

# THE CLUTCH

Beginners' guide to technology, problem solving and the odd bit of trivia. Simon Goldsworthy packs it all into the first of our new series

**T**O GET a car moving requires a lot of links. The pistons go up and down, which in turn rotate the crankshaft. This rotational movement is passed into the gearbox and, after some jiggery pokery, comes out the other end at a different speed. It is then carried on down the propshaft to the differential. Here it is split in two and sent along the driveshafts, finally being passed via the road wheels and tyres onto the ground.

So far so good. But when you're starting the engine or sitting at the lights, you clearly have to interrupt this flow of power. And that's where the clutch comes in. Stepping on the clutch pedal (disengaging the clutch) effectively separates the engine and gearbox. Letting the pedal back up (engaging the clutch) re-connects the power and sends you trundling off down the road.

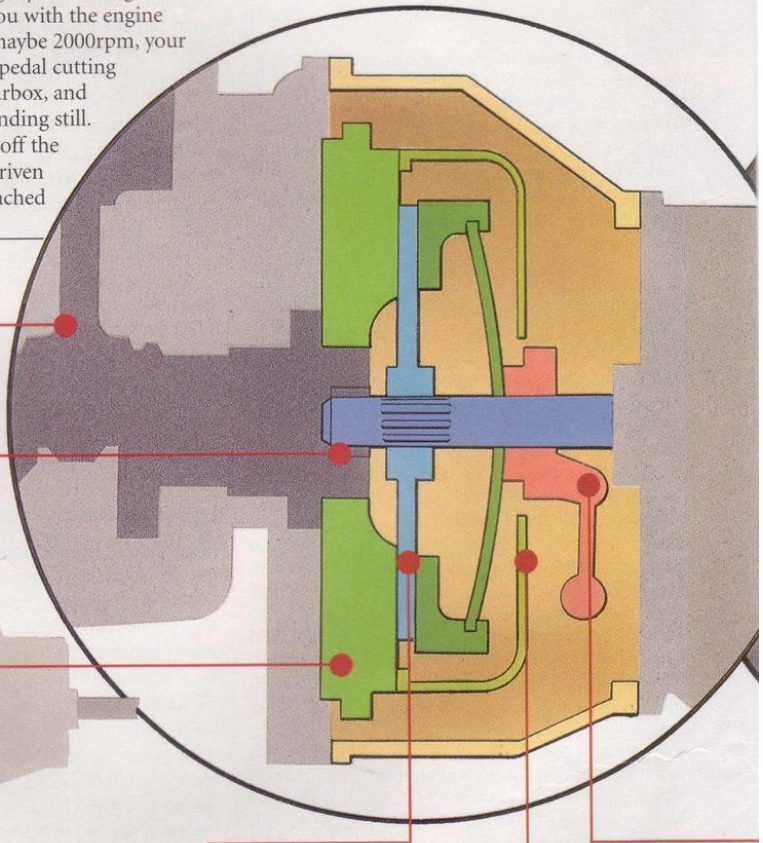
But this breaking and re-connecting of

power has to be a gradual process. If it were a simple on/off arrangement, then every start would be accompanied at high revs by spinning wheels scrabbling for grip, at low revs with the engine stalling out. That's because, in one respect, the internal combustion engine is inferior to the electric motor found under your local milk float. That can generate maximum torque from rest, allowing Mr Milko to climb in, step on the accelerator and move smoothly away. But you need revs before a petrol engine creates enough torque to get you moving.

So, that leaves you with the engine spinning away at maybe 2000rpm, your foot on the clutch pedal cutting off drive to the gearbox, and everything else standing still. As you start to lift off the pedal, the clutch driven plate (which is attached

to the gearbox) gets pressed lightly against the flywheel (which is attached to the engine). While the pressure is slight, the two surfaces can slip past each other with just a little of the flywheel's momentum getting passed on. But, as you let the pedal rise higher the pressure increases, the driven plate can slip less and it picks up more of the flywheel's rotational speed. Eventually, with your foot off the pedal, the two parts are locked so tightly together that they rotate as one until you disengage again to change gear.

**Clutch engaged:** the flywheel is bolted to the engine crankshaft, the driven plate is locked onto the gearbox shaft by splines and the pressure plate is clamping the two together. In this mode, none of the plates can slip and drive is passed from engine into the gearbox.



CLUTCH COVER

FLYWHEEL



**Pilot bearing:** this sits inside the crankshaft. It supports one end of the gearbox shaft but allows it to turn independently of the crankshaft.



**Flywheel:** this is bolted directly onto the crankshaft, and is one slice of bread in the clutch sandwich. Outside teeth are turned by the starter motor.

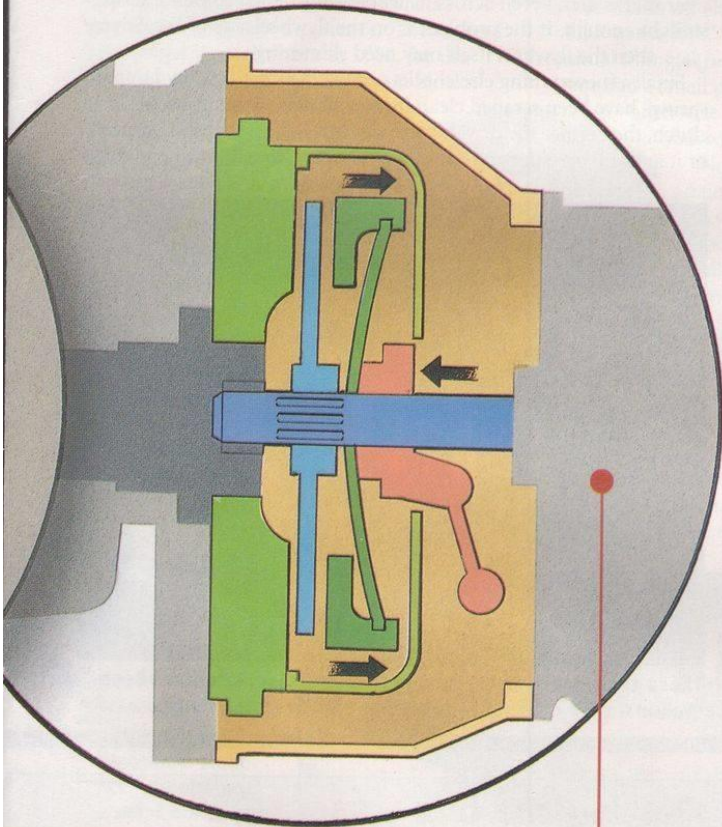
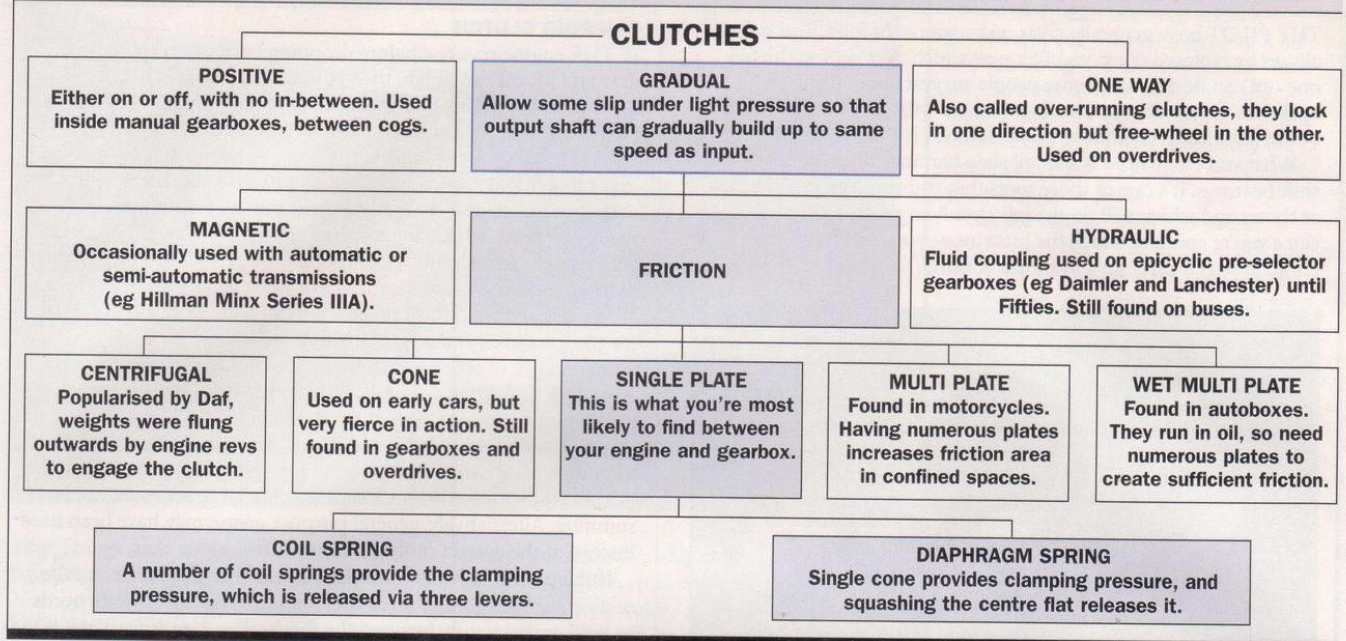


**Driven plate:** also called the friction disc or clutch plate, this is the sandwich filling. It's clamped between the flywheel and the pressure plate.



**Clutch cover:** second slice of bread in the clutch sandwich. Outer edge bolts directly onto the flywheel and a sliding pressure plate sits inside.

**THERE'S MORE TO THE CLUTCH FAMILY TREE THAN JUST A STRAIGHTFORWARD CHOICE BETWEEN COIL SPRING AND DIAPHRAGM UNITS TO SEPARATE ENGINE AND GEARBOX. HERE ARE THE OTHERS THAT MAY BE FOUND ON YOUR CLASSIC:**



**Release bearing:** clutch pedal pushes the release bearing into the clutch cover. It can either turn with, or slip over, the rotating levers of the cars.

Clutch disengaged: stepping on the clutch pedal pushes the release bearing against levers. These in turn pull in the opposite direction to the clutch's springs and move the pressure plate away from the engine. The driven plate is no longer clamped in place and can now move along the splines away from the flywheel, separating engine and 'box.

### Diaphragms and coils - the two most popular methods of power planning

CLUTCH COVERS come with the pressure plate and springs riveted in place. Until the Sixties, they contained coil springs and levers, and it is fairly easy to look at one and figure out how it works:



The release bearing pushes onto the three levers protruding into the centre of the cover.



Inside, coil springs push a pressure plate away from the cover into contact with a driven plate.



Push levers and they pivot like a see-saw, pulling pressure plate away from driven plate.

The diaphragm clutch contains, not surprisingly, a diaphragm. This acts as both spring and lever. Its natural tendency is to form a cone, with the outer ring pushing the pressure plate towards the driven plate. Each of the fingers acts as a lever, pivoting about a rivet at the mid-point. Pushing these fingers in leads to the cone being reversed, with the outer ring pointing away from the driven plate.



Here's a diaphragm clutch. This one has a central thrust washer to meet the release bearing.



Red paint on fingers and white on the pivot point show how the fingers act as levers.



All clutches must allow pressure plate to slide in and out while still turning with the cover.

Diaphragms have taken over from levers because:

- ❖ they give a lighter pedal;
- ❖ they increase their clamping pressure as the clutch plate wears (coil springs exert less force as they extend);

- ❖ they are more compact, so clutch housings can be shorter;
- ❖ fewer levers, pivot points and sliding surfaces mean fewer squeaks and rattles;
- ❖ they are lighter and easier to balance in high-revving engines.

## Special tools for clutches

THE PILOT bush generally costs just a couple of quid, and should always be replaced when you fit a new clutch. But getting the old one out can be difficult. Some people suggest either using an anchor bolt to pull it, or packing the hole with grease to push it out hydraulically. Neither of these methods is sure to succeed.

What you really need is a small slide hammer purpose-made to shift bearings. It's one of those tools that you can pick up cheaply at shows and which will do the job cleanly in seconds. Alternatively, since you're going to chuck the bush away, you can always use a chisel to peel it carefully out of the housing.



Worn pilot bush can cause all sorts of alignment problems.

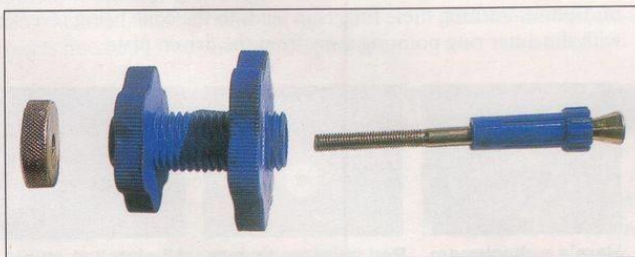


To shift it with an anchor bolt, you need room for it to expand beyond the bush.



You won't use it often, but nothing beats a special puller when you change a clutch.

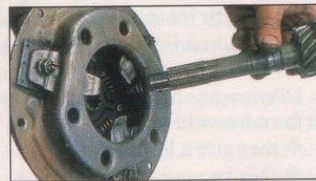
The other time that a special tool comes in handy is when you refit the clutch. The gearbox input shaft passes through the driven plate, and sits in the crankshaft at one end and the gearbox at the other. All three points must be in a straight line, and this is what we mean by aligning the clutch. The driven plate is the link that can slip out of line when you tighten the clutch cover. Countless clutches have been fitted using a wooden dowel wrapped with tape to align the components. But a universal clutch aligning tool costs less than a tenner and makes sure you get it right.



This is a clutch aligning tool from Draper. It cost us just £7.50.



It clamps driven plate and clutch cover together, but struggles with heavy items.



If you've got a spare gearbox, the input shaft from that is the ultimate clutch aligning tool.

## Problem solving

### SLIPPING CLUTCH

IF THE engine revs rise before dropping back when you engage gear and lift off the clutch, then your clutch is slipping. But before separating the engine and gearbox, make sure that the link between your pedal and the clutch (the actuation linkage) is working correctly and properly adjusted.

A cable might appear sound, but a broken strand of wire inside the outer sleeve, or a cable that is bent into a very tight arc, will make the clutch release mechanism slow to disengage. The same will happen on hydraulic systems if a pipe gets kinked or partially blocked. And both systems may have some facility for adjusting out excessive freeplay in the linkage – look in your workshop manual for the correct clearance gap on your model.

If you have to take the clutch out, look first for oil contamination on the friction surface – faulty seals on the crankshaft or gearbox are the most common reason for clutch failure. If the seals are sound but the facing is still contaminated, then it is probable that too much grease was applied to the splines during past work and this was then flung around inside the clutch while the shaft was spinning. Alternatively, general purpose grease may have been used instead of the correct molybdenum stuff.

If there is no obvious contamination within the clutch, are the mating surfaces getting on as they should? The driven plate needs to be clamped tightly between the flywheel and pressure plate. If the wear marks aren't even across its whole width, then something isn't straight enough. If the problem is on the flywheel side of the driven plate, then the flywheel itself may need skimming.

Finally, if everything else checks out OK, but the torsion damper springs have been scraped clean by contact with other parts of the clutch, then either the driven plate was fitted the wrong way round or it and the pressure plate do not belong together.



These torsional damping springs in the driven plate have been ground flat by contact with the flywheel or clutch cover.

## Getting the bits

COMPLETE clutches are available for more modern classics from your local factor, and you may be surprised just how far back they can go. Supplies are equally plentiful from the many clubs, marque and model specialists that advertise in Practical Classics and from various shows and good autojumbles.

If you want a one-stop service, Classic Factor (029 2070 6306)

have thousands of different clutches in stock. Past Parts (01284 7507290) also hold huge stocks, and if they can't supply an exchange unit then they may be able to recondition your original. Relining with new friction material is rarely a problem, and even if one of your components is beyond repair, then they could dig up an alternative one that's more readily available and from

### CLUTCH JUDDER

THIS UNPLEASANT complaint can make it impossible to make a smooth getaway, and is usually at its worst when moving off in reverse up any sort of gradient. But check first that the engine, gearbox and propshaft mountings are sound and that the carbs or injection system is properly tuned. Problems in any of those areas could give similar symptoms to clutch judder.

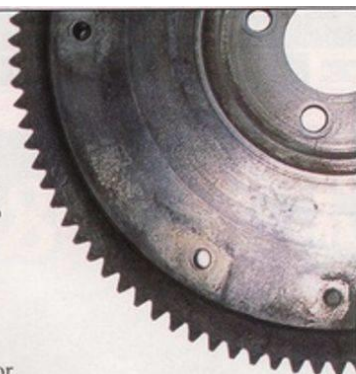
There's also plenty of crossover between the causes of clutch judder and clutch slip. So an uneven contact pattern on the driven wheel, contamination by grease and faulty cables all make a reappearance here. But we can also add a couple of new factors.

A bent clutch cover will almost certainly lead to clutch judder. This could be the result of a manufacturing defect or because the cover was

dropped before being fitted. But more likely the fixing bolts weren't tightened evenly and in sequence, or the cover was poorly positioned on the locating dowels.

Push-starting a car in first or second gear could put the clutch under enough load to bend the straps linking clutch cover and pressure plate, leading to judder. So could slamming the car into a low gear when travelling too fast for that ratio. And if some of the fingers on a diaphragm spring are bent, the resulting clamping action will be uneven.

Finally, how are the splines on your driven plate? If the plate has been forced onto the shaft or is the wrong one for that 'box, the teeth could have been damaged or worn to a taper. If they can then rotate slightly on the shaft, you'll never be able to take-up drive smoothly.



If the cover isn't located correctly on the flywheel dowels, it will get bent as you tighten the fixing bolts down.



In a rare show of thoughtfulness, manufacturers make it impossible to fit a driven plate the wrong way round.

### NOISY CLUTCH

A RUMBLING noise when you step on the clutch pedal that disappears when you release it is probably caused by a release bearing on the way out. But noise that remains when you leave the pedal alone can have several causes.

If the wrong driven plate is fitted, or the correct one is fitted the wrong way round, then the hub or torsion damper might come into contact with the flywheel. On some designs, that can also happen if the flywheel is refaced but the clutch cover isn't skimmed as well.

Lugging an engine (driving at low speeds in too high a gear) can also cause the torsion damper cover plate to break, a damper spring to fall out, or the rivets holding damper unit and plate together to bend or break.

### CLUTCH DOESN'T CLEAR

THIS IS what happens when pressing the clutch pedal fails to separate the engine and gearbox. In extreme cases, you might not be able to engage gear at all, but at other times it might go in with some crunching and grinding. This is the opposite problem to clutch slip, but the starting point for fixing it is the same. Check that the operating clearance is correct, and that the hydraulic system is working. Leaking pipes, defective seals in master or slave cylinder, low fluid in the reservoir or air in the system can all give rise to this problem.

Inside the clutch, look first for worn, bent or broken diaphragm spring fingers or clutch levers. They can get damaged as a result of incorrect adjustment of the release bearing, leaving these components in permanent contact, or by a seized bearing that no longer turns to take up drive gradually.

Warped, cracked or broken clutch covers also stop the clutch clearing, as do worn, damaged or rusty splines. This wear could be accelerated by a worn spigot bearing or failure to align engine and gearbox correctly.



If the gearbox splines are rusty, the driven plate won't slide. Go sparingly with the grease, though, and don't use a general purpose grade.

which parts can be cannibalised.

Hydraulic components should present no difficulty, as clutch and brake specialists, such as JEM (01455 230626), can supply either new cylinders, rebuild kits or have rare items resleeved. And if your specialist is having trouble locating a clutch cable for you, companies such as Speedy Cables (020 7226 9228) will be happy to make you a new one up from scratch.

## Final thoughts

- ❖ We've described the most common clutch layout, but it is by no means the only one in existence. So, for example, the Austin 7 had friction material on the flywheel and pressure plate, with a metal spinner plate sandwiched between them. And VW Golfs have the release bearing on the wrong end of the gearbox, a clutch cover bolted to the crankshaft and a flywheel bolted to that.
- ❖ Manufacturers have used a number of techniques to spring the central hub of the driven plate in an attempt to soften the take-up of drive, including coil springs set into the hub. Don't worry if some of yours feel looser than others – they have variable springing rates to spread the shock more widely.
- ❖ Competition clutches contain friction material with more grip and less slip, as well as stronger springs pushing on the pressure plate. Ultimately, these come very close to the on-off-with-nothing-in-between scenario we mentioned in the introduction. That's why they are totally unsuitable for general road use.
- ❖ You may have heard of people burning oil off contaminated driven plates and re-using them. That may have been possible with asbestos linings. But asbestos is now banned, and trying the same trick on the friction material currently in use will make the contamination worse, not better.