Fundamentals of Automotive Systems
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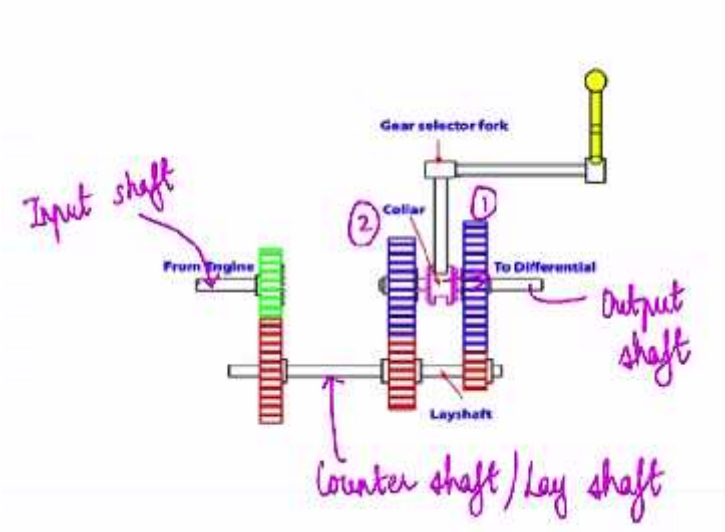
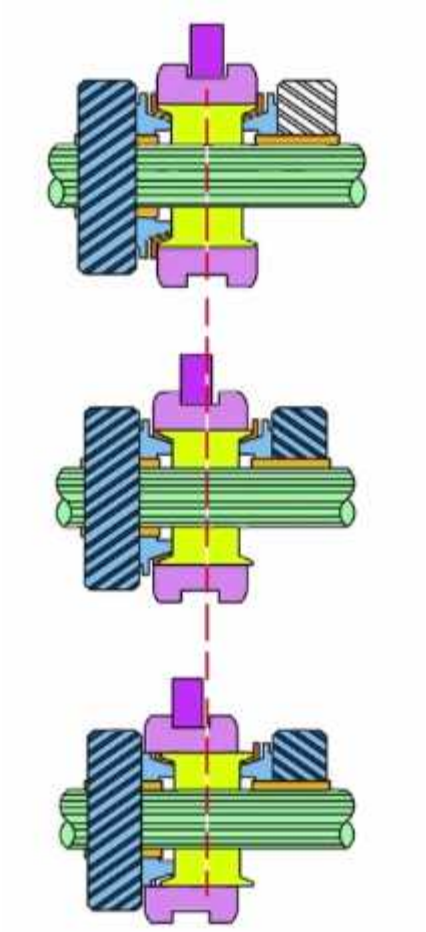
Lecture - 34
Transmission Part 02

But, however you know like as we discussed, even if you use a collar, we have an issue why because there is going to be a speed differential between the output gear and the output shaft right. Suppose, if I want to go from gear one to gear two, so let us say gear one is rotating at some omega one. So, the output shaft would be rotating at omega one, when it has been connected to gear one now we want to shift to gear two, gear two is rotating at omega two. Now, the output shaft is going to rotate close to about omega one then the question becomes how do I engage them smoothly that becomes a challenge with this collar arrangement.



So, that is the reason why we have moved to the synchronizer. So, let us look carefully at how this synchronizer achieves this action much better than the collar. So, let me one second. So, let me paste the schematic on the next page so that it is clear okay. So, this is just a schematic of a synchronizer so, what happens here is that the synchronizer let me first label the components only 1 side has been shown for simplicity.



SYNCHRONIZER UNIT AT VARIOUS POSITIONS

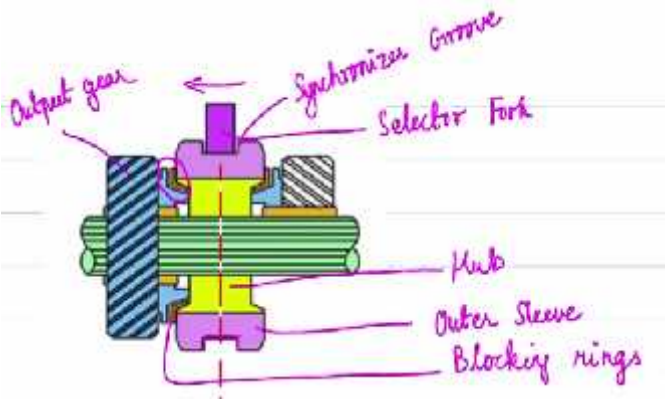
This is once again a schematic it has an essentially a hub okay and it has what is called as an outer sleeve which slides on the hub and it has these blocking rings which are nothing but rings with a conical cavity okay. So that is those are some key components in this synchronizer.

So what happens is that, if you look at this outer sleeve so if you look at key components, we have a hub we have an outer sleeve and we have these blocking rings there are two blocking rings one on either side. The Hub is connected is mounted on the output shaft. So any rotation of the hub is going to result in rotation of the output shaft. This outer sleeve has teeth on its internal surface, inner surface and can slide over the hub okay so that is the arrangement okay and these blocking rings have a conical cavity. So, these are the three main components. So, let me come to this schematic and explain how it works.

So when what to say synchronizer is in neutral position that is it does not engage with any of the gears, this is how it is. So, you can see that there is a gap between the this is the output gear which is under consideration. So, you can see that there is a gap between the output gears, conical projection and the blocking ring which is a conical cavity in the synchronism. Now, how do we engage the synchronizer there is a synchronizer groove so, there is a groove which runs along the periphery of the synchronizer.

So, you can see this groove right and the so called selector fork which is attached to this selector rod that is moved by the driver rest in this groove. Suppose I give a motion to this selector from to the left. So, what happens is a following this selector fork first pushes this outer sleeve over the hub. So, there is an outer sleeve, which is mounted on the hub okay. The hub has teeth on the periphery; outer sleeve has corresponding meshing teeth on the inner surface. So, you can see that now the outer sleeve is moving sliding over the hub. When it slides over the hub. It is pushing this blocking bring against the conical projection on the output gear.

So this is an intermediate stage where the blocking ring is pushed by the outer sleeve against the conical projection on the output gear right then okay what happens due to this action the speed differential between the output gear and the synchronizer starts to reduce.



OPERATION OF A SYNCHRONIZER

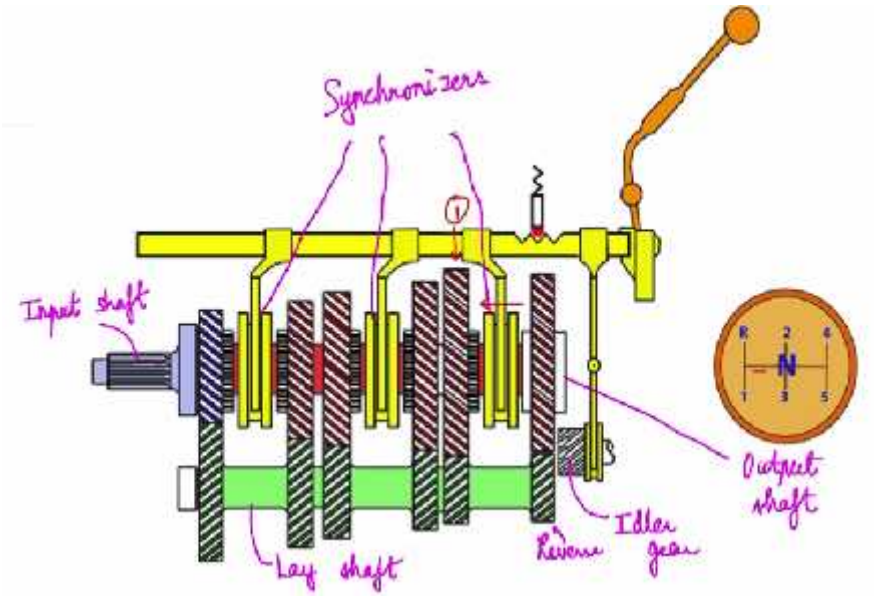
So, the speed difference starts to decrease due to this action. Now, the outer sleeve continues to move during the first phase of displacement of the outer sleeve, the blocking ring is pushed against the cone and the speed differential is reduced.

The outer sleeve is further displaced due to which it will travel past the blocking ring and then teeth on the inner surface of the sleeve will then engage with the teeth on the side of the output gear okay and then the synchronizer and the output gear are locked with one another right because the teeth have meshed it with each other okay than the entire what to say unit is set to be synchronized because the output gear the synchronizer and output shaft will be rotating at the same speed and the energy will be transferred .

Okay so, this is the way in which the synchronizer achieve this task okay. So, let me write down the main points so that we can recall them later. So, the synchronizer has a cone shaped groove that slides on a corresponding cone shaped projection on the output gear when the synchronizer is first shifted okay. So first action is that the outer sleeve is moved or displaced on the hub by the selector fork okay so that is the first step then this cone shaped grew on the blocking ring goes and also links with the cone shaped projection this starts to reduce the speed differential between the output gear and the synchronizer.

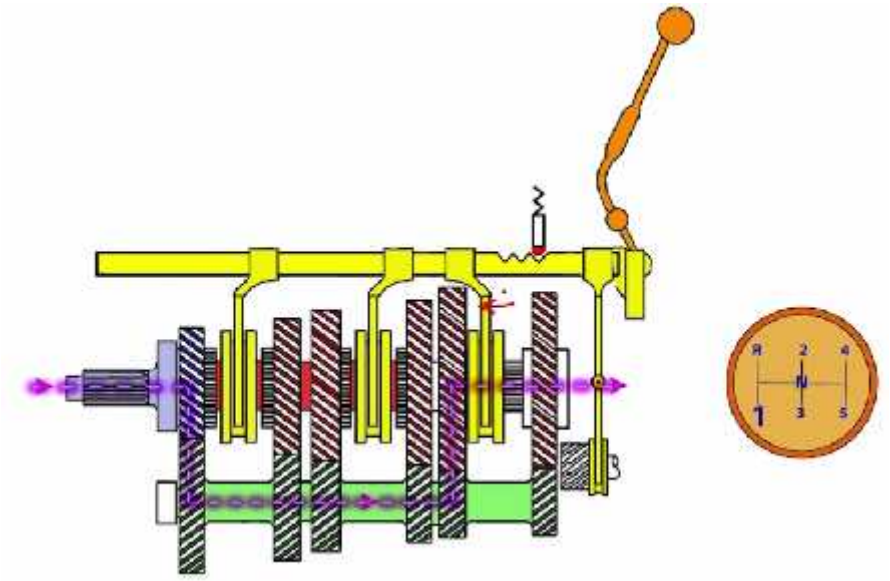
Okay so, then what happens the outer sleeve travels further on the hub and the teeth on the inner side of the outer sleeve mesh with those on the output gear okay. So it is now that the entire unit is synchronized and then energy is transferred to the output shaft okay. So this is a sequence of operation in a synchronizer okay. Now how does this gear transfer take place you know like in a multi speed gearbox that is something which we are going to look at?

So if we look at a simple schematic of a multi speed gearbox, so, let me just insert the figure here. So, let us say we consider a multi speed gearbox and let us say in the stick shift the pattern of gear selection is this okay so, if we look at this schematic, so, in this schematic this is the input shaft okay, this is the lay shaft or the countershaft and this is the output shaft right. So, and we can observe that there are three synchronizers 1, 2 and 3 so these are the 3 synchronizers right and the reverse gear.



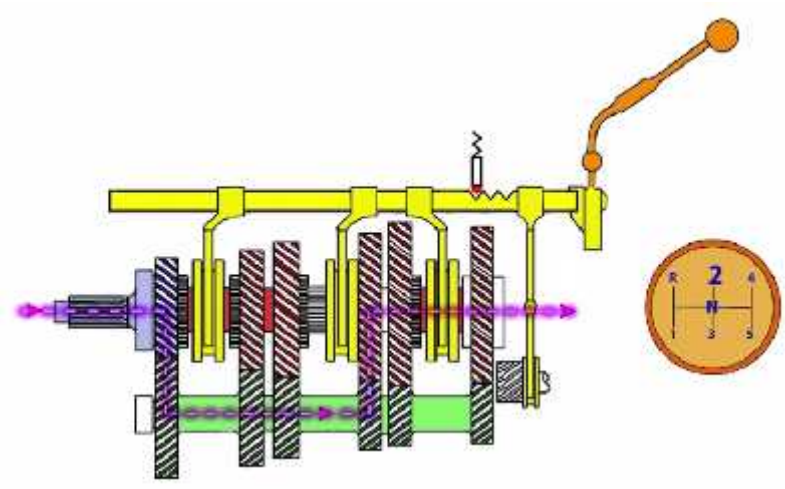
NEUTRAL POSITION IN THE GEAR BOX

This is a reverse gear arrangement which is achieved by what is called an idler gear will come shortly to that okay so now what happens is that like in this arrangement this is the first gear, the way this schematic has been set up. So, this is the first gear. So, if I want to engage the first gear, what do I do? I push the synchronizer to the left okay, so that corresponds to the stick shift coming to the left hand going down.



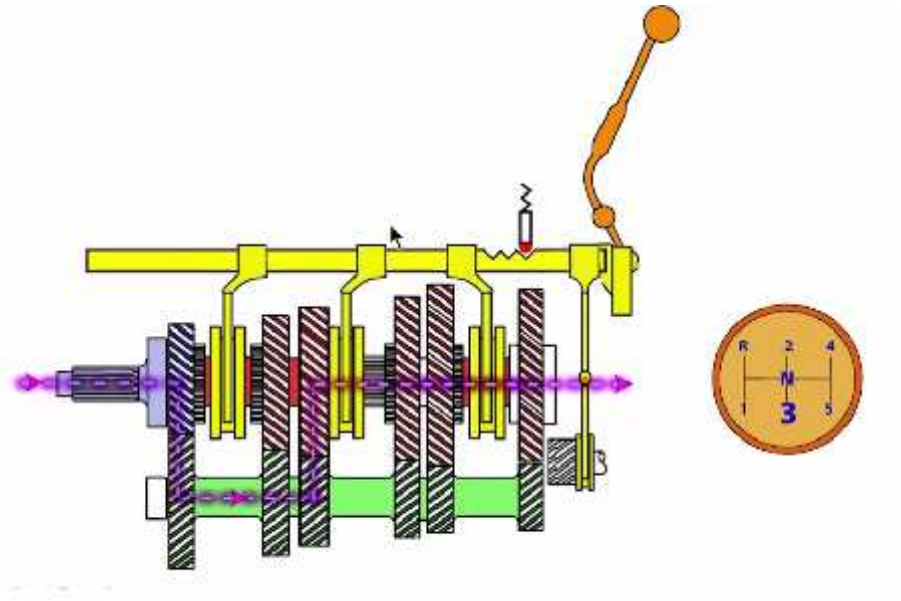
1ST GEAR ENGAGED

So that will push the synchronizer to the left. Now if I want to come to the second gear what I will do, I will come up in the stick shift, go to and go forward.



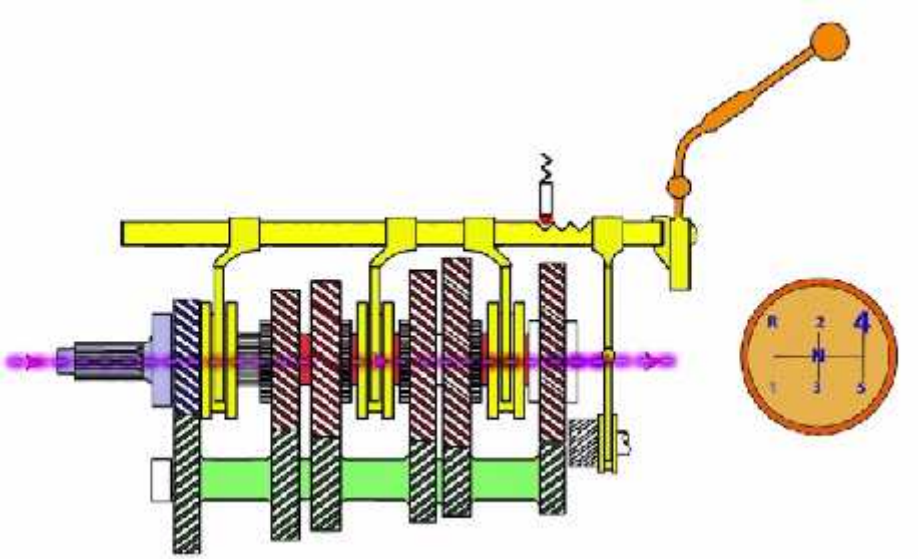
2nd GEAR ENGAGED

So, what that will do is that like it will essentially take this next synchronizer and engage with the second gear okay. And if I want to essentially engage a third gear, I just need to push it down then the synchronizer is moved to the other side and it engages with the corresponding gear.



3rd GEAR ENGAGED

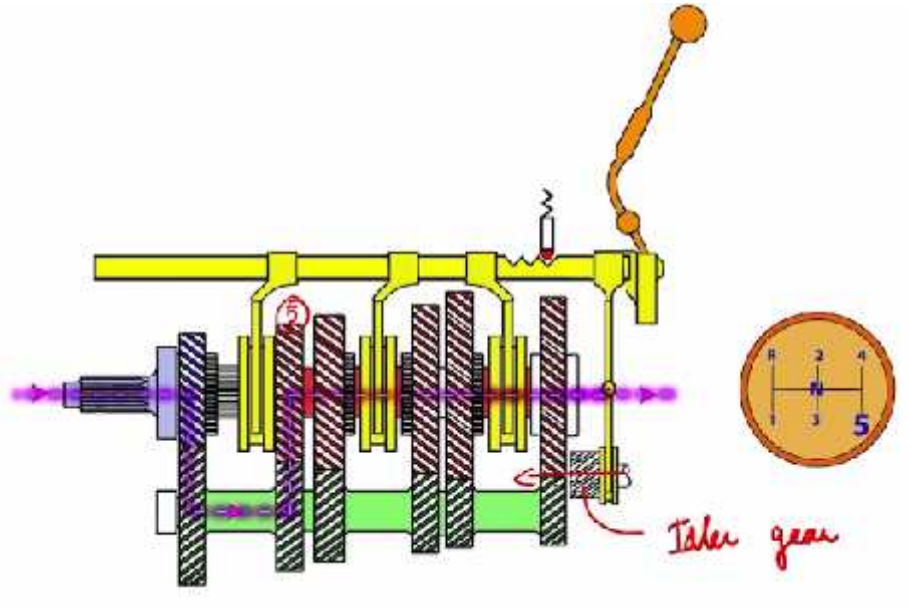
Typically in most manual transmissions fourth gear is what is called as a direct drive. So, what is a direct drive is that the synchronizer directly connects the input and output shaft in this configuration in essence the gear ratio is 1.



4th GEAR ENGAGED-DIRECT DRIVE

So, what happens is that when you select the fourth gear, this synchronizer moves like this and then directly engages the input gear and the output shaft okay so, that will be the fourth gear, fifth gear is this way you move this way and then like it engages with the fifth gear typically, fifth gear is an overdrive gear. So, that is the method in which we essentially use this multi speed gear set right. So, if I if we engage the first gear, what is going to happen is that so, the path of energy flow is going to be like this from the input shaft.

It will come to the lay shaft from the lay shaft it will go to the first corresponding first gear pair from the first gear pair it will go to the synchronizer and then to the output shaft okay. So that so, the energy flow will happen okay. So, that will be the path of energy flow fine so let me quickly show you know like how these various gears are engaged by just using a series of schematics right. So, as we observe so this is the, what is a neutral position.



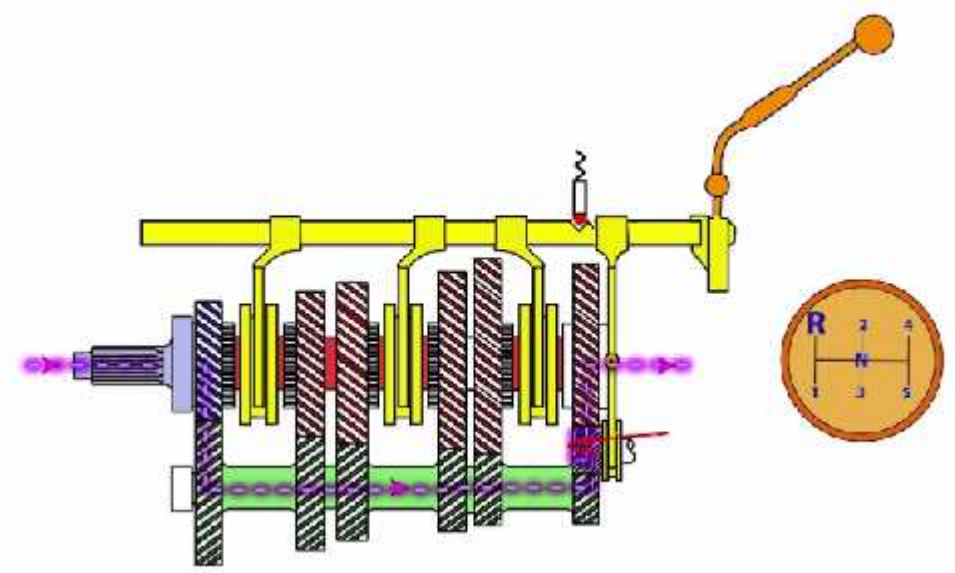
5th GEAR ENGAGED

So you can immediately see that when you engage the first gear, this synchronizer move to the left and this is the path of energy flow. Now, when we want to engage the second gear, you can see that this synchronizer move to the right. So, this is the second gear, so this was the first gear right, and then the energy flow is shown appropriately. Now, when we come down from 2 to 3, what is going to happen this synchronizer is going to be shifted to the left. So, that is what you can observe. So, you can see that the same synchronizer is now shifted to the left and then we have the third gear which is chosen.

Then we essentially choose the fourth gear you can observe what happened in the fourth gear. So, this synchronizer just engage the input gear directly. So, we have what is called as a direct drive here. So, you can we can observe that the input shaft and output of shaft got connected directly and when we were went to the fifth gear when you want to go from the fourth to the fifth gear we push the what to say selector for down and that is going to result in the synchronizer moving to the right and now we can see that this is the 5th gear that is engaged.

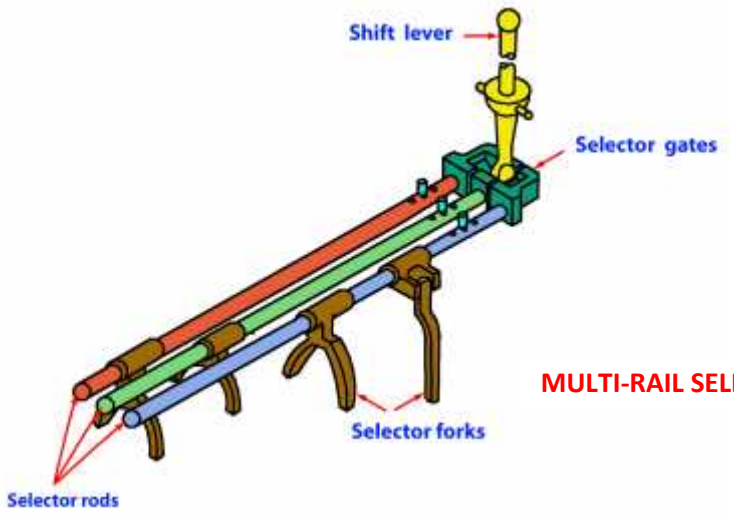
Okay so now what happens with this reverse gear there is something called as an idler gear typically, because in the reverse gear we need to change the direction of motion. So we have one more year and how is reverse gear typically engage we bring the vehicle to a stop and then we

press the clutch the brake and then we engage the reverse gear. So, the reverse gear still works as pushing this idler gear in between these 2 gears on the input shaft and the output shaft we have to manually push the corresponding idler gear between the 2 gears on the counter shaft and the output.



REVERSE GEAR

So, when we engage the reverse gear you can see that the idler gear has been shifted okay. And essentially it goes and creates a link between the output shaft and the lay shaft which was previously not there along this path. And that is how the reverse gear is engaged okay. So, this is way. This is how the various gear what to say as are chosen okay. So the last component which I want to discuss is.



MULTI-RAIL SELECTOR

How these are selected by using what is called as a multi rail selector. So what does this multi rail selector, you can immediately see that I need to engage with these various gears by pushing the corresponding synchronizer right. So the synchronizers are pushed by the selector forks right, the selector folks rest in this synchronizer groove see for example, in this arrangement there are three synchronizers right. So, each synchronizer will require a separate selector fork so we can see that there are 1, 2 and 3 selector forks.

And each selector fork is mounted on a particular selector rod and how are these rods engaged they are engaged 1 at a time by means of this shift lever, the bottom part of it which rest in what is called as the selector gate. So, what happens is that if you for example, if you want to engage the first what to say selector, a fork and push it forward what do we do? We want this to be moved in this manner right. So, we want this end to come this way. So, I would push the shift lever to the right and then I want to push the blue selector rod forward that means that this end should go like this. So, what should happen to the top end it should go back right.

So, if I have a motion to the shift lever which is like this, this bottom end will align with the selector gate and then push the selector rod forward when the selector road 1 let us say this moved like this, let us say the corresponding selector rod is resting on gear 1 that synchronizer cavity it just pushes the corresponding synchronizer okay. So let us say this was selector rod 1 okay. So what happens is this gets that this pushes the synchronizer in the corresponding direction okay.

So, this arrangement is what is called as a multi rail selector okay so, the shift lever which is under the control of the driver is used to convert use you regulate the synchronizer by using this selector rod selector fork can selector gate mechanism okay. So, that is how the selection of the corresponding synchronizer and the gear happens okay. So these are the broad components of multi speed gearbox. So, I will stop here and we will continue with our discussion on transmissions and analysis in the next class. Thank you.