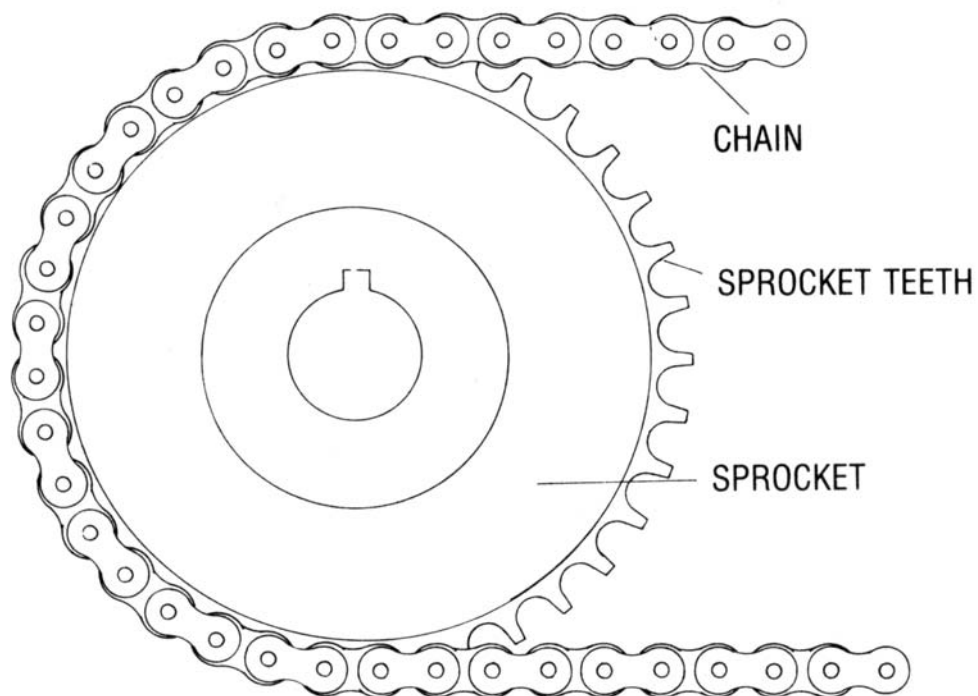


Chain Drives

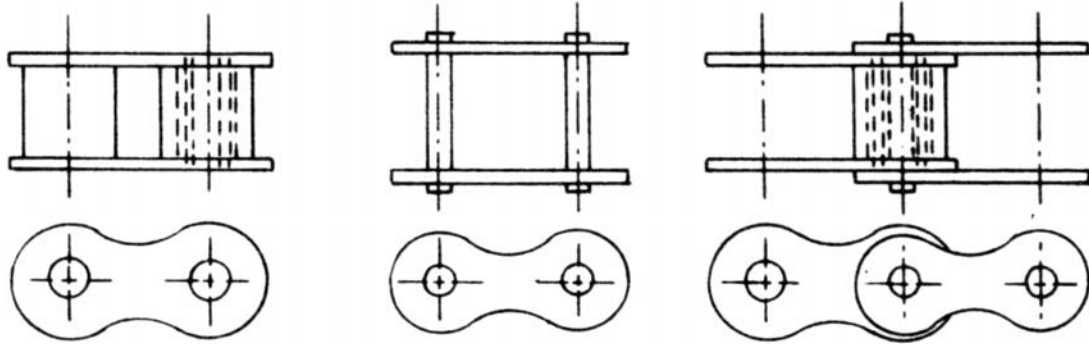
Chains and sprockets provide a positive form of drive which does not slip and they can therefore be used where synchronisation of motion is important. There are various types of chain available, the most common being the roller chain. Many of the maintenance practices described also apply to other types of chains such as silent chain, rollerless chain etc.

Principles of Operation

Chains and sprockets fulfil the same basic function as belts and pulleys in transferring power between two parallel shafts. Instead of relying on friction, a chain drive is a positive drive in which the links of the chain engage with specially formed teeth on the sprocket.



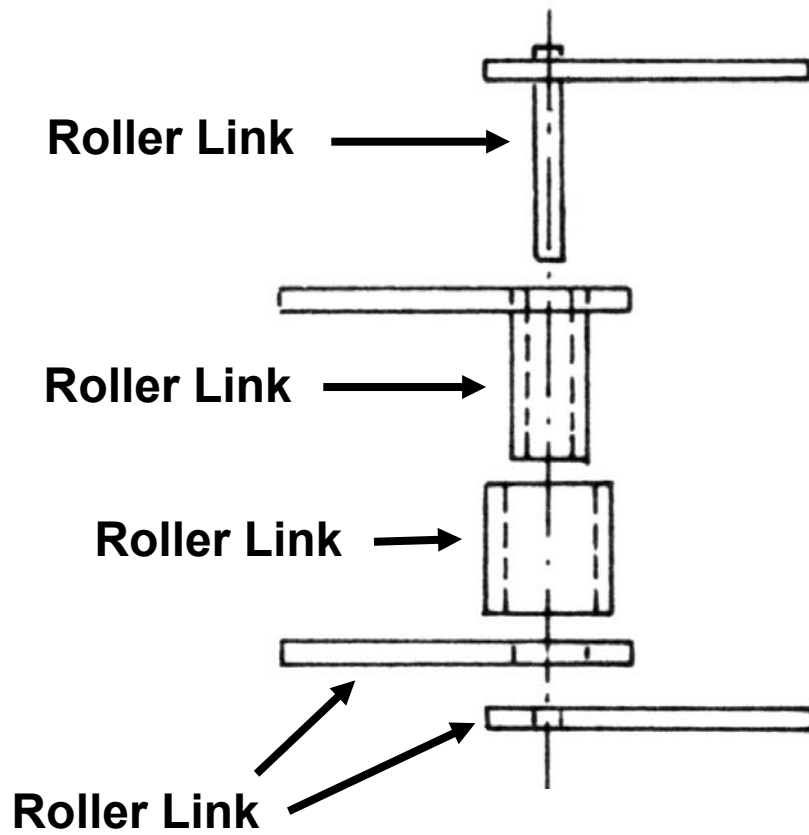
Standard roller chain is made up of alternate roller links and pin links.



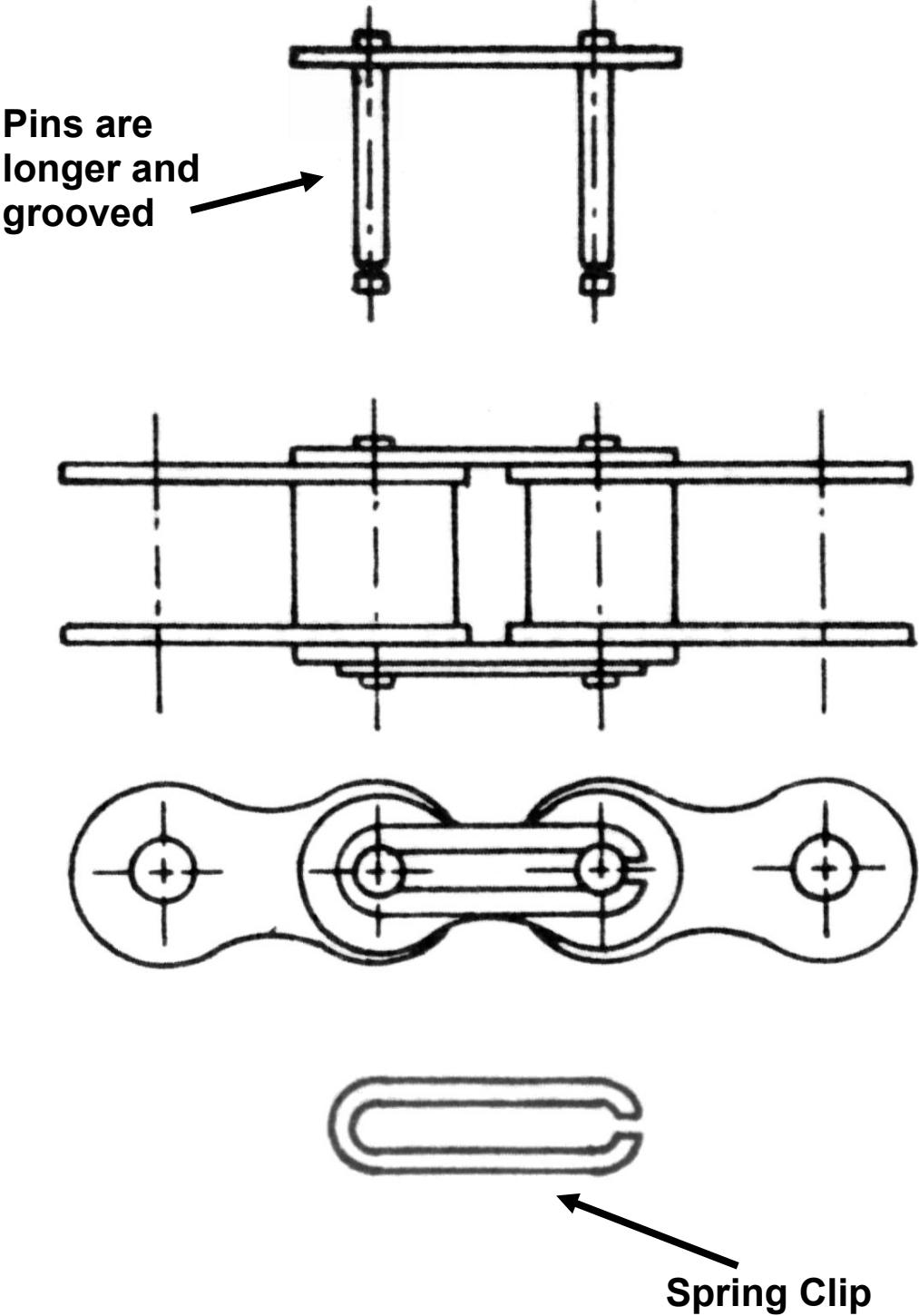
Roller Link

Pin Link

Assembled Links

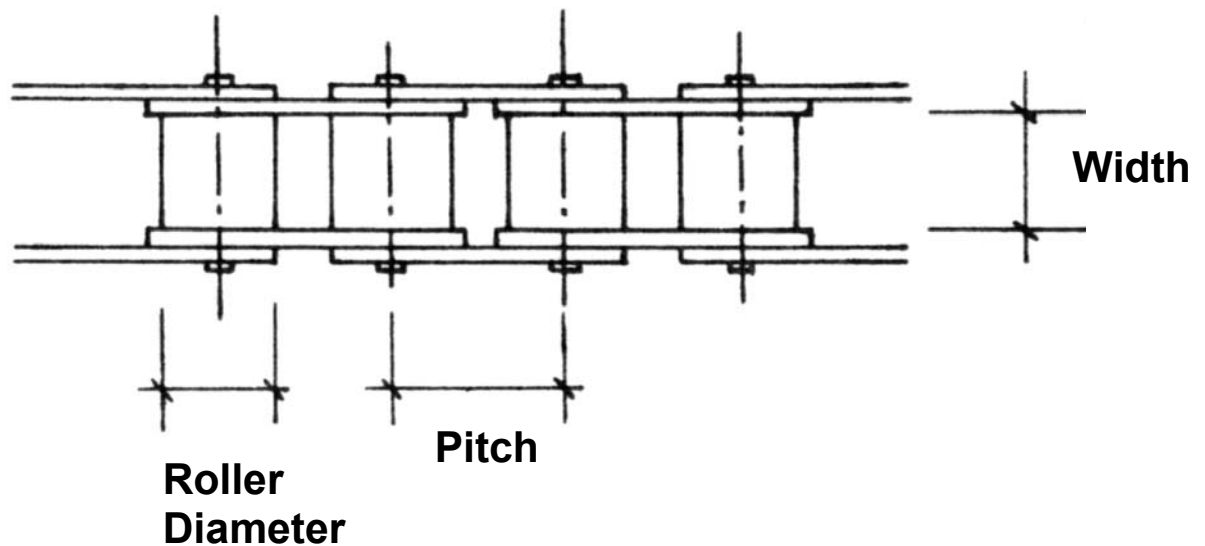


The pitch of the chain is determined by the length of the side plates, and the bushings and pins are press-fitted into the side plates. The pins of a special joining link may be longer and grooved to take spring clips as shown below.

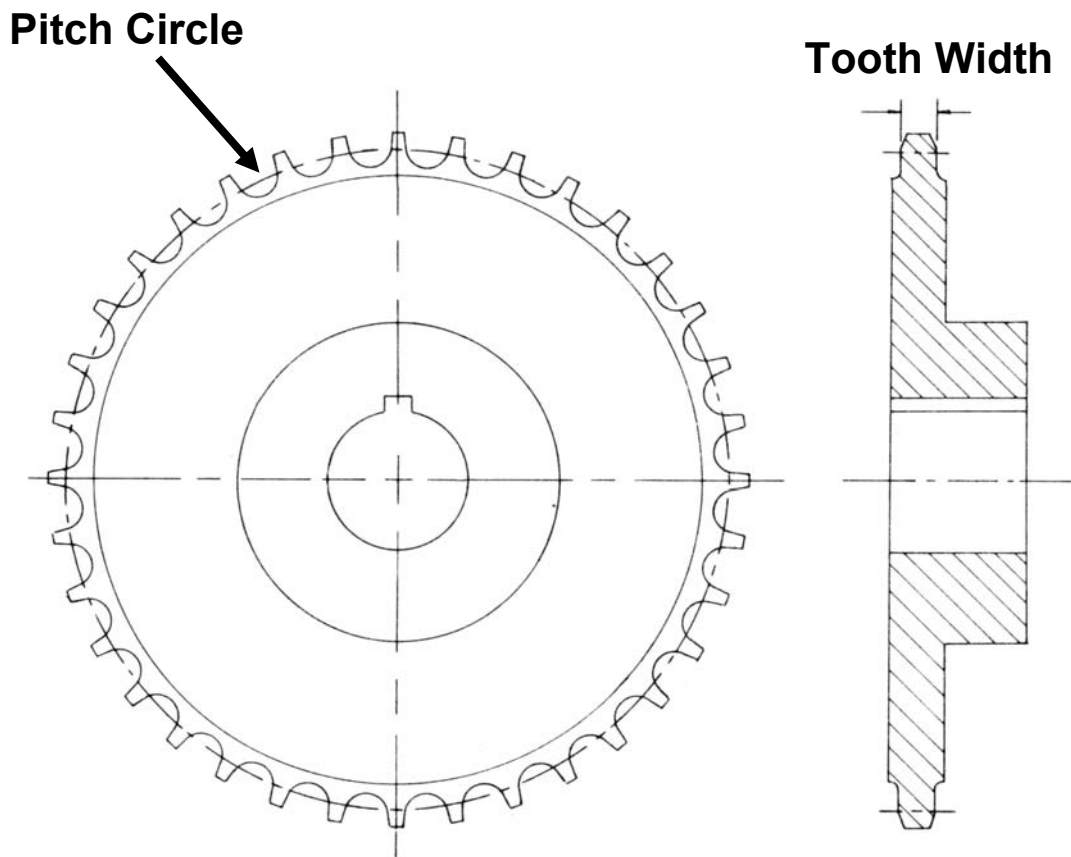


The rollers are free to rotate on the bushings, and this reduces the rubbing action between the chain and the sprocket as the chain links roll on to the sprocket and thus avoid excessive wear from sliding friction. Because each roller and bushing functions like a plain journal bearing, lubrication is essential to the operation of chain drives.

The critical dimensions by which roller chain is identified are the pitch, width and roller diameter.



Chain drive sprockets have teeth cut around the periphery, like a gear, and are specified by pitch circle diameter, width and number of teeth. They are usually manufactured with an integral hub as shown below.



It is normal practice to design chain drives in such a way that the number of chain pitches and the number of sprocket teeth ensure that the same link does not contact the same tooth each revolution. If there are an even number of pitches on the chain there must be an uneven number of teeth on the sprocket and vice versa. This helps to reduce uneven wear.

Chain drives are more sensitive to misalignment than belt drives and must be properly tensioned. They are generally suitable for speeds up to 1350 metres per minute (4500 feet per minute).

The speed of the driven sprocket in relation to the speed of the driver can be determined by using a simple formula based on the number of teeth on the driver and driven sprockets as shown below.

$$\text{speed of driven (RPM)} = \text{speed of driver (RPM)} \times \frac{\text{No of teeth on driver}}{\text{No of teeth on driven}}$$

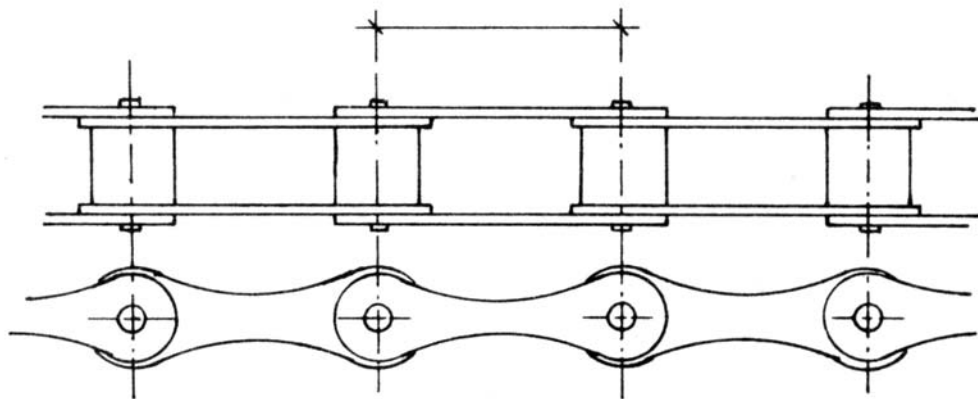
Exercise

Exercise

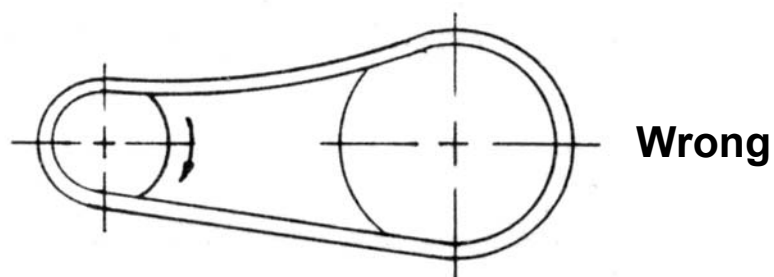
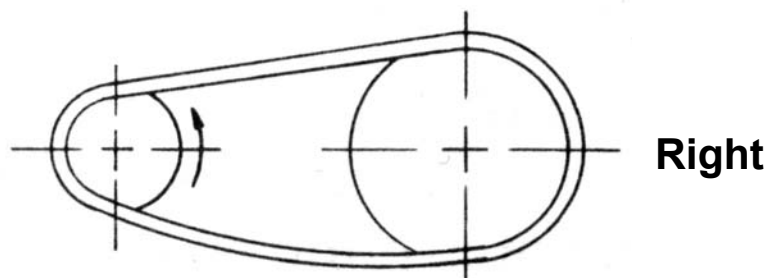
Types and Arrangements

Standard roller chain is available in single and multi-strand form, and the number of strands required will depend on the power to be transmitted. Double pitch chains are also available. They are cheaper, and are suitable for light loads and low speeds.

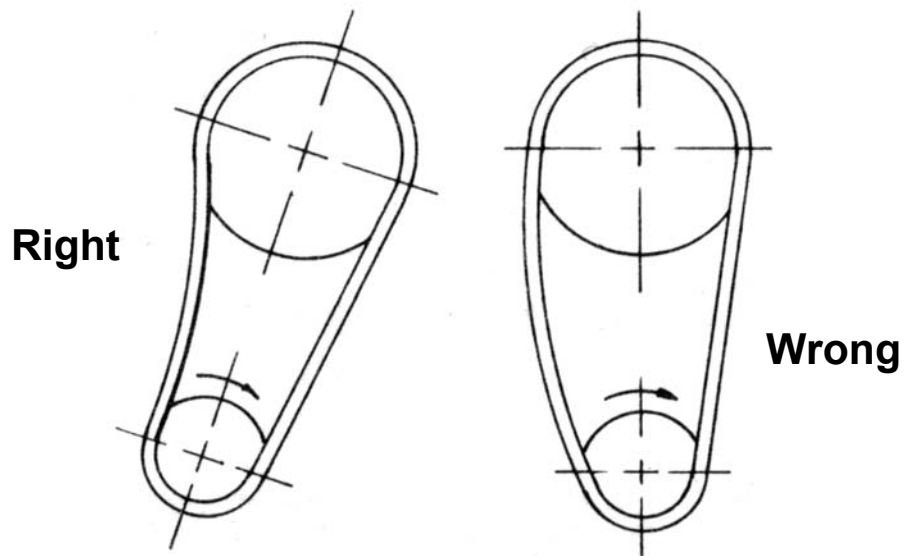
Pitch = 2 x Standard Pitch



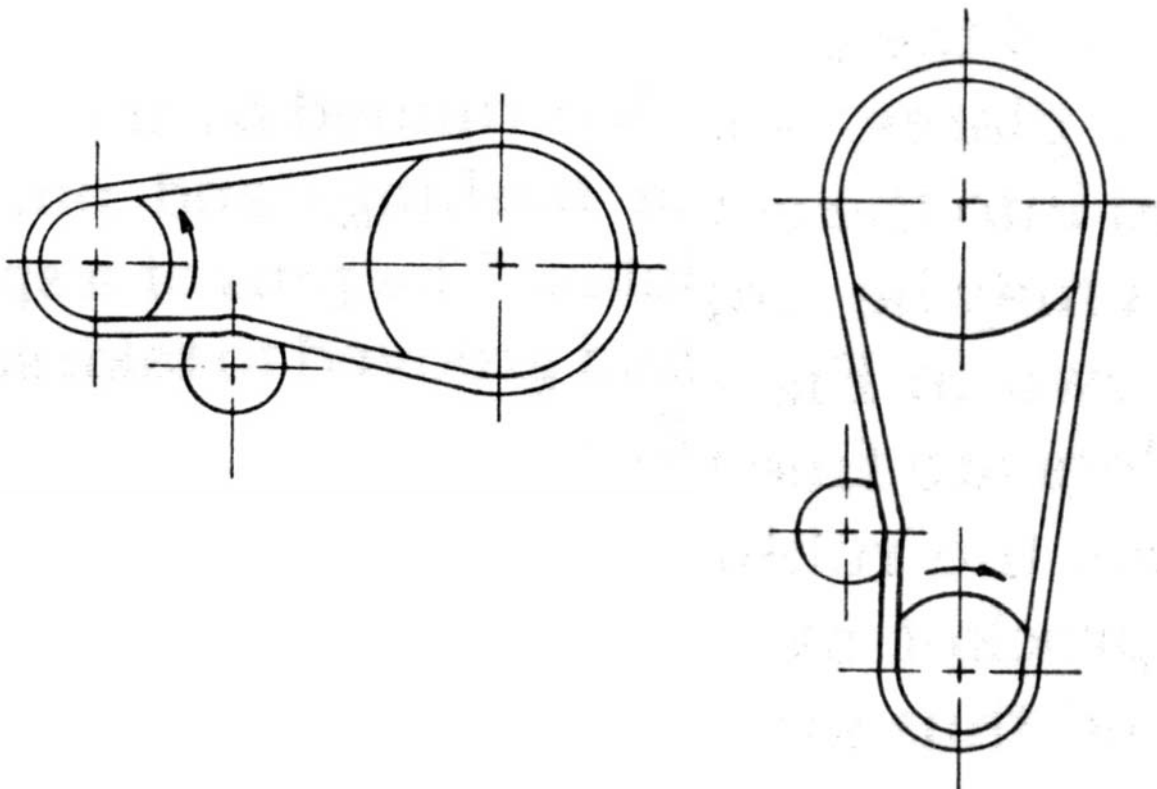
Chain drives are used most commonly as horizontal drives and any slack in the chain, resulting from wear, should accumulate on the lower strand as shown below.



Vertical drives should be arranged so that accumulated slack falls into the driven sprocket rather than away from it, to prevent misengagement.



Where chain tensioners are used they should be used on the side of the chain where the slack is expected to accumulate.



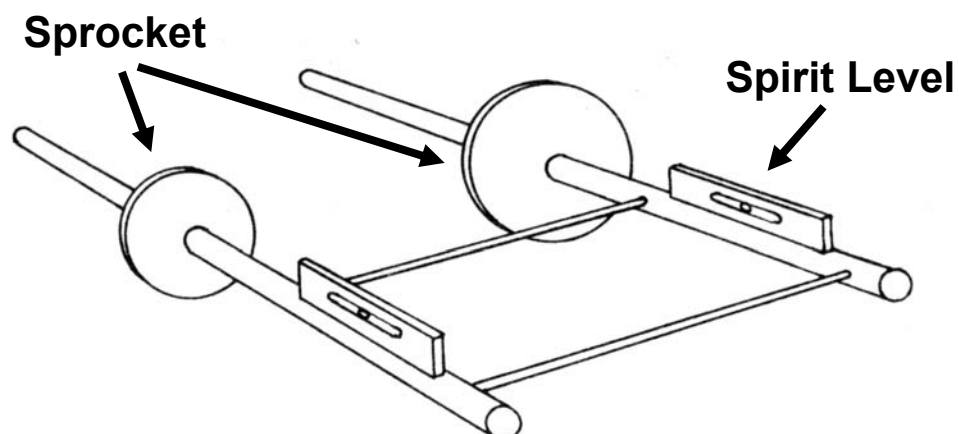
Maintenance Practices

The general point to be taken into account in the maintenance of chain drives are:

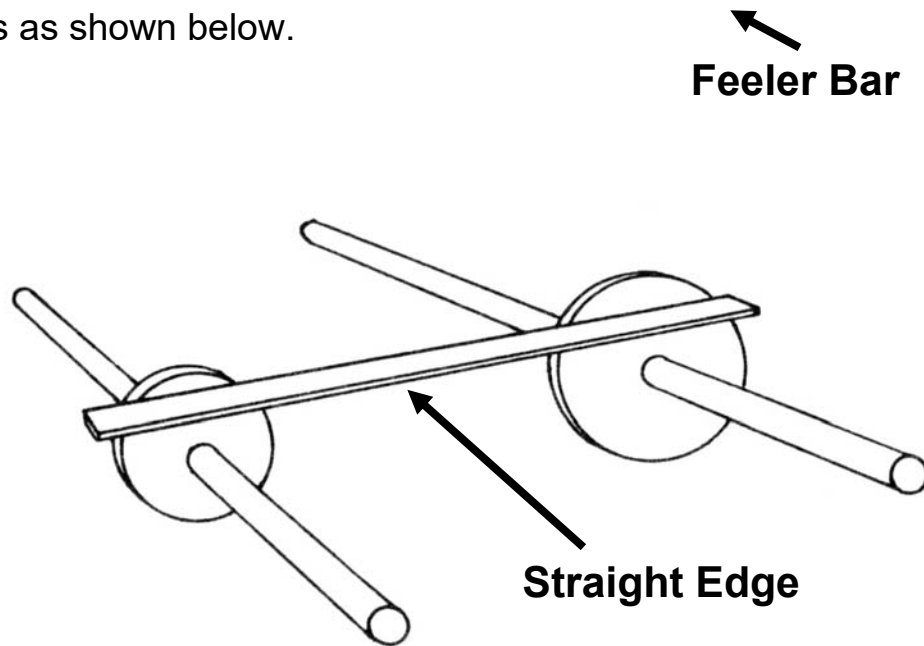
- As with belt drives, alignment and proper tensioning are critical to the operation of the drive.
- Chain drives should be kept clean and protected from dirt and should be provided with an adequate supply of a suitable lubricant.
- New links should not be installed in chains that have been significantly lengthened by wear.
- New chains should not be installed on badly worn sprockets. Sprockets may be reversed on the shaft to extend their life if necessary.
- New chains should be stored in protective wrappings until ready to use, and protected from excessive heat and moisture.
- Chain drives, like belt drives, should be properly guarded and protected from interference.

Alignment

The alignment of chain sprockets is critical to the operation of the drive and the procedure should be carried out with care. As for V-belts, the two shafts are first checked for level and parallel alignment using a spirit level and feeler bars or gauges.



A straight edge can then be used to check alignment of the sprocket faces as shown below.



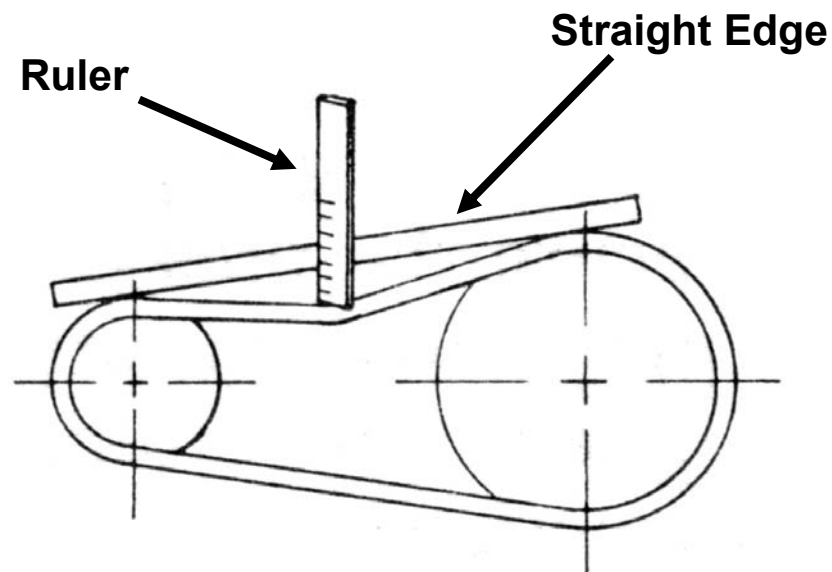
If either of the shafts is subject to end float then align the sprockets with the shaft in its normal running position.

If the centre distance between the shafts is too great for a straight edge a taut piano wire may be used instead. Rotate the sprockets and check the alignment in several positions.

Slack Adjustment

Unlike belt drives, chain drives do not require initial tension but should merely be adjusted to take up the slack. If a chain is too tight it will bind on the sprockets and wear rapidly. If it is too loose it will tend to whip, which will cause vibration and reduce life.

For chains installed on units with adjustable centres, the slack should be adjusted to approximately 2% of the centre distance. In other words, if the centre distance is one metre then the slack should be about 20mm. This can be adjusted by pulling the chain taut on one side and measuring the slack on the other using a ruler and straight edge.



For drives on fixed centres, an idler sprocket or spring loaded tightener of some kind will automatically take up the slack.

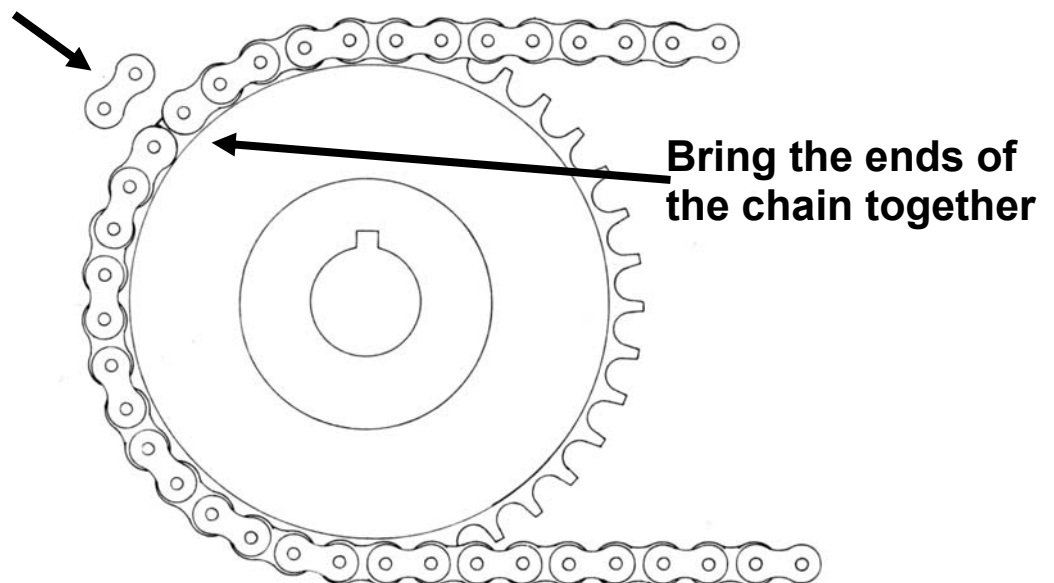
It is important to recognise that chains stretch during operation and drives with adjustable centres may need to be readjusted from time to time. The so-called stretch is not due to any physical deformation of the chain links but due to wear in the rollers, bushings and pins which must be compensated for.

Installation of Chain Drives

The following procedure is recommended when installing a chain drive.

1. Check the condition of the sprockets and make sure they are clean and free from damage.
2. Align the sprockets as recommended in the previous notes.
3. Loosen the tighteners so that the chain will fit over the sprockets.
4. Remove the chain from its wrapping and bring the ends together over one of the sprockets. Use the sprocket teeth to hold the chain and install the final link.

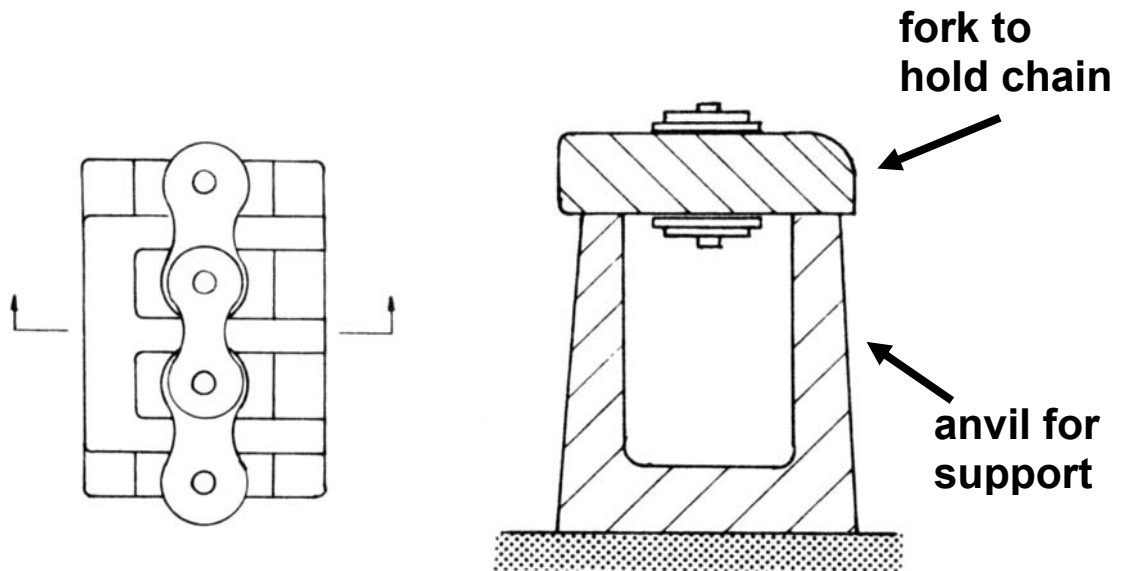
Join chain by installing connecting link



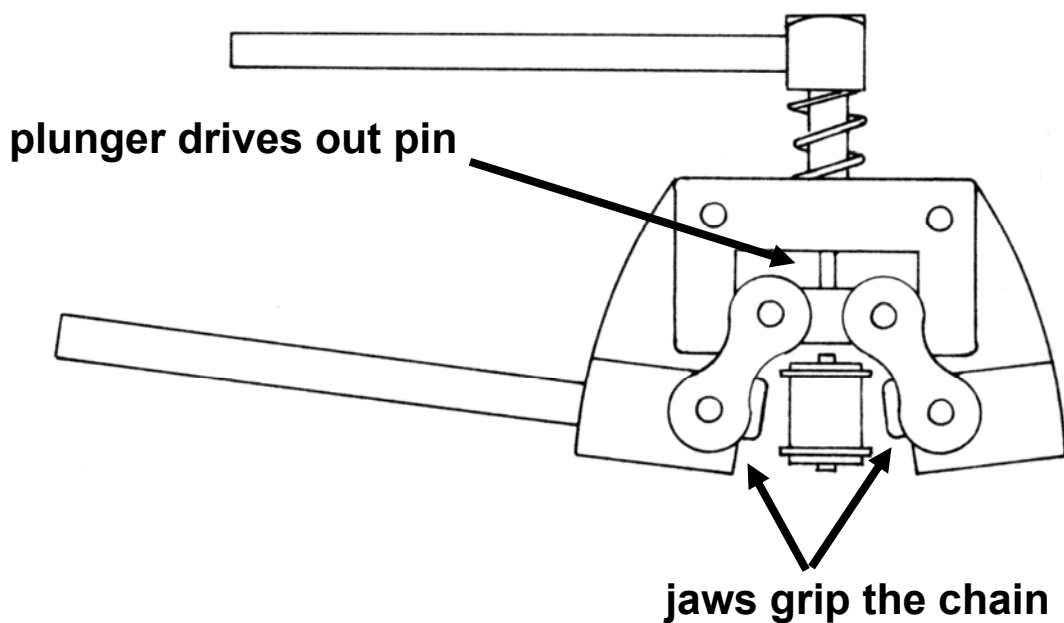
5. Fit the side plate and spring clips or whatever device is used to secure the pins.
6. Take up the slack in the drive as outlined above.
7. Lubricate the chain according to the manufacturer's instructions.
8. Start up the machine and check that the chain runs true, without excessive noise and without binding or whipping.
9. Ensure that the lubrication system is working properly.
10. Install a suitably designed guard to prevent interference with the drive. ***(Do not attempt to do this while the drive is in operation).***

Chain Removal

If the drive adjustment allows the chain to be removed without being broken by the removal of a link then use this method. If the chain needs to be shortened by removing a link a chain detacher should be used to hold the chain while the link is removed.



Chain detaching tools are also available to drive the link pins out.



Cleaning

Whatever the operating conditions it is advisable to remove the chain and clean it from time to time. The debris of normal wear and gummed lubricant will cause wear to the pins and bushings if it is not removed and if the atmosphere is dusty, regular cleaning becomes even more important.

The procedure recommended is as follows:

1. Remove the chain
2. Check the chain and the sprockets for wear and corrosion.
3. Wash the chain in kerosene or similar cleaning fluid. Soaking may be necessary for a very dirty chain.
4. Drain off the cleaning fluid and soak the chain in lubricating oil.
5. Hang the chain and allow excess lubricant to run off.
6. Clean the sprockets and check alignment.
7. Reinstall the chain.

Lubrication

Proper lubrication is critical to the operation of the chain drives and the achievement of satisfactory service life. The general principles of lubrication apply and the following points should be remembered.

- Lubrication should be regular and the frequency determined by the operating conditions.
- Whatever lubrication system is employed, the lubricant must penetrate the chain joints.
- Chains should be cleaned regularly so that lubricant can flow into the joints.
- The higher the chain speed the greater the the supply of lubricant required.
- Some means of protecting the chain from dirt and other contaminants should be provided.

The most common methods of chain drive lubrication are:

Manual	Using a brush or oil can	Suitable for simple drives
Drip Feed	Low horsepower and low speed drives	
Automatic	Using oil bath or an oil spray	Suitable for moderate to high speed drives.

Failure Patterns

The common symptoms and causes of chain drive malfunction and failure can be summarised as follows:

Operating Symptoms

Noise

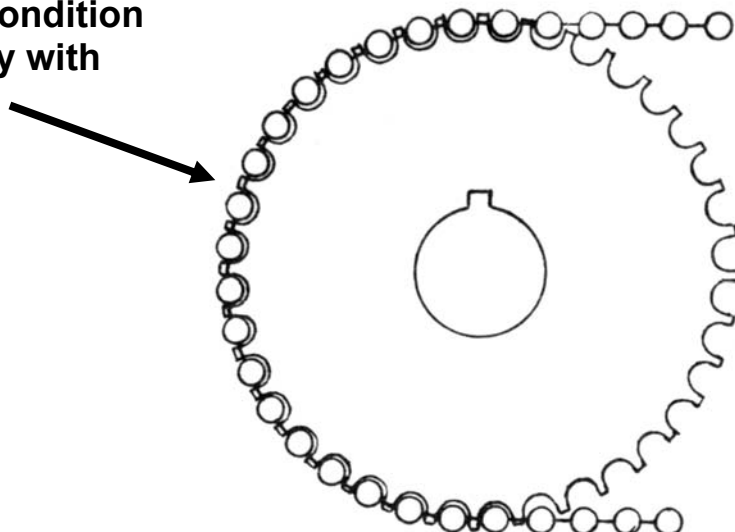
Chain drives are generally relatively noisy, certainly more so than belt drives, but if noise becomes excessive it may be an indication of malfunction. As for other indicators of the condition of machine elements, it is useful to establish an operating level when the system is new and properly adjusted so that changes in noise level can be detected. Intermittent ticking or slapping sounds may be associated with interference and should be investigated immediately.

Chain Jumping

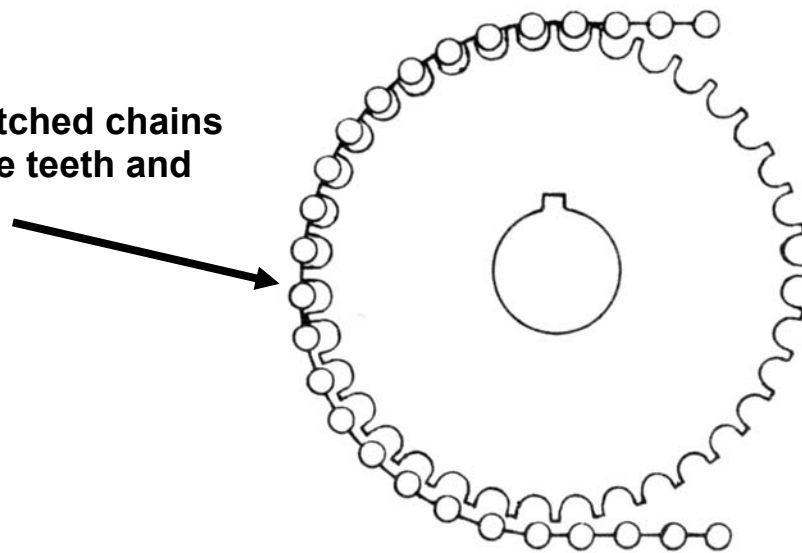
Chains can have a tendency to climb the sprockets and can reach a point where they jump off. This may be due to wear or to excessive slack, both of which allow the chain to ride high on the sprocket teeth.

Alternatively, excessive material build-up on the sprocket teeth may interfere with the correct mating of the chain and teeth.

Chain in good condition meshes properly with sprocket teeth



**Worn and stretched chains
run high on the teeth and
out of mesh**



Chain Whipping

Too much slack, or pulsating loads, may cause the chain to whip. This may also occur if some of the chain links have become stiff or have seized.

Chain Breakage

It is rare for a chain to break completely although this may occur if a condition of malfunction has existed for some time and excessive fatigue has taken place. It can also occur when a chain is badly worn. The lengthened chain may jump a tooth on the sprocket which causes excessive tension and consequent failure of the side plates.

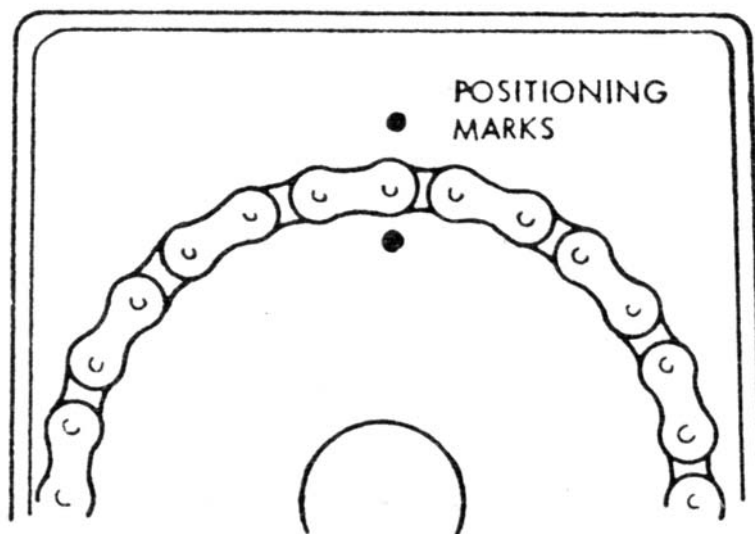
Overheating

Operating temperatures are an indication that the drive is operating at too high a speed, with too great a load, or with inadequate lubrication. It is often difficult to determine the temperature of a chain during operation but it can be checked as soon as the machine is shut down. Once again, a comparison with normal operating conditions must be made in order to detect evidence of malfunction.

Removing Chains

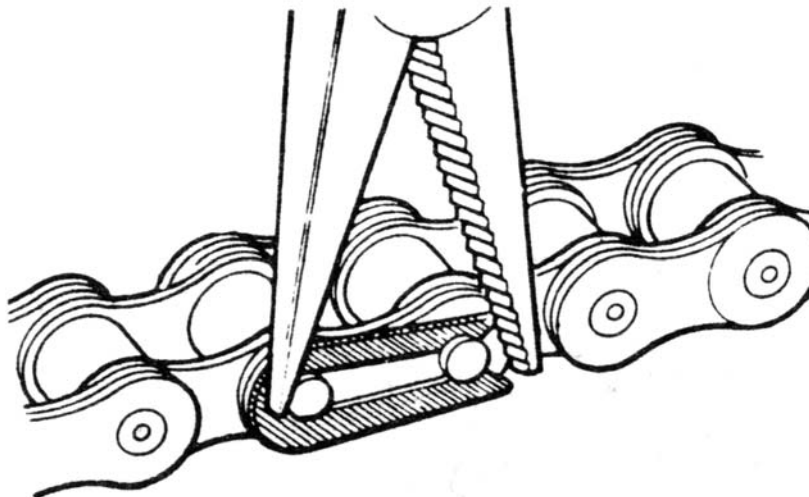
Before removing a chain:

- Check that the safety precautions have been followed.
- Check to see if the chain has to be fitted with the sprockets in a particular position. If necessary mark the sprockets so that the position can be found again.
- Slacken the tension adjustment completely.

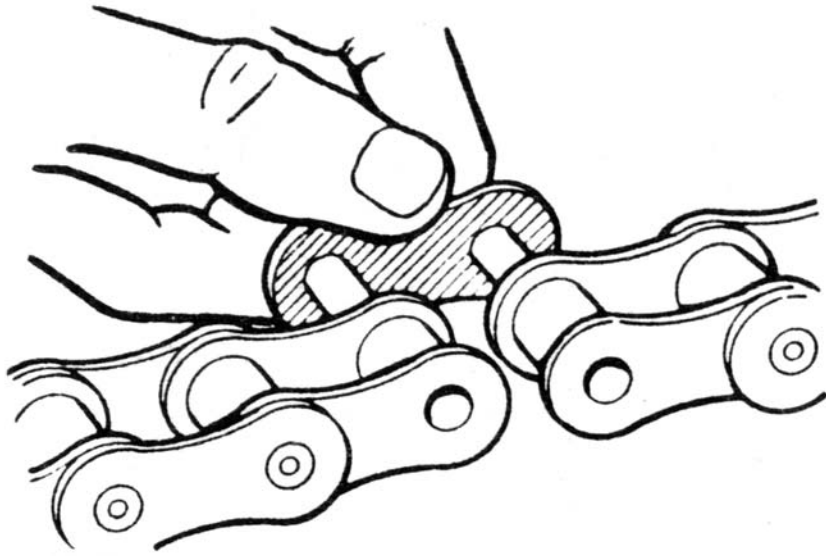


When removing a spring clip join:

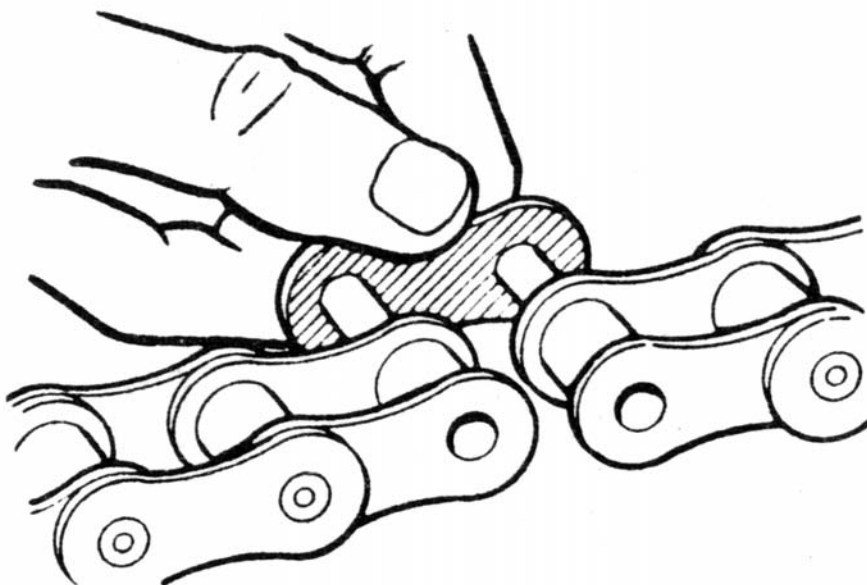
- Remove the spring clip with a pair of pliers.



- Remove the outer plate from the end of the spindles.



- Pull the remainder of the joining link out of both adjacent links at the same time so that the chain is not bent.

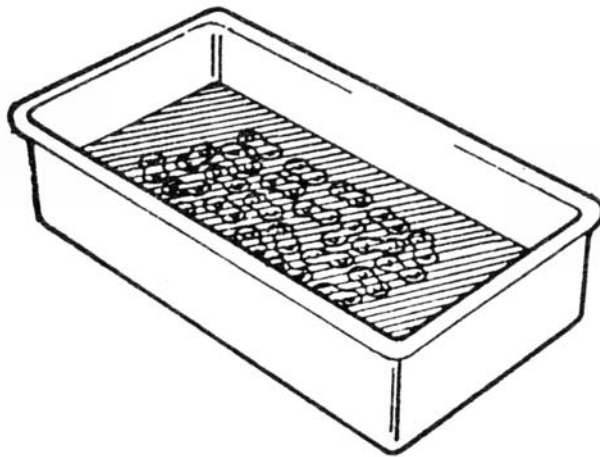


Chains that are not totally enclosed with an automatic oiling system

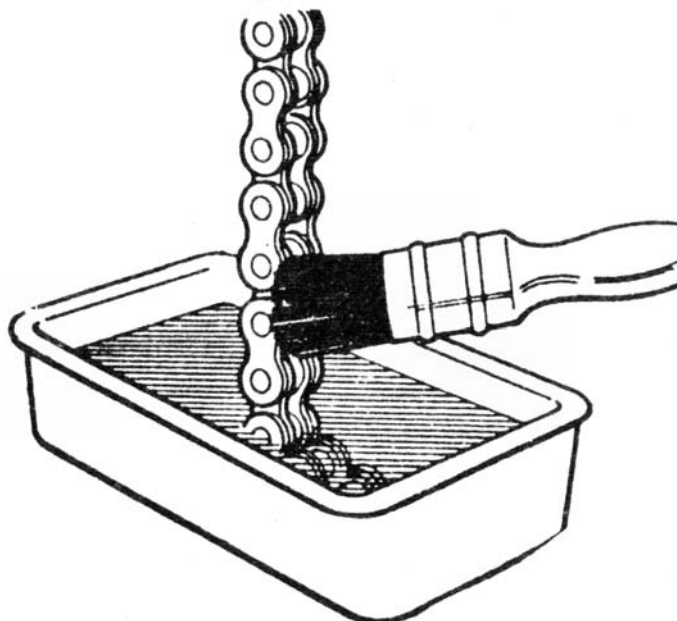
Cleaning and oiling a chain: minimise wear.

When cleaning a chain:

- Remove the chain from the drive.
- Roll up the chain and leave it to soak in a bath of cleaning agent.



- Remove the chain and hang it vertically.
- Scrub the chain with a stiff brush, rinsing the brush in the cleaning agent regularly.
- Rinse the chain in fresh cleaning agent.

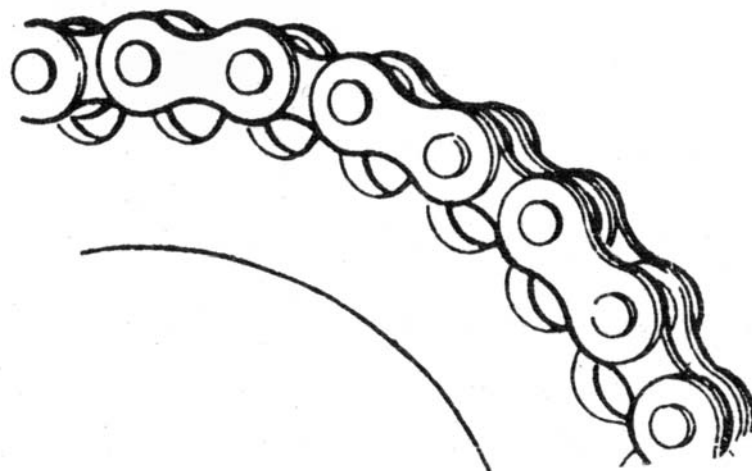


- Check that the chain is thoroughly clean.
- Roll up the chain and leave it to soak in a bath of oil for several hours. If possible, heat the oil so that it flows into the

When oiling a chain easily.

Chain drive wear

Worn chains or sprockets will cause the chain to jump, and possibly come off the sprockets, this will damage the machine and cause a breakdown. Therefore chain drives must frequently be checked of wear.



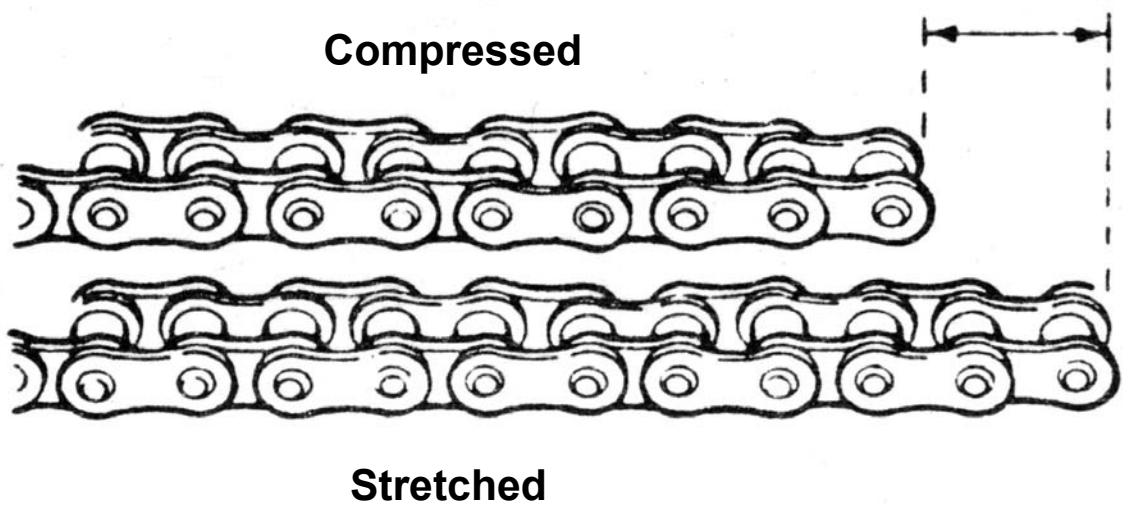
Checking Chain Wear

Chains do not wear evenly, so check the complete length for wear. If any part is worn replace the complete chain.

Chains must be thoroughly cleaned before checking for wear.

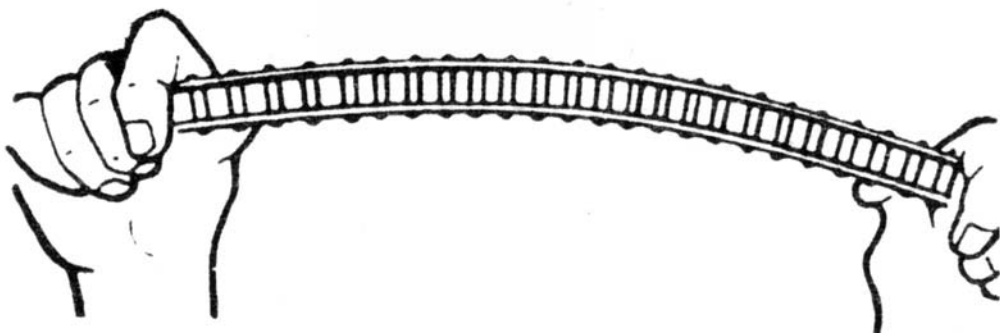
Stretching

Compare the compressed and stretched lengths of the chain. The difference between the lengths indicates the amount of wear when compared with a new chain.



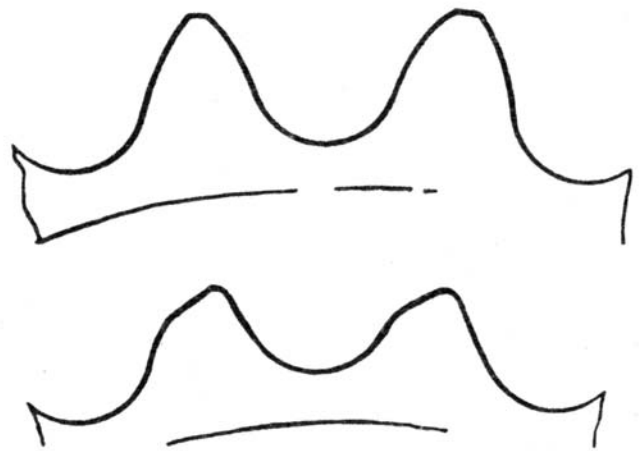
Bending

Bend the chains sideways. The amount of curvature indicates the amount of wear when compared with a new chain.



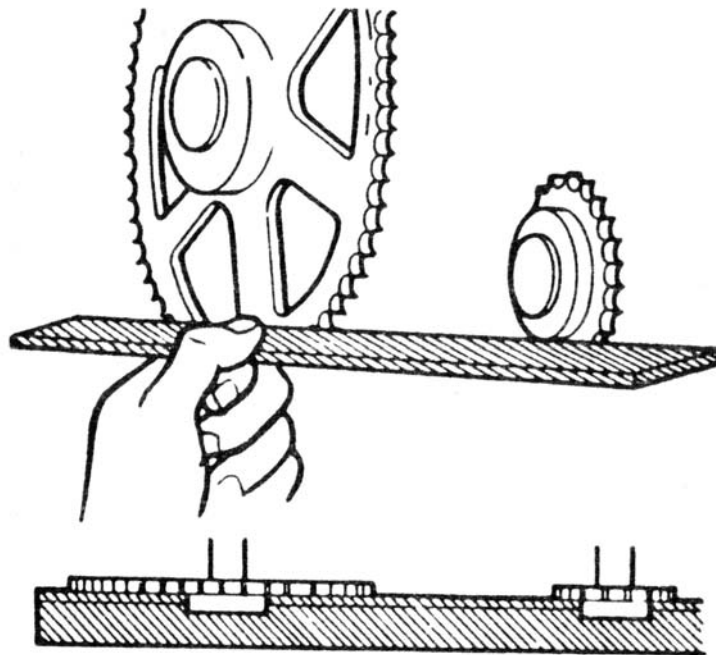
Sprocket Wear

Examine the teeth on the sprocket. If the teeth are pointed or hooked, the sprocket is worn and should be replaced.



Chain Sprocket Alignment

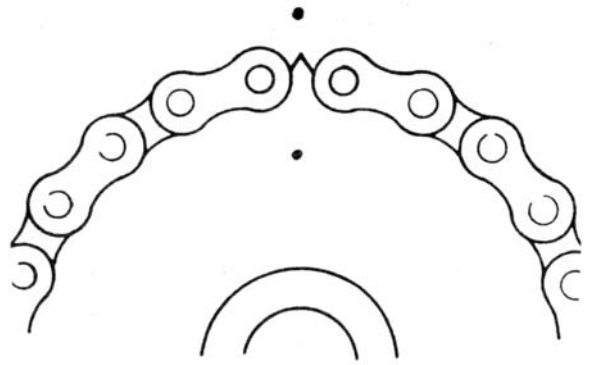
Chain sprockets must be correctly aligned to minimise chain wear and prevent the chain from jumping off the sprockets.



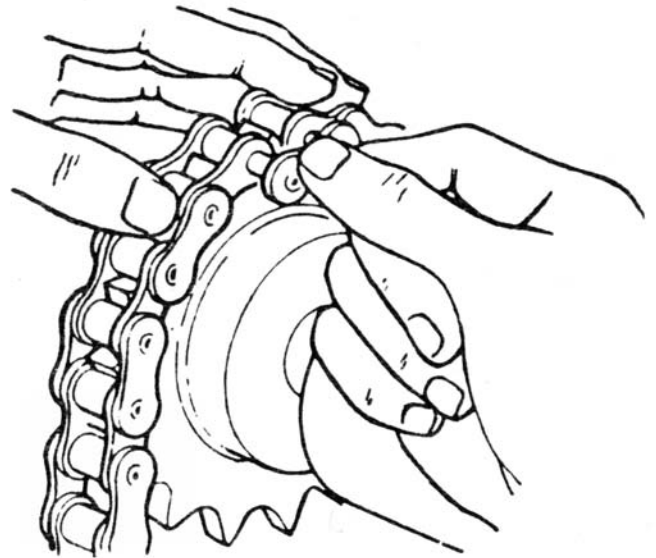
Sprocket alignment must always be checked before a chain is fitted, by placing a straight edge against both faces of the sprocket. Ensure the sides of the chain sprockets are clean.

Fitting Chains

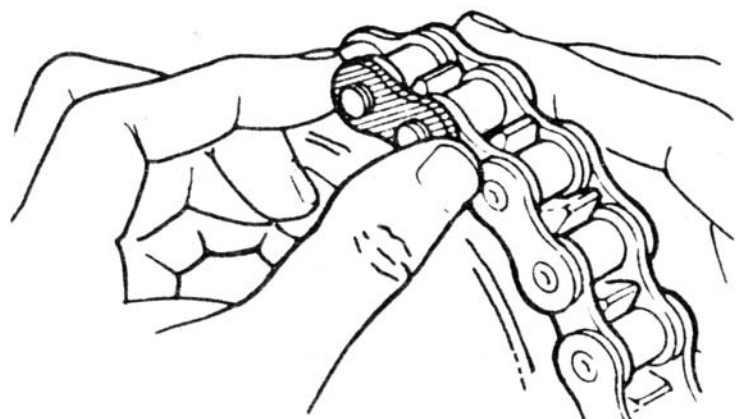
- Lay the chain around the sprockets so that both ends are on one of the sprockets.
- If the sprockets have to be in a special position, check that they have not moved.



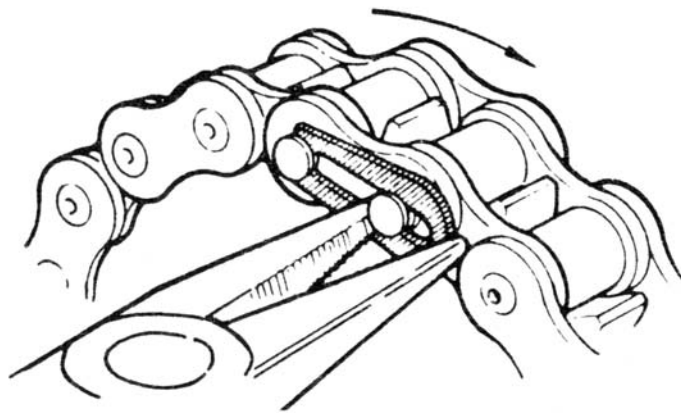
- Hold the ends of the chain against the sprocket and push the joining link into the chain.



- Push the outer plate on to the spindles of the joining link.

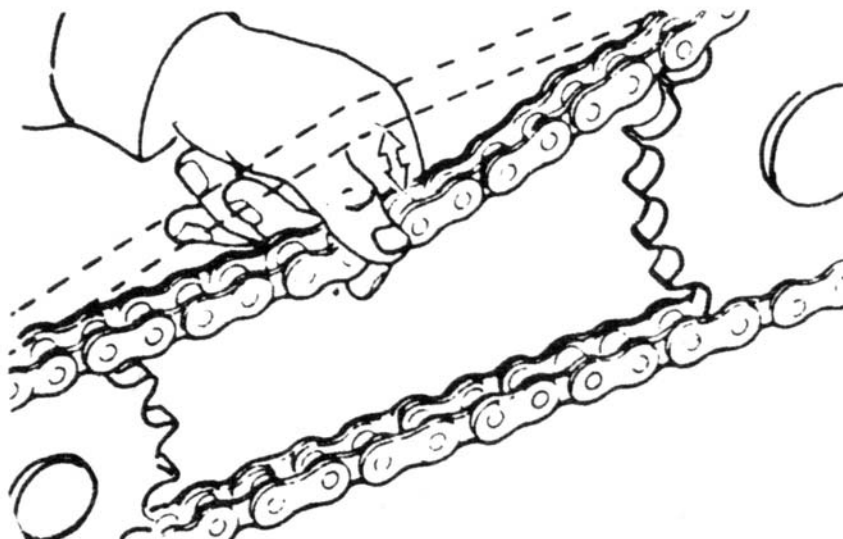


- Clip the spring on to the groove in the leading spindle of the joining link.
- Twist the slip around so that the open end is against the groove in the trailing spindle.
- Push the spring clip into position with a pair of pliers.



Chain Tension

Chains wear and stretch during use, therefore their tension must be checked and adjusted regularly.



When measuring deflection in a chain:

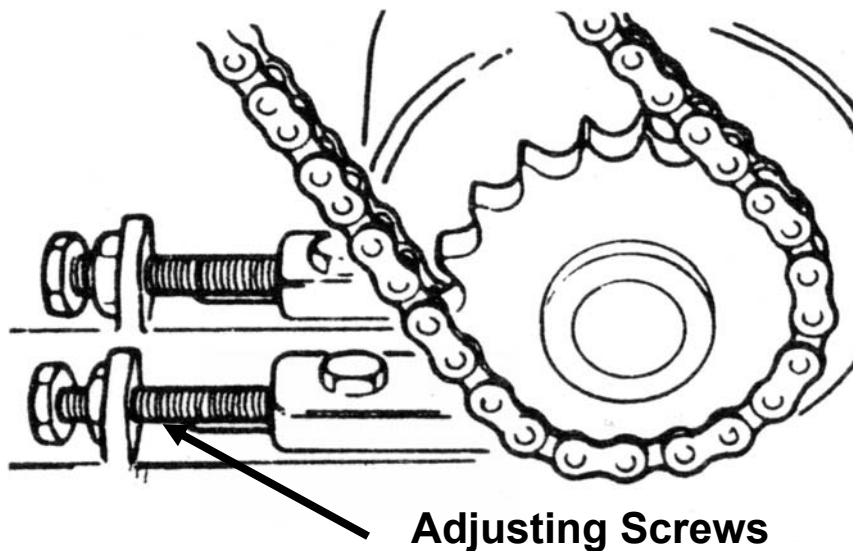
- Find out what the correct amount of deflection is.
- Find the middle of the longest span of chain between the sprockets.
- Push the midpoint in, then pull it out and note the total deflection.
- Compare with the correct deflection.

When adjusting chain tension:

- Slacken off the adjustment clamping bolts.
- Move the sprocket with the adjusting screws to alter the tension.

Note:

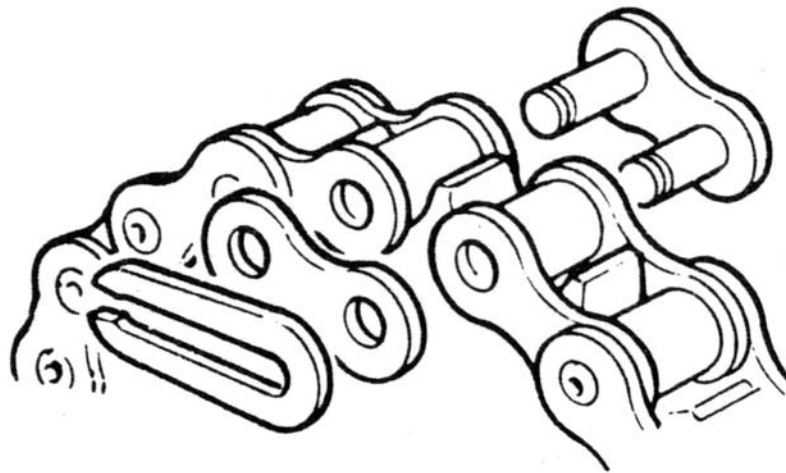
The adjusting screws must be turned equally to keep the sprockets correctly aligned.



- Tighten the clamping bolts.
- Check the tension

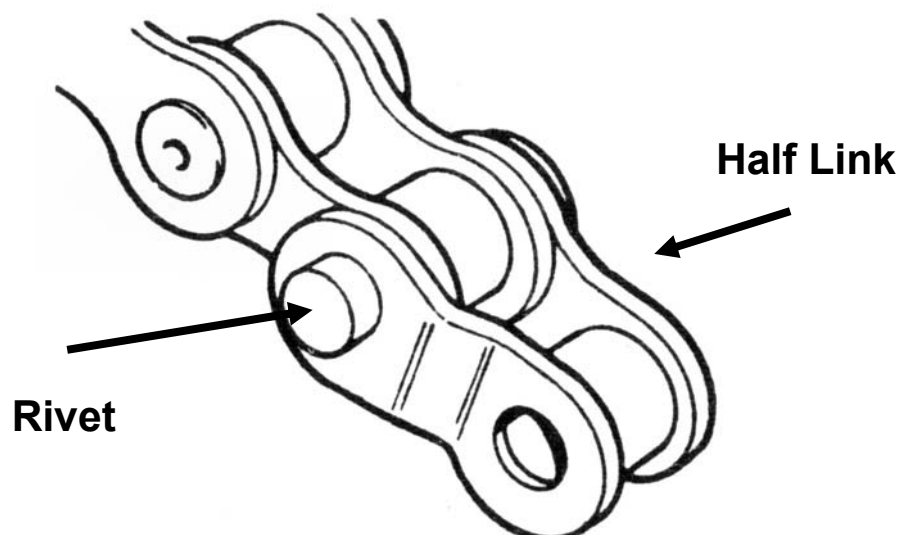
~~Note~~ Half Links

Chains should be adjusted at the tightest position as they stretch unevenly.
Half-links are used as a means of adjustment between fixed centres, or when limits of adjustment are too close to allow correct tension to be obtained by the addition or removal of a full link.

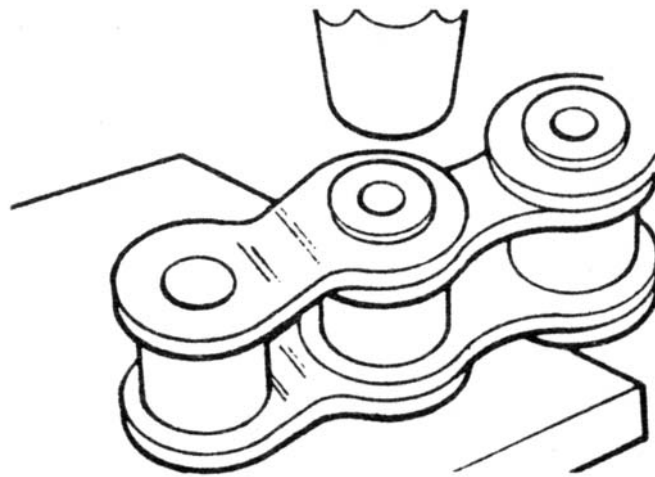


To fit a half-link:

- Remove the joining link.

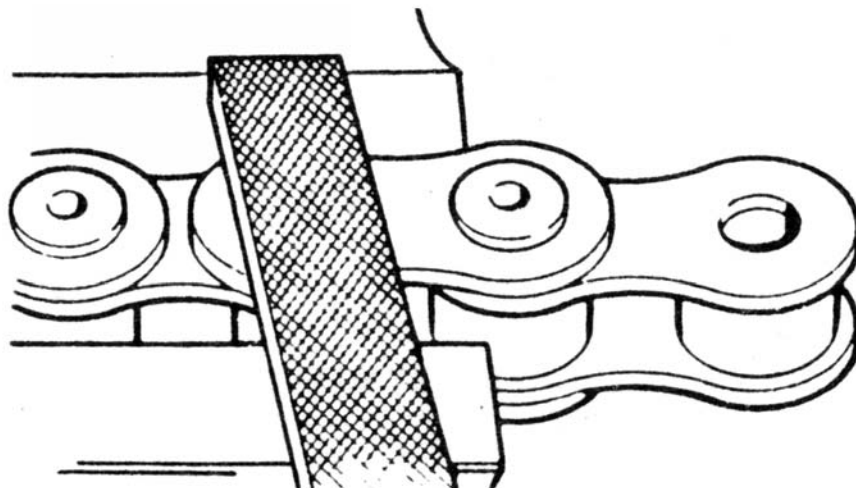


- Place the open end of the half-link over one end link.
- Connect the two items with a chain rivet of the correct length.
- Peen over the ends of the rivet

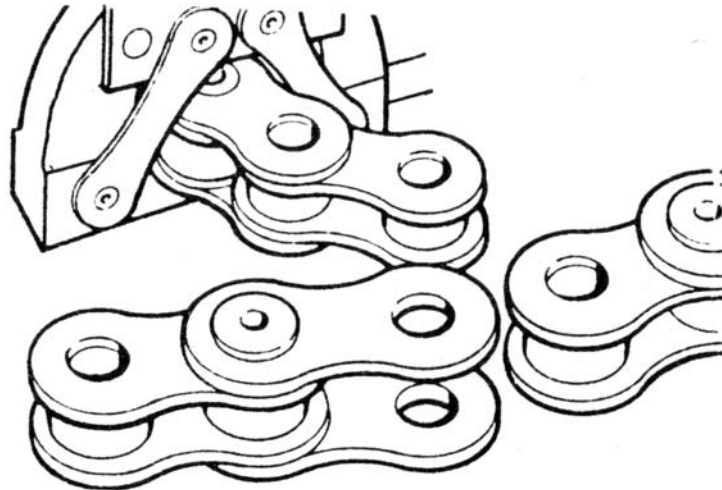


To shorten a chain by a half a link:

- Remove the joining link.
- File off one end of the rivet passing through the inner ends of the outer plates of one end link.



- Using a chain rivet extractor of the correct size, and with the extractor bolt bearing on the files end, extract the rivet and remove the full link.



- Fit a half-link.



Jockey Sprocket

A spring-loaded jockey sprocket can be used to tension a chain which transmits the drive between the sprockets with fixed centres.

