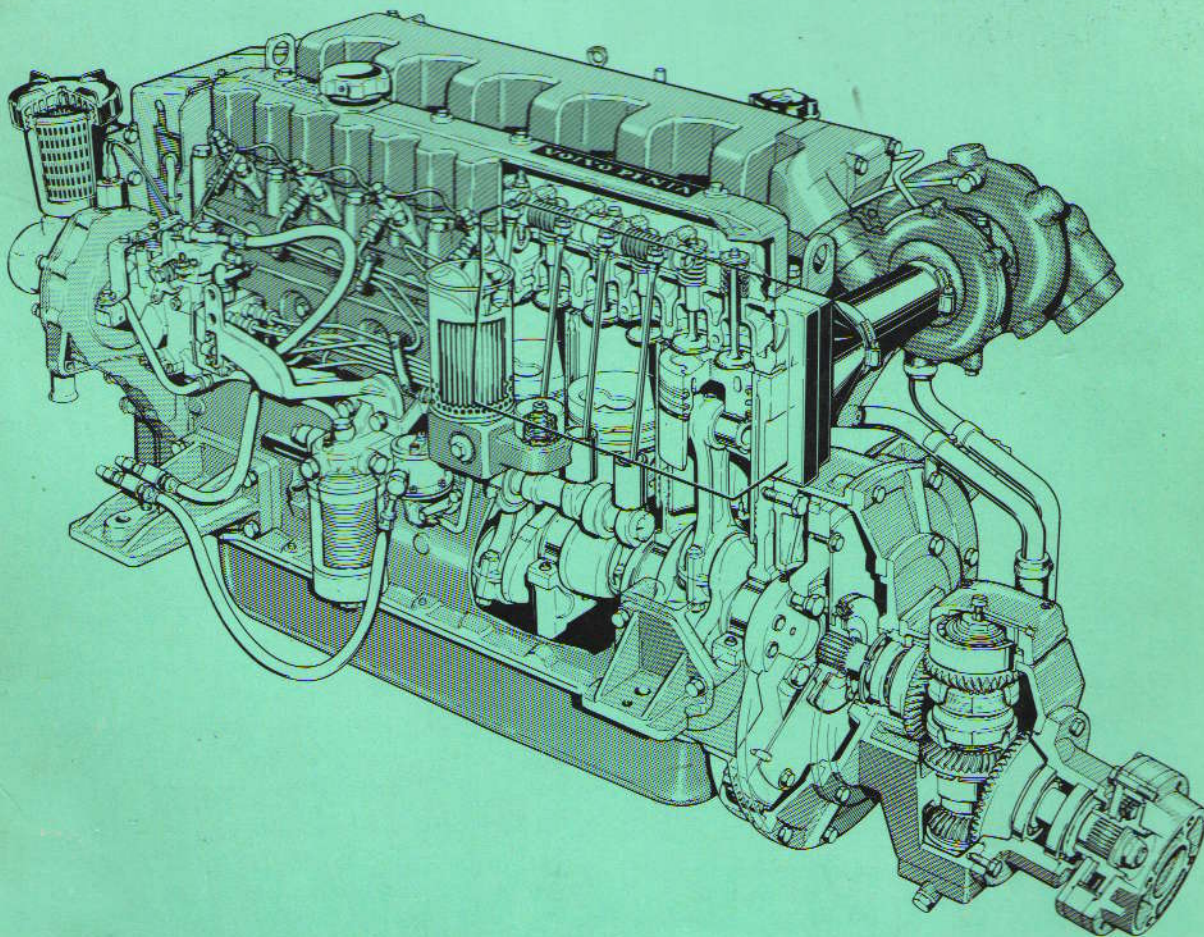


VERKSTADSHANDBOK WORKSHOP MANUAL

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Overhaul of MS3B Gearbox only

AQD40A TMD40A



MOTORENHET
ENGINE UNIT

VOLVO PENTA

Volvo Penta - MS3B Reverse Drive / Gearbox Assembly

Instructions for Overhaul - Dismantling & Re-Assembly

These notes have been written following overhaul of my own MS3B gearbox following an embarrassing failure whilst underway at sea. Following extensive searching on the Internet I have found plenty of parts drawings, but no instructions, so I have invented my own. The only special tool required is access to a decent hydraulic press.

A Removal from Engine / Shaft

- a. Disconnect Change cable, Cooling water to cooling jacket manifolds (jubilee clips & bolts 2 x 10mm AF). Allow water to drain, then undo pipe clip to main casing of engine, and set pipes aside clear of gearbox.
- b. Undo 4 bolts (16mm AF socket / ring spanner) to output coupling. Pull shaft back clear of coupling, at least 50 mm to allow removal of gearbox.
- c. Attach suitable rope strop around gearbox to take weight - about 15 kg.
- d. Loosen all 6 bolts (17mm AF socket / ring spanner), attaching box to engine casing. Remove leaving 2 loosened, but in place either side.
- e. Break joint carefully, taking care not to damage the light alloy gearbox housing / mount plate. Take weight of gearbox and remove last 2 bolts.
- f. Pull back gearbox about 50mm to disengage splined input shaft from engine flywheel.
- g. Lift gearbox clear to padded surface.

B Dismantling

- a. Remove 4 bolts (10mm AF) securing gear change device to gearbox. Two of these mount the change cable support bar, and these are slightly longer. Do not drop spring loaded shift dog bar (70), and note offset orientation of the shift dog bar, offset to output side (to right as viewed) of the cone clutch selector groove.
- b. Tip over to drain oil into clean container. Retain for further examination for metallic debris / water contamination. I filtered the drained oil through a fine cotton cloth, which left the debris behind. If any large particles of metal are present investigate all internal parts to find out where from.
- c. Remove 6 bolts (12mm AF) securing Output casing & shaft assy. Gently tap around housing to pull assy clear of box. If necessary use pry bars (broad screwdrivers) to persuade casing to slide free. Then remove 6 bolts (14mm AF) securing Input shaft assy with Engine mount plate - as for Output shaft.

Note On each assy there is a shim pack between housing and gearbox. Count qty of shims & Measure thickness with micrometer, write down detail for each. Input shaft (41); Output shaft (53). Repeat this procedure for each shim pack encountered.

- d. Remove 4 Bottom housing cover bolts (14mm AF), and remove Lower Lay Pinion. Check content of sludge / debris within bottom housing cover.
- e. Remove Top cover allen bolts (3 x 8mm AF plus a Banjo bolt). Note position of this Banjo bolt (6), plus retrieve small sealing O ring (7). Note details of shim pack (8 i) atop bearing pack / within top cover recess.
- f. Using suitable splined socket (about 21mm AF) secure lower end of lay shaft, taking care not to damage splines and undo Top nut (25) (30 mm AF NOTE LEFT HAND THREADED).
- g. Remove upper bearing housing assy (23) gently, using pry bars if reqd. This should come free with upper part of cone clutch (10). Note qty & thickness of shim pack (24) if present.
- h. Remove cone clutch slider (20), and immediately wipe dry and mark upper face. Remove spring (19) below.

- i. Invert gearbox and press out lay shaft from lower bearing assy, with lower pinion / cone clutch cup, ensuring press bears on pinion **and not lay shaft itself**. **Note qty & thickness of inner shim pack (22)** if present.
- j. Remove retaining circlip (21), then lower bearing should drift out from below with little effort, then remove **shim pack below bearing (8 ii) if present, noting details**.

C Top housing Assy Detail

- a. Press upper pinion and clutch cone assy from upper bearing (9).
- b. Drift upper bearing (9) from housing.
- c. Remove needle bearings (2 x 14) & inner spacer (15) from upper pinion & clutch cone.
NB if Clutch Cone & pinion are in good order there is no need to separate these items.
- d. Insert new main bearing (9) into housing, then press upper pinion / clutch cone assy into bearing from below.
- e. Insert new needle bearing (14), spacer (15) & 2nd needle bearing (14).
- f. Lubricate & protect ready for re-assembly.

D Layshaft Assy Detail

- a. Invert shaft & tap down on lock collar (12) to release pair of split collets (11).
- b. Remove lock collar (12), Wear ring (13) **(note orientation)**; pinion & cone clutch assy.
NB if Clutch Cone & pinion are in good order there is no need to separate these items.
- c. Remove needle bearings (2 x 14) & inner spacer (15) from lower pinion & clutch cone.
- d. Insert new needle bearing (14), spacer (15) & 2nd needle bearing (14).
- e. Lubricate layshaft, insert this into needle bearings in lower pinion & clutch cone, **taking care not to dislodge the needle bearings from the support cage**.
- f. Slide over new wear ring (13) correct way round, then lock collar (12).
- g. Install split collets (11), then close down lock collar to hold these in place.
- h. Lubricate & protect ready for re-assembly.

E Bottom Lay Pinion Detail

- a. Drift out upper bearing (26) outer ring from bottom of main casing. **Note shim pack (22) details if present**.
- b. Remove & replace upper and lower taper bearing inner race & cage assys.
To remove these taper bearings requires patience and some metal butchery skill. It will be necessary to destroy these bearings to remove them from the output shaft. Firstly remove the cage & rollers, then try heating the inner ring quickly with a blowtorch, but **DO NOT OVERHEAT THE GEAR PINION TEETH OR THE CASE HARDENING COULD BE DESTROYED**. If this does not work grind off using an angle grinder taking care not to touch the adjacent gear pinion or shaft.
- c. Remove outer race ring from lower cover plate, **noting any shims (29) present**.
- d. Install new outer ring of bearing (28 / 28A) with shimming as found.
- e. Press new Inner race assys of bearings to shaft, upper (26) & lower (28).
- f. Invert Gearbox casing, insert assembled pinion into position, and affix bottom cover. Check for free play or tightness of pinion by rotating from output shaft aperture. The pinion should have light stiffness only.
If too tight reduce shim pack (29), if too loose increase shim pack (29).
- g. Remove from casing in preparation for Gearbox re-assembly, lubricate & protect.

F Output Shaft Detail

- a. Secure output pinion in large vice and undo output shaft coupling retaining nut (66 - RIGHT HAND THREAD). Remove pad washer (65). Remove output shaft coupling / slip clutch assy (63).
- b. Remove output shaft seal housing (60) 4 bolts (13mm AF).
- c. Press output shaft (27) through double taper roller pack. Remove output side taper bearing, and **note shim pack (54B) qty & thickness**. Remove spacer ring (54A).

Note the assembly view shows the adjustment shim (54B) to the right of the outer bearing (54), this is incorrect, as this is correctly positioned between the spacer (54A) & RH bearing (54). Later exploded views show this shim in the correct position.

- d. Remove input end taper bearing (54 LH). Note comments above re section E item c.
- e. Install new inner bearing race & cage assy (54 LH) using press to push fully home. If any free play exists due to prior bearing spin use Loctite 601 or similar bearing fit compound.

Note Ensure only SKF bearing (as original) is used as other makes may have differing dimensions on the cage, which may cause fouling upon re-assembly. This also applies to item 38 on Input shaft assy.
- f. Remove outer bearing rings from each end of output shaft housing, noting any shims below these rings (none are shown on dwg). Insert the new outer rings from each new bearing (54), ensuring the matched ends are not mixed up.
- g. Assemble the shaft into the housing and lay down on press with the innermost bearing abutting its outer ring. Insert Spacer (54A) and then the shim pack (54B) as removed. Position the RH bearing (54) and press home. As the rollers load up, note the tension and freeplay in the bearings by rotating the housing. The bearings should remain free turning with just slight stiffness when the bearing is pressed fully home onto the inner shims (54B). There should be no observable side play between the housing and the shaft at all, with the light stiffness mentioned.
- h. If the bearing remains loose, press the shaft back out and reduce the thickness of shim pack 54B. If the bearing binds increase thickness of 54B.
- i. Install a new Lipseal (58) into seal cover. Replace outer sealing O ring (57). Thoroughly lubricate the inner area in way of the new bearings.
- j. Insert new O ring (59) onto shaft (this sits in groove at end of splined shaft adjacent to bearing inner race. Slide Output coupling half onto shaft, lubricating the outer surface where it passes through the Lipseal. Insert washer (65) & nut (66), using high strength Loctite 270. Tighten this fully holding inner pinion wheel carefully in a vice.

Note the Shim pack (64) may not be present, and the O ring (62) appears to serve no function.

- k. To double lock this nut use centre punch to tapered end of nut impinging this onto shaft. Please note over-doing this will make subsequent removal very difficult.
- l. Renew Outer sealing O ring (52).
- m. Assembly ready for re-installation. Protect ready for re-assembly.

G Input Pinion Assy Detail

- a. Separate assembly from mounting plate (50). Check mounting plate for cracks, and TIG weld repair any found.
- b. Undo Allen screw (48) (10mm AF) from pinion shaft. Release circlip adjacent to outer lipseal. Remove spacer (44) and note qty & thickness of shim pack (46), which is found within recess at end of spacer (44) abutting against pinion shaft (10).
- c. Press out input pinion (10) from bearings.
- d. Drift out bearing outer rings, taking care not to damage oil deflector ring (39), also note orientation of deflector.

- e. Replace bearing outer rings (37 & 38). Inner of these (38) holds the deflector ring (39) in place, which sits in an annular recess in the housing (35). Ensure this remains concentric when installing the outer race ring of the bearing (38).

Please note inner bearing assy (38) removal will be difficult as per output shaft (notes above). Press new bearing (38) inner race assy onto pinion fully home, using Loctite bearing fit as reqd.

- f. Assemble Input shaft into spacer (44), ensuring new O ring (45) is installed.
- g. Assemble housing onto inner pinion & bearing race (38). Position outer bearing outer race assy (37) & press gently home, but not fully yet.
- h. Insert Input shaft into position, with Shim pack (46) held in place within the back of spacer (44) with light coat of grease. Press input shaft home gently, noting freeplay in bearings. As the input shaft presses fully home it will drive bearing (37) further onto the pinion shaft until the shim pack 46 bears tight against the end of the input pinion (10). At this point the bearings should just be lightly stiff with no freeplay and no discernible sideplay or wobble between shaft & housing.

If bearings bind, remove input shaft with spacer (44), press pinion (10) back out slightly & increase shim pack (46) thickness. If bearings are loose repeat above, but decrease shim pack (46) thickness.

- i. Once bearings tension is correct, remove input shaft & spacer. Insert new Lip seal (42) into housing from outer side, re-affix retaining circlip, then re-insert input shaft & spacer, first lubricating the seal surface.

Note throughout this procedure take care that O ring (45) does not dislodge from the annular groove in the front of the spacer (44).

- j. Insert & tighten allen bolt, using Loctite 243 or similar compound.
- k. Insert pinion assy into mount plate. Assy now ready for re-installation. Protect for re-assembly.

H Main casing

- a. Remove water cooling manifolds top & bottom - 2 x 3 bolts (10mm AF narrow wall socket)
- b. Remove sealing O rings (95), then slide out water cooling inserts (92). If these are scaled use Fernox or Kilrock descaler to clean.
- c. Thoroughly clean entire housing ensuring any swarf or debris is removed. Chip off any loose paint from casing, otherwise this will hamper a clean re-assembly.
- d. Flush casing with spirit cleaner, and blow dry with compressed air.

I Re-assembly

Remember clean, clean and clean again. If hands become dirty at any stage, stop and wash hands before continuing. This also applies to the assembly of the sub-assemblies above.

Ensure all sub assemblies are scrupulously clean, and well lubricated with clean engine oil.

- a. Ensuring proper shim pack (8 ii). Insert new lower main bearing (9) into housing. Re-insert retaining circlip (21), ensuring circlip properly engages.
- b. Lower the lay shaft assy into position, then press lower pinion home bearing weight of press via the upper surface of the cone clutch cup (DO NOT PRESS THE LAYSHAFT ITSELF).
- c. Lubricate spiral splines of the lay shaft then slide on spring (19) & cone clutch slider (20).
- d. Position shim pack (24) over top housing register as found at dismantling, then insert top housing into casing over lay shaft. Take care not to dislodge needle roller bearings. Lubricate from above.
- e. Prepare Lay shaft nut (25) with some Loctite 243. View layshaft from below to ensure lock collar is correctly positioned over collets, then hold layshaft up with fingers to prevent the collets falling from position. Whilst holding shaft up with one hand, mount securing nut & washer (25) with the other & take up slack - **REMEMBER LEFT HAND THREAD.**

- f. Then check finally collets (11) are still within lock collar recess (12).
- g. Tighten securing nut (25), whilst holding lower splined shaft (as per dismantling).
- h. Thoroughly lubricate, then check mechanism is free to turn, and check the cone clutch slider can move freely from upper to lower position. Check cone clutch slider springs off lower cup by action of Spring (19).
- i. Invert gearbox casing, and insert lower output lay pinion into position & lubricate bearings. Install new O ring (30) to bottom cover, and secure cover. Re-check pinion can still rotate freely via output casing aperture.
- j. Affix upper shim pack (8 i) into top cover using light grease coating to hold in place whilst positioning the cover. Install new seal ring (5) into top cover recess, then lower inverted casing onto cover. When fully home, flip over and refit securing allen bolts, using a new O ring (7) for the single banjo bolt (6).
- k. Refit shim pack (53) to Output shaft assy, fit new O ring (52). Lubricate gear teeth, then insert Output assembly into casing. As teeth engage, rotate slightly back & forth to ensure teeth mesh between Output shaft gear & Output lay pinion.

The housing should pull up fully home without undue force. If stiffness is found stop and find out why. Most likely cause is burring of the housing / register.

- l. When fully home check free rotation of shaft from the output coupling. Fully tighten bolts and re-check movement is free.
- m. Refit shim pack (41) to input housing register (Note assembly dwg shows these shims assembled to the wrong side of the register spigot). Fit new O ring (40) to register recess groove.
- n. Lubricate gear teeth then insert housing into casing. Rotate shaft as per Output assy to ensure teeth mesh. Also take care that shim pack shims do not fall into O ring recess as assembly is pulled up fully home. As for Output assy this assy also should go all the way home without undue force.
- o. When fully home check for free movement of input pinion, but note the new Lipseal will induce some stiffness to the motion. Tighten the bolts and re-check free movement.
- p. Assemble selector housing with drive selector dog bar (70) properly orientated, with elongated portion towards output side of gearbox (to right side of aperture - see assembly dwg). Fit new O ring (77). Push housing fully home without undue force, ensuring selector engagement remains free to move.
- q. Once fully home, re-mount the selector cable support bar to the output side of the selector block, using the two longer bolts.
- r. Check the function of the gearbox by manually turning the input shaft clockwise. Lifting the selector should engage 'Ahead' so the output coupling should rotate same way, then lowering the selector bar should reverse the direction of rotation of the output coupling.
- s. If any fouling is noted, the further dismantling to investigate why will be necessary.
- t. Re-insert Cooling Inserts (92) with new O rings (95) over each end. Refit upper & lower manifolds.

J Re-mounting to engine

- a. This procedure is straightforward reversal of removal.
- b. Note that the Change cable may require adjustment, because the new parts & wear ring will have made the mechanism tighter.
- c. Renew the rubber seal on the cooling water outlet pipe.
- d. Fill with fresh Engine grade Oil (CD specification) to bottom of dipstick. After initial run of 20 - 30 minutes, drain this oil using suction pump and refill with fresh oil to top of dipstick.

K Shaft Alignment - Volvo Blackjack style shaft seal

- a. Check the shaft coupling plate pulls up square to the output coupling. Insert a 0.25mm feeler to one side, and push the coupling up to give a snug feel. Then check for similar resistance around the periphery of the coupling plates.

- b. Out of the water - Pull back the shaft seal then check the concentricity of the Shaft within the shaft tube. The gap should be equal all way around + - 0.5mm
- c. In water - DO NOT PULL BACK SHAFT SEAL. Mount laser level to output coupling, with the beam concentrated in one position midway along sealing bellows retaining clip. Rotate coupling, taking care not to disturb laser device. Observe position of beam, then adjust engine mounts to give an even alignment, so that when rotated the beam remains at a constant position on the seal bellows clip.

The above procedure was adopted in absence of a proper procedure from Volvo. Note I did not alter the original settings of the shims setting the Layshaft position (shim packs 8 & 24), nor those determining the insertion and hence mesh position of the input & output shafts (41 & 53). Providing identical bearings are used and excess wear or damage is not present to the gear teeth this should suffice.

Bearing, O ring & Lipseal listing

Bearings ...

		Dwg No.		Dwg no.	
Input Shaft		37	NTN 30207 taper	38	SKF 31307 taper
Lay shaft	2off	9	NTN 3210E dbl ball	14	K24X30X17 needle 4 off
Output Lay pinion		26	SKF 320/32 X	28 / 28A	88649 / 88610 Taper
Output Shaft	2 off	54	SKF 31307		

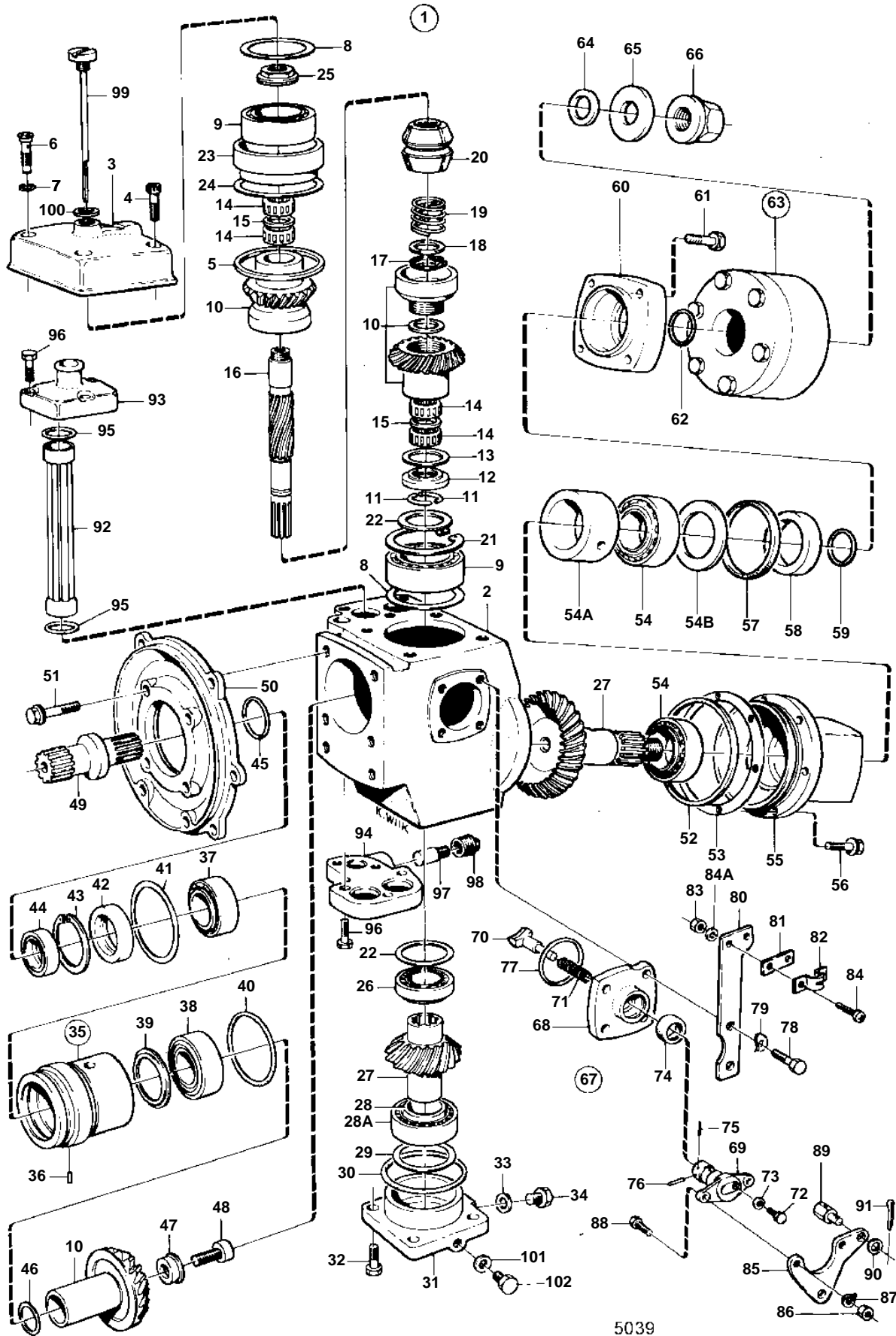
O rings ...

Input hsg assy (40); Output lipseal Cover plate (57);Bottom cover (30) RM0795-30

Input shaft / Spacer seal	(45)	RM0351-16
Output hsg Seal	(52)	BS127x3
Output coupling seal	(59)	BS217
Top cover banjo seal	(7)	
Selector block seal	(77)	RM0695-30
Cooling insert	4 off (95)	BS218

Lip seals ...

Input Shaft	75 OD x 45 ID x 8 thick single lip seal	45X75X
Output Coupling	72 OD x 50 ID x 8 thick single lip seal	50X72X
Gear selector shaft	36 OD x 25 ID x 6 thick single lip seal	25X36X



MS3

REF	PART NO.	QTY	DESCRIPTION	SEE SEC.	NOTES
1	850413	1	Reversing gear		RATIO 1,92:1
2	850414	1	• Gear housing		
3	832667	1	• Gear housing cover		(832668)
4	956585	3	• Screw		
5	832669	1	• Gasket	IK	
6	814643	1	• Hollow screw		
7	955989	1	• O-ring	IK	
8	943866	X	• Adjusting washer		TH = 0,1 MM
	943867	X	• Adjusting washer		TH = 0,2 MM
	943868	X	• Adjusting washer		TH = 0,4 MM
9	853542	2	• Ball bearing		(183729)
10	839027	1	• Drive gear set		
11	897312	2	• Lock ring		
12	850422	1	• Spacer ring		
13	852433	1	• Wear washer		(850243)
14	181359	4	• Needle bearing		
15	897308	2	• Spacer ring		
16	897385	1	• Shaft		
17	951077	1	• Lock ring		
18	26411	1	• Spacer		
19	813970	1	• Spring		
20	852949	1	• Sliding sleeve		(852548)
21	850433	1	• Lock ring		
22	949071	X	• Adjusting washer		TH = 0,1 MM
	949072	X	• Adjusting washer		TH = 0,15 MM
	949073	X	• Adjusting washer		TH = 0,35 MM
	949074	X	• Adjusting washer		TH = 0,50 MM
23	832644	1	• Bearing sleeve		
24	946179	X	• Adjusting washer		TH = 0,1 MM
	943870	X	• Adjusting washer		TH = 0,2 MM
25		1	• NUT		
	839332	X	• • Nut		ALT TH = 2,10 MM
	839333	X	• • Nut		ALT TH = 2,37 MM
	839334	X	• • Nut		ALT TH = 2,65 MM
26	184165	1	• Roller bearing		
27	850415	1	• Gear set		
28	181303	1	• Roller bearing		(183840)
28A	181304	1	• Cup		(183840)
29	87655	X	• Adjusting washer		TH = 0,1 MM
	191840	X	• Adjusting washer		TH = 0,15 MM
	87654	X	• Spacer		TH = 0,35 MM
30	925256	1	• O-ring		
31	850272	1	• Cover		
32	946329	4	• Flange screw		
33	957173	1	• Gasket	IK	
34	960628	1	• Plug		
35	875425	1	• Bearing box	IK	
36	951940	1	• • Tensioning din		
37	183247	1	• • Bearing		
38	183668	1	• • Roller bearing		
39	897772	1	• • Oil deflector		EARLY TYPE
40	925256	1	• O-ring	IK	
41	941826	X	• Adjusting washer		TH = 0,05 MM
	941827	X	• Adjusting washer		TH = 0,2 MM
	948230	X	• Shim		TH = 0,35 MM
42	839253	1	• Sealing ring	IK	
43	914538	1	• Lock ring		
44	832675	1	• Washer		
45	956000	1	• O-ring	IK	
46	943871	X	• Shim		TH = 0,05 MM
	943872	X	• Shim		TH = 0,1 MM
	943873	X	• Shim		TH = 0,2 MM
47	839013	1	• Washer		

MS3

REF	PART NO.	QTY	DESCRIPTION	SEE SEC.	NOTES
48	851293	1	• Screw		(945090)
49	850275	1	• Axle shaft		
50	850276	1	• Intermediate section		
51	965185	6	• Flange screw		
52	925096	1	• O-ring	IK	
53	850472	X	• Adjusting washer		TH = 0,1 MM
	850473	X	• Adjusting washer		TH = 0,15 MM
	850474	X	• Adjusting washer		TH = 0,35 MM
54	183668	2	• Roller bearing		
54A	851114	1	• Spacer ring		BN1805-
54B	84219	1	• Adjusting washer		BN1805- TH = 0,1 MM
	84218	1	• Spacer		BN1805- TH = 0,35 MM
55	850269	1	• Bearing housing		
56	946671	1	• Flange screw		
57	925256	1	• O-ring	IK	
58	958879	1	• Sealing ring	IK	
59	125018	1	• O-ring	IK	
60	850270	1	• Cover		
61	955297	4	• Screw		
62	925069	1	• O-ring	IK	
63	850417	X	• Slip clutch		
		X	• • COMPONENTS		
64	400870	X	• Adjusting washer		BN-1804 TH = 0,1 MM
	400871	X	Adjusting washer		BN-1804 TH = 0,15 MM
	949070	X	Washer		BN-1804 TH = 0,35 MM
65	850471	1	• Washer		
66	947855	1	• Lock nut		
67	839504	1	• Shift mechanism		
68	839505	1	• • Bearing housing		
69	897816	1	• • Eccentric piston		
			• • Bulletin P-44-1-7	P-44-1-7-EN	Shift mechanism, eccentric piston
70	814603	1	• • Dog		
71	814184	1	• • Spring		
72	897711	1	• • Screw		
73	897871	X	• • Adjusting washer		TH = 0,2 MM
74	958838	1	• • Sealing ring		(941866)
75	951924	1	• • Tensioning din	IK	
76	942871	1	• • Pin		
77	925093	1	• • O-ring	IK	
78	955273	4	• Screw		
79	941906	4	• Spring washer		
80	850350	1	• Cable attachment		
81	819068	1	• Washer		
82	819067	1	• Brace		
83	946577	2	• Lock nut		(940092)
84	955246	2	• Screw		(950022)
84A	940090	2	• Washer		
85	852363	1	• Lever		(834021)
86	955781	2	• Nut		
87	955948	2	• Lock washer		
88	955270	2	• Screw		
89	804312	1	• Cube		
90	955892	1	• Washer		
91	907834	1	• Cotter pin		(17276)
92	850741	2	• Insert		
93	850742	1	• Cover		
94	850833	1	• End cover		(850743)
95	942353	4	• O-ring	IK	
96	955276	6	• Screw		
97	804107	1	• Zinc electrode		FOR 800475
	838929	1	• Zinc anod		FOR 838928
98	800475	1	• Plug		REPLACED BY PLUG-838928 AND ELECTRODE-838929
	838928	1	• Plug		

MS3

REF	PART NO.	QTY	DESCRIPTION	SEE SEC.	NOTES
99	839351	1	· Oil dipstick		
100	955974	1	· O-ring		
101	897682	1	· Gasket		
102	814179	1	· Plug		
	875628	1	Gasket kit		