

HOW A CAR WORKS

- [Articles](#)
- [Video Course](#)
- [Sign in](#) [Sign in](#)

[Back to Top](#) [Blog](#) [About](#) [Patent Prints](#) [Workshop Manuals](#) [Video course](#)

[Facebook](#) [Twitter](#) [YouTube](#)

Search for:

[Home](#) / [Basics](#) /

How manual gearboxes work

[gearbox transmission](#)

The [Video Course](#) teaches you everything about modern cars.

Internal-combustion engines run at high speeds, so a reduction in gearing is necessary to transmit power to the drive wheels, which turn much more slowly.

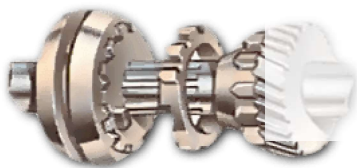
The gearbox provides a selection of gears for different driving conditions: standing start, climbing a hill, or cruising on level surfaces. The lower the gear, the slower the road wheels turn in relation to the [engine](#) speed.

The constant-mesh gearbox

The gearbox is the second stage in the [transmission](#) system, after [the clutch](#). It is usually bolted to the rear of the engine, with the clutch between them.

Modern cars with manual transmissions have four or five forward speeds and one reverse, as well as a neutral position.

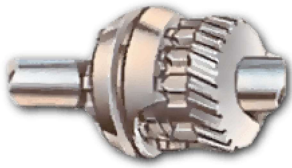
Synchromesh disengaged



The gear turns freely on a bush, rotated by a meshing gear on the layshaft. The synchromesh unit, splined to the mainshaft, rests near by.

Synchromesh engaged

Last viewed on 03/22/2021



The fork moves the synchroneshift towards the selected gear. Friction surfaces synchronise the shaft speeds, and synchroneshift and gear lock together.

The gear lever, operated by the driver, is connected to a series of selector rods in the top or side of the gearbox. The selector rods lie parallel with shafts carrying the gears.

The most popular design is the constant-mesh gearbox. It has three shafts: the input shaft, the layshaft and the mainshaft, which run in bearings in the gearbox casing.

There is also a shaft on which the reverse-gear idler pinion rotates.

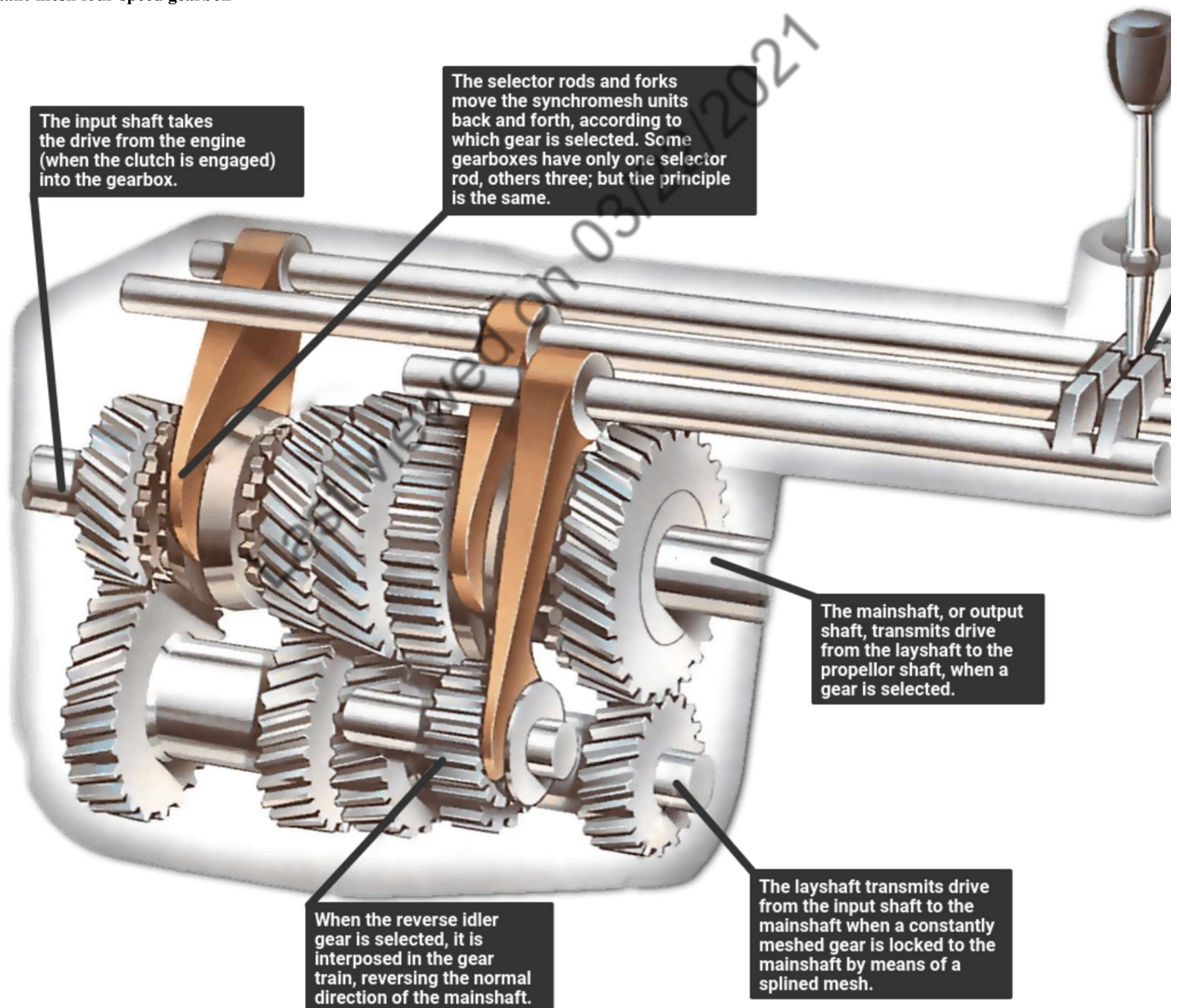
The engine drives the input shaft, which drives the layshaft. The layshaft rotates the gears on the mainshaft, but these rotate freely until they are locked by means of the synchroneshift device, which is splined to the shaft.

It is the synchroneshift device which is actually operated by the driver, through a selector rod with a fork on it which moves the synchroneshift to engage the gear.

The baulk ring, a delaying device in the synchroneshift, is the final refinement in the modern gearbox. It prevents engagement of a gear until the shaft speeds are synchronised.

On some cars an additional gear, called overdrive, is fitted. It is higher than top gear and so gives economic driving at cruising speeds.

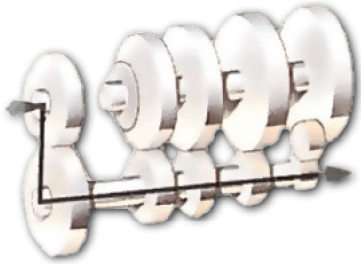
Constant-mesh four-speed gearbox



The gears are selected by a system of rods and levers operated by the gear lever. Drive is transmitted through the input shaft to the layshaft and then to the mainshaft, except in direct drive - top gear - when the input shaft and the mainshaft are locked together.

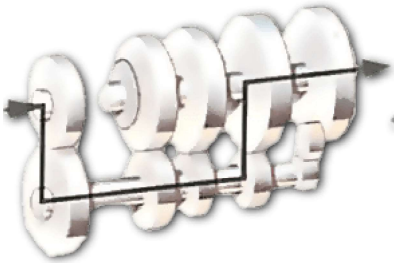
How gear ratios work

Neutral



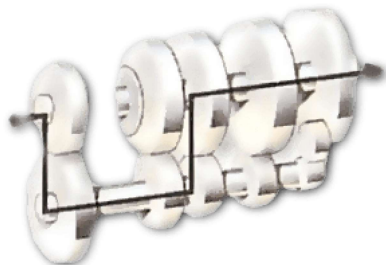
All the gears except those needed for reverse are constantly in mesh. The gears on the output shaft revolve freely around it, while those on the layshaft are fixed. No drive is being transmitted.

First gear



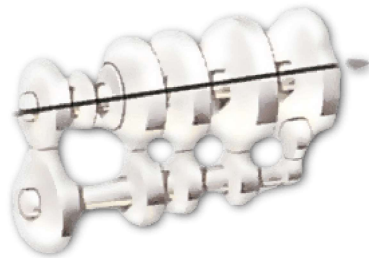
In first gear, the smallest gear on the layshaft (with the fewest teeth) is locked to it, passing drive through the largest gear on the mainshaft, giving high torque and low speed for a standing start.

Second gear



In second gear, the difference in diameter of the gears on the two shafts is reduced, resulting in increased road speed and lower torque increase. The ratio is ideal for climbing very steep hills.

Fourth gear



In fourth gear, the input shaft and mainshaft are locked together, providing 'direct drive': one revolution of the propeller shaft for each revolution of the crankshaft. There is no increase in torque.

Reverse

Last viewed on 03/22/2021



For reversing, an idler gear is interposed between gears on the two shafts, causing the mainshaft to reverse direction. Reverse gear is usually not synchronised.

Synchronising the gears

The synchromesh device is a ring with teeth on the inside that is mounted on a toothed hub which is splined to the shaft.

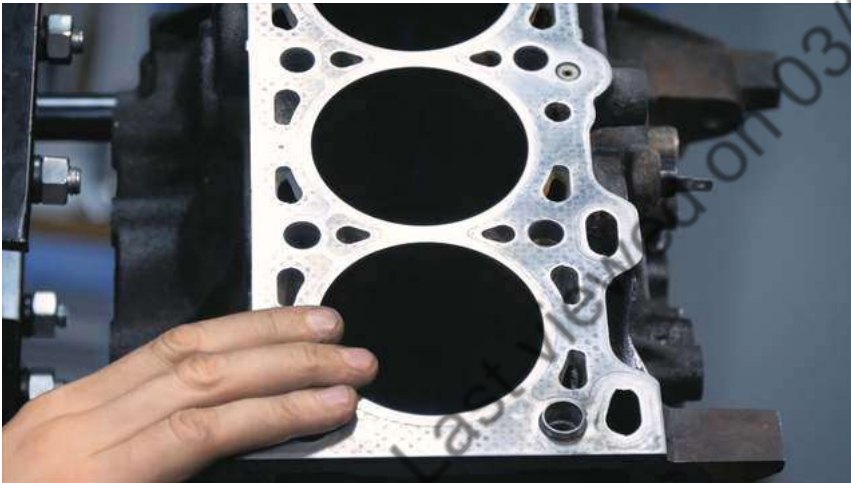
When the driver selects a gear, matching cone-shaped friction surfaces on the hub and the gear transmit drive, from the turning gear through the hub to the shaft, synchronising the speeds of the two shafts.

With further movement of the gear lever, the ring moves along the hub for a short distance, until its teeth mesh with bevelled dog teeth on the side of the gear, so that splined hub and gear are locked together.

Modern designs also include a baulk ring, interposed between the friction surfaces. The baulk ring also has dog teeth; it is made of softer metal and is a looser fit on the shaft than the hub.

The baulk ring must be located precisely on the side of the hub, by means of lugs or 'fingers', before its teeth will line up with those on the ring.

In the time it takes to locate itself, the speeds of the shafts have been synchronised, so that the driver cannot make any teeth clash, and the synchromesh is said to be 'unbeatable'.



Engine Block 18 minutes
Stop wasting time on YouTube and get serious!



The Ultimate Car Mechanics video course

Learn everything about modern cars from our new video series.

[Learn more >](#)

- **We build a Mazda MX5 Miata from scratch**

We start by tearing down and then rebuilding the whole car.

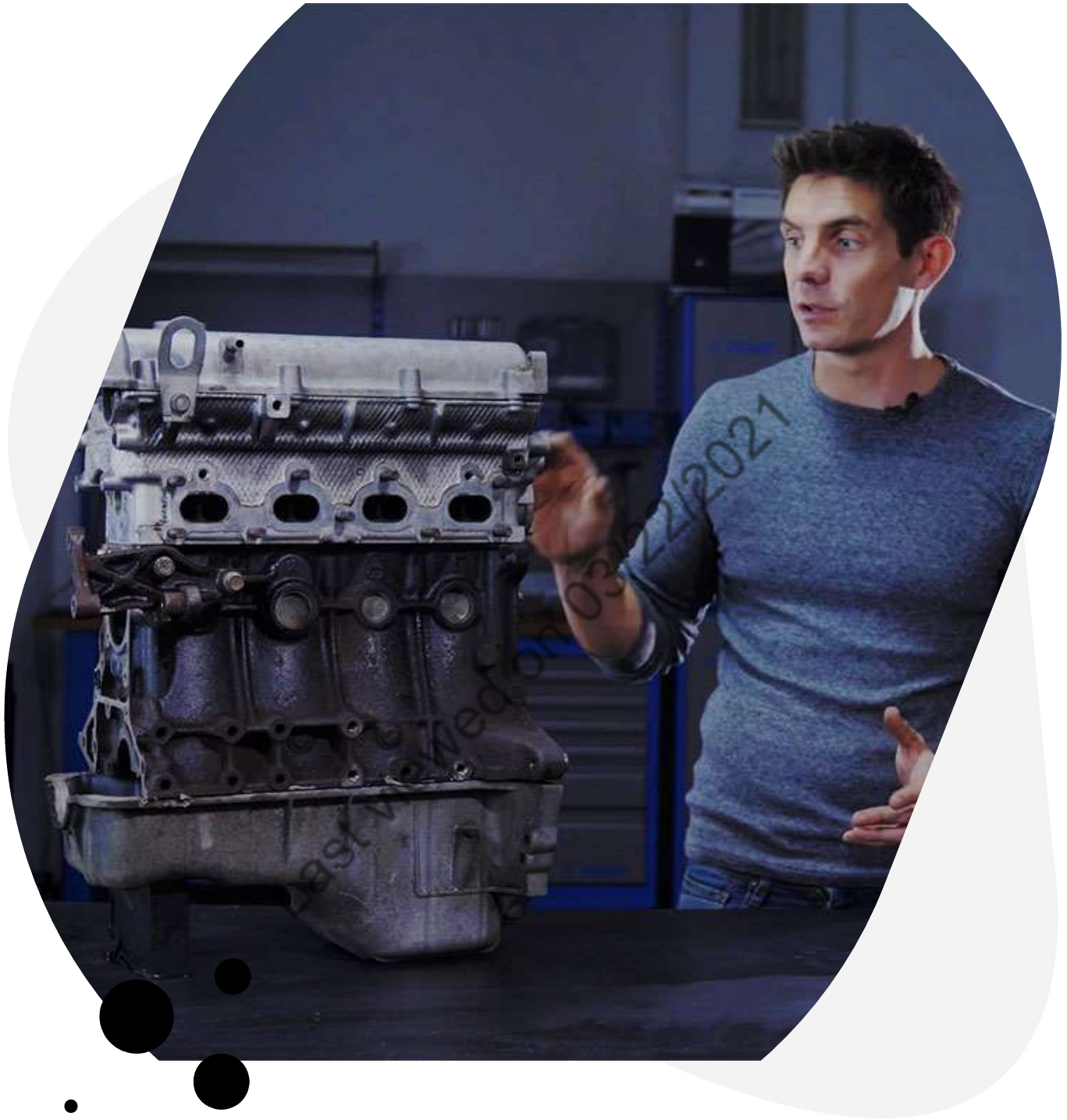
- **Every part explained**

There's ridiculous detail on every part. Clearly and easily explained.

- **All modeled in 3D**

We've created the most detailed 3D model ever produced so we can show you everything working.

[Start watching](#)



Super detailed explanations in the video course

15 hours of pro-quality, HD content with subtitles

[The video](#)

[course](#)

Engine 2 mins

[Bonus: Dismantling the engine](#)



Engine 18 mins

[Engine Block](#)



Engine 18 mins

[Crankshaft](#)



Engine 4 mins

[Tools: Using a tap set](#)



Engine 4 mins

[Using an engine stand](#)



Engine 12 mins

[The Pistons](#)



[+ 15 more hours](#)

Basics

Last viewed on 03/22/2021

[How automatic gearboxes work](#)

Most modern automatic gearboxes have a set of gears called a planetary or epicyclic gear train.
Transmission

[Driven wheel hubs](#)

The hubs of the driven wheels often look similar to those of undriven ones, but there are some differences in the way they are constructed because the driven hubs have to incorporate drive shafts too.

Basics

[How the transmission works](#)

In a front-engined rear-wheel-drive car, power is transmitted from the engine through the clutch and the gearbox to the rear axle by means of a tubular propeller shaft.

[Facebook @howacarworks](#) [Twitter @howacarworks](#) [YouTube @howacarworks](#)



How a Car Works is created, written by, and maintained by [Alex Muir](#). I don't really have adverts here: it's funded by wonderful people buying [the Car Mechanics Video Course](#).

The design of this site was heavily, heavily inspired by [CSS-Tricks](#) under their [supercool licence](#). If you're into design, go and check them out.

Some stuff

[Contact](#) [About](#) [Press](#) [Blog](#) [Video Course](#)

Last viewed on 03/22/2021