# Borg Warner Gearbox Overhaul.

## 3 Speed with Overdrive.

## Fitted to the pre-war Riley Big4 model range. Model code “X”.

**Start point.**

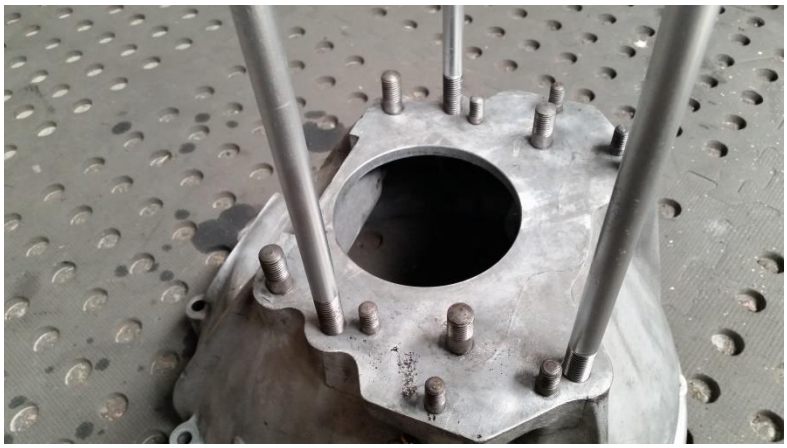
If possible check the operation of the gearbox and note any issues that will need to be investigated.

Prior to removal from the vehicle the oil should be drained. Check the oil for any foreign matter that may be an indication of gearbox condition.

An initial clean of the outside of the gearbox is recommended to avoid contamination of the internal parts and for ease of stripping.

**Remove the Bell Housing**.

Remove the nuts from the 4 brace studs, the 6 bolts to remove the 2 rear stay brackets and the 4 nuts from the front gearbox face to bell housing.



Lightly tap the bell housing to remove from the gearbox.

*Mark clutch release arm to shaft position. Undo pinch bolt and remove arm from spline on end of the shaft.

Undo the cotter pin retaining nut and tap out pin to release clutch actuating folk. Remove and discard split pin from end of shaft. Remove washers and shaft being careful not to damage carbon release face.

The 2 retaining spring clips can be removed from the thrust bearing pivot pins for inspection and cleaning.

# GEARBOX AND OVERDRIVE

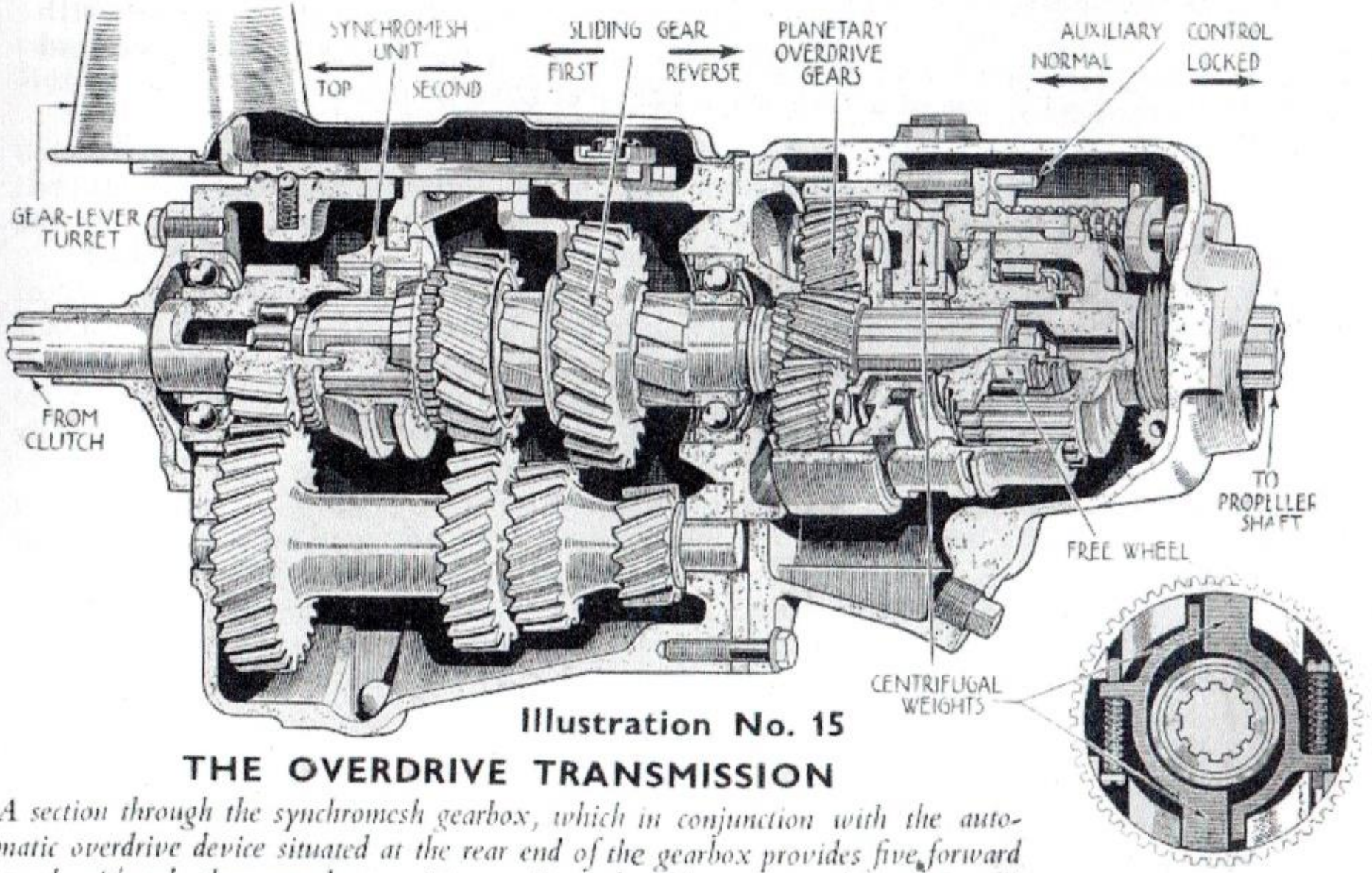



**Illustration No. 15**

## THE OVERDRIVE TRANSMISSION

*A section through the synchromesh gearbox, which in conjunction with the automatic overdrive device situated at the rear end of the gearbox provides five forward speeds with only three gear lever positions.—Reproduced by courtesy of the "Motor."*

**Separate Gearbox from Overdrive Unit.**

Undo and remove 5 off bolts from the central jointing flanges. Carefully separate the overdrive flange from the central adaptor plate leaving the plate attached to the gearbox.

The overdrive unit will separate at the free wheel bearing allowing the rollers to fall free. Ensure all 12 off rollers are collected before progressing.

## The Gearbox.

Locate the bolt in the centre of the free wheel and remove. It should be noted, at this point, that the gearbox contains both Imperial and American threads so spanner, tap and die selection is critical.

The central bronze bush, bolt and washer can be removed along with the free wheel hub and thrust washer.



Now the centrifugal weight and annulus gear unit can be removed complete with bronze bush and thrust washer followed by the planetary gear housing. Finally the back stop circlip on the shaft can be removed.

From the top of the gearbox with the gear lever turret removed (necessary to allow removal of the gearbox from the vehicle) remove the 4 off screws from the selector arm retainers. Each arm can now be lifted out. The loose interlock ball must be removed and stored. The 2 indent balls are locked in position and do not need to be removed.


The gearbox intermediate shaft assembly complete with the central adaptor plate can be removed whilst holding the synchromesh unit in place as this will not clear the lay shaft second gear. Lift out synchromesh unit from top of the box.

With the central adaptor plate removed the lay shaft and reverse idler shaft locks are exposed. Drift the lay shaft towards the rear of the box and remove the woodruff key lock. Remove the lay shaft and replace as you go with a dummy lay shaft 0.748" dia. x 168m/m long. Allow the lay shaft cluster gear to fall to the bottom of the case.

Remove the 3 retaining bolts from the input shaft bearing cover and remove cover. From inside of box carefully tap out input shaft assembly taking care not to lose any of the 14 off spigot bearing rollers.


From inside of the box drift out the reverse idler shaft recovering the woodruff key lock once exposed. Once the idler gear has been removed along with its thrust washer the lay shaft cluster complete with thrust washers and roller bearing end plates can be lifted out.

## The Overdrive Housing.

The following instructions assume that the drive shaft universal joint has already been removed.

Unscrew speedo drive from housing.


Remove the 8 off retaining nuts from the rear bearing cover and remove cover to expose bearing.

Using a soft hammer drive the final drive shaft into the overdrive box leaving the bearing in the housing until the shaft can be extracted from the open end. The centrifugal clutch dog ring can now be disengaged from the selector and removed. The speedo worm gear can be removed from the shaft.

To remove the selector linkage the Auxiliary Control rod protruding from the case face can be slid out. The actuator arm is held onto the shaft by a locking bolt that can be accessed from outside by removal of a plug. Next to this plug is a grub screw that must be removed to allow the indent ball and spring to be retrieved.


The selector arm and spring are held in position on the shaft by a spring clip that can be pulled out from within the box. Once these items have been undone and removed the shaft can be tapped out towards the rear of the case removing the welch plug on its way.

Now the external actuator arm can be removed by removing the nut and washers and removing the locating bolt from the top of the case boss. The actuator cross shaft can now be extracted from inside of the box and allows the removal of the felt seal ring.

## Component Description and Inspection.

Input shaft bearing cover showing oil drain pocket at the bottom of the flange. It should be noted that the bolt holes are not equally spaced ensuring the installation is in the correct position.

The lip seal dimensions are:- 1 5/8” OD. X 15/16” ID. X 3/8” Wide.



To remove the input shaft bearing the circlip and anti-rotation washer have to be removed. The bearing can then be driven off with a soft hammer. The bearing number is 6207-ZNR C3 JP and has an external circlip and is shielded on the inboard side.

The input shaft to intermediate shaft spigot bearing has 14 off rollers, 0.2175” dia. X 0.529” long. There are 2 small drillings in the gear to feed oil to this bearing which must be checked to ensure that they are not blocked.


The lay shaft assembly consists of a cluster gear mounted on a ¾" dia. lay shaft supported on 22 off 0.125" dia. X ¾" long rollers at each end with a central spacer sleeve to fix their position. Each roller bearing assembly is enclosed with a steel washer with a bronze thrust washer between them and the gearbox housing. There is an oil drain hole in the section between first and second gear which should be checked to make sure it is not blocked. The shaft is locked in position by the woodruff key seated in the shaft groove and located in the gearbox case pocket.


The reverse idler is mounted on a ¾" dia. shaft and has a bronze bush fitted. The shaft is locked in position by the woodruff key seated in the shaft groove and located in the gearbox case pocket.

Remove the circlip retaining the gearbox intermediate shaft bearing into the central adaptor plate and lightly tap the shaft to remove bearing from the plate. This now exposes the circlip holding the bearing onto the shaft. After removing this circlip and the anti-rotation washer the bearing can be removed. The bearing number is 6207 2ZR but only requires one shield to be placed on the inboard side during re-assembly.


The first gear can now be slid off the shaft spline for cleaning and inspection.

The second gear is held in position by a ring that is locked in the fixed position by means of a sprung loaded pin. By depressing this pin the ring can be rotated to align with the spline and allow removal of the gear.


The synchromesh unit should be stripped to inspect the condition of the 6 x ¼" dia. balls and springs. On re-assembly position the balls on an unworn set of splines if available.


View showing the overdrive side of the central adaptor plate with fixed sun gear.

Planetary gear housing. Would not recommend stripping this unit down as parts are crimped into position.

Planetary gear housing showing the three sets of gears with the annulus gear.

Centrifugal weights on the back of the annulus gear. With the spring fully depressed the drive dogs would be fully engaged with the dog ring.

The free wheel sprung loaded cage holds 12 off 5/16” dia. X 5/8” long rollers. The thrust bearing sits between the back face of this unit and the centrifugal weight assembly. The bronze bearing locates at the front of this unit after the bolt and washer are fitted.


This view shows the dog ring, overdrive output shaft and speedo worm gear. The outside splines on the shaft locate into the teeth in the dog ring. The dog ring position within the gearbox is changed by the selector unit. The free wheel assembly fits inside the shaft spline hub with a central journal that fits into the bronze bush detailed above. The speedo worm gear fits up to the shaft shoulder and is locked in position by the bearing and universal joint once the shaft nut is tightened.

The dog ring selector mechanism laid out as it would be once installed into the overdrive case. The welch plug was found to be re-usable.


##### Rear bearing cover showing the circlip used as a spacer. Behind the circlip is a lip seal, 2 7/16” OD x 1 9/16” ID x 3.4” wide. Unfortunately this seal was not available so have used 2 off 3/8” wide seals back to back.

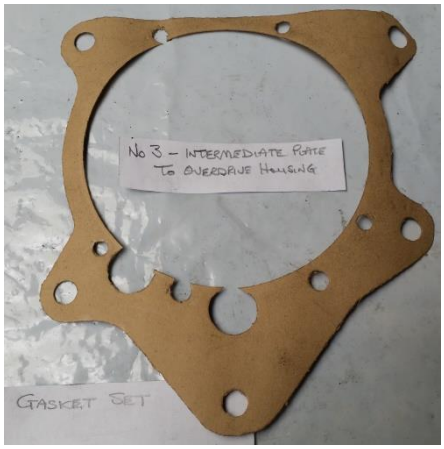
This view shows the speedo drive unit's components. A worn section on the main shaft can be seen where the felt seal comes into contact. Although not desirable by using a compressible type of valve gland packing it should overcome this potential oil leak point. The alternative is a new shaft.


No.1

Front cover and bell housing to gearbox gasket.

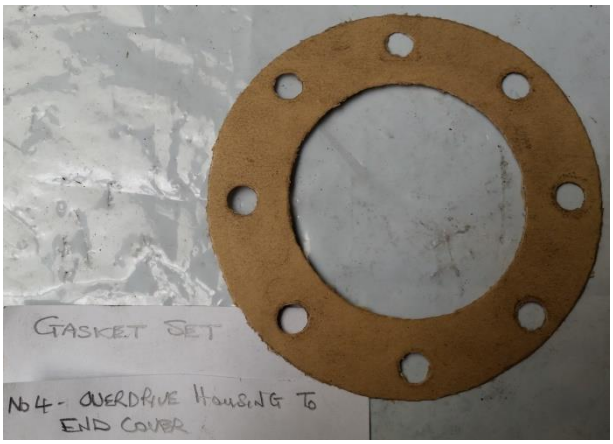

No.2

Gearbox to central adaptor plate gasket. Note the oil feed cut out to the left of the large hole also the 2 smaller holes either side of the lay shaft hole which are there to allow the oil to pass from the gearbox to the overdrive unit.




No.3

Central adaptor plate to overdrive case gasket. As above the 2 holes either side of the lay shaft hole are there to allow the oil to pass from the gearbox to the overdrive unit.




No.4

Overdrive case to overdrive output shaft bearing cover gasket


No.5

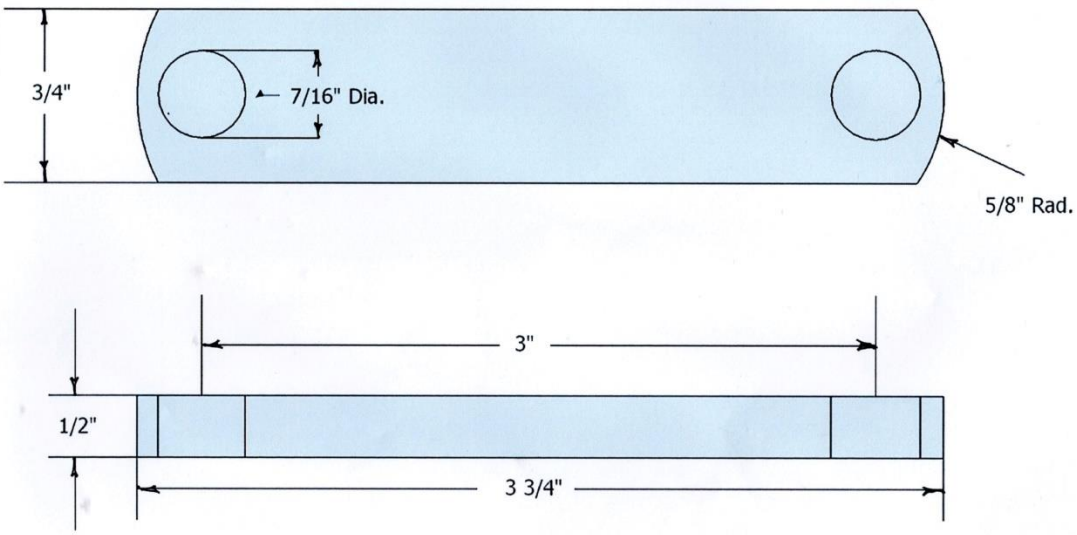
Gearbox selector cover gasket.

No.6

Gearbox Turret Seal.

Material 1/2" thick felt.

NTS. All measurements in inches.




## Assembly.

All gearbox and overdrive components should be thoroughly cleaned and inspected for wear and damage. Replace worn items where possible.

Purchase new bearings and lip seals.

Bearing identification numbers –

1 off 6207-ZNR-C3 JP

1 off 6207-2ZR

1 OFF 6206

Lip seal dimensions –

1 off - 1 5/8” OD x 15/16” ID x 3/8” Width.

2 off – 2 7/16” OD x 1 9/16” ID x 3/8” Width.

Other purchase requirements –

0.25m/m gasket paper.

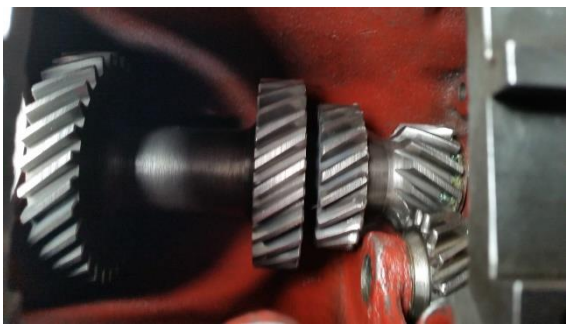
½” thick felt.

Black engine paint.

### Gearbox.

Introduce dummy lay shaft with spacer sleeve into cluster gear bore. Using heavy grease pack each end with 22 off rollers. Using a thin film of grease attach steel washer to either end of cluster gear followed by the bronze thrust washer.

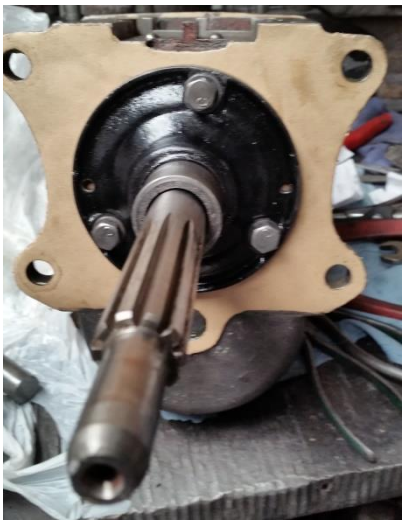
Position a light cord into the bottom of the gearbox with each end of the cord hung over opposing sides of the gearbox. Carefully position the cluster gear assembly between the locating faces within the gearbox resting on the cord and bottom of the gearbox.



Lightly oil the input shaft bearing journal. Position the new bearing, outer race circlip on clutch spline side of shaft, and drive bearing onto the journal until back faces touch. Force must only be applied to the inner bearing race. Install anti-rotation tab washer followed by the circlip. Tap outside diameter of circlip to ensure correct seating.

# Coat input shaft internal spigot journal with grease and pack with 14 off rollers ensuring that they are between the back face and retaining clip.

Carefully fit input shaft assembly into the gearbox, using force on the outer race only, until the circlip comes into contact with case face.



Using a light film of grease on the case gasket face stick the gasket (No1) into position.

Carefully install the new lip seal into the front bearing cover ensuring that it is not distorted and is square to the bore. Lubricate the seal face with grease and slide bearing cover along shaft and up to the bearing. Fasten to the case. Note that the bearing cover bolt holes are not evenly spaced and will only fit in one position.

Using the cord lift the cluster gear assembly up until the lay shaft holes are inline. Introduce the plain end of the lay shaft into the gearbox central end face hole carefully pushing the dummy shaft out as you go. The shafts should remain in contact for the whole operation to ensure the integrity of both needle roller sets and the roller bearing closure washers and thrust washers do not move out of alignment. Ensure that the key slot in the shaft aligns with the pocket in the gearbox end face as the operation nears completion. Place woodruff key into the slot and tap the shaft home ensuring the key is completely home. The cord can now be removed.

The idler gear can now be installed with similar methodology as above but made easier as there are no roller bearings to be considered.

The gearbox intermediate shaft can now be reassembled.

Insert the small spring into the hole at the end of the synchromesh spline on the shaft followed by the pin. Slide the second gear over the pin and onto the journal with the synchromesh dogs facing out. Slide the splined locking ring up to the pin. Depress the pin with a suitable thin narrow blade and slide locking ring over pin. Rotate locking ring until pin engages with gap between teeth locking the ring and gear in place.

Slide the first gear, selector groove end first, onto shaft spline. ## This is then followed by the circlip that will locate the outer race into the central adaptor plate at a future operation. The bearing, shield side first, can now be fitted. Note. If the bearing is supplied with both sides shielded flip out one side only with a screw driver. Force is only to be applied to the inner race when fitting. Fit the anti-rotation tab washer followed by the circlip onto the shaft. Lightly tap the outside diameter of the circlip to ensure correct seating.

To assemble the synchromesh unit install each spring followed by a ball bearing held in place by grease. Using a hose clamp compress the balls into the synchromesh hub. The hose clamp should be a firm fit on the hub splines but still allow the hub to be moved with a hard push. Adjustment to this fit can be made at the assembly stage. Introduce the synchromesh outer ring onto the hub ensuring correct way around and align balls with un-used spline if available.

A hard push on the hub while holding the hose clamp hard up against the ring face will complete the operation. Continue to push the hub into the ring until they lock together in the central position.

Fit the adaptor plate onto the intermediate shaft bearing and secure with the circlip installed at a previous operation.(##)

Check the previously installed internal spigot rollers (#) in the input shaft to ensure that they are still held in place by the grease.

Lightly grease gearbox central end face and fit gasket (No2) ensuring all the holes are cut and align.

While supporting the synchromesh assembly within the gearbox at its approximate running position install the intermediate shaft assembly feeding the synchromesh unit onto the intermediate shaft spline when able to do so. Once this is in place carefully insert the intermediate shaft spigot journal into the input shaft internal rollers until fully home.

Lightly grease the overdrive side of the adaptor plate and fit the gasket (No3) ensuring all the holes are cut and inline. #### Hold adaptor plate in position by installing 1 off flange bolt finger tight only.

### Insert circlip into intermediate shaft just in front of fixed sun gear. Lightly tap around outside diameter of circlip to ensure fully engaged in groove.

Install planetary gear assembly onto intermediate shaft spline and into engagement with the fixed sun gear. No further movement will be possible once the planetary gear assembly contacts the circlip previously installed. ###

With a light smear of grease on the thrust washer install it onto the register and up to the wear face on the planetary gear assembly. Slide the bronze sleeve onto the journal protruding from the planetary gear assembly.

Install the annulus ring gear/centrifugal weights unit onto the planetary gear assembly until contact is made with the thrust washer.

With a light smear of grease on the second thrust washer install it onto the register and up to the wear face on the free wheel unit. Slide this unit along the intermediate shaft splines until the thrust washer makes contact with the face on the centrifugal/annulus gear unit, Install the bolt and heavy gauge washer into the centre of the free wheel unit and tighten. Fit bronze bush into centre journal once bolt and washer have been tightened.

Pack free wheel roller cage with grease and install the 12 off rollers ensuring that there is enough grease to hold them in place during installation.

Introduce the output shaft free wheel hub end to the caged rollers turning the output shaft anti-clockwise to assist with the engagement of the rollers. Once engaged the output shaft can be pushed fully home so that the free wheel cage dogs are in line with the output shaft hub external spline.

Preparing the overdrive case for fitting.

Install selector cross shaft through the case from the inside ensuring the arm is in the correct position. Fit seal and back up washer and attach actuator lever in correct relationship to the internal arm.

Fit the spring and spring clip into the dog ring shifter ensuring alignment with the holes. Insert the main selector shaft, taper first, into the hole on the internal case face roughly aligning the indent holes with the case drilling. Continue pushing the shaft through until the selector link arm can be engaged. Continue to push the main selector shaft inwards until it can be inserted into the dog ring shifter. Continue to push the shaft through until resistance is felt at which time it has come into contact with the spring clip. Check the case hole from the other end to ensure shaft to spring clip alignment before proceeding. Adjust the spring clips position if necessary. Once satisfactory alignment is achieved continue, using greater effort, pushing the shaft through the clip until the clip is felt engaging the groove in the shaft.

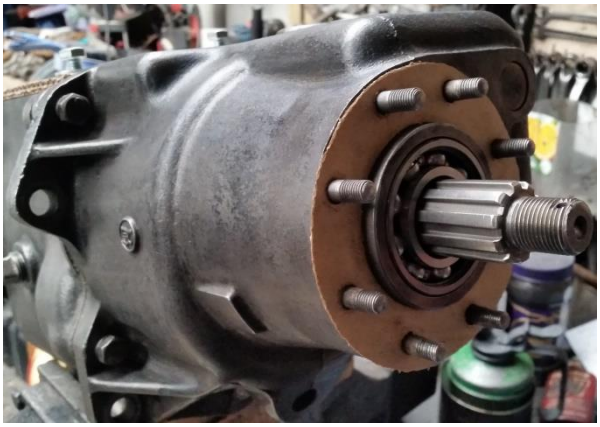
Looking through the plug hole align the hole in the shaft with the selector link locking bolt hole using the screw driver slot on the tapered end of the main selector shaft for adjustment purposes. Once aligned fit the locking bolt and tighten.

With the selector link now in the locked position the indent ball and spring can be inserted into the case drilling followed by the grub screw plug. Tighten the grub screw until head is level with case surface.

Finally the auxiliary control rod can be inserted in the drilling above the main selector shaft engaging with a drilled hole in the dog ring shifter with the other end protruding from the internal case face.

With the case upside down the dog ring can be installed ensuring that the shifter is engaged with the dog ring groove. In this position the dog ring will sit square and central.

With the gearbox assembly held in a vice and the single hand tight intermediate plate retaining bolt removed (####) the upside down overdrive case assembly can be introduced to the intermediate shaft. A small amount of manoeuvring should align the dog ring internal teeth with the output shaft hub spline allowing the 2 units to come together. As the overdrive case moves forward it must be rotated so that the auxiliary control rod can enter into the drilling provided in the adaptor plate. Fit the 5 off overdrive case to gearbox bolts and tighten.



Slide speedo drive worm gear along output shaft with the internal taper first followed by the bearing. Force to be applied to the outer race only until contact is made with the internal circlip fitted to the overdrive case. Lightly grease the case gasket face and fit the gasket (No4).

Fit the 2 off lip seals into the location in the rear bearing cover. Please note that, as the original width seal was not available 2 off half width seals were used to achieve the same dimension.

The spacer circlip was then fitted into the recess in front of the seal back face as original. ##### The rear bearing cover was then fitted and all nuts tightened.

Fit all plugs to gearbox and overdrive cases. Re-fit welch plug to selector shaft hole.

Mask all machined surfaces.

Paint assembly using suitable oil resistant and high temperature paint. Original colour was black.

The Bell Housing.

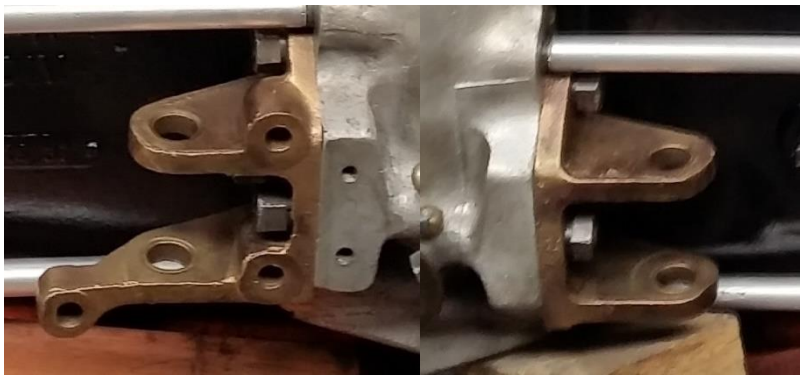
A new split pin must be fitted to the clutch actuator shaft followed by the washer. The shaft and pivot bores should be lubricated with grease. Insert the actuator shaft from the left hand side (right hand drive vehicles) through the clutch release fork ensuring that it is in the correct orientation and through the other side of the bell housing.

Fit the other washer onto the shaft followed by the clutch release arm ensuring the marked splines are in line.* Tighten pinch bolt with the arm positioned to minimise shaft end float without restricting movement.

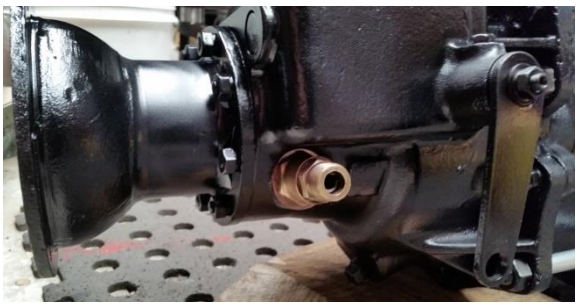
Locate and tighten the clutch release fork cotter pin.

Fit bell housing to gearbox ensuring clutch release fork and bearing are free to operate. Tighten all of the retaining nuts and brace studs.

Fit rear stay brackets to either side of bell housing after tightening main fixing nuts.



Using a new and annealed copper gasket screw in the speedo drive ensuring the driven gear is located in the worm drive.



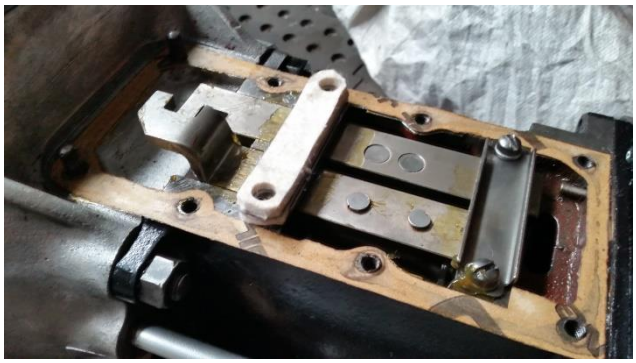
Fit second and third selector to groove in synchromesh outer ring after lightly greasing slide ways and indents.

Place interlock ball in indent with grease to hold in position.

Fit first and reverse selector into gear groove after lightly greasing slide ways and indents.

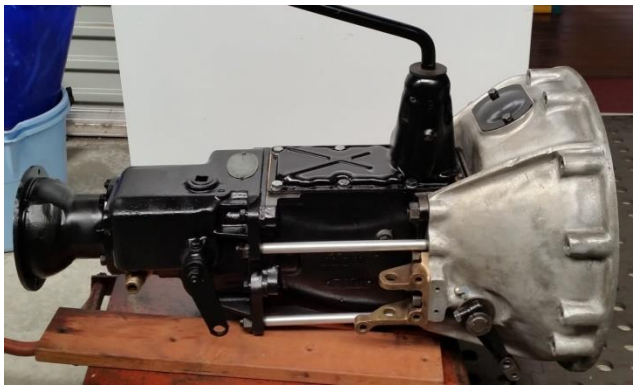
Fit the 2 off clamp plates and tighten screws

.Lightly grease gearbox and bell housing gasket face and fit gasket (No5).



Lightly grease forward clamp plate upper face and lay felt seal (No6) into recess. Lightly grease corresponding area on turret plate.

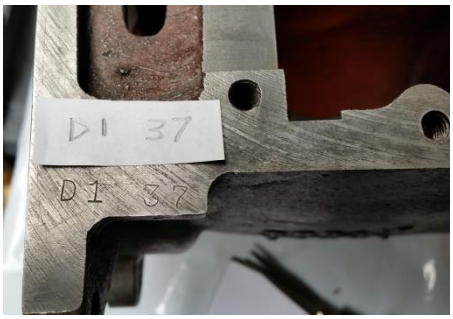
Fit gear lever turret onto gearbox and bell housing ensuring the gear lever engages with the selector gates.



# Appendix

Numbers found on my gearbox identified in BLACK and spare gearbox identified in RED

Stamped numbers on top machined face of gearbox




D1-37


D8-37

Casting marks and stamps on right hand side of gearbox.


T86-IP

W.G. DIV

4

2-18-37

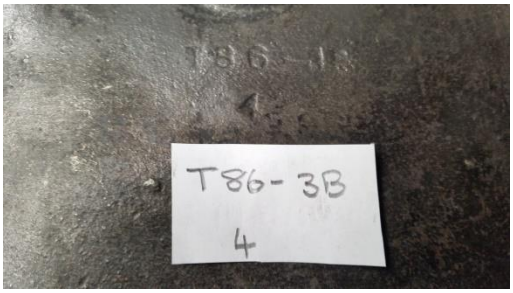

T86-IP

W.G. DIV

AL 2

2-18-7

Stamp marks found on left hand side of gearbox.




T86-3B

4


T86-IP

2