

G

Gearbox

FACTORY

SERVICE INSTRUCTION LEAFLET

ISSUED BY

BENTLEY MOTORS (1931) LTD.



BM/G 1

SB.1/JM.

Subject : Shock Absorber Control Pump Drive.
Oil Leaks.
3½ litre and 4¼ litre.

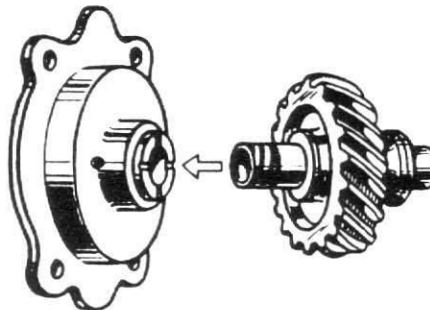
Date
of
Issue 4th December, 1946

IMPORTANT

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It is possible to produce a serious oil leak from the gear box if the skew gear which drives the governor pump is fitted the wrong way round. This is quite easily done since it will drive either way, and there is no apparent disability in functioning.

The correct method of assembly is shown in the drawing herewith, from which it will be seen that the Acme thread fits into the cover and acts as an oil return. If it is fitted the other way round, the Acme thread does not function, also the length of bearing is so short that the oil return hole is uncovered and permits a direct outlet for the oil.



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BENTLEY MOTORS (1931) LTD., SERVICE STATION, HYTHE ROAD, WILLESDEN, LONDON, N.W.10

SERVICE INSTRUCTION LEAFLET

ISSUED BY

BENTLEY MOTORS (1931) LTD.



BM/G2.

SB/VA.2/SF.

Subject :

TO OVERHAUL A BENTLEY 3½ & 4½ LITRE
GEARBOX, EXCLUDING 'M' SERIES (OVERDRIVE) CHASSIS

Date

of 20th December, 1954.

Issue

GENERAL:

Four speeds and reverse with positive interlock selector mechanism. Synchromesh on third and fourth speed gears and from second to third speed gear. A servo motor of the dry, disc-clutch type and a plunger type pump with a centrifugal governor (carried in a casing and incorporated on Chassis No. B-1-CW onwards) for the rear controllable shock dampers are mounted on a gearbox and driven from the 3rd motion shaft, together with the speedometer drive.

NOTE: Retailers in the British Isles are advised that gearboxes requiring major repairs should be returned to the London Service Station.

For the removal and re-installation of the gearbox, refer to Service Instruction Leaflet No. BM/F2. "Clutches".

1. SPECIAL TOOLS REQUIRED:

Tool No.	No. Off.	Title.	Application.	Remarks.
R-3181	1	Extractor.	Diaphragm.	If this tool is not available, a simplified and cheaper version can be made from details shown in Fig. 5.
-	1	Box spanner.	Nut-1st Motion shaft.	The width across the flats of the nut is 1.825"

Apart from the above, a 7/8", 15/16" and a 1" (B.S.F.) box spanner will be required for removing the retaining nuts of the 2nd and 3rd motion shafts. A 1" (Whitworth) box spanner will also be required for removing the nut from the servo motor countershaft.

2. PARTS REQUIRED:

Part No.	No. Off.	Title.	Designation.	Remarks.
RG-7081	1	Ball bearing	1st Motor shaft.	) It is recommended that when a gearbox is being overhauled, new bearings should be fitted. It should not however be necessary to change the two ball bearings supporting the servo drive shaft.
G-55822	1	Ball bearing	3rd Motion "-centre	
100/0296	1	Ball bearing	3rd Motion "-rear (end.	
100/0288	1	Ball bearing	2nd Motion shaft-front (end.	
GB-432	1	Ball bearing	2nd Motion shaft-centre	
100/0276	1	Roller bearing	2nd Motion shaft-rear (end.	
E-27491	2	Aluminium washer.	Oil drain plugs	On L.H. side of gearbox.
E-27491	3	Aluminium washer.	Inspection plugs	
E-70781	1	Aluminium washer.	Plug-plunger housing	

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Part No.	No.Off.	Title.	Designation.	Remarks.
G-78565	1	Aluminium washer.	Oil filler plug	
G-54710	2	Lockwasher	1st Motion shaft	)An extra lock-washer is included in case of need.
G-54681	2	Lockwasher	2nd Motion " -front end	
G-54681	2	Lockwasher	3rd Motion " -rear end	
G-54678	2	Lockwasher	2nd Motion " -rear end	
G-77672	1	Lockwasher	Nut-servo suspension brkt	
G-52135	1	Lockwasher	(Nut-servo pressure plate. Required up to (In case of need if servo Chassis No.B-199-DK (is dismantled.	
G-56555	1	Lockwasher	(Nut-servo pressure plate (In case of need if servo (is dismantled.	Required from Chassis No.B-2-EF onwards.
G-52731	2	Joint(Vellumoid)	C/shaft housing flange.	
G-54743	2	Joint(" ")	Rocking shaft bearings.	
G-54744	1	Joint(" ")	3rd & 4th speed selector guide.	
G-56149	1	(Joint("Oaken-strong").	Selector lever cover.	
G-54817	1	Joint(Vellumoid)	Diaphragm.	
G-54818	1	Joint(" ")	Plunger housing - selector shafts.	
G-54825	1	Joint(" ")	Rear cover-3rd motion shaft.	
G-54862	1	Joint(" ")	Cover-plunger housing.	
G-55642	1	Joint(" ")	Rear cover-2nd motion shaft.	
G-55643	1	Joint(" ")	Front end cover.	
G-56150	1	(Joint("Oaken-strong")	Front top cover.	
G-56151	1	(Joint("Oaken-strong")	Rear top cover.	
G-56152	1	(Joint("Oaken-strong")	Change gear & speedo drive bracket.	Required from Chassis No.B-1-AE to B-203-EJ
GB-1781	1	(Joint("Oaken-strong")	Change gear & speedo drive bracket.	Required from B-2-FB onwards.
F-60287	2	Joint(Vellumoid)	End plate & main casing of governor control for dampers.	Required from B-1-CW onwards, when it is necessary to remove the main casing.
G-55824	2	Bush(bronze)	2nd speed driver gear.	2nd Motion shaft
G-55811	2	Bush(bronze)	3rd speed constant mesh gear.	3rd Motion shaft
E-89081	2	Corru.washer.	Exhaust pipe.	Required when assembling gear-box to chassis.
G-52881	1	Adjusting washer (54 Fig.2)	2nd Motion shaft.	
G-54844	1	Adjusting washer (48 Fig.2)	2nd Motion shaft.	
G-55001	1	Distance piece (50 & 52 Fig.2)	2nd Motion shaft.	
G-54843	1	Adjusting washer (23 Fig.2)	3rd Motion shaft.	
G-54686	1	Adjusting washer (26 Fig.2)	3rd Motion shaft	
G-54846	1	Adjusting washer (29 Fig.2)	3rd Motion shaft.	

NOTE: The adjusting washers and the distance piece listed, are the thickest and longest of the range specified for the 2nd and 3rd motion shafts. Where it is found that an existing adjusting washer or distance piece is of insufficient thickness or length due to wear, a new one should be reduced to the required size. The faces must be kept parallel.

3. TO DISMANTLE THE GEARBOX (AFTER REMOVAL FROM CHASSIS):

NOTE: It is recommended that the 2nd and 3rd motion shafts and their associated parts should be put into separate containers during the dismantling operations.

- (i) Drain out the oil. Remove the front and rear top covers.
- (ii) Remove the selector lever cover from the top of the gearbox.
- (iii) If the change gear support bracket has not already been removed prior to the removal of the gearbox from the chassis, then unscrew the set-bolts and nuts securing it to the gearbox and remove the bracket complete with the governor casing (if the latter is fitted). Before removal, push the change gear lever towards the gearbox and manoeuvre the unit out of position and withdraw the square speedometer drive shaft (1 Fig.1)
- (iv) Remove the external oil pipe from the top of the clutch casing.
- (v) Remove ten nuts securing the clutch casing. Only remove the nuts from the bolts of which the heads are visible inside the clutch casing. Do not remove at this stage, the two nuts situated about halfway up the casing on either side. Remove the clutch casing by lightly tapping it with a hide mallet.
- (vi) Remove the clamping bolt securing the lever (on L.H. side of gearbox) to the servo countershaft which passes through the gearbox; remove the lever, its key and adjacent washer.
- (vii) Next, remove the large nut and washers from the end of the servo countershaft and the clamping bolt and coil spring from the suspension link.
- (viii) Disconnect the oil pipe from the brake damper cylinder and remove the damper unit.
- (ix) Remove the eight bolts securing the servo friction plate to its driving disc.
- (x) Remove the 5/16" (B.S.F.) nut securing the servo bridge (plate) to its bracket near rear end of the gearbox; withdraw the servo mechanism and remove the bracket secured by two nuts.
- (xi) Withdraw the servo drive shaft (2 Fig.1) simultaneously collecting the distance pieces (3 & 6), the adjusting washers (4 & 7), and the worm gear (5). It should not be necessary to remove the ball bearings of the drive shaft.
- (xii) Remove the external oil pipe from the L.H. side of the gearbox.
- (xiii) Pass a drift through the aperture at the top of the front end of the gearbox and tap out the two steel bearings supporting the rocking shaft and operating stirrup. These bearings have oval flanges which abut against the outside of the gearbox on either side. Withdraw the rocking shaft complete with the operating stirrup.

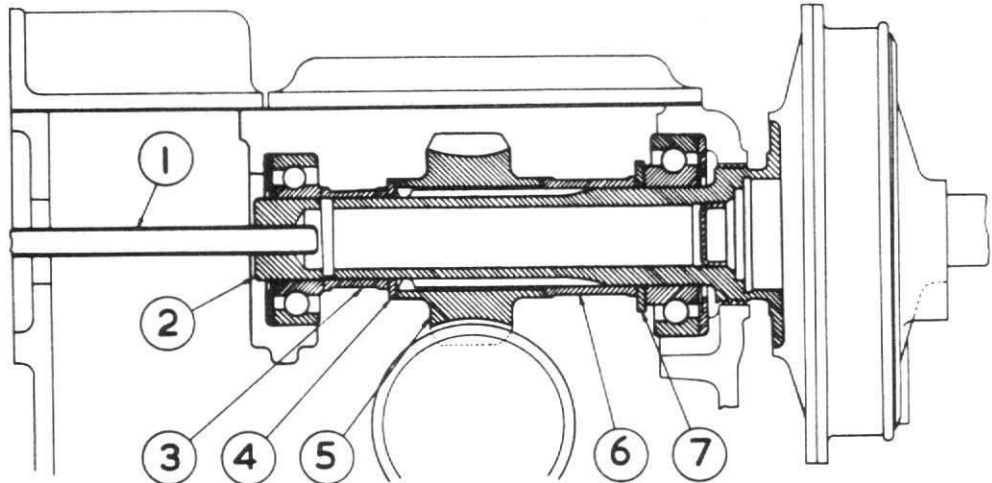


FIG.1. SECTION - SERVO MOTOR & SPEEDOMETER DRIVE.

- | | |
|-----------------------------|----------------------|
| 1. Speedometer drive shaft. | 5. Worm gear. |
| 2. Servo drive shaft. | 6. Distance piece. |
| 3. Distance piece. | 7. Adjusting washer. |
| 4. Adjusting washer. | |

- (xiv) The next operation is to lock the 1st, 2nd and 3rd motion shafts so that the retaining nuts of these shafts can be removed. Proceed as follows:-
- a) Place a circular lever (about 14" long x 7/16" dia.) through the aperture at the top of the front end of the gearbox, enter the lever in the stirrup groove of the 3rd and 4th speed actuating sleeve (11 Fig.2) and push the sleeve towards the rear of the gearbox to engage the 3rd speed gear.
 - b) Pass the lever through the selector lever cover aperture (top of gearbox), and enter it in the jaw of the reverse gear selector shaft (i.e. shaft nearest to centre of gearbox) and push the shaft rearwards to engage the reverse gear.
- (xv) Remove the retaining nut, 34 (R.H.thread) from the rear end of the 3rd motion shaft, collect the clamping washer (32) and withdraw the coupling flange (31) from the shaft.
- (xvi) Remove the gearbox support bracket from the rear of the box and the cover for the 3rd motion shaft complete with oil drain pipe (if the latter is fitted). Remove the adjusting washer (29) and TIE it to the coupling flange.
- NOTE: Do not remove at this stage the 2nd motion and reverse shaft cover from the rear of the box.
- (xvii) Remove the cover (secured by 11 nuts) from the front end of the gearbox, collect the thin metal oil baffle adjacent to the ball bearing of the 1st motion shaft and the aluminium distance piece adjacent to the ball bearing at the front end of the 2nd motion shaft. Remove the nut, 58 (R.H.thread) from the front end of the 2nd motion shaft and collect the clamping washer (56).
- (xviii) Remove the nut, 64 (L.H.thread) from the 1st motion shaft and collect the clamping washer (66).

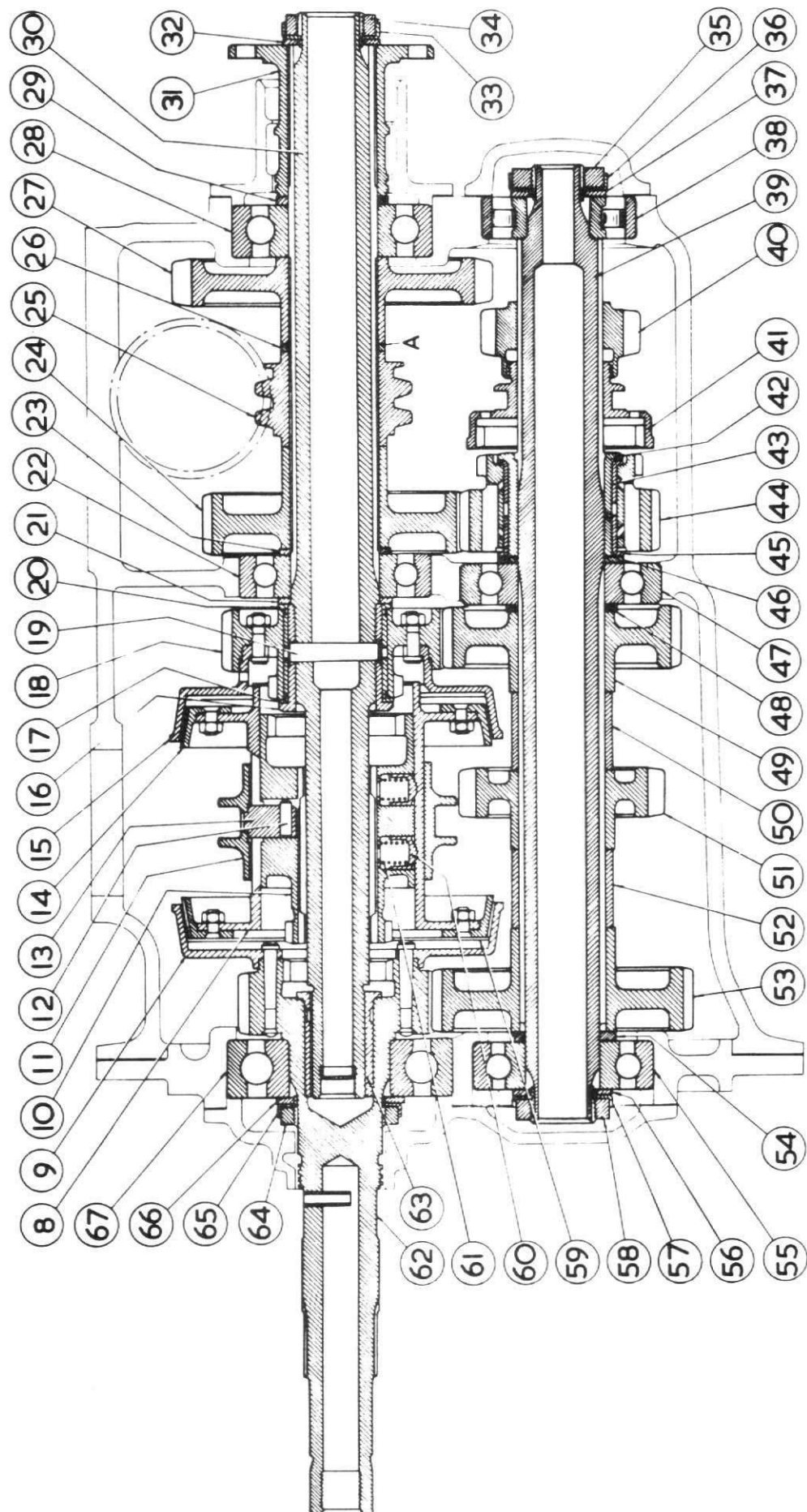


FIG.2. SECTION - 1ST, 2ND AND 3RD MOTION SHAFTS.

Notation List for Fig.2.

- | | |
|---|--|
| 8. Outer member-synchromesh, 3rd & 4th speed. | 38. Roller bearing-2nd motion shaft. |
| 9. Outer cone-front. | 39. 2nd Motion shaft. |
| 10. Sliding piece-3rd & 4th speed. | 40. 1st speed driver gear. |
| 11. Actuating sleeve-3rd & 4th speed. | 41. 2nd speed sliding gear. |
| 12. Pin-operating cam. | 42. Sleeve(fixed)-2nd motion shaft. |
| 13. Operating cam-synchromesh. | 43. Bush-2nd speed driver gear. |
| 14. Inner cone-rear. | 44. 2nd speed driver gear. |
| 15. Outer cone-rear. | 45. Bush-2nd speed driver gear. |
| 16. Sleeve(fixed)-3rd motion shaft. | 46. Thrust washer. |
| 17. Bush-3rd speed constant mesh gear. | 47. Ball bearing-2nd motion shaft. |
| 18. Constant mesh gear-3rd speed. | 48. Adjusting washer. |
| 19. Taper pin-sleeve-3rd motion shaft. | 49. Constant mesh gear. |
| 20. Bush-3rd speed constant mesh gear. | 50. Distance piece. |
| 21. Thrust washer. | 51. Reverse driving gear. |
| 22. Ball bearing-3rd motion shaft. | 52. Distance piece. |
| 23. Adjusting washer-2nd speed driven gear). | 53. Constant mesh gear. |
| 24. 2nd Speed driven gear. | 54. Adjusting washer. |
| 25. Worm gear-servo drive. | 55. Ball bearing-2nd motion shaft. |
| 26. Adjusting washer. | 56. Clamping washer. |
| 27. 1st speed driven gear. | 57. Lockwasher. |
| 28. Ball bearing-3rd motion shaft. | 58. Retaining nut-2nd motion shaft. |
| 29. Adjusting washer. | 59. Inner cone-front. |
| 30. 3rd Motion shaft. | 60. Plunger. |
| 31. Coupling flange-3rd motion shaft. | 61. Plunger spring. |
| 32. Clamping washer. | 62. 1st Motion shaft. |
| 33. Lockwasher. | 63. Floating bush-1st & 3rd motion shafts. |
| 34. Retaining nut-3rd motion shaft. | 64. Retaining nut-1st motion shaft. |
| 35. Retaining nut-2nd motion shaft. | 65. Lockwasher. |
| 36. Lockwasher. | 66. Clamping washer. |
| 37. Clamping washer. | 67. Ball bearing-1st motion shaft. |

(xix) Remove the spring loaded cover (secured by 2 nuts) from the bronze plunger housing at rear of gearbox and the three springs (75 Fig.3). Remove the plunger housing (73) as follows:-

- a) Remove the nuts and pull the housing away from the gearbox, if obstinate to remove, then slide any one of the three selector shafts backwards and forwards simultaneously shaking the housing to and fro to release it from the internal ball operated locking mechanism.
- b) Collect the plunger mechanism pin (72) from the end of the centre selector shaft, also collect the two .375" dia. and the three .500" dia. steel balls (71 & 74).

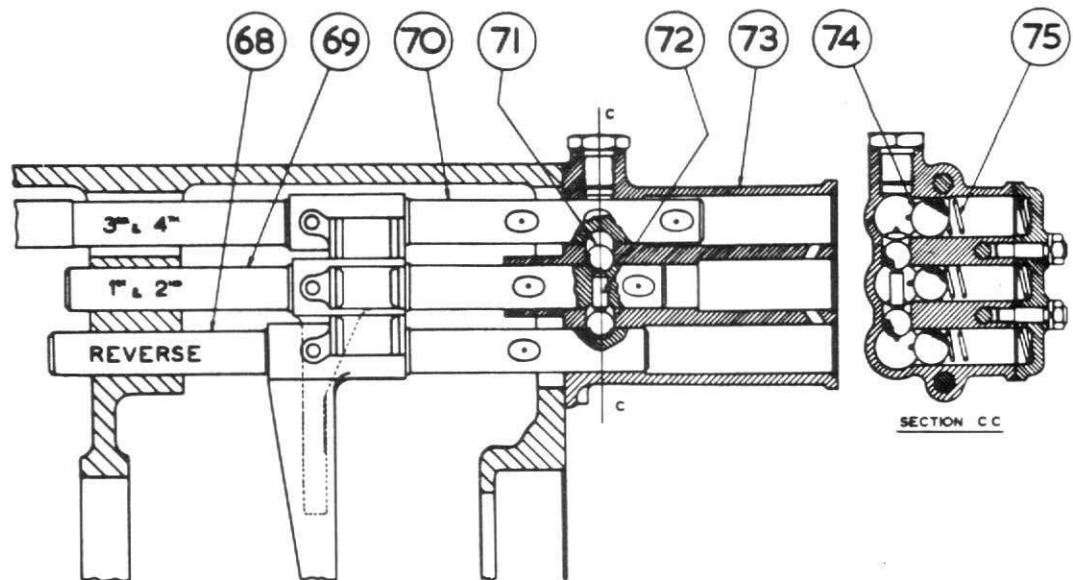


FIG.3. SECTION - SELECTOR SHAFTS & INTERLOCK MECHANISM.

- | | |
|---|---------------------------------------|
| 68. Selector shaft, reverse | 72. Pin-interlock mechanism. |
| 69. Selector shaft, 1st & 2nd speed. | 73. Plunger housing-selector shafts. |
| 70. Selector shaft, 3rd & 4th speed. | 74. Ball, .500" dia.-plunger housing. |
| 71. Ball, .375" dia.-interlock mechanism. | 75. Plunger spring. |

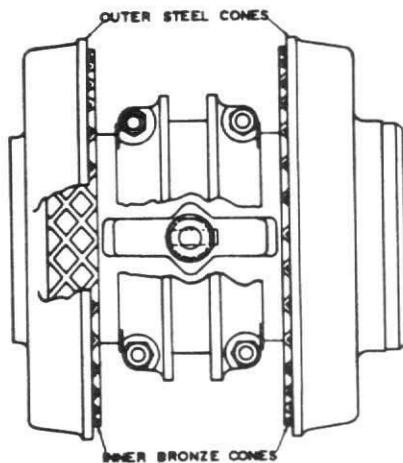


FIG.4. PLAN VIEW-3RD & 4TH SPEED SYNCHROMESH UNIT.

(xx) Remove the two 5/16" (B.S.F.) nuts from the countersunk head screws holding the large circular diaphragm to the front end of the gearbox. Secure the extractor R-3181 (or one made from the detail drawing, Fig.5) to the diaphragm in line with the 2nd motion shaft; withdraw the diaphragm complete with the 1st motion shaft, at the same time collecting the adjusting washer (54) and the constant mesh gear (53), TIE the adjusting washer to the gear.

(xxi) Remove the first distance piece (52) from the 2nd motion shaft; withdraw the 3rd and 4th speed synchromesh assembly from the 3rd motion shaft, together with the reverse driving gear (51) from the 2nd motion shaft; remove the second distance piece (50).

(xiii) Remove the constant mesh gear (49) and the adjusting washer (48) from the 2nd motion shaft and TIE the washer to the gear.

(xiii) Next, remove the 3rd motion shaft (30) as below:-

NOTE: A mild steel drift, 12" long x $\frac{3}{8}$ " dia. will be required one end of which should have a 60° chamfer to abut against the corresponding internal chamfer at the rear end of the 3rd motion shaft. Do NOT use a drift that will pass down the bore of the shaft, as this would damage the taper pin (19) near the centre of it.

a) Pull the reverse motion shaft forward clear of its rear bearing.

- b) With the drift and a mallet, progressively tap the 3rd motion shaft towards the front end of the gearbox, removing the gears and adjusting washers up to the centre ball bearing (22). TIE the adjusting washer (26) to the servo drive worm gear (25) and the adjusting washer (23) to the 2nd speed driven gear (24).
- (xxiv) Remove the 2nd and reverse motion shaft cover from the rear of gearbox (do not remove the small retaining cover secured by four 2-BA nuts.)
- (xxv) Manoeuvre the reverse motion shaft rearwards sufficiently to disengage the selector fork and draw the shaft forwards out of the gearbox.
- (xxvi) Slide the 2nd speed gear and the 1st speed driver gear assembly, (41 and 40) to the rear of the gearbox, and with a mallet, tap the 2nd motion shaft (39) towards the front of the gearbox until the rollers of the rear end bearing (38) are clear of the outer race and manoeuvre the shaft out of the gearbox. Remove the selector shafts.
- (xxvii) If new ball bearings are being fitted, then remove the 1st motion shaft and its bearing and the front bearing of the 2nd motion shaft from the circular diaphragm, taking care not to distort the latter. also remove the outer race of the 2nd motion shaft roller bearing from the gearbox.
- (xxviii) Unscrew the retaining nut, 35 (L.H. thread) from the rear end of the 2nd motion shaft and remove the remaining parts from it. TIE the thrust washer (46) to the 2nd speed driver gear (44).
- (xxix) Withdraw the drilled distance piece (adjacent to the front end bush of the reverse motion shaft) from the diaphragm so that the oil passages in the latter can be cleaned to remove sludge.
- (xxx) Thoroughly clean the gearbox and all dismantled parts leaving the washers tied to their respective gears.

4. 3RD & 4TH SPEED SYNCHROMESH UNIT (ON 3RD MOTION SHAFT):

Normally it should NOT be necessary to dismantle the 3rd and 4th speed synchromesh unit, as it is not subject to appreciable wear, even after a very large mileage has been covered.

- (i) To dismantle, remove the four 2-BA nuts and bolts securing the two halves of the actuating sleeve (11 Fig.2) and remove the two operating cams (13) from the sliding piece (10) and collect the two pins (12) if free.
- (ii) Push the sliding piece out of the outer member (8), taking care not to lose any of the six or eight plungers and springs. This may be avoided by wrapping a piece of cloth around the outer member prior to removal of the sliding piece.
- (iii) If the splines of the sliding piece are found to be worn, the piece should be renewed; wear is more likely to occur on the splines of the 3rd motion shaft. The width of the splines of the sliding piece (new) are .350" + .0005"; the corresponding width of the splines on the front end of the 3rd motion shaft (new) are .349" - .001".
- (iv) If the circular portion at the upper end of the two operating cams (13) where they locate in the actuating sleeve, are worn, new cams should be fitted.
- (v) When re-assembling the unit, four new 2-BA bolts (G-55649) and four nuts (K-4307) will be required. After tightening the nuts, centre punch each nut in four places to lock.

5. TO RE-ASSEMBLE THE GEARBOX:

When re-assembling, discard all old tab locking washers, aluminium washers, Vellumoid and red fibre (or "Oakenstrong") joints. If the 1st speed gears are noisy due to wear of the teeth beneath the hardened surface, opportunity should be taken to fit a new driver and driven gear (40 & 27 Fig.2), Part No.CB-435 and CB-430, otherwise the small particles of metal which disintegrate from worn gears will be carried around in the oil and may cause damage to the teeth of other gears and the bearings.

If the 2nd motion shaft is worn on the centre journal due to revolving of the inner race of the ball bearing (47), a new shaft should be fitted. This also applies if the centre and rear journals of the 3rd motion shaft are worn.

The diameter (new) of the centre journal of the 2nd motion shaft (adjacent to the non-flanged end of the sleeve 42) is 1.37795" + .00025" (35 m/m). The diameter (new) of the centre and rear ball bearing journals of the 3rd motion shaft is 1.3779" + or - .0001" (35 m/m).

a) 2nd Motion Shaft:

NOTE: When re-assembling the parts to the 2nd motion shaft, the gears must be placed the correct way round and the various washers positioned as shown in Fig.2.

- (i) Hold the rear end of the shaft horizontally in a vice. Fit two new bronze bushes (43 & 45) to the 2nd speed driver gear and check the gear for freedom of rotation on the shaft. The bushes should be a floating fit on the shaft and in the gear.

Next, place the thrust washer (46) in position; press hard against it and ascertain that the gear can be revolved freely with the minimum of end float, i.e. NOT more than .002". If the gear is not free due to lack of end float, lightly rub down the flanged faces of the bushes until the correct fit is obtained after which they should be oiled.

- (ii) If the adjusting washer (48) is worn, measure the thickness on the unworn portion and fit a new washer of the same thickness. This washer controls the amount of "nip" (which should not exceed .003") on the inner race of the ball bearing (55) when the nut (58), is fully tightened.
- (iii) With gear (44) and the thrust washer (46) in position, fit the remaining ball bearings, gears, distance pieces and washers to the front end of the shaft, including the clamping washer 56 (omit the lockwasher 57 at this stage).

NOTE: The distance pieces (50 & 52) are identical but may differ in length, therefore the distance piece marked 1 should be positioned between the gears (49 & 51) and the one marked 2 positioned between the gears (51 & 53).

- (iv) Tighten up the retaining nut (58) and again check the gear (44) for freedom; if not free, this will be due to excess of "nip" on the inner race of the ball bearing (55) causing the thrust washer (46) to exert a slight load on the bronze bushes. Fit a thinner washer (48) of the required thickness.

Conversely, if after tightening up the nut, the distance pieces (50 & 52) can be rotated, this will be due to lack of "nip" and it will be necessary to fit a longer distance piece. To determine length, proceed as follows:-

- a) Select a feeler gauge which can just be pushed between a distance piece and a gear.
- b) If for example, the gap is .007", fit a distance piece .010" longer which will give the required "nip" of .003".
- (v) Remove all parts from the 2nd motion shaft up to the gear (49) and reverse position of shaft in vice.
- (vi) Screw the 2nd speed sliding gear (41) into the 1st speed driver gear (40) as far as it will go and then screw back until the etchings on the gears are in line; the internal splines of both gears will then be in line with one another. Place this sub-assembly on to the shaft.
- (vii) Tap the roller bearing (38) fully home on the shaft. Fit the clamping washer (37), the lockwasher (36) and tighten up the retaining nut and check that a .002" or .003" thick feeler gauge cannot be inserted between the clamping washer and the inner race of the roller bearing. If a feeler can be inserted, the clamping washer should be counterbored to a depth of the feeler thickness plus .004" at a diameter of 1.000" in order to give the required "nip" on the roller race. Fit the counterbored side of the washer against the roller race, tighten up the retaining nut and lock.

NOTE: It is important to observe that when finally tightening up the retaining nuts of the 1st, 2nd and 3rd motion shafts, prior to locking, that the lockwasher does NOT ROTATE, otherwise this would cause the inner tabs of the washer to shear, in which case, another washer must be fitted.

b) 3rd Motion Shaft:

NOTE: When re-assembling the parts to the 3rd motion shaft, the gears must be placed the correct way round (this does not apply to the worm gear 25) and the various washers positioned as shown in Fig.2.

- (i) Hold the front end of the shaft horizontally in a vice. Fit two new bronze bushes (17 & 20) to the 3rd speed constant mesh gear (18) as described in sub-para.(i) for the 2nd motion shaft.
- (ii) If the adjusting washer (23) is worn, measure the thickness on the unworn portion and fit a new washer of the same thickness.
- (iii) With the gear (18) and the thrust washer (21) in position, fit the remaining ball bearings, gears, washers and the driving flange (31) to the shaft including the clamping washer (32); omitting the lockwasher (33) at this stage.
- (iv) Tighten up the retaining nut (34) and again check the constant mesh gear (18) for freedom, if not free, this will be due to excess of "nip" on the rear face of the driving flange (31) causing the thrust washer (21) to exert a slight load on the bushes. Remove the adjusting washer (26), and fit a washer of a thickness that will allow the end face of the driving flange to stand out .003" beyond the ends of the splines of the shaft to give the required nip when the retaining nut is fully tightened up. Conversely, if after tightening up the retaining nut, the 1st speed driven gear (27) has end float, however small, proceed as follows:-
 - a) Select a feeler gauge which can just be inserted between the washer (26) and the gear (27) i.e. at point 'A' Fig.2.
 - b) If for example, the gap is .002", fit a .005" thicker washer to give the required "nip" of .003".

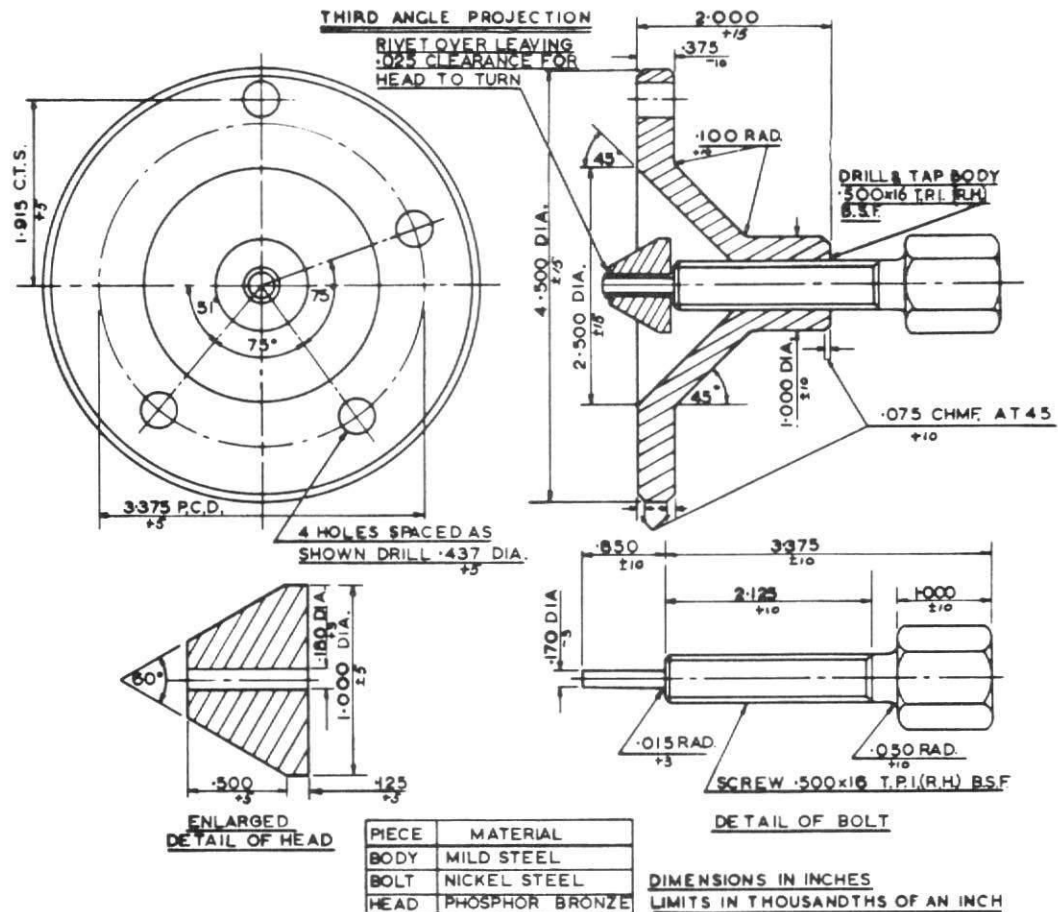


FIG. 5. EXTRACTOR - DIAPHRAGM.

- (v) Remove all parts from the shaft up to the washer (23); greasing the latter to keep it in position against the ball bearing.
- (c) Re-Assembling the Motion Shafts etc. to the Gearbox:
 - (i) Fit a new outer roller race (38) to the rear end of the gearbox.
 - (ii) Place the centre selector shaft (69 Fig.3) in the gearbox. With the constant mesh gear (49 Fig.2) in position on the 2nd motion shaft, enter the shaft into the gearbox, simultaneously engaging the fork of the selector shaft with the corresponding groove in the 2nd speed sliding gear (41), taking care to enter the roller bearing (38) SQUARELY into its outer race.
 - (iii) Enter the reverse motion shaft into position, place the reverse selector shaft (68) in the gearbox and manipulate the fork of it into the groove in the reverse motion shaft and then slide the selector shaft into its bore in the gearbox.
 - (iv) Fit the 2nd and reverse motion shaft cover to the rear end of the gearbox and slide the reverse motion shaft into its rear bearing.
 - (v) Place the remaining selector shaft (70) in position.
 - (vi) Next fit the 3rd motion shaft as follows:-
 - a) Place the 1st speed driven gear (27) and the 2nd speed driven gear (24) into the gearbox the correct way round. Pull the reverse motion shaft forwards as far as it will go.

- b) With the adjusting washer (23) still in position, enter the shaft at the front end of the gearbox and engage the gear (24), the worm gear (25), the washer (26), this washer must be placed at the REAR END of the worm gear, (as shown in Fig.2) and the gear (27).
 - c) Continue to push the shaft rearwards simultaneously engaging the constant mesh gear (18) with the constant mesh gear (49) on the 2nd motion shaft; line up the centre ball bearing (22) with its housing in the gearbox and tap the shaft into position until the ball bearing is centrally located in the housing.
 - d) Fit the rear ball bearing (28) followed by the washer (29); greasing the latter to keep it in position.
- (vii) Next, place No.1 distance piece (50) on the 2nd motion shaft.
- (viii) Slide the reverse driving gear (51) on to the end of the 2nd motion shaft, hold this gear with the left hand and the 3rd and 4th speed synchromesh assembly with the right hand and manoeuvre the synchromesh assembly on to the 3rd motion shaft, the gear (51) will then be about midway between the two bronze cones. The synchromesh assembly should be positioned so that the external teeth of the sliding piece (10) face towards the front of the gearbox.
- (ix) Push the reverse motion shaft into its rear bearing.
- (x) Place No.2 distance piece (52) on to the 2nd motion shaft.
- (xi) Fit the ball bearing (67) to the diaphragm and tap the 1st motion shaft into this bearing.
- (xii) Replace the drilled distance piece in the diaphragm.
- (xiii) With the floating bush (63) in position in the 1st motion shaft, hold the constant mesh gear (53) against the diaphragm with the left hand and enter the diaphragm into position on the gearbox simultaneously guiding the gear on to the 2nd motion shaft.
- (xiv) In order to correctly align the three close fitting bolt holes in the diaphragm and the front face of the gearbox, proceed as follows:-
- a) Fit the two 5/16" (B.S.F.) countersunk head screws to the diaphragm and gearbox and tighten the nuts finger tight at this stage.
 - b) Temporarily fit the clutch casing to the gearbox (tap into position with a soft mallet) which will allow the three close fitting bolts of the casing to align the corresponding bolt holes in the diaphragm and gearbox. Tighten up the nuts of the two countersunk head screws to secure the diaphragm in position.
 - c) Remove the clutch casing.
- (xv) Next, assemble to the 2nd motion shaft, the washer (54), the ball bearing (55), the clamping washer (56), the lockwasher (57) and lightly tighten up the retaining nut.
- (xvi) Assemble to the 1st motion shaft, the clamping washer (66), the lockwasher (65) and also lightly tighten up the retaining nut.
- (xvii) Re-assemble the interlock mechanism of the selector shafts as follows:-
- a) Push the centre selector shaft rearwards; grease and place the pin (72 Fig.3) in the rear end of it.

- b) Apply a soft type of grease to the horizontal passage in the bronze plunger housing (73) in which the two .375" dia. steel balls are housed and place the latter in position.
 - c) It will be observed that spherical recesses are machined in the top and side/s of the three selector shafts for ball location. Push the plunger housing on to the centre shaft until the inner spherical recess on the top of the shaft can be seen upon looking down the centre vertical hole in the housing.
 - d) Whilst holding the casing, push the reverse selector shaft rearwards until the recess in the side of it lines up with the corresponding recess in the left-hand side of the centre shaft.
 - e) Next, whilst still holding the plunger casing, move the outer shaft into position in the casing and push the latter up to the gearbox and secure.
 - f) With the jaws of the three selector shafts in line (i.e. in neutral position), move the reverse selector shaft into reverse gear and check that the remaining two shafts are locked. Repeat likewise for the 1st and 2nd, and the 3rd and 4th gear selector shafts.
 - g) Assemble the three .500" dia. steel balls and springs to the housing and fit the top cover.
- (xviii) Fit the 3rd motion shaft rear cover and the gearbox support bracket.
- (xix) Assemble the washer (29), the coupling flange (31), the clamping washer (32) and the lockwasher (33) to the rear end of the 3rd motion shaft.
- (xx) Next lock the 1st, 2nd and 3rd motion shafts as described in Sub-para. xiv of Para.3, and fully tighten up the retaining nuts of the 1st, 2nd and 3rd motion shafts and bend back the tabs of the lockwashers to lock.
- (xxi) Place the aluminium distance piece against the ball bearing at the front end of the 2nd motion shaft and the oil baffle (.047" thick) against the ball bearing of the 1st motion shaft and fit the front end cover to the gearbox.
- (xii) Assemble the clutch casing to the gearbox.
- (xxiii) Move the outer selector shaft (70) into its neutral position, fit the rocking shaft and operating stirrup assembly and its two bearings to the gearbox. Temporarily replace the front top cover to prevent ingress of foreign matter.
- (xxiv) Assemble the servo motor drive shaft to the gearbox; (the worm gear (5 Fig.1) may be fitted either way round) correctly positioning the distance pieces (3 & 6) and the adjusting washers (4 & 7) as shown in Fig.1. Temporarily replace the rear top cover.
- NOTE: When replacing the servo motor, particular care should be taken to see that the driving disc(attached to the servo drive shaft)is not pulled away from the gearbox, as this may result in the distance piece (3) and the washer(4)dropping into the gearbox. If the servo motor requires attention, opportunity should be taken before it is replaced on the gearbox.
- (xxv) Refit the servo motor and its mechanism to the gearbox by reversing the procedure for removal. Do not omit to refit the key to the end of the servo countershaft.

- (xxvi) Remove the front and rear top covers. Inspect that the distance piece (3) and the washer (4) are still in position on the servo drive shaft. Turn the gearbox upside down to dislodge any foreign matter that may have fallen in. Replace the two top covers and secure.
- (xxvii) Place the speedometer drive shaft (1 Fig.1) in position and fit the change gear support bracket complete with the governor casing (if the latter is fitted) providing the support bracket was not removed during the removal of the gearbox from the chassis.

NOTE: Opportunity should be taken to remove and renew if necessary, the ball thrust bearing of the clutch operating mechanism.

- (xxviii) The gearbox should be replenished with oil after it has been re-assembled to the car. Use a recommended S.A.E.30 oil; see "Lubricants Chart for Rolls-Royce & Bentley cars" Ref:-No.RR/D2c.
- (xxix) The correct tension for the coil spring of the Ferobestos lined suspension link ("swinging arm") of the servo mechanism is finally adjusted during road test. Proceed as below:-
- a) With the front brakes functioning correctly and correctly adjusted externally, tighten the nut (1-BA-R.R.) of the clamping bolt choc-a-bloc to compress the coil spring, then release the nut back one complete turn. This adjustment will prevent the front brakes from thumping when the brake pedal is applied.
 - b) If the front brakes are not correctly adjusted, the above adjustment will not overcome thumping. If the nut is not screwed back one turn, it will probably cause the front brakes to shudder and also prevent the brake pedal from returning to its 'off' position.

7.
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Bentley Repair Depot London.

6th November 1934.

DEPOT SERVICE NO. Hd.267.

RATTLES IN TRANSMISSION - BENTLEY CHASSIS.

Origin of information:
C10/C31.10.34.

A number of Owners have complained of rattle and fuss generally in getting away from rest on Bentley cars, and it is usually found that this trouble has occurred owing to the Owner taking off in second gear.

It should be impressed on Owners by all concerned that this trouble can be avoided entirely if the car is started away from rest in first gear. An easy and pleasant change can then be made straight into synchromesh third gear and the rattle complained of will be avoided altogether.

Owner's should realise that in starting away in second gear they are attempting to use a gear on which the car is capable of doing 55 m.p.h. and which is roughly equivalent to starting a 20/25 HP. Rolls Royce car in third gear.

Hd.

4

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Perrot Duval & Cie., Geneva.

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Sa. - Spain.

R. P. Collyer, Ltd.,)

Canada.)

Mr. Avis.

21st January 1936.

DEPOT SHEET NO. Hd.297.

GEAR LEVER RATTLES.*

20/25 HP. and Bentley Chassis.

Origin of information:-
Hd/SB29/HR.20.11.35.

It has been found that the chief cause of gear lever rattles is vibration of the lever as a whole against the slot in the gate, see Fig. 1.

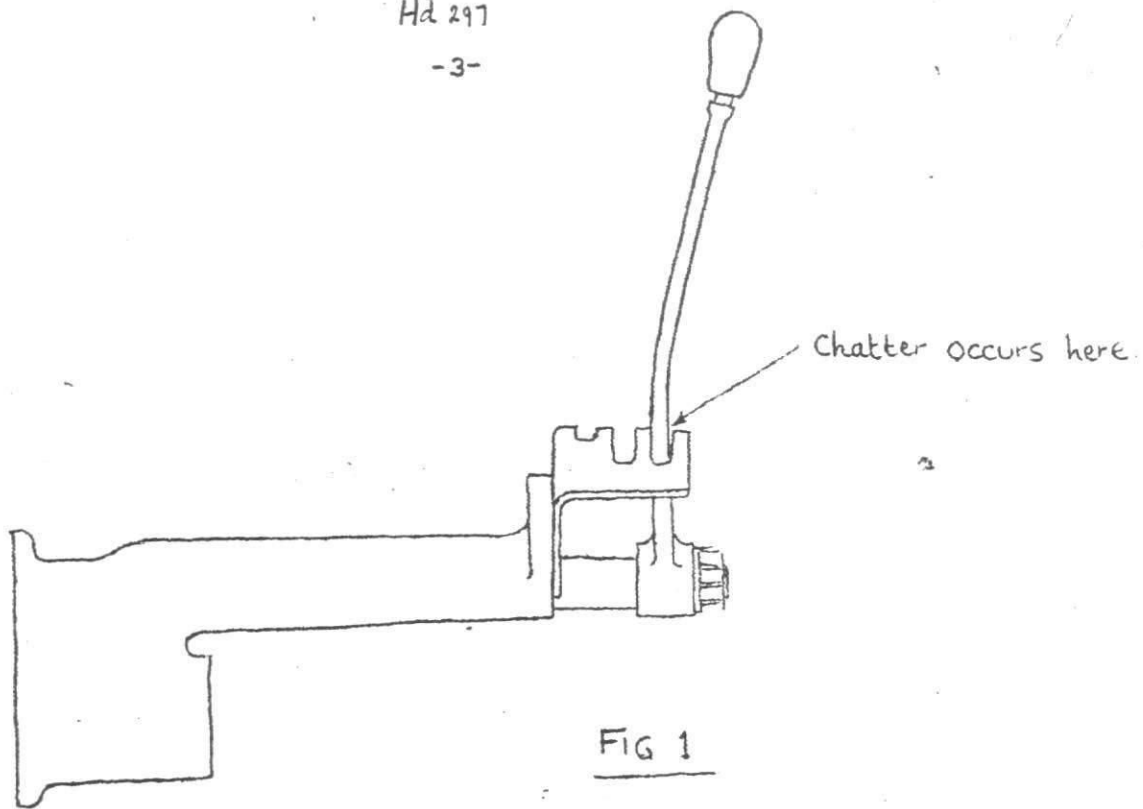
This noise may be eliminated by applying pressure to the end of the selector shaft when in third or fourth gear, thus causing the lever to be pressed sideways against the slot in the gate. This is achieved by applying a suitable rubber pad which abuts against the end of the selector shaft when in third or fourth gear.

-continued-

Hd 297

-3-

4



Drill and C'sink
for 2BA screws

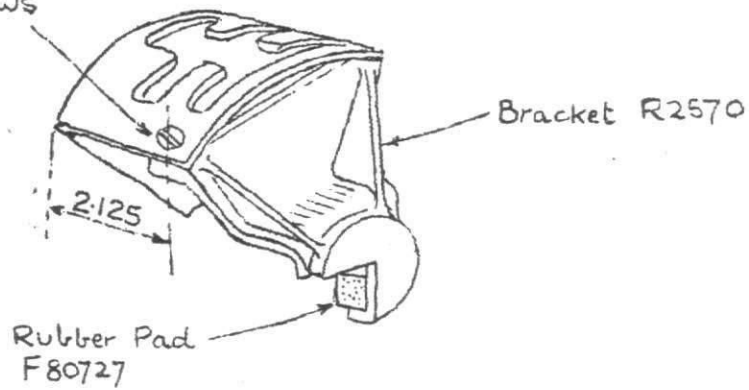
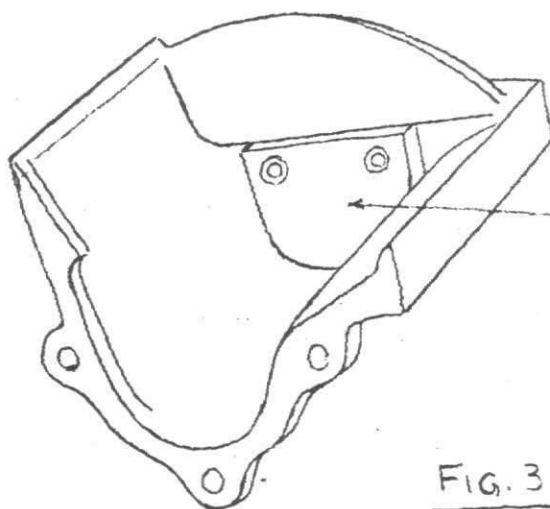


FIG. 2.

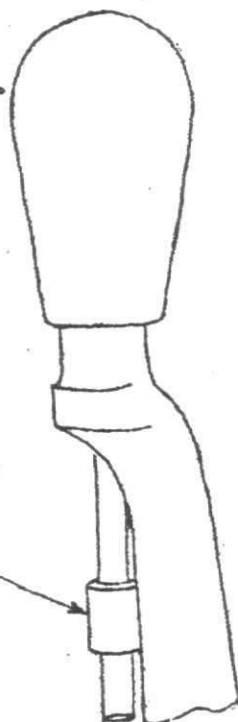
Hd. 297

83



Rubber Pad secured to
Bracket by means of
 $\frac{1}{8}$ " rivets & washers.

FIG. 3



Rubber Bush slipped over
Push Rod.

FIG. 4

g.	Mr. Reid. - Glasgow.
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Bentley Repair Depot - London.	Repair Department.

10th August 1937.

AMENDMENT TO
DEPOT SHEET NO. Hd.326.

TRANSMISSION RATTLES.
25/30 HP. AND BENTLEY 4 $\frac{1}{4}$ LITRE
CHASSIS.

Origin of information:-
BY.10/N.3.8.37.

With reference to the above Depot Sheet, which instructs the fitting of propeller shaft dampers to all 25/30 HP. and 4 $\frac{1}{4}$ litre Bentley cars, it should be noted that it has now been decided that it is unnecessary to fit these on existing 25/30 HP. cars except when actual complaints of transmission rattles are received.

The fitting of dampers to 4 $\frac{1}{4}$ litre Bentley cars will continue as already arranged.

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H.	C/o Clyde Auto Co. Ltd.	Repair Department.

12th July 1938.

AMENDMENT TO
DEPOT SHEET NO. Hd.326.

TRANSMISSION RATTLES.
25/30 HP. AND BENTLEY 4½ LITRE
CHASSIS.

Origin of information:-
BY.24/N.7.7.38.

With reference to the above Depot Sheet, which instructs the fitting of propeller shaft dampers to all 25/30 HP. and 4½ litre Bentley cars, it should be noted that it has now been decided that it is unnecessary to fit these on any more early 4½ litre Bentley cars, except when actual complaints of transmission rattles or judder are received.

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Repair Department.

14th January 1937.

AMENDMENT TO
DEPOT SHEET NO. Hd.326.

TRANSMISSION RATTLES.
25/30 HP. AND BENTLEY 4 $\frac{1}{2}$ LITRE
CHASSIS.

Further to the above Depot Sheet, it should be noted that there is a possibility that the bronze cover at the rear end of the selector shafts in the gear-box will foul the hub of the slipper flywheels.

This should be avoided by filing a flat on the casting adjacent to the hub of the flywheels so as to obtain sufficient working clearance.

Hd.

Continued:-

This is not so on the 4½ litre Bentley, and it is therefore necessary to replace the existing coupling flange with a new one, G.56815. This will probably upset the balance of the propeller shaft, and it is therefore essential that the complete shaft be re-balanced. It will be best to fit a complete new propeller obtained from W., or, if time permit, to send the existing propeller shaft to W. for modification. In the case of cars abroad, the modification would only be applied in the event of a complaint from a customer, owing to the necessity for sending out a complete new propeller shaft.

Most cars are fitted with a body crossmember just behind the gearbox, and care must be taken to ensure that there is adequate clearance for the slipper flywheels. It may sometimes be necessary to cut away the centre portion of this crossmember, and fit a metal bridge to restore its rigidity.

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7th January 1937.

DEPOT SHEET NO. Hd.326.

TRANSMISSION RATTLES.
25/30 HP. AND BENTLEY 4 $\frac{1}{2}$ LITRE
CHASSIS.

Origin of information:-
Rm/Smth3/R.29.12.36.

All 25/30 HP. cars up to chassis
No. GXM-72, and all 4 $\frac{1}{2}$ litre Bentley cars, have been
turned out without a frictional damper on the propeller
shaft.

It has now been agreed that when any
of these cars suffer from transmission rattles when
taking off, a damper should be fitted to the propeller
shaft. This is to be done whether the customer
complains or not.

On 25/30 HP. cars, the propeller shaft
is already equipped with a suitable flange on which to
bolt the hub of the slipper flywheels.

-continued-

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Derby Bentley Society – technical paper compilation

G

Gearbox

RREC, RROC & Misc Articles

when in equilibrium round a curve the rear drift angle is the other way. A bit unnerving for the driver.

All the above is, of course, 'old hat' for the vehicle engineers — it has been known of for over forty years — but I don't think it has been sufficiently canvassed for the average motorist.

An American truck was built in the last war (1939 to 1945) with all four wheels steering — front wheels one way, rear wheels the other — but was quickly dropped from production when it was found to be unstable.

The moon buggy had similar steering arrangements, but since the maximum speed was about ten to twelve miles per hour and it drove over soft earth, or should I say soft moon, it formed ruts or rails which kept it on the path, presumably with one sixth of the earth's gravity any steering arrangements would not have prevented the machine from skidding, it having the same mass.

Many fork lift and dump trucks steer from the rear only, but these have limited speed and if you watch a similar truck on the road the wheels will intermittently skid and the driver is continually adjusting the steering wheel to keep it on the prescribed path.

The proposed Japanese car, with steering on all four wheels, has, in normal motoring, all four wheels steering in the same direction — opposite to the American truck mentioned above and to the moon buggy, but the rear steering will only be a tenth or so of the front steering angle, thus almost completely eliminating the problems of rear wheel only steering. For parking etcetera the front and rear wheels turn in opposite directions, but this is only at low speeds.

Under and oversteering

Understeering, with the front wheels drifting more than the rear, results in the front paying off and the centrifugal force opposing the initially applied centrifugal force and tending to avoid increasing deviation. Oversteering will add to the initial centrifugal force and will, if not corrected, cause the vehicle to spin.

Using the vernacular, cars with oversteer are said to 'drive like a pig', motorcycles are said to 'ride like a camel', and trucks are said to 'have their rear ends skidding into the ditch'.

Conclusion

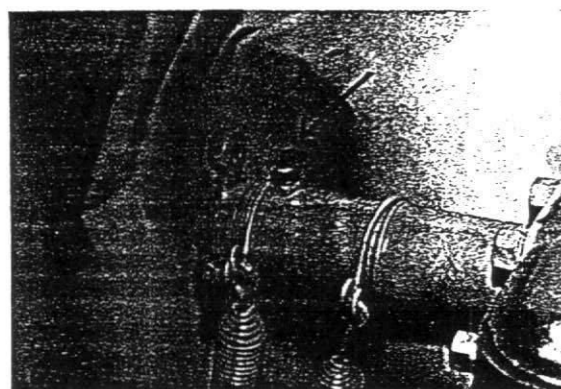
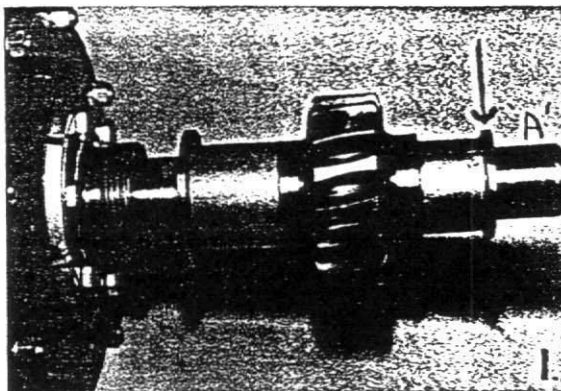
To make a really disastrous vehicle, design one with only the rear wheels steering and having oversteer.

This is really courting trouble!

Bentleys prewar: A grand tour of the gearbox appendages

by David Mico

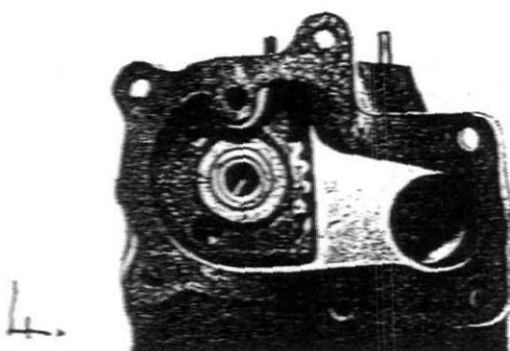
As the gearbox evolved it gathered a collection of parts which found it a useful spot to hook on to, or to take off power. Let us start at the rear, on the left



hand, or rear, side. The servo has been fully discussed, but two matters could be usefully enlarged upon. You have been warned about a washer on the drive shaft which can drop into the gearbox oil. A picture being worth a thousand words, photograph 1 shows the servo drive shaft. The end section 'A' lives in the offside ball bearing, while the offending phosphor bronze spacer washer, arrowed, lives in-board of it. While you are energetically stripping down the servo, the drive shaft is no longer held against the gearbox. As you are concentrating on the intricacies of the servo, the drive shaft moves out of its offside bearing and the washer plops down into the oil.

The ball bearings in the servo lead a dog's life, particularly the one within the draft shaft at the servo clutch end. This is the modified bearing with internal sideplay to ensure that the servo operates instantly, see drawing. The grease which is put in the bearing when fitted is limited for fear of contaminating the servo. It is flung out anyway, via four grooves, after which this bearing gets nothing. Possibly an odd oily molecule, an escapee from the oil seal, might waft along in its direction. A little more designing is necessary, for this bearing turns all the time that the car is moving, albeit at a geared down speed.

Moving forward we arrive at the shaft which operates the servo. This goes through the gearbox, an oil seal on each side of the box retaining the oil. On the



Gearbox Appendages *continued*

left side, at the end of the shaft, the bronze bush was in luck. By drilling just one hole the centralised lubrication could be tapped. However, the right side bush is in an arid area, so it gets no lubricant at all. The thought of two pieces of metal rubbing together dry puts your teeth on edge, so why not fit an oiler, see photograph 2. There are several points in the area requiring the oil can, so an extra one will make no difference.

Now we are on the offside, or right side, moving to the rear. The shaft piece for the power drive for the speedometer and the shock absorber pump is a short square section of soft iron. If, due to very severe neglect, the flexible speedometer drive, or the pump, seizes up; nothing on earth will stop the geared-down power, which then twists up the soft iron piece into knots, hopefully saving all the really vital parts.

During the past fifty years the shock absorber pump has taken on an extra role. It is now also a mechanical hammer. Its connecting rod has a very big big-end, which will keep fit for ever, but a very small small-end, which is actually a balljoint. See photograph 3. This balljoint is now very loose. Look at the top of the little brass piston. It is covered with soft solder. Melt this off with a butane flame. The Ronson, though rather a toy for many jobs, is ideal for this one. Below is a slotted brass cap. Unscrew it and you have arrived at

the balljoint. Put in some carborundum paste and work it around until it is sweet and happy. Set it just right and resolder, but *well*. Clean everything with acetone before soldering, and used killed-spirits flux (Baker's fluid). As you will not look in the pump again for the next fifty years, say about AD 2036, you may as well replace the bearings while you have it opened up.

Finally, we come to the one and only gasket in the world designed to let oil out instead of keeping it in. See photograph 4. The missing centre portion of the gasket, arrowed, leaves a narrow metal slit. The idea is that oil being flung about in the gearbox, on the left, will cascade through the slit on the bottom end of the gear lever, which is busily poking the various gears in and out of mesh. A cascade of oil seems optimistic, but an oil mist is perhaps possible. And here we are at the end of the tour. Except for the gearbox support, down below. After being sat on for fifty years the rubber is as hard as a brick. No one seems inclined to help you and you are tempted to pop the old one back. But do not forget that Henry Royce is looking over your shoulder, appraising the quality of your work, which at this moment is about to drop to zero. Just hang on for a while, an article is coming which contains new information.

The Marles Steering Box

by David Mico

You only need to get one really bright idea and you are made. When it dawned on Mr Marles that two pieces of metal *rolling* together were far superior to two pieces *rubbing* together, he was off and running.

The next task is to find propshafts. The type required must have a flange at both ends and one sliding joint. However, I found that most makes of car do not have this requirement. But, believe it or not, and this had me laughing for quite a while, both the Reliant Robin and Morris Marina had the right design! They of course would not have been strong enough. However, I did find that some models of Volvo and Jaguar were right and tough enough. These were then shortened to suit. I needed one propshaft to fit between the gearbox and overdrive, and a second between overdrive and back axle — balancing these shafts being of course very important. Adaptor flanges must be made to join propshafts to the gearbox and back axles as the centres of the bolt holes are wrong.

I then had to form an operating switch, this being electrically engaged by means of a solenoid, an integral part of the unit. A switch can be fitted to the dashboard wherever suitable and a power source found under the dash and wired to the unit. The unit must only be engaged at over 35 mph in third or top gear. Anyone who has driven a car with overdrive will recall that they only operate in these gears. A demobiliser switch must be designed and fitted to the base of the gear lever to kill the power in any other gear, the reason being that in the lower gears the revs are too slow and damage to the unit may result. The switch must NEVER be engaged in reverse gear as irreparable damage will be done because inside the overdrive unit is an oil pump operating an epicyclic gear which is *not* designed to operate in reverse.

The unit will usually hold $1\frac{1}{2}$ pints of oil, so at this level a hole should be drilled and tapped to fit a level and filler plug. In its natural application oil would find its own level in the unit from the gearbox. Dirty oil from the gearbox has been the usual cause of overdrive problems, but in this design that should not occur. A breather on top of the unit must also be fitted, this again would have been in the gearbox. Fitting this allows for pressure building up as the unit runs quite hot. Obviously I have not dealt with every last detail — but that basically is about it!

Now the moment of truth, would it work or not? Would the entire thing explode into a ball of flames? I must confess I was very nervous. Sunday morning, fingers crossed, I quietly crept from my garage and out on to the main road. So far so good — no silly noises. I got the car up to 40 mph. This is it, I engaged the switch. The engine revs dropped to around 28 mph but the road speed is still 40 mph. It works! What a relief. Feeling more confident I disengaged and engaged again — fantastic, it works exactly as it should, no fuss and no bother at all.

I found that by pressing the clutch, as if making a normal gear change, the change can be made with only the engine note to give it away. On a good road the car now finds very long legs and no more does a long journey feel like a long journey. Our first serious outing was the recent Scottish tour, covering 1,400 miles on those beautiful roads, the car felt in a class of its own. Mileage now covered is over 2,000, all with no problems.

The main idea of fitting this overdrive was not to achieve ridiculously high speeds (although I must admit the car will do just that) but to cruise at the maker's recommended speed with 27 per cent less engine revs and the added bonus of better miles per gallon. The entire project was not really all that difficult, although basic engineering skills are necessary and the help of a friendly local engineer for the machining side of things does help.

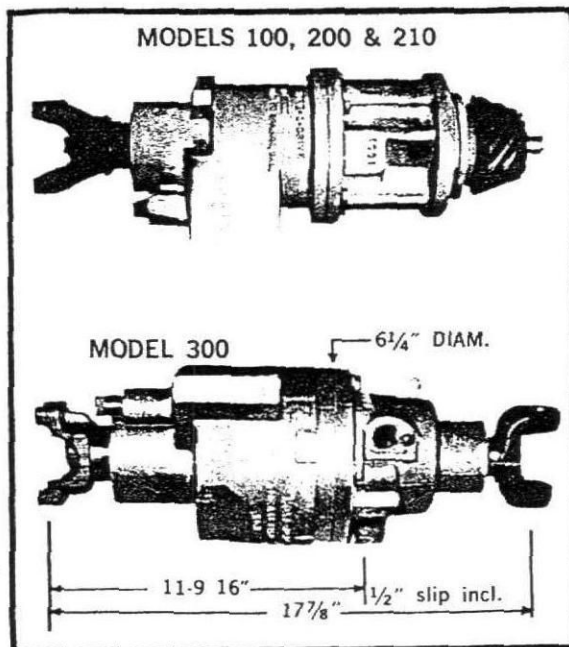
Overdrives

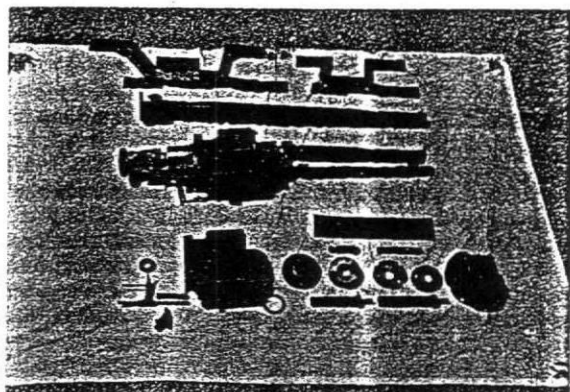
by Norris Allen, St. Louis, Missouri, USA

David Thompson's article concerning the gearing on his 20/25 cars and the subject of overdrives (B167/33) caused me to enquire of the General Secretary as to whether he would be interested in this article by me on the subject. Some remarks herein may seem sophomoric when considered by an automotive engineer or some really knowledgeable enthusiasts; however, I shall attempt to explain the subject for general consumption.

Since the publication of my first article on the subject in 1959 in the 'Flying Lady' (see later article, 'Flying Lady', March 1979, page 2174), I have read many statements which show that the subjects of engine revolutions, gearboxes and back axle gearing and their relation to each other are less than generally understood.

In a car of usual arrangement the final gearing is fixed by the revolutions per minute of the pinion gear at the end of the drive shaft to the ring gear or crown wheel. For example, if the pinion has ten teeth and the crown wheel has forty, the gearing is four to one,





which means that the engine turns over four revolutions to one of the rear wheel.

In a normal gearbox the input shaft from the clutch provides, in top gear, a straight through drive, with the output shaft at the same revolutions per minute.

Many people talk about having a three-speed or four-speed gearbox, which doesn't ordinarily change the top gear arrangement. In view of the above paragraph, the top gear is no 'gearing' at all, except as stated next.

In early Ghosts, late PIIIs and certain postwar Bentleys, the output gearbox shaft in overdrive revolved faster than the input shaft. It is accomplished by changing the relative number of teeth in the main shaft gears and the countershaft gears to do the opposite of the result of shifting to a lower gear. This arrangement is referred to as an overdrive gearbox.

The following are ways of slowing the revolutions of the engine to each turn of the rear wheel:

1. Have a factory overdrive gearbox.
2. Append an overdrive unit against the back of the normal gearbox (usually by the factory).
3. Shorten the drive shaft — install a universal joint to the output shaft of the gearbox and to the auxiliary gearbox unit which provides the overdrive and another to the back end of the unit. In the event of an X frame member it may be necessary to provide a short shaft to the unit and another from the unit to the rear axle universal joint. Remember to provide an inch or so of telescoping movement on the slip joint for spring deflection or movement.
4. Install an overdrive unit against the forward end of the pinion housing.
5. Change the rear axle ratio — not the best solution.
6. Have a two speed rear axle which incorporates a train of gears with an epicyclic arrangement behind the crown wheel, such as Auburn did — a factory job.
7. Install bigger wheels or larger tyres at the rear (obviously not very appropriate on a Rolls-Royce).

Years ago, the magic speedster number was three to one. With higher speed engines the gearing went even lower (automobilely speaking) and in many instances exceeded five to one, with very high engine revolutions per mile.

David Thompson mentions a gear ratio of 4.55 to one. In the latest Bentley models with the powerful engines the gearing is less than two and a half to one. The subject is controlled not only by whether the car will go a certain speed but rather how will it do it and with what results.

In driving in traffic or around the hedgerows, the lower ratio is quite satisfactory. With an auxiliary gearbox on level concrete roads at rather high speeds the slower revolutions per minute reduce engine wear, cut down the fuss, reduce oil consumption, greatly improve petrol mileage and provide, in an older car, a more satisfactory ride for the occupants.

If cutting the drive shaft is abhorrent, any truck repair shop can make up a new drive shaft or a set of two if necessary, due to an X frame member, that will be at least as good as the original one which can be reinstalled if desired.

In the June 1959 issue of the 'Flying Lady', at page 389, there appears a picture of the unit I installed on my PIII prior to driving it from St. Louis to a meeting in Montreal, a distance of 1,200 miles. Four cars were driven, a PII, a Springfield PI coupe and another PIII.

I had overhauled the engine on my PIII and finished the job the day before we left. At every second filling station I drove in with the others. Each of the other cars had petrol consumption of nine miles per gallon at fifty-five miles per hour. My PIII did twelve. Later on, in a drive to Pennsylvania, with five people and

luggage aboard, the mileage was fourteen to the American gallon, which to the Imperial gallon should calculate to a shade less than nineteen miles per gallon. Of course, if one has a heavy foot it is easy to increase the fuel consumption.

My PIII in the epicyclic gear arrangement simply floats at highway speeds. All PIIIs were geared 4.25 to one. The usual stateside on overdrive gear change for passenger cars is point seven (0.7); for trucks point eighty-two (0.82). Multiplying 4.25 by 0.7 gives a final ratio of a bit under three to one. The 4.25 ratio for city driving is fine; the overdrive ratio is perfect for highway driving.

I have installed three gearboxes, dubbed 'Brownie Junior', made for light trucks, with a step up of 0.82 which were quite satisfactory. These are countershaft units and make a slight hum in overdrive. They are not now available.

No problem is encountered in an open driveshaft car called a Hotchkiss drive. However, when considering an overdrive for a Ghost or a Phantom I with a two section torque tube, the forward tube of some seventeen or twenty inches is replaced by a rigid unit containing the gearbox. The unit is attached to the back tube and to the sphere. I have fashioned such a unit.

Frank Cooke of Massachusetts, who is in the automotive business, has engineered some of these, for

which he claims satisfactory results. I understand that Laycock has made some units that may be adapted.

My own experience has been quite extensive on the subject. I have installed units in three PIIIs I have owned, one unit in my eight litre Bentley (3.53 x 0.82), a transmission with an overdrive step up in my Dusen-berg S.J. roadster, and a unit in my D.E. 36 Daimler — the Lady Docker gold car. I have finished the engineering on the front torque tube section on my Springfield PI York roadster and I trust it will be installed soon.

Of course, one must not endeavour to go up very steep grades with the small horsepower cars in overdrive and thus 'lug' the engine.

I recently spoke to a person who has a 20/25 with heavy convertible coachwork. His car has a unit with a step up of point seven. I had wondered if the small engined car could handle such gearing. He has a home in Florida and one in St. Louis, with some twelve hundred miles between them. He assured me that at highway speeds the car runs as desired in overdrive.

An organisation called Hone-O-Drive, situated in Sparks, Nevada, outside Reno, has made units including an epicyclic unit for caravans and such applications. It is numbered 350-T. It seems to have gone out of business. To a mechanic of reasonable mentality, this whole subject is really quite simple. Brakes in proper condition can easily handle highway speed driving. In the States, Borg Warner made thousands of units installed behind the gearboxes and in about

1970 made units to append to pinion housing, but never went into production on these. The little gearbox called Brownie Junior is no longer produced. The Dana Corporation of Toledo, Ohio, made some units for in-line application, one of which I have adapted for the PI roadster to replace the forward section of the torque tube, but here again sales did not justify production. It seems that adaptable units may be available in England.

The result of an installation is so satisfactory that the trouble in searching for a unit is worthwhile.

A few Silver Wraith axle gears have been installed in PIIIs. They are pitifully puny compared to the PIII gears and only give a partial benefit in gear reduction.

I drove the James Young parallel door PIII, with my aged mother of one hundred and one years resting in the back seat, some 825 miles with the car in overdrive in one day. It drove at least as well as one of my PVs.

A number of club members in the States have added this improvement to Ghosts, PIs, PIIIs, PIIIs, my eight litre Bentley and other cars. In each instance they extoll the virtues of the arrangement.

The large automotive parts company of J. C. Whitney and Co., 1917 Archer Avenue, Chicago, Illinois, USA 60680, appears to stock a series of overdrive two-speed auxiliary transmissions specifically for various General Motors and Ford trucks, vans and automobiles. I am quite sure that one of these could be adapted for an 'in-line' application.

Silver Cloud Gearboxes

by Marsden Robinson

(These notes are written for a Silver Cloud I but applicable to later cars.)

THE gearchange in your car should be almost undetectable if the gearbox is in good order. If the changes are jerky or slip, you can probably effect a substantial improvement in a matter of minutes.

The thing to attack is the rod which comes forward from the gearbox, on the left side of the car, to the cross-shaft connected to the throttle. It will be found above the starter motor, and has a clevis at the front end.

The gearbox must be thoroughly warmed up first — take the car for a ten mile run before starting the experiment.

Slacken off the locknut behind the clevis, and remove the split pin and clevis pin; adjust by screwing the clevis further on to the rod, or unscrewing it.

Screw off (anti-clockwise from the front) if the gear-

change slips or is slurred, or if 'kickdown' does not occur readily enough.

Screw on (clockwise from the front) if the gear-change occurs with a bang.

I suggest that you adjust half a turn at a time, and road test the car. The range between slipping and thumping is about three full turns. You can easily stop on the side of the road and make a further adjustment.

If you can't achieve satisfactory results, the bands in the gearbox may need adjusting, or the gearbox may need an overhaul.

In practice, you may not be able to find an absolutely perfect setting, and instead have to make do with a compromise where no changes are quite as smooth as you would like, but none is too bad.

Rebuilding the Small Horsepower Transmission

By R. PIERCE REID, MA—Technical Editor
Photography © 1998 by K. and M. KARGER

"You don't need to mess with the transmission." "They never go wrong." "Small Horsepower transmissions are bulletproof."

So stated a number of armchair mechanics with whom the author discussed rebuilding the transmission on Derby Bentley B143HM.

But Bob Jefferson of Sports Classics, in his usual quiet and calm voice, asked: "You will be replacing the bearings in your transmission, won't you?" And when Bob suggests something in the form of a question, you respond by saying one thing: "Of course, Sir!"

Prior to taking on this rebuild, the author had three somewhat hard and fast restoration rules: I am a mechanic, not a body man; wiring is a necessary evil; and I don't do transmissions. Now, only two rules remain. Transmission rebuilding is not as daunting as it appears and can be handled by personal restorers with minimal equipment. And even if you do not want to do it yourself, it certainly makes sense to have your restorer or mechanic pull the transmission and restore it during an engine rebuild. The parts cost is low; the hours are reasonable.

After all, what is the point of having a silent engine when the transmission screams like a banshee?

The rebuild has resulted not only in a smooth and silent transmission, but in a new appreciation for the ruggedness, simplicity—and Achilles heels—of Henry Royce's Small HP transmission.

The purpose of this article, which will run in two parts, is to both de-mystify the Small HP transmission and to provide a photographic and textual supplement to the Service Sheets. Though the Service Sheets are an excellent reference, they leave out points useful to anyone who was not a premium apprentice at Derby.

Also, though a lot of the material in this article will be applicable to a full overhaul and gear replacement, it primarily focuses on bearing replacement which is a mostly straightforward exercise in dismantling, cleaning and refitting. Several steps that must be carried out when new gears or shafts are fitted are not covered in detail. And since the servo, ride control pump and speedometer drive are projects in and of themselves, they won't be detailed here.

The Basic Design

There are actually three major variants of the Small HP transmission. The article focuses on the four-speed unit fitted to the late 20 HP, the 20/25, the 25/30 and Derby Bentleys through L-Series. The basic principles, however, apply to all models from PII through the rationalized range.

The first Small HP transmissions were a center-shift three-speed used in the 20 HP cars up to 1925. Many claim this to be superior to the later four-speed. However, center shifting was regarded as a feature suitable only for "cheap cars" and though the customers may not have needed four speeds, they were not going to settle for only three.

So, after customers and pundits alike panned his brilliant three-speed, business-savvy Royce sat in his West Wittering studio and gave the customers what they wanted: a four-speed side shift transmission so well-designed that there was little need in three decades to change it.

From a technical standpoint, this transmission is a four-speed H-pattern side shift with synchromesh on top gear. The transmission also serves as a power take-off for the speedometer drive, the brake servo and, later, the ride control pump.

The design of the transmission is quite straightforward. Two of three motion shafts run in caged ball bearings with the second motion shaft riding in a roller bearing at its rear end. The reverse shaft runs in a delicate white-metalled bushing. Think twice before participating in auto gymkhanas which require high-speed reversing!

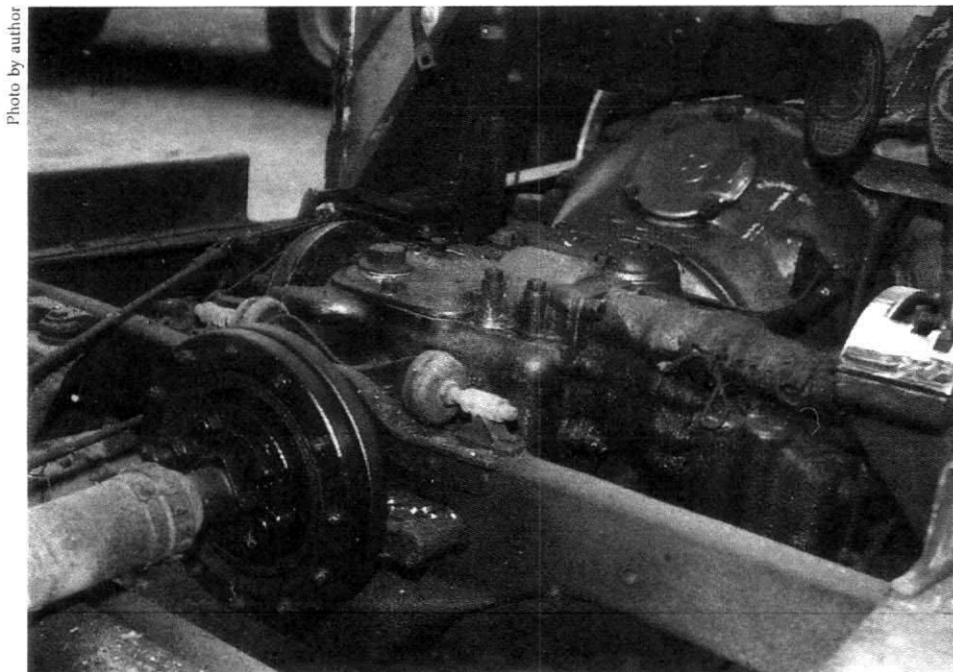
But the simplicity of the transmission is its savior and unless it has run dry of oil or the gears have been mashed so many times that they are spitting teeth, it is likely to only need cleaning and bearing replacement to return it to new.

A Word about Safety

Before removing the transmission, the car will need to be raised on jack stands for easy access. Put some additional supports under the chassis for added safety. Never go under a car supported only on jacks. Also the transmission itself is heavy so be very careful handling it.

By the Book

Before proceeding, you need some factory literature, namely the Bentley Service Sheets published after the war and available from Club Stores (Item 3566). Though written for the Derby Bentley, the transmission section covers all four-speed small HP transmissions and is an excellent reference. Especially useful are the schematics and it is worth going to a copy-center and having a poster-size



Transmission after de-bodying. 60 years of oil, dirt and muck come to light. But the real work is inside.



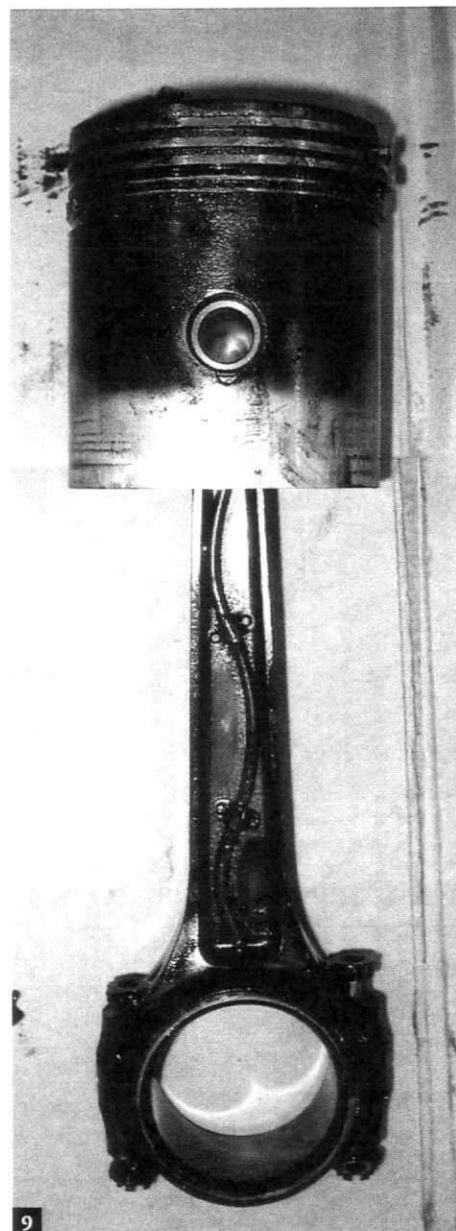
7 The crankshaft has hollow journals that fill with oily sludge as a result of the centrifugal-like action of the spinning crankshaft. Aluminum plugs seal the ends of the journals and are held in place by through-bolts. The plugs should be removed and the sludge cleaned out so that oil flows freely to the big ends of the connecting rods. Note build-up of sludge in journal.



8 Aluminum sludge trap seals showing build-up of oil sludge and plug of sludge (middle) removed from journal.

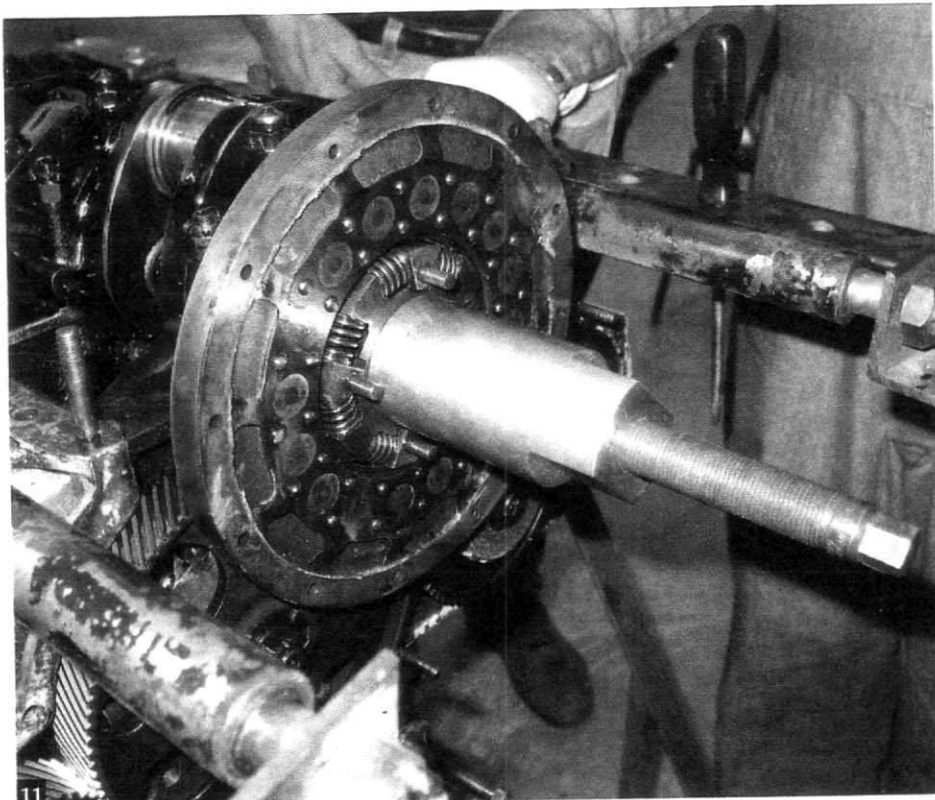
antifreeze. After removing the radiator from the car, plug the bottom drain and fill the radiator with an antifreeze/water mixture. This prevents corrosion build-up and the old solder from drying out and possibly resulting in pin-hole leaks. Tim uses a torque wrench to remove each nut on main and connecting rods **6**. The torque values required to loosen each nut are recorded,

Robert Reynolds (MI), Tim Jayne (PA) and Peter Egeli (MD) inspect a piston for carbon build-up, scuffing, and piston ring integrity after removal from the block.

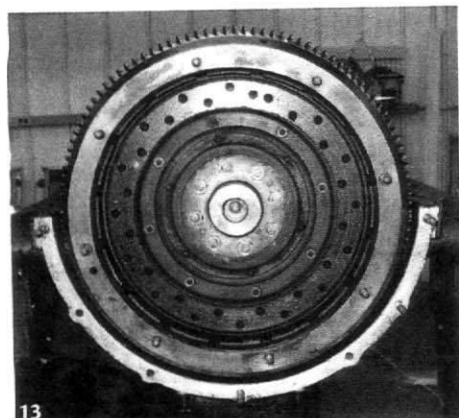


9 The connecting rod has an external oil line that is soldered at the top and bottom of the rod. The solder joints are subject to coming loose and should be pressure tested to insure they do not leak. You can fish a piece of piano wire down each oil line to insure it is clear. The integrity of the oil line is important since it is the sole source of lubrication to the small end of the connecting rods.





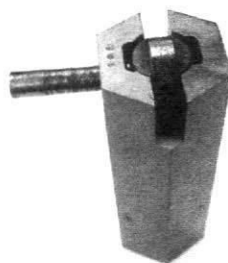
11 Removal of the slipper flywheel requires a left-hand threaded puller.



13 The flywheel bolts are peened over or center-punched to secure them. You have to grind off the bolt edges to remove the nuts. Be sure and use new bolts on the rebuild.

noting the cam side and off side torque values. Comparison of the torque values might highlight potential bearing problems and can be used to reinstall the existing bearings if they do not require new babbitt and line boring [7], [8].

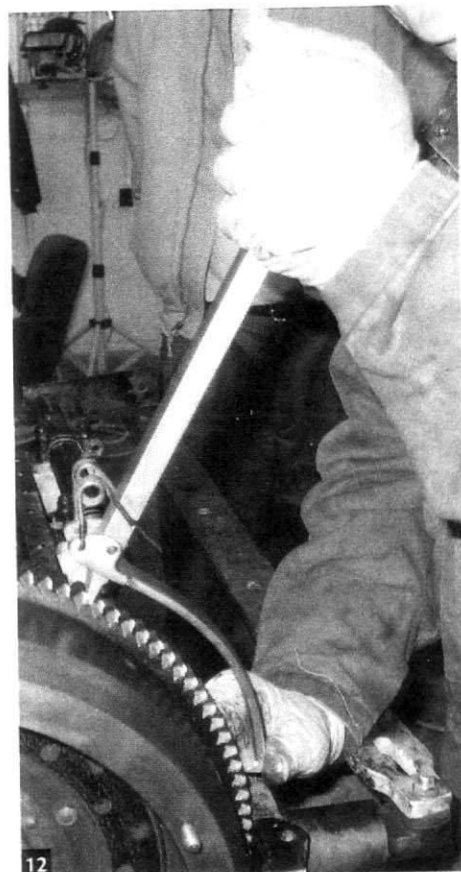
The connecting rods on early cars have an external oil pipe that should face the center of the engine when they are reinstalled [9], [10]. In dismantling the slipper flywheel, look for alignment marks on facing surfaces (usually an "o"). If no such marks can be found, use a punch to mark facing surfaces to assist in reassembly. The puller for the slipper flywheel is left-hand threaded [11]. The bolts attaching the flywheel are peened over the nut or are center-punched to secure



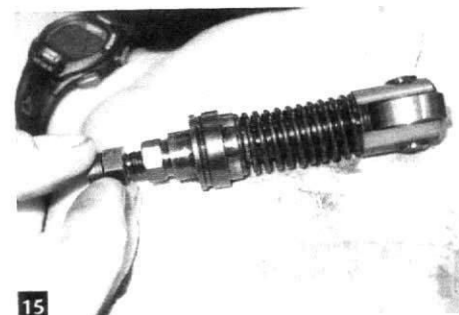
14 Shop-made tool to remove the pin in the cam roller bearing. The hex stock was bored out to accept the cam roller bearing and slotted to hold the wheel in place. A cross-drilled hole allows a punch to be centered on the wheel for removal of the pin.

them in place [12]. You have to grind off the peened-over portion of the bolt flush with the nut before they can be removed. This destroys the bolt, and new ones should be used on reassembly [13]. Tim reassembles the flywheel nuts with Loctite rather than peening over the bolt to secure them in place. The cam is held in place by steel dowels that require a puller to extract them from the block [14]. With the pins removed, the camshaft and cam bearings can be removed intact from the front of the engine [15].

In removing the main bearing caps on the crankshaft, be sure you keep the orientation of the caps the same as removed (do not reverse). After the crankshaft is lifted from the engine,



12 Snap-On makes a generic flywheel tool (A144) that fits the small horsepower flywheel. It can be used to turn the flywheel or hold it in place to remove the flywheel bolts.



15 Cam roller bearings should be removed and closely inspected for pitting of the cam wheel and play in the wheel. The pin and/or wheel should be renewed if worn to assure a smooth running engine.

reinstall bearing caps in the same orientation as removed.

1 Fiennes Engineering, Clanfield Mill, Little Clanfield, Oxfordshire OX18 2RX, ph 01367 810438, email: enquiries@fiennes.co.uk, Web: www.fiennes.co.uk

2 Ristes Motor Company Limited, Gamble St, Nottingham NG7 4EY, ph 0115 9785834, email: info@ristes.zee_web.co.uk

3 Rolls-Royce Small Horsepower Engines (The overhaul of Rolls-Royce 20 h.p., 20/25 h.p., 25/40 h.p., Bentley 3½ litre and 4½ litre engines), R. Haynes and M.A. Grigsby, published by Rolls-Royce Enthusiasts Club, 1977

4 Antonini Radiator, Inc., 325 East Railroad St., Pottsville, PA 17901, ph 570-622-3044



Using the Schematics and General Arrangements Drawings is a must. Here the author compares the second motion shaft to the drawing from the Service Sheets.

drawing of each made to hang on your shop wall. The Derby Bentley Technical Manual published by the Bentley Drivers Club is an outstanding reference and much of it applies to the entire small HP range.

A copy of the General Arrangement Drawings for transmissions is also useful and can be ordered from Club Stores.

Also needed will be a variety of hand tools, an assortment of wrenches, a rubber mallet, ball-peen hammer, brass drift about 6 inches long by 1/2 inch in diameter, hones for de-burring any damaged gears and, possibly, a machinist's scraper. You will also need a wrench that can accommodate a 1.825 inch nut. And since there are several operations where a hydraulic press is a must, that 20-ton press you bought to restore your shock dampers will pay for itself yet again.

Finally, you should invest in a set of metal stamps and a paint pencil (available at most art stores) to mark parts as they are disassembled.

Getting it out

First drain the oil by removing the front and back drain plugs.

Transmission removal will vary by model, but generally involves removing the engine pans and disconnecting the propshaft. Disconnect the brake linkages, ride control (if

fitted), Bijur lines, speedometer drive and unbolt the shifter gate from the frame. You may have to move some wiring conduits as well. Unbolt the engine from the bellhousing and unbolt the rear support crossmember and the pedal shaft from the frame. Check for snags or hang-ups before final removal.

If the body is off, the transmission lifts out easily from between the frame rails after moving it backwards to disengage the drive splines from the flywheel. If the body is on, the transmission must be moved backwards and then lowered from between the frame rails. A transmission jack is very helpful in this case and can be obtained from rental centers. Do not use a floor jack as the transmission can slip off easily with dire results for the cast aluminum housing.

Once the transmission is out, unbolt the bellhousing by removing the ring of ten nuts inside the casting. However, do not disturb the two nuts at eight and four o'clock, as they are threaded on countersunk screws and are removed later with the diaphragm plate.

As an aside, you will have easy access to the clutch and flywheel at this point. Inspect the flywheel for wear and look at the clutch. If you don't know the provenance of your clutch, have the flywheel ground, a new nose bearing fitted and the clutch plate relined while you can.

YUCK!

This will be the first word out of your mouth when you finally see the transmission.

For an initial cleaning and disassembly the author mounted the transmission on an engine stand. For final disassembly and re-assembly, a humble Black and Decker Work-Mate was ideal.

Once the transmission is secured, attack it with GUNK degreaser and hot water, alternating between the two until the transmission is clean on the outside. Several hours of work will transfer all the oil and filth from the transmission casting to your clothes, hands, hair, face, etc. If you have been looking to involve your wife, kids, neighbors or friends in your restoration, this would be a great time.

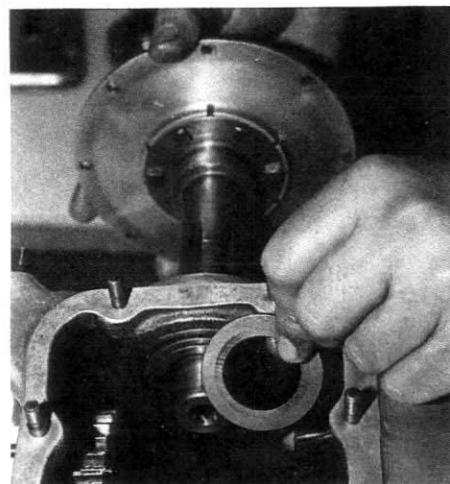
Once the casting is clean, remove the two top covers, saving the gaskets for use as patterns.

Taking Off The Peripherals

Start by removing all the Bijur lines and level plugs.

Remove and set aside the aluminum top cover from the gear selector shaft on top of the transmission, then remove the ride control pump and speedometer drive, taking with it the shifter. Take careful note of the gasket patterns. The gaskets between the transmission and shifter are intentionally designed with an opening to let air and oil mist circulate to the speedometer drive. Whether this is effective is unknown, but perhaps a few molecules of lubricant waft their way to the accessory drives. In any case, the gaskets must be remade exactly as original, so save as a pattern.

Next, remove the servo parts, taking good notes so you can get it back together. Be



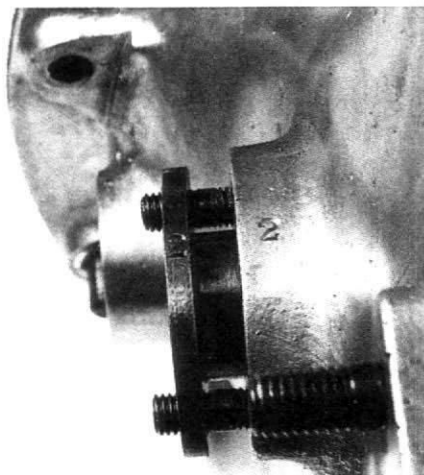
The servo shaft thrust washer. If not held carefully, this will drop into the depths of your transmission. Fine if the transmission is on a bench... difficult if it is in your chassis.

careful of the notorious "ker plop" washer. This thrust washer is so named because when you pull the shaft out a little too far, you will hear "ker plop" as it falls into the bowels of the transmission. Not so bad if the transmission is on the bench, but a real pain when the transmission is in the chassis. Mark the servo drive gear before removal so you will orient it correctly on reassembly. It will fit back in either direction, but should be assembled as it came out to bed correctly with its mating gear. Now remove the servo countershaft, which is a large shaft running through the center of the transmission. Inspect the top-hat bushings in which the shaft rides for wear or damage, though it is likely to be in good condition. Remove the servo bridge pieces and pneumatic damper. Inspect servo linings and renew as necessary.

Now you are ready to start dismantling the transmission itself.

Stage Fright Sets In

So far, you are probably pretty confident, especially since everything is well-documented and straightforward. But now it's time to pull apart the casting and dig around inside. Don't be afraid.



Bushings for the Synchromesh actuator.



Synchromesh actuator and bushings. Do not disassemble this unit further, as it is fitted and aligned at the factory. Clean the unit as a whole.



Reverse motion shaft. This rides in a white metal bearing, which is quite delicate. High-speed reversing is not recommended in your Small Horsepower Rolls-Royce or Derby Bentley.

Start by removing the actuator for the synchromesh unit by undoing two egg-shaped housings on either side of the transmission. These are marked 1 and 2 with corresponding marks stamped in the aluminum housing. The actuator then lifts out through the rectangular portal, with some fiddling and colorful language. Do not disassemble the actuator further—clean as a unit.

Now follow the instructions in the Service Sheets to lock the transmission motion shafts so that the retaining nuts can be removed. Using a bar to push the center selector shaft forward, engaging third gear. Then push the left selector shaft backwards, engaging reverse. By simultaneously engaging both gears, the transmission is locked solid.

Next, bend over the lock tabs and remove the retaining nut (RH thread) from the third motion shaft and remove the coupling flange for the propshaft. Once the nuts are off, remove the distance washers and put them in carefully-marked baggies or tie them to the appropriate nuts. You do not want to mix up any of the distance pieces or thrust washers.

Remove the support bracket from the rear of the transmission, keeping careful track of the order of the various plates, bushings and rubber blocks. Now remove the cast aluminum oil retainer/oil drain pipe, exposing

the large retaining nut and bearing for the third motion shaft.

Next, remove the bearing cover from the diaphragm by undoing the 11 nuts. This will expose the large retaining nuts that hold the front ends of the first and second motion shafts. Remove the nut (LH thread) from the first motion shaft and save the clamping washer. Then remove the nut (RH thread) from the second motion shaft.

Around back again

Now remove the bronze shifter rod guide/detents. Start by removing the aluminum plunger housing cover. Remove the three springs and the three .500 ball bearing detents. Undo the nuts securing it to the transmission housing, move gearchange actuator rods forward and remove the housing. Whether rebuilding your transmission or not, simple cleaning of the housings will do wonders for the smoothness and crispness of gear-changing on your car. The passages are a magnet for sludge that virtually glues the rods into place.

Do not remove the figure eight-shaped plate at the rear of the transmission yet. This supports the second motion shaft and reverse motion shaft and must be left in place until the front retaining nuts are removed and the shafts are ready to come out.

Open 'er up

Start by removing the large cast-aluminum diaphragm from the front of the transmission. Though the Service Sheets reference a rather complex and substantial puller, in practice the cover comes off with little difficulty. The diaphragm will bring with it the first motion shaft which runs only a third the length of the transmission and ends with the forward synchronizer cup.

If the diaphragm is somewhat reluctant to come off, it should go without saying that you must never use a chisel or sharp screwdriver in the joint line. This will ruin your castings and make an oil seal virtually unattainable. If the diaphragm does not move

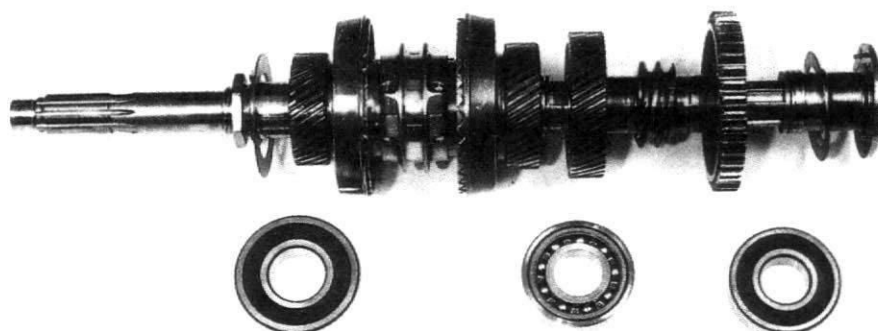
easily, try using a rubber mallet to strike glancing blows around the circumference. Try heating the main casting with a propane torch. If all else fails, borrow or build the puller described in the Service Sheets. Never pry apart components on your Rolls-Royce or Bentley.

How about a Tip?

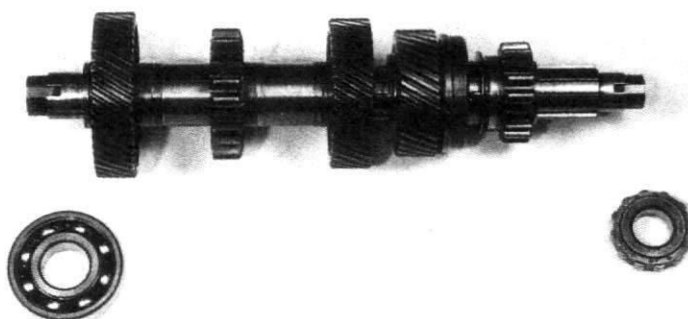
Now it's time to start removing the shafts and their gears. Though this is described well in the Service Sheets and does not warrant detailed repetition here, several tips may come in handy.

First, everything must go back into the transmission in precisely the order and orientation it came out. Not only must you get the distance pieces and thrust washers back between the gears correctly, but you must make sure that the gears are oriented in the right directions. The reverse driving gear, for example, will fit either direction on its shaft and will even mesh part-way on its mating gear. When assembled backwards, the transmission will turn quite nicely—until a load is applied. Then the gears slip badly and the reverse gears grind each other to pieces.

Photograph and sketch everything! Since the shafts are among the last items removed from the main casting, use some rods or pieces of broom handle as shaft substitutes to keep the parts correctly oriented on the bench during disassembly. Also, some of the gears will not come out until others are removed, as they overlap. To help visualize the design, ease reassembly and keep parts together, lay out the shafts with the gears and bearings as they mesh in the transmission.



First and third motion shafts and associated bearings. The first motion shaft is on the left and fits into the flywheel, ending at the left synchronizer cup. The third motion shaft runs from the rear synchronizer cup to the output flange for the driveshaft.



Second Motion Shaft and bearings. Angle cut gears are constant motion gears used to keep the shafts moving in the correct relationship. Straight cut gears are driving gears.

Step-by-Step

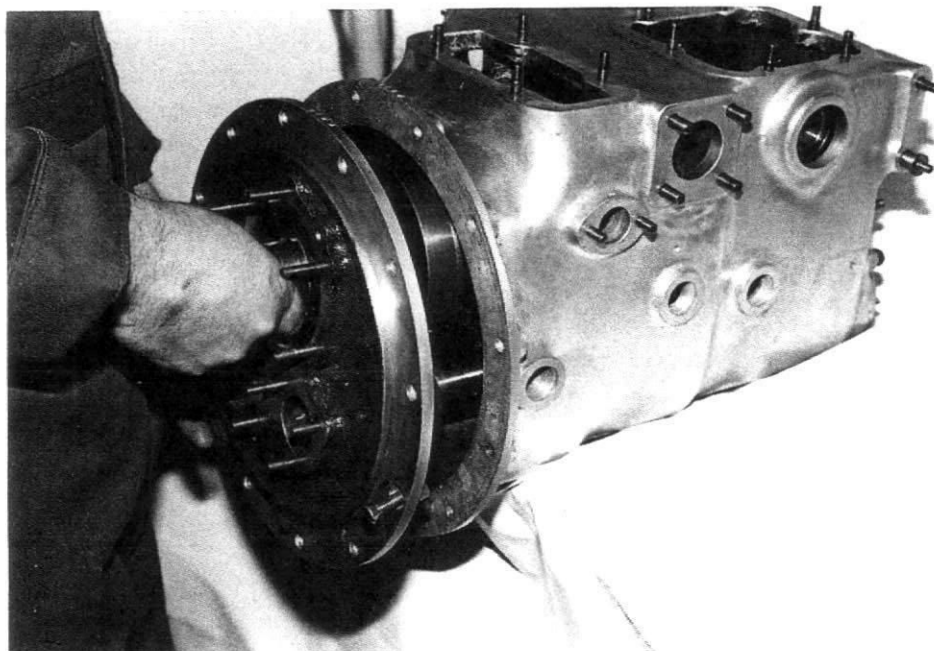
Again, the Service Sheets will provide the detail, but the major steps in dismantling are as follows:

Drift out the third motion shaft. Though

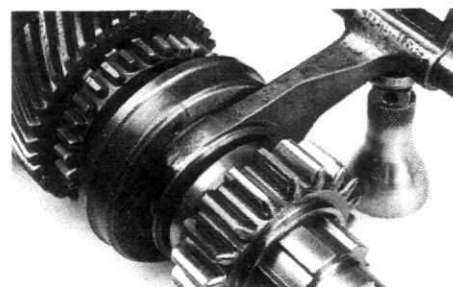
the manual suggests a beveled steel drift $\frac{7}{8}$ " in diameter and 12 inches long, the author used an aluminum drift instead with no problems. It is critical that you not distort or damage the end of the shaft.

Now remove the small figure eight-shaped plate at the base of the transmission to expose the ends of the second motion shaft and the reverse shaft.

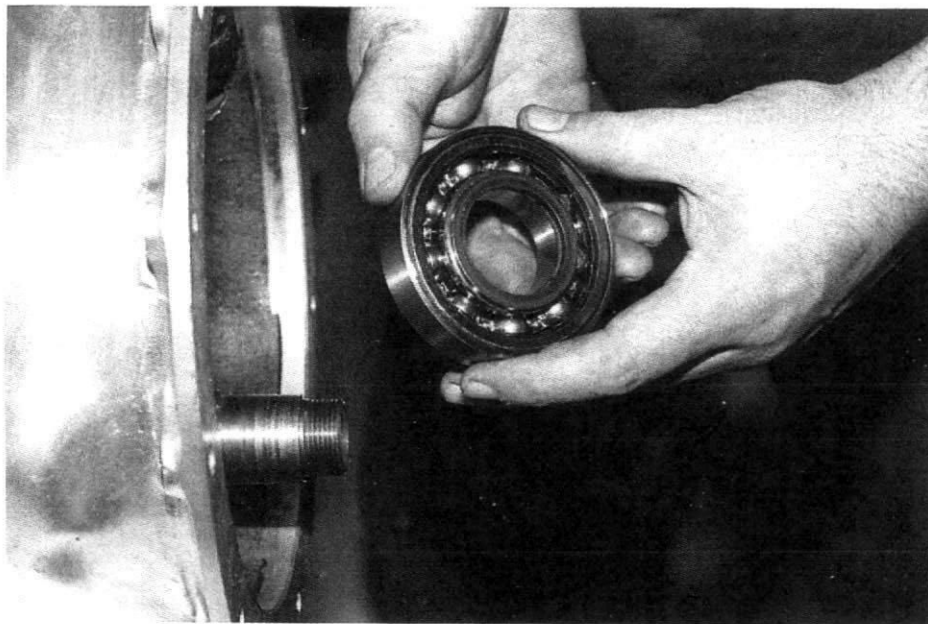
The second motion shaft, which runs on roller bearings at its rear should remove without difficulty but a brass drift may help dislodge the bearing in the center web of the transmission. Remove the corresponding shift actuator fork as the shaft comes out. Remove the reverse motion shaft and its corresponding actuator.



Removing the diaphragm which brings with it the first motion shaft and the front synchronizer cup. The Service Sheets state that a puller is needed, but this is usually not the case.



Second Motion Shaft showing shift actuator rod in place. Note the etched line on either side of the rod. You must align these parts to match up the etched lines... these were put in at Derby.

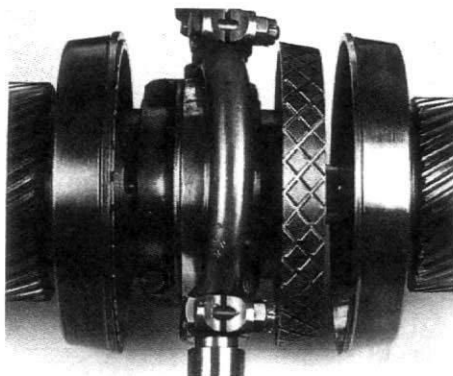


Center bearing for second motion shaft. This is one of the five bearings you will be replacing.

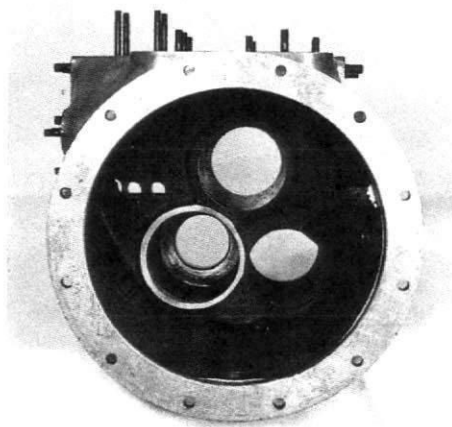
Finally, since bearing replacement is the primary reason for dismantling the transmission, the first motion shaft and its synchronizer cup will have to be pressed from the diaphragm. Be careful to support the diaphragm well so as not to distort it. Use a brass drift to remove the second motion shaft bearing from the housing.

In Synch

The last unassembled parts you will have in hand are a pair of synchro clutches. It is unlikely that these are worn, even after tremendous mileage. They are peened together and final machined as a unit. Unless the synchros are seriously damaged, there should be no reason to disassemble them. Clean them as a unit, using a toothbrush and solvent to clean out all the channels and machined surfaces. Do not bead blast or use a benchtop wire brush. Use only solvents, hot water and soft brushes.



Synchronizer unit shown in relation to synchro cups. Do not disassemble this unit. It should be gently cleaned using solvents and soft brushes. It is unlikely to show any wear, even after tremendous mileage.



Casting after several rounds of cleaning. Factory paint inside was impervious to everything, so the author decided to leave it alone to do its job for another 60 years.

Let the cleaning begin!

Now you have an aluminum casting filled with sludge and filth (but hopefully not any gear teeth.) Clean this unit both inside and out. Bead blasting is not recommended as the beads will end up in passages and blind spots only to come out when the transmission is back together. The author used wire brushes, GUNK degreaser and several rounds with the garden hose to achieve a spotless transmission housing. The diaphragm should be treated the same way.

The rest of the parts will need to be cleaned spotless so that any damage, cracks or other faults can be spotted and rectified. If you don't own a parts washer, these inex-

pensive tools are a great investment. Save the dishwasher for the china. Never wire-brush or use abrasive cleaning on gear teeth. Use solvent, hot water, toothbrushes and rags to remove grease and dirt.

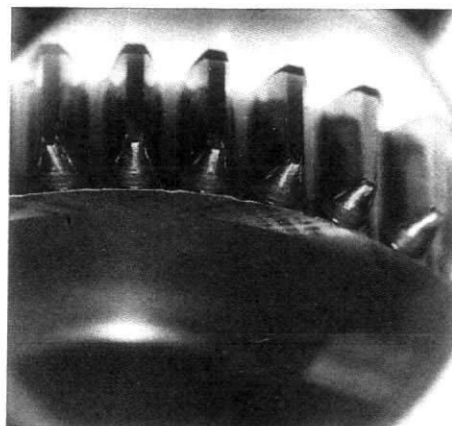
Inspected by number . . .

Once the parts are clean, some inspection is in order.

Check the gear teeth and look for any cracks, broken teeth or severe damage from poor shifting and gear-grinding. Cracked or broken gears will have to be replaced, always in pairs. Used replacements are often available from Dale Powers and new-manufacture gears are available from Fiennes Engineering for most transmissions. If you are replacing gears, a more involved fitting procedure requiring precise measurements and spacer washers is necessary. See the Service Sheets.

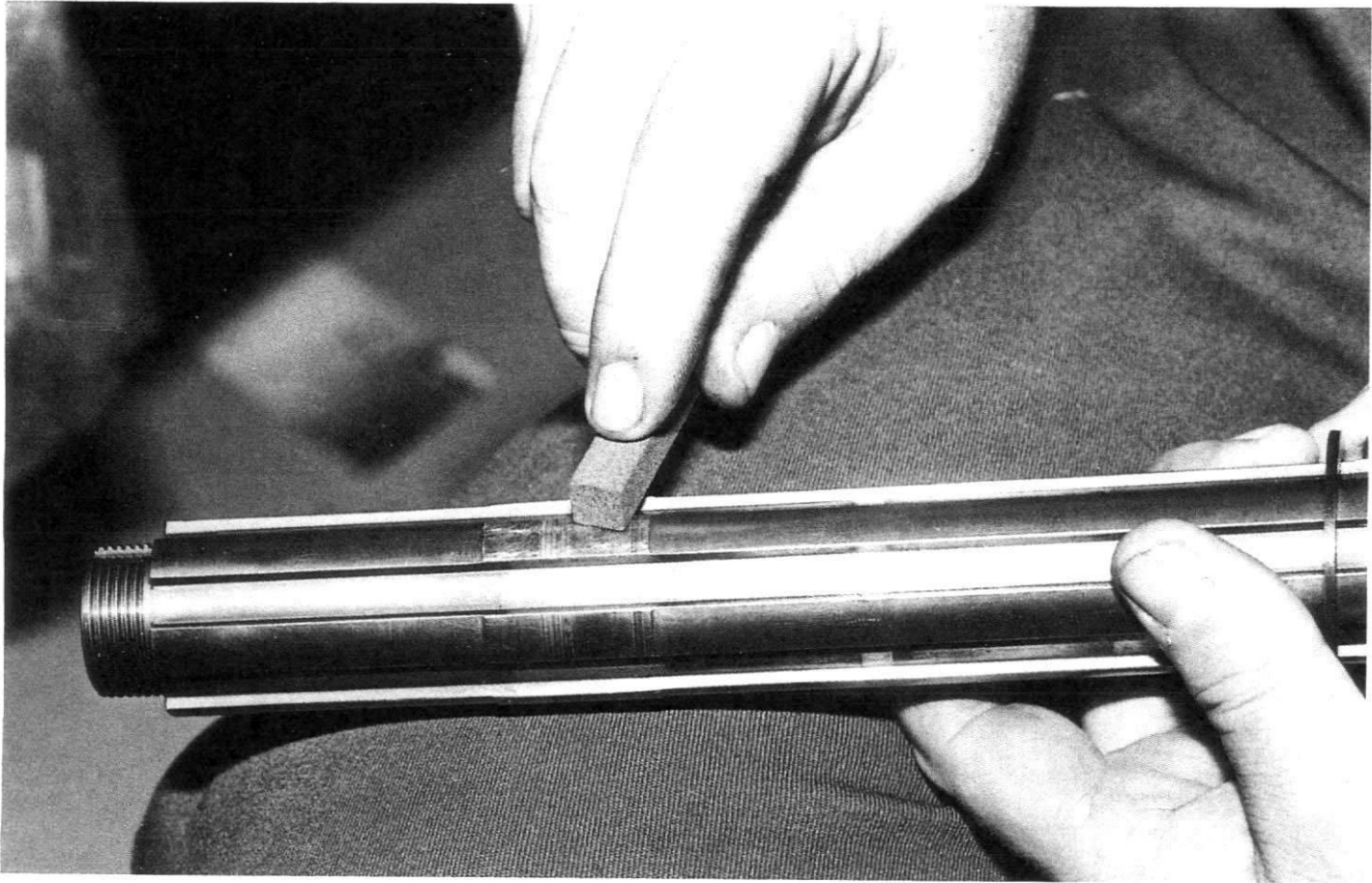
Note that there are two types of gears: straight cut gears, which are the actual driving gears; and angle-cut constant motion gears that keep gears moving together to ensure smooth shifting. The constant motion gears are likely to be in fine shape. But if any of your driven gears are damaged or missing teeth, check the constant motion gears closely for damage. These, too, must be replaced in pairs as they are run in at the factory in rouge.

The shafts also need inspection with special attention to the second motion shaft. Under some circumstances, this can dislodge from the center race of the middle bearing and spin within the locked bearing, causing a groove. This also can apply to the center and rear journal of the third motion shaft. The diameter of the center journal of the second motion shaft is $1.37795 + 0.00025$. The diameter of the third motion shaft is $1.3779 + 0.0001$. If these tolerances are off, new shafts will be required or the old ones will need to be built up and ground to specification.



Close-up of gear teeth taken after dressing with a fine stone to remove burrs. If too badly damaged, gears will have to be replaced—always in pairs.

Photo by author



Using a hone to remove slight burrs from the second motion shaft. Measure the shafts for wear and replace or renew any that are out of specification.

Also inspect the shaft splines for damage or burrs. Hone smooth any ridges or roughness with a fine oil stone.

Finally, inspect the thrust washers, distance pieces and other running surfaces for wear or damage such as galling. Unless the transmission was run without oil or has sustained physical damage, the surfaces are likely to be in good shape. Inspect anyway. Henry Royce is watching.

Burr under the saddle

If any of the drive gears have minor burrs or roughness, you can use hones to remove the high spots. This is tedious work and it will not likely be possible to completely smooth out damage to the forward edge of the teeth. But removal of any protrusions or sharp ridges will help quiet the transmission.

It is important to understand that the driving gears are nitrided, which is a surface hardening process that extends about .020 into the metal. If the wear is significant on the running surfaces of the teeth, the nitriding may have been cut through, necessitating replacement of the gear. Once the hardened surface is worn through, exposing the soft steel underneath, your teeth will wear to nubs in a relatively short time producing metal particles that will wear the rest of your gears down.

Inspect also the white metal running surface in which the reverse motion shaft runs. It is likely that this will be fine, but if the wear is severe or there is damage, it will need to be sent off to a specialist to be white-metaled and bored on a fixture.

Parts is not parts

Now you have everything apart and clean and you know exactly what needs replacing. At a minimum you will need five new ball bearing sets and a complete lock tab washer set. The three end ball bearings are standard sizes and your local bearing distributor can

order new ones for you right out of their catalog. The two center bearings are another story. These little monsters are a combination of Metric and inch dimensions that sent the author's bearing supplier into a rant about British engineering. Fortunately, they are available from Fiennes Engineering. Also available from Fiennes are rubber transmission mounting blocks. Order a complete set.

Break time

Now it's time to kick back and wait for UPS to deliver all those new parts. In part II, you will be ready with everything you need to reassemble your Small Horsepower transmission. 

SOURCES:

Bearings and lock tab washers:

Fiennes Engineering
Clanfield Mill
Little Clanfield, Clanfield, Oxfordshire
OX18 2RX
(011 44) 1367 810438

Replacement gears, shafts, and parts:

Dale Powers
P.O. Box 796
Anna Maria, FL 34216
Ph 941-778-7270



White metal bushing for reverse motion shaft. If out-of-round or worn through at any points, it will have to be re-metaled and rebored by a specialist.

Rebuilding the Small Horsepower Transmission, Part II

By R. PIERCE REID, MA—Technical Editor
Photography © 1998 by K. and M. KARGER

If you followed the instructions in Part I, you now have all your parts clean, properly arranged and you have in hand a new set of bearings and lock tab washers. Now that you have had a nice two month vacation, it's time to get back to the garage and get some work done!

With everything spotlessly clean and ready to go, transmission assembly is actually a simple weekend job. In fact, if you have done your job right at the parts washer you can do it in a white shirt and not even get dirty!

An Oversight

But before jumping into Part II, the author left a minor item out of Part I, concerning the bearings that carry the brake servo drive shaft. These ball bearings have little load and turn very slowly, so generally will not need replacing. However, when washing the transmission casting, it is important to dry these bearings lest they rust. After the transmission housing is completely clean, dry these bearings with a propane torch or blow-dryer and douse them with 10 weight

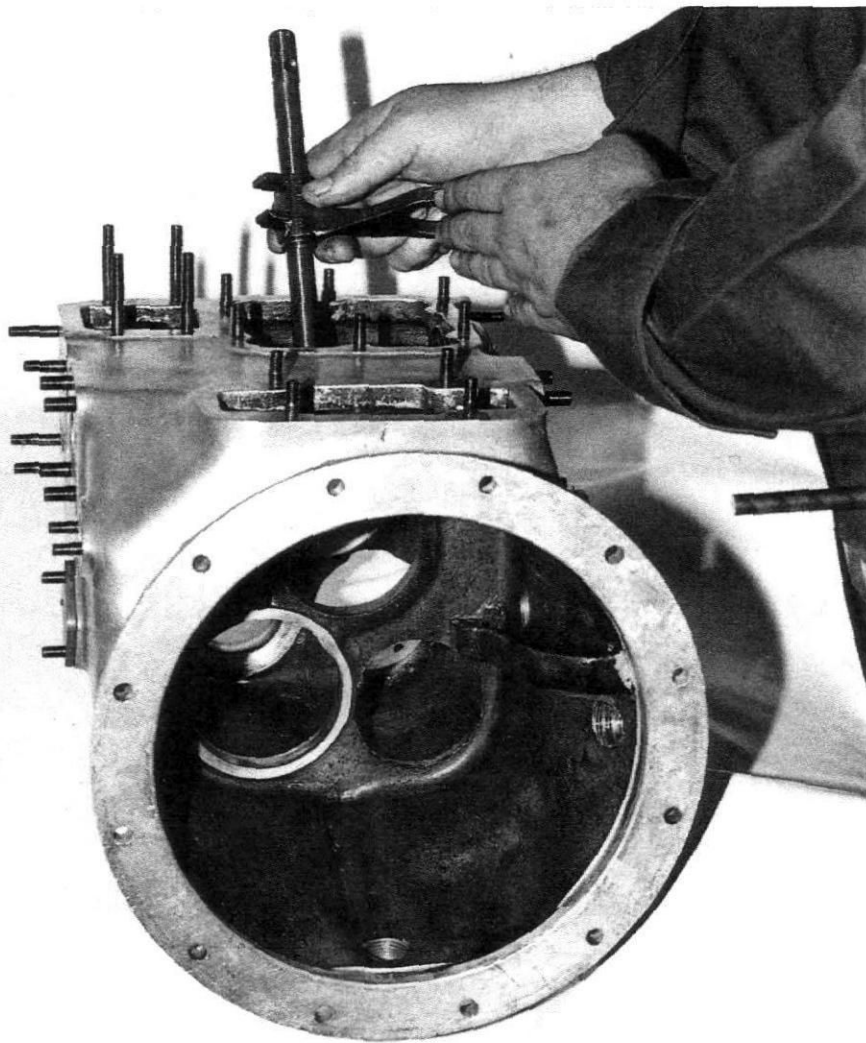
assembly oil. Never dry bearings by blasting compressed air on them and spinning them.

Also, the picture at the top of FL 5781 shows the author looking at a shaft and comparing it to the drawings. This is the third motion shaft, not the second motion shaft as is listed in the caption. Apologies for the error.

Back to Work

In addition to the tools you needed in Part I, you will also need some gasket paper (grocery bags work well), an engineer's compass, razor blades, a 3"-4" micrometer, Hylomar blue sealant, grease and an oil can full of 10 weight oil for use during assembly. This oil will protect the parts against rust until the transmission is filled and will help ensure that when you rotate the shafts and test the transmission, everything will move smoothly.

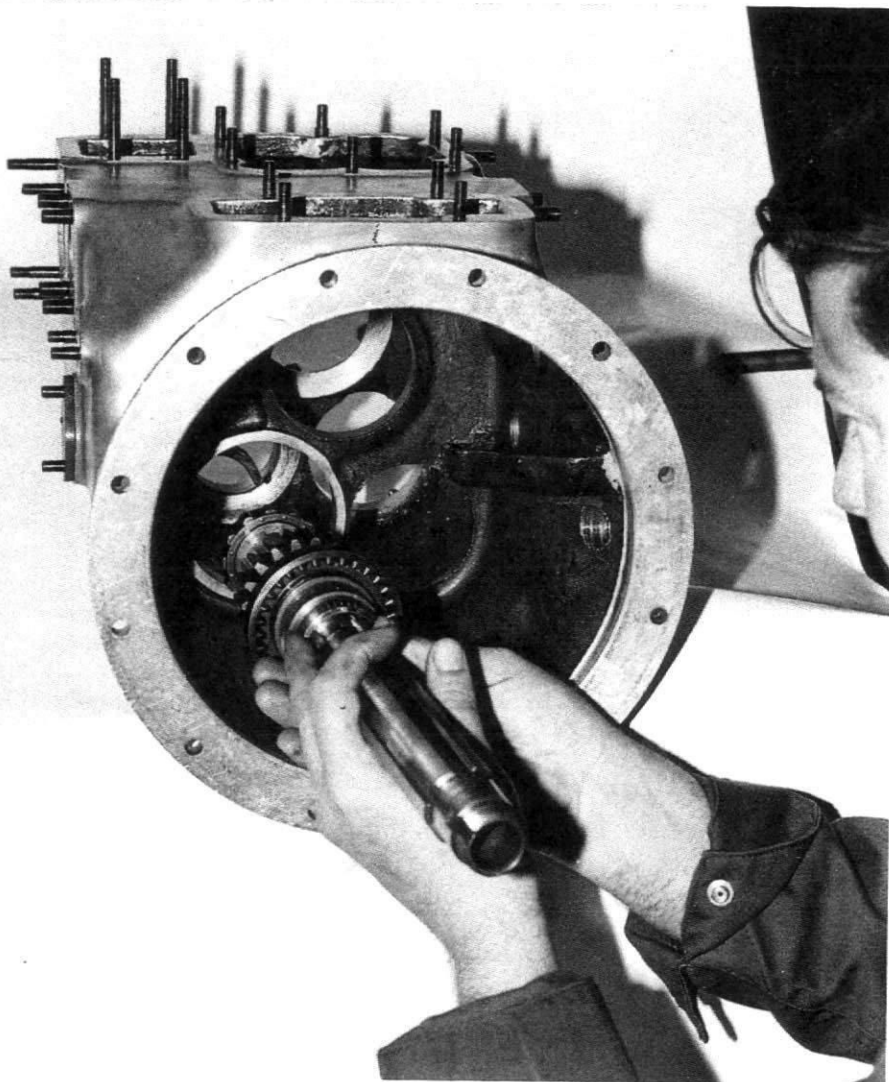
Again, you will need the Service Sheets and the instructions on reassembly are quite good, though they again make the assumption that you were trained at Derby. Also, remember that this article is intended to help replace bearings in a transmission, but does not go through the more complex steps involved in fitting new gears and/or new shafts. All the original parts, except bearings and lock tab washers, were retained and so a number of instructions in the Service Sheets where precise measurements and setting of tolerances are given are not applicable. Though, again, the disassembly/reassembly steps are applicable and should give some guidance.



Inserting the first and second speed selector shaft.



Pressing the roller bearing onto the rear of the second motion shaft. The author's left hand is on the second speed sliding gear.



Installing the second motion shaft. Note the shifter fork visible through the bearing housing.

Step One is Easy

Start by installing the third and fourth speed selector shaft, which fits through the square guide inside the transmission casting. Grease lightly prior to installing. Also, make sure it is oriented correctly with the ball detents at the rear of the shaft pointing upwards and the notch for the synchromesh actuator facing the center of the transmission.

Swing into Motion

Start by assembling the second motion shaft. This shaft is separated into two ends by a permanently affixed flange/sleeve (16).

The first step is to screw the first speed driver gear (40) all the way into the second speed sliding gear (41). Then unscrew until the etched marks on the gears line up (see photo FL 5783, lower right). Now slide the thrust washer (45) onto the shaft, followed by the second speed sliding gear assembly. Now, install the roller bearing (38) on the rear end of the shaft. This bearing will often not need replacing due to the nature of

roller bearings. However, if it does need replacing, its race must also be drifted or pressed out of the transmission casting and replaced in conjunction with the bearing.

Next, test-fit the center bearing (47) into the hole in the center of the transmission

casting. It should be a good interference fit. If it does not fit, put down that hammer and read on. If it does fit, remove the bearing and set aside.

Then secure the transmission casting in the WorkMate or on your bench and install the first and second speed selector shaft through the center passthrough in the transmission casting. Slide the second motion shaft into place, inserting the selector shaft into its race adjoining the second speed sliding gear. Next, install the bearing you test-fitted earlier, sliding it down the shaft and drifting it into position in the casting. Mild heat from a propane torch applied on the center diaphragm of the transmission casting might help make this easier. The author used a foot-long, one-inch diameter aluminum bar as a drift.

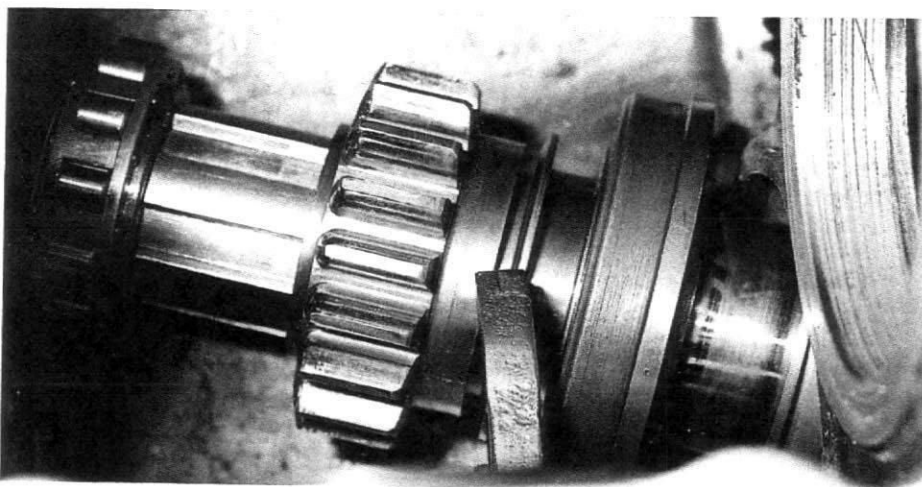
Back it Up

The reverse motion shaft goes in now. Insert the shaft with its integral gears through the center diaphragm of the transmission casting. The smaller gear goes toward the rear. At this point, the shaft will be unsupported at both ends until the front diaphragm and rear bushing/white metal bearing are installed. With the reverse motion shaft in place, install the reverse gear selector shaft through the remaining hole in the center diaphragm.

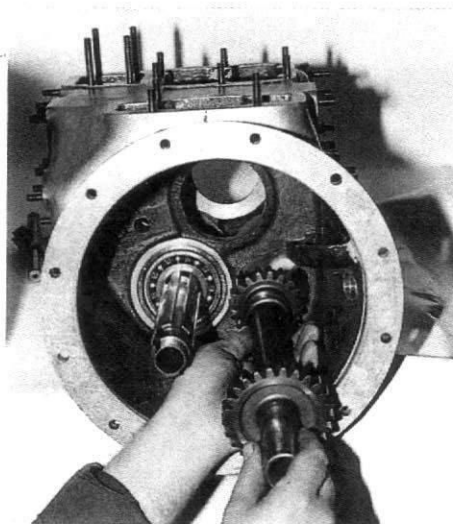
Safe at Third

With the second motion shaft and the reverse shaft in place, it's time to assemble the third motion shaft. This is the actual output shaft to the propeller (drive) shaft and also holds the worm gear that drives the brake servo, ride control pump and the speedometer drive.

Begin by pressing the third speed constant mesh gear (18) onto the shaft, snugly fitting it against the flange (16). This gear is



Roller bearing, first speed driver gear and second speed sliding gear on second motion shaft. Author is lining up the shifter fork with its running surface between the flange and the cup.



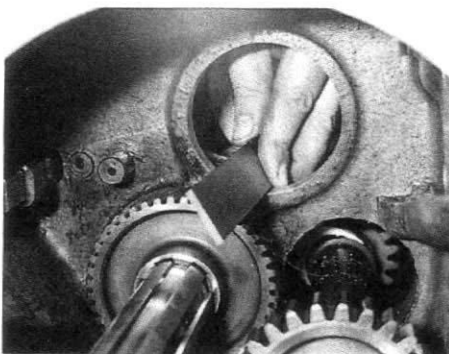
Installing the reverse motion shaft. The center bearing is in place on the second motion shaft. At 11 o'clock from the bearing is the hole through which the reverse gear selector shaft passes.

riveted to the rear female synchronizer cup and the two should not be separated as they appear to be fitted and final-machined as a unit. With the gear/cup in place, slide the thrust washer (21) onto the shaft.

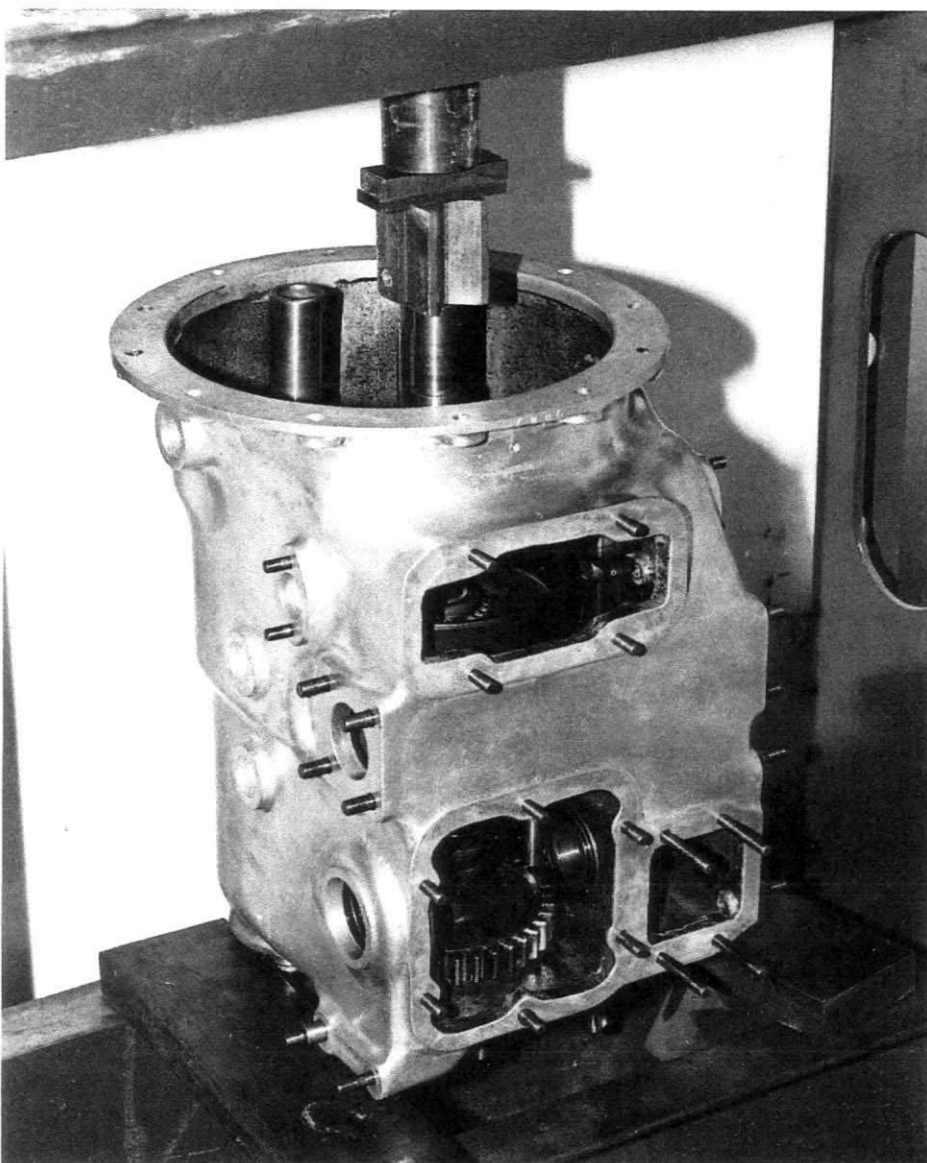
As an aside, Part I pointed out that it is vital that all thrust washers go back into their original locations. Tying them to the appropriate gears will ensure you don't mix them up. If you do mix up the thrust washers it will be necessary to follow the more detailed Service Sheet instructions to reset the nip and clearances for all the gears. Trust me on this . . . buy a ball of string.

Keeping your bearings straight

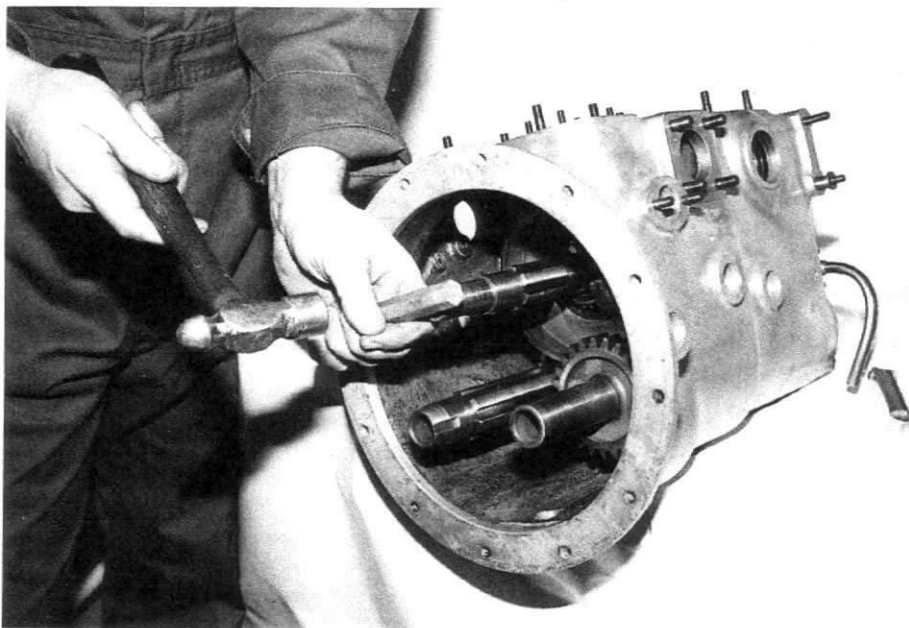
With the third speed constant mesh gear in place, turn your attention again to the casting and test-fit the center bearing (22) to its opening in the center diaphragm of the transmission casting.



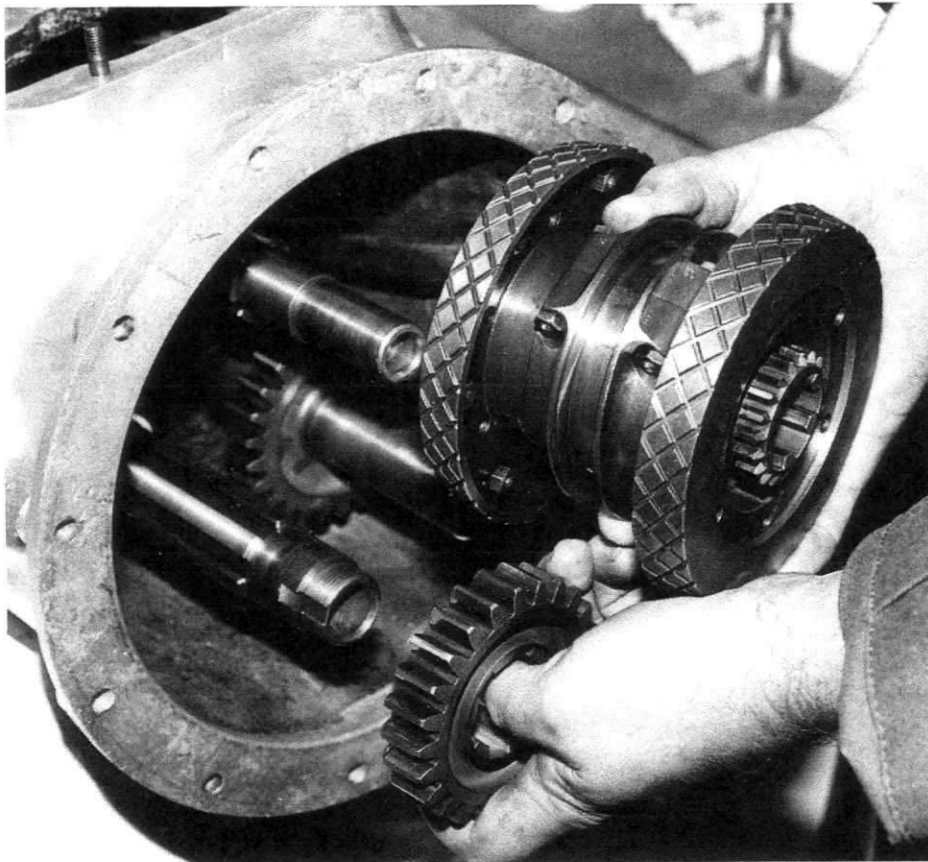
Scraping the center bearing housing for the number three motion shaft. About .0007" was removed to give a tight interference fit. Don't take off too much, or the bearing may spin. Too little and you can crack the casting. Scrape, test, scrape, test. Boring, but effective. Note all three selector shafts are in place on the left.



Pressing the third motion shaft into the transmission casing.



Final positioning of the third motion shaft. Note the use of a brass drift, alternating at either end of the shaft. It is vital that you not damage the shaft. You must use a soft drift.



Reverse driving gear and synchromesh unit. These must be installed together as the reverse gear sits between the two synchro plates. Note that in the picture the reverse gear is backwards. It goes in with the flange (just visible) facing the front of the transmission. This was a time-consuming error as the transmission had to come apart to correct it.

Unlike the first center bearing, this one didn't fit. Turning it the other direction did not help. Nor did invective. A micrometer and a telescope measure showed that the replacement bearing was oversized by about .0015". Accurately reducing the outside diameter of a hardened steel bearing is not practical. So, the diaphragm was opened up by scraping away .0007" of aluminum evenly around the perimeter using a sharp steel scraper. Do not try to hammer a recalcitrant steel bearing into an aluminum casting. The bearing is an irresistible force and the casting is a crackable object. But don't take too much off the casting,

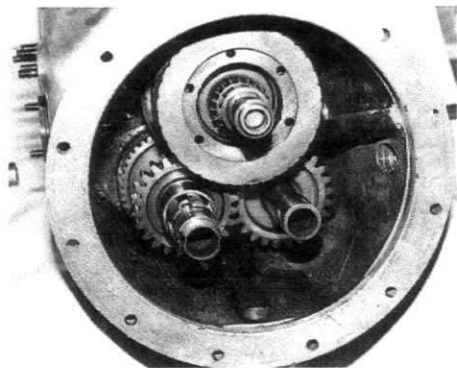
either. If the bearing is loose, the steel outer race may start turning in the casting. A good interference fit is what you are striving for.

Now that you know the bearing will fit in the casting, press the bearing onto the third motion shaft, seating it firmly against the thrust washer.

You are now almost ready to install the third motion shaft into the casting. First, however, you have to install the thrust washer (48) and the third speed constant mesh gear (49) onto the second motion shaft, as these will be impossible to fit after the third motion shaft has been installed.

Third Goes Home

The third motion shaft now goes into the casting. This is not as easy as it sounds, because you will have to add gears as you slide it in. First, slide thrust washer (23) onto the shaft. Now, slide the shaft through the opening in the casting center diaphragm, so that the nose protrudes a couple of inches. Install the second speed driven gear (24) and push the shaft another couple of inches. Slide the servo drive worm gear (25) onto the shaft followed by its thrust washer (26). Orient the worm gear the same way it came out, since you went to all the trouble of marking it when you removed it.



Reverse gear in place (backwards!) with spacer visible. Everything fits together nicely, even when it's wrong. Do yours right!



Pressing the first motion shaft into the bearing in the diaphragm. Support this aluminum casting well. You don't want to break or warp it.

Last gear to install on the shaft is the first speed driven gear (27) and this takes some juggling to slip into place while sliding the shaft forward and avoiding dropping the thrust washer. Borrow a third hand, if you can.

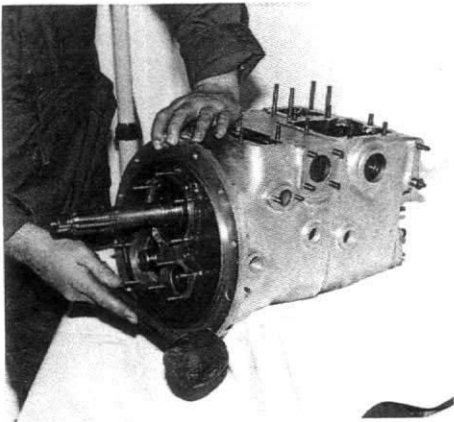
With all the gears in place, seat the bearing in the center diaphragm. The author used a press with the ram placed on the nose of the shaft to ease the bearing and assembly into place. A light hammer and soft brass drift were used alternately on the front and the rear of the shaft to achieve the final positioning.

Synchronicity

With the shafts in place, the synchromesh unit is installed on the third motion shaft and the remaining gears are installed on the second motion shaft. Install the spacer (50) on the second motion shaft. As an aside, the



Removing the seal from a bearing. Use a sharp knife to simply pop the seal off.

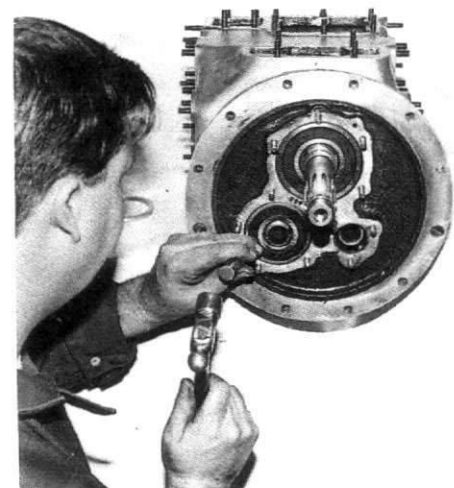


Seating the diaphragm onto the casting.

spacers (50 and 52) are virtually identical in appearance, but can be a few thousandths different in length. Make sure you keep track of the spacers so you can put them back exactly as they came out.

Now install the reverse driving gear (51). Note that this gear can go on the shaft in either direction. If you put it in backwards, everything looks and feels fine—that is until you put the transmission into gear and apply a load to the input shaft. Then the gears will grind against each other badly. *You must install the gear with the flange facing the front of the transmission (see diagram).* The author, by the way, learned this the hard way and discovered the error only minutes before installing the transmission in the chassis. The whole transmission, including the servo, had to come apart to correct this error. Measure twice, cut once. Note that the photo accompanying this article shows the gear being installed the *incorrect* way.

Now that you know which way the gear goes, install it at the same time as you install the synchromesh unit, holding the reverse driving gear in between the male synchro cones.



Seating the front bearing on the number two motion shaft. Inner seal has been removed, but outer seal is in place. Much more reliable than oil slingers to alleviate leaks.

The Outer Limits

Turn your attention to the outer diaphragm, which seals the transmission and carries the bearings for second and reverse motion shafts. The diaphragm also carries the first motion shaft (62), which is permanently riveted to the front synchro cup. The first motion shaft is the transmission power input shaft. When the transmission is mated to the engine, the first motion shaft carries the clutch driven plate and its nose fits into a bearing in the center of the flywheel.

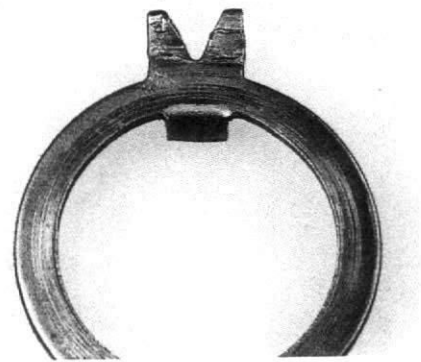
The first step is to press the bearing (67) into the outer diaphragm. Then, press the shaft (62) into the bearing from the back of the diaphragm. Again, ensure that the bearing is a good interference fit with the casting, but is not so tight that it will crack the aluminum casting.

As mentioned in Part I, all the bearings except the two center bearings are standard off-the-shelf parts available from any local bearing supplier. The author finds that buying sealed bearings and removing the seals is the least expensive option. They have another advantage in that the seals can be left in place on the outside so that the oil can lubricate the balls, but won't pass through the bearing and leak out around the flanges. Of course, the screw-type flingers are supposed to take care of that, but we all know how well they work.

To remove the seals, simply slide a razor blade under the rubber seal and pop it off. Don't worry about the grease inside . . . the transmission oil will absorb it and you will flush it out at your 500 mile break-in transmission oil change.

Close the Hatch

The diaphragm is a snug fit to the main casting, but there is a paper gasket between



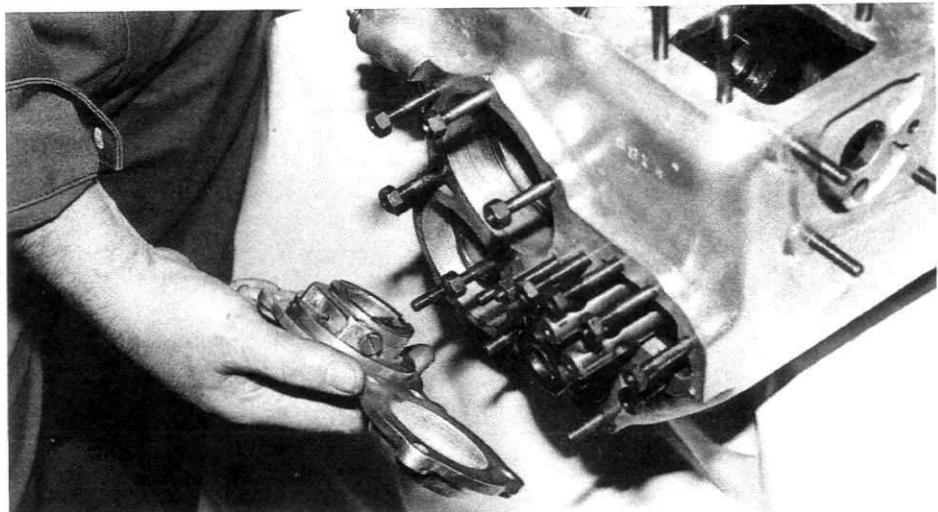
Used lock washer. Note fatigue cracks forming. Tab will likely break off next time it's bent. Buy a new one, you can afford it.

the two. This will have to be made up and requires some patience and some work with razor blades and an X-acto knife. Once completed, give the gasket a thin coat of Hylomar sealant and adhere it to the main casting. You will now have to work fast before the Hylomar sets up.

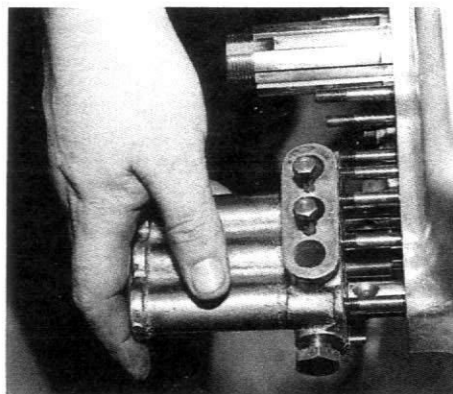
Install the spacer (52) on the second motion shaft. Then, holding the constant motion gear (53) in your left hand and meshing it with its mate on the first motion shaft, align the diaphragm with the three shafts and fit it to the main casting. Use the countersunk machine screws at eight and four o'clock to hold it in place. Bed the diaphragm in place gently with a rubber mallet and then install nuts and bolts in about half the perimeter holes to snug the casting and the diaphragm together.

Installing the End Bearings

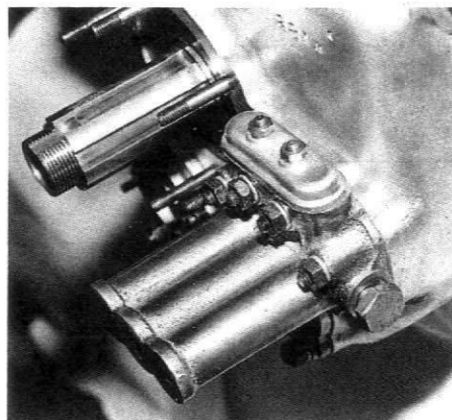
With the diaphragm in place, install the spacer washer (54) and the front bearing (55) at the front end of the second motion shaft. This is seated into its recess with a brass drift. Tap lightly on opposite sides of



Installing the reverse motion shaft bearing and second motion shaft bearing cover. This takes three hands to do without knocking the reverse motion shaft out of its front bearing. Note gasket is not yet installed—but there will be one fitted.



Installing selector shaft guide housing. A forest of studs!



Selector shaft guide in place.



Inserting the synchronesh actuator unit. It goes in only one way, so if it does not drop into place instantly, lift out and try again.

the bearing, working around the circumference until it is seated. You can tell when it seats because the brass drift will start to "ping" when you tap it. It may be necessary after installing the bearings to use the drift on the shaft itself to ensure it remains correctly positioned in the casting so that it rotates freely.

Now install the spacer washers (37 and 56) and a new lock tab washer along with the retaining nuts on each end of the second motion shaft. Don't reuse lock tab washers. Though they may look fine, bending them fatigues the metal to the breaking point. A whole set of new lock tab washers is about \$25. If you must skimp, stop buying Grey Poupon for a while. Tests show it causes the winds.

Next, install the white metal bearing and aluminum cover for the reverse motion shaft, making sure you squirt plenty of assembly oil on the white metal running sur-

face. It may take some fiddling to get the shaft lined up and you'll need one hand inside the transmission, one hand aligning the bearing and one hand at the front of the transmission keeping the reverse shaft from falling out of its front bearing. Since that adds up to three hands, an assistant would come in (dare I say it . . .) handy. Once in place, the bearing cover is held on with six nuts. Always use new lock washers.

As an aside, the author uses both mild steel and stainless lock washers. In an application that will be painted after assembly, standard steel lock washers are used. On something like the transmission, where the lock washers will be exposed to the elements, stainless lock washers are used. No sense having a beautifully rebuilt transmission held together by rusty lock washers, now, is there? And because nuts rust too, the author uses a chemical black kit to phosphate-black and seal the nuts. Not rust

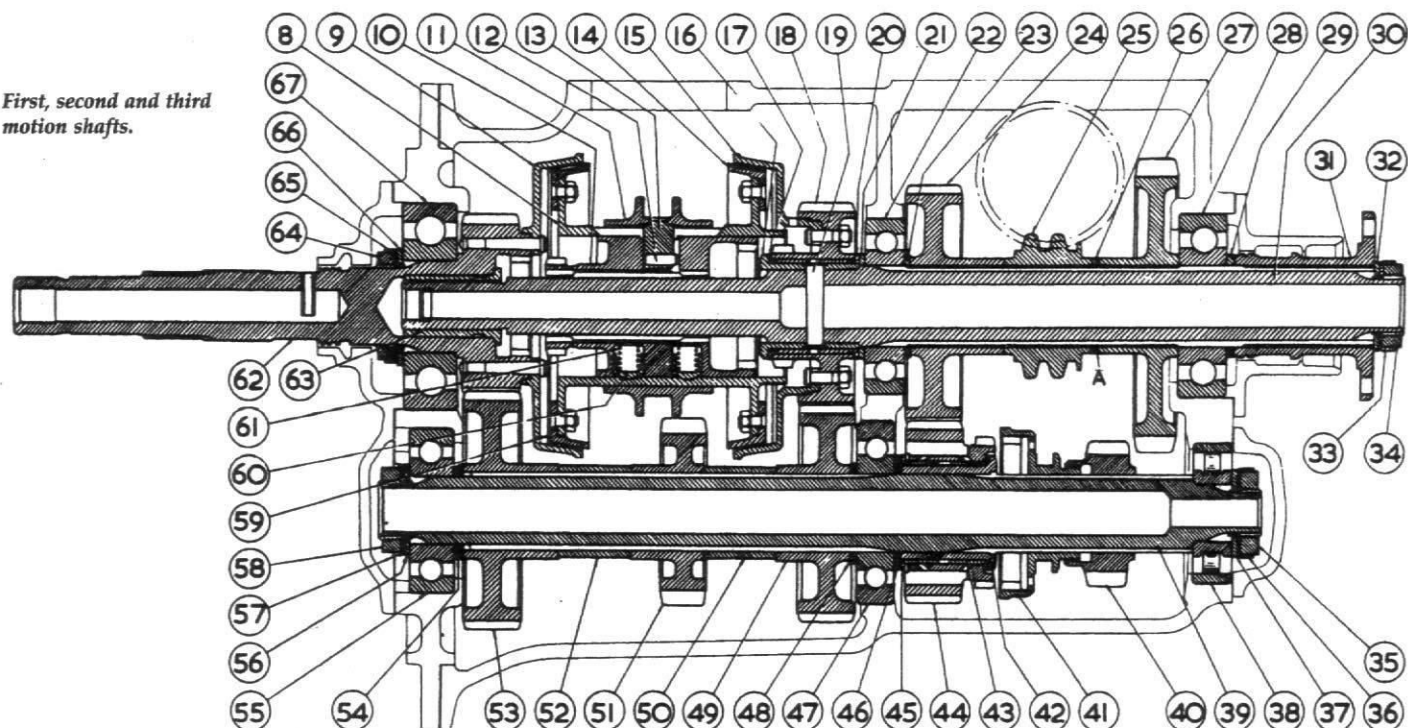
proof . . . but pretty rust resistant. And for rust-proof nuts, prime them and paint them with Testors Model Master Gunmetal paint (available from your local hobby shop). They will stay rust free virtually forever and are indistinguishable from the original blacking.

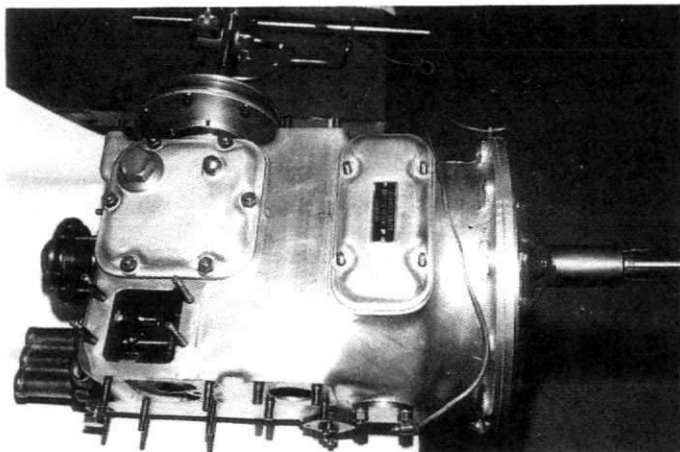
Finally, drift in the bearing (28) at the rear of the third motion shaft.

The Moment of Truth

Though you should have been checking for smooth rotation of the shafts throughout assembly, now is the moment of truth. Everything should be spinning smoothly and silently with all the shafts turning independently. As soon as the selector housing and interlock mechanism is in place, you can test for shifting as well and you can test to see how the various gears mesh. But for now, it is good enough to know that there is no binding, noise or roughness on the shafts.

First, second and third motion shafts.





Transmission partly buttoned up, awaiting servo parts and peripherals. Even the patent badge is restored (hint of a future article).

If the unthinkable happens and there is binding, go back inside and rectify the problem. It will *not* get better on its own. The shafts should turn with light finger pressure alone and should rotate on their own through about $\frac{1}{4}$ to $\frac{1}{2}$ turn after giving them a spin. If any effort is required or if the shafts bind up anywhere, something is wrong.

Once everything is spinning well, smooth sailing lies ahead . . . well, mostly smooth sailing.

Going for the Bronze

The bronze casting that holds the selector shafts and interlock mechanism is installed next. The Service Sheets detail this well. Again, some fiddling is necessary to install it. As mentioned in Part I, this assembly can be dismantled and cleaned even if not doing a full transmission rebuild. A good cleaning will do wonders for the smoothness of your shifting.

When making the replacement gaskets for the interlock, use the originals as patterns and reproduce them exactly. There are openings in the gaskets to allow lubricant to circulate. Apply a thin coat of Hylomar to the gaskets prior to installation.

Elephant Through the Eye of a Needle

The Service Sheets refer to the step of fitting the synchromesh actuator in deceptively simple terms. In reality, it is somewhat more complex. True, it is supposed to simply drop in place, but if not inserted in exactly the right orientation through the narrow inspection opening at the front of the transmission, it won't fit. And no amount of fiddling will make it fit. If it goes through the opening correctly aligned, it will drop into place in seconds.

Unfortunately, there is no easy way to describe the "right way." But if it does not fit into place almost instantly, take it out and try again. You'll get it eventually. Make sure the stud on the long arm engages with the notch in the selector shaft and grease it for

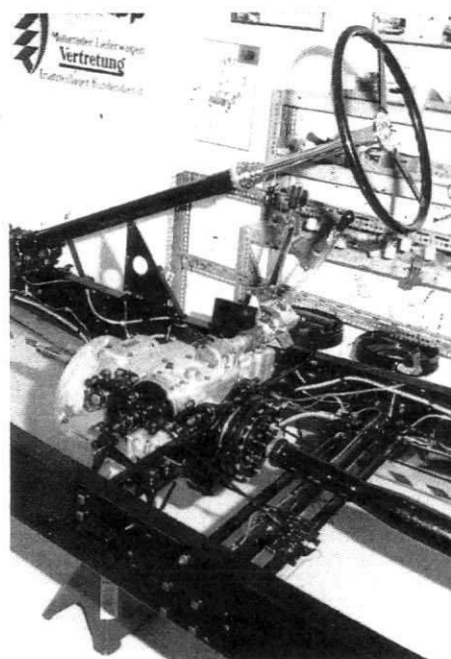
good measure.

Dab some assembly grease on the ends of the shaft and install the bushing housings on the transmission casting (don't forget the gaskets). Make sure that the 1 and 2 marks stamped on the parts are lined up with their counterparts on the casting (see picture FL 5782).

Quality is in the Details

The remainder of the transmission assembly primarily involves fitting several covers and the aluminum spacer washers that hold the bearings into their housings in the aluminum castings.

One point to note is that the steel casting that covers the front bearings is quite delicate, especially the nose portion of the casting that fits up inside the clutch release bearing housing. If you drop it, it will shatter into a dozen pieces. If you try and pick



Transmission in place with driveshaft installed on the transmission output shaft. A far cry from the "before" picture on FL p. 5780.

up the transmission using the casting nose as a handle, chances are it will crack off in your hands. If it is broken, replacements are being made in the UK, but they aren't cheap. Better to take care of yours.

Make new gaskets for all the covers and use Hylomar as you button them up. Don't forget to install the inner rear transmission mount before installing the driving flange (31) and install all new rubber transmission buffers as you reassemble the mounts to the car. Reinstall the fill, level and drain plugs, always using new aluminum washers.

Reassemble the servo, ride control pump, speedometer drive, shift mechanism, Bijur lines, servo countershaft and all the related peripherals. Most of these assemblies are covered in detail in past issues of *The Flying Lady*.

Back in the Saddle

With the transmission reassembled, bench-test it by spinning the shafts in all gears. Also, grip the input and output shafts and try and get them to jump out of gear by rotating them against each other.

Install all new transmission mount rubbers as you put the crossmember back in place on the back of the transmission. Reinstall in your chassis following the reverse of the procedure listed in Part I. Hopefully you also rebuilt your clutch and had your flywheel faced while the transmission was out.

Don't forget to fill with the correct amount and type of oil specified by your handbook. Good quality gearbox oil in the correct weight is preferable to miracle elixirs and wonderpotions. After 500 miles, change the oil and inspect for any metal particles that would indicate a problem. Whenever you change the oil, fit new aluminum washers to the fill, level and drain plugs. Aluminum washer kits are available from Dennison Motors and they are good to have around. You always seem to need an aluminum washer.

Silence of the Trans

With a little skill, anyone can rebuild a Small Horsepower transmission, returning it to new condition for little expense. And if you run into any problems, feel free to contact the author.

When you are done, you will truly be able to appreciate that few sounds are more appealing than your Small Horsepower Rolls-Royce or Derby Bentley wafting along in high gear . . . making no sound at all. 

SOURCES:

Aluminum washer kits:
Dennison Motors Inc.
322 South Concord Road
West Chester, PA 19382
Ph/fax 610-436-8668