THE EXPERT **STEWART SANDERSON**

Having worked as a tuner for over 20 years, Stewart 'Stu' Sanderson is one of the most-respected names in the business.

A Level 5-trained fuel-injection technician, Stu has worked for a Ford Rallye Sport dealer, a well-known fuel-injection specialist and various tuning companies.

11 years ago he joined forces with Kenny Walker and opened up Motorsport Developments near Blackpool (01253 508400, www.remapping.co.uk), specialising in engine management live remapping, as well as developing a range of Evolution chips which are now sold all over the world.

He is the creator and administrator of www.passionford.com, which he started in 2003. It has grown rapidly from a few friends contributing, to one of the biggest Ford communities on the web.

Stu's enviable knowledge of the workings of modern-day Ford performance engines means that every month he's just the man to explain how and why things work, and importantly how they can be improved.

Words: Stewart Sanderson and James Wills

CLUTCH SYSTEMS

It's all well and good having shed loads of power, but without a clutch strong enough to handle it you'll be going nowhere. Stu explains why…

It's not uncommon for a customer to drop his car in for a nice sensible conversion to give him more power, only to be told some hours later that the clutch has given up, he won't be able to use that power, and must now nurse it home carefully.

That's never a nice conversation and usually leaves the customer wondering if we broke it as it was fine when he dropped it off.

A recent occurrence of this and subsequent discussion with the customer got me thinking that it would be a good subject to cover and swot up on. So let's look at how they work and the different types that are available...

WHY DO WE NEED A CLUTCH?

The clutch is needed to ensure we can make a smooth transition from the engine being connected to our road wheels and, conversely, not being connected and not moving us along. Remember, the engine spins all the time but the car's wheels do not. In order for the wheels to stop without also stopping the engine, the wheels need to be disconnected from the engine somehow.

The clutch allows us to smoothly engage a spinning engine to a non-spinning transmission by controlling the slippage between them. Trying to set off with full engine drive would be impossible, as any of you who've let go of the clutch too fast and stalled or shot across a junction will appreciate. Controlling the slippage between them is essential to ensure we have full control of the speed which we move from a standstill.

WHAT IS A CLUTCH?

A basic clutch system is based on three main components. These are the pressure plate, the friction plate and the release bearing. These components work together to provide us with what you would do well to remember as a semi permanent neutral, a clutch operated neutral gear if you like.

HOW DOES IT WORK?

The pressure plate is bolted only to the flywheel with the friction plate jammed in between it and the flywheel. The gearbox input shaft is connected only to the friction plate, so we have a connection between the flywheel and gearbox, via the two clutch components.

In essence, when we push the clutch pedal down, the clutch release bearing is pressed against the pressure plate's release mechanism, which then releases tension from the friction plate and stops pushing it against the flywheel. This causes the friction plate to stop rotating at full engine speed, along with the gearbox input shaft which is of course connected to it. This is what allows us to sit with the car in gear, but not moving even though the engine is running. It is also what allows us to control just how quickly and smoothly we connect the engine and the car's wheels together when we move off from stationary.

WHAT EACH PART DOES **THE RELEASE BEARING**

The release bearing is usually attached to the clutch fork which is simply an arm that is directly attached to your clutch pedal via a cable, or if hydraulic via a slave cylinder mounted to the gearbox.

It sits on the nose cone of the gearbox and is usually clipped to the clutch fork to prevent it moving.

This bearing is pulled, or in some cases pushed, on to the centre of the pressure plate. As the pressure plate is rotating at engine speed, there's a rotary bearing fitted to the end of the release bearing which allows the contact face to freely rotate when the pedal's pushed.

These bearings can become noisy and wear out over time. It is usually pretty simple to diagnose as the noise will dramatically change pitch when loaded up by pressing the clutch pedal. If these units fail the damage can be serious as the clutch fork can be pushed into the pressure plate, which usually results in the fork being ripped off its mounting then thrown around the bell housing!

THE PRESSURE PLATE

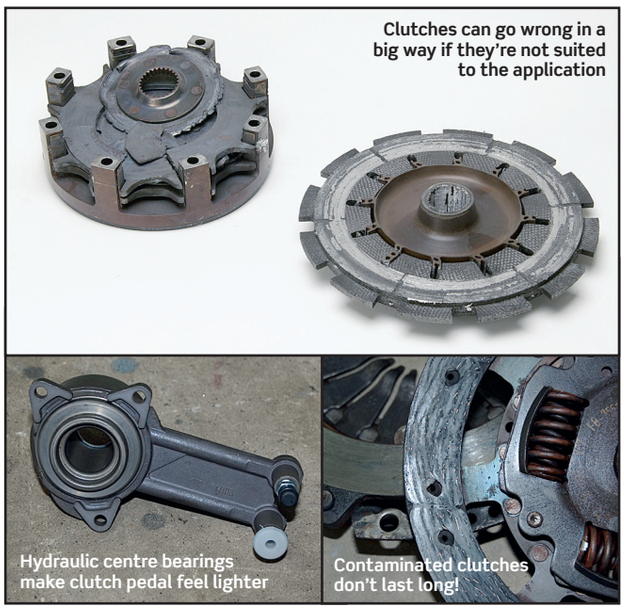
The pressure plate is by far the heaviest part of the clutch and it is firmly mounted to the flywheel with several bolts. The job of the pressure plate is simply to apply pressure to the friction plate (which is physically connected to the gearbox input shaft remember) and force it against the engine's flywheel. In doing so, it makes both the engine and the gearbox rotate at the same speed.

It achieves this pressure by means of a strongly sprung inner section that has a smooth mating surface for the friction plate to sit against. This section is pushed under spring pressure against the friction plate thus clamping it firmly to the flywheel. In essence the pressure plate itself is simply a very large spring that constantly pushes the friction plate against the flywheel while providing the facility to remove all pressure or vary the pressure at the driver's will.

The pressure is released or adjusted by means of the clutch pedal in the car. The pedal is connected to the release bearing by means of a cable or hydraulic system, but regardless of which system is fitted, you are just transferring movement at the pedal into movement of the release bearing. If you take a close look at a pressure plate you will see a series of fingers on the large sprung area in the centre. This is where the release bearing pushes to release the clamping force which holds the friction plate to the flywheel.

The pressure plate is designed to allow enough clamping pressure to maintain 100% contact of the friction plate and flywheel for a given torque figure. If you exceed that torque figure the clamping pressure will not be enough and the engine will start to break free and accelerate without the friction plate, and therefore, the gearbox. This is the phenomenon we know as "clutch slip". A good way to picture this in your mind is a bicycle or car braking system. The brake pads (the flywheel and pressure plate) grab the friction plate (your bicycle wheel or brake disc) with a certain amount of force and that force can be overcome if you rotate the part with enough torque. A clutch works exactly the same way. If that clamping force is enough to stop the friction plate breaking free when the flywheel is rotating at 300lb/ft of torque, then the gearbox input shaft rotates 1:1 and transmits the same torque to the transmission. However if that clamping force cannot hold on the engine will start to speed up faster than the friction plate and the gearbox input shaft connected to it. The resulting friction of the two items slipping against each other causes

Multiplate clutches offer a greater surface area to spread the load



Clutches can go wrong in a big way if they're not suited to the application

Hydraulic centre bearings make clutch pedal feel lighter

Contaminated clutches don't last long!

COMMON CLUTCH PROBLEMS

CLUTCH DRAG

Clutch drag is the term used when the two components do not make a full neutral when the clutch is pushed. If the pressure plate does not clear properly and allow the friction plate to rotate freely from the flywheel, the engine will still try to transmit drive to the gearbox. This can cause all manner of gear change problems and under extreme conditions can also prevent the car stopping at junctions while in gear.

The common causes of this issue are a faulty or incorrectly-sized friction plate, a faulty or broken pressure plate, or the most common issue would be a poorly adjusted clutch cable not giving enough travel of the clutch fork to break the drive or, conversely, air in the hydraulic line on hydraulic versions.

Another problem is contamination. If any of the assembly is subjected to oil the pressure and heat turns it into a glue. Then when the pressure is released instead of centrifugal force throwing the friction plate away from the flywheel it sticks to it, and therefore maintains the connection between gearbox and flywheel.

HEAVY CLUTCH PEDAL

A heavy clutch pedal is a common problem. All clutches require some amount of force to depress them fully. If you have to press hard on the pedal, there may be something wrong. Sticking or binding in the pedal linkage, cable, cross shaft, or pivot ball are all common causes. Sometimes a blockage or worn seals in the hydraulic system can also cause a hard clutch.

NOISY RELEASE BEARING

Another problem associated with clutches is a worn clutch release bearing. This bearing applies force to the fingers of the spinning pressure plate to release the clutch. If you hear a rumbling sound when the clutch engages while releasing the pedal you might have a problem with the release bearing. This can often be silenced by depressing the clutch pedal a little as it loads up the bearing, removing play from the worn components within it.

Side note 1:
It is well worth noting that all clutches operate using friction to perform their required task so, just like a braking system, they suffer immensely if they come into contact with fluids or lubricants. Therefore all oil seals must be checked when a clutch is being changed.

Side note 2:
The clutch only wears while the friction plate and flywheel are spinning at different speeds. When they are locked together the friction material is held tightly against the flywheel and they spin in sync. It's only when the clutch disc is slipping against the flywheel that wear occurs. So if you are the type of driver who slips the clutch a lot, you'll wear out your clutch a lot faster.

Heavy duty organic clutches are a good upgrade for fast road applications

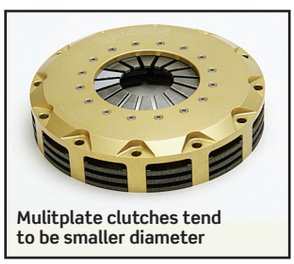
Paddle clutches are more 'switch-like' but can handle healthy power increases

overheating and worsens the situation very rapidly. It's important to note that the strength of this pressure plate is directly related to the heaviness of the clutch pedal and its cost of manufacture, so the vehicle designers fit as light a pressure plate as possible.

THE FRICTION PLATE

The friction plate is the part of the clutch that is fixed to the gearbox input shaft. It is also the part that takes all of the abuse as it is the component that gets squashed between the flywheel and the pressure plate and takes up the difference in rotational speeds when we set off and when we change gear. It spends a lot of its time slipping against rotating components and getting very hot. It is a friction material and performs much the same function as a brake pad.

The friction plate will also usually house a set of springs around its centre. These help to absorb the shock of taking up drive, making the unit as smooth as possible as well as preventing any damage. They come in differing materials for different purposes and uses, but most standard road clutches are made from an organic material similar to brake pads. Failure of this component can again lead to a slipping clutch simply because as the material wears down and it becomes thinner, the clamping force from the pressure plate is dramatically reduced.



Mulitplate clutches tend to be smaller diameter

CLUTCH TYPES
ORGANIC CLUTCH KIT

The organic material clutch is the one normally used for a road car. The friction plates are made from similar material to brake pads and can be lightly sprung to allow a nice smooth take up in drive. Their coefficient of friction is such that we can easily adjust the slippage ration between the flywheel and gearbox with no problem, they rarely try and grab suddenly and respond extremely well to small movements of the clutch pedal.

Prolonged hard use or launching can kill these units very quickly as they struggle to deal with such heavy use and excessive heat. They come paired with a suitably sprung pressure plate that will be good enough for the standard road cars power output and usually up to 20% more without too much bother. It is normal for these to give a nice light pedal action as the pressure plates aren't usually too strong, as the stronger they are the heavier the clutch pedal and more extreme the biting action.

FOUR/SIX-PADDLE KITS

These units are mainly used for fast road and track day cars. They can still be used with fairly lightly sprung pressure plates as the friction material used will essentially upgrade the torque rating of the clutch using the same cover pressure, so you can often find these friction plates mates to a standard pressure plate. However, suitably uprated pressure plates will often be heavy enough to warrant the use of hydraulic conversions if cable type clutches are used as standard.

The clutch material is split into 4 or 6 'paddles' that are made from a metallic friction material. This type of friction material can deal with abuse and heat much better than the organic units and can be used for the odd launch as well. These units can be used for road use, but the user will likely notice a slight judder as drive is taken up because this material's friction coefficient is much higher and it likes to 'grab' the flywheel fiercely as soon as it makes contact. That is what makes it so strong, but also makes it a little more 'switch like' so gentle pull aways and hill starts can be a little hit and miss. It's also worth noting that due to the harsh material the paddles are made from flywheel and pressure plate wear will also be quite heavy. It's recommended to uprate your gearbox, engine, and diff mounts when using a paddle clutch in order to alleviate the judder as much as possible, as worn or soft mounts here will accentuate the clutch grab significantly.

MULTI PLATE KITS

These are mainly used for competition cars. They follow the same principal as a normal clutch but the cover unit houses several friction plates all working upon each other to increase the surface area of the clutch unit. They are usually quite noisy and often rattle at idle speeds. There are some very good ones on the market now and their action is improving all the time, but as a general rule of thumb these can sometimes be very hard to use and very snatchy, making hill starts very hard indeed. These units are best avoided for road use unless there is no other option. However, if you do wish to use one, these units can take large amounts of abuse and huge power levels.

SO WHAT CLUTCH IS BEST FOR MY USE?

The main thing to consider when choosing a clutch is the amount of power it will need to be able to deal with and the type of use the car is going to have. It would be no good at all having a very strong clutch on a car used in heavy traffic every day, because it would be almost unbearable and very hard to use.

You need to take into consideration the amount of maintenance the unit you choose will require too. It would, for example, be a very expensive exercise to fit a clutch that needs new plates fitting after every 5k miles to a road car doing 50k miles per year!

For road use the best option by far is an organic item if it is possible, but as power levels increase it can be out of the range of these units' capabilities. At that point you need to take a long hard think about the unit you are going to use as it can often be the make or break of the car and its drivability. Hydraulic clutch conversions are readily available to convert old cable style units over to hydraulic, so much heavier sprung clutches can be used but the pedal will remain soft and usable. Hydraulic conversions will also increase clutch life.

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