TRUCKING

Tractor-Trailer Driver Handbook/Workbook

INSTRUCTOR'S GUIDE

PIDIA
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Professional Truck Driver Institute of America

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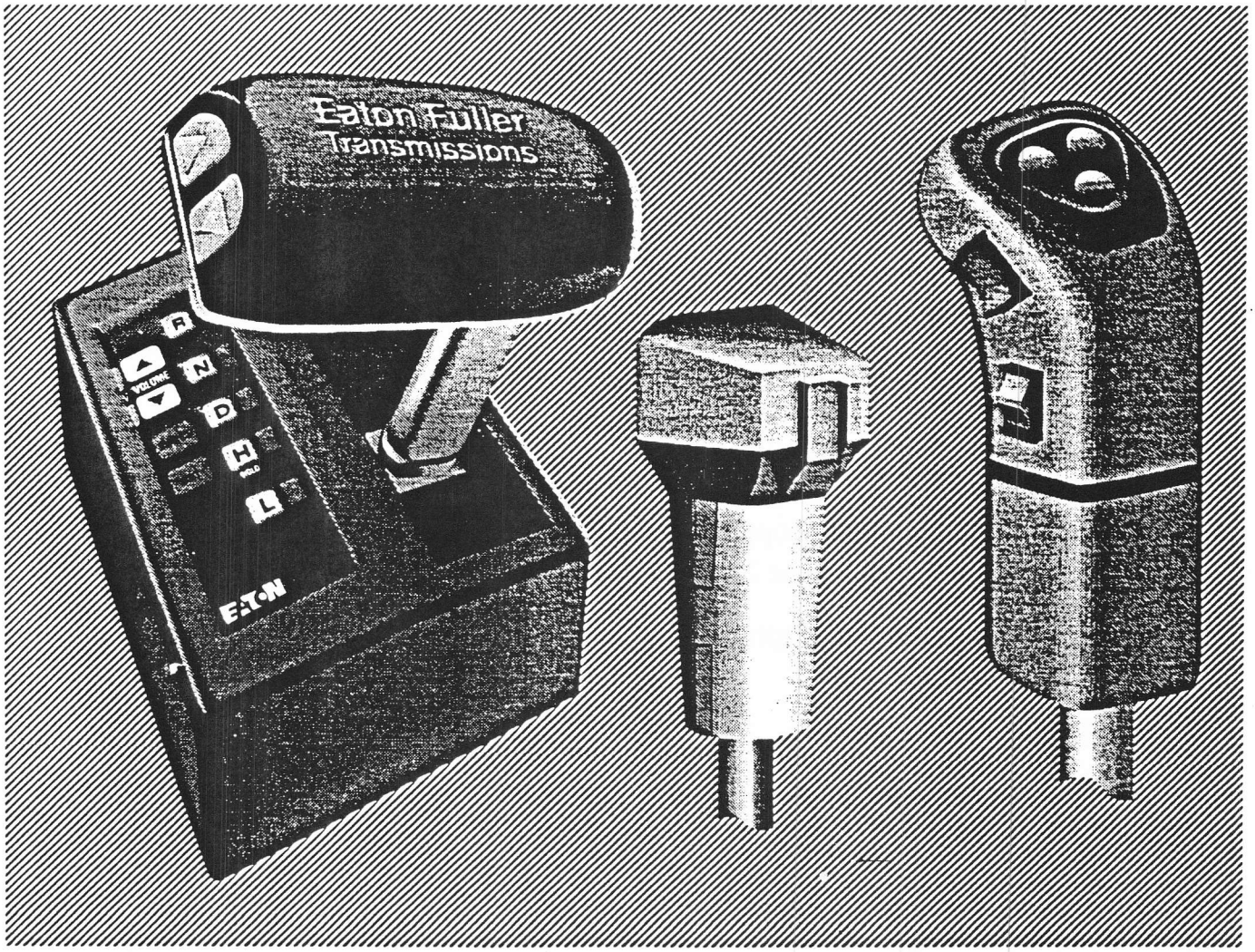
Chapter Seven

SHIFTING

Instructor's Guide



Key Elements of Shifting • Shift Controls • Coordination of Controls • When to Shift Upshifting • Downshifting • Aids to Shifting • Double Clutching • Types of Transmissions • Shifting Patterns • Progressive Shifting • Good Shifting Habits

OBJECTIVES

When the student has mastered this chapter, he or she will be able to:

- Describe the basic gear shifting patterns
- Explain the shift patterns for major types of transmissions
- Present methods of shifting up and down through the gears of all major types of conventional transmissions
- Describe double clutching and the timing of the shift for a smooth and fuel-efficient performance
- Explain how to select the proper gears for speed and road conditions
- Describe shifting with both fully automatic and semi-automatic transmissions
- Describe the different procedures needed to operate synchronized and nonsynchronized transmissions
- Explain the instruments and controls needed to shift gears properly
- Understand the common shifting errors and their results
- Demonstrate the proper use of hands, feet, sight, and hearing in shifting to obtain the best performance
- Explain how the improper use of the clutch and transmission can damage the rig

CHAPTER OVERVIEW

This chapter will introduce the student to the procedures for shifting gears. Because the concept of shifting may be new to some students, the instructor is encouraged to spend as much time as is needed on the basic principles involved in shifting gears smoothly. The students will learn the shift patterns of the major types of transmissions and how to shift up and down through the gears of these transmissions. Synchronized and non-synchronized transmissions are discussed and the procedures needed to operate them are outlined. The students will learn the shifting patterns for both automatic and semi-automatic transmissions.

Driver-trainees will learn how to double clutch and select the proper gears for the conditions. Students will learn about the controls used to shift gears, as well as how to coordinate these controls. The gauges and controls useful in knowing when to shift are explained. The students will test their knowledge of how to shift gears smoothly by answering the Review Questions.

CHAPTER SEVEN

SHIFTING

INTRODUCTION

Shifting gears in a heavy vehicle is more difficult than it is in an automobile. Experience with a manual transmission in an automobile helps, but it is only slightly similar and is far less demanding.

It is possible there may be students who have never driven a stick shift car. If that is the case, you may need to explain the shifting process in detail. A lesson or two in an automobile may also be helpful.

This section will introduce you to the differences among shifting patterns and explain clutch and accelerator control. It will also explain how to coordinate the eyes, hands, feet, sound, and feel to handle the transmissions found in tractor-trailers.

You will not learn all you need to master shifting from reading this chapter. You also need behind-the-wheel practice. What you learn will serve as a reference when you practice in your rig. Proper gear shifting involves both knowledge and skill.

KEY ELEMENTS OF SHIFTING

To drive a tractor-trailer, you need to know the controls that are used in shifting. You also need to understand how to coordinate them when shifting, and when to shift.

SHIFT CONTROLS

With a manual transmission, the controls used in shifting are the:

- Accelerator
- Gearshift lever
- Clutch

They are shown in Figure 7-1.

Be sure the students understand the relationships among these controls and why certain sequences must be followed for smooth shifting.

Show Overhead OH-96 as you explain the different controls.

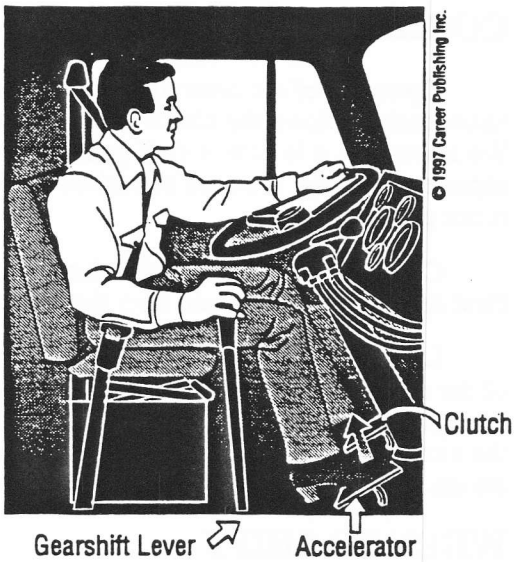


Figure 7-1

Accelerator

The accelerator controls the flow of fuel to the engine and sets the speed of the engine. This is not new information, but it is important to remember because engine speed and shifting are closely related.

Be sure the students understand the relationship between shifting gears and engine speed. You shift up as you accelerate and shift down as you slow.

Gearshift Lever

The gearshift lever selects the gear. The gear determines how the engine speed is transferred into road speed. For example, at a given engine speed, placing the transmission in a low gear may produce a lot of power but little road speed. A low gear multiplies the power of the engine and supplies the power needed to build up road speed. In low gear, the power of the engine can be

Be sure the students understand this important concept. You may want to spend some time taking the students through some what-if situations to show results of shifting to different gears.

multiplied 10-15 times. In a high gear, high road speed is attainable but available engine power is reduced.

You may need to explain what is meant by disconnecting the transmission and engine. Explain what happens when shifting occurs and the engine and transmission are not disconnected.

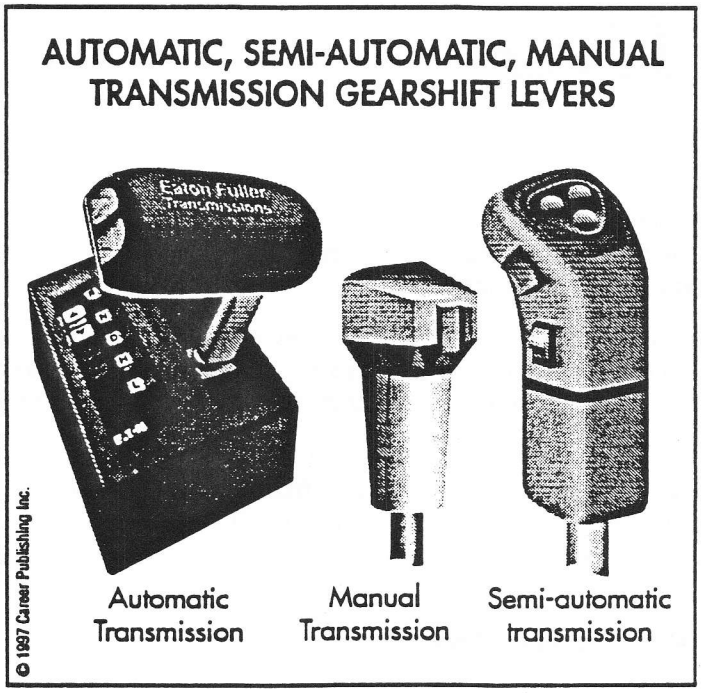


Figure 7-2

Clutch

The clutch connects or disconnects the transmission and engine. It makes shifting gears possible. When the driver pushes down the clutch pedal, the engine is disconnected (disengaged) from the transmission, and the gears may be safely shifted.

If the idea of engaged and disengaged is hard to understand, think of it as with people. Engaged people are together. If the engagement is broken, they are disengaged, or separated.

COORDINATION OF CONTROLS

Operation of the controls requires coordination and careful timing. We know pushing down the clutch pedal separates the engine from the transmission. We know, too, it is safe to shift gears only when the engine and transmission are separated. Plainly, it would be foolish to try to shift gears when the clutch pedal is not pushed down.

Coordinating the use of the clutch pedal and the gearshift lever is logical. First depress the clutch, and then shift gears.

Spend enough time on this concept for the students to thoroughly understand it.

Lack of coordination of the accelerator and clutch pedal can cause revving of the engine. When this happens, engine speed increases before the transmission is engaged. If there is not enough acceleration when engaging the clutch again, the momentum can push the tractor and damage the drive line components. If you are on a slippery surface, this can cause you to skid or lose control of the rig.

WHEN TO SHIFT

Gears can be shifted either up or down depending on what is needed. The following section will explain when to upshift and when to downshift.

Upshifting

Explain what will happen if a higher gear is chosen.

A vehicle requires more power to start moving than to keep moving. Low gears provide a great deal of power but little speed. Thus, we select low gear to get the rig in motion.

As the speed increases, shift to a higher gear to gain more speed. The purpose of upshifting is to allow the rig to gain speed. We lose power as the speed increases but less power is needed to maintain speed.

Explain what will happen if upshifting does not occur.

Downshifting

A vehicle that is reducing speed will, at certain points, require more power to prevent lugging (overstraining) the engine. For example, when you must slow down or go down a hill, you may need to shift down one or more gears as you slow. Shifting down increases engine power to the drive wheels while giving up some speed.

This is a good place to introduce the concept of downshifting when going downhill instead of braking.

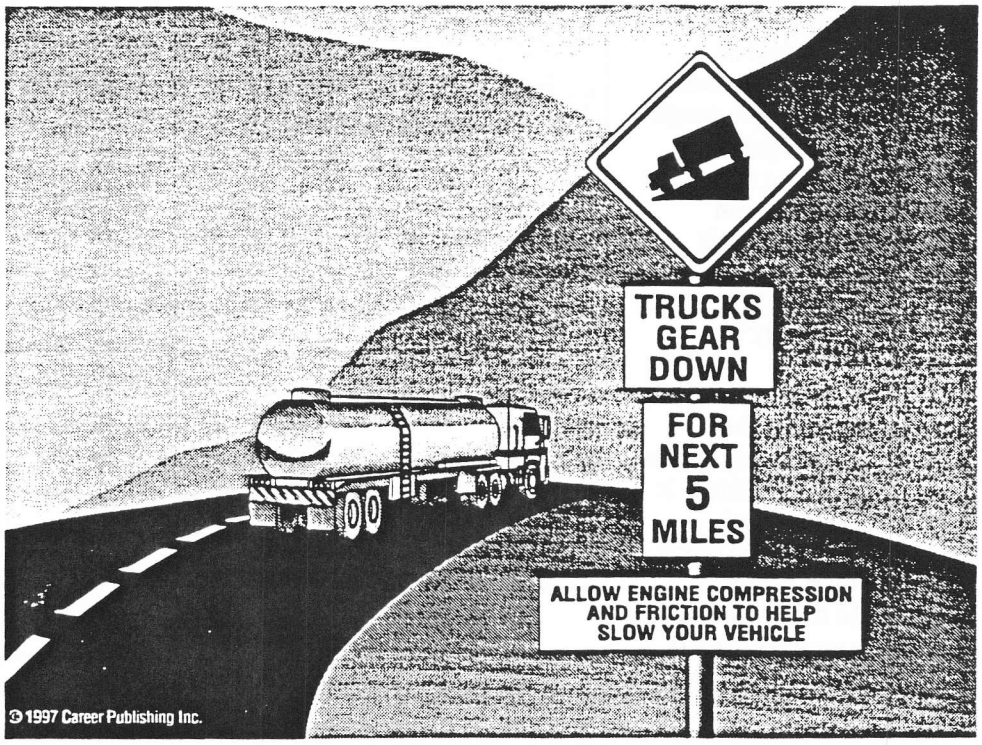


Figure 7-3

Downshifting too early can result in the vehicle having too much momentum or speed for the next lower gear. This can cause the engine to rev beyond its operating range and strain its parts. Also, you may not be able to complete the shift. Shifting down too soon may also prevent rapid acceleration if it is needed.

Relate actual driving situations to the students so they understand the importance of knowing when to shift.

AIDS TO SHIFTING

The speedometer, tachometer, governor, and clutch brake are all useful or, in some cases, necessary tools for shifting.

Emphasize that these controls and gauges serve a useful purpose that helps them to become better drivers.

Speedometer

While speed ranges vary with the type of transmission, there is a range of road speeds to correspond to every gear. A driver must learn the speed ranges for his or her rig. Then the driver can upshift or downshift as needed.

Be sure the students understand the importance of learning the correct ranges of speed for each gear.

Emphasize the usefulness of the tachometer for correct shifting.

Show Overhead OH-97.

Discuss the relationships between the gear and MPH. Discuss the differences between 1300 RPMS and 1800 RPMS.

Discuss the advantages of a governor and the way in which it is used on trucks today.

Be sure the students understand the use of the clutch brake. This will probably be a new component for them.

Show Overhead OH-98.

Explain the sequence the clutch uses while in operation.

When the top of a speed range is reached for a given gear, the driver will have to upshift. When the bottom of a speed range is reached for a gear, he or she will have to downshift.

Tachometer

The tachometer displays the engine speed in revolutions per minute (rpm). Just as there is a road speed range for each gear, there is an rpm range for each gear. Upshifting and downshifting should be coordinated with rpm ranges the same as it is with road speed ranges.

Governor

The governor is a device that keeps the engine from revving up too much during upshifting. It also reduces the fuel supply to the engine when the maximum rpm is reached. In today's new electronic engines, this is controlled by a computer chip or module.

Clutch Brake

A clutch has three phases.

1. Free Play
2. Working
3. Clutch Brake

The clutch brake stops the gears from turning. To engage it, push the clutch pedal all the way to the floor. It keeps the gears from clashing when shifting into low or reverse. Use the clutch brake only when the vehicle is completely stopped.

- *Measures Engine Speed in RPM's*
- *Tells You When to Shift*

Groundspeed and Gear

Examples of Specific Gear to Groundspeed Relationships for a Nine-Speed Transmission

Gear	MPH at 1300 RPMs	MPH at 1800 RPMs
Low	0	4
1	4	7
2	7	10
3	10	14
4	14	19
5	19	26
6	26	38
7	38	53
8	53	65 *

* Governor set at 1640 RPMs

Figure 7-4

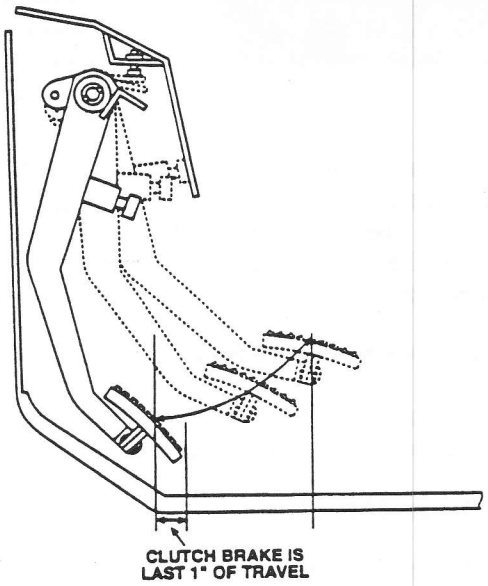


Figure 7-5

NONSYNCHRONIZED TRANSMISSIONS

Some students may not know what is meant by double clutching. Be sure they understand this concept before proceeding.

Later in this chapter, we will deal with synchronized transmissions. The following information is for nonsynchronized transmissions, which require double clutching.

Double Clutching

Explain that these procedures may take some practice to perfect, but it is important to be able to do them well.

Double clutching is used to let the driver control the engine rpms and the gears, so the gears can be shifted smoothly. While the method involves more than the simple routine shown here, it is important to understand and master this basic sequence.

Upshifting

1. Release the accelerator.
2. Push the clutch pedal down, disengaging the clutch. Be careful not to engage the clutch brake.
3. Move the gearshift lever to neutral.
4. Release the clutch pedal, engaging the clutch.
5. Push the clutch down when the proper rpm for the next gear is reached.
6. Move the gearshift lever to the next higher gear.
7. Release the clutch pedal, engaging the clutch and transmission.
8. Accelerate.

Downshifting

1. Release the accelerator.
2. Push the clutch down.
3. Move the gearshift lever to neutral.
4. Release the clutch.
5. Accelerate the engine enough to match the rpms with the road speed. This avoids clashing gears.
6. Push the clutch down.
7. Shift into the next lower gear.
8. Release the clutch.

Be sure the students understand how to determine if they are maintaining the correct engine speed.

Be sure to maintain the correct engine speed throughout the procedure.

Synchronizing Skills

Although depressing and engaging the clutch two times on each shift is a very big part of handling a nonsynchronized transmission, it is not the main shifting event. The key action — the one that requires special shifting skills — is synchronizing (bringing to the same speed) the teeth of the mating gears (the driving gear and the driven gear). When this is done properly, there is no grinding, or clashing, of the gears.

Engine speed can be read on the tachometer and can be heard. It can also be felt as a vibration in the tractor. Some drivers think they are using engine rpms to tell them when to shift when they are really using their sense of rpm.

Explain that being able to sense what the engine is doing comes only with experience.

A skilled driver of a nonsynchronized transmission rig uses his or her sense of rpm to know when to shift. Three basic skills are necessary to shift this kind of a rig. They are:

1. Being able to identify engine rpm
2. Knowing the rpm at which the engine should be turning
3. Being able to bring the engine to the correct rpm

Stress the importance of the driver's relating to how the engine is performing.

What, exactly, does the driver do to control the tooth speed of the driving gear? After depressing the clutch and shifting into neutral, the driver releases the clutch. This allows the engine rpms to drop (upshift) or speed up (downshift). This adjusts the tooth speed of the next driving gear to the speed/rpms of the engine.

Be sure the students know this information as the starting point of learning when to shift.

How does the driver know how much to increase or decrease the engine speed? Based on manufacturers' recommendations, a general rule of thumb is, "when you change gears you must change the rpm by about 25 percent (25%) or 500 rpms."

Emphasize that these skills will come with experience, and they should not become discouraged by their early efforts.

As long as shifts are started at the same rpm, the synchronizing rpm will be about the same for each shift. For this reason, shifts are a matter of timing and coordination.

In more complex shifts, the synchronizing rpm is not always in the same place. Shifts may be started at various rpms, so the rpm at which the next gear will synchronize will also vary. On upgrades, the rig loses speed during shifts. On downgrades, speed increases. On upgrades, start your shift a little earlier than you would on flat ground.

Any change in vehicle speed that occurs during shifting will affect the synchronizing rpm. A skilled driver is able to deal with these variations.

Besides shifting up and shifting down, handling a nonsynchronized transmission demands a third shifting skill. When a vehicle is rolling in neutral, the driver must get the transmission into the proper gear. This process is known by many names, such as:

- Picking a gear
- Hunting a gear
- Finding a gear
- Hitting a gear

Emphasize this knowledge will come with experience.

The possible mph/gear/rpm combinations can be worked out either by math or by *sense* or *feel*. In general, for each possible mph there will be only one possible gear.

Most drivers handle this situation by sense or feel. The skill is to sense the truck's mph and recall where the stick should be when the truck feels as it does. Then simply put the stick in front of that gear position.

As you take students out on the driving range, let them experience these sounds and vibrations.

Think how the engine should be vibrating at that speed in that gear. Then, with the clutch engaged, throttle up or down until the vibrations feel right and push the stick.

It may drop into gear. If it does not, work the throttle and feel how changing the engine rpm changes the stick vibrations. If the rpms are too high, the grinding noise will be high. If they are too low, the sound will be deep and hollow. Close to the proper rpm, the stick vibrations will feel larger and farther apart. When the correct rpm is reached, the stick will begin to fall into gear. At that point, disengage the clutch and push the stick into place. Release the clutch and speed up.

Being able to find the synchronizing rpm under all possible shifting conditions is the major skill needed to handle a nonsynchronized transmission.

Again, emphasize these skills will come with experience.

Summary of Shifting Skills

Good shifting technique is a sign of a professional driver. Skills include:
- Good timing and coordination
- Shifting without forcing, raking, or grinding the gears
- Never riding the clutch pedal
- Always using the clutch to shift
- Selecting the proper gear for the best fuel economy
- Anticipating changes in terrain or traffic

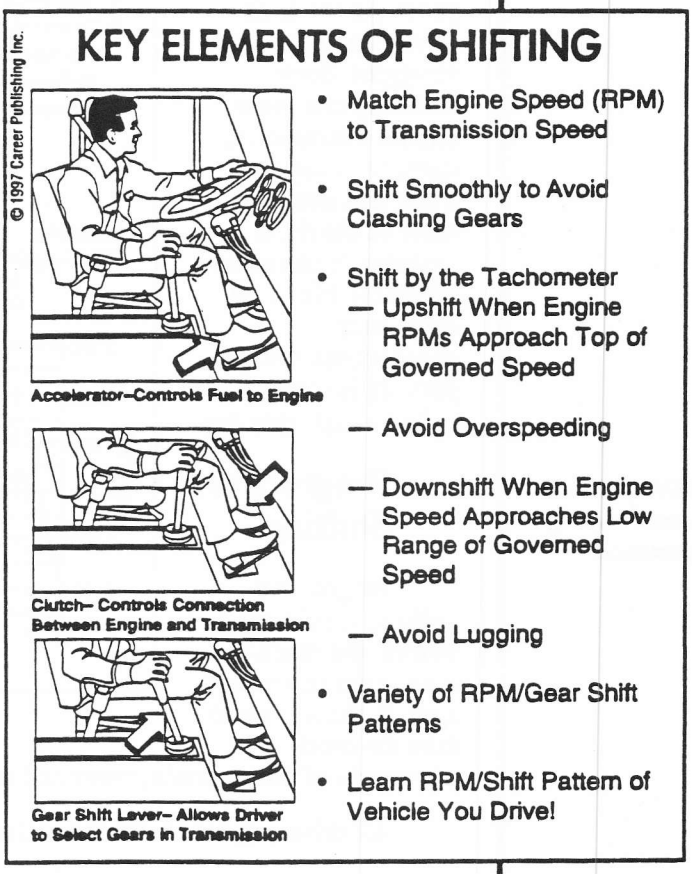
A driver needs to know:
- What gear he or she is in at any given time
- The top mph and rpm for each gear

When using the engine to cut the speed of the rig, the range selector should be shifted to the next lower range. If the vehicle exceeds the maximum speed for the lower gear, use the service brakes to reduce speed. Automatic transmissions have a longer *coast down* time than manual transmissions. You will need to learn to slow down earlier or use the service brakes until the downshift occurs.

SHIFTING SYNCHRONIZED TRANSMISSIONS

So far we have dealt mostly with nonsynchronized, or *constant mesh*, transmissions which are by far the most common in heay trucks. But some large trucks also have synchronized transmissions which must be shifted differently.

A synchronized transmission uses small plates between the gears called synchronizers to match gear speed during shifting. This allows a driver to depress the clutch and change gears without double-clutching or using the accelerator to bring up engine speed. You would use the same shifting methods as you would in a car or light truck with a manual transmission.



Show Overhead OH-99 as you discuss the key elements of shifting.

Figure 7-6

IMPORTANCE OF PROPER SHIFTING

Proper shifting is the sign of a skilled driver. These drivers do not grind, clash, or force the gears. Shifting is not a matter of strength. It can be done with the thumb and index finger. When done correctly, the gears practically fall

into place.

Keys to Shifting:
- Use good timing and coordination (the driver matches the road speed, rpm, and gear).
- Always know what gear the transmission is in.
- Know the top mph and the maximum and minimum rpm for each gear.
- Anticipate changes in terrain or traffic.

Stress the importance of the driver and vehicle functioning as a single unit.

Important Knowledge:
- Know the vehicle.
- Know the top tachometer readings for each gear and road speed.
- Know the load and road. For example, do not attempt to shift to a higher gear until the trailer (not just the tractor) is over the crest of a hill.

Results of Shifting into Too Low a Gear by Mistake

The engine will run too fast. This can damage the clutch, engine, transmission, or drive shaft. It can also cause loss of vehicle control.

Lugging

Lugging occurs when the driver fails to downshift when the engine speed starts to fall below the normal operating range. In this condition, the tractor produces too little power and lugs, or struggles. Such straining can cause engine overheating, damage to the drive train, and stress on most of the rig's systems. It can also affect the life of all drive train components. Over revving is sometimes called a high rpm lug.

Use Overhead OH-100 to explain progressive shifting. Explain its importance.

Progressive Shifting

Progressive shifting is shifting before you reach the maximum governed rpm. It allows you to take the most advantage of the engine's power and save fuel at the same time.

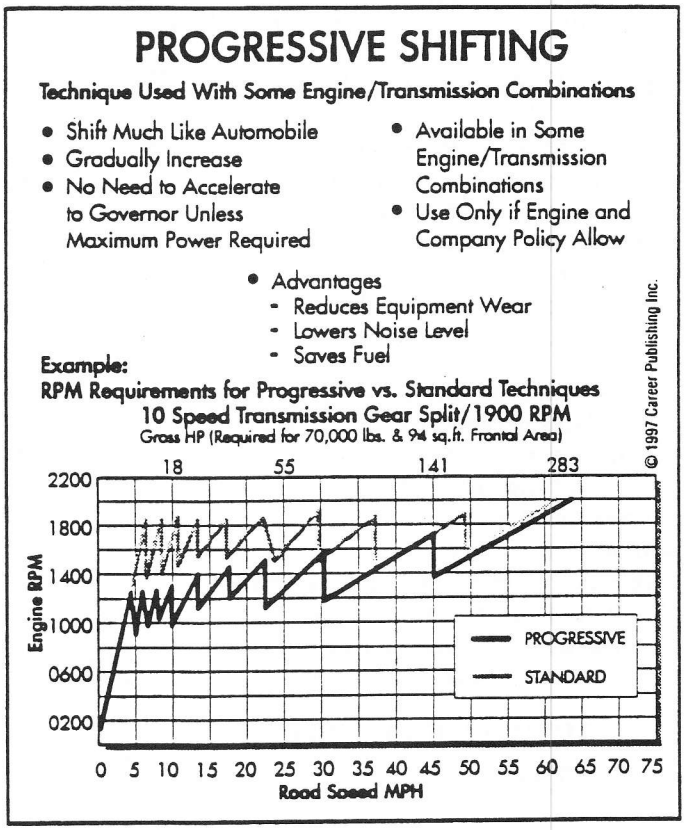


Figure 7-7

All drivers should learn the technique. This is shown in Figure 7-7.

Shifting Procedure

Upshifting
- Shift when the engine reaches cruise rpm instead of the maximum set by the governor.
- In lower gears, shift at the lowest rpm possible without lugging the engine.

Downshifting
- Shift as soon as the rpm reaches torque peak (1,300 rpm on most engines. Check the operator's manual).

Benefits

Progressive shifting is advised by many companies because it:
- Reduces equipment wear
- Lowers the noise level
- Saves fuel

Emphasize the advantages and the importance of these advantages to the carrier.

SHIFTING PATTERNS AND PROCEDURES

In this section, we will look at the shift patterns of five common transmissions: the *Spicer Pro-Shift Seven Speed, Eaton Fuller Nine Speed, Eaton Fuller Super Ten, Rockwell Ten Speed, Eaton Fuller Thirteen Speed, Eaton Fuller Top 2, Spicer Automate-2,* and *Rockwell Engine Synchro Shift (ESS).*

Although your school may have only one type of truck; students should become familiar with all of the shifting patterns.

Spicer Pro-Shift Seven Speed

The Spicer Pro-Shift Seven Speed is a constant mesh (non-synchronized) twin-countershaft transmission with a single range operation.

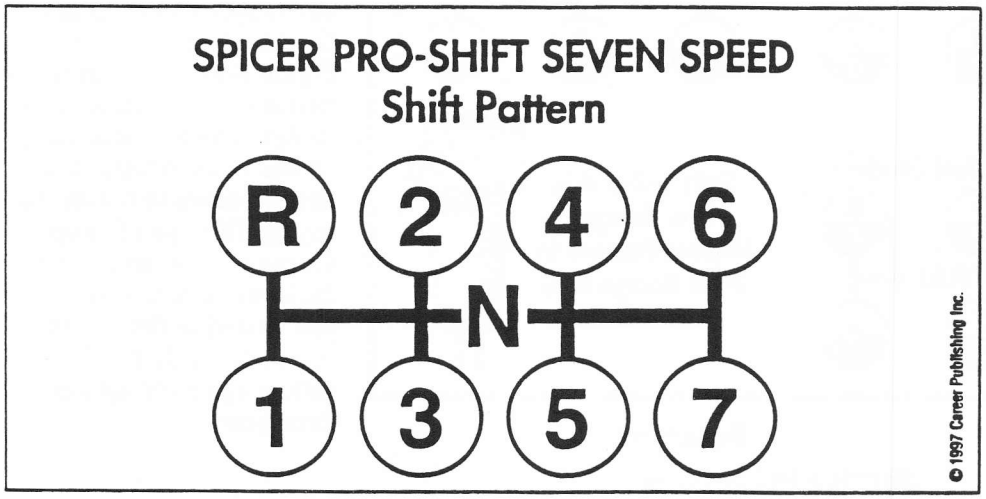


Figure 7-8

Shift Pattern

The transmission uses a simple no-repeat shift pattern, starting with first at the bottom left and working up through the gears to seventh at the bottom right (see Figure 7-8). No levers or buttons are needed for any of the shifts.

Use Overhead OH-101 to explain the Spicer Pro-Shift Seven Speed shifting patterns.

As you explain shifting procedures, be sure to include any "tricks of the trade" that you have learned.

Shifting Procedures

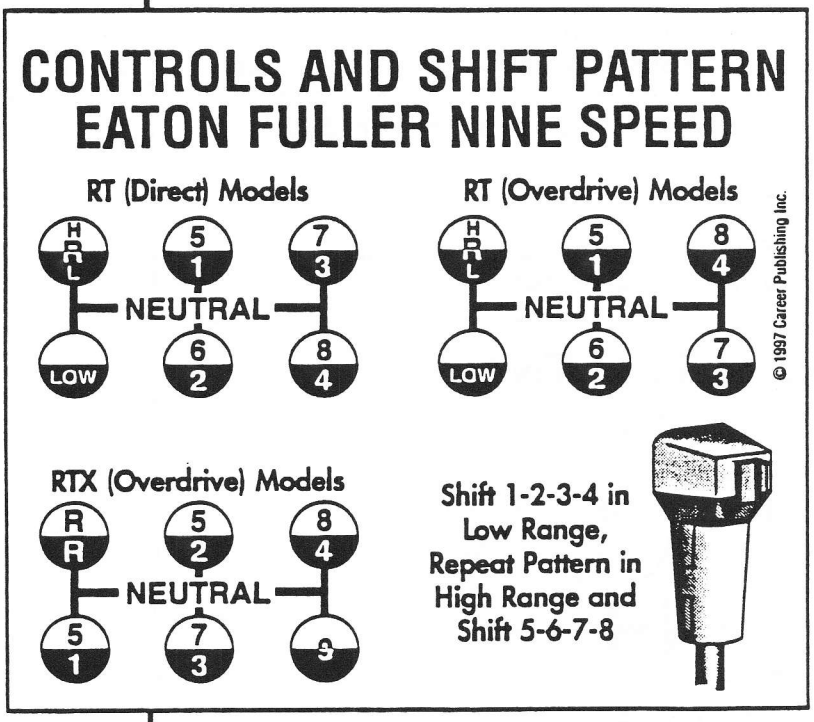
Upshifting:
- Depress the clutch.
- Move the gear down and as far left as possible for first gear.
- To shift to second, double-clutch, move the lever up and slightly to the right.
- Shift up through the next five gears using the normal double clutching and following the standard "H" pattern.

Downshifting:
- Shift from seventh to sixth by double clutching, moving the lever straight forward, and matching the engine speed to the road speed before shifting.
- Use the same procedure for all further downshifts, following the "H" pattern back down to first.

Eaton Fuller Nine Speed

The Eaton Fuller Nine Speed is a constant mesh (non-synchronized) twin-countershaft transmission with high and low range operation.

Show Overhead OH-102 as you discuss the shifting pattern of the Eaton Fuller Nine Speed.



Compare the differences between shifting gears following the standard "H" pattern and shifting gears following a Double H pattern.

Shift Pattern

Low range has five forward gears: Low through 4th gear. To use high range, you lift the range control lever. High range has four more gears (5th through 8th). The shifting sequence is commonly known as the Double H pattern (see Figure 7-9). You start in first at the top left, then straight down to second, up and right to third, and straight down to fourth. To engage fifth, you flip up the range lever and move the lever back to where you started in first. Then you go through the "H" pattern again for the top three gears.

Figure 7-9

Shifting Procedures

Upshifting:
- Depress the clutch.
- Make sure the range lever is down (low range).
- Move the gear lever to first gear (use low gear only if you are starting from a steep grade with a heavy load).
- Shift up through fourth gear using normal double clutching.

- To shift from fourth to fifth, lift the range control lever up before moving the gear lever.
- As the gear lever passes through neutral, the transmission automatically shifts to high range.
- Shift from fifth to eighth using normal double clutching.

Downshifting:

- Shift down from eighth to fifth using normal double clutching and engine and road speed matching.
- To shift down from fifth to fourth, push the range lever down before moving the gear lever.
- As the gear lever passes through neutral, the transmission automatically shifts to low range.
- Shift down from fourth to first using normal double clutching and engine and road speed matching.

Point out any unique characteristics or sounds that may occur while either upshifting or downshifting.

Eaton Fuller Super Ten

The Eaton Fuller Super Ten is a constant mesh (non-synchronized) twin-countershaft transmission with a low-inertia design and auto-range actuation to make shifting easier. With low-inertia technology, the main shaft is disconnected from the back box during compound shifts. Drivers can preselect all button shifts up and down, helping to speed shifts and reducing misshifts.

Show Overhead OH-103 as you discuss the shifting pattern of the Eaton Fuller Super Ten.

Point out any unique features of the Eaton Fuller Super Ten.

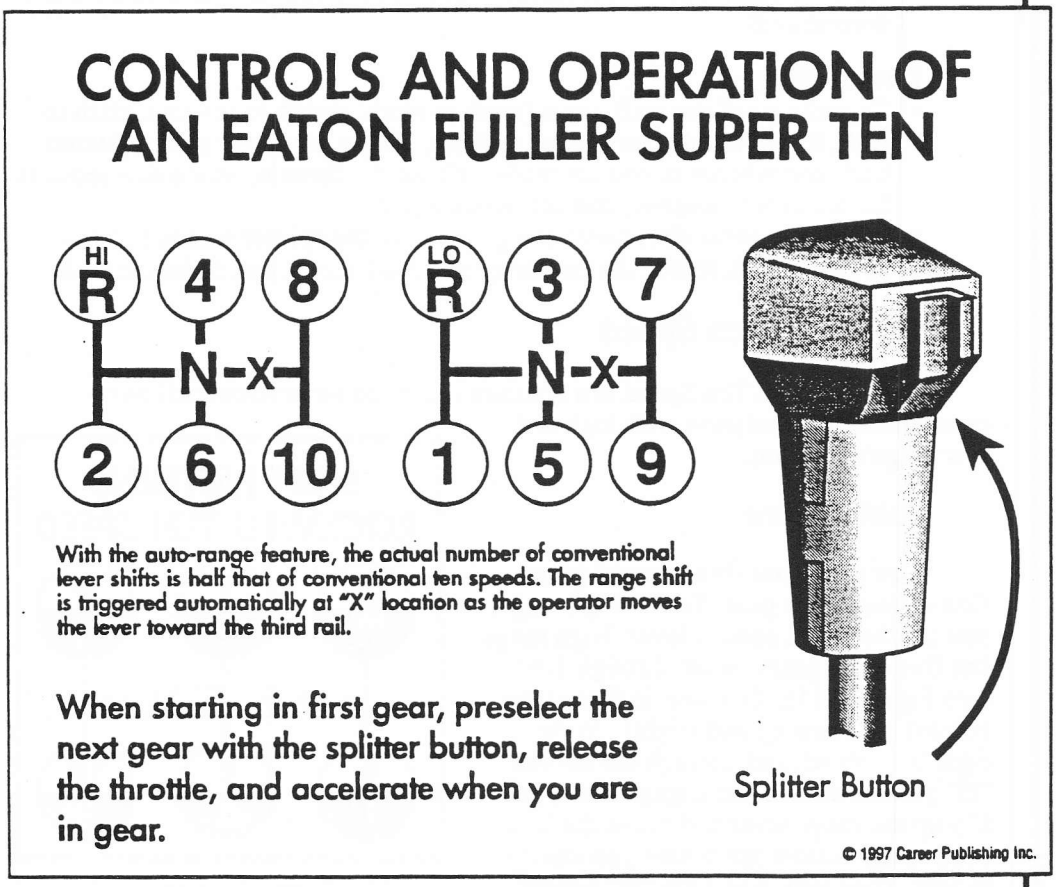


Figure 7-10

Shift Pattern

Unlike other dual range transmissions, the Super 10 does not have a range change lever. Instead, you just have five gear positions that you split, reducing gear lever movements by half. For example, you start in first gear at the bottom left (see diagram shown on the previous page). Then you preselect the next gear with a splitter button. To engage the gear, all you need to do is release the throttle to break torque, and then accelerate again when you are in gear. You only need to move the gear lever from second to third, fourth to fifth, sixth to seventh, and eighth to ninth.

Shifting Procedures

Upshifting:

- Depress the clutch.
- Make sure the range lever is down (low range).
- Move the gear lever to first gear (use low gear only if you are starting from a steep grade with a heavy load).
- To make a splitter shift (first to second, third to fourth, fifth to sixth, seventh to eighth, or ninth to tenth), move the splitter button forward, take your foot off the throttle, wait a few seconds for the gear to engage, and then accelerate.
- To make a lever shift (second to third, fourth to fifth, sixth to seventh, or eighth to ninth), move the splitter button back, double clutch, and make a normal shift

Downshifting:

- To make a splitter shift down (tenth to ninth, eighth to seventh, sixth to fifth, fourth to third, or second to first), simply move the splitter button back and whenever you are ready, release the throttle, wait a few seconds for the gear to engage, and accelerate again.
- To make a lever shift down one gear, move the splitter button forward, double clutch, match the engine rpm to road speed, and make the shift.

Rockwell Ten Speed

The Rockwell Ten Speed is a constant mesh (non-synchronized) twin-countershaft transmission with high and low range operation.

Show Overhead OH-104 as you discuss the shifting pattern of the Rockwell Ten-Speed transmission.

Point out any unique characteristics of the Rockwell Ten Speed.

Shift Pattern

Low range has five forward gears: first through fifth gear. To use high range, you lift the range control lever. High range has five more gears — 6th through 10th (see Figure 7-11). You start in first at the bottom left, then up and slightly to the right for second, and through the normal "H" pattern to fifth. To engage sixth, you flip up the range lever and move the lever back to the bottom left where you started in first. Then you repeat the "H" pattern again for the top four gears.

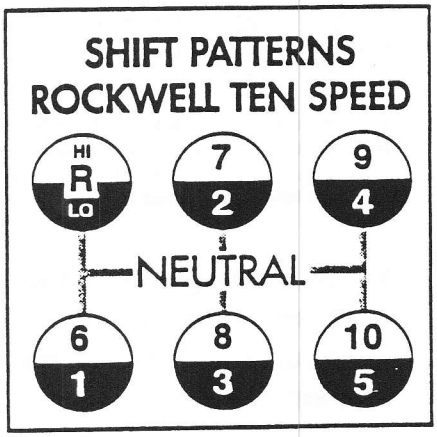


Figure 7-11

Shifting Procedures

Upshifting:
- Depress the clutch.
- Make sure the range lever is down (low range).
- Move the gear lever to first gear at the bottom left.
- Shift up through fifth gear using normal double clutching.
- To shift from fifth to sixth, lift the range control lever up before moving the gear lever.
- As the gear lever passes through neutral, the transmission automatically shifts to high range.
- Shift from sixth to tenth using normal double clutching.

Downshifting:
- Shift down from tenth to sixth using normal double clutching and engine and road speed matching.
- To shift down from sixth to fifth, push the range lever down before moving the gear lever.
- As the gear lever passes through neutral, the transmission automatically shifts to low range.
- Shift down from fifth to first using normal double clutching and engine and road speed matching.

Eaton Fuller Thirteen Speed

The Eaton Fuller Thirteen Speed is a constant mesh (non-synchronized) twin-countershaft transmission with high and low range operation, as well as a splitter on high range gears.

Shift Pattern

The transmission has five gears in low range, including a low-low gear. High range has four direct ratios, as well as another four overdrive ratios. Overdrive can be engaged in high range with a splitter switch. But the splitter must be in the direct mode to operate in low range (the transmission will not allow you to downshift into low range unless the switch is in direct). The shift pattern is the basic *double H*. You start in first at the top left (see Figure 7-12), then move through the "H" to fourth, flip the range lever up, move to fifth, and repeat the pattern.

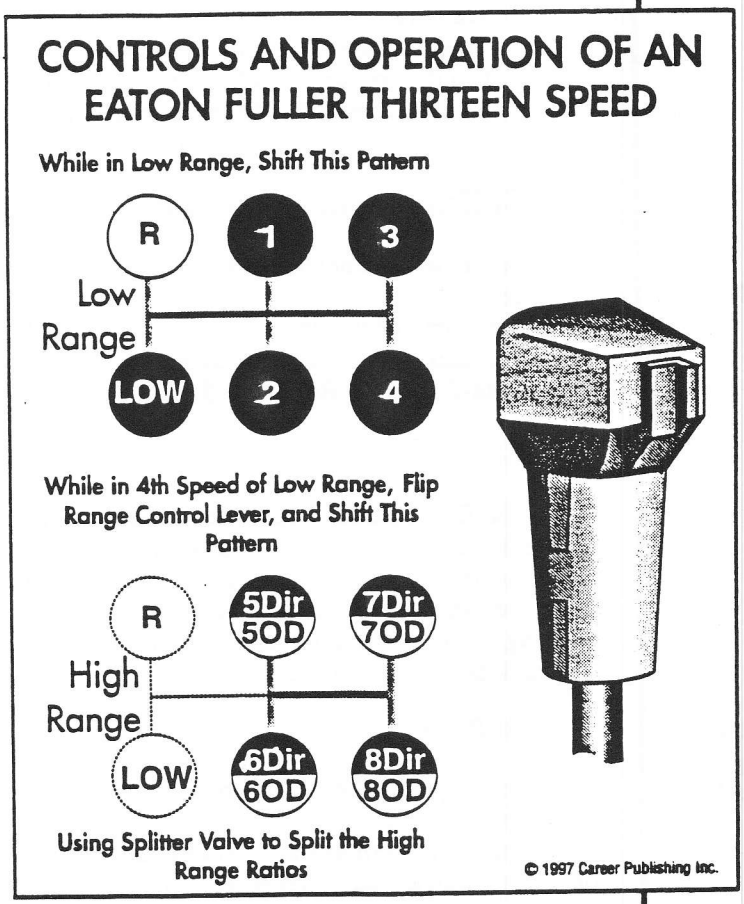


Figure 7-12

Show Overhead OH-105 as you discuss the shift pattern of the Eaton Fuller Thirteen Speed.

Be sure to explain how shifting a thirteen-speed transmission differs from shifting a ten-speed or nine-speed transmission.

Shifting Procedures

Upshifting:

- Depress the clutch.
- Make sure the range lever is down (low range).
- Move the gear lever to first gear (use low-low only if you are starting from a steep grade with a heavy load).
- Shift up through fourth gear using normal double clutching.
- To shift from fourth to fifth, lift the range control lever up before moving the gear lever.
- As the gear lever passes through neutral, the transmission automatically shifts to high range.
- Shift from fifth to eighth using normal double clutching.
- To split a gear in high range (go from direct to overdrive), flip the splitter switch, release the accelerator, depress and release the clutch, and accelerate again.
- To shift from overdrive to direct drive in the next higher gear, move the gear lever into the next gear and flip the splitter switch just before your foot has come off the clutch

Downshifting:

- To split down from overdrive to direct in the same gear, flip the splitter switch, release the accelerator, depress and release the clutch, and accelerate again.
- To shift down from direct in one gear to overdrive in the next lower gear, flip the splitter switch to overdrive and make a normal downshift.
- To shift from fifth direct to fourth, push the range lever down, double clutch, and make a normal downshift.

Shifting Semi-Automatic Transmissions

Explain the specific differences drivers will encounter when using electronic controls.

Some newer transmissions use electronic controls to help you shift. They are essentially manual transmissions, with a clutch and a similar-looking gear lever, but some of the gears are automated. In this chapter, we will look at the operation and shift patterns of three types: The Eaton Fuller Top 2, the Spicer AutoMate-2, and the Rockwell Synchro Shift (ESS).

Eaton Fuller Top 2

The Eaton Fuller Top 2 uses the control module of an electronically-controlled engine to automatically change the top two gears. It comes in two versions: the Super 10 Top 2 (a 10-speed) and the Super 13 Top 2 (a 13-speed). Both are twin-countershaft nonsynchronized transmissions with AutoRange shifting (no range change lever) and low-inertia technology which disconnects the back box during compound shifts.

Show Overhead OH-106 as you discuss the shifting pattern of the Eaton Fuller Super Ten Top 2.

Shifting Pattern

The Super 10 Top 2 has the same shift pattern as the standard Super 10 (see instructions under Super 10 on p. 7.13) and the Super 13 Top 2 has basically the same change pattern as the Eaton Fuller 13-speed with a few exceptions: Instead of using a range change lever move between ranges, AutoRange does it automatically and the shift pattern is no-repeat. You only have to move the gear lever once through all the positions to get all the gears. With both transmissions,

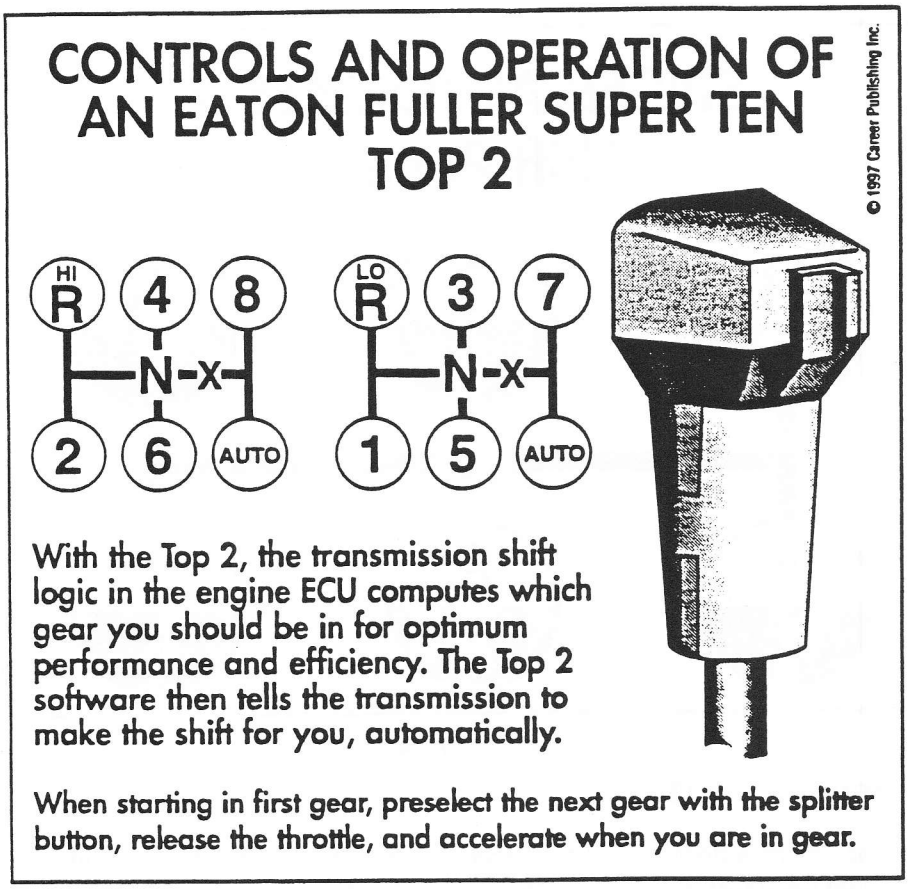


Figure 7-13

the top gear position is marked A. Once the gear lever is in this position, all upshifts and downshifts between the top two gears are automatic.

Emphasize this automatic shifting is the main difference encountered in a semi-automatic transmission.

Shifting Procedure

- Both transmissions are operated as normal nonsynchro transmissions in all gears but the top two.
- Automatic mode can only be engaged when the vehicle is travelling over 40 mph.
- With the Super 10 Top 2, you change normally to 8th, then double clutch and move into the "A" position.
- With the Super 13 Top 2, you shift normally to 11th, then double clutch and move into "A".
- While in the "A" position, the engine and transmission work together to change, up or down, when needed. When a shift point is reached, the engine speed automatically changes to match road speed and the change is made — all without driver input.
- You can delay an upshift by applying more throttle or delay a downshift by easing off the throttle.
- With the engine brake on, the electronic controls automatically extend governed engine speed by 200 rpm to help maintain the lower gear on a downgrade.

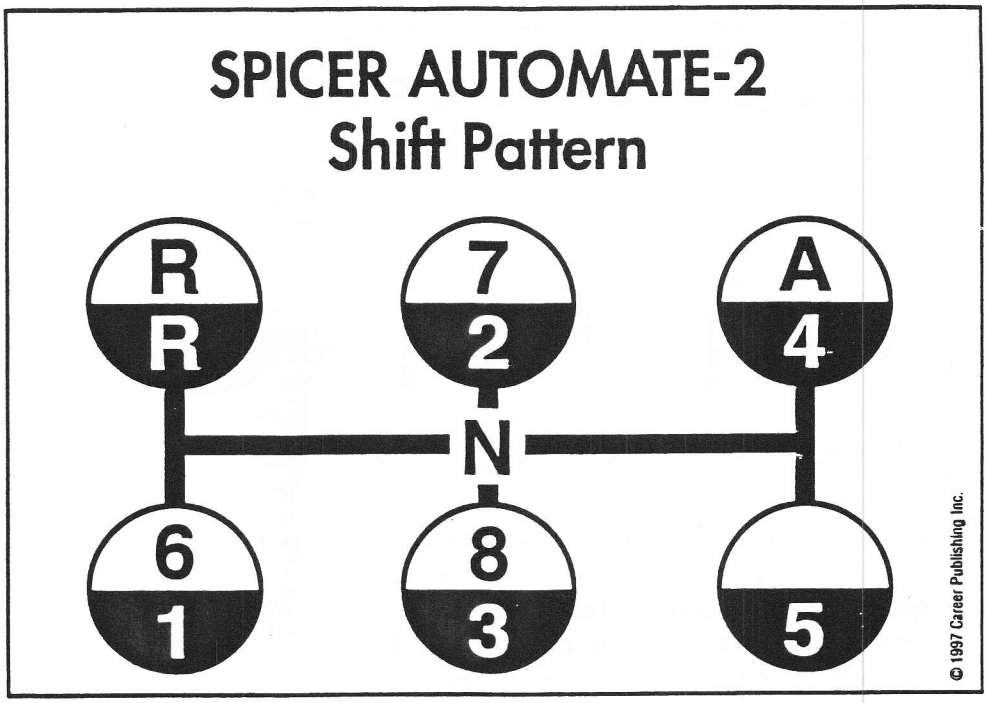


Figure 7-14

Spicer AutoMate-2

The Spicer AutoMate-2 is a 10-speed transmission that uses electronic controls on the transmission to automatically change the top two gears. It is available in direct-drive and overdrive versions.

Show Overhead OH-107 as you discuss the shifting pattern of the Spicer AutoMate-2.

Shifting Pattern

The AutoMate-2 has a familiar 10-speed shifting pattern. First gear is at the bottom left, second is up and to the middle, third straight down, etc. When you reach fifth, you flip the range lever up and come back to the bottom left, then up and the middle for 7th and straight down for 8th. The letter A is where 9th would normally be. Once the lever is moved to that position, the transmission automatically senses road and engine speed and changes up to 10th and back down to 9th when necessary.

Shifting Procedure

- The AutoMate-2 is operated as a normal non-synchro transmission in the bottom eight gears. You first use the clutch and then change up or down by manually matching the road and engine speeds.
- The truck must be travelling over 38 mph to engage the automatic mode.
- When you reach 8th gear, double clutch and move to the A mode.
- No driver input is needed to change gears in 9th and 10th. The transmission automatically senses when a change is needed, adjusts the engine speed (no matter where the driver has the throttle), and makes the change.
- Upshifts in the A mode can be delayed by applying more throttle, and downshifts can be delayed by easing off the throttle.

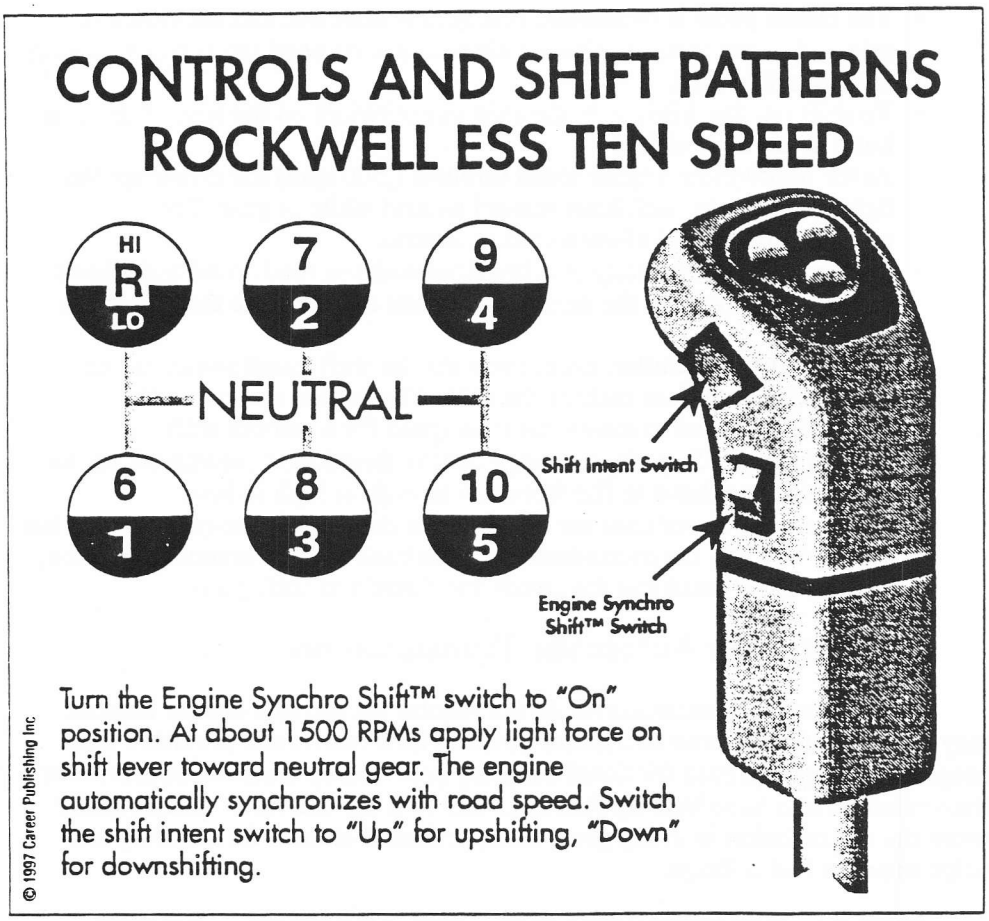


Figure 7-15

Rockwell Engine Synchro Shift (ESS)

Explain how the Rockwell ESS transmission differs from the other transmissions.

The Rockwell Engine Synchro Shift (ESS) uses engine electronic controls to automatically synchronize the engine speed to road speed during shifts in all gears. The system reads the input and output speeds of the transmission, the neutral position of the gear lever, and the position of a special shift intent switch on the side of the gear knob. The engine controller processes the information and sends a message to the fuel control system to automatically increase or decrease the engine speed to synchronize with the road speed during shifting. In essence, it turns a nonsynchro box into a synchronized one. The driver has the option of turning the system off and operating the transmission as a fully manual box.

Shifting Pattern

Show Overhead OH-108 as you discuss the shifting pattern of the Rockwell Engine Synchro Shift.

ESS is fitted to either the Rockwell 9-speed or Rockwell 10-speed manual transmissions. It allows the driver to move through the standard shifting pattern. Both transmissions are nonsynchro boxes with range-change shift patterns. (See Figure 7-15)

Shifting Procedure

- Starting out, the driver turns the ESS switch on the side of the gear knob to the on position.

- The clutch pedal is depressed, first gear is selected, and the clutch is released. After that, the clutch only needs to be used again when coming to a complete stop.
- To shift up, the driver puts the *shift intent* switch on the side of the gear knob in the up position.
- At the appropriate engine speed (around 1,500 rpm) the driver applies light force on the shift lever toward neutral while in gear. The transmission should allow a shift to neutral.
- The engine automatically synchronizes with the road speed and allows the driver to move to the next gear without touching the throttle or the clutch.
- Downshifting is similar, except you put the shift intent switch in the down position before making the shift. The engine automatically increases its speed to match the road speed for a smooth shift.
- While in the ESS mode, the range control function is automated, so the driver does not have to flip from low to high or high to low.
- Any time the driver uses the clutch while the truck is moving or turns the ESS switch off, the transmission reverts back to fully manual operation, and the driver must use the clutch and throttle to shift gears.

Shifting Fully Automatic Transmissions

Explain the differences between the Rockwell ESS transmission and a fully automatic one.

Fully automatic transmissions do not require the use of a clutch. Instead, they use a torque converter to transfer power. These converters provide a fluid coupling instead of a hard frictional coupling provided by a clutch. Some newer transmissions also have lock-up functions that lock the converter mechanically when the transmission in in top gear. This provides a more solid coupling and helps improve fuel mileage.

Many automatic transmissions have a lever to change gears. But some newer models with electronic controls use buttons instead. To select a gear position, the operator pushes a button instead of moving a lever.

Range Selector Positions

Cite examples of on-the-road use of these positions to explain when each of the gears explained in this section is used.

Neutral (N)

Neutral is used for starting, standing, and parking the vehicle. The parking brake should be set when the vehicle is standing or parked. Never coast in neutral because transmission damage and loss of control of the rig can result.

Reverse (R)

Reverse is used to back the rig. There is one gear in the reverse range. The vehicle must be stopped (no movement) before shifting into reverse. A reverse warning signal sounds when the gear is placed in reverse.

2-5 or Drive

This position is used for all normal driving conditions. It starts in 2nd and shifts up to 3rd, 4th, and 5th as you accelerate. Downshifting is automatic as your speed slows.

2-3/2-4 Lower Range

Some road, cargo, or traffic conditions make it desirable to restrict automatic shifting to the lower range. Low ranges provide greater engine braking. When the need for this range is over, shift back to high range (Drive or 2-5).

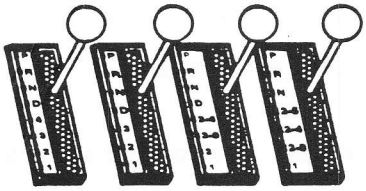
2/Low Gear

This gear is used for pulling through mud and snow or driving up a steep grade. It provides the most engine braking power. The lower ranges (2-3/2-4) will not upshift above the highest gear selected unless the engine governor speed for that gear is exceeded.

1/Creeper Gear

For off-highway use. Provides the greatest traction. You should never make a full power shift from creeper gear to a higher range.

CONTROLS AND SHIFT PROCEDURES FULLY AUTOMATIC TRANSMISSION



Neutral
Use When Starting, Standing, Parking
Reverse
Vehicle Must Be Completely Stopped Before Using
2-5 or Drive
All Normal Driving Conditions
2-3 / 2-4
Lower Range for Load Types, Driving Conditions
2
When Pulling Through Mud, Snow, Up Steep Hills
1
Creeper Gear for Off-Highway Use

Figure 7-16

Show Overhead OH-109 to assist in your explanation.

Upshifting and Downshifting with an Automatic Transmission

Upshifting using the accelerator

- The pressure of the foot on the accelerator pedal influences automatic shifting.
- When the accelerator is fully depressed, the transmission automatically shifts up to the recommended speed of the engine.
- When partly depressed, upshifts occur sooner at a lesser engine speed.
- Either method provides the accurate shift spacing and control needed for maximum performance.

Downshifting

- Occurs automatically
- The transmission prevents downshifting when the engine speed is too high.

SUMMARY OF GOOD SHIFTING HABITS

1. Know the shift pattern of the vehicle.
2. Start the rig in the lowest gear.
3. Use the clutch brake properly.
4. Upshift smoothly.
5. Downshift at the precise point and time required.
6. Use double clutching.
7. Avoid snapping or riding the clutch.
8. Use the tachometer and speedometer to time shifts.
9. Avoid lugging or revving the engine.
10. Do not force the transmission into gear.
11. Avoid overloading the rig.

This is a review of the entire chapter. These are the important points to remember.

Use Overhead OH-99 in your review.

KEY WORDS

Automatic transmission — One that, when set for a certain speed range, will not exceed that speed and the engine automatically shifts through the gears until it reaches that speed.

Manual transmission — One that must be shifted by the driver through the different gears. A clutch must be used.

Non-synchronized transmission — One that does not have thin plates between the gears to assist in shifting. The driver must double-clutch.

Semi-automatic transmission — One that is essentially a manual transmission, but uses electronic controls to automate some of the gear changes.

Synchronized transmission — One that has thin plates between the gears called synchronizers. Allows shifting without double-clutching.

LEARNING ACTIVITIES

True-False Questions

If the statement is true, circle the T. If the statement is false, circle the F.

(T) F 1. The clutch connects and disconnects the engine and transmission. *(p. 7.4)*

T (F) 2. Pushing down on the clutch pedal engages the engine. *(p. 7.4)*

(T) F 3. A standing vehicle requires more power to get it moving than to keep it moving once it is underway. *(p. 7.4)*

(T) F 4. Nonsynchronized transmissions require double clutching. *(p. 7.7)*

(T) F 5. Double clutching enables the driver to control engine rpms and the gear so the gears can be engaged smoothly. *(p. 7.7)*

(T) F 6. Double clutching, though an obvious action, is not the main shifting event. *(p. 7.7)*

(T) F 7. Bringing the teeth of the driving gear and those of the driven gears to the same speed (synchronizing) requires special shifting skills. *(p. 7.7)*

T (F) 8. Nonsynchronized gears can be synchronized easily without double clutching. *(p. 7.7)*

T (F) 9. In double clutching, the driver disengages the clutch after shifting into neutral and accelerates to increase the tooth speed of the driving gear. *(p. 7.8)*

(T) F 10. When a vehicle with a nonsynchronized transmission is rolling in neutral, the driver must hunt, find, or hit a gear. *(p. 7.8)*

(T) F 11. The ability to find the synchronizing rpm under all possible shifting conditions is the major skill necessary in handling a nonsynchronized transmission. *(p. 7.9)*

(T) F 12. Controls differ for the many different transmissions, but all work on the principle of providing power and speed as needed for driving conditions. *(p. 7.9-7.18)*