

Mike Fishwick

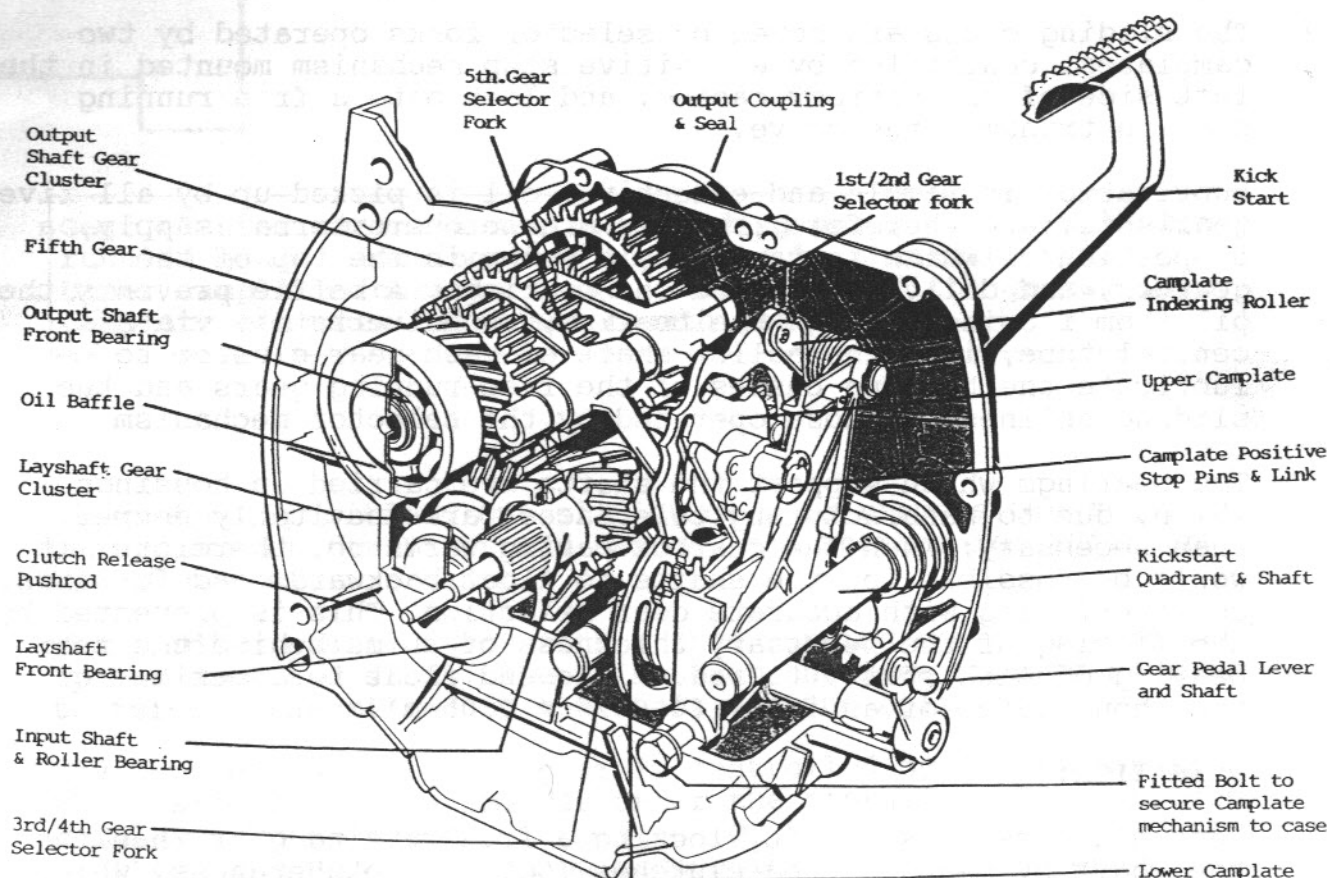


R-SERIES 5 SPEED GEARBOX

When the "Modern" twin cylinder machines were introduced in 1969, in the guise of the Five Series models, they were equipped with a four-speed gearbox, which was closely based upon that used by the Earles fork range (R50, R60, R69S etc) which had preceded them.

This unit was used until 1973, when, with the advent of the Six Series, a new five-speed gearbox was adopted, which was to be used across the model range from R45 to R100. This gearbox was markedly different from its predecessor, particularly in the area of the selector mechanism, and was to continue with few changes through the Six and Seven Series ranges, the major design change of 1981 and the 1984 monolever models, until the advent of the R259 eight-valve boxer range in 1993.

Most people regard BMW gearboxes as a bit of a mystery, due no doubt to the requirement that various special tools must be available before any work can be undertaken. Gearboxes in general are regarded as a bit of a "Black Art" even by those who do not turn a hair to carry out other, more major, mechanical operations. The BMW R Series five-speed gearbox, is however, easy to work on, given that one has access to certain tools.



BMW R - SERIES GEARBOX, SHOWING MAIN COMPONENTS

(Shown in Fourth Gear position)

LAYOUT:

The gearbox has three shafts - an Input Shaft, which transfers drive from the Clutch to the Layshaft - an Output Shaft, which couples the selected gear ratio to the Drive Shaft, and also carries one half of each gear set - and a Layshaft, which carries the other half of each gear set.

The intermediate gear wheels have teeth of the straight cut type, providing great strength in a relatively narrow wheel, while those of the fifth gear - the Input Shaft, and the front gears of the other shafts - are helical cut, to provide quieter running.

The Input Shaft contains a spring-loaded coupling, which absorbs the shock loadings which would otherwise be produced by rapid engagement of the clutch, and reduces the tendency for transmission "Snatch" at low speeds in high gears. The speedometer is driven by a scroll gear on the tail of the Output Shaft.

The Input Shaft runs on a roller bearing at the front end, and a ball race at the rear; the Layshaft and Output Shaft run on ball races at either end.

The gear cluster basically consists of five pairs of gear wheels, which, even in Neutral, are always driven. They therefore maintain a slowly changing relationship with their adjacent gears; this permits ready engagement of any pair of gears to provide the ratio required. These gear wheels are of three different types: They are either free to rotate, able to slide along the shaft on splines, or, in the case of those at the ends of the Layshaft, are locked to the shaft.

The sliding gears are moved by selector forks operated by two camplates, controlled by a positive stop mechanism mounted in the left side of the gearbox casing, and lock onto a free running gear to transmit the drive.

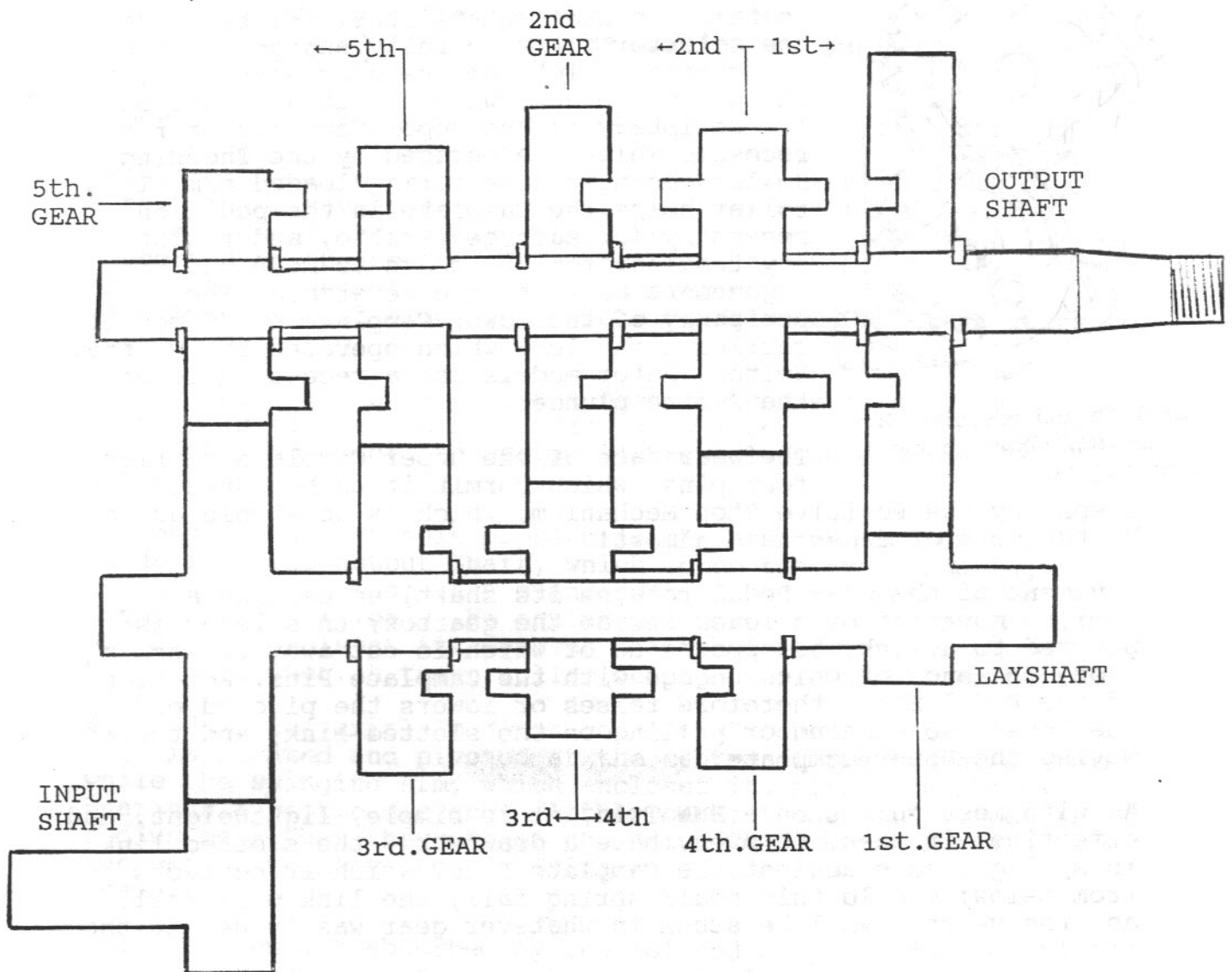
Lubrication is simple and effective; oil is picked up by all five gear sets, and therefore provides a generous external supply, a proportion of which is caught by a scoop in the top of the gearbox, and delivered behind the bearings. A baffle prevents the oil from flowing through the bearing, and diverts it, via a central tube, into the hollow shaft of each gear cluster to lubricate the bearing bushes of the free running gears and the sliding splines of those operated by the selector mechanism.

The bearings which support the shafts are carried in housings which, due to manufacturing tolerances, are inevitably deeper than necessary; when the gearbox casing warms up, therefore, it would be possible for the shafts to float backwards and forwards, so interfering with accurate gear selection. This is prevented by the fitting of the necessary thickness of shims behind the rear bearing of each shaft, to reduce the end float to a maximum of two thousandths of an inch. (0.002" = 0.05mm)

OPERATION:

Gear engagement is made by locking a free-running gear wheel to the shaft by means of dog clutches (Square protuberances, which engage into longer curved slots) mounted on the three sliding gear wheels; they are therefore able to move into engagement with the gear wheels on either side, or be held in a central,

GEAR TRAIN - TRANSMISSION DETAILS

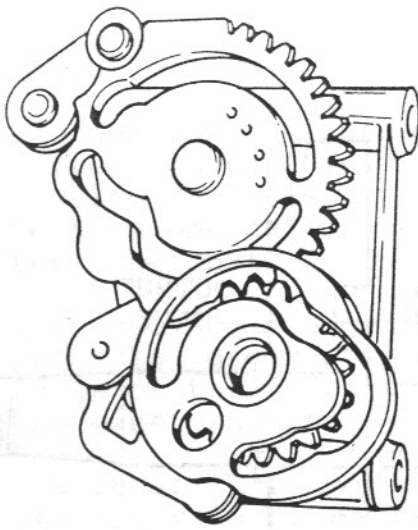


Gear cluster shown in neutral. Sliding gears engage with free running gears, locking them to shafts to transmit drive. Upper camplate controls first, second, and fifth gears; lower camplate controls third and fourth gears.

disengaged, position. One sliding gear is responsible for Fifth gear, another for First and Second, and another for Third and Fourth gears.

The sliding gears engage with a free running gear, locking to it by the dogs and slots. The drive from the free running gear is therefore transmitted to the shaft via the splines.

Movement of each sliding gear is controlled by a Selector Fork, which slides along a Spindle under the operation of a rotating Camplate. There are two Camplates (Or Shift Discs, as BMW refer to them) the upper one being responsible for First, Second, and Fifth gears, while its mate controls Third and Fourth. The Camplates are geared together, the mating teeth, in later gearboxes, being marked for engagement in the First Gear position.



Camplate and Positive Stop Mechanism, shown in first gear position.

As the Camplates rotate, their slots slide the selector forks to fully engage the Dog Clutches and slots of one gear at a time, in the correct order, with a Neutral position. The periphery of the upper Camplate carries recesses which are engaged by the Indexing Roller, mounted on a spring loaded arm. This roller holds the Camplate in the position necessary for each gear ratio, and resists any tendency for the gears to move out of engagement under torque reversals. The periphery of the lower Camplate on /6 models carries a cam lobe which operates the Neutral Switch. Later models use a recess to release the switch plunger.

The rear face of the upper Camplate carries four pins, which permit it to be rotated, in steps, by the Positive Stop Mechanism, which is so simple as to be the work of a genius - almost!

Movement of the Gear Pedal rotates its shaft, so causing a similar movement of a lever inside the gearbox; this lever is pivoted to a link, the upper side of which is cut away to form a slot, the ends of which engage with the Camplate Pins. Rotation of the Pedal Shaft therefore raises or lowers the pivoted end of the lever, so pushing or pulling on the slotted link, and thereby moving the Upper Camplate.

As with most things on a BMW Twin, it is simple, lightweight, and effective; it does, however, have a drawback - the slotted link is spring loaded against the Camplate Pins, which it contacts from below; should this small spring fail, the link will fall, and the gearbox will be stuck in whatever gear was in use at the time!

PROBLEMS:

While the R Series gearbox is pretty reliable, it is known to give some problems, unlike its K Series cousin, where problems seem to be unknown.

Spring Failures are the most common problem, and do not appear to fall into any pattern of age or mileage; the most common problem is an inability to change gear, due to a failure of the spring which forces the positive stop link against the camplate pins. It is, however, possible to select another gear if the machine is inverted - really! It has been done...

Failure of the gear pedal return spring will be obvious, while a broken return spring on the camplate indexing roller arm will cause one to jump out of gear, overrun the required gear (Usually falling into a neutral position) or occasionally change two gears at a time! A similar symptom can be caused by the plastic indexing roller breaking up.

Bearing Failures are not common, but are not unknown; rapid wear of bearings is usually due to the fitting of too great an amount of shims - this forces the outer races inwards, and therefore causes the balls to bind against the sides of their grooves. This is, of course, a sign of incorrect assembly, and should not happen - my R100, however, suffered from this problem when new, but was not diagnosed by the dealer, who simply replaced the worn

bearings under warranty. Unless the bearings have begun to break up, there will be little advance warning except noise, and a little extra travel in the gear pedal.

A more serious symptom is the regular loss of fifth gear - it will engage, but the gearbox slips into neutral, generally when the throttle is opened. This is due to the front bearing of the Output shaft having broken its cage - the balls will then crowd to one side of the bearing, and the shaft will no longer be supported at the centre of the bearing. As the fifth gear wheels are at the front of the shaft - behind the bearing - such misalignment will allow the torque reaction between the gears to force them out of mesh.

Should this happen to you, the best advice is to stop immediately - there is always the risk that the gearbox could lock up, and the misalignment of the gears will rapidly cause damage to their teeth.

The basic cause of this problem is the transmission of axial loads into the Output Shaft, which force the front bearing hard against its housing; as a standard type of ball race cannot absorb an axial load, the entire pressure is placed on the cage, which then fails at its weakest point - the rivets which both its halves together. A taper roller bearing would have been better!

Where do these axial loadings come from? Consider the Drive Shaft - it is located and pivoted at the centre of the universal joint, while the Swinging Arm, which encloses it, pivots on its own bearings a little distance further back; these differences in radius mean that the rear of the Drive Shaft moves forwards and backwards, relative to the Swinging Arm, as the suspension operates.

This movement is absorbed by the splined coupling between the Drive Shaft and the pinion of the Final Drive; should this coupling tend to bind, the Drive Shaft will be compressed as the suspension moves; something has to give, and that is the bearing cage.

The usual cause of this problem is wear in the coupling, lack of lubrication (Degraded oil) or a build up of tolerances in the gearbox and final drive which reduce the amount of free movement possible. It is usually confined to the /6 and early /7 models, but has occurred on post '81 models.

Unusual Problems are, by their very nature, difficult to predict, but a good example is the way in which my R100 used to slip out of third gear on the overrun after about five thousand miles; the basic problem was that the gear teeth of the camplates had not been correctly meshed, with the result that when the upper camplate was held in the third gear position, the lower camplate was out of position to such an extent that the engagement dogs were mated only at their corners. As the Layshaft bearings had been grossly overshimmed, they wore quickly, so producing enough end float for the dogs to disengage.

Normal Problems are usually confined to the transfer of oil from the Swinging Arm, which is generally caused by overfilling; I found that the use of the normal dip stick-type procedure exceeded the recommended volume - use of the stated 110 cc cured the problem.

Most R Series gearboxes tend to become stiff and notchy when hot, and also often overrun a gear when changing down quickly. the use of a multigrade gear oil (85-140 EP) works wonders by providing better lubrication, and by thickening up when hot - try it and see! Both Bel-Ray (MC-2) and Shell (Spirax HD) manufacture suitable oils.

Oil Contamination: Emulsification of gearbox oil (The transformation into that thin cottage cheese-like stuff!) can be prevented by several means - make sure that there is nowhere for water to enter the gearbox, such as around the speedometer cable or clutch pushrod bellows - replace and/or seal with silicone rubber 'Instant Gasket'. Take care that, when washing the machine, you do not direct a hosepipe at the battery earth cable bolt, as the gearbox breathes via a small orifice at its centre. Also check that the speedometer cable outer sheath is not damaged, so permitting water to enter and drain down inside it. On post-1981 models it is possible, if all else fails, to fit a suitably baffled breather from the bolt in the base of the air cleaner, so that any damp air is drawn into the carburettors.

The Swinging Arm, incidentally, is also vented through the gearbox, via a small semicircular cut-out above the edge of the output shaft seal. Should this breathing arrangement become obstructed, the Swinging Arm oil will be transferred into the gearbox - don't ask me why! This cut-out was not present on the earlier /5 series four-speed gearboxes.

Clutch Mechanism: The clutch release bearing at the back of the input shaft can give problems, generally confined to the pre-1981 type, which uses radial rollers - as the peripheral speed of the rollers changes considerably from the centre to the edge of the bearing, the rollers tend to slide, eventually becoming square! The sliding motion of the rollers tends to damage the surfaces of the thrust piston, which would in turn damage a new bearing; as the hardening is very deep, the surfaces can be reconditioned by use of an oil stone. The post-1981 gearbox uses a ball race, which is a far more logical approach.

The post-1981 clutch release arm pivots on a needle roller bearing, but has no means of lubrication; if you cannot manage to drill the pivot bolt and inner race for convenient greasing, remove the arm every two years at least, to clean and grease the bearing. A mud flap mounted at the front of the rear mudguard will protect this vulnerable bearing from water and debris.

The post-1981 thrust piston is made of aluminium, and has been known to stick when it warms up and expands within the tail of the gearbox, making clutch action heavy. The remedy is to carefully reduce its diameter, by machining or use of emery tape.

Kickstart: The BMW kickstart may be a thing of beauty, but the mechanism within the gearbox leaves something to be desired! Operation depends upon the Idler Wheel being meshed between the quadrant and the gear mounted on the rear of the Input Shaft; should the arm which carries the Idler Gear be a free fit around the kickstart shaft, it will not be raised into position when the kickstart is operated, and a thicker thrust washer must therefore be fitted between the idler arm and the shaft circlip. A weak return spring will permit the idler to repeatedly engage while the engine is running, when it will be thrown out of mesh, causing wear to both itself and the Input shaft gear.

Should you fancy a kickstart, and are not discouraged by the foregoing, it is easy to modify an existing gearbox, as the internal machining is already there - all which is required is to cut through from the inside of the cover, and then to machine a recess in the outside to accommodate the shaft seal. Installation of the necessary gears etc is straightforward.

Clutch Pushrod: Pre-1981 clutch pushrods have a step about half way down, to carry a felt seal which prevents gearbox oil from reaching the clutch; these pushrods have been known to fracture at the step. The probable cause of this malady is that the clutch pressure plate, which is contacted by the pushrod nose during clutch release, is not supported evenly, due to a partially collapsed diaphragm spring, and is therefore no longer concentric. Post-1981 pushrods are of uniform section, and oil travel is prevented by a small lipped seal at the back of the Input Shaft.

Neutral Switch: Should you manage to break off the connectors of the Neutral Switch - a common experience when removing the gearbox - cut away some of the surrounding plastic, and solder on a wire with a similar connector on its end. If replacing the switch, remember that the /6 units operate in the opposite direction to the later switches. In order to avoid such damage, unplug the small wiring loom which serves this switch and the engine oil pressure switch, and remove it with the gearbox. The switch can be replaced in situ by removing the frame spacer.

MODIFICATIONS:

The five-speed gearbox survived for over twenty years with very few changes, which must be a tribute to its basic good design:

Rear Seal: An early modification was to reverse the position of the output shaft seal, to stop oil migrating from the drive shaft. The seal is now fitted with its spring side outwards.

Casing: The only really major change was the adoption of a new gearbox casing from the 1979 model range; this casing can be easily recognised by its externally ribbed design, and was introduced to provide a stiffer casting which would resist the tendency of the previous type to gradually stretch in service. This stretching increased the input shaft end float, and produced rather fierce clutch operation.

Shaft End Float: The end float of the shafts, limited by shims fitted at the back of the bearing housings in the rear cover, was originally set at 0.004". This was reduced to a maximum of 0.002" as part of the 1981 modifications, to improve the accuracy of gear selection and clutch operation.

Input Shaft: A new input shaft was introduced for 1981, with a modified profile to its gear teeth; this made it possible to remove or replace the shaft independently of the output and layshaft clusters.

This shaft also featured a lip-type seal at the rear (In place of the previous felt bush fitted around the pushrod) to prevent gear oil passing along the clutch pushrod.

Another input shaft was introduced with the monolever range in 1984, with nickel plated splines; this plating acts as a lubricant for the splines of the clutch friction plate,

permitting it to slide forwards on disengagement to reduce wear on the rear friction lining, a problem which on the earlier models required more frequent removal of the gearbox, in order to grease the splines.

Gear Pedal: The "Kinematic" gear pedal, mounted on the footrest, was introduced in 1979, which was able to increase the torque applied to the gearchange shaft by approximately three times; this pedal was fitted in combination with the "sprung" drive shaft, the torsional damper of which was able to absorb the occasional shock loadings caused by the sudden gear engagement.

Rear Cover: The later clutch, introduced in the major design change of 1981, required an increased amount of pushrod travel; this necessitated a new gearbox rear cover, on which the position of the pivot point for the clutch release arm was changed. Sealing for the clutch release bearing piston was also improved, the rear of the thrust piston and its return spring being totally enclosed by a flexible bellows, replacing the previous "O" ring seal and exposed spring.

Clutch Release Mechanism: From 1981 the revised clutch was released by an aluminium pushrod of uniform section (In place of the stepped steel type) to reduce the risk of fracture, and maintain adjustment due to its expansion rate matching that of the gearbox. A revised release bearing, using a ball thrust race (Replacing the radial roller type) was mounted in an aluminium thrust piston.

Camplate: A revised camplate was also introduced on the 1984 models, providing smoother engagement of second gear, particularly on downchanges.

Springs: The camplate indexing roller spring originally tended to wear and fracture, and was replaced during the /6 series period by a variant with more coils, in order to reduce the relative movement between adjacent coils.

(NB: For further information regarding the clutch mechanism, see SW Section Technical Bulletin No.4 - Boxer Clutches)

REPAIR OPERATIONS:

The procedures for dismantling and reassembly of the gearbox are well documented, and do not require any particular skill. It is, however, essential that you have access to suitable tools for holding the output flange while the centre nut is released, and for drawing the flange from its taper.

Dismantling: Remember to drain the gearbox oil! Remove the speedometer drive gear. Fit holding tool to the output flange, secure the tool with the steady bar, and unscrew the nut. Remove the nut and its wave washer, and fit the puller after liberally oiling its forcing bolt. Secure the tool, and tighten the forcing bolt fully with a suitable socket - this means very tight! It will probably be necessary to stand on the end of the socket bar, after which the flange and tool will separate from the output shaft with a loud crack. Do not panic! The older separate types of tool - BMW 234 & 232 - have been replaced by a combined unit - BMW 231.1.700 - but either type will do the job easily, or suitable improvised tools can be made up, as shown in the Haynes manual. The similar tools for the pre- /5 series models - BMW 500 and 501 - will also fit the later models without problem.

Removal of the rear cover requires the use of a blowlamp to heat the metal in the region of the bearings to about 110 degrees C - boiling spit temperature! The cover may then be removed by carefully tapping the edges, and pulling on the release bearing housing with BMW 23.1.620 or a pair of large pliers. Make sure that the shims are not mixed up. Remove the oil baffles from the bearings.

If possible, remove the Input Shaft at this stage - it will pull out of its front bearing, if the gearbox is post-1981; otherwise it may only be removed with the other two shafts.

Remove the gear pedal shaft (5mm hex key) and unfasten the two 13mm-head fitted bolts on the front face. The positive stop mechanism and camplate assembly can now be removed from the casing and dismantled. When replacing the springs, ensure that they do not pass over any sharp edges; stone the edges of the links if necessary.

If you need to remove the gear cluster, withdraw the Selector Forks and their spindles - the upper forks and spindle can always be removed easily, but the lower spindle on post-1984 gearboxes is a tight fit in the casing, and is secured by an external circlip. It is therefore preferable to remove the lower fork with the layshaft cluster. Note the different shapes of the forks, their locations, and relative positions.

Use your blowlamp again to heat the front face, and remove the shafts together. Note the oil baffles below the bearings.

Carefully drive out the seals from the inside, noting that the output shaft seal is fitted with the spring side **outwards**.

Removal of the Output Shaft front bearing, if necessary, is made by use of a standard two or three-legged puller to withdraw the bearing and the fifth gear wheel together; the wheel can then be replaced, but the new bearing must be expanded by heating in oil before it can be fitted over the shaft. **Do NOT** drive the bearings onto the shafts - they are a very tight fit, and it is easy to damage them.

The above procedure is typical - in general, one requires a puller with very thin feet, or a divided plate-type puller, as is shown in the BMW workshop manual.

The Input Shaft may be dismantled with ease, for examination of the torsional damper. After removal of the rear bearing the shaft should be held in a large engineers vice to carefully compress the coupling spring until the circlip can be levered out. The use of an extra pair of hands to prevent the shaft from jumping out of the vice is recommended! The spacer can then be removed, and the torsional damper cam and spring removed for examination. This procedure is also followed if a worn kickstart gear is to be replaced.

Examination: Check the front bearing races and rollers of the input shaft, all gear teeth, engagement dogs and slots, and the damper cam profiles for pitting, wear, or other damage. Ensure that the ballraces spin freely, and do not have excessive end float. Check the bearings of the free running gears for excessive radial and axial play, and the splined sliding gears for smooth movement and freedom from excessive rotary play. If in doubt ask!

Spare parts are available to component level, with the exception of the Layshaft, which (apart from the bearings) must be replaced as a unit.

Check that the selector forks are not worn, at both the open fork and camplate ends, and that the camplates do not rock on their pivots. Check the upper camplate rivets for wear, and make sure that they are not loose. Check that the ends of the slot in the camplate actuating link are not worn. Examine all springs, seals, and the camplate indexing roller - replace them if in doubt.

Clean the spines of the Input shaft, and check them for wear. Engage the shaft into the splines of the clutch friction plate, and ensure that it slides smoothly without excessive radial play.

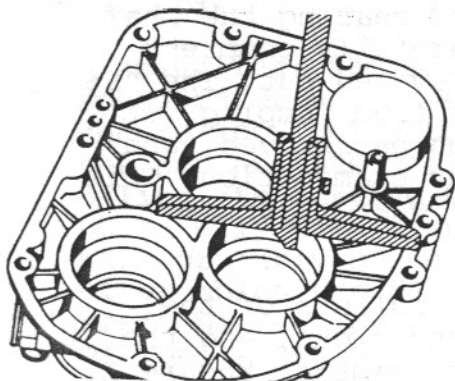
Do not forget the clutch pushrod seal at the rear of the post-1981 input shaft; replacement now is easier than changing an oily clutch plate later! (The seal can be replaced in situ, after the swinging arm has been removed)

If your gearbox is fitted with a kickstart, examine the gear teeth of the quadrant, the idler (On the arm which pivots around the kickstart spindle) and the drive gear at the rear of the Input Shaft. The idler arm should be sufficiently tight on the spindle to support its own weight when lifted - if it is free it will not be lifted to engage between the quadrant and the Input Shaft when the Kickstart is operated. If necessary, tighten it by adding a thicker washer between the arm and the shaft circlip.

If you have removed any circlips - particularly large ones - ensure that they are fitted the correct way round. A slight chamfer may be found one side of some types - fit it on the inward side.

Assembly: Rebuilding the gearbox is basically the reverse of the above. After carefully cleaning the casing and end cover, heat the casing to 100° C. Fit the oil baffle plates into the Layshaft and Output Shaft bearing housings before inserting the gear clusters (and layshaft selector fork on later gearboxes) Ensure that the bearings are fully seated.

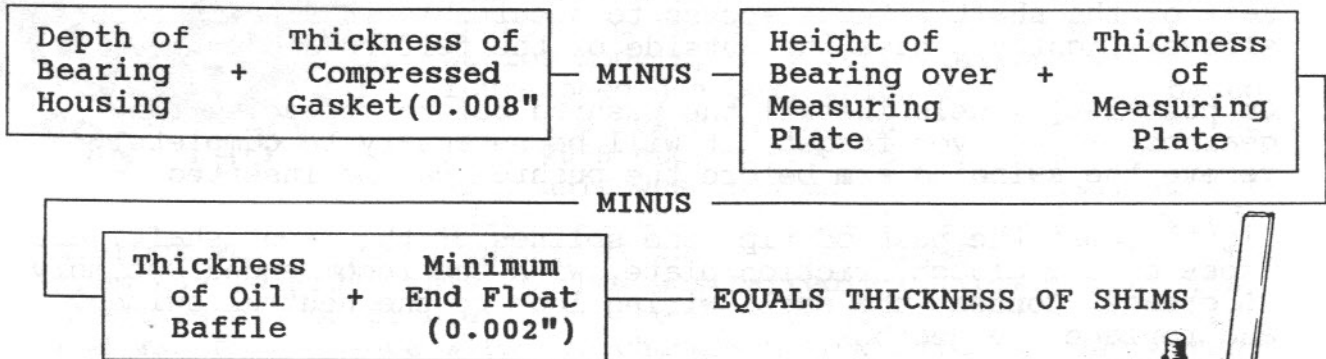
When replacing the seals, it is essential that the casing be supported from the inside when the new input shaft seal is fitted; the casing is very thin, and could be distorted if not supported. The output shaft seal is fitted with its spring side facing outwards, and can best be fitted by use of BMW tool 23.1.750. If this is not available the output flange holding tool can be used as an insertion drift. Grease the lips of the seals.



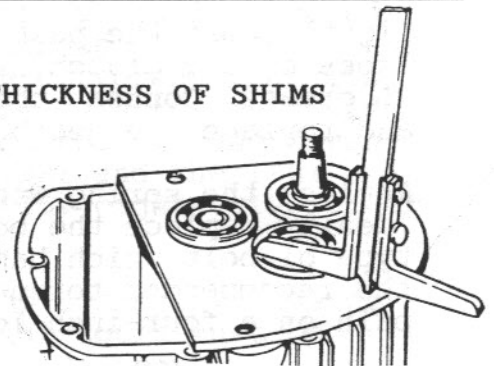
Measurement of bearing housing depth in rear cover.

Measurement of the installed heights of the bearings should really only be necessary if the shims have been mixed up, or the shafts have been transferred from another gearbox; replacing the bearings should not make any difference, as they are the most accurate part of the machine! If the equipment is available, however, measurement is a wise precaution to check that the shimming is correct. Pre-1979 gearboxes (Without the ribbed exterior) tend to stretch a little with use, and should be checked as a normal procedure, but take care that the cause of any change is not worn bearings!

Measurement of Bearing Shims: The object of this procedure is to calculate the thickness of shims required to fill the gap between the rear face of each bearing, and the end of its housing, when the maximum end float (0.002") is obtained. The procedure requires the use of a depth micrometer and either measuring plate BMW 23.3.650 or a strip of ground steel, of sufficient length to span the mouth of the casing. Measure the thickness of the shims and oil baffles with an external micrometer. The calculation procedure for each bearing housing is as follows:



The procedure for shimming is well described in the Haynes manuals, but it should be noted that they specify a clearance of 0.040" - probably something was gained in the conversion from millimetres!



Measurement of installed height of bearings over joint face, using BMW Measuring Plate 23 3 650.

Rebuild the camplate assembly, and ensure that the first teeth of each camplate gear are meshed correctly; post-1981 camplates are marked with centre punch dots for engagement in the first gear position. On earlier types, check the engagement by rotating the upper camplate from its first to fifth gear positions; the teeth should remain in mesh at both extremes.

Fit the gear change shaft to the camplate mechanism and operate it throughout the full travel of the camplates. Operate it back to the neutral position, fit the 1st/2nd and 5th gear selector forks with their spindle, and insert the camplate assembly, mating the camplate slots with the forks. Coat the fitted bolts with Loctite, insert them from the front of the gearbox, and fully tighten.

Operate the gearbox through all ratios before replacing the rear cover. The quality of the gearchange will appear to be pretty awful, and will improve if an assistant can rotate the input shaft by means of a rope coiled around it!

If satisfactory, fit a new paper gasket to the casing, place the shims in the rear cover bearing housings and the oil baffle on top of the layshaft shims. Use your blowlamp to heat the rear cover to 100°C. With the front of the gearbox slightly tilted up from the horizontal, hold the heated cover with pliers from the clutch release bearing housing, and check that the shims are not displaced as it is fitted. If a kickstart is fitted, slightly rotate its shaft in order to provide clearance for the quadrant.

Degrease the tapers of the output shaft and drive shaft coupling flange, and replace the flange. The nut should be tightened to 160 lb-ft, which can cause a little difficulty in holding the gearbox! I generally place a plank on top of the inverted gearbox, with someone standing on it while I stand on the end of

the socket bar with the holding bar of the holding tool on the floor - for my weight and socket set, this gives the required torque.

REPLACEMENT:

If working on a pre-1981 model, remember to fit the clutch pushrod and its felt seal from the front of the input shaft before replacing the gearbox! The felt seal will not enter the rear of the shaft without access to a suitable internally tapered sleeve. Lightly grease the outside of the felt to aid entry.

On post-1981 models install the pushrod before replacing the gearbox; Should you forget, it will be necessary to completely remove the swinging arm before the pushrod can be inserted.

Lightly coat the pushrod tip, the splines of the input shaft, and those of the clutch friction plate, with the recommended Optimoly PL grease. Connect the small wiring loom to the neutral switch, and replace the gearbox.

Replace the spring washers below the driveshaft coupling bolts; ideally replace the bolts as well, or use the latest (shorter) type of bolt which has a built-in washer area. As a good guide, the recommended torque of 10 lb-ft represents the threshold of pain on a four-inch long spanner.

As you will see, gearbox work is not a mystery, but does require a little care and a certain level of general competence; as with most things, it is better to have initial guidance from someone who has a little experience of such work - free advice is one thing which is readily available in the BMW Club!

Tools: (Essential tools marked *)

Purpose	BMW Code	Alternative	
Output Flange Holder*	234 or 231.1.700	500	See Haynes Manual
Output Flange Puller*	232 or 231.1.700	501	
Measuring Plate	23.3.650	Ground Steel Bar	
Rear Cover Removal	23.1.620	Large Pliers	
Front Seal Insertion	231.1.750 or 630 (With 00.5.500)		
Brg & Housing Depth*	00.2.550	Depth Micrometer	
Rear Seal Insertion	23.1.750 or 231	234 (See Text)	

Tool Hire: See the BMW Club Handbook for details of the Tool Hire Service and current fees; The name and address of the Tool Hire Secretary is on page 2 of the Journal.

Safety Warning: The best degreasing agent to use on the tapers of the output shaft and its coupling flange is Trichlorethelene or Trichloroethane. These chemicals can be absorbed through the skin, and dissociate when hot to produce poisons such as Dioxin and Phosgene. They are also carcinogenic. Do not inhale the fumes or permit the fluid to contact hot surfaces or your skin!