

# Rebuilding, uprating and fitting a Lotus 5-speed gearbox to the Lotus Elan.

## Tips and hints to get a lasting solution.

By Victor Hollnagel

Ba.Sc.Mech.Eng. and Danish club member

Many Lotus Elan owners seem to share the opinion that the Elan is in need of a 5<sup>th</sup> gear to keep revs and noise on acceptable levels for motorway driving.

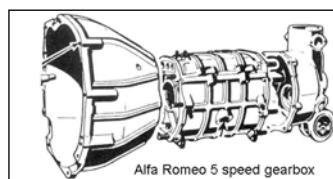
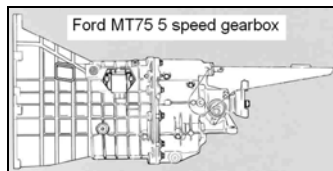
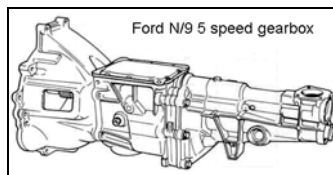
The last 3 Elan Sprints delivered from Lotus in 1973 was actually equipped with the 5-speed gearbox from the slightly bigger +2 version. Furthermore a Lotus parts bulletin of 04.09.1974 was issued, describing a 5-speed conversion kit for the Elan Sprint and the Elan +2S 130.

Having carried out the 5 speed conversion on my own Lotus Elan Sprint DHC 1973, I will in the following elaborate on my experiences, hopefully inspiring other Elan owners to consider a similar conversion.

The Lotus 5 speed gearbox has got an undeserved reputation of being troublesome. The number of Lotus Service Bulletins with modifications could at first glance seem to confirm that image.

### Alternatives considered

With that first impression in mind other alternatives were considered,



**Top: Ford N/9**  
**Middle: Ford MT 75**  
**Bottom: Alfa Romeo**

such as Ford's type N/9 gearbox, Ford's MT75 gearbox, both of

Sierra fame, and even the Alfa Romeo gearbox used in the type 105 Bertone Coupe (see the article written by Murray Valentine in "Club Lotus News" 3/1987, page 10).

An important point was to avoid cutting neither in the chassis nor in the interior in order to be able to later convert the car

back to its original condition. This appeared to be quite ambitious, as the chassis is narrow around the gearbox, and as the gearlever comes up through the floor in a for most cars unusual forward position.

None of the above three gearboxes could fulfil these requirements. Therefore the Lotus 5 speed gearbox was further investigated.

### Origin of internals

Basically the gears in the Lotus 5 speed gearbox are from the BL Austin Maxi being one of the few mainstream cars sporting a 5 speed gearbox at that time. These gears were installed in a Lotus designed aluminium casting.

A new input and output section was designed by Lotus to convert the original transversely mounted Maxi gearbox internals to its new inline position.

### Not fragile

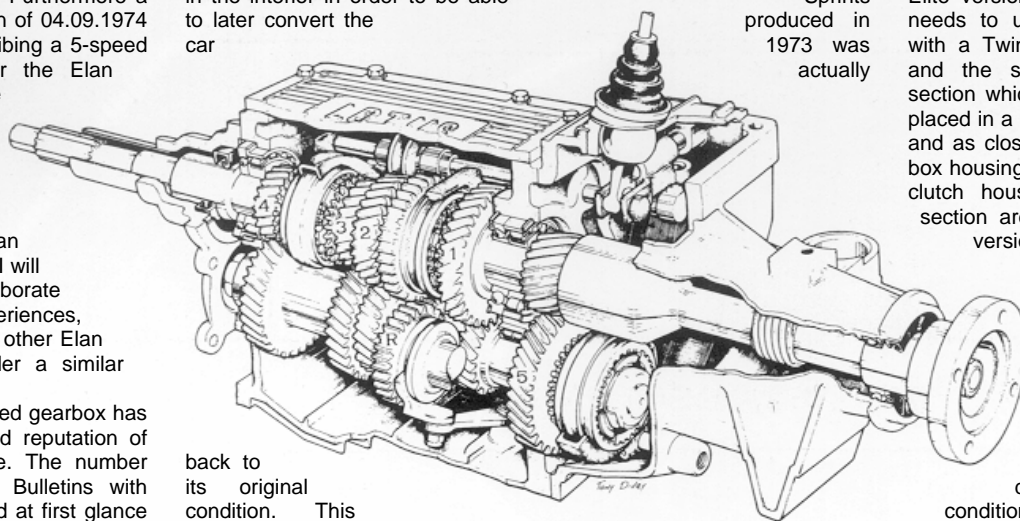
The Lotus 5 speed gearbox was originally intended for and used in the quite heavy new Elite (2240 lb/1016 kg) with its powerful 2 litre 16 valve type 907 engine developing 160 HP, all of which when driven in anger took the stresses on the gearbox close to its limits.

This might be the reason for the reputation of the gearbox of being somewhat fragile.

In a 1558 ccm, 126 HP and 1540 lb/700 kg Elan Sprint loads are immensely reduced compared to the Elite.

One of the above mentioned last 3 original 5 speed Elan

Sprints produced in 1973 was actually



exported to Denmark and bought by Mr. Claus Gaarde; a long time Danish Lotus enthusiast. Claus could inform me, that he – after rebuilding the gearbox himself in 1984 to the latest specifications – drove 150 000 troublefree kilometres with the box behind a slightly uprated 140 HP Twin Cam engine. Claus kindly lent me all his technical information (parts list, service manual and service bulletins) on the box. Claus also had a nearly complete gearbox as spare parts, which I was invited to examine.

After going through all this information I could see no reason why a Lotus gearbox should not be able to work satisfactory in my Sprint as well.

### Elite and Elan versions

The version of the gearbox used in the new Elite has a longer output section and the clutch housing has a different engine flange compared to the version of the 5 speed box used in the Elan and Elan +2. But the central gearbox section carrying the gears is the same on the Elite and Elan variants.

### Prices

Elite Lotus 5 speed gearboxes are obtainable for realistic money, due to them being frequently swapped for the later used Getrag 5 speed gearbox for improved reliability. Only the mid gearbox section can be used from these Elite versions, though. The Elan needs to use a clutch housing with a Twin Cam engine flange and the short gearbox output section which has the gear lever placed in a position as far forward and as close to the central gearbox housing as possible. Both the clutch housing and the output section are unique to the Elan version, and unfortunately

these parts are no longer available from Lotus. Therefore quite stiff prices varying between £ 750 and £ 1500 are asked for Elan +2 5 speed gearboxes depending on condition. Actually you are paying these prices only for the clutch housing and for the output section, because the central gearbox section carrying the gears can – as mentioned earlier – be used directly from the Elite gearbox, which should be



**Output housings: At top for Elan and below Elite**

possible to get for £ 100 to £ 250 depending on condition.

When buying an Elan 5 speed gearbox remember to get the propshaft with integral sliding spline at the gearbox end and the gearbox mount too, as these parts are unique to the Elan version as well.



### Elan propshaft with integrated sliding spline

My own way to the Elan 5 speed gearbox was to put an ad in Club Lotus News. For £ 1100 I ended up buying a dismantled gearbox with a couple of new gears and with the convenient possibility to inspect the box's internals too. My intention was to disassemble and renovate the gearbox anyway.

However this appeared to be no cheap experience. But take it as a hobby, consider what other people spend on their hobbies (what did your wife spend on shoes lately?) and enjoy the originality of the conversion which is done just like Lotus did. If done properly, it should raise the value of your car too.

### Equipment

To carry out the conversion it is necessary to have good workshop experience, to be patient, and to use plenty of common sense.



### 1<sup>st</sup> motion shaft puller

You should have access to a hydraulic press and have common workshop tools. It is



### 3<sup>rd</sup> motion shaft support

also necessary to be able to make up a couple of special parts and tools to get the job done properly. You should get hold of the original section F from the Elan +2 workshop manual and all the Lotus service bulletins regarding the 5 speed transmission. It will be of great help to you, if you have a parts list, too.

On that basis you should be able to make a well functioning 5 speed gearbox and even enjoying the pleasure of doing the job yourself.

### Lotus vs. Ford box

The Elan is normally equipped with a Ford gearbox first used in the Ford Corsair 2000E. Hence it's often referred to as the Ford 2000E gearbox. This gearbox weighs 33 kg with its cast iron clutch- and gearbox housing. The Lotus box weighs only 27 kg with its aluminium housings. By fitting the Lotus box you are "adding lightness" to your car, just as Colin Chapman prescribed.

The gear ratios of the first 4 gears are nearly the same in the Ford 2000E and in the Lotus box: The biggest difference is found between the ratios of the 1<sup>st</sup> gears; the Lotus box's 1<sup>st</sup> (1:3,20) is 7% lower the Ford box's 1<sup>st</sup> (1:2,97) giving a slightly easier

### Numbers and markings

In the bottom of the gearbox housing a series number is stamped.

Some of the gearbox housings were machined to odd tolerances, and were fitted with oversize bearings, which are no longer available. These boxes are identified by "OS" stamped beside the series number. Try to avoid these boxes as they are more difficult to rebuild.

From series number 1492 and on the angle of synchromesh on 1<sup>st</sup> and 2<sup>nd</sup> gear is changed from 5° to 6° to improve synchromesh life and action.

From series number 2174 and on a nice trust needle roller bearing for the 1<sup>st</sup> speed gear and an

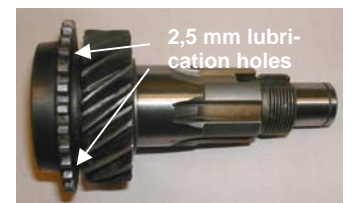
for a much stronger standard size ball bearing with a ring to compensate for the slightly smaller outer diameter. This change greatly enhanced the rigidity and location of the input shaft, and the lifetime of the input shaft bearings. If your gearbox does not have this modification, you can make it yourself, if you have



access to a lathe. To make room for the wider bearing you will have to spigot the input shaft slightly and deepen out the recess in the input housing.

To improve lubrication of the needle roller bearing between the 1<sup>st</sup> motion and the 3<sup>rd</sup> motion shaft, two holes were introduced in the 1<sup>st</sup> motion shaft radially through the land beside the teeth of the gearwheel.

If your input shaft does not have these lubrication holes, you can drill them yourself. Grind off the hard surface with a small stone in a Dremel or equivalent, making a slight grub, buy a normal 3 mm brick-wall drill, grind its side down to 2,5 mm, and you are able to drill through the rather hard steel using a little oil for cooling. Much cheaper than buying a new shaft with holes



for £ 150. Remember to carefully grind off the sharp edges, not damaging the bearing surface inside the 1<sup>st</sup> motion shaft in the process.

### Bearings

The gearbox contains 4 ball bearings, 3 roller bearings and 5 needle roller bearings. They are all of RHP or Torrington origin.

Only 2 ball bearings and 4 needle roller bearings are standard catalogue items, the other 6 bearings are special.

The way to get hold of all the bearings is to contact a bearing specialist company with the right UK contacts. Provide the list of the bearings, and they should be able to source them all for you.

The 6 special bearings will not be cheap. Be prepared to pay in the region of £ 500 for all of the 12 bearings.

Vehicle speed							
Final drive ratio:		3,778		pinion: 9		cr. wh.: 34	
Tyre dynamic radius:		281 mm		tyre dimension:		155/80R13	
Gearbox	eng. rpm	1st	2nd	3rd	4th	5th	Rev.
		km/h					
Lotus	1000	9	14	20	28	35	8
Ford	1000	9	14	20	28	-	8
Lotus	6500	57	91	133	182	229	53
Ford	6500	61	91	130	182	-	55

and less clutch stressing start from stand still with the Lotus box.

The other ratios are the same within 3%, a difference you will hardly notice. In top gear at 130 km/h revs drops from 4600 rpm in the (Ford) direct 4<sup>th</sup> gear to 3700 rpm in the (Lotus) 1:0,80 ratio 5<sup>th</sup> gear, giving a very useful 900 rpm drop and reduction in the noise level on longer journeys. The layout of the Lotus' 5<sup>th</sup> gear as an overdrive is confirmed by the gearknob badge: "1 - 2 - 3 - 4 - O/D".

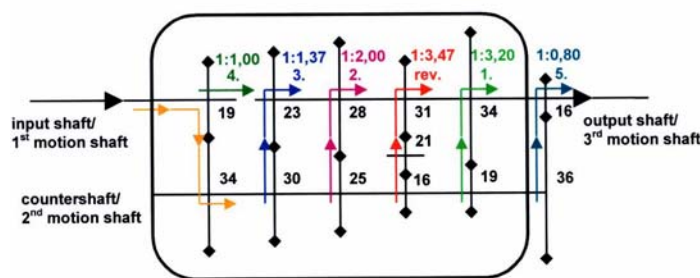
accordingly revised 1<sup>st</sup> speed gear is used.

From series number 2016 and on a smaller roller bearing is used at the rear end of the countershaft. In my opinion a slightly retrograde step.

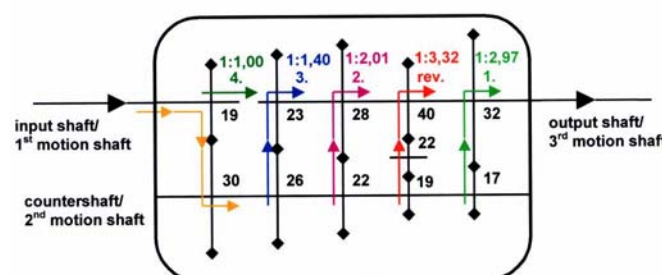
### Design changes

Beside the above mentioned changes an important change of the odd narrow, large outer diameter ball bearing at the input shaft was made. It was changed

### Lotus 5 speed gearbox



### Ford 4 speed "2000E" gearbox





## Modifications

### Selector shaft finger

The standard selector shaft finger has round sides, which grip into the selector fork's square cut-outs with straight sides. The 3<sup>rd</sup>/4<sup>th</sup> selector fork is made of brass and has narrowed down sides. Consequently the sides of the selector fork cut-out are deformed leading to a sloppy gear change.

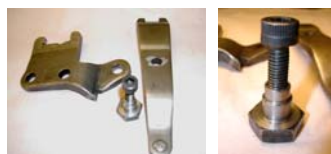
The solution is to make up a selector finger with a square head and straight sides just like the selector fork cut out, which it grips



into. Make the revised finger from a piece of Uddeholm "Arne" steel, which can be hardened and tempered to the right strength and hardness. The selector shaft is modified to take the now Allen screw secured selector finger.

### Lever pivot

The lever for the 5<sup>th</sup> gear and the reverse gear is secured at its pivot point with a tiny circlip which is reported to easily slip off. The solution is to make up a new pivot point and securing system of a



turned down M10 bolt of 8.8 steel quality. This bolt is secured by a M6 Allen screw. By tuning the tolerances it is now possible to have a secure and free turning pivot without sloppiness.

### Selector line up

The cut outs in the selector forks and in the 5<sup>th</sup>/rev. lever should be aligned in neutral; otherwise the gear lever cannot be moved across the gaiter freely. In my case the cut out in the



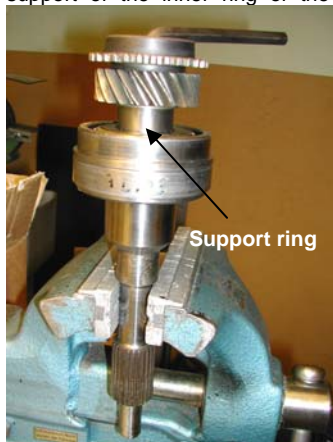
5<sup>th</sup>/rev. lever was about 0,7 mm out of line. This was compensated by making up new retainers (see drawing position 18) for the interlock plate with 0,5 mm eccentric holes and threads. It was now possible by turning the retainers



to move the bracket with the 5<sup>th</sup>/rev. lever until its cut out was aligned with the selector fork cut outs.

### Support ring

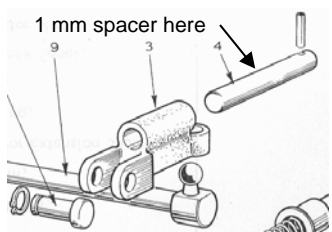
The input shaft and the 1<sup>st</sup> motion shaft are mated with splines around the above mentioned heavier ball bearing and a roller bearing. The inner ring of the improved ball bearing only sits on the spigotted end of the input shaft. The alignment of the mated shafts to the ball bearing and the support of the inner ring of the



ball bearing can be enhanced by making up a support ring filling up the remaining space between the 1<sup>st</sup> motion shaft spline and the inner diameter of the ball bearing.

### Spacer

Put a 1mm plain washer over the selector link pin (position 4) to space the selector link out from the gearbox side. This will take up



excess sideways sloppiness in the gear lever when it is in the 1<sup>st</sup>/2<sup>nd</sup> gear position.

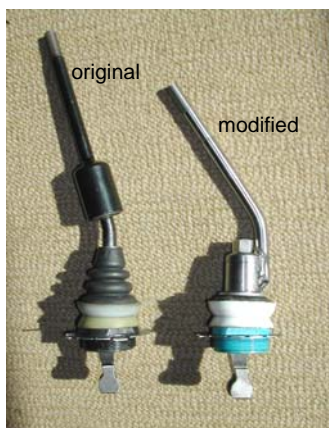
### Offset gear lever

An offset gearlever should be made up like the lever used on the original 2000E 4 speed gearbox, but the offset should be to the front instead to the rear. The reason for this is that the gear lever from the Lotus box comes

up through the tunnel in a rearward position in relation to the cut out in the tunnel and the tunnel console. This is compensated for by making up a new gearstick with an offset rubber bush house, with the gearlever welded to the front of the bush housing. The original gearstick is disassembled at the concentric rubber damper,



the lower gearstick part is carefully straightened, a M10x1 thread is cut at the end of it, the conical



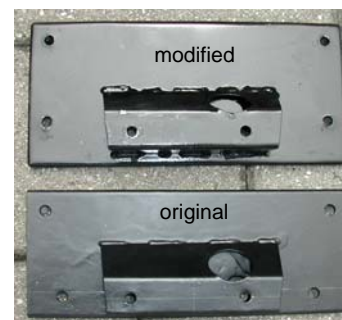
rubber spring is cut down, suitable spacers made up, and the new forward offset gearlever



can be assembled. The rubber bushing used is a part from the rear suspension A-arm outer bushing. The mounting of the new - disassembled - gearlever to the gearbox is now much easier too. The photo should give the general idea.

### Gearbox mounting plate

According to Lotus fitting instruction the gearbox mounting plate for the Lotus box should be mounted to the chassis in holes drilled in new positions. I preferred to make up a new gearbox



### Gearbox mounting plate

mounting plate which made it possible to use the existing holes in the chassis instead.

### Concentric slave cylinder

The clutch originally uses an outside mounted slave cylinder, too close to the exhaust manifold. On hot days and in town traffic this situation often leads to cooked clutch fluid and a malfunctioning clutch release.



To overcome this a SAAB 900 concentric slave cylinder was mounted inside the clutch housing, doing away with a lot of the mechanical parts. A console plate



was made up to take up the new clutch cylinder. The necessary hydraulic lines, fittings and an outside bleed screw had to be made up too.





## Assembly

It is wise to make a trial assembly of the gearbox with the old bearings to check the function and free running of all the parts. Shift through all gears and turn the shafts. For my part on my trial assembly I found the input shaft binding and loosing up for every 180° turned which was tracked down to an out of true 1<sup>st</sup> motion shaft. I had to have a new shaft fitted!

When fitting bearings to the gearbox housing, always heat up the housing with a heat gun. When heated, aluminium expands three times as much as steel. This should assure you correct and much easier fitting of the bearings.

The gearbox housing should be thoroughly cleaned before assembly. Nowadays ball and roller bearings are dimensioned not only by the loads, but by the cleanliness of the lubricant as well. Even the smallest amount of dirt can greatly reduce the lifespan of your expensive bearings. It pays well off to be thorough.

When tightening the big nuts at the 3<sup>rd</sup> motion shaft and on the 2<sup>nd</sup>

teethes and the shafts. Instead take a surplus synchroniser collar ring and have it bolted up in a tool with a lever arm. This tool can be used to carefully hold back the 2<sup>nd</sup> motion shaft on the 5<sup>th</sup> gear synchroniser mechanism while tightening down the nuts, without overloading the gearbox.

The baulk rings can present a slight problem, as they have to be of the correct angle, which as mentioned earlier was changed. It should be possible to feel if the baulk ring fits properly to the cone of the corresponding gear wheel. I had to go through a couple of sets before I had a full set of the correct angle baulk rings.

To eliminate the risk of the bearings rotating in the gearbox housing when the gearbox reaches working temperature, or due to bad tolerances, always use Locktite bearing securing fluid. Be careful not to drop Locktite into the bearings.

All bolts and nuts should be secured with Locktite for bolts, especially the long Allen bolt securing the input shaft to the 1<sup>st</sup> motion shaft. It is critical if it works loose. But it won't if you are careful.

Be sure to use a magnetic bottom drain plug to catch steel deposits from the oil. I ended up using one from a Triumph Spitfire gearbox as it was NLA from Lotus.

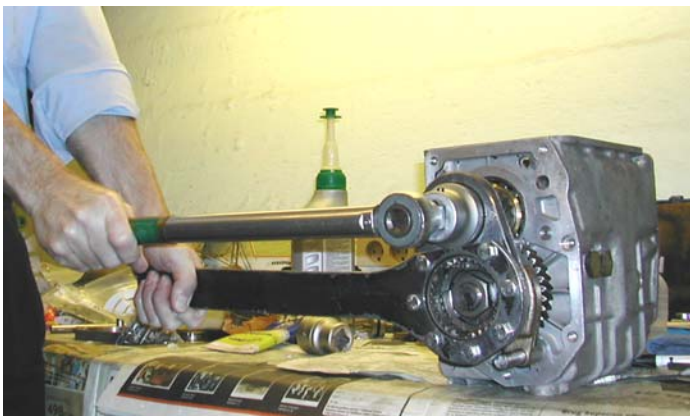
You will need an approx. 15 cm longer speedometer cable. A cable specialist firm should have the answer to that.

Otherwise do exactly as stated in the Lotus workshop manual, and be careful to keep the speci-

fied tolerances. They are of great importance to the function and shift quality of the gearbox.

Use the best synthetic gear oil you can get, for instance Castrol TAF-X. The gearbox will take 1,7 litre.

You should now be able to enjoy motoring in your Elan even more when cruising long distances in 5<sup>th</sup> gear!



motion shaft, the workshop manual says that you should put the gearbox in 1<sup>st</sup> and 3<sup>rd</sup> gear at the same time, locking up the gearbox. I would advise you not to use this method, because you put immense loads on the gear

Generally, Locktite only works when the surfaces are clean and free from oil and grease.

The sealing compound to use on the gaskets is Hylomar or an equivalent not drying up RR specification sealing compound.



### Acknowledgements

This project could not be tackled without invaluable help from many friends and specialists:

Nick Abbott at the Bull and Butcher in Turville sold me the gearbox, provided a nice meal, a pint of Breakspears bitter and bed and breakfast on my visit to collect the box in England.

Pat Thomas at Kelvendon sourced a much needed new 1<sup>st</sup> motion shaft.

Paul Matty Sportscars sourced

a brand new 5<sup>th</sup> gear pinion among numerous other important bits and pieces.

Alan Voight supplied many NLA items.

Michael Taylor sold me a nice used Elite gearbox, a new input housing, not to mention finding a gearknob with the all important "1-2-3-4-O/D" shift pattern badge to enjoy.

Murray Valentine, Australia kindly sent me his absolutely thorough and detailed 10 page description of how to fit an Alfa 5

speed gearbox in an Elan (you will have to cut a little in the chassis and move the engine and gearbox a bit forward. It has been done a couple of times with good results and it's not expensive).

Claus Gaarde supplied his complete Lotus literature on the subject and the opportunity to have a thorough look at the hardware.

Peter Kjøl, Niels Johansson and Henrik Andersen provided knowledge of material and heat treatment for the selector shaft finger,

sourced all bearings and welded the balancing weights properly onto the propshaft.

Torben Valerius provided the possibility to have some gearbox surfaces cleaned up in a big lathe at his disposal.

Frank Thrusholm - last but not least - took the trouble to read the proofs on my ramblings.

Thanks to you all!

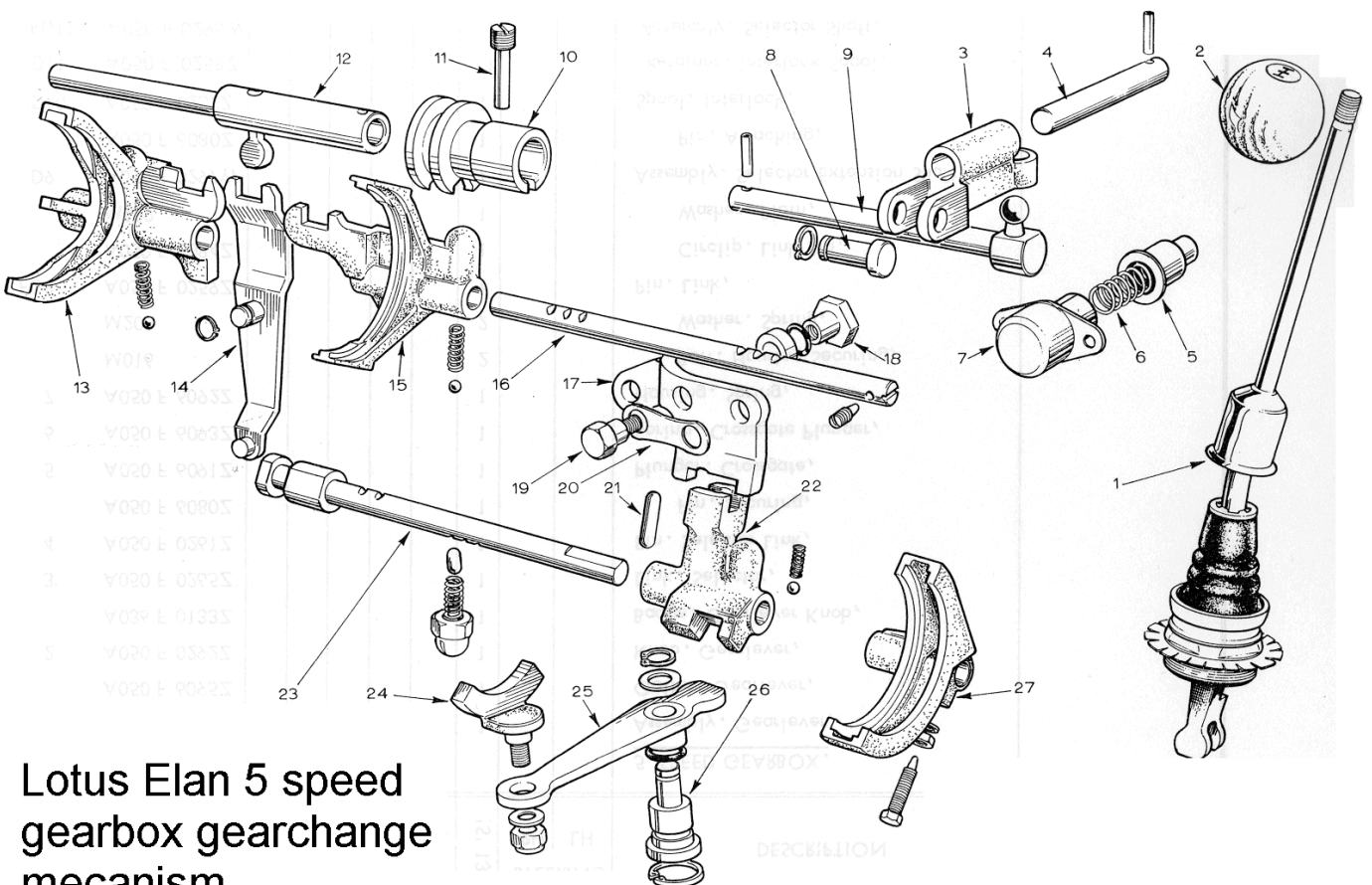
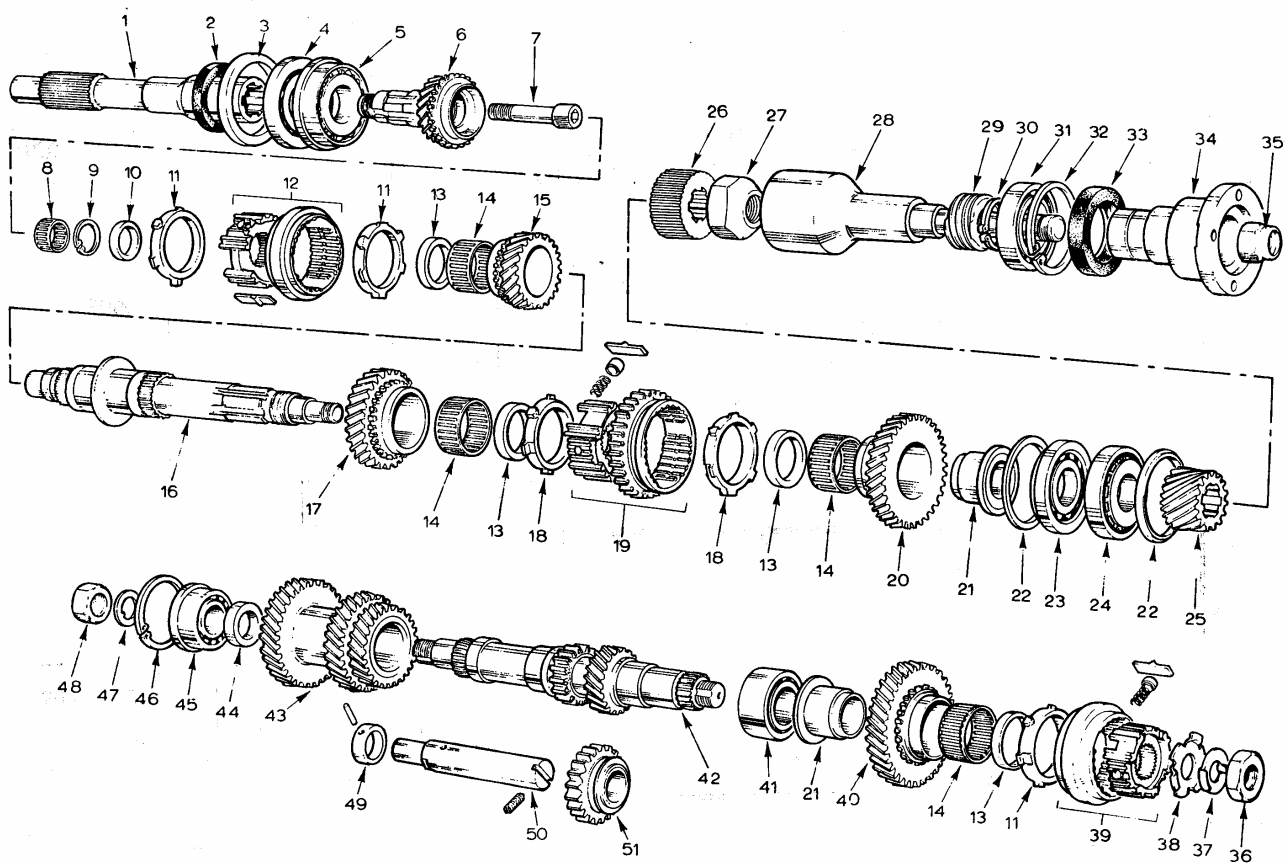
## Lotus 5 speed gearbox bearings

Pos. # drawing	Qty.	Bearing	Make	Type	Inner diameter	Outer diameter	Width	Width of flange	Outer diameter of flange
4	1	Ballbearing	RHP	6207	35 mm	72 mm	17 mm	-	-
5	1	Rollerbearing with flange	RHP	17LRJ30	30 mm	72 mm	16 mm	4 mm	3"
8	1	Needlebearing, caged	?	?	20 mm	26 mm	12 mm	-	-
14	3	Needlebearing, caged	Torrington	FWJ 354025	35 mm	40 mm	≈ 24,5 mm	-	-
14	1	Needlebearing and aksialneedlebearing with innerbushing	Torrington	TE-160-680	27,15 mm	40 mm	35,3 mm	3,9 mm	55,55 mm
23	1	Ballbearing with recess in outerring	RHP	2LJ1 <sup>1</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>16</sub> "	68,7 / 59,5 mm	12,6 mm	8,5 mm	-
24	1	Rollerbearing with different with of inner- and outer ring	RHP	14RJ1 <sup>1</sup> / <sub>16</sub>	1 <sup>1</sup> / <sub>16</sub> "	68,8 mm	16 / 12 mm (innerring / outerring)	-	-
31	1	Ballbearing	RHP	6006	30 mm	55 mm	13 mm	-	-
41	1	Rollerbearing	RHP	1DXLLRJB30	≈ 30 mm	55 mm	25 mm	-	-
45	1	Ballbearing, double with flange	RHP	3LDJT20	20 mm	47 mm	20,5 mm	4 mm	52 mm

## Engine rpm

Final drive ratio:		3,778		pinion: 9		cr. wh.: 34	
Tyre dynamic radius:		281 mm		tyre dimension:		155/80R13	
		1st	2nd	3rd	4th	5th	Rev.
Gearbox	km/h	eng. rpm					
Lotus	130	-	9292	6360	4636	3687	-
Ford	130	-	9316	6475	4636	-	-

# Lotus Elan 5 speed gearbox shafts, bearings and gearwheels



Lotus Elan 5 speed  
gearbox gearchange  
mecanism