Fundamentals of Automotive Systems
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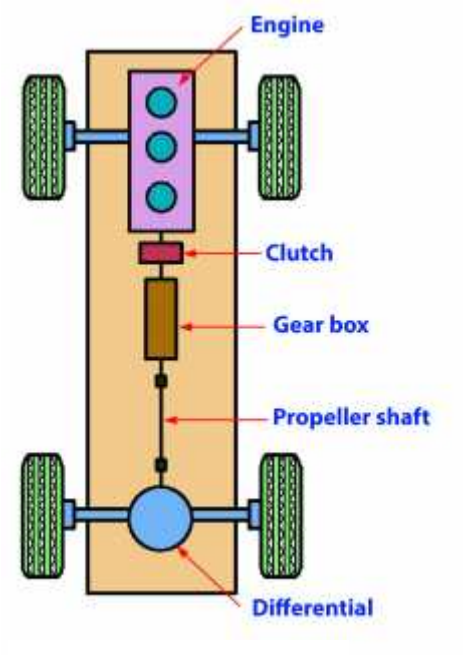
Lecture - 31
Automotive Clutch Part 01

Greetings so, let us get started with today is class. So a quick recap of what we did in the previous class you know like we are looking at the components of the power train. And we saw that you know, like what were the typical power speed and torque speed characteristics of IC engines and what is ideally required from a prime mover and why the IC engine does not meet the ideal traction requirements and hence, one requires a multi speed gearbox you know like to match what the IC engine provides to what the vehicle would required.

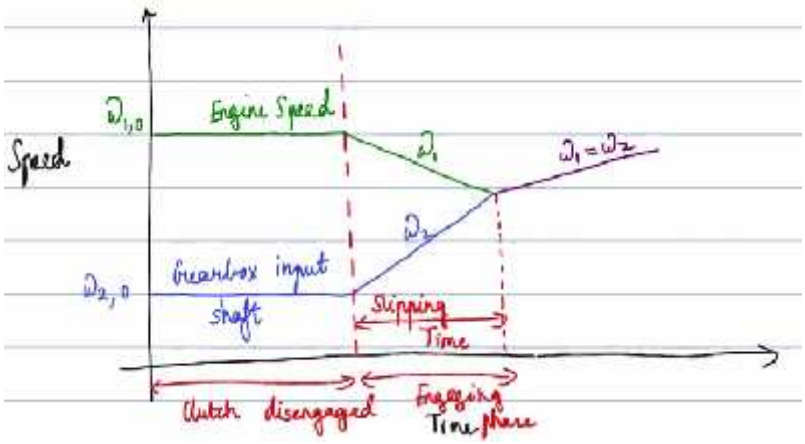
So that is where we stopped yesterday. So, and one more important requirement of an automotive power train is that like the power train should enable the vehicle to move from rest and since a typical IC engine delivers very little torque at a low speeds, we typically require what is called as a Move-off element to enable the vehicle to be moved from the rest okay, so that is what we are going to look at today.

So, before we start discussion on the so-called move-off element, which typically in most transmissions that we encounter know like is realized as a clutch okay. So we will look at how the different components are arranged in a vehicle. So, let us say you know like we have a vehicle where the engine is mounted in the front this is essentially called as a longitudinal orientation of the engine because you can see that the axis of the crankshaft is along the longitudinal axis of the vehicle.

So, in other layouts, you can one can also have a transverse orientation of an engine where the axis of the crankshaft is going to be perpendicular to the longitudinal axis when looked at looked at it from the top okay. So that is another orientation of the engine.



TRANSMISSION LAYOUT



"Move Off" Element [Clutch]

In this particular schematic, one can see that the engine is mounted longitudinally, and the output of the engine is connected to what is called as a clutch and the clutch transmits the energy to the gearbox.

And the gearbox transmits the torque to a final drive through a propeller shaft and this differential unit distributes the torque to the two driven wheels. So, these are the driven wheels in this particular case okay. So one or this is essentially what is called as a front engine mounted rear wheel drive. So, this configuration is what is called as a front engine mounted rear wheel

drive. So, they the meaning is obvious from the term because the engine is mounted in the front and the rear wheels are the ones which are driven okay.

So, this is quite popular in trucks and buses right and even some light commercial vehicles in most passenger cars today, you know we would see that the engine is mounted in the front and the front wheels are the ones which are driven then what happens is that like typically the engine is mounted in that transvers fashion that is the crankshaft is going to be perpendicular to the axis of the crankshaft is going to be perpendicular to the longitudinal axis and the gearbox is mounted close to the engine, the clutch and the gearbox.

So, we look at the configuration also later on. So, that is what is called as a transverse layout. And typically, we will also observe that when we have this front engine mounted front wheel drive, we have what is called as a transaxle gearbox where the gearbox and the final drive are integrated as one and typically when we have a rear engine mounted rear wheel drive also we may have a similar configuration arrangement okay of the primary gearbox on the final drive. So, these are all different layouts of the power train which are typically used okay.

So this is front engine mounted rear wheel drive we can have front engine mounted front wheel drive, we can have real engine mounted rear wheel drive, So those are all like popular configurations of the drives, in automotive powertrains currently okay, So, but the typical components are the prime mover, the clutch, the gearbox the final drive okay, so the those remain the same, the way they are oriented and mounted and integrated may have some small differences depending on the configuration.

So now what does this move-off element do? So suppose imagine a scenario where the engine is idling, and our car is stopped at a signal and we want to essentially move the car from this what do we do We engage the first gear and then slowly leave the clutch pedal while slowly pressing the accelerator pedal so that is what we do. Now, in fact, when the clutch pedal is pressed, the clutch is disengaged, so the operation is counterintuitive.

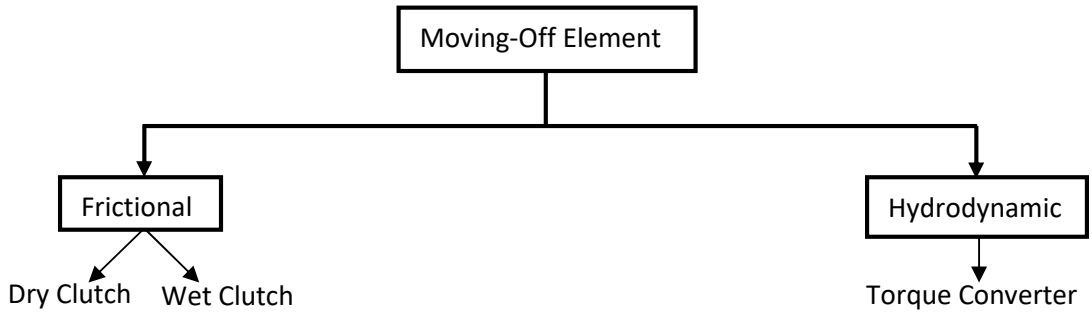
So when we are depressing the clutch pedal we will shortly see that the clutches in fact disengaged from the engine fly wheel okay. So, when we are engaging the clutch by slowly releasing the clutch pedal, the wheels and the gearbox shaft and the clutch are going to be at rest initially right while the engine is going to be rotating at some speed correct some nonzero speed. So, there is a speed differential between the two and that needs to be overcome okay.

And it needs to be overcome in such a way that the engine is not suddenly loaded because the engine cannot provide so much of torque at low speeds. So, there should be a smooth transfer of torque to start the vehicle while ensuring that after some time all the components are rotating as one in synchronization right. So, that is an important requirement. So, if you want to visualize what happens, let us say the engine is initially rotating at some speed omega 1 O so, this is the engine speed.

And let us say the input shaft to the gearbox is rotating is at some speed omega 2O it can be stationary also, omega 2O can be 0 also so, there is a speed differential when the clutch is disengage, so in this phase the clutch is disengaged. So one can immediately see that the clutch serves as a link between the engine and the gearbox right. So that is a one of the primary roles of the clutch okay.

So now when we start removing the force from the clutch pedal we are engaging the clutch. So, what happens is the following this engine speed starts to decrease because of the load coming on the engine flywheel while the speed of the input shaft of the gearbox starts to increase and at some point this speed differential is overcome almost. So, this is the phase where the clutch is getting engaged so this is the engaging phase and this is the period over which there is some slip between the two elements after that once this happens these two start rotating us one unit okay.

If you look at the engines output shaft and the gearbox input shaft is concerned. So, this is a typical visualization of how there exists an initial speed differential and once the clutch is engaged .

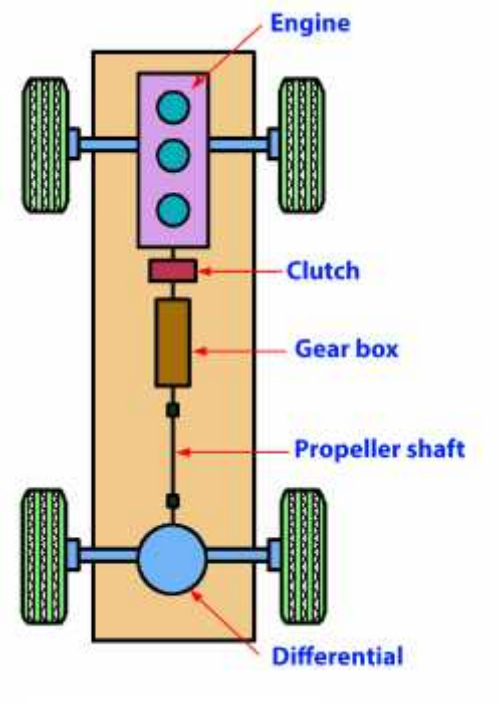


Essentially there is a slip but with as time progresses you know like that slip is overcome and then essentially the engine output shaft and the gearbox input shaft start rotating as one after same time. So, we are going to see how these are released in practice. So, before we look at the construction and realization. So, this moving off element broadly it can be classified as a frictional device or the frictional clutch. So, frictional clutches are further subdivided into what are called as dry clutch and wet clutches and this moving off elements can also be hydrodynamic in nature.

So, a common hydrodynamic moving off element is what is called as a torque converter which is widely used in automatic transmissions okay, So, we would be focusing on dry clutches, which are very commonly used in manual transmissions okay, so, that is what we are going to look at okay. So, what are the functions of these clutches so we will look at dry clutch okay, so what are the functions of a dry clutch so, the first function is that it provides a link between the prime mover and the transmission okay, so that is very important then the clutch should allow for a smooth take up of drive when the vehicle is moved from rest okay.

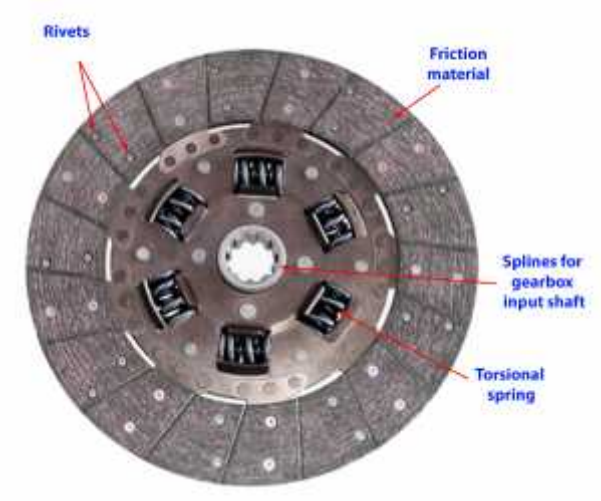
Also it should allow for brief disengagement between engine and gearbox when gear change is done okay, so, these are typical expectations of on this clutch okay. So, if we look at clutch action persay what happens is that is a following. So, as we are discussing a friction clutch, so, the flywheel which comes out of the engine is rotating along with the engine crankshaft and the so-called clutch plate which we are going to look at shortly is connected to the input shaft to the gearbox.

When let us say the vehicle is at rest and the engine is rotating at some nonzero speed. When the clutch is going to be engaged, this clutch plate is pushed against the flywheel and there is a speed differential and due to friction okay, the speed differential is overcome and the torque is transmitted from the flywheel to the clutch plate and they start rotating as one, that is why it is called as a friction clutch

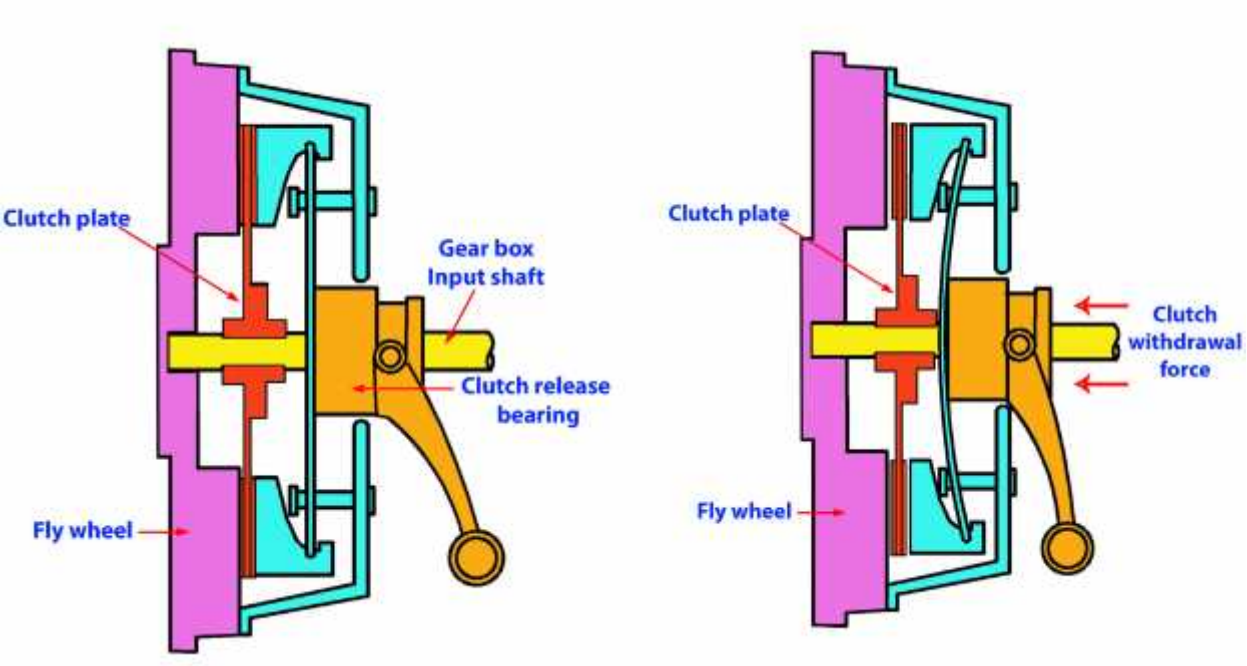


REAR WHEEL DRIVE

So what are the typical components of a dry clutch so, the main component is what is called as a clutch plate. So, the clutch plate is pushed against the flywheel by what is called as a pressure plate, a pressure plate assembly. So, this pressure plate is the component which pushes the clutch plate you know against the flywheel and when we want to disengage and engage the clutch it happens through a mechanism that ultimately uses what is called as a clutch fork and the release bearing you know to do this action. And all these components are housed in a clutched housing, so these are the main components.



CLUTCH PLATE



CLUTCH ENGAGED

CLUTCH DISENGAGED

Okay so let us look at what happens these are components various components of a clutch so this a just a schematic, to just show the clutch operation. So, we will look at each component in detail. Typically, what happens is that like when the clutch is engaged you can see this clutch plate this, of course is a very simple schematic? Right so, this red element which is a clutch plate, this is the flywheel and this element is the pressure plate. So, when the clutch is engaged

that means we are not pressing the clutch pedal, so, the clutch plate is pressed against the flywheel with the pressure plate.

And this clutch plate is mounted on this gearbox input shaft. So the flywheel is rotating along with the engine. So what is going to happen when the clutch plate is pushed against the flywheel by the pressure plate after some initial slip, the clutch plate and the flywheel and the pressure plate are going to rotate as one unit right and the energy is transmitted from the engine through the flywheel through the clutch plate through the input shaft to the gearbox to the transmission and further downstream, right in the powertrain.

So that is how the energy transfer happens when the clutch is engaged. So now when the clutch is disengaged, what happens so we can immediately see that when the clutch is disengaged or in other words the clutch pedal is now pressed, when the clutch pedal is pressed, what happens is it there is a force, this is the release bearing and this is the clutch fork right. So, when the clutch is what to say clutch pedal is pressed, what happens is that a force is applied by the release bearing on what are called what is called as a diaphragm spring we look at what this is shortly.

There is a spring called diaphragm spring on the pressure plate this the pressure play So, when this force is applied in this direction, so, you can see that the forces are applied in this direction, this end of the diaphragm spring moves to the right in this diagram okay, So, it moves the pressure plate assembly to the right so, when the pressure plate is assembly moves to the right the force, which holds the clutch plate against the flywheel is released.

So you can immediately see that the contact between the clutch plate and the flywheel and the pressure plate is broken okay. So the link between the engine and the gearbox is now broken. That is what happens when the clutch pedal is pressed. Please remember and the clutch pedal is pressed the clutches disengaged. Now if I release the clutch pedal the exact opposite sequence of operations so what happens is this force is released.

Now, the diaphragm spring will move like this it will push the pressure plate to the left and then the clutch plate will be pushed against the flywheel and the motion will be transmitted to the

gearbox. So that is what happens in this friction clutch right. So these are the various components, you know, and this is how the friction clutch works. So let is look at each and every component and we will observe how they contribute.