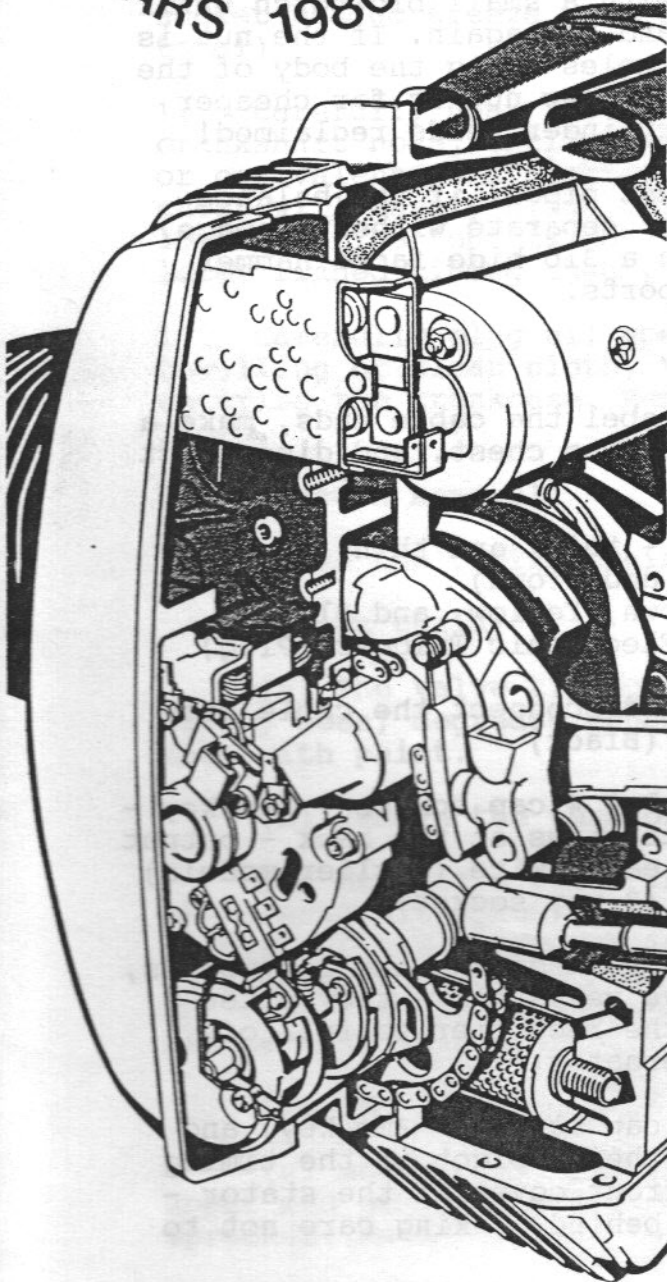


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BOXER TIMING CHAIN REPLACEMENT

Since the advent of the /5 Series in 1969 BMW have fitted two different types of timing chain, the original duplex item being superseded from the 1980 model year by a simplex type, the use of which can be easily identified by the associated finned timing chest. Although this change was initially regarded as a retrograde step (What changes are not?) the new chain was provided with more efficient tensioning arrangements, it permitted the use of a greatly improved type of contact breaker and centrifugal advance unit, and eliminated the camshaft front seal, replacing it with a simple "O" ring.

The duplex chain was tensioned by a "Hairpin" shaped spring bearing onto the tensioner, while the later type is provided with a rubber coated tensioner, actuated by a spring loaded hydraulic piston, and a rubber coated guide plate to restrict movement of the chain on the tension run.

Both chains are of the same Imperial dimensions ($3/8"$ X $7/32"$) the duplex variety being of endless construction, while the simplex type is fitted with a split link. Use of a split link with a duplex chain makes replacement far easier, as it does not require removal of the sprockets and crankshaft outrigger bearing, and does not introduce long term problems.

In spite of its relatively simple tensioning arrangements, the duplex chain will generally last for about 50,000 miles, while the simplex chain is usually past its best at 30,000 miles or so. The wear - induced slack in the timing chain produces a deep knocking sound in the general area of the crankcase, and also permits the camshaft to oscillate (Under the influence of the valve springs) as it rotates, producing an error in the ignition timing, which can be seen as a false timing mark when checking the ignition timing with a strobe lamp.

Removal Procedure:

Precautions:

1. Disconnect the battery earth cable, tape the end, and drain the engine oil. Remove the petrol tank, drain the float chambers, and ensure that the front of the engine is clean.

Exhaust System:

2. Slack off both exhaust pipe finned nuts - **Ensure that the cylinder head is absolutely cold.** Fit the special wrench fully onto the nut, and give it a solid tap from a 2 to 3lb hammer. If this is not effective, warm the nut with a small blowtorch until it is at "Boiling Spit" temperature and try again. If the nut is still tight, drill a series of small holes along the body of the nut, and split it off with a chisel - a new nut is far cheaper and a better repair than having the cylinder heads reclaimed!

3. Remove the silencer(s) and exhaust pipes; if the balance pipe(s) are well corroded, and may not separate without damage, carefully tap both exhaust pipes with a 3lb hide faced hammer until they are clear of the exhaust ports.

Electrical System:

4. Remove the engine front cover, label the cable ends, make a sketch of the cable routes into the timing chest, and disconnect all cables from:

- (a) Rectifier (Two black cables - thick and thin)
- (b) Alternator Brush Box (Black and Brown)
- (c) Alternator Stator (Blue, Brown, Yellow, and Black)
- (d) Contact Breaker (Black) or Electronic Trigger (Plug)

5. Remove the engine top cover, and disconnect the cable from the starter motor contactor solenoid (Black)

6. Remove the rectifier (Later models) 4 cap screws - 3mm key - or (Earlier models) 4 nuts. Disconnect wires at the back - output to the Voltage Regulator (blue wire) earth wire (Earlier models) and input from the alternator stator (3-way socket)

7. Remove the four resilient mounts used on the earlier models, and **replace them** if they are over five years old - they often break up at about 10 years, causing the rectifier to fall off, short circuiting the battery and alternator!

8. Remove the alternator stator (3 cap screws - 3mm key) and withdraw the stator laminations from their spigot in the timing chest. If tight, **do not** pull on the front cover of the stator - carefully lever the laminations from behind, taking care not to damage the windings.

9. Remove the socket screw and washer from the alternator rotor (6mm key) and insert the extractor bolt (eg Moto-Bins 99700) into the rotor. Remove the rubber grommet from the timing mark hole, and lock the flywheel by inserting a strong screwdriver into the starter ring gear. Tighten the extractor bolt until the rotor is pulled from its taper on the crankshaft nose. **Do not allow it to fall off!**

10. Remove the contact breaker unit:

(a) **Pre - 1980 Models:** Remove the centrifugal advance unit from the camshaft nose (10mm spanner) and withdraw the unit. Remove 2 cheese headed screws and withdraw the contact breaker unit and plate from its spigot in the timing chest. Remove the capacitor from its location above the alternator.

(b) **Post - 1980 Models:** Remove the contact breaker/trigger unit clamping screws (3mm key) and withdraw the unit.

Timing Chest:

11. Unscrew the timing chest - there are 4 socket screws (5mm key) at the top and 4 at the bottom, with 1 socket screw and 3 socket-headed sleeve nuts (6mm key) in the central area. (12 in total)

12. Carefully heat the timing chest in the area around the crankshaft nose, until it is too warm to touch, fit BMW tool 214 or equivalent, and tighten its forcing bolt by hand; the timing chest will easily slide off the outrigger bearing on which it is located. (The tool is not really necessary, particularly on the later finned timing chest, which can easily be gripped)

13. Carefully plug all apertures into the crankcase with paper towelling or clean cloth, to prevent the spring link or debris entering the crankcase. Remove the gasket, and clean the joint faces.

Timing Chain Removal:

14. Remove the timing chain:

Duplex Chain:

(a) The valve timing mark on the crankshaft sprocket is not easily seen; degrease opposite teeth on both sprockets, and mark them with paint.

(b) Remove the tensioner (Circlip) and spring (Sleeve nut)

(c) Extract a rivet from the chain at a link one pitch below the crankshaft sprocket on the tension side of the run; if a suitable rivet extractor is not available, file the head off a convenient rivet, and push it out with a suitable pin punch. It may be necessary to bend the rivet with pliers behind the chain. Remove the timing chain.

Simplex Chain:

(a) Rotate the engine to position the spring link at the upper end of the guide plate one link below the crankshaft sprocket. Mark opposite teeth of both sprockets with paint.

(b) Pull back the tensioner blade, and retain it with a nylon tiewrap or wire.

(c) Remove the guide plate (13mm socket)

(c) Remove the U-shaped spring, plate, and joining link. and remove the timing chain.

Chain Lubrication:

15. Wash the new chain in petrol or a volatile degreaser to remove all packing grease from between the rollers and rivets, dry it off, and immerse for about half an hour in engine oil (Or ideally Molyslip etc) heated over boiling water. This will ensure that the chain is properly lubricated from the beginning of its life.

Chain Tensioners:

16. **Duplex:** Examine the working face of the tensioner for signs of wear, the apex and ends of the spring for cracking. Ideally compare the profile with a new component - if in doubt replace.

17. **Simplex:** The rubber faces of the tensioner blade and guide plate do not wear appreciably, but it is wise to check them for hardening (Prod with a fingernail) and general deterioration. If in doubt replace both items. Remove the tensioner piston and spring, examine for scoring, check for freedom of movement, lubricate, and replace.

Replacement Procedure:

Installing the Chain:

18. **Simplex Chain:** Fit the tensioner blade to fully compress the piston, and retain it with a nylon tiewrap or wire.

19. After checking that the painted marks still coincide, carefully replace the chain around the sprockets, with the first end one link below the crankshaft sprocket on the tension side of the run. Fit the chain around the sprockets, and draw the ends together with a nylon tiewrap until the old joining link can be easily inserted from the front.

20. Withdraw the joining link slightly, and carefully insert the new joining link from the back of the chain; this may require a little patience, as space is limited, and the use of tweezers or a bent piece of metal rod may be useful. Use the new link to push out the old one, then fit the plate and U-shaped spring. Remember that the closed end of the "U" must face the direction in which the chain moves (ie: Upwards)

21. Release the tensioner, and rotate the engine in the correct direction to provide normal chain tension. Fit the guide plate, and adjust it until inward movement of the chain is minimal. Fully tighten the nuts, and check chain movement again.

22. **Duplex Chain:** Replacement is basically similar to the procedure described above, with the following exceptions:

(a) The tensioner and spring can be fitted after the chain.

(b) Due to the additional width of the duplex chain it is not possible to fit the joining link from the rear; it is not, however, too difficult to install the plate and U-shaped spring at the rear of the chain. Should the U-shaped spring become lost inside the crankcase, it invariably lodges on top of the oil filter housing.

Timing Chest Replacement:

23. **Preparation:** This is a good opportunity to clean the timing chest, and to repaint it if of the black variety. (Remove loose paint and corrosion with a wire brush, and use a good primer, such as Finnigans Number 1, followed by either Smootherite or International Yacht Enamel) Carefully wipe excess paint from the ribs while it is wet, and when dry clean away residue with abrasive paper (Wet & Dry grade 320, followed by 600 and Solvol)

24. Replace the crankshaft front seal to the same depth as the original (Do not drive the replacement seal in too far - usually to the level of the outer of the ribs around its periphery) and in the case of duplex models remove the camshaft seal. Do not replace this seal at this stage. Ensure that the centralising bush (If required - see para 27) all the necessary socket screws and sleeve nuts, with their washers and hexagon keys, are laid out for securing the timing chest before it cools down.

25. **Final Inspection:** Make a final check of the timing chest area - ensure that you have removed all pieces of cloth or paper etc from the crankcase apertures, that the painted marks line up, the spring link is secure and correctly fitted, the tensioner is correctly fitted and free, its spring clip is secure, the guide plate is correctly fitted and secured, that the entire area is free of foreign bodies, and that wiring etc will not impede installation.

26. **Installation:** Place the new gasket in position, and lightly oil the chain and outrigger bearing. Fit BMW tool 214 and heat the timing chest around the bearing housing (Take care not to damage the seal) until too hot to touch, and install the timing chest; it should fit over the outrigger bearing without any effort, and press against the gasket.

27. **Duplex Models:** As the timing chest is free to rock around the outrigger bearing, subject to the clearances between the holes and studs, it is **essential** that the camshaft seal mounting is concentric with the camshaft nose. This is ensured by use of a suitable centralising bush, such as BMW 225, which should be installed as soon as the timing chest has been fitted onto the outrigger bearing.

28. Fit the socket screws and sleeve nuts, and secure the timing chest, working from the centre area first. Although BMW recommend that the area behind the alternator should now be struck with a hide-faced hammer "To relieve the stresses in the deep - groove ball bearing" such practice should not be necessary if the timing chest has been heated before fitting.

29. **Duplex Models:** Remove the centring bush from the camshaft nose, and fit the seal, ideally using insertion drift BMW 224.

30. **Alternator Rotor:** Clean the rear edge of the rotor, on which the seal runs, with 600 grade paper, and thoroughly clean. Degrease the mounting tapers, and slide it over the crankshaft nose. Check that the lip of the seal grips the rotor before it is fully home, and that the rotor does not foul the front face of the seal - insert a small steel ruler to check. If necessary carefully drive the seal inwards, paying attention to maintaining it square with the crankshaft. The correct BMW tool is ideal, but careful use of a small hammer, or a mallet and a large socket wrench will suffice.

Reassembly:

31. Reassembly of the engine is basically the reverse of paras 1 to 10, with particular emphasis on the following items: (Those marked * are fully described in SW Technical Bulletin No.2 - Boxer Servicing)

(a) Alternator * : Remove the slipring brushes, replace them if necessary, and thoroughly clean the brush box of carbon dust etc. Ensure the cables will not be trapped under the front cover.

(b) Contact Breaker/Trigger * : The contact breaker and/or centrifugal advance unit should be checked and lubricated. Always replace the "O" ring seal at the rear of the unit on simplex models; they invariably leak if reused. If difficulty is experienced in replacing the unit, check that the coupling is correctly aligned with the crankshaft (It is not symmetrical)

(c) Rectifier Replacement: The blue wire can be fitted to either connector at the back of the rectifier - they go to the same place! Remember that the thick black wire connects to the starter motor contactor solenoid. Do not forget to fit the 3 - way socket of the alternator output cable. The earth cable fits between the rectifier upper heat sink and the timing chest side of a resilient mount - ensure that it fits against clean metal, as aluminium oxide is a very good insulator!

(d) Ignition Timing * : Set the ignition timing statically - with the engine stopped, and therefore in the retarded condition. After completion it should also be checked and adjusted dynamically, with the engine running, using a timing lamp to observe the operation of the centrifugal advance unit, viewing both the retarded and advanced settings.

Static: With the ignition 'on' and a voltmeter connected between the black wire (+) on the contact breaker unit and earth (-) rotate the engine until the meter reads 12 volts. The contact breaker will now have just opened, and the 'S' mark should be aligned correctly. If you have electronic ignition the plugs may be connected and laid across the cylinder head to provide visual indication of the spark, instead of using the voltmeter. If adjustment is necessary, set the crankshaft to the "S" mark, and rotate the contact breaker in an Anticlockwise direction until the contacts open (Or the spark occurs)

Dynamic: With the engine warmed up, connect a suitable timing lamp to one of the plug leads. The Inductive type of lamp is to be preferred, as these clip around the insulation of the plug lead, and do not involve the use of bare high voltage connectors. With the engine at idle, the 'S' mark should be aligned, and as the engine speed is slowly increased it will move upwards, being replaced by the "Z" mark at about 3000 rpm.

It may be found that the "S" and "Z" marks do not both align, as the advance unit wears with use to increase its range by about 4° or so. Generally speaking, the R100 engines prefer to be slightly advanced at speed, while the R45/65 prefers a little retard, and the R80 would sooner be correctly timed. Remember that the fully advanced setting is the important one.

(e) Electronic Ignition System * : Check all connectors for water or corrosion, clean and grease as necessary. Make sure that the trigger cable will not be trapped under the front cover.

Chain Tensioner - Limitations and Modification

A chain tensioner is usually designed to apply pressure at a point midway between the sprockets on the "Slack" side of the run, so that it is able to compensate for an appreciable amount of wear - induced "Stretch" in the chain.

Limitations: Neither type of Boxer tensioner can be described as a stunning piece of design - each suffers from basic design deficiencies due to their pivoting action:

(a) **Duplex Models:** The point of contact of the tensioner is just above the camshaft sprocket; after the chain has worn slightly the point of contact moves downwards, until the tensioner presses the chain against the sprocket; any subsequent wear is therefore not compensated by further tensioner travel.

(b) **Simplex Models:** The point of contact of the tensioner is just below the crankshaft sprocket, the clearance between the chain on the sprocket and the upper part of the tensioner slipper is approximately 1mm; As the chain wears, the point of contact moves upwards, until a small amount of wear has taken place, when the slipper presses the chain against the sprocket. Tensioner travel is no longer possible, and further chain wear is therefore not compensated.

The result, in either case, is that after a certain milage the chain rapidly becomes noisy, but after removal the total stretch (measured against a new chain) is in the order of 1 to 2mm - about $\frac{1}{4}$ to $\frac{1}{2}$ % of the total!

Modification: There is nothing which can be done to improve the duplex tensioner, except perhaps by grinding the end to make it a little shorter, but the later duplex type is capable of being modified with little difficulty.

By carefully bending the steel blade of the tensioner, at a point between the rubber slipper and the pivot sleeve, it is possible to increase the clearance between the top of the slipper and the crankshaft sprocket to about 3mm, thereby moving the point of contact downwards to a point between the sprockets, around the tensioner piston.

This will increase the travel of the tensioner, and also make it more effective at the point of maximum chain movement - between the sprockets.

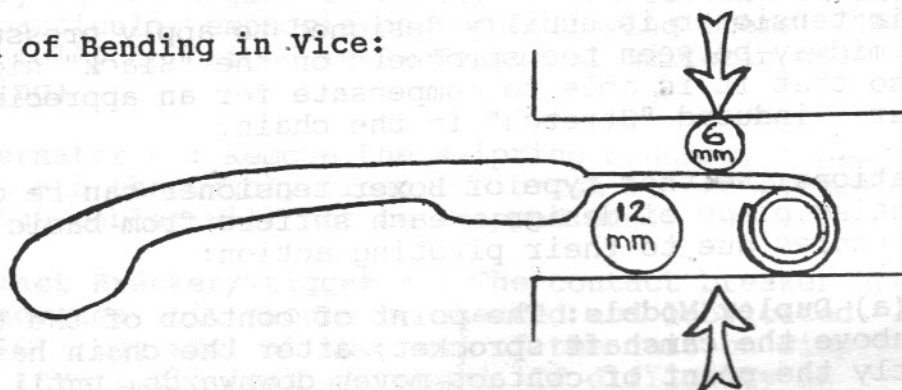
Care must be taken not to bend the blade too far, as the point of contact would then be moved too far from the piston. The early (1980 - 81 model) tensioner blades are soft, and bend easily, but the current type is hardened, and will snap easily; It is, however, possible to anneal the upper portion of the blade with a small flame (Oxy-acetylene is ideal) but care must be taken not to overheat the rubber slipper.

The actual bending is best carried out in a vice. using a 12mm bolt on the outer (ie: Non-chain) side of the blade, about 2mm from the rubber slipper, and a 6mm bolt on the inner side, midway between the 12mm bolt and the pivot sleeve, until the blade is bent to the profile shown.

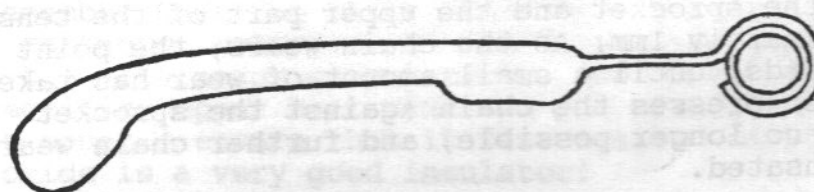
Check that the blade is not cracked, as a broken tensioner could otherwise result! If in doubt remain in standard condition.

Modification of Simplex Chain Tensioner Blade:

Method of Bending in Vice:



Modified Tensioner Profile:



IF you ride throughout the winter, it is a good idea to lightly coat everything inside the front cover of the engine with Waxoyl, to prevent corrosion, with the exception of the alternator brush box, and the contact breaker plate of Duplex models. The use of Vaseline or silicone grease on all electrical connectors is a Good Thing.

Special Tools: (Essential tools marked *)

Purpose	BMW Code	Alternative
Alternator Rotor Extractor Bolt *	5030 or 12.3.600 M8X80mm; end 40mm thread removed	Moto-Bins 99700
Timing Chest Puller	247 or 11-1-800	Insert Bolts & and wear gloves
Crank Front Seal Insertion Bush	224 or 11-1-850 and 00-5-500	50mm dia metal bar or socket
Camshaft Seal Centring Bush *	225 or 11-1-830	20mm diameter 10mm bore
Camshaft Seal Insertion Bush	225 or 11-1-830	25mm diameter socket
Exhaust Pipe Nut Wrench 1969 on *	18-0-600	Moto-Bins 99100
Exhaust Pipe Nut Wrench - /7 on *	(Better fit than above)	Ultimate Source 1505

SEE the current copy of the BMW Club Handbook for details of the Tool Hire Service and procedures. The address of the tool hire Secretary is on Page 2 of the Journal.