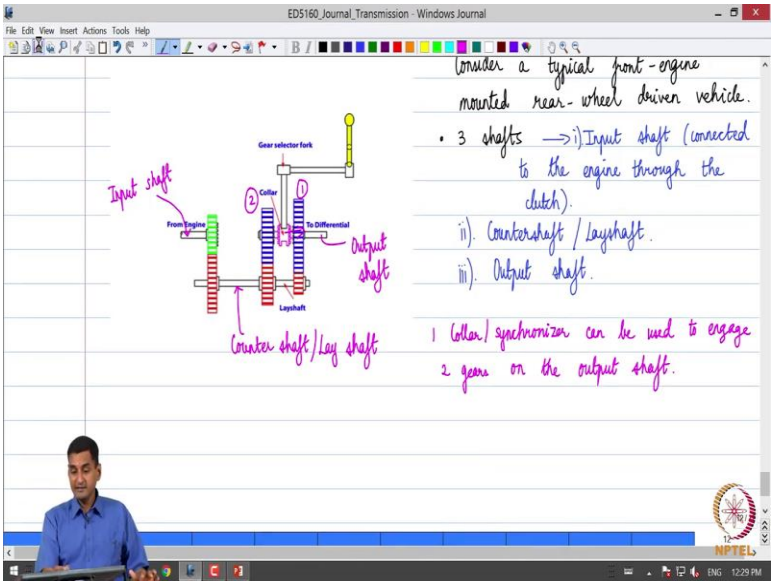
Fundamentals of Automotive Systems
Prof. C. S. Shankar Ram
Department of Engineering Design
Indian Institute of Technology-Madras

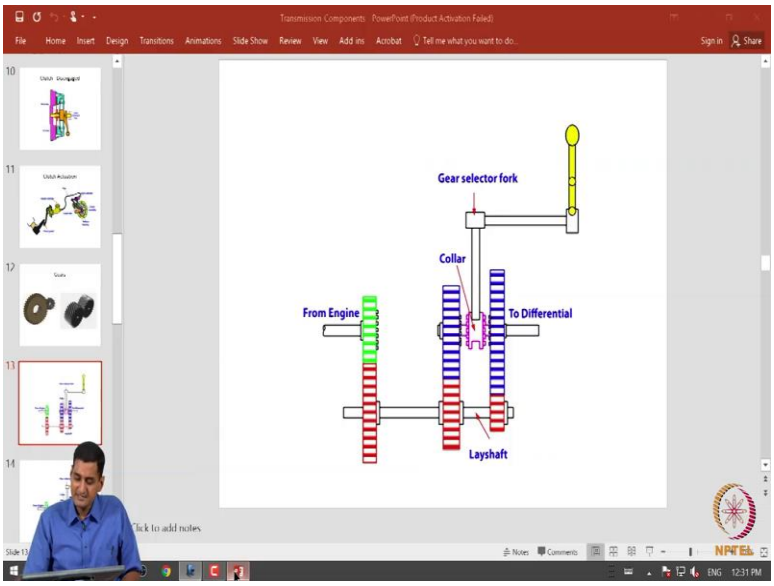
Lecture - 34
Transmission Part 02

(Refer Slide Time: 00:14)

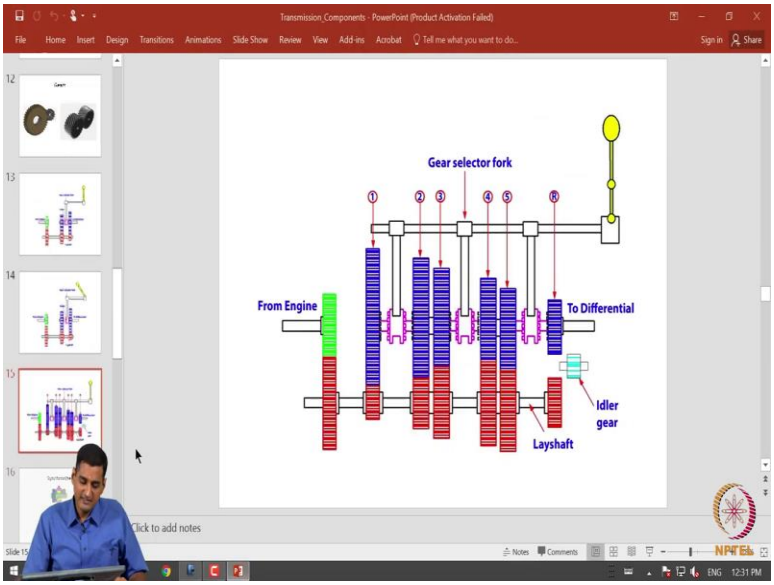


But, now as we discussed, even if you use a collar, we have an issue why because there is going to be a speed differential between the output gear and the output shaft. Suppose, if I want to go from gear 1 to gear 2, so let us say gear 1 is rotating at some omega 1. So, the output shaft would be rotating at omega 1, when it has been connected to gear 1 now we want to shift to gear 2, gear 2 is rotating at omega 2. Now, the output shaft is going to rotate close to about omega 1 then the question becomes how do we engage them smoothly that becomes a challenge with this collar arrangement.

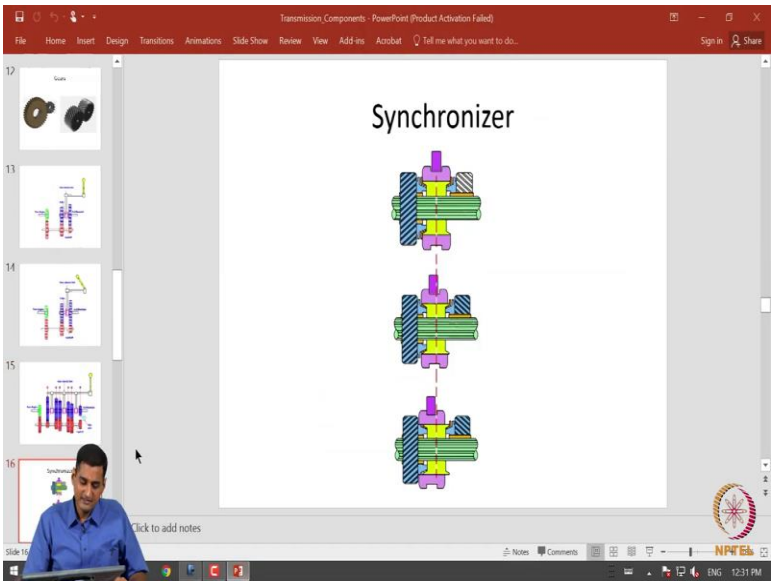
(Refer Slide Time: 01:23)



(Refer Slide time: 01:25)

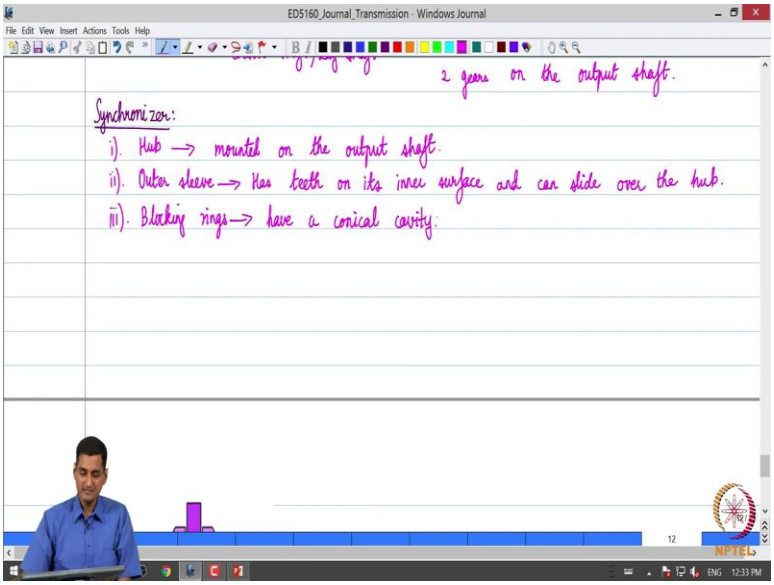


(Refer Slide Time: 01:26)



So, that is the reason why we have moved to the synchronizer. So, let us look carefully at how the synchronizer achieves this action much better than the collar.

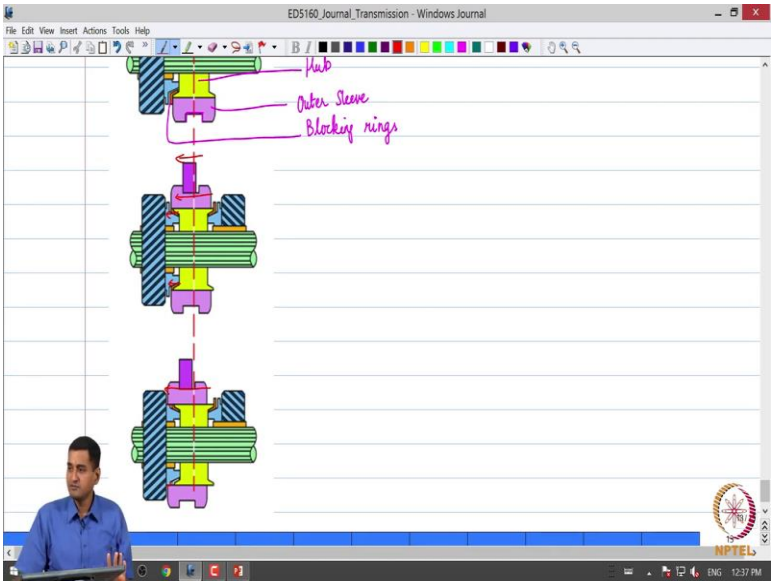
(Refer Slide Time: 01:41)



So, let me hopes on that. So, let me paste the schematic on the next page so that it is clear. So, this is just a schematic of a synchronism so, what happens here is that the synchronizer let me first label the components only 1 side has been shown for simplicity. This is once again a schematic it has an essentially a hub 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. So that is those are some key components in this synchronism.

So what happens is then, 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 links there are 2 blocking links 1 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 peed on its internal surface, inner surface and can slide over the hub so that is the arrangement and these blocking rings have a conical cavity. So, these are the 3 main competence. So, let me come to this schematic and explain how it works.

Refer Slide Time: (04:11)



So when what is a synchronizer is a neutral portion that is it does not engage with any of the gears, there is orders. So, you can see that there is a gap between then this outputs here 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 group so, there is a group which runs along the ferry of the synchronizer.

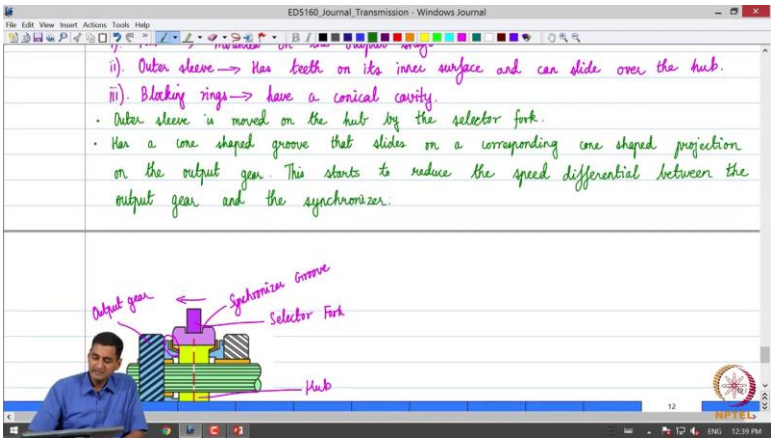
So, you can see this group and the so called selector fork which is attached to the selector rod that is moved by the driver rest in this group. Suppose I give a motion to this selector for to the left. So, what happens is a falling this selector fork first pushes this out asleep over the hub. So, there is an outer sleeve, which is mounted on the hub. The hub has teeth on the ferry, outer

sleeve has corresponding missing 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 block 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 production on the output gear then what happens due to this action the speed differential between the output gear and the synchronizer starts to reduce. So, the speed difference starts to decrease due to this action. Now, the outer sleeve continues to move during the first phase of displacement outer sleeve, the blocking during this pushed against the cone and the speed differential is reduced.

The outer sleeve was further displaced due to which it will travel past the blocking ring and then on the inner surface of the sleeve will then engage with the teeth on the side of the output gear and then the synchronizer and the output gear our lock with one another because the teeth has meshed it with each other than the end is 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 over.

(Refer Slide Time: 07:41)

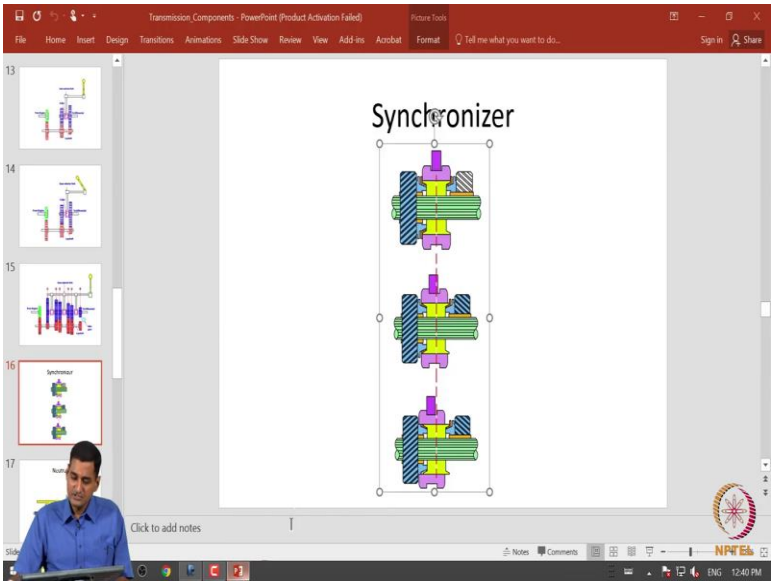


So, this is the way in which the synchronism achieve this task. So, let me write down the main points so that we recall them later. So, the synchronism has a cone shaped group that slides on a corresponding cone shaped projection on the output gear when the synchronizer is first shifted. So first action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

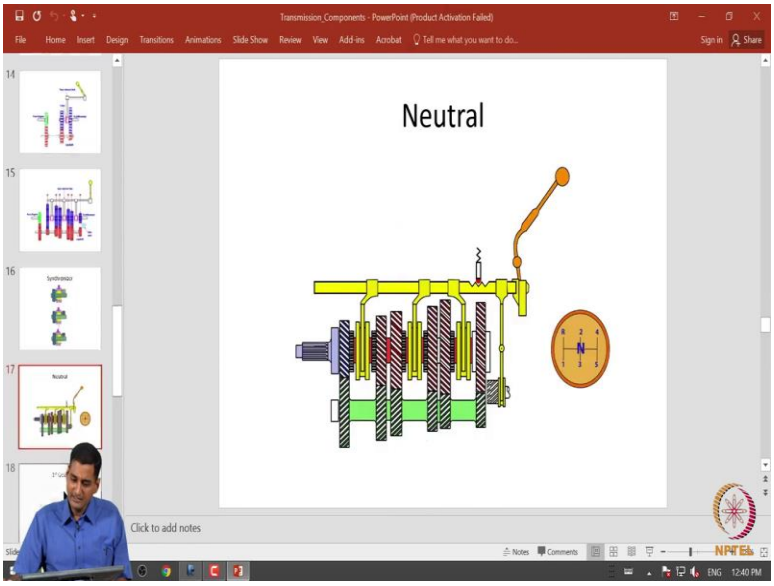
concept production this starts to reduce the speed differential between the output gear and the synchronism.

So, then what happens the output of the sink 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. So it is now that the interior the synchronized and then energy is transferred to the output shaft. So this is a sequence of operation in a synchronization. Now how does this get transfer take place you know like in a multi speed gearbox that is something which we are going to look at?

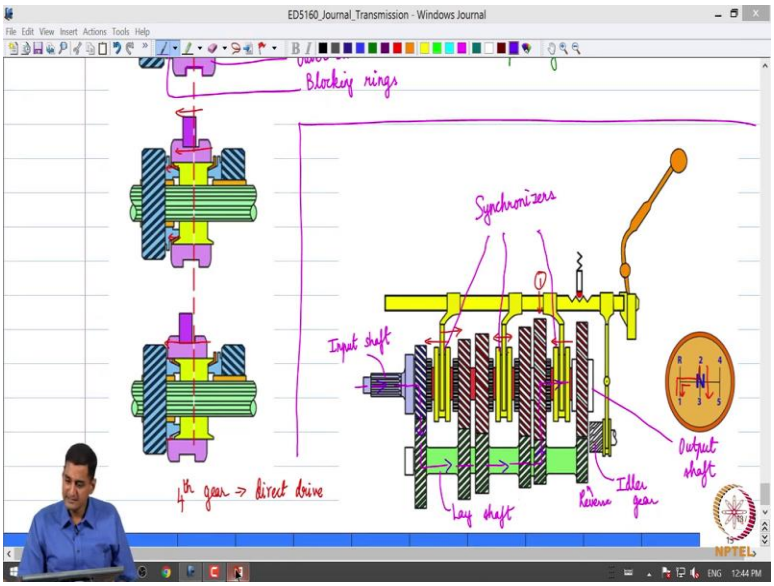
(Refer Slide Time: 10:59)



(Refer Slide Time: 11:00)



(Refer Slide Time: 11:06)



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 so, if we look at this schematic, so, in this schematic this is the input shaft, this is the lay shaft or the countershaft and this output shaft. So, and we can observe that there are three synchronizers 1, 2 and 3 so these are the 3 synchronizers and the reverse gear.

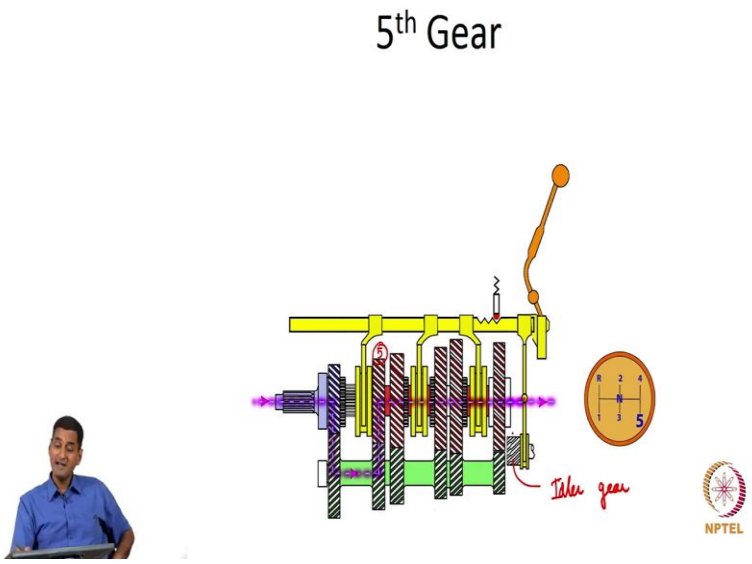
This is a reverse gear arrangement which is achieved by what is called an idler gear will come shortly to that so now what happens is that like in this arrangement this is the first gear, the way this schematic has been set up. So, this is the first gear. So, if I want to engage the first gear, what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

So, what that will do is that like it will essentially take this next synchronizer and engage with the second gear. 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. 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.

So, what happens is when you select the fourth gear, this synchronism moves like this and then directly engages the input gear and the output shaft so, that leader 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. So, if I if we engage the first gear, what is going to happen is that so, the part 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 from the first gear pair it will go to the synchronizer and then to the output shaft. So that so, the energy flow will happen. So, that will be the part of energy flow fine let me quickly show you in on how these various gears are engaged by just using a series of schematics. So, as we observed so this is the, what is a neutral position.

(Refer Slide Time: 15:15)



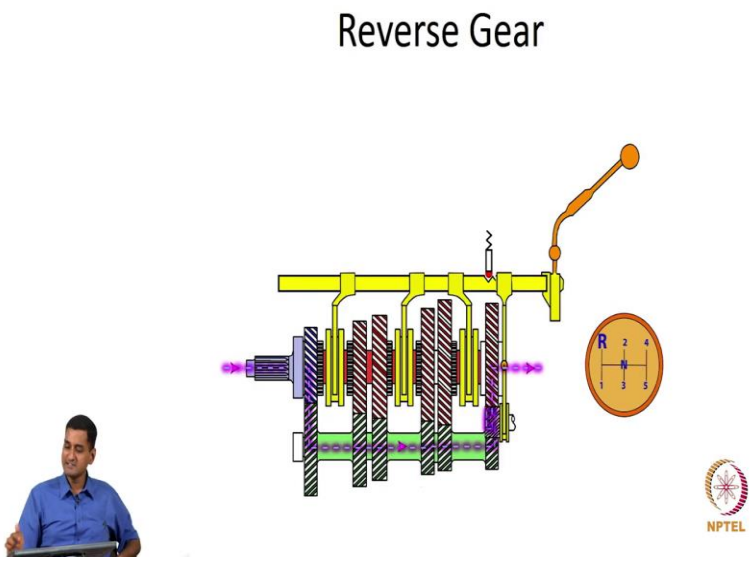
So you can immediately see that when you engage the first gear, the synchronizer move to the left and this is the part of energy flow. Now, when we want to engage the second gear, you can see that the synchronizer move to the right. So, this is the second gear, so this was the first gear, and then the energy flow is shown appropriately. Now, when we come down from 2 to 3, what is going to happen the 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 water scholars a direct drive here. So, you can we can observe that the input shaft and output of shaft connected directly and when we were going to the fifth gear when you want to go from the fourth to the fifth gear be pushed to say selector for down and that is going to result in the synchronizer moving to the right and now we can see that is engaged.

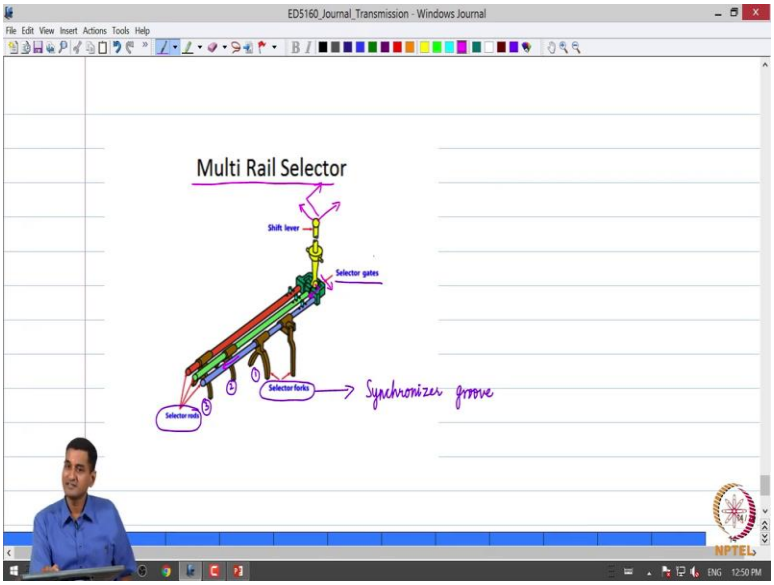
So now what happens with this reverse gear there is something called as an idler gear typically, because in the reverse gear we need to change the direction of more. So we have one more year and how was drivers get typically engage we have been the vehicle to a stop and then we press the clutch the brake and then we engage the reverse gear. So, the reverse gear still works as pushing this idea in between these 2 gears on the input shaft on the output shaft we have to manually push the corresponding idler gear between the 2 gears on the counter shaft on the output.

(Refer Slide Time: 17:30)



So, when we engage the reverse gear you can see that the idler gear has been shifted. 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 encouraged. So, this way, these are the various gear what to say as are chosen. So the last component which I want to discuss is.

(Refer Slide Time: 18:08)



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. So the synchronizers are pushed by the selector folks, the selector folks rest in this synchronizer group. So, for example, in this arrangement there are three synchronizers. So, each synchronizer will require a separate selector for so we can see that there are 1, 2 and 3 selector folks.

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 the shift lever, the bottom part of it which rest and what is Collins selected gate. So, what happens is it if you for example, if you want to engage the first what is say selector, a fork and push it forward what do we do? We want this to be moved in this manner. 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 road forward that means that this end should go like this. So, what should happen to the top and it should go back.

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

So, this arrangement is what is called as a multi rail selector 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 for can select a gate mechanism. So, that is all the selection of the corresponding synchronizer and the gear happens. 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 the next class. Thank you.