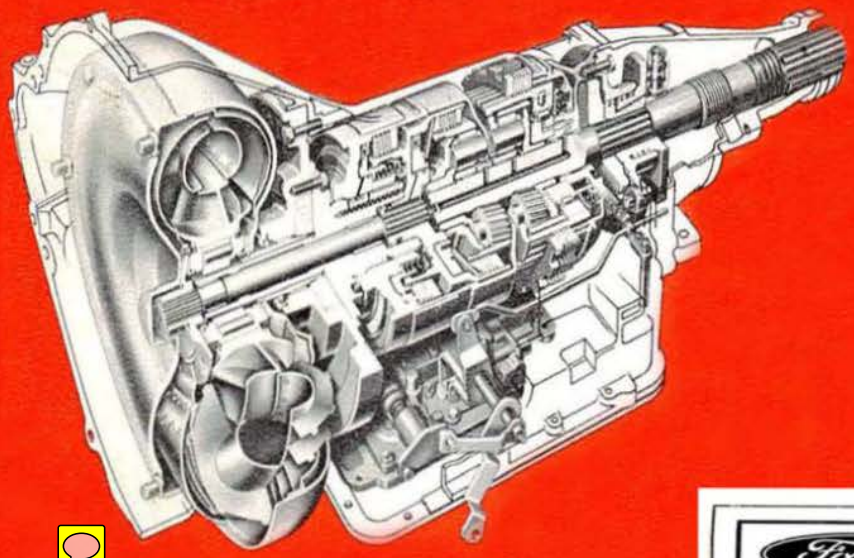
The C6 AUTOMATIC TRANSMISSION

TRAINING HANDBOOK

COURSE 1710-104



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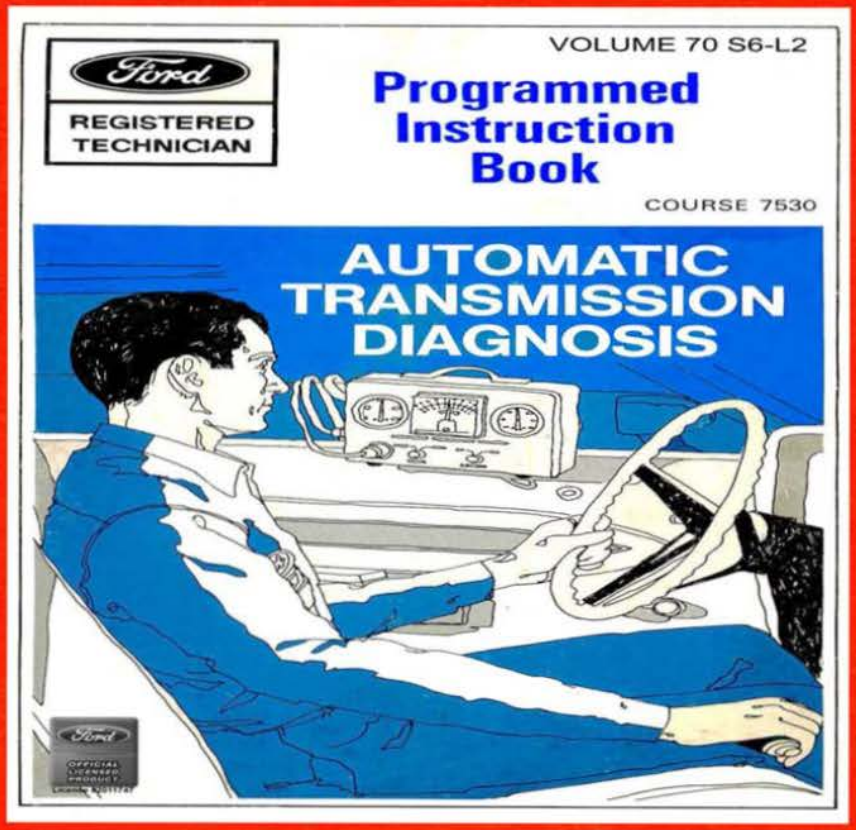

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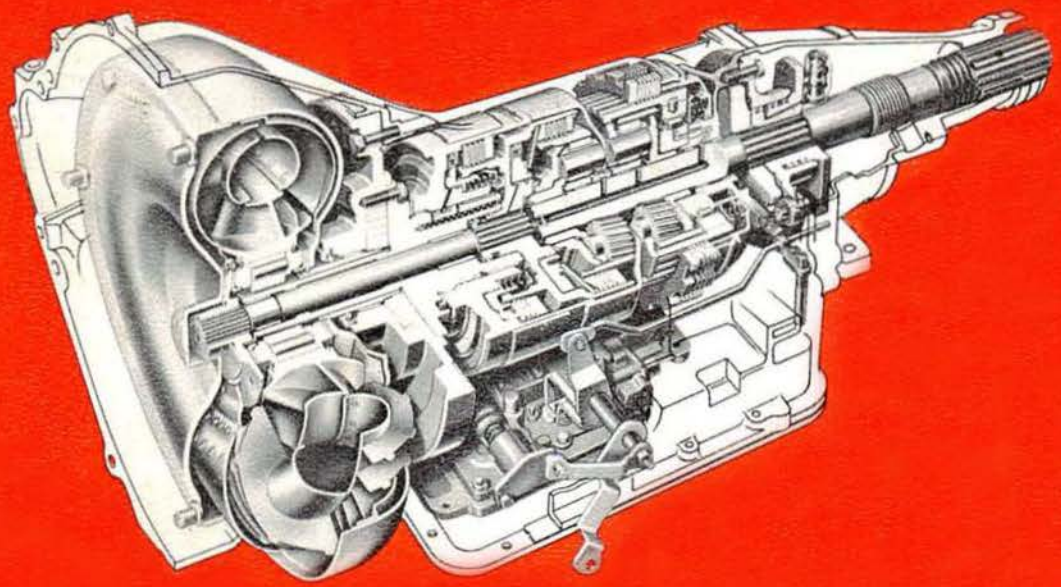

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THE C6 AUTOMATIC TRANSMISSION

Training Handbook

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INTRODUCTION

This handbook has been prepared so that a technician with no knowledge of automatics can learn the C6 operation by reading the following sections and studying the diagrams. There is a glossary of technical terms used in the copy at the end of the book, which can be used for reference during the study.

If you are already an experienced automatic transmission man and understand the operation of automatics well, a quick reading of some sections will do for you. You should put your greatest study emphasis on the control valve section where the most significant changes are. Of course, in any case, be sure to keep this handbook for reference after you finish studying the C6 automatic transmission.

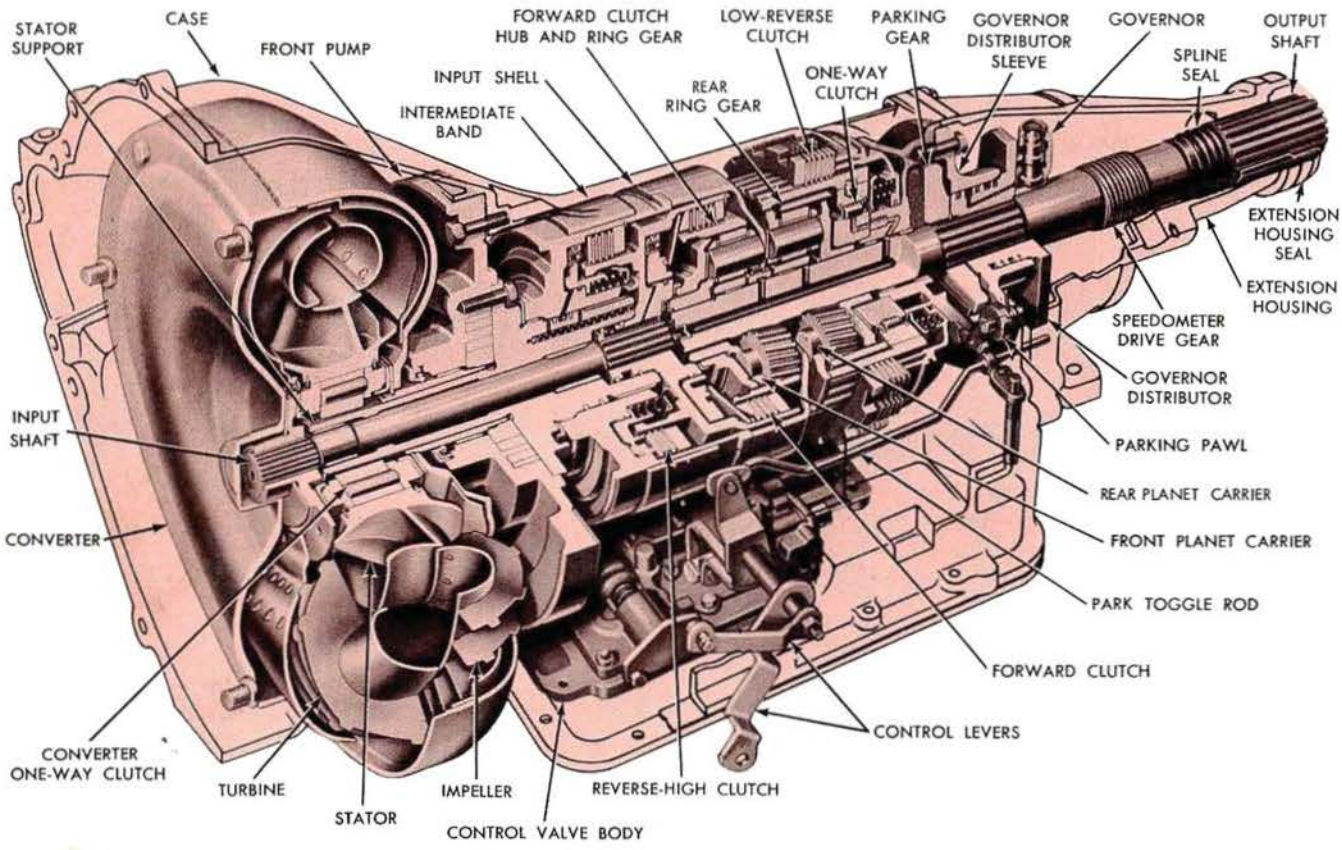
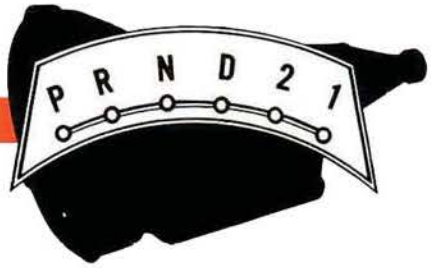


Fig. 1–C6 Transmission

TORQUE CONVERTER



OPERATION

The C6 is a fully automatic three-speed transmission, with the same driving ranges as other Cruise-O-Matics. It consists essentially of a torque converter; a compound planetary gear train controlled by one band, three disc clutches, a one-way clutch, and a hydraulic control system (Fig. 1). It uses the standard Cruise-O-Matic shift selector (Fig. 2) with six positions – "P" Park, "R" Reverse, "N" Neutral, "D" Normal Drive Position, "2" Second Gear Manual, and "1" Low Gear Manual.

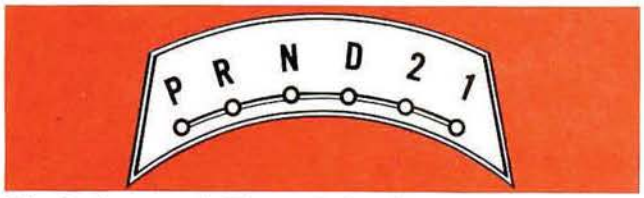


Fig. 2–Automatic Transmission Selector

In the normal driving range (D), the car starts in low gear, with automatic upshifts to second and high as road speed increases. With the throttle closed, the transmission downshifts from high to low at about 10 mph.

In Second Gear Manual (2), the car is in second gear and there is no upshift or downshift.

Manual Low (1) range is designed primarily for engine braking. Starting in this position, the car is in low gear and there is no upshift. If the transmission is in high gear in D and the driver moves the selector lever to 2, a downshift to **second** occurs, and the transmission stays in second down to about 25 mph. Then it downshifts to low.

PARKING PAWL

The transmission gear train is in neutral in both the P and N positions. There is no pressure to any clutch and only the transmission input shaft turns. In park, a pawl engages a parking gear which is splined to the transmission output shaft (Fig. 1) to lock the rear wheels to the transmission main case.

FORCED DOWNSHIFTS

Forced downshifts (kickdown shifts) from high to second gear are possible at speeds as high as 90 mph in D. It is possible to force a downshift to first gear up to 48 mph, depending on engine, axle ratio and tire size.

The carburetor is at full throttle before the accelerator is floor-boarded. Up to full throttle, a "torque demand" downshift to second is possible up to 40 mph. "Manual" downshifts require depressing the accelerator to the wide open throttle position to actuate the downshift valve in the transmission.

TORQUE CONVERTER

The C6 torque converter (Fig. 3) is typical of converters used in other Ford automatics. It consists of an **impeller** or pump, the driving member; a **turbine**, the driven member; and a **stator** or stationary member – all in a welded housing. The impeller forms the rear section of the housing and the converter covers the front section.

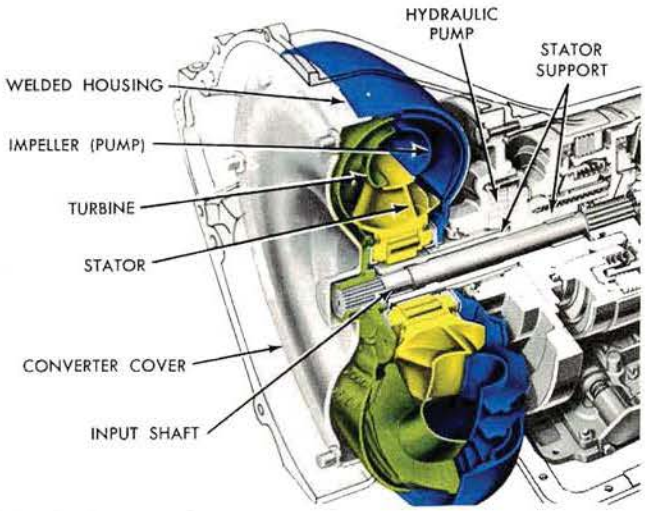


Fig. 3–Torque Converter

STATOR SUPPORT

The converter is supported by the pump housing and by the engine crankshaft. Studs in the cover fasten it to a driving plate attached to the crankshaft. The converter assembly serves as the engine flywheel. The rear hub of the impeller housing pilots in the transmission pump, and flats on the hub drive the pump whenever the engine is turning.

HYDRAULIC CLUTCH

There is no mechanical connection between the impeller and the turbine, which is splined to the transmission input shaft. The converter acts as an

TORQUE CONVERTER

automatic clutch with the engine driving the impeller mechanically, the impeller driving the turbine hydraulically and the turbine driving the gear train mechanically. There is no neutral or disengaged clutch position in the converter. The only neutral is in the gear train.

IMPELLER PUMPS FLUID

The purpose of the impeller is the same as any pump – to put the fluid in motion. Inside the impeller housing (Fig. 4), many curved vanes, along

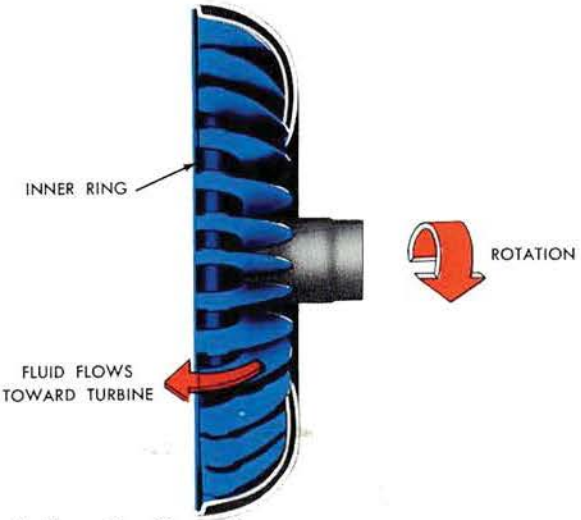


Fig. 4–Impeller Operation

with an inner ring, form passages for the fluid to flow through. The rotating impeller acts very much like a centrifugal pump. Fluid is supplied by the hydraulic control system, and flows into the passages between the vanes. When the impeller turns, the vanes accelerate the fluid and centrifugal force pushes the fluid outward so that it is discharged from openings around the inner ring. The curvature of the impeller vanes directs the fluid toward the turbine, and in the same direction as impeller rotation.

FORCE ON TURBINE

The vanes in the turbine are curved opposite to the impeller, and the impact of the moving fluid on the turbine vanes (Fig. 5) exerts a force that tends to turn the turbine in the same direction as impeller rotation. When this force creates a great enough torque on the transmission input (turbine output) shaft to overcome the resistance to motion, the turbine begins to rotate.

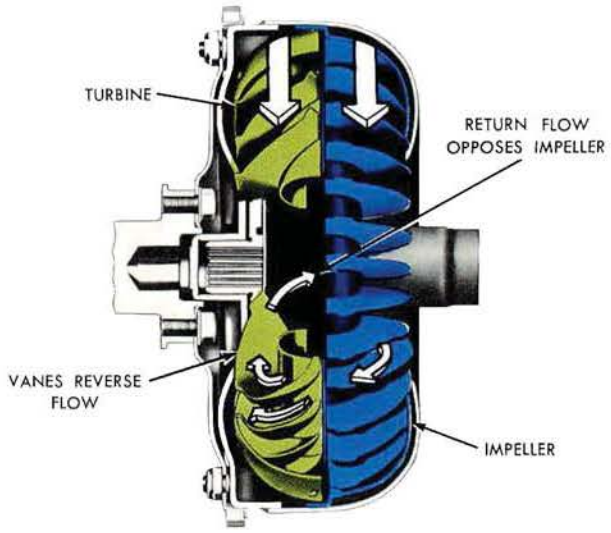


Fig. 5–Fluid Coupling

Now the impeller and turbine are acting as a simple fluid coupling, but we have no torque multiplication yet. To get torque multiplication, we must return the fluid from the turbine to the impeller and accelerate the fluid again to increase its force on the turbine.

REVERSING THE FLOW

To get maximum force on the turbine vanes when the moving fluid strikes them, the vanes are curved to reverse the direction of flow (Fig. 5). Less force would be obtained if the turbine deflected the fluid instead of reversing it. At any **stall** condition, that is, with the transmission in gear and the engine operating, but the turbine standing still, the fluid is reversed by the turbine vanes and pointed back to the impeller. You can see, that without the stator, any momentum left in the fluid after it leaves the turbine would resist the rotation of the impeller.

STATOR AND ONE-WAY CLUTCH

The stator reverses the fluid again (Fig. 6) and returns it to the impeller in the direction of impeller rotation. A one-way clutch prevents the force of this fluid from turning the stator opposite the impeller and turbine.

As the fluid flows from the stator to the impeller, the impeller has another opportunity to accelerate the same fluid, and it does so. The fluid leaves the impeller with perhaps twice the energy it had the first time, and exerts a greater force on the turbine.

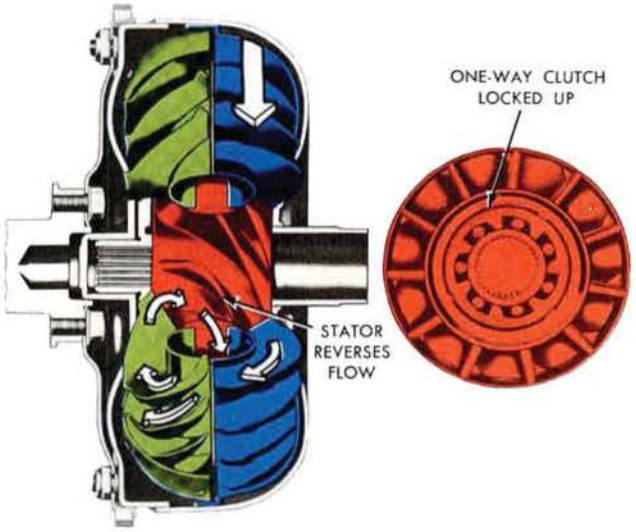


Fig. 6–Torque Multiplication

VORTEX FLOW

We call the flow of fluid through the impeller, to the turbine, to the stator, and back through the impeller, the **vortex flow**. At high impeller speed and low turbine speed, the vortex flow velocity is the sum of the impeller produced velocity, plus the velocity of the fluid returning from the turbine and stator. It is vortex flow that gives us torque multiplication.

TORQUE MULTIPLICATION

By torque multiplication, we mean that there is more torque on the turbine shaft than the engine is putting out – because the vortex fluid is accelerated more than once. Torque multiplication is obtained at the sacrifice of turbine rotation. Actually, it's no different from mechanical advantage which you get from gearing down. You gain torque by sacrificing motion.

Torque multiplication takes place anytime the turbine is turning at less than 9/10 impeller speed. At full stall, the C6 converter produces a 2.1 to 1 torque multiplication. As the turbine speed increases in relation to the impeller, torque multiplication decreases.

ROTARY FLOW

Vortex flow is not the only fluid force trying to turn the turbine. The vortex flow leaving the impeller is not only flowing out of the impeller at high speed, but it is also rotating faster than the turbine. As this rotating fluid strikes the slower turning or stationary turbine, it exerts a turning force against the turbine. This is referred to as the **rotary flow**.

COUPLING PHASE

When the coupling phase is reached – that is, when the turbine speed is about 9/10 impeller speed – there is no longer any torque multiplication. The converter then is simply transmitting engine torque to the gear train.

As the turbine begins to rotate and steadily picks up speed, the vortex flow steadily loses speed because of the increasing centrifugal force acting against the flow through the turbine. The rotating impeller produced a centrifugal force in the fluid which caused it to flow from the center outward. The same centrifugal force is acting in the rotating turbine, trying to prevent the fluid from flowing inward. As the vortex flow slows down, torque multiplication is reduced.

ONE-WAY CLUTCH UNLOCKS

As the turbine catches up with the impeller, the angle at which the fluid leaves the turbine is constantly changing (Fig. 7), due to centrifugal force and to the turbine absorbing more of the energy of the moving fluid. In the coupling phase, the fluid

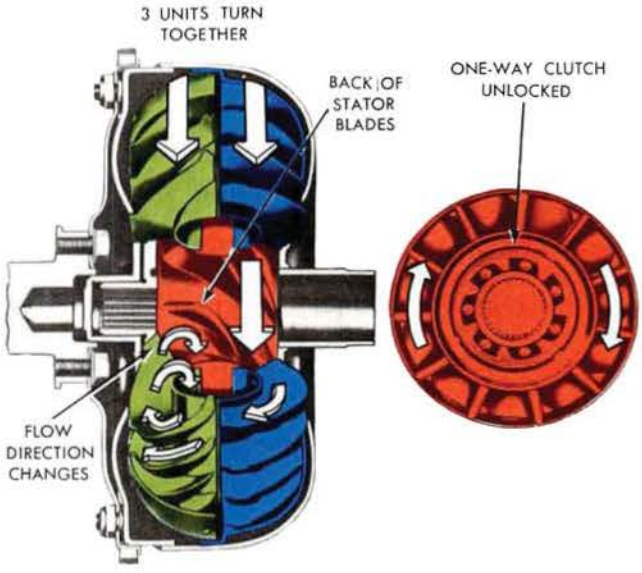


Fig. 7–Coupling Phase

leaving the turbine strikes the **backs** of the stator vanes. The one-way clutch unlocks then and the impeller, turbine and stator turn together.

AUTOMATICALLY ADJUSTS TORQUE

Let's discuss some aspects of the converter that we may have missed. Since vortex flow speed is governed by the difference between impeller and turbine speed, the torque converter automatically adjusts converter output to drive shaft torque requirements.

When the drive shaft torque requirements become greater than the engine output torque, the turbine slows down and causes an increase in vortex flow velocity and thereby, an increase in torque multiplication. This automatic adjustment between torque input and output permits the converter to absorb the shock of sudden ratio changes (gear shifts) in the planetary gearset, especially at the lower road speeds.

If we are driving a C6 Automatic and cruising at 20 mph in high gear, then suddenly depress the accelerator pedal to less than a full-throttle downshift position, we hear the engine speed increase rapidly, while the road speed will increase somewhat slower. In this case, it is not entirely accurate to say that the converter is slipping. (There is, of course, some slippage in the converter at all times.) It is more accurate, in this instance, to say that the torque converter has automatically adjusted itself to produce a greater engine torque multiplication to increase drive shaft speed. Torque multiplication can occur in the converter only when the turbine rotates at less than 9/10 impeller speed.

When the converter is in multiplication, the recirculating vortex flow causes heat to be generated. To keep the fluid from overheating, a constant flow of fluid into and out of the converter is maintained. The fluid coming out of the converter is forced through a cooler located in the radiator tank.

In summary, the torque converter automatically performs the following functions:

Acts as an automatic clutch. At engine idle speed, it permits the engine to operate and the car to stand still.

Adjusts, within its design limits, engine input torque to drive shaft torque requirements.

Absorbs the shock of gear ratio changes (shifts).

PLANETARY GEAR SYSTEM

The C6 transmission uses a compound planetary gearset with one band, three friction clutches and a one-way clutch to provide the three speeds forward and one reverse. Before we see exactly how this system is put together and operates, let's review the operating principles of planetary gears.

PLANETARY GEAR PRINCIPLES

THE SUN AND THE PLANETS

A simple planetary gearset (Fig. 8) consists of an internal gear or **ring gear**, a **sun gear**, and a number of **planet pinions**. The planet pinions are mounted on shafts or pins on a **planet pinion carrier**. Thus, the pinions can rotate on their own axes, and also can revolve about the sun gear of the pinion carrier is free to turn. The gearset and its parts get their name from their parallel with the sun and the planets.

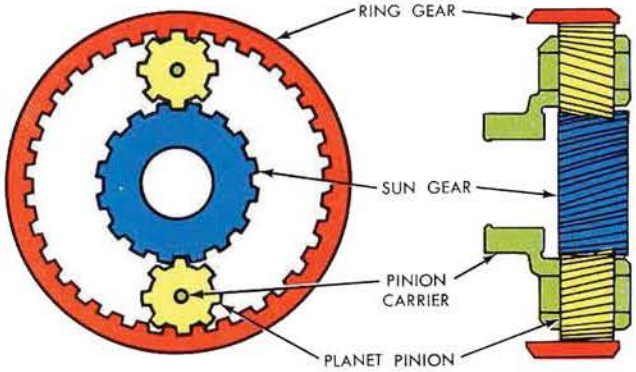
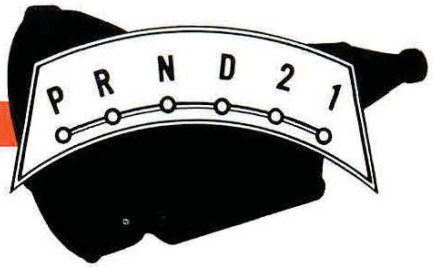


Fig. 8–Planetary Gearset

ALWAYS IN MESH

One thing that's immediately evident about this gearset is that the gears are always in mesh. You can also see that unlike the spur gears in a manual-shift transmission, planetary gears are not subject to high side loads when they're under torque. Also, we have many more teeth working at any time in a planetary gearset. What this all adds up to is that the driver doesn't have to be nervous about doing a lot driving in the lower gears – such as in stop and sta traffic or using first gear for down-hill braking.

PLANETARY GEAR SYSTEM



GEAR COMBINATIONS

With a single planetary gearset, we have a number of possible gear combinations. These are:

DIRECT DRIVE
REDUCTION
REVERSE
NEUTRAL
OVERDRIVE

We'll encounter all these combinations in the C6 except overdrive. As a matter of interest, though, with all the reduction we get in the C6 transmission and with a high-speed rear axle, we actually get all the benefits of overdrive along with automatic shift. At cruising speed in high gear, the engine is turning at about the same rpm it would with overdrive.

DIRECT DRIVE

Direct drive is accomplished in the planetary gearset by locking any two members together (Fig. 9). Then, no matter which member is driven, the

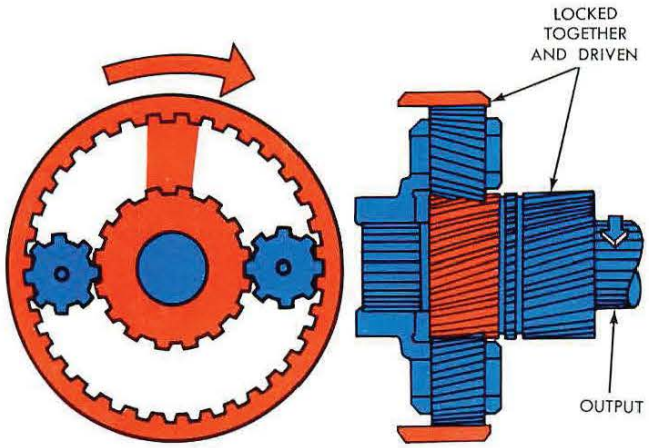


Fig. 9–Direct Drive

complete set turns as a unit. If, for example, our pinion carrier is splined to an output shaft, and the ring gear and sun gear are locked together and driven by an input shaft, we have a direct drive through the gearset, with output through the pinion carrier.

REDUCTION

One way to obtain reduction in a planetary gearset is to hold the sun gear and drive the ring gear with the planet carrier as the output member (Fig. 10). Rotation of the ring gear makes the planet pinions

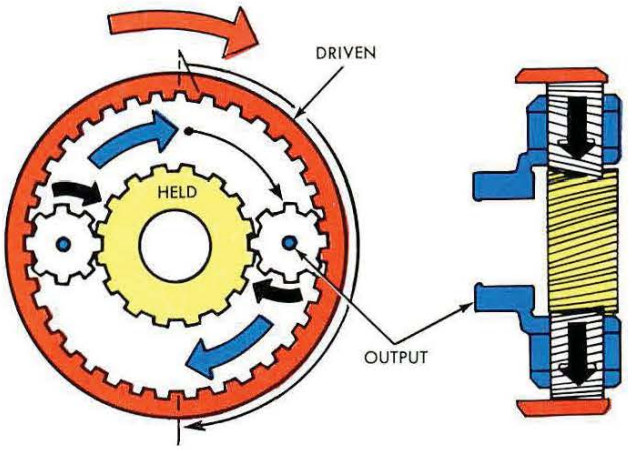


Fig. 10–Reduction

"walk" around the sun gear, in the same direction the ring gear is turning, but not as fast. Input torque is increased or multiplied since output speed is less than input.

REVERSE

In a simple planetary gearset, we get a reverse output anytime we hold the planet pinion carrier and drive another member. The planet pinions just turn on their axes then and act as idler gears – reversing the direction of the input.

For instance, if we drive the sun gear clockwise with the pinion carrier held (Fig. 11), the pinions turn counterclockwise and cause the ring gear also to turn counterclockwise.

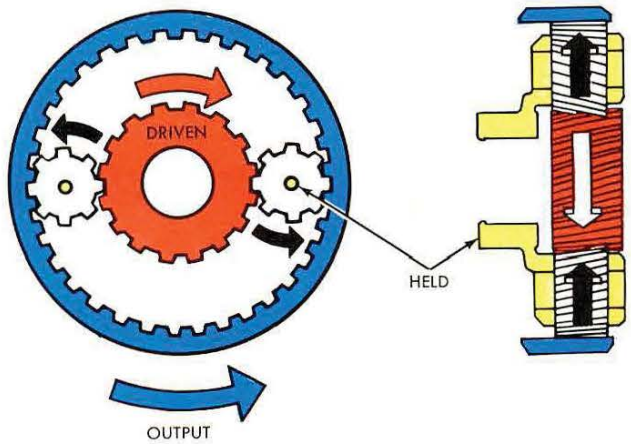


Fig. 11–Reverse

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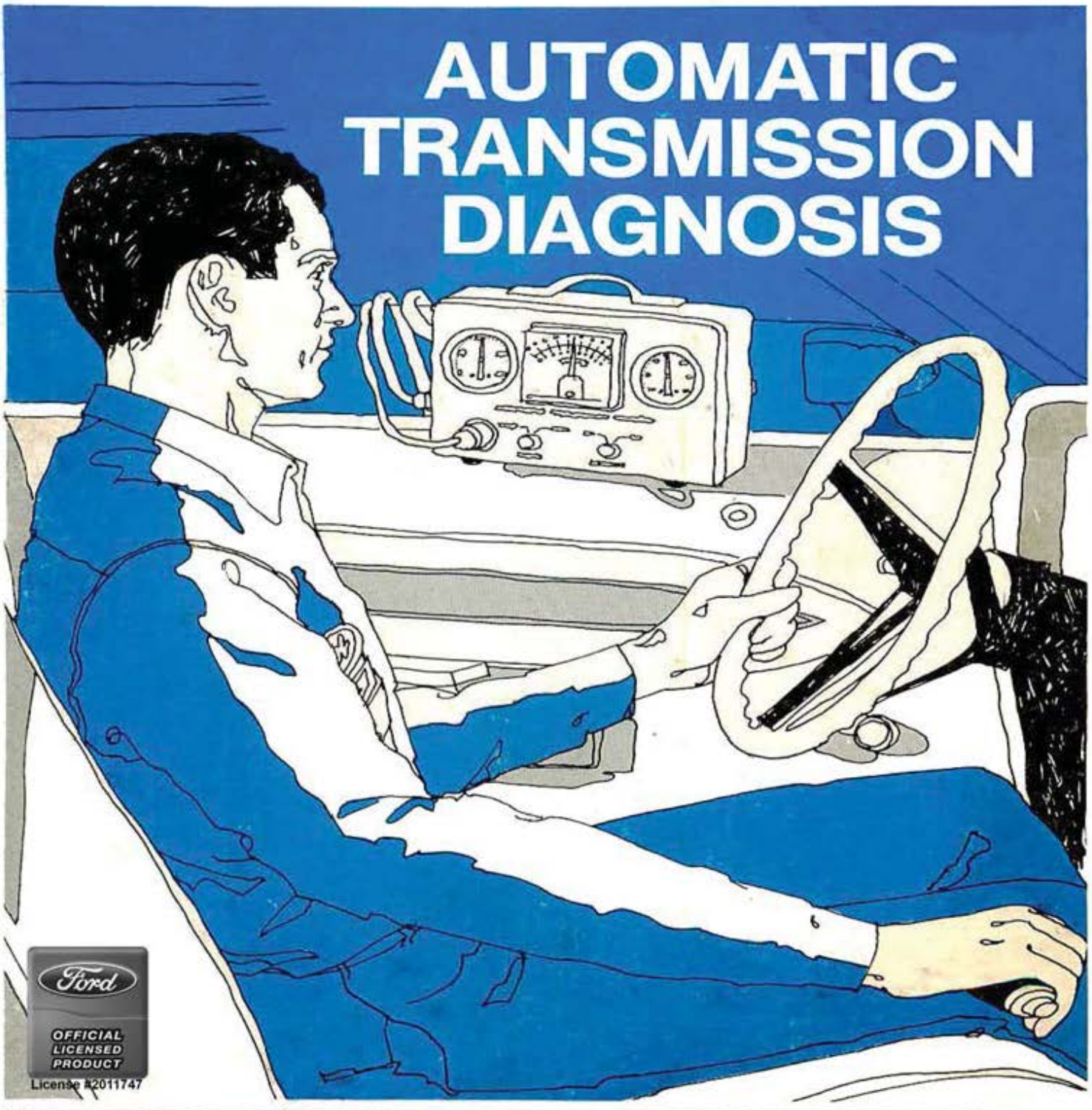

AUTOMATIC TRANSMISSION DIAGNOSIS

FORD DIVISION
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OBJECTIVES

This programmed instruction book is designed to teach you to diagnose the various troubles that may occur in Ford automatic transmissions. As you complete this course, you should be able to:

1. Locate specific procedures in the appropriate shop manuals for checks and adjustments that are part of the diagnosis procedure.

2. Use the Automatic Transmission Diagnosis Guide to record your test findings and diagnose the failure cause.

3. Follow the appropriate "road map" Diagnosis Charts in locating the causes of specific complaints.

4. Properly connect necessary test equipment used in the diagnosis procedures.

5. Perform and correctly interpret fluid checks, shift speed checks, pressure tests, governor checks, fluid cooler flow checks and stall tests.

6. Locate the origins of external leakage from the transmission or other components near the transmission, which cause oil to be deposited on the transmission.

7. Determine what specific repair procedure is required to correct the diagnosed problem and restore proper operation.

It is assumed that, prior to studying this book, you already have the technical knowledge and skills needed to repair and adjust the automatic transmission components used on Ford cars.

NOW PLEASE READ THE COURSE INTRODUCTION ON PAGE D FOLLOWING.

INTRODUCTION

This programmed instruction book is divided into a number of small units or lessons designed to help you learn quickly and easily. The lessons are presented in the sequence of the normal automatic transmission diagnosis procedure.

Using this method, you will build your knowledge step by step. Be certain that you understand each lesson before proceeding to the following lesson. There is no need to hurry. You can put the book aside at any time and later resume your study where you left off.

PROGRAMMED INSTRUCTION FORMAT

To help you learn more effectively, the material is presented in a programmed instruction format. You will be asked a number of questions as your study proceeds. Each time you encounter a question, select the best answer and **mark your answer on the answer sheet you'll find at the back of the book.** Then, turn to the page the answer directs you to, and check your answer. When you turn to the page, read **only** the material that corresponds to your specific answer at that point, as identified by the question number and the answer letter. For example, 15B would designate that you chose answer B to question 15. From then on, simply follow the instructions the book gives you for reviewing material as necessary and proceeding to the next lesson.

The answer sheet is for **your** use only; it will not be checked or examined by anyone else. The course material is not designed to see how well you score, but to help you learn the material effectively.

Now, before you begin the course:

1. **Remove the answer sheet from the back of the book.**

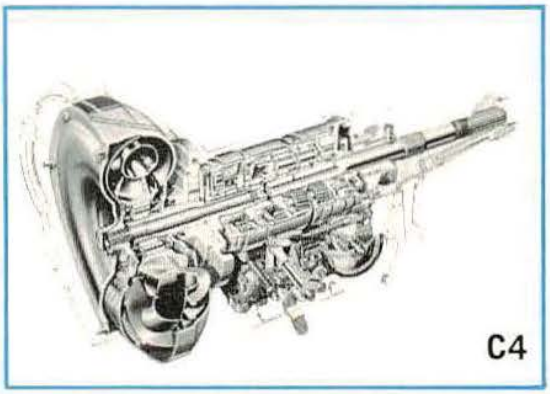
2. **Work the "sample lesson" on page E following.**

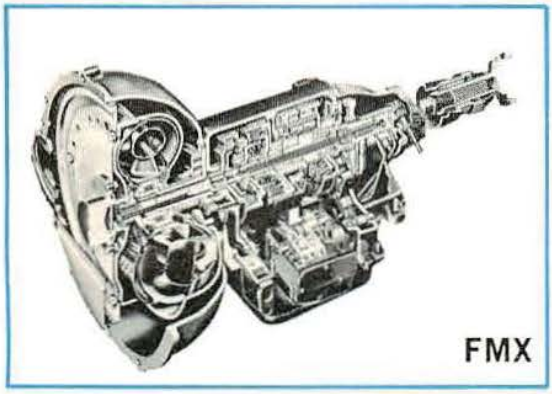
SAMPLE LESSON

In this course book, you will deal with three basic automatic transmission designs: the FMX, the C4 and the C6.

The FMX design goes farthest back into Ford history, having evolved through several stages of refinement from the first Fordomatic and Merc-omatic design. The C4 transmission was an entirely new design when released in 1964 for use with lower torque engines. Model C6, with the same design gear train as the C4, was released in 1966 for use with higher torque engines.

AFTER YOU STUDY THE FOLLOWING MATERIAL, PLEASE RESPOND TO THE FOLLOWING QUESTION BY MARKING "A" OR "B" ON YOUR ANSWER SHEET OPPOSITE "SAMPLE LESSON."





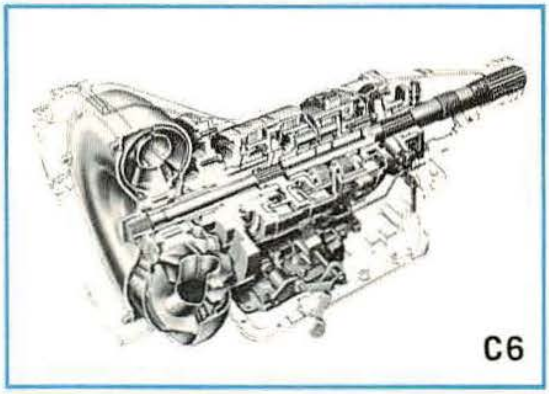


FIGURE A — FORD AUTOMATIC TRANSMISSIONS

SAMPLE Question:

Which of the following are most similar in design:

A. FMX and C4 . . . turn to page F.

B. C4 and C6 . . . turn to page 4.

SAMPLE Answer A:

You said that the FMX and C4 are most similar in design from the choices given. While there are similarities, these units have entirely different gear trains and hydraulic control systems. However, the C4 and C6 are very close in design as the lesson and pictures show.

Turn back to page E and compare the pictures in Figure A; then choose answer B.

NOW PROCEED TO LESSON 1 ON PAGE 3.

PART I

DIAGNOSIS GUIDE

NATL SVC 10 - 67 FD-1863-AT

AUTOMATIC TRANSMISSION DIAGNOSIS GUIDE (FOR ALL FORD PASSENGER VEHICLES & LIGHT TRUCKS)

General: This form must be completely filled in throughout the steps required to diagnose the problem and attached to Forms 1863 covering the correction of transmission malfunction complaints (e.g., erratic shifting, slippage during shifts, failure to shift, harsh and delayed shifts, noise, etc.). It is not necessary to complete this form on complaints involving external leaks.

Transmission Model _____ Transmission Date Code/or Serial No. _____

R.O. No. _____ Axle Ratio _____ Tester _____

DIAGNOSIS PROCEDURE

Following steps will provide complete data necessary to perform an accurate diagnosis of transmission difficulties.
(Note: Items 1, 2, 3 and 5 also should have been performed during pre-delivery)

1. Check transmission fluid level ☐ Full ☐ Overfilled ☐ Low
2. Engine idle: (RPM)

ENGINE (CID)	RECORD SPECIFICATION	THERMACTOR	AS RECEIVED	SET TO
		☐ YES ☐ NO		

3. Check kickdown and manual linkage ☐ O.K. ☐ Other (Explain) _____
4. Perform stall test to check engine performance and for any sign of transmission slippage. ☐ Performed.
   After each stall test move selector lever to neutral with engine running at 1000 RPM to cool the transmission.
   Caution: Release throttle immediately if slippage is indicated.

STALL SPEED DATA

Selector Lever Position	Specified Engine RPM	Record Actual Engine RPM	DIAGNOSIS	
			Above Specified Engine RPM	Below Specified Engine RPM
R			1. Transmission slippage 2. Clutches or bands not holding	1. Poor engine performance, such as need for tune-up 2. Converter one way clutch slipping or improperly installed
D				
2				
1				

Note: Stall test with transmission at operating temperature. DO NOT hold throttle open over five seconds during tests.

5. Drive the car in each range, and through all shifts, including forced downshifts, observing any irregularities of transmission performance.

6. Shift Test

Throttle Opening	Range	Shift	Shift Points (MPH) Record Actual	Shift Points (MPH) Record Spec.
Minimum (Above 18" Vacuum)	D	1-2	— —	— —
	D	2-3	— —	— —
	D	3-1	— —	— —
	1	2-1	— —	— —
To Detent (Torque Demand)	D	1-2	— —	— —
	D	2-3	— —	— —
	D	3-2	— —	— —
Thru Detent (WOT)	D	1-2	— —	— —
	D	2-3	— —	— —
	D	3-2	— —	— —
	D	2-1 or 3-1	— —	— —

7. Control Pressure Test – Transmission fluid must be normal operating temperatures.

Engine RPM	Manifold Vacuum Ins. Hg	Throttle	Range	PSI Record Actual	PSI Record Spec.
Idle	Above 18	Closed	P	— —	— —
			N	— —	— —
			D	— —	— —
			2	— —	— —
			1	— —	— —
			R	— —	— —
As Req.	10	As Req.	D,2,1	— —	— —
As Req.	1	As Req.	D	— —	— —
			2	— —	— —
			1	— —	— —
			R	— —	— —

NOTE: After road test you should know the following items:

- CONTROL PRESSURE – Does the transmission have the CORRECT CONTROL PRESSURE? YES ☐ NO ☐
- CONTROL VALVES – Beyond the manual valve are all the CONTROL VALVES FUNCTIONING? YES ☐ NO ☐
- HYDRAULIC CIRCUITS – If the first two items check out good, then check the transmission's internal hydraulic circuits that are beyond the VALVE BODY. These circuits must be checked during transmission disassembly.

8. TORQUE CONVERTER AND OIL COOLER (Where applicable)
   - Record torque converter turbine and stator end play. TURBINE _____ STATOR _____
   - Was torque converter flushed with a mechanical cleaner? YES ☐ NO ☐
   - Was oil cooler flushed with a mechanical cleaner? YES ☐ NO ☐

9. The problem was diagnosed to be: _____

10. If it was necessary to disassemble the transmission, record the actual problem found: _____

LESSON 1

USE OF THE AUTOMATIC TRANSMISSION DIAGNOSIS GUIDE FD-1863-AT

Diagnosing of automatic transmission problems is not as complicated as it appears if the recommended procedures are followed. The only way to be certain of simplifying diagnosis is to follow a definite, proven procedure. Taking shortcuts, or assuming that someone else has performed certain critical tests, checks or adjustments, is bound to cause you trouble.

The general order of a systematic diagnosis procedure is shown on the Automatic Transmission Diagnosis Guide FD-1863-AT shown at the left (page 2). This guide is keyed to the "road map" diagnosis charts for specific complaints, which you will encounter further along in the handbook, and also in the Diagnosis Manual.

First, though, the course will take you through the procedures required to complete the Automatic Transmission Diagnosis Guide as called for by the complaint.

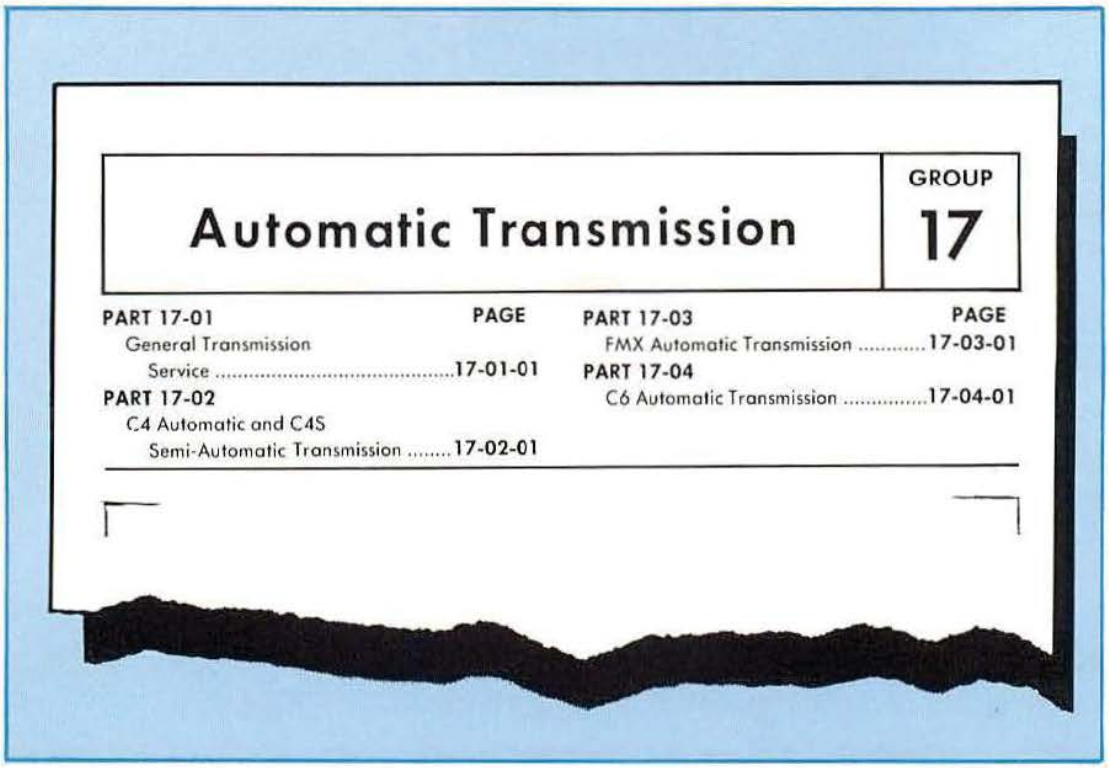
For this first lesson, read through and familiarize yourself with the contents of the guide. Then answer the following question:

Question No. 1:

The Automatic Transmission Diagnosis Guide (FD-1863-AT) is used to cover the correction of automatic transmission complaints on:

A. Passenger cars only . . . turn to page 8 (bottom).

B. Passenger cars and light trucks . . . turn to page 10 (bottom).



Automatic Transmission

GROUP 17

PART 17-01	PAGE	PART 17-03	PAGE
General Transmission Service	17-01-01	FMX Automatic Transmission	17-03-01
PART 17-02		PART 17-04	
C4 Automatic and C4S Semi-Automatic Transmission	17-02-01	C6 Automatic Transmission	17-04-01

FIGURE 1 — CUTOUT OF AUTOMATIC TRANSMISSION SERVICE INDEX

SAMPLE Answer B:

Right! As Figure A shows and as the lesson tells you, the C4 and C6 transmissions have basically identical gear trains. Also, the hydraulic controls are very similar. The FMX uses an entirely different gear train and control system.

Please turn to page 3 now and begin the course with Lesson 1.

LESSON 2

LOCATION OF SERVICE PROCEDURES

One of the delights of the automatic transmission diagnosis procedure is that it includes certain specific service or adjustment procedures, which in themselves may correct the complaint. We shall not repeat all of these procedures in this handbook, since most of them are detailed in your Shop Manuals for the specific car or truck.

For instance, the cut-out at the top of page 4 (Figure 1 at left) shows the beginning of the typical Shop Manual section on automatic transmission service. Notice that there are three basic types of automatic transmission given coverage — (1) C4 and C4S, (2) FMX and (3) C6. The General Transmission Service Section in the Shop Manual covers testing; common adjustments and repairs; and cleaning and inspection for all three types. The other sections then cover specific procedures for the individual types.

In addition, there are methods for various linkage adjustments and other procedures in the Engine Section of the Shop Manual. We'll get to those in Part III of this course.

Question No. 2:

Automatic transmission service and adjustment procedures not covered in this book are found in:

A. General Transmission Section of the Shop Manual . . . turn to page 12 (bottom).

B. Engine Section of the Shop Manual . . . turn to page 6 (bottom).

Answer No. 3A:

Not so! If the transmission fluid is cold, you cannot get an accurate reading of its level.

The engine should be operated at fast idle (about 1200 rpm) until the fluid reaches its NORMAL OPERATING TEMPERATURE.

Go to page 9 and reread the material.

Answer No. 2A:

No! The automatic transmission procedures are not found in the Engine Section; though linkage adjustment procedures which you will have to perform are there.

Go back to page 5; reread the lesson; and try again.

PART II

FLUID CHECKS