over a greater area, however the teeth of the

sprockets still wore more rapidly than is desirable from the sliding friction against the bushings. The addition of rollers surrounding the bushing sleeves provided rolling contact with the teeth of the sprockets resulting in excellent resistance to wear of both sprockets and chain also. This design exhibits very low friction, as long as the chain is sufficiently lubricated. Continuous, clean, lubrication of roller chains is of paramount importance for efficient operation as well as to keep the correct tension maintained.

The anatomy of a roller chain can be seen below as follows:

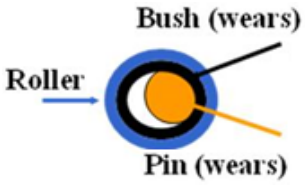
1. Outer link plate
2. Inner roller link plate
3. Pin
4. Bushing
5. Roller



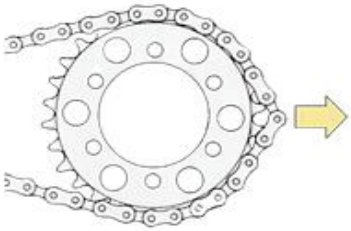
Care and maintenance of chains and their associated sprockets is critical to prolonging their life. Chains inside an engine, unlike motorcycle chains for example, operate in a clean environment, and thus the wearing surfaces, that is, the pins and bushings, are protected from airborne grit. Some roller chains are designed to have O-rings built into the space between the outside link plate and the inside roller link plates, for example on motorcycle chains as these are subject to much road dirt. These O-rings form a barrier that holds factory applied lubricating grease inside the pin and bushing wear areas, whilst at the same time preventing dirt and other contaminants from entering inside of the chain linkages where these contaminants will cause significant wear.

There are also many chains that have to operate in dirty conditions, and for size or operational reasons cannot be sealed. Examples include chains on farm equipment, bicycles, and chain saws. These chains will have a relatively high rate of wear, especially if the operators are prepared to accept more friction, less efficiency, more noise and more frequent replacement as they neglect the need for lubrication and adjustment.

As chains begin to wear, their pitch, that is the distance from one pin centre to the next, lengthens due to the wearing of the pins, bushings and rollers and so the overall chain will get longer. If it lengthens, then it will also run slack and this slack will be snapped up sharply when power is applied then releases, thus exacerbating the wear problem. A good way to check for how much wear is present is to hold the chain pointing outward horizontally but keeping it held sideways. Ideally it shouldn't bend, but a worn chain will.



Sprocket teeth will also wear due to the change of chain pitch, and so it is prudent when replacing a worn chain to also replace both sprockets. Below left shows a sprocket with curled teeth due to running a stretched chain. Below right shows a way to check for chain wear. You can simply try to pull the chain away from the sprocket at the point where there is a chain pin – it should not be possible to do this with a new chain but it will be possible with a more worn chain.



Chains can be split to remove them from the driving and driven sprockets in order to replace them, or perhaps to remove some links in order to achieve correct tensioning. It's worth noting that if you are removing links from a chain that is already in service in order to take up significant slack that may have developed, then it would be wiser to replace the chain as this chain has stretched excessively and is already in the process of damaging the sprockets. Chains are commonly joined by:

- Quick release link
- Split link
- Cotter link
- Rivet link

Quick release links are mostly found on light chains such as bicycles. They have a slotted opening as you can see from the picture so that when the two rollers are pulled together the link plates on either side can be separated.

Split links are very common and the picture here shows the outer plate with its two link pins, the opposing plate, and a horseshoe shaped clip to keep the assembly together. It is important to keep the closed end of the horseshoe clip pointing towards the direction that the chain moves. Why do you think this is?

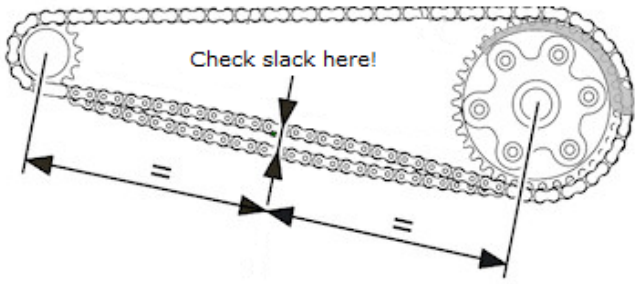
Cotter pin chain links are very similar to the split link type shown above, with the exception that the closing link plate is secured by two cotter pins passed through holes in the link pins as shown. Be sure to put a bend in one of the cotter pin legs to stop it from falling back out through the link pin holes.

Rivet links are a very secure way to make up an *endless chain*. When you buy a riveted link set it looks like as shown here.

It requires a special type of tool to both separate and re-join the chain. It is the most secure way to make a chain connection and used extensively on motorcycle drive chains. They usually come with the appropriate seals included if the chain is a sealed type. How to separate and to re-join these chains is shown on this video.

Duplex and triplex chains are available when heavy duty power transmission is required. The picture to the right shows a triplex chain.

Tensioning of roller chains must be carried out correctly if the chain, sprockets, and bearings are to give service for their designed life span. This requires that the correct amount of *slack* is present on the *return run* of the chain.



Some recommendations give particular measurements for slack, for example, 20mm, but in fact the correct amount of slack depends on the distance between centres of the sprockets. The ideal adjustment is to have **minimal** slack, without any semblance of tension present on the return run.

Ensure to check the slack over an entire revolution of the chain so as to make sure that there are no tight spots. Tightness should be avoided at all costs as this will stress the chain, sprockets, and bearings.

Chains are very efficient mechanisms and will work extremely reliably for long periods if given some basic care!