



*1st Printing  
August, 2011*

# INTRODUCTION

## DODGE RAM 68RFE

Beginning at the start of production for the 2006 model year Chrysler Corporation has introduced a new version of the 5/45RFE transmission and is found in Dodge Ram trucks. The new 68RFE designation tells us that this new unit has **6** forward speeds, a relative torque rating of **8**, is for **Rear** drive vehicles and is **Fully Electronic** controlled. Refer to Figure 1. The 68RFE transmission is a sophisticated, multi-range, electronically controlled transmission which combines optimized gear ratios for responsive performance, improved efficiency features, and low NVH (Noise, Vibration, Harshness). Other features include driver adaptive shifting and three, 6 pinion, planetary gear sets to provide wide ratio capability with precise ratio steps for optimum drivability. There have been several engineering changes in the geartrain to improve durability and reliability.

The primary mechanical components consist of the following:

- Larger Bell Housing, different bolt pattern and a cutout to accommodate diesel applications.
- Three multiple disc driving clutch packs.
- Three multiple disc brake clutch packs.
- Three 6 pinion planetary gear sets (Totally New Design).
- Dual stage hydraulic oil pump.
- Valve Body and TRS/Solenoid pack.

No part of any ATSG publication may be reproduced, stored in any retrieval system or transmitted in any form or by any means, including but not limited to electronic, mechanical, photocopying, recording or otherwise, without **written** permission of Automatic Transmission Service Group. This includes all text illustrations, tables and charts.

*The information and part numbers contained in this booklet have been carefully compiled from industry sources known for their reliability, but ATSG does not guarantee its accuracy.*

*Copyright © ATSG 2011*

**WAYNE COLONNA**  
PRESIDENT

**DALE ENGLAND**  
FIELD SERVICE CONSULTANT

**PETER LUBAN**  
TECHNICAL CONSULTANT

**JON GLATSTEIN**  
TECHNICAL CONSULTANT

**GERALD CAMPBELL**  
TECHNICAL CONSULTANT

**GREG CATANZARO**  
TECHNICAL CONSULTANT

**JIM DIAL**  
TECHNICAL CONSULTANT

**ED KRUSE**  
TECHNICAL CONSULTANT

**GREGORY LIPNICK**  
TECHNICAL CONSULTANT

**DAVID CHALKER**  
TECHNICAL CONSULTANT

**AUTOMATIC TRANSMISSION SERVICE GROUP**  
**18635 S.W. 107 AVENUE**  
**CUTLER BAY, FLORIDA 33157**  
**(305) 670-4161**



## DODGE RAM 68RFE

# INDEX

<b>IDENTIFICATION TAG INFORMATION &amp; FLUID REQUIREMENTS</b> .....	3
<b>COMPONENT LOCATIONS AND CLUTCH APPLICATION CHART</b> .....	4
<b>SOLENOID OPERATION AND APPLICATION CHART</b> .....	5
<b>ELECTRICAL AND LIMP-IN MODE OPERATION</b> .....	6
<b>SOLENOID DESCRIPTION</b> .....	7
<b>WIRE SCHEMATIC</b> .....	11
<b>CASE CONNECTOR TERMINAL IDENTIFICATION</b> .....	12
<b>CONTROLLER LOCATION</b> .....	13
<b>CONTROLLER CONNECTOR TERMINAL IDENTIFICATION</b> .....	14
<b>CLUTCH VOLUME INDEX INFORMATION</b> .....	16
<b>AIR PRESSURE TESTS</b> .....	18
<b>EXTERNAL SENSOR LOCATIONS</b> .....	19
<b>TRANSMISSION RANGE SENSOR/SOLENOID BODY</b> .....	20
<b>DIAGNOSTIC TROUBLE CODES</b> .....	22
<b>CHECKBALL LOCATIONS</b> .....	25
<b>PRESSURE TAP LOCATIONS AND TEST PROCEDURES</b> .....	26
<b>ACCELERATOR PEDAL POSITION SENSOR INFORMATION, 6.7L DIESEL</b> .....	28
<b>CONVERTER CLUTCH OPERATION</b> .....	29
<b>CASE &amp; OIL PUMP PASSAGE IDENTIFICATION</b> .....	30
<b>TRANSMISSION DISASSEMBLY</b> .....	32
<b>COMPONENT REBUILD SECTION</b>	
<b>EXTENSION HOUSING</b> .....	44
<b>TRANSMISSION CASE ASSEMBLY</b> .....	44
<b>LOW/REVERSE CLUTCH HOUSING ASSEMBLY</b> .....	46
<b>2-4 CLUTCH RETAINER ASSEMBLY</b> .....	53
<b>GEAR TRAIN ASSEMBLY</b> .....	56
<b>INPUT CLUTCH HOUSING ASSEMBLY</b> .....	60
<b>OIL PUMP ASSEMBLY</b> .....	72
<b>VALVE BODY ASSEMBLY</b> .....	78
<b>TRANSMISSION FINAL ASSEMBLY</b> .....	90
<b>SETTING REAR TRANSMISSION END-PLAY</b> .....	95
<b>SETTING FRONT TRANSMISSION END-PLAY</b> .....	97
<b>CLEARANCE SPECIFICATIONS AND BOLT IDENTIFICATION</b> .....	105
<b>THRUST BEARING IDENTIFICATION</b> .....	106
<b>TORQUE SPECIFICATIONS</b> .....	108
<b>SPECIAL TOOLS</b> .....	109
<b>HEAVY DUTY LOW ROLLER CLUTCH</b> .....	112

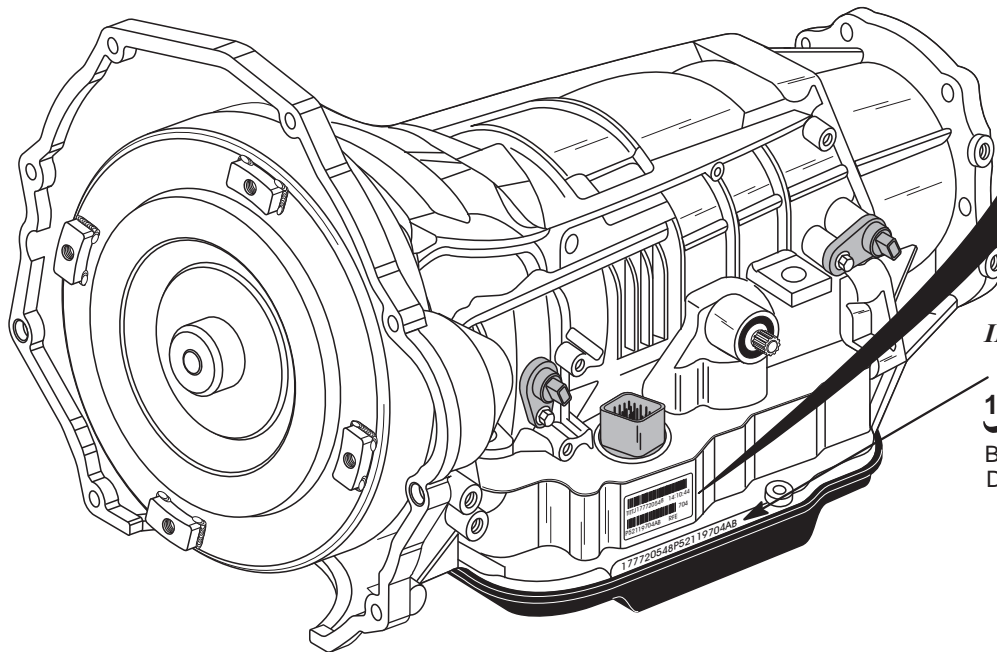
**CAUTION:** ATSG service manuals are intended for use by professional, qualified technicians. Attempting repairs or service without the proper training, tools and equipment could cause injury to you or others and damage to the vehicle that may cause it not to operate properly.

**AUTOMATIC TRANSMISSION SERVICE GROUP**  
**18635 S.W. 107 AVENUE**  
**CUTLER BAY, FLORIDA 33157**  
**(305) 670-4161**

Copyright © ATSG 2011

## **DODGE RAM TRUCKS 68RFE TRANSMISSION** **FOUND BEHIND 5.9L (L6) and 6.7L Diesel Engines**

*Bar Code Label*



*ID Numbers Also Etched Into  
Case Pan Rail Here*

<b>1777</b>	<b>20548</b>	<b>P52119704AB</b>
<b>Build Date</b>	<b>Serial Number</b>	<b>Part Number</b>

**6 = Six Forward Speeds**

**8 = Relative Torque Capacity**

**R = Rear Wheel Drive**

**FE = Fully Electronic**

**Fluid Requirements**  
**"Mopar® ATF+4"**

Copyright © 2011 ATSG

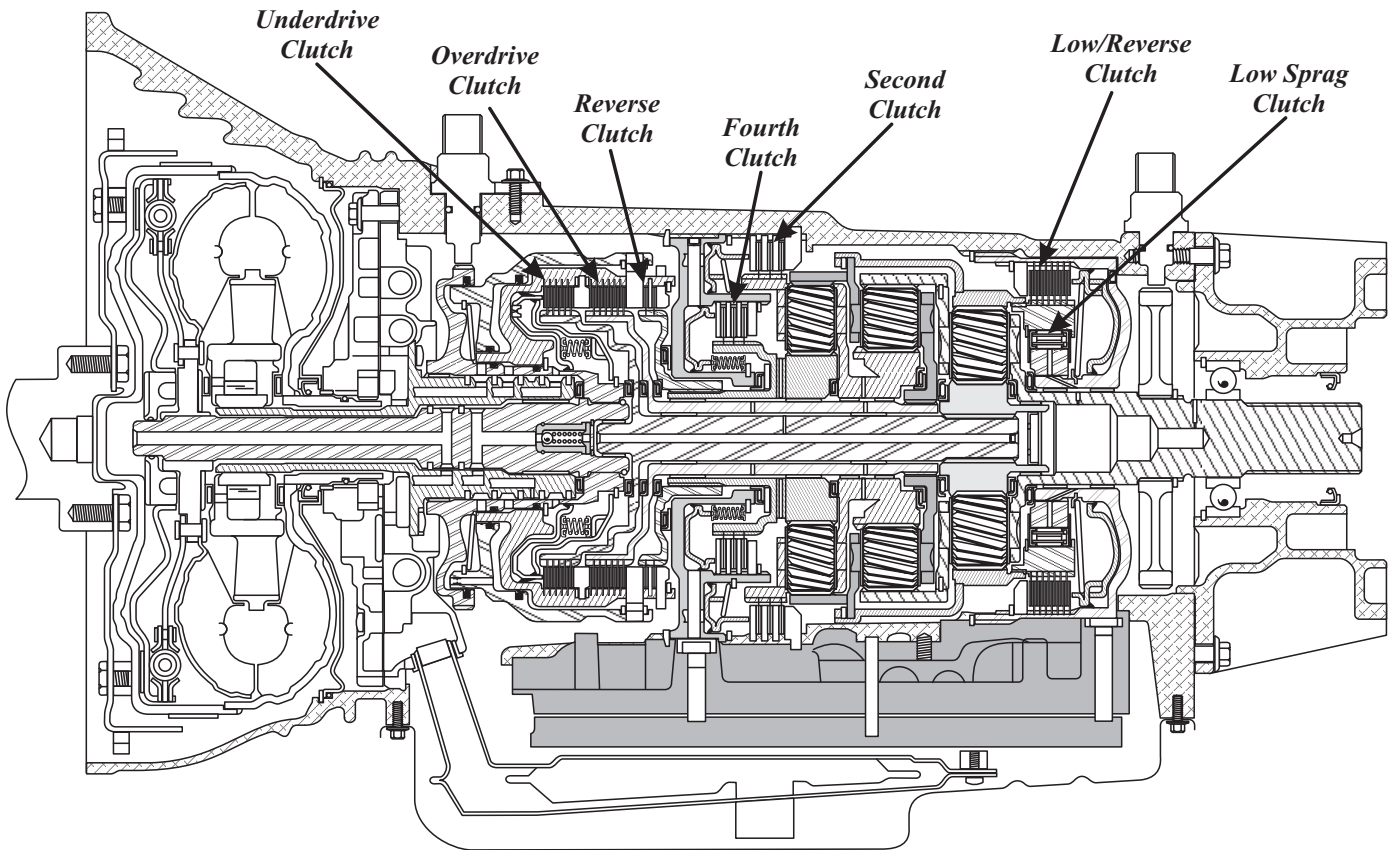
Figure 1

## CLUTCH APPLICATION CHART

SELECTOR POSITION	LO/REV CLUTCH	UD CLUTCH	SECOND CLUTCH	OD CLUTCH	FOURTH CLUTCH	REVERSE CLUTCH	LOW SPRAG CLUTCH	GEAR RATIO
PARK	ON							
REVERSE	ON					ON		4.44:1
NEUTRAL	ON							
OD-1ST	ON*	ON					HOLD	3.23:1
OD-2ND		ON	ON					1.83:1
OD-3RD		ON			ON			1.41:1
OD-4TH		ON		ON				1.00:1
OD-5TH				ON	ON			0.81:1
OD-6TH			ON	ON				0.62:1
OD-LIMP		ON		ON				1.00:1
(2)-1ST	ON*	ON					HOLD	3.23:1
(2)-2ND		ON	ON					1.83:1
(2)-LIMP		ON	ON					1.83:1
(1)-1ST	ON	ON					HOLD	3.23:1

\* L/R Clutch is on only with the output shaft speed below 150 RPM.

## COMPONENT LOCATIONS



Copyright © 2011 ATSG

Figure 2

## MECHANICAL OPERATION

The operation of the 68RFE is very similar to the Chrysler 45RFE. Drive range provides reduction 1st, 2nd, and 3rd gear, direct 4th gear and overdrive 5th and 6th gears. The shift into 5th and 6th gear occurs only after the transmission has completed the shift into 4th gear. Upshifts into 5th and 6th gear will be delayed when the fluid temperature is below 4.5°C (40°F) or above 115°C (240°F). The Input Clutch Housing retains the "single-sided" underdrive clutch, "single-sided" overdrive clutch and the reverse clutch. It is set up almost identical to the 41TE transaxle, except much larger. The 68RFE also contains separate holding clutches, such as the 2nd clutch, 4th clutch and the "single-sided" low/reverse clutch. This unit also uses one freewheel device called the low sprag.

To achieve its different gear ratios, the 68RFE applies different combinations of two clutch packs at a time, as shown in Figure 2. In Park and Neutral, only the low/reverse clutch is applied. Refer to the chart in Figure 2 for the clutches that are applied for each shift lever (gear) position.

Another feature of the 68RFE is the three planetary gear sets, as shown in Figure 2, that are all equipped with 6 pinion carriers to accommodate the Diesel engine. These planetary gear sets also provide a deeper 1st and reverse ratio. All gear ratios are also shown in the chart in Figure 2.

## SOLENOID OPERATION

Solenoids are used to control the L/R, 2C, 4C, UD and OD friction elements. The Reverse clutch is controlled by the manual valve in the valve body and line pressure. The Multi-Select solenoid is used primarily to provide 3rd gear and reverse "limp-in" operation. The TCM energizes or operates the solenoids individually by grounding the return wire of the solenoid as necessary. When a solenoid is energized, a fluid passage is opened or closed (vented or applied), depending on its default operating state. The result is an apply or release of a friction element. Refer to the chart in Figure 3.

<b>SOLENOID APPLICATION CHART</b>							
	N.V.	N.A.	N.V.	N.V.	N.V.	N.A.	N.V.
SELECTOR POSITION	LR/CC SOLENOID	UD SOLENOID	OD SOLENOID	2nd CLUT SOLENOID	4th CLUT SOLENOID	Multi-Select SOLENOID	Line Pressure SOLENOID
Park/Neutral	ON					ON	Modulating
Park/Neutral	ON					ON	Modulating
REVERSE	ON					***OFF	Modulating
OD-1ST	*ON	ON				ON	Modulating
OD-2ND	**	ON		ON		ON	Modulating
OD-3RD	**	ON			ON	ON	Modulating
OD-4TH	**	ON	ON			OFF	Modulating
OD-5TH	**		ON		ON	OFF	Modulating
OD-6TH	**		ON	ON		ON	Modulating
(1)-1ST Or Autostick	ON	ON				ON	Modulating
FAILSAFE	OFF	OFF	OFF	OFF	OFF	OFF	OFF
<p>* L/R Clutch is on only with the output shaft speed below 150 RPM.</p> <p>**Modulating (EMCC) if the Converter Clutch has been signaled.</p> <p>***Off Below 8 MPH, On Above 8 MPH.</p> <p>N.V. = Normally Vented N.A. = Normally Applied</p> <p>Copyright © 2011 ATSG</p>							

Figure 3



**ELECTRICAL OPERATION****Transmission Control Module (TCM)**

Vehicles equipped with the 68RFE and a 6.7L Diesel engine use a Transmission Control Module (TCM) housed in the New Generation Controller (NGC) utilizing only the C1 and C4 connectors. The TCM controls *all* of the transmission functions. The controller is located at the rear of the engine compartment, near the right inner fender, as shown in Figure 12. The Powertrain Control Module (PCM) *does not* control the transmission. The electronic components of the 68RFE transmission consist of various sensors and switches as input information to the TCM, that the TCM uses to determine the appropriate gear ratio and shift schedule points. There is also the associated wiring, fuses, relays, connectors, splices and grounds for the transmission to function as designed. A complete transmission wiring schematic has been provided for you in Figure 10.

The final output from the TCM is to the six shift solenoids and the line pressure control solenoid located in the Solenoid Body/Transmission Range Sensor assembly and bolted on the valve body as shown in Figure 9. The solenoids in this transmission are unique in that some are normally vented and some are normally applied and this is also illustrated in Figure 9. The TCM also communicates with other control modules, such as the PCM, and the New Generation Controller (NGC) modules currently use PCI or CAN C bus.

The TCM receives power from two sources, fused battery power to pin 18 (C4 connector) and fused ignition switch input to pin 30 (C1 connector). The TCM also has several grounds to complete its electrical circuit, as shown in Figure 10.

**ADAPTIVE LEARNING**

The 68RFE transmission uses an "Adaptive Learning" feature which allows the TCM to modify the clutch apply rate to maintain consistent shift quality. This is done based on the amount of wear on the friction elements. The TCM then adjusts the duty cycle of the shift solenoids to achieve the smoothest possible upshifts and downshifts. The TCM adjusts the "Clutch Volume Index" when a shift change takes place to optimize clutch to clutch timing. Clutch Volume Index is described on Page 16, along with proper clutch volumes and clutch clearances for the 68RFE transmission shown in Figure 15.

**LIMP-IN MODE OPERATION**

The TCM has the ability to monitor all transmission related electrical components and if it detects a problem, takes appropriate action, and most of the time results in the TCM setting a Diagnostic Trouble Code (DTC). Whether this results in MIL illumination, or Limp-in Mode operation, depends on the type of DTC that was set.

If the TCM determines that transmission damage may result from the DTC type that was set, the TCM will shut off the ground signal to the transmission control relay which will shut off all power to the transmission and the vehicle will be in Limp-in Mode Operation.

When in Limp-in Mode Operation, with the shift lever in the "Drive" position the transmission will be in 4th gear, and if the shift lever is moved to "2" or "L" position the transmission will be in 2nd gear. This will allow the driver to manually shift the transmission to Limp home.

**Note: Vehicles equipped with Electronic Range Select (ERS) do not provide 2nd gear limp-in, because the shift lever has no "2" or "1" shift lever positions.**

The hydraulic control system design, without any electronic assist, provides the 68RFE transmission with PARK, REVERSE, NEUTRAL, and FOURTH gears based solely on driver selection. This design allows the vehicle to be driven in "limp-in" mode (4th gear) in the event of a total electronic control system failure, or a situation that the TCM recognizes as potentially damaging to the transmission (DTC Stored).

## INPUTS TO THE TCM

**Input and Output Shaft Speed Sensors** - are located on the left side of the transmission and are illustrated in Figure 5. The input shaft speed sensor reads input shaft speed off of a tone wheel on the input clutch housing. As the teeth of the tone wheel pass the sensor coil, an AC voltage is generated and sent to the TCM. The TCM interprets this information as input shaft rpm.

The output speed sensor generates an AC signal in a similar fashion, though its coil is excited by rotation of the parking gear teeth. The TCM interprets this information as output shaft rpm.

The TCM compares the input and output speed signals to determine the following:

- Transmission gear ratio.
- Speed ratio error detection.
- Clutch Volume Index calculation.
- Torque Converter Clutch slippage.

Both speed sensors are the same and will interchange. New speed sensors, when checked for resistance, read 535 ohms at room temperature.

**Pressure Switches** - are located inside the solenoid and pressure switch assembly and are only serviced by replacing the complete solenoid/TRS assembly. The TCM relies on five pressure switches to monitor pressure in the Low/Rev, 2nd Clutch, 4th Clutch, Underdrive, and Overdrive hydraulic circuits. The primary function of these switches is to help the TCM detect when clutch circuit hydraulic failures occur. The switches close at 23 psi and open at 11 psi, and indicate whether or not pressure exists. The switches are continuously monitored by the TCM for the proper states (Open or Closed) in each gear, shown in the chart in Figure 4.

<b>68RFE PRESSURE SWITCH CHART</b>					
	Low/Rev	2nd Clut	4th Clut	Underdrive	Overdrive
Park/Neut	Closed	Open	Open	Open	Open
Reverse	Open	Open	Open	Open	Open
First	Closed*	Open	Open	Closed	Open
Second	Open	Closed	Open	Closed	Open
Third	Open	Open	Closed	Closed	Open
Fourth	Open	Open	Open	Closed	Closed
Fifth	Open	Open	Closed	Open	Closed
Sixth	Open	Closed	Open	Closed	Closed

\* L/R is closed if output speed is below 150 RPM in Drive and Manual 2.  
L/R is open in Manual 1.

Copyright © 2011 ATSG

Figure 4

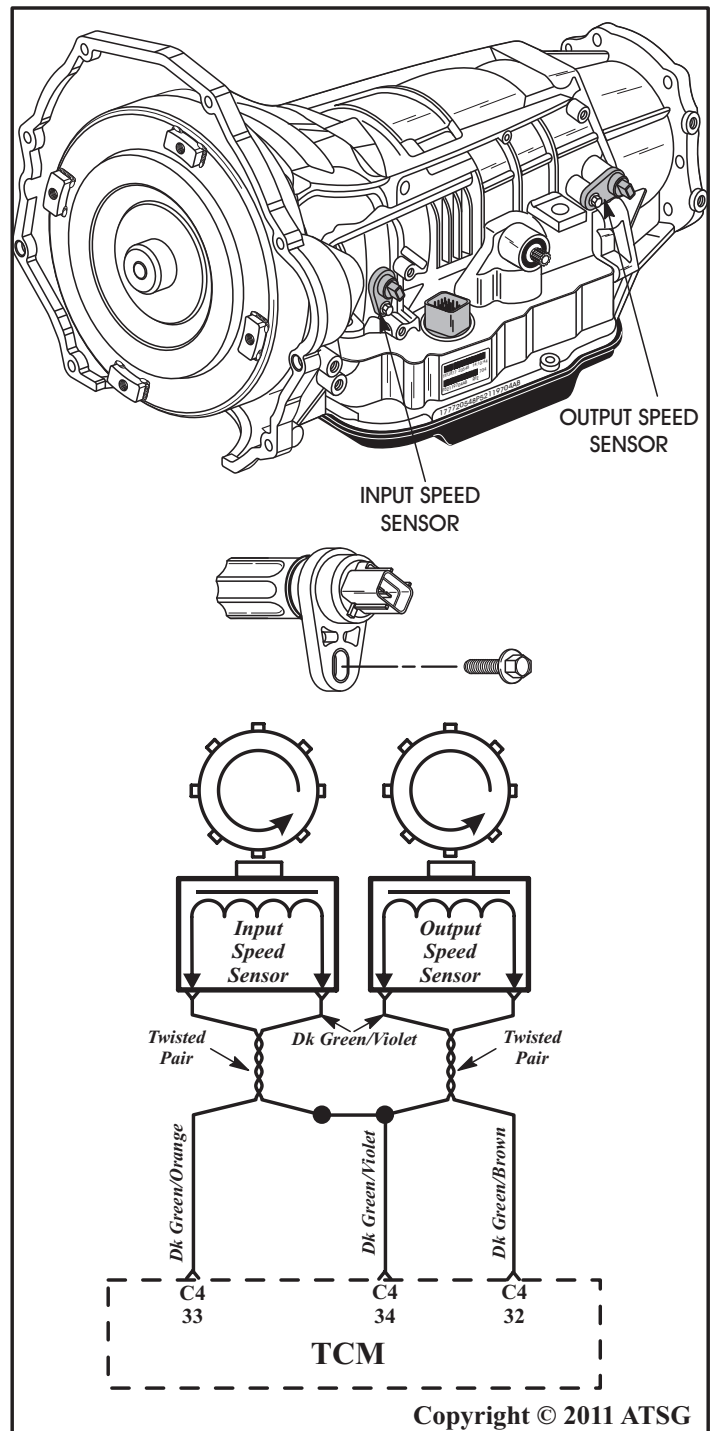


Figure 5

**Inputs To The TCM**  
Continued on Page 8

## INPUTS TO THE TCM (CONT'D)

**Tow/Haul & Auto-6 Electronic Range Select (ERS) Switches** - are located in the manual shift lever, as shown in Figure 6. The switches are momentary contact devices that signal the TCM to toggle current status of the Tow/Haul function and adjust the ERS maximum allowed gear range. At key on, normal operation is provided. Pressing the switch enables Tow/Haul mode and the Tow/Haul lamp will be illuminated. In Tow/Haul mode, 4-5 upshifts are delayed. Shifts into 5th and 6th gear are still allowed under steady cruise conditions. Pressing the switch a second time restores normal operation.

The Electronic Range Select (ERS), if equipped, allows the selection of the desired top gear, when the selector lever is in the D (Drive) position. For example, if ERS 4th is selected, the transmission will never shift above 4th gear, but can down shift into 3rd, 2nd or 1st when needed.

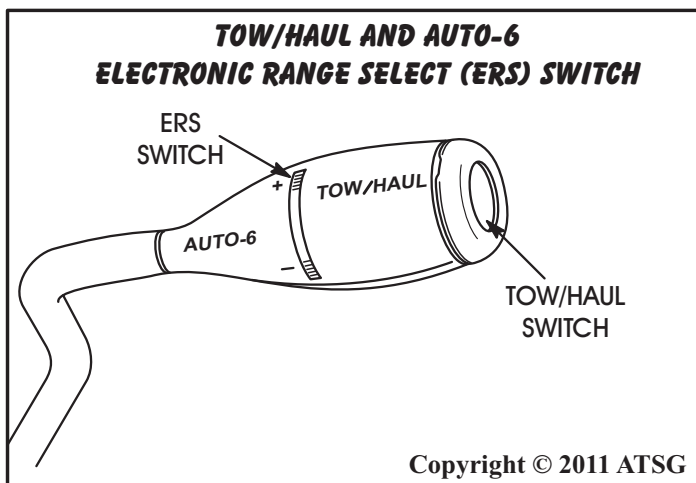


Figure 6

**Transmission Range Sensor (TRS)** - communicates the manual shift lever position to the TCM with a combination of open and closed switches. Each manual shift lever position has an assigned combination of switch states (open/closed) that the TCM receives from four sense circuits. The TCM interprets this information and determines the appropriate transmission gear position and shift schedule. Transmission Range Sensor is an integral part of Solenoid Pack/TRS body and serviced only as an assembly. Checking the TRS for proper operation is shown on Page 20 and 21.

**Line Pressure Sensor** - is located on the right rear of transmission, as shown in Figure 7, and supplies the TCM with line pressure information. The line pressure sensor operates much like a throttle position sensor.

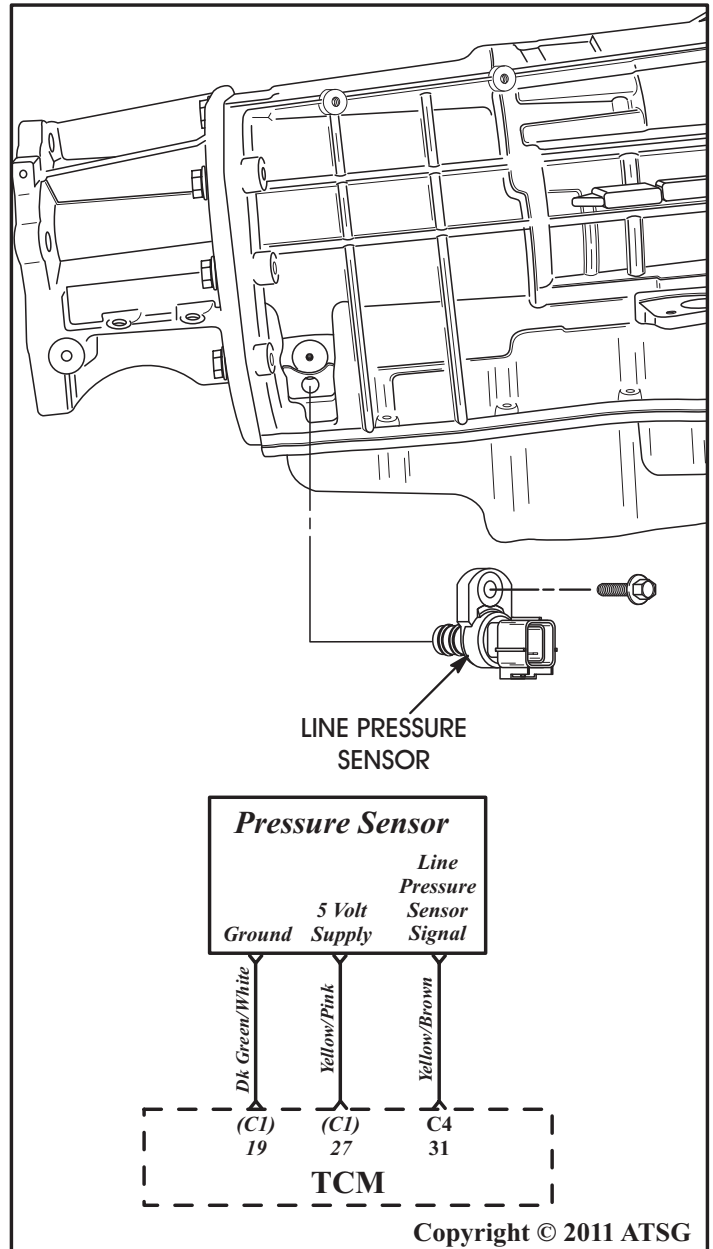


Figure 7

**Transmission Fluid Temp Sensor** - is located in the Solenoid Pack/Transmission Range Sensor and is a thermister that the TCM uses to monitor transmission fluid temperature. The TFT is an integral part of Solenoid Pack/TRS body and serviced only as an assembly.



## OUTPUTS FROM THE TCM

**Transmission Control Relay** - is located in the Integrated Power Distribution Module (IPDM), as shown in Figure 8, and receives a ground signal from terminal (C1) 18 at the TCM to close the relay. Refer to the wiring schematic in Figure 10.

**Underdrive Solenoid** - is *normally applied* and controls oil to the Underdrive Clutch in 1st, 2nd, 3rd, and 4th gears of the transmission.

**Overdrive Solenoid** - is *normally vented* and controls oil to the Overdrive Clutch in 4th, 5th, and 6th gears in the transmission.

**4th Clutch Solenoid** - is *normally vented* and controls oil to the 4th clutch in 3rd and 5th gears in the transmission.

**2nd Clutch Solenoid** - is *normally vented* and controls oil to the 2nd clutch in 2nd and 6th gears in the transmission.

**Low/Reverse Solenoid** - is *normally vented* and is used to apply the Low/Reverse clutch in 1st gear from Park or Neutral, or a coast down to 1st gear. This solenoid also controls oil pressure for the converter clutch engagement based on switch valve position.

**Multi-Select Solenoid** - is *normally applied* and controls the Overdrive Clutch in 4th gear Limp-in, and the Low/Reverse clutch for reverse block. This solenoid is Off below 8 MPH, On above 8 MPH.

**Line Pressure Solenoid** - is *normally vented* and is used to control all oil pressures in the transmission.

**Note:** Refer to Page 20 for a solenoid resistance chart for all solenoids.

## DIAGNOSIS AND SERVICE INFORMATION

You have been provided with the 23-way case connector pin cavity identification and pin function in Figure 11. The 38-way Diesel NGC/TCM connector pin cavity identification and pin function is shown in Figure 13 and 14. A complete transmission wiring schematic is provided in Figure 10, and transmission control relay location in the power distribution center is shown in Figure 9.

Special tools that might be needed are illustrated on Page 26 and 27, along with the identification of the pressure taps that are available on the main valve body. Air pressure test passage identification is provided for you in Figure 17.

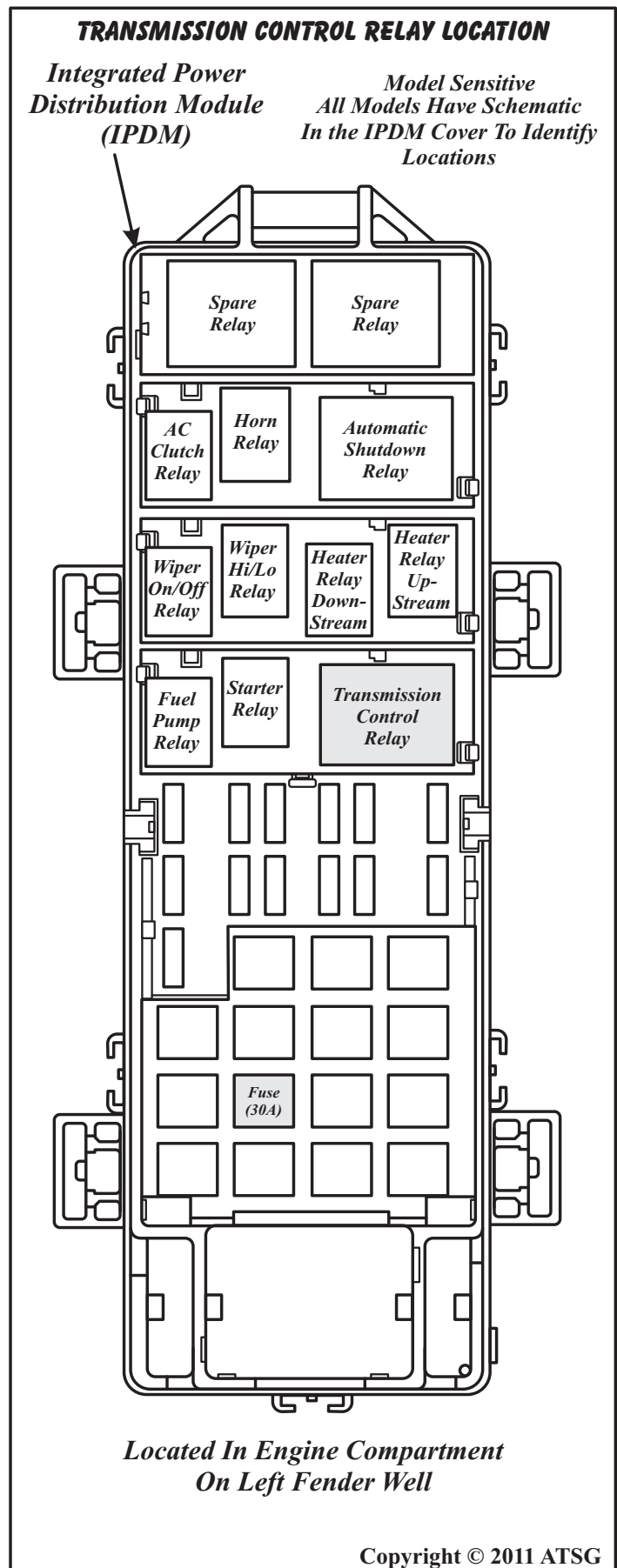
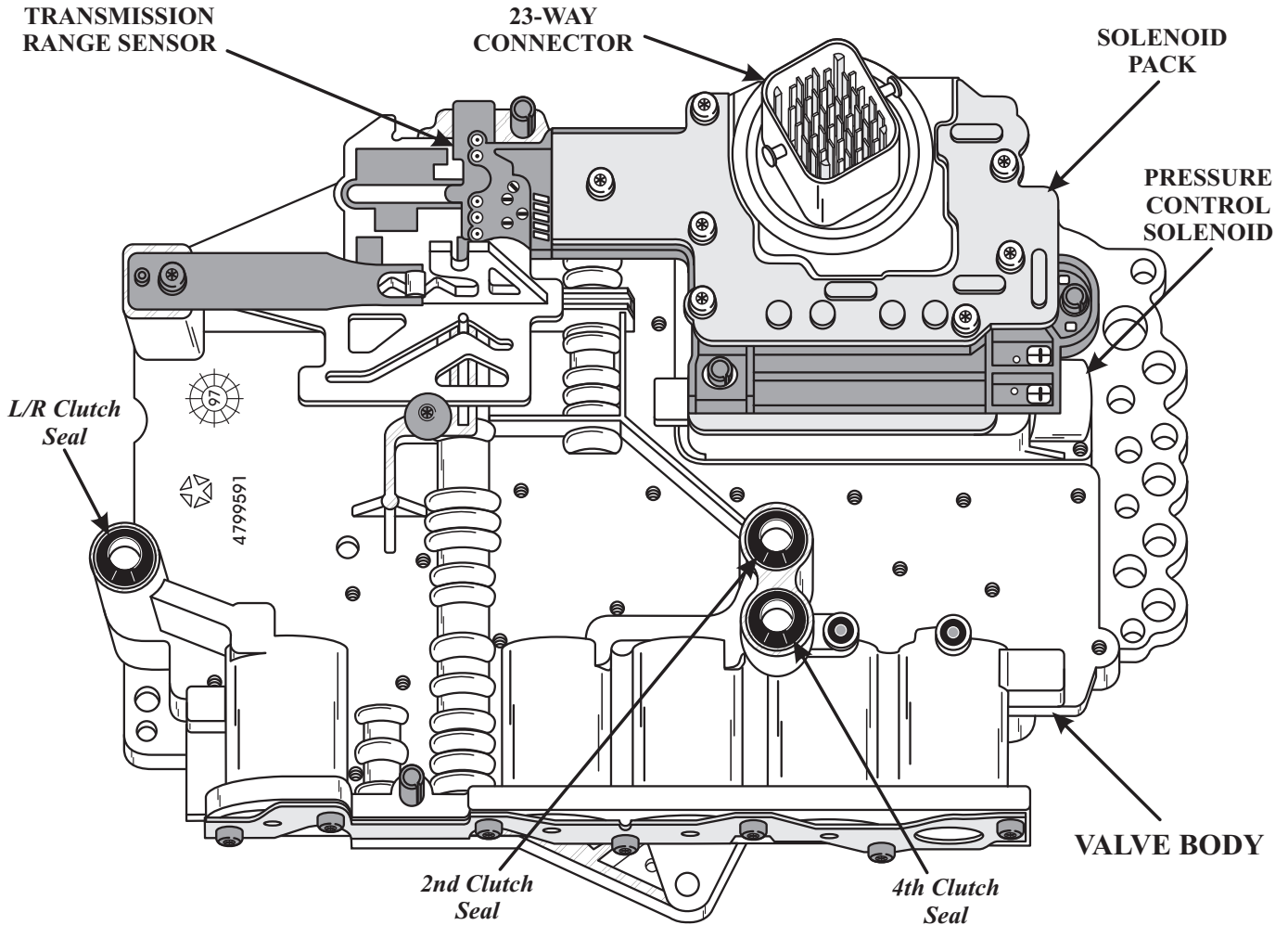
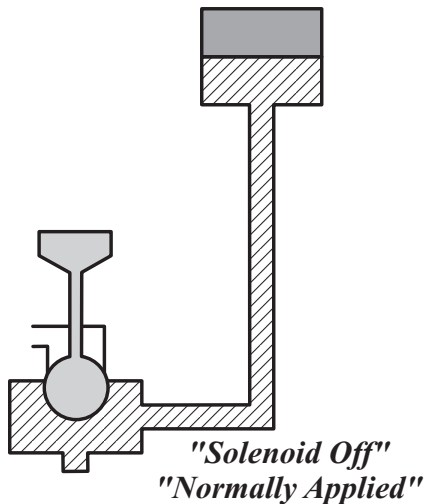


Figure 8

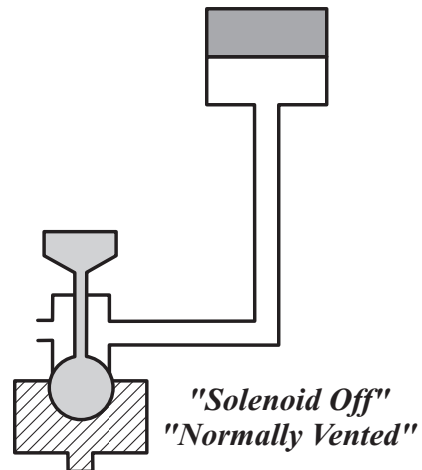


## TWO DIFFERENT TYPES OF SHIFT SOLENOIDS

*Underdrive Solenoid  
Multi-Select Solenoid*



*Overdrive Solenoid  
4th Clutch Solenoid  
2nd Clutch Solenoid  
Low/Reverse Solenoid  
Line Pressure Solenoid*



Copyright © 2011 ATSG

Figure 9

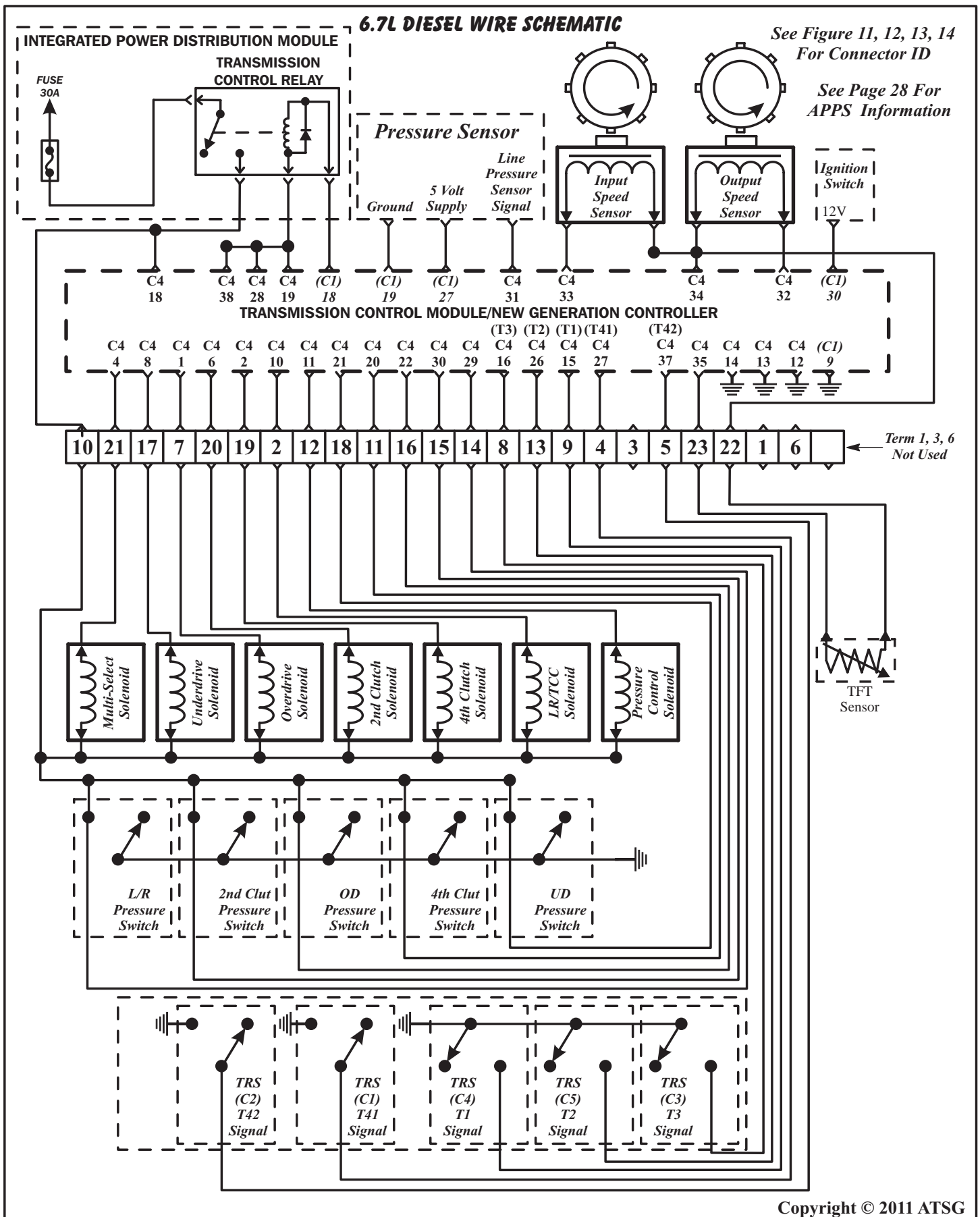
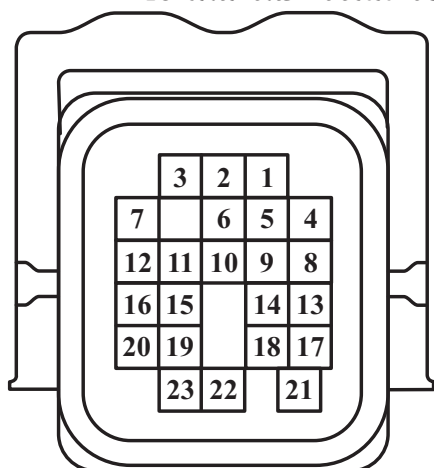
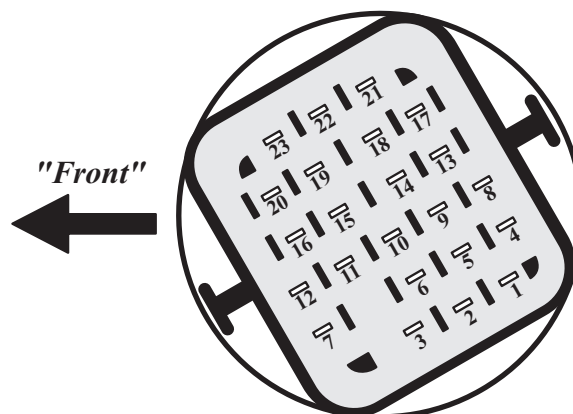


Figure 10

## 23-WAY CASE CONNECTOR PIN CAVITY IDENTIFICATION AND FUNCTION



Vehicle Harness Connector



Transmission Case Connector

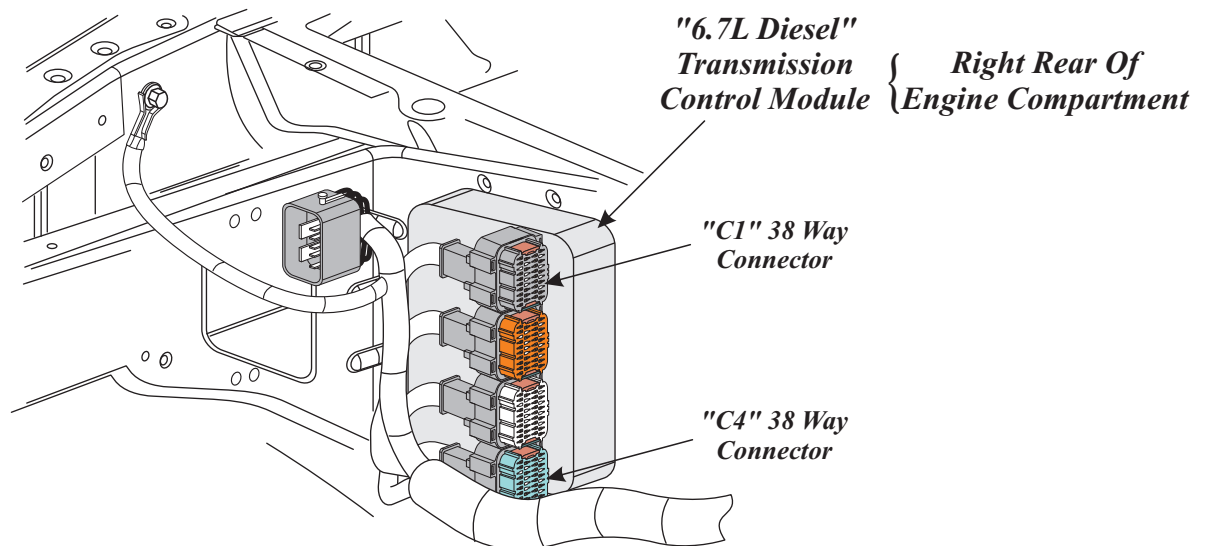
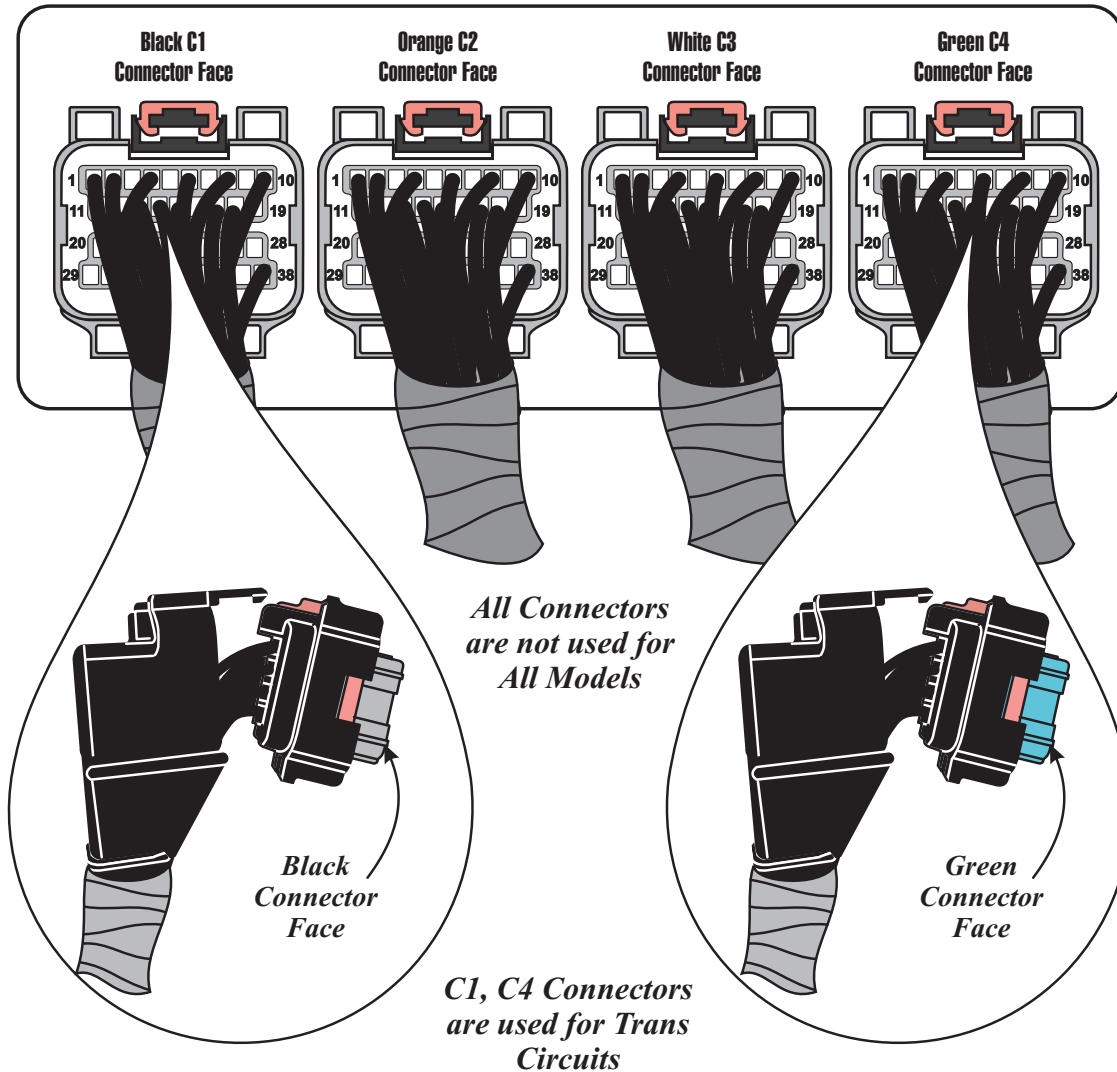
PIN CAVITY	WIRE COLOR	FUNCTION
1		(Not Used)
2	Dk Green/White	LR/TC Clutch Solenoid Control
3		(Not Used)
4	Yellow/Dk Blue	Transmission Range Sensor T41 (C1) Signal (P/N)
5	Dk Green/Yellow	Transmission Range Sensor T42 (C2) Signal
6		(Not Used)
7	Yellow/Gray	Overdrive Clutch Solenoid Control
8	Dk Green/Dk Blue	Transmission Range Sensor T3 (C3) Signal
9	Dk Green/Lt Blue	Transmission Range Sensor T1 (C4) Signal
10	Yellow/Orange	Transmission Control Relay Output
11	Brown/Yellow	4th Clutch Pressure Switch Signal
12	Dk Green	Line Pressure Control Solenoid Control
13	Dk Green/Red	Transmission Range Sensor T2 (C5) Signal
14	Dk Green/Pink	Low/Reverse Clutch Pressure Switch Signal
15	Yellow/Tan	2nd Clutch Pressure Switch Signal
16	Dk Green/Tan	Overdrive Clutch Pressure Switch Signal
17	Yellow/Lt Blue	Underdrive Clutch Solenoid Control
18	Yellow/White	Underdrive Clutch Pressure Switch Signal
19	Yellow/Dk Green	4th Clutch Solenoid Control
20	Yellow/Lt Green	2nd Clutch Solenoid Control
21	Yellow/Gray	Multi-Select Solenoid Control
22	Dk. Blue/Dk Green	Speed Sensor Ground
23	Dk Green/Orange	Transmission Oil Temperature Sensor Signal

Wire Colors  
May Vary

Copyright © 2011 ATSG

Figure 11

## 68RFE NGC CONNECTOR IDENTIFICATION



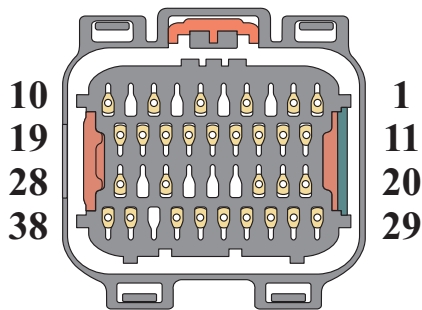
Copyright © 2011 ATSG

Figure 12

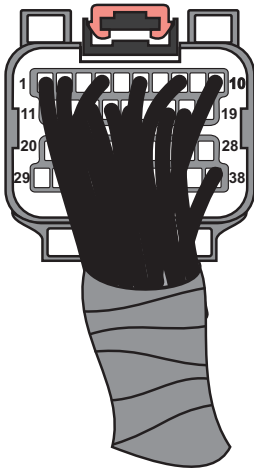


## 68RFE NGC "C1" CONNECTOR TERMINAL I.D.

**C1 Connector  
Face View (Black)**



**C1 Connector  
Wire Side View**



*Wire Colors  
May Vary*

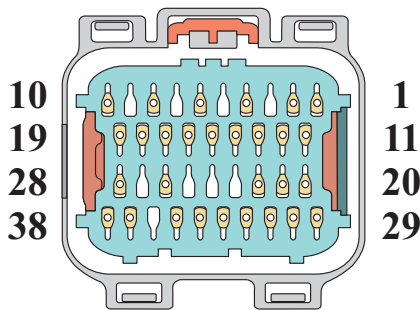
PIN CAVITY	WIRE COLOR	FUNCTION
1		
2		
3		
4		
5		
6		
7		
8		
9	Black/Brown	Ground
10		
11	Pink/White	Fused Ignition Switch Output (Run/Start)
12	Pink/White	Fused Ignition Switch Output (Run/Start)
13		
14		
15		
16		
17		
18	Black/Dk Green	Ground For Transmission Control Relay
19	Dk Green/White	Line Pressure Sensor Ground
20	Dk Green/Yellow	Electric Range Select (ERS)-Tow/Haul Signal
21		
22		
23		
24		
25		
26		
27	Yellow/Pink	5 Volt Supply
28		
29	Red	Fused Battery (+)
30	Yellow	Ignition Start
34	White/Lt Green	CAN C Bus (+)
35	White/Lt Blue	CAN C Bus (-)
36		
37		
38		

Copyright © 2011 ATSG

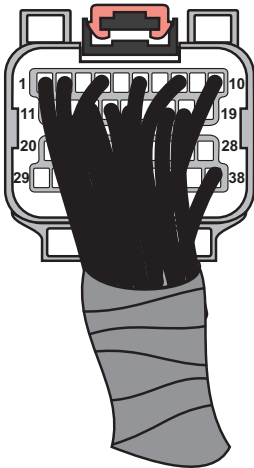
Figure 13

## 68RFE NGC "C4" CONNECTOR TERMINAL I.D.

**C4 Connector  
Face View (Green)**



**C4 Connector  
Wire Side View**



*Wire Colors  
May Vary*

PIN CAVITY	WIRE COLOR	FUNCTION
1	Yellow/Gray	Overdrive Clutch Solenoid Control
2	Yellow/Dk Green	4th Clutch Solenoid Control
3		
4	Dk Green	Multi-Select Solenoid Control
5		
6	Yellow/Lt Green	2nd Clutch Solenoid Control
7		
8	Yellow/Lt Blue	Underdrive Clutch Solenoid Control
9		
10	Dk Green/White	LR/TC Clutch Solenoid Control
11	Yellow/Gray	Line Pressure Control Solenoid Control
12	Black	Ground
13	Black	Ground
14	Black	Ground
15	Dk Green/Lt Blue	Transmission Range Sensor T1 (C4) Signal
16	Dk Green/Dk Blue	Transmission Range Sensor T3 (C3) Signal
17	Dk Green	Towhaul Overdrive Off Switch Sense
18	Yellow/Dk Blue	Transmission Control Relay Control
19	Yellow/Orange	Transmission Control Relay Output
20	Brown/Yellow	4th Clutch Pressure Switch Signal
21	Yellow/White	Underdrive Clutch Pressure Switch Signal
22	Dk Green/Tan	Overdrive Clutch Pressure Switch Signal
23		
24		
25		
26	Dk Green/Lt Blue	Transmission Range Sensor T2 (C5) Signal
27	Yellow/Dk Blue	Transmission Range Sensor T41 (C1) Signal
28	Yellow/Orange	Transmission Control Relay Output
29	Yellow/Tan	Low/Reverse Clutch Pressure Switch Signal
30	Dk Green/Yellow	2nd Clutch Pressure Switch Signal
31	Yellow/Brown	Line Pressure Sensor Signal
32	Dk Green/Brown	Output Speed Sensor Signal
33	Dk Green/Orange	Input Speed Sensor Signal
34	Dk Green/Violet	Speed Sensor Ground
35	Dk Green/Orange	Transmission Oil Temperature Sensor Signal
36		
37	Dk Green/Yellow	Transmission Range Sensor T42 (C2) Signal
38	Yellow/Orange	Transmission Control Relay Output

Copyright © 2011 ATSG

Figure 14

## CLUTCH VOLUME INDEXES

An important function of the TCM is to monitor Clutch Volume Indexes (CVI). CVIs represent the volume of fluid needed to compress a clutch pack properly.

The TCM monitors gear ratio changes by monitoring the Input and Output Speed Sensors. The Input Speed Sensor sends an AC voltage signal to the TCM that represents input shaft rpm. The Output Speed Sensor provides the TCM with output shaft speed information.

By comparing these two inputs, the TCM can determine actual gear ratio. This is important to the CVI calculation because the TCM determines CVIs by monitoring how long it takes for a gear change to occur.

Gear ratios can be determined by using the DRB Scan Tool and reading the Input/Output Speed Sensor values in the "Monitors" display. Gear ratio can be obtained by dividing the Input Speed Sensor value by the Output Speed Sensor value.

For example, if the input shaft is turning at 1000 rpm and the output shaft is turning at 500 rpm, the TCM can determine that the gear ratio is 2:1. In 3rd gear the gear ratio changes to 1:1. The gear ratio changes as clutches are applied and released. By monitoring the length of time it takes for a gear ratio to change following a shift request, the TCM can determine the volume of fluid used to apply or release a friction element.

The volume of transmission fluid needed to apply the friction elements are continuously updated for the adaptive controls. As friction material wears, the volume of fluid needed to apply the friction element increases.

Certain mechanical problems within the transmission assembly such as broken return springs, out of position snap rings, excessive clutch pack clearance, or improper assembly can cause inadequate or out-of-range CVI readings. The chart in Figure 15 identifies the proper CVIs, when they are monitored and updated, and the proper clutch pack clearances.

<b>CLUTCH VOLUMES AND CLEARANCES</b>			
<b>CLUTCH</b>	<b>WHEN UPDATED</b>	<b>PROPER VOLUME</b>	<b>CLUTCH CLEARANCE</b>
<i>Low/Reverse</i>	<i>2-1, 3-1 or 4-1 Downshift</i>	<i>45 to 134</i>	<i>1.18-2.09mm (.046"-.082")</i>
<i>2nd Clutch</i>	<i>4-3 or 3-2 Downshift</i>	<i>25 to 85</i>	<i>0.99-1.65mm (.039"-.065")</i>
<i>2nd Clutch</i>	<i>5-6 Upshift</i>	<i>25 to 85</i>	<i>0.99-1.65mm (.039"-.065")</i>
<i>Overdrive</i>	<i>3-4 Upshift</i>	<i>30 to 100</i>	<i>0.75-1.61mm (.030"-.063")</i>
<i>4th Clutch</i>	<i>4-5 Upshift</i>	<i>30 to 85</i>	<i>0.77-1.39mm (.030"-.055")</i>
<i>4th Clutch</i>	<i>4-5 Upshift</i>	<i>30 to 85</i>	<i>0.77-1.39mm (.030"-.055")</i>
<i>Underdrive</i>	<i>5-4 or 6-4 Kickdown shift</i>	<i>30 to 100</i>	<i>1.02-1.72mm (.040"-.068")</i>
<i>Reverse</i>	<i>Not Monitored</i>	<i>Not Monitored</i>	<i>0.58-1.47mm (.023"-.058")</i>
Copyright © 2011 ATSG			

Figure 15

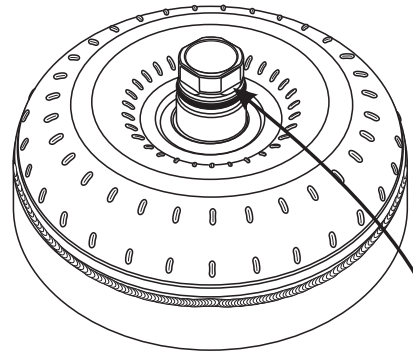
## OIL PUMP OPERATION

A dual stage oil pump is also used for the 68RFE. The pump has three gears, one drive gear and two driven gears as shown in Figure 16. Both stages of the pump supply fluid during idle and at low engine speeds. Under these conditions there is not enough pressure from the primary stage to close the shuttle valve. As engine speed increases, so does the output from the primary stage. Once the pressure from the primary stage builds up, the shuttle valve is forced closed and in this condition the secondary stage has no effect and the primary side supplies all of the pressure needed for proper transmission operation. The 68RFE pump has four lugs on the drive gear instead of the previous two and the driven gears now rotate on a permanent shaft that is part of the oil pump body, as shown in Figure 16. The oil pump body also no longer contains a pocket for the converter hub seal, as the seal is in front cover. These features make the oil pumps non-interchangeable.

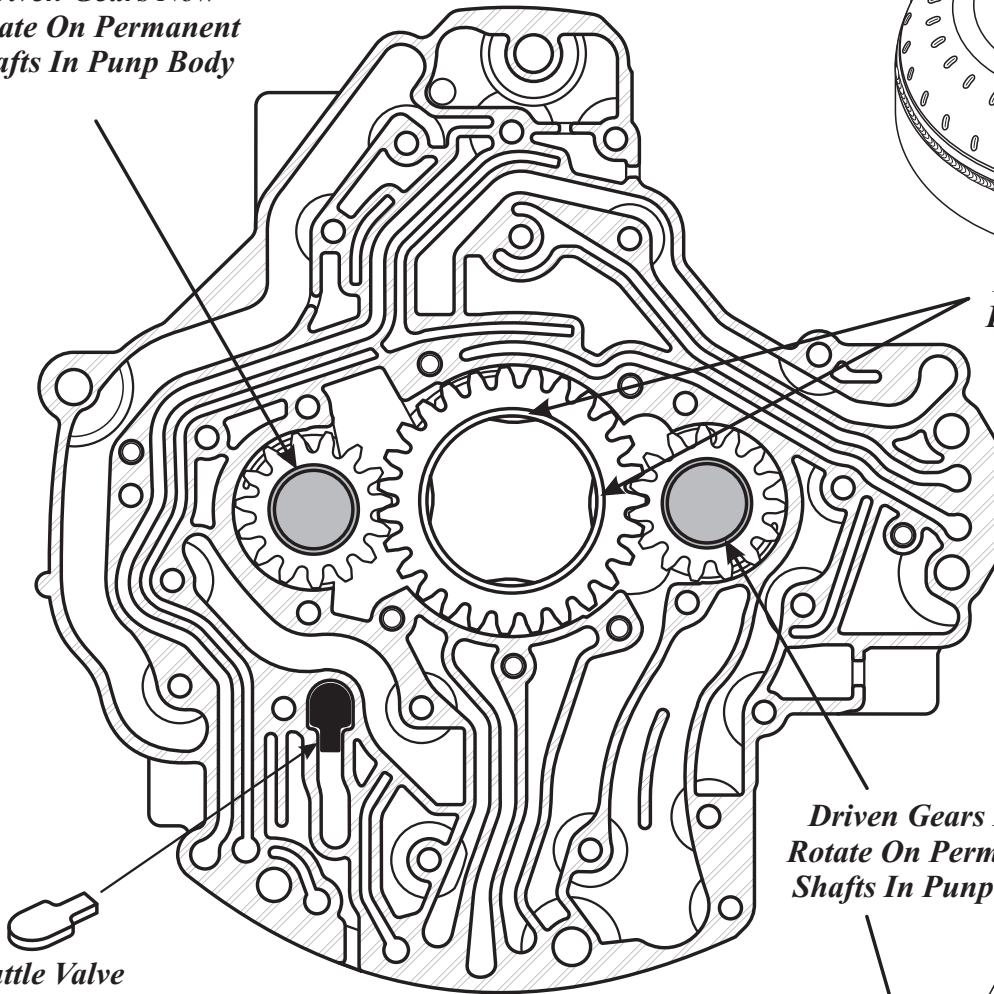
## 68RFE OIL PUMP BODY AND GEARS

ProCarManuals.com

*Driven Gears Now  
Rotate On Permanent  
Shafts In Pump Body*

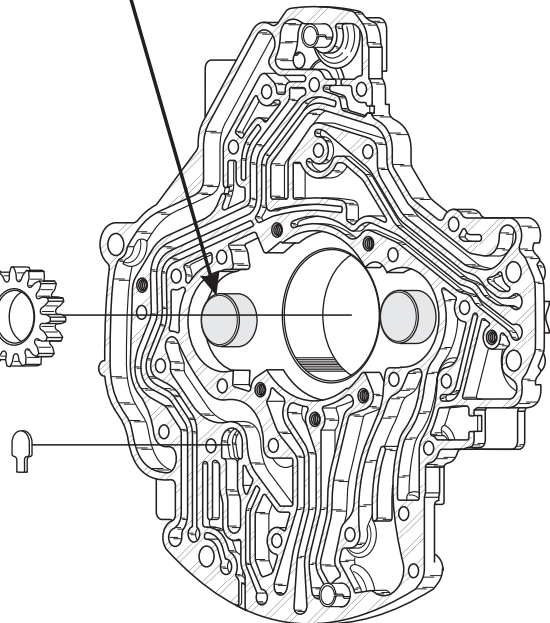
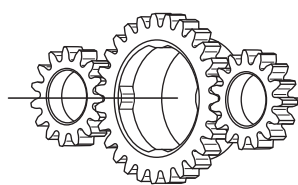


*Four Drive Lugs On  
Drive Gear And Four  
Flats On Converter*



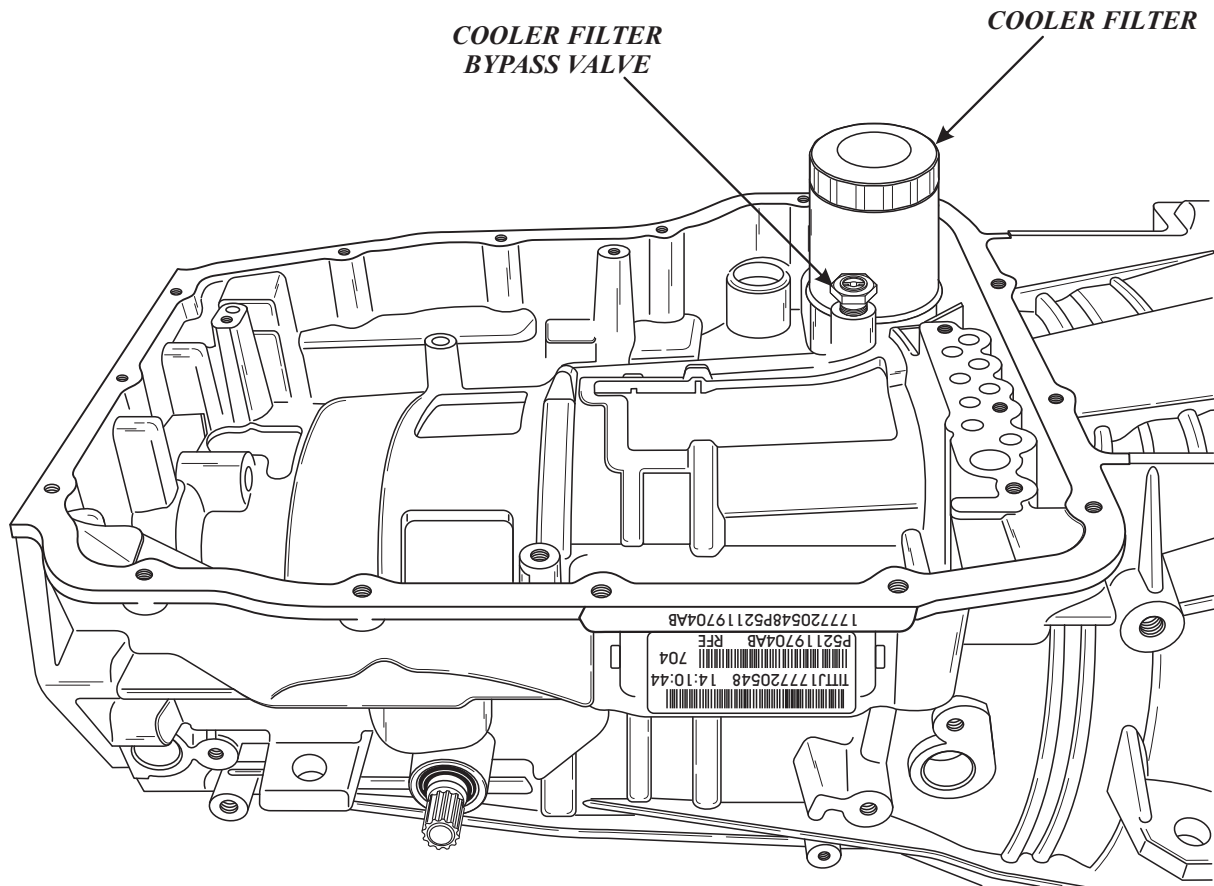
*Shuttle Valve*

*Driven Gears Now  
Rotate On Permanent  
Shafts In Pump Body*

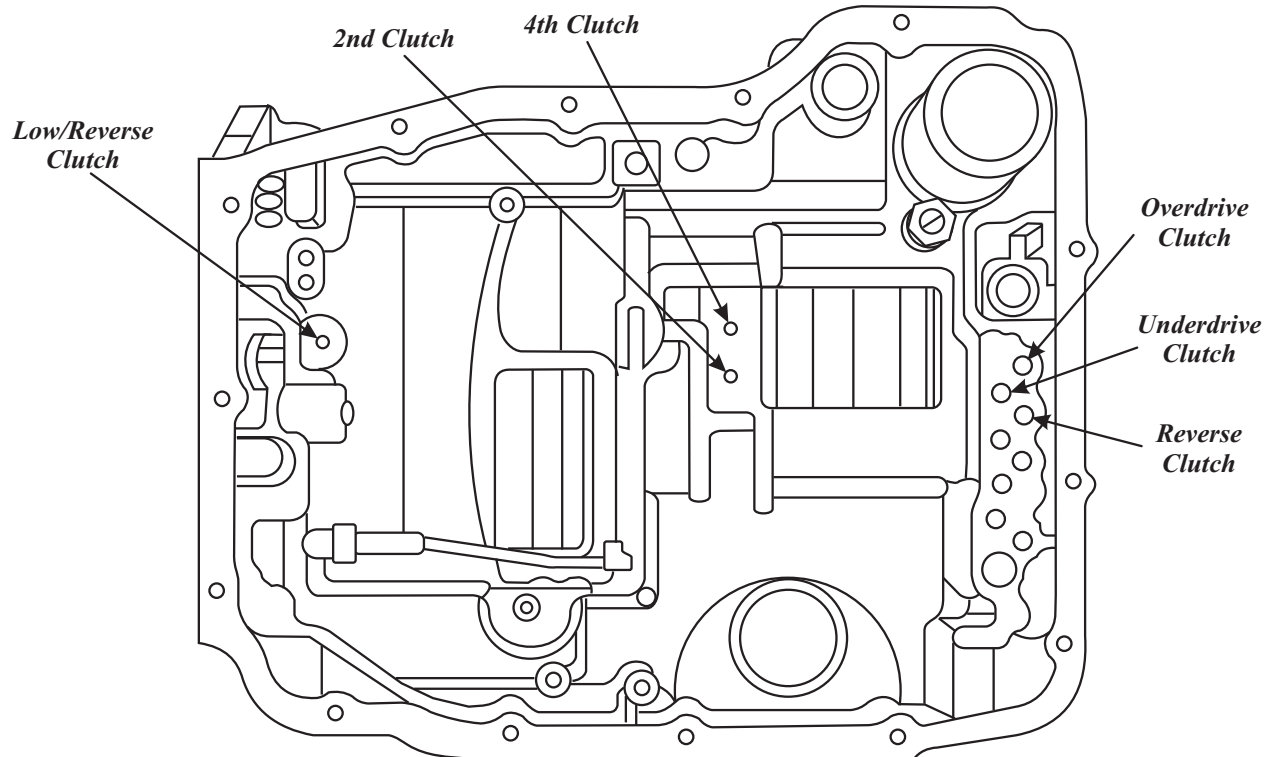


Copyright © 2011 ATSG

Figure 16



## AIR PRESSURE TESTS

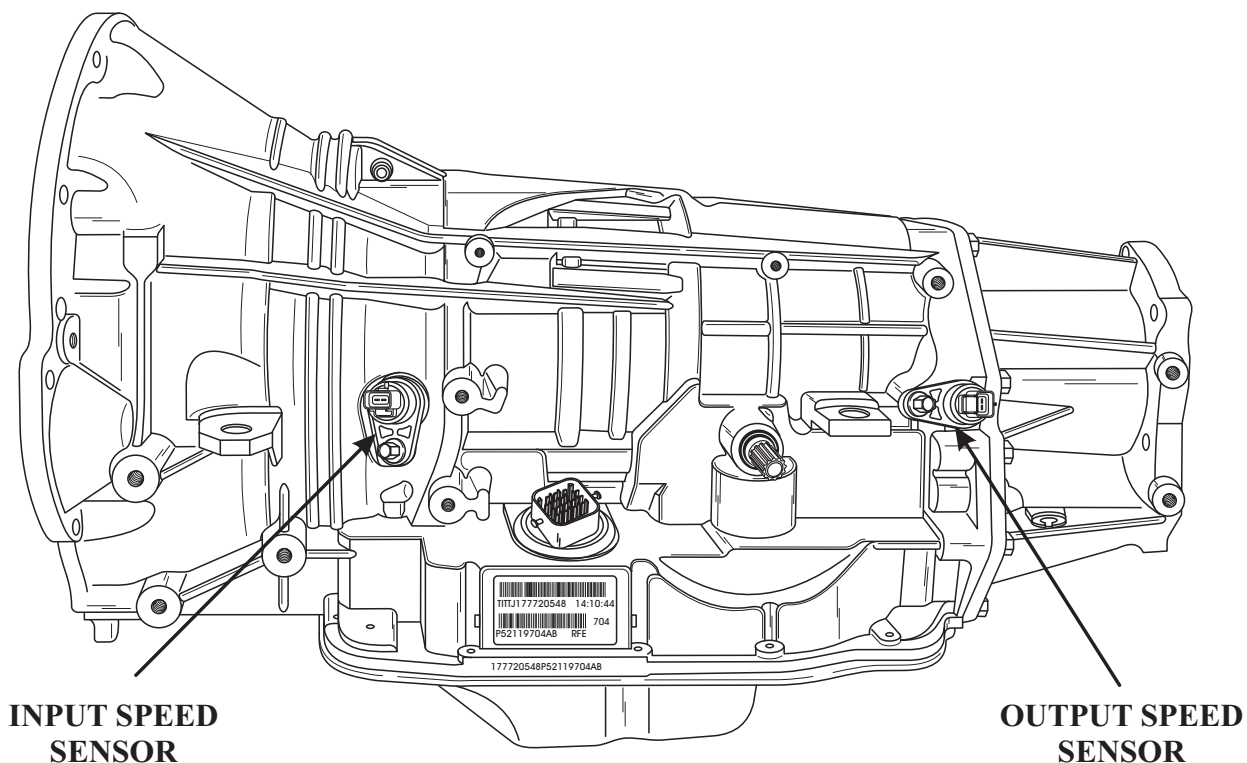


Copyright © 2011 ATSG

Figure 17

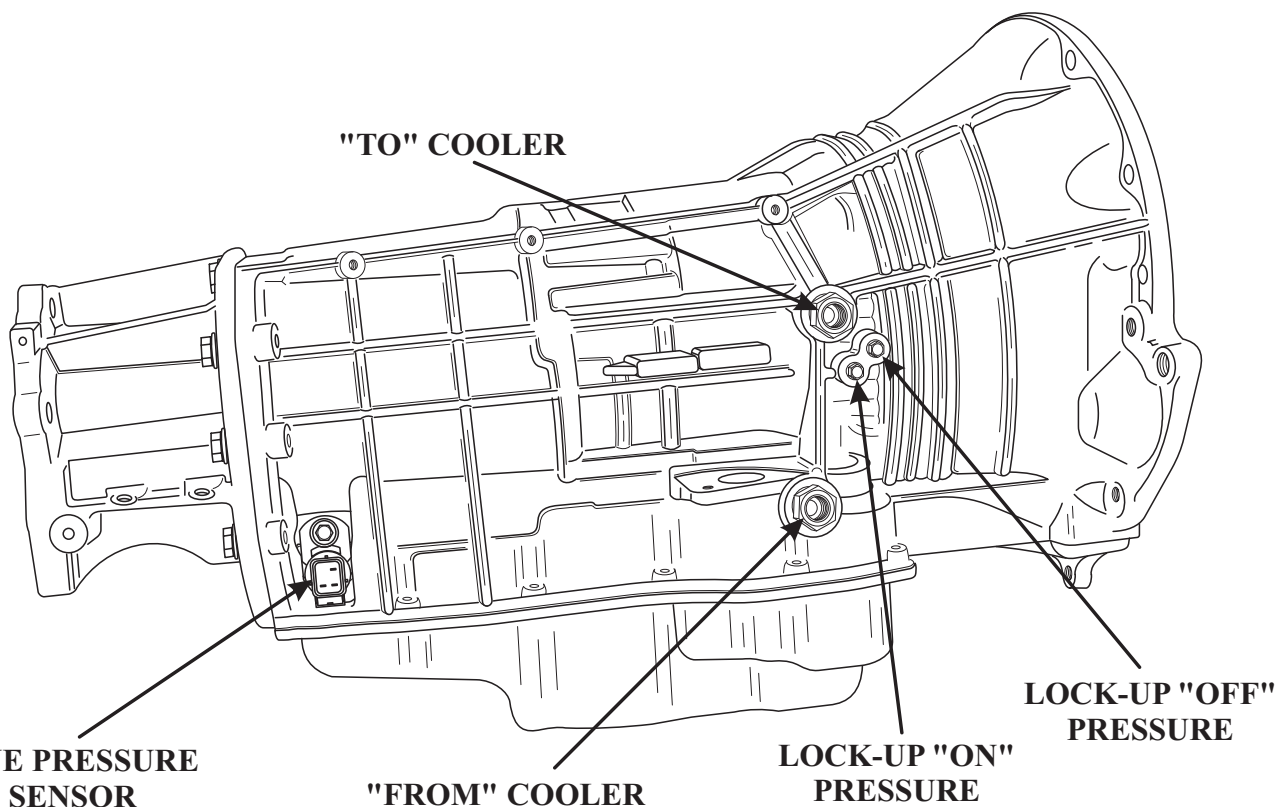


## EXTERNAL SENSOR LOCATIONS AND COOLER LINE IDENTIFICATION



**INPUT SPEED  
SENSOR**

**OUTPUT SPEED  
SENSOR**



**LINE PRESSURE  
SENSOR**

**"TO" COOLER**

**"FROM" COOLER**

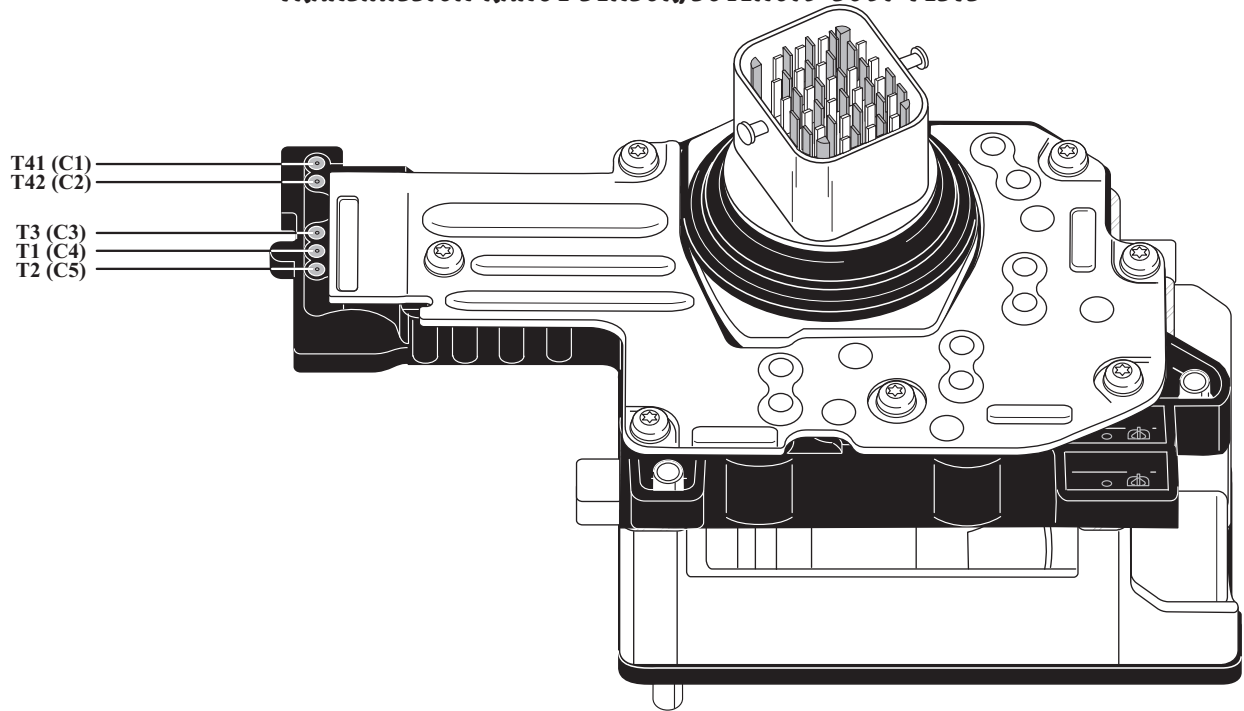
**LOCK-UP "ON"  
PRESSURE**

**LOCK-UP "OFF"  
PRESSURE**

Copyright © 2011 ATSG

Figure 18

## TRANSMISSION RANGE SENSOR/SOLENOID BODY TESTS



### TRANSMISSION RANGE SENSOR CHART

CIRCUIT	METER	P	R	N	OD	2*	1*
T41 (C1)	T41 & GRD OR CONNECTOR PIN 4 & GRD	C	O	C	O	O	O
T42 (C2)	T42 & GRD OR CONNECTOR PIN 5 & GRD	C	C	C	O	O	O
T3 (C3)	T3 & GRD OR CONNECTOR PIN 8 & GRD	O	O	C	C	O	C
T1 (C4)	T1 & GRD OR CONNECTOR PIN 9 & GRD	O	O	O	C	C	O
T2 (C5)	T2 & GRD OR CONNECTOR PIN 13 & GRD	C	O	O	O	C	C

\* Vehicles equipped with Electronic Range Selector (ERS) do not have "2" or "1" positions on the shift lever.

C = Closed    O = Open

### SOLENOID RESISTANCE CHART

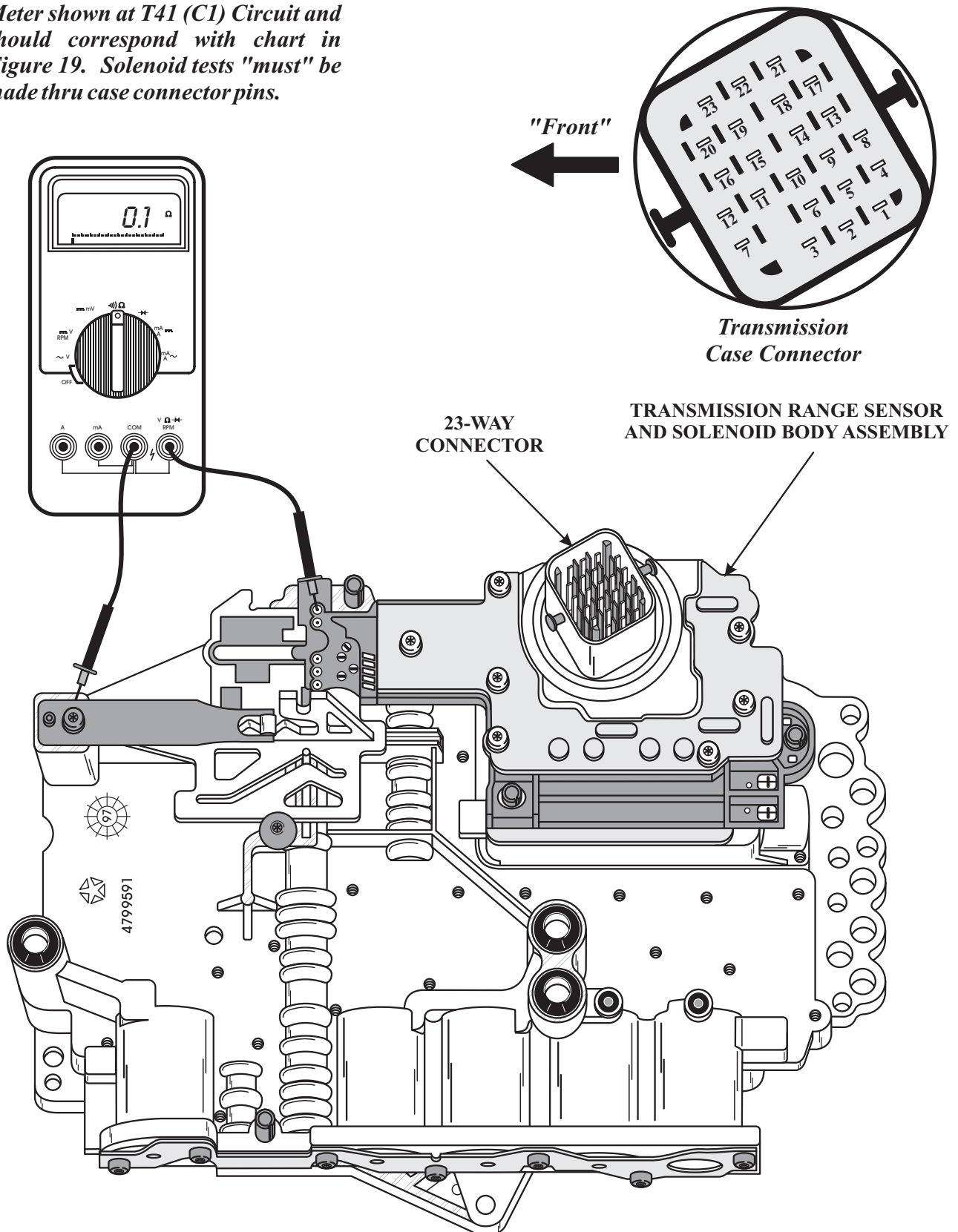
SOLENOID	23-WAY CONN. PINS	RESISTANCE
LR/TCC	10 AND 2	1.9 $\Omega$ @ 72°F
OVERDRIVE	10 AND 7	1.9 $\Omega$ @ 72°F
UNDERDRIVE	10 AND 17	1.9 $\Omega$ @ 72°F
2ND CLUTCH	10 AND 20	1.9 $\Omega$ @ 72°F
4TH CLUTCH	10 AND 19	1.9 $\Omega$ @ 72°F
MULTI-SELECT	10 AND 21	1.9 $\Omega$ @ 72°F
LINE PRESSURE	10 AND 12	4.3 $\Omega$ @ 72°F
TOT SENSOR	22 AND 23	9.37k $\Omega$ @ 72°F

See Figure 20 For 23/Way Connector Pin Identification.

Copyright © 2011 ATSG

Figure 19

*Meter shown at T41 (C1) Circuit and should correspond with chart in Figure 19. Solenoid tests "must" be made thru case connector pins.*



Copyright © 2011 ATSG

Figure 20

## 68RFE DIAGNOSTIC TROUBLE CODES

<b>DTC</b>	<b>DESCRIPTION</b>
P0101	Mass Air Flow Sensor Circuit Performance
P0102	Mass Air Flow Sensor Circuit Low
P0103	Mass Air Flow Sensor Circuit High
P0116	Engine Coolant Sensor Circuit Performance
P0117	Engine Coolant Sensor Circuit Low
P0118	Engine Coolant Sensor Circuit High
P0122	TPS/APP Circuit Low
P0123	TPS/APP Circuit High
P0124	TPS/APP Circuit Intermittent
P0218	High Temperature Operation Activated
P0560	Battery System Voltage
P0562	Battery System Voltage Low
P0563	Battery System Voltage High
P0571	Brake Switch Performance
P0572	Brake Switch Stuck On
P0573	Brake Switch Stuck Off
P0604	Control Module, Internal RAM Error
P0605	Control Module, Internal ROM Error
P0613	Internal Transmission Control Module Error
P0700	Transmission Control System, MIL Request
P0702	Transmission Control System, Electrical
P0706	Transmission Range Sensor Rationallity
P0707	Transmission Range Sensor Circuit Low
P0708	Transmission Range Sensor Circuit High
P0711	Transmission Temperature Sensor Performance
P0712	Transmission Temperature Sensor Circuit Low
P0713	Transmission Temperature Sensor Circuit High
P0714	Transmission Temperature Sensor Circuit Intermittent
P0715	Input Speed Sensor Circuit Performance
P0717	Input Speed Sensor, No Signal
P0721	Output Speed Sensor Performance
P0722	Output Speed Sensor, No Signal

Continued on Page 23

Copyright © 2011 ATSG

Figure 21

<b>68RFE DIAGNOSTIC TROUBLE CODES</b>	
<b>DTC</b>	<b>DESCRIPTION</b>
P0729	Sixth Gear Ratio Error
P0731	First Gear Ratio Error
P0732	Second Gear Ratio Error
P0733	Third Gear Ratio Error
P0734	Fourth Gear Ratio Error
P0735	Fifth Gear Ratio Error
P0736	Reverse Gear Ratio Error
P0740	Torque Converter Clutch Out Of Range (Slip Fault)
P0745	Line Pressure Solenoid Circuit
P0750	Low/Reverse Clutch Solenoid Circuit Fault
P0755	Second Clutch Solenoid Circuit Fault
P0760	Overdrive Clutch Solenoid Circuit Fault
P0765	Underdrive Clutch Solenoid Circuit Fault
P0770	Fourth Clutch Solenoid Circuit Fault
P0841	Low/Reverse Clutch Pressure Switch Rationallity
P0845	Second Clutch Pressure Switch, Pressure Test
P0846	Second Clutch Pressure Switch Rationallity
P0854	Overdrive Clutch Switch Circuit Low
P0868	Line Pressure Low
P0869	Line Pressure High
P0870	Overdrive Clutch Pressure, Pressure Test
P0871	Overdrive Clutch Pressure Switch Rationallity
P0875	Underdrive Clutch Pressure, Pressure Test
P0876	Underdrive Clutch Pressure Switch Rationallity
P0882	Transmission Control Module Power Input Low
P0883	Transmission Control Module Power Input High
P0884	Power Up At Speed
P0890	Switched Battery Fault
P0933	Line Pressure Sensor Performance
P0934	Line Pressure Sensor Circuit Low
P0935	Line Pressure Sensor Circuit High
P0944	Loss If Hydraulic Prime
P0957	Autostick Circuit Low (Electronic Range Select)
Continued on Page 24	
Copyright © 2011 ATSG	

Figure 22

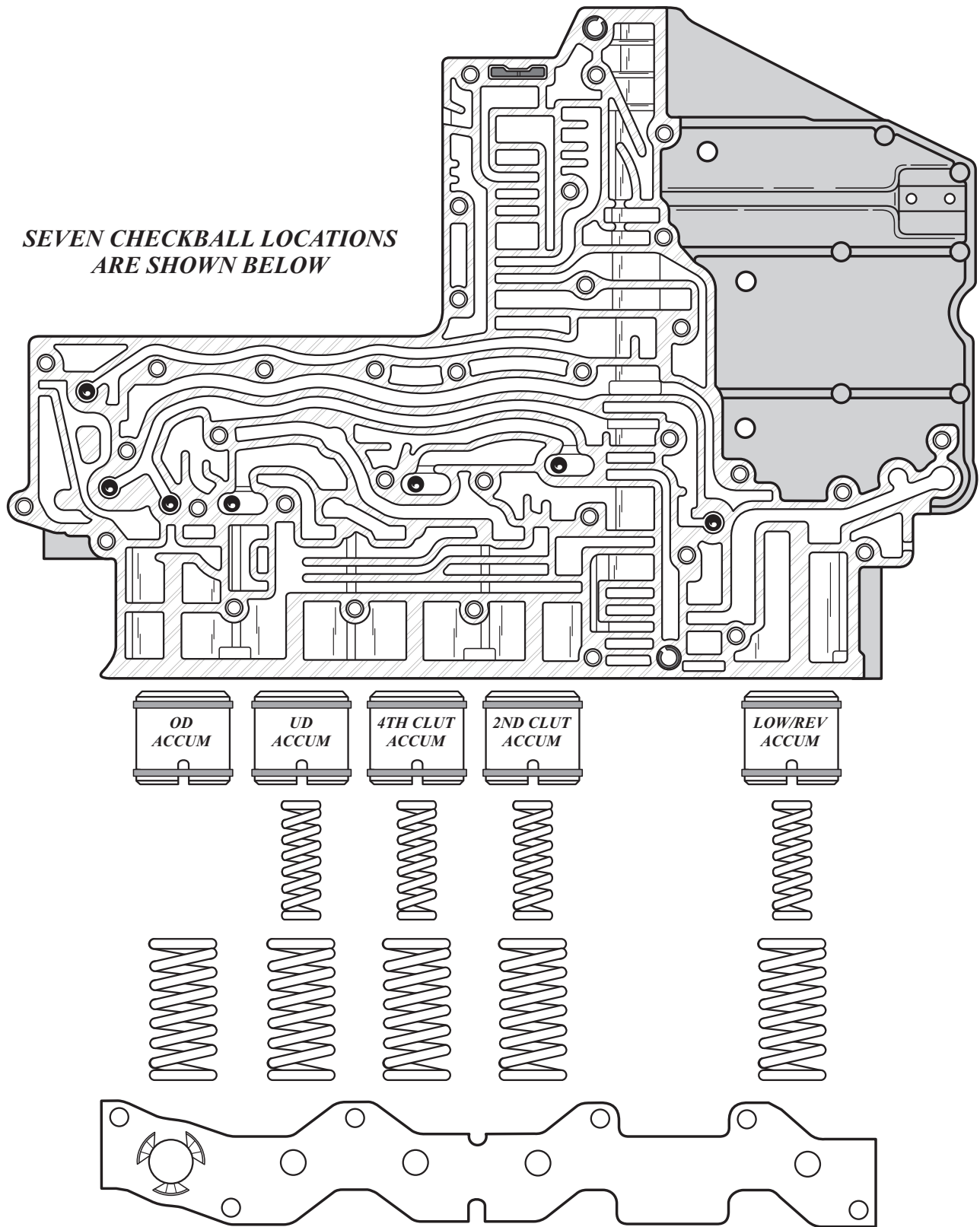


[illegible]

Figure 23

## 68RFE ACCUMULATOR AND CHECKBALL LOCATIONS

*SEVEN CHECKBALL LOCATIONS  
ARE SHOWN BELOW*



Copyright © 2011 ATSG

Figure 24

## PRESSURE TEST LOCATIONS AND PROCEDURE

There are only 2 pressure taps supplied externally on the case. The torque converter ON and torque converter OFF taps are located on the right side of the transmission case, shown in Figure 25.

There are two available methods to determine main line pressure. The DRB Scan Tool can be used to read main line pressure from the line pressure sensor. The 2nd method is to install Line Pressure Adapter 8259 into the transmission case, and re-install line pressure sensor and the pressure gauge into the adapter, as shown in Figure 25.

This will allow a comparison of the DRB readings and the pressure gauge to determine the accuracy of the feedback to the controller. Refer to the chart in Figure 25 for proper pressure readings.

To access any of the other pressure tap locations, the transmission oil pan must be removed, the pressure taps removed from the valve body and the Valve Body Pressure Tap Adapter 8258 installed. Refer to Figure 26. The extensions supplied with Adapter 8258 will allow the installation of pressure gauges to the valve body to test individual clutch pack pressures.

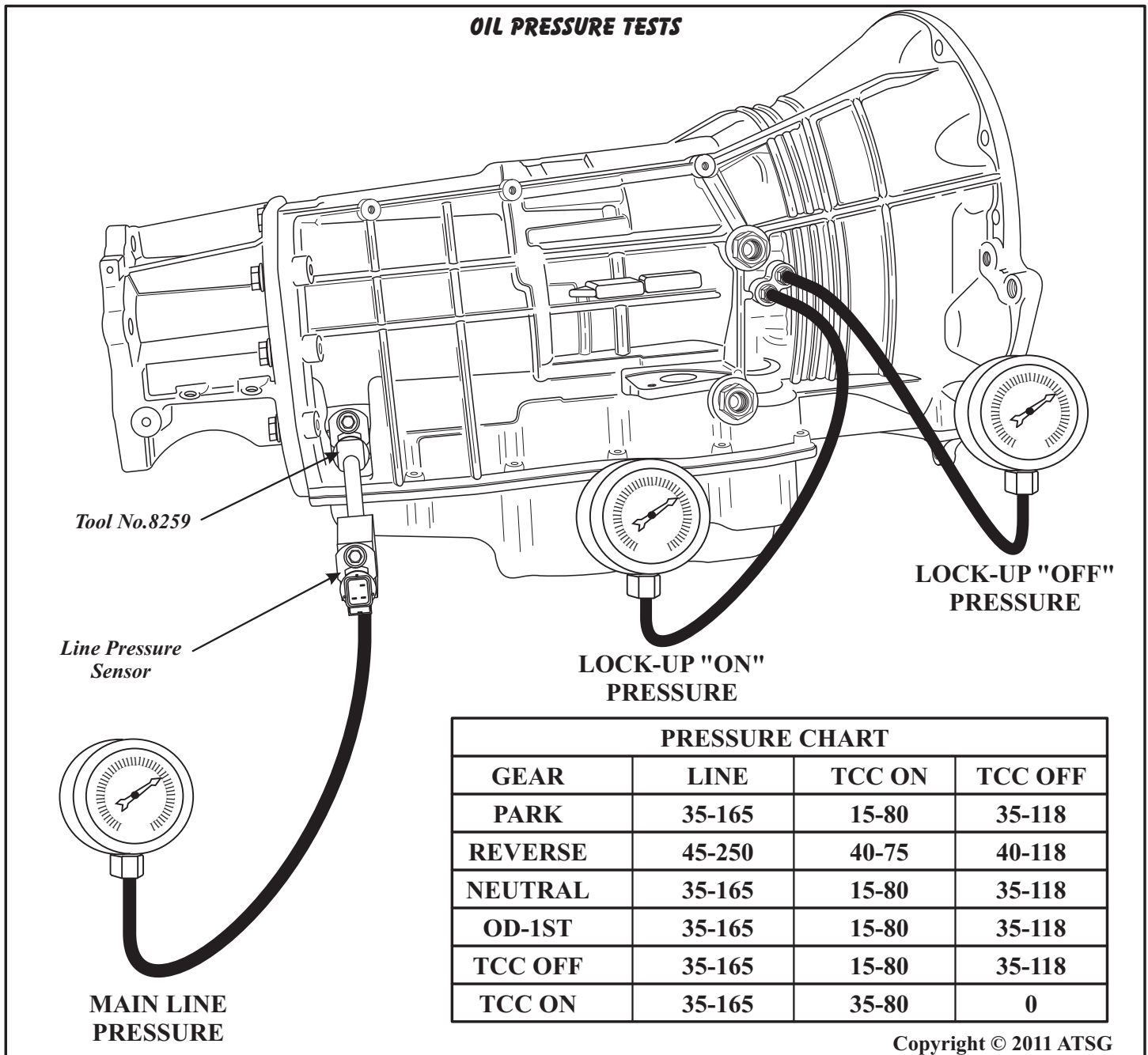
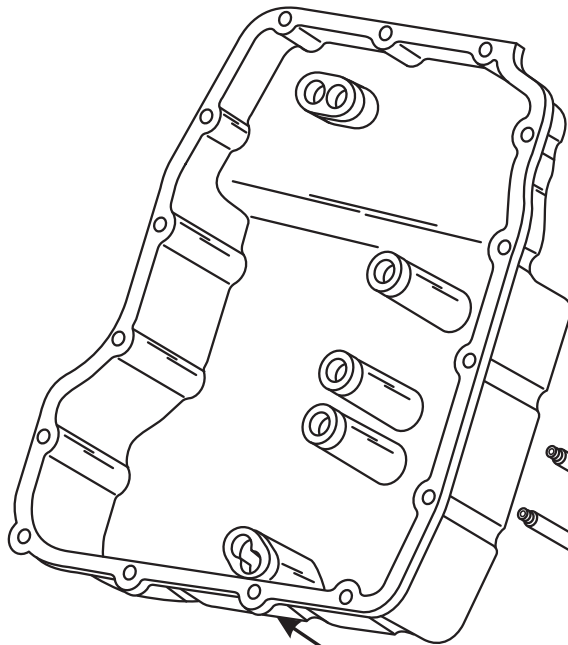
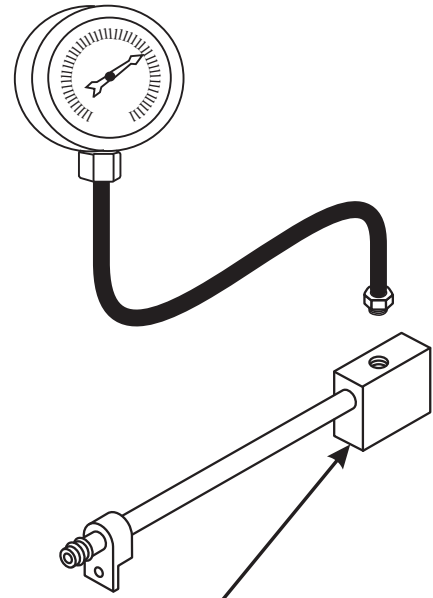


Figure 25

## MANDATORY TOOLS NEEDED FOR CHECKING PRESSURES ON 68RFE



*Pressure Tap Adapter Tool No. 8258, to check oil pressures through the valve body taps.*



*Line Pressure Adapter Tool No. 8259, to install into the line pressure sensor circuit, and then reinstall the sensor and pressure gage.*

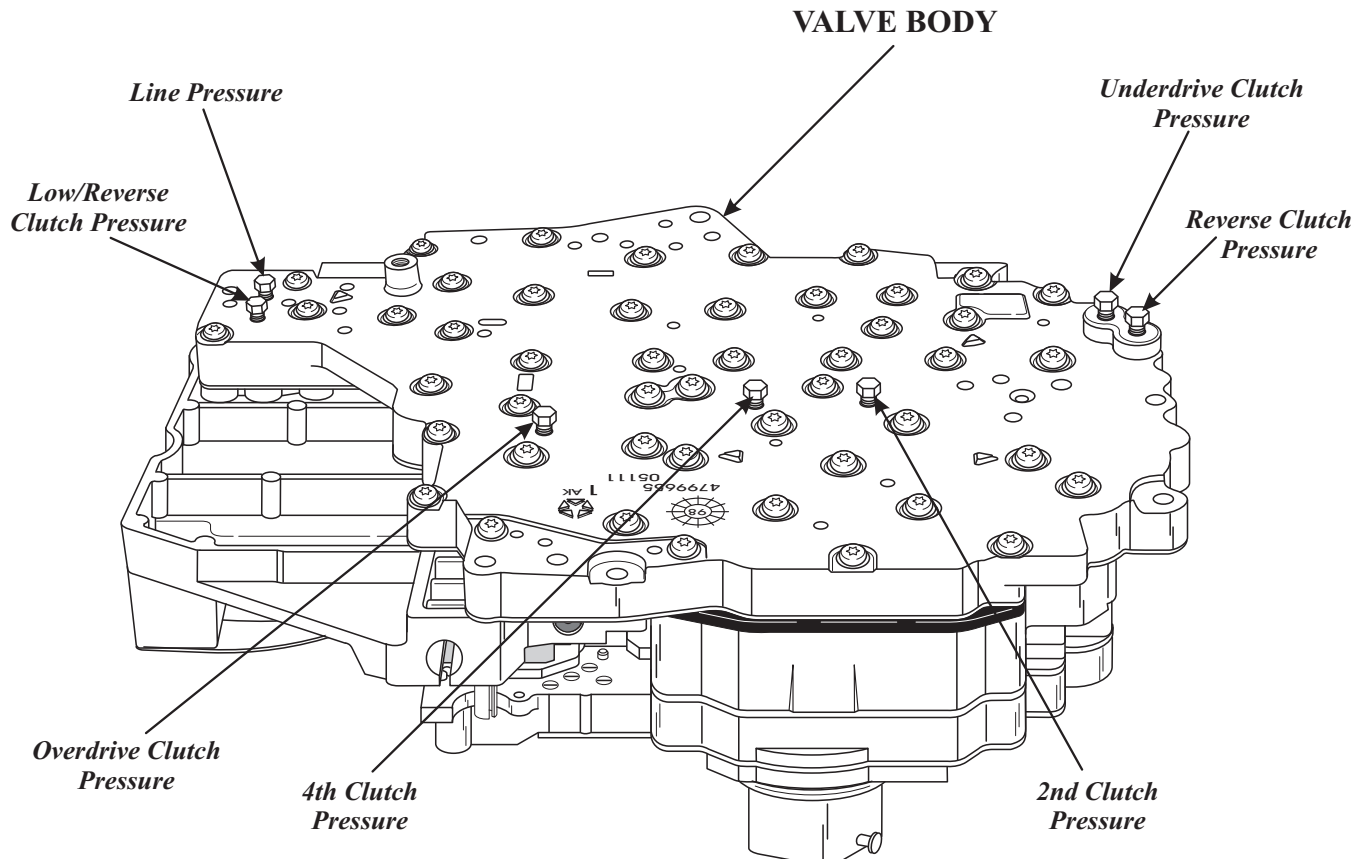
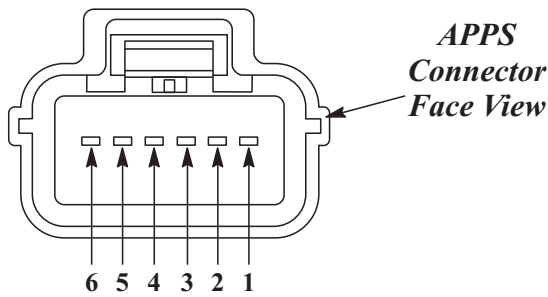
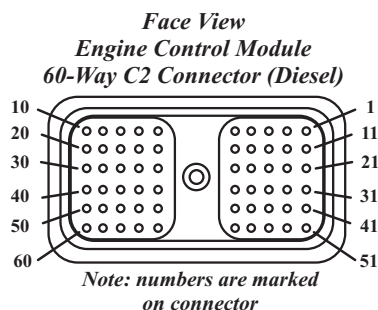
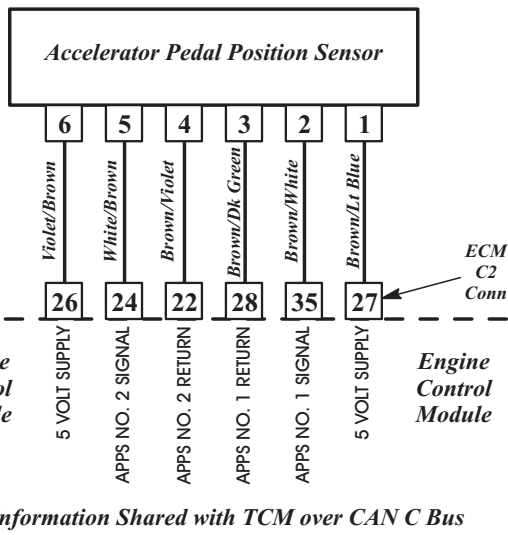


Figure 26

## ACCELERATOR PEDAL POSITION SENSOR 6.7L DIESEL DIAGNOSTIC INFORMATION



CAVITY	WIRE COLOR	FUNCTION
1	Brown/Lt Blue	5 Volt Supply
2	Brown/White	APPS No. 1 Signal
3	Brown/Yellow	APPS No. 1 Return
4	Brown/Violet	APPS No. 2 Return
5	White/Brown	APPS No. 2 Signal
6	Violet/Brown	5 Volt Supply



Copyright © 2011 ATSG

Figure 27

## FLUID LEVEL CHECK PROCEDURE

- (1) Transmission fluid level must be checked before performing the pressure tests and must be at normal operating temperature for accurate check. Drive vehicle if necessary to bring fluid temperature up to normal operating temperature of 82°C (180°F).
- (2) Position vehicle on flat level surface.
- (3) Start and run engine at curb idle speed.
- (4) **Apply Parking Brakes.**
- (5) Shift transmission through all gear ranges and then back to the Neutral position.
- (6) Remove dipstick and check fluid level.
  - (A) Correct level is in crosshatch area.
  - (B) Correct maximum level is to MAX arrow.
  - (C) Incorrect level is at or below MIN line.
- (7) If fluid level is low, add only enough of the **Mopar® ATF Plus 4**, to restore correct fluid level. Do not overfill (See Figure 28).

**Dexron II fluid is NOT recommended. Clutch chatter can result from the use of improper fluid.**

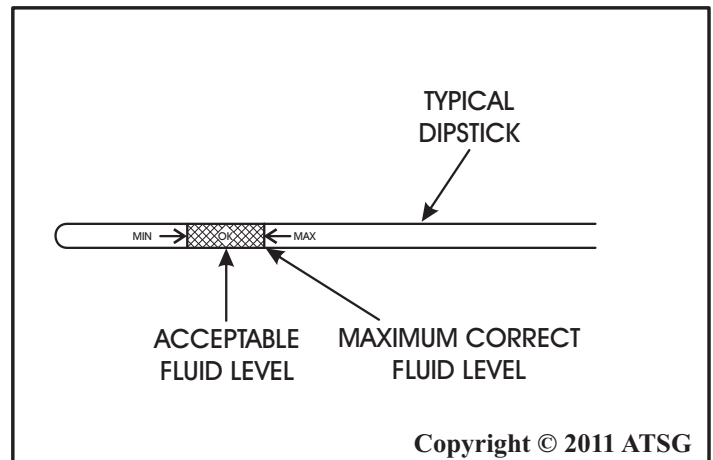


Figure 28



## CONVERTER CLUTCH OPERATION

The Torque Converter Clutch can be engaged in all gear ranges except first, depending on the Tow/Haul and ERS status. In normal operation, the converter clutch will engage after the shift to fourth gear. If the Tow/Haul mode is enabled, the converter clutch will engage after the shift to third gear.

The TCM controls the torque converter clutch via the duty cycle of the L/R-TCC Solenoid. There are four different TCC operational modes.

- *No EMCC*
- *Partial EMCC*
- *Full EMCC*
- *Gradual EMCC Release*

This function, referred to as Electronically Modulated Converter Clutch (EMCC), can occur at various times depending on the following variables:

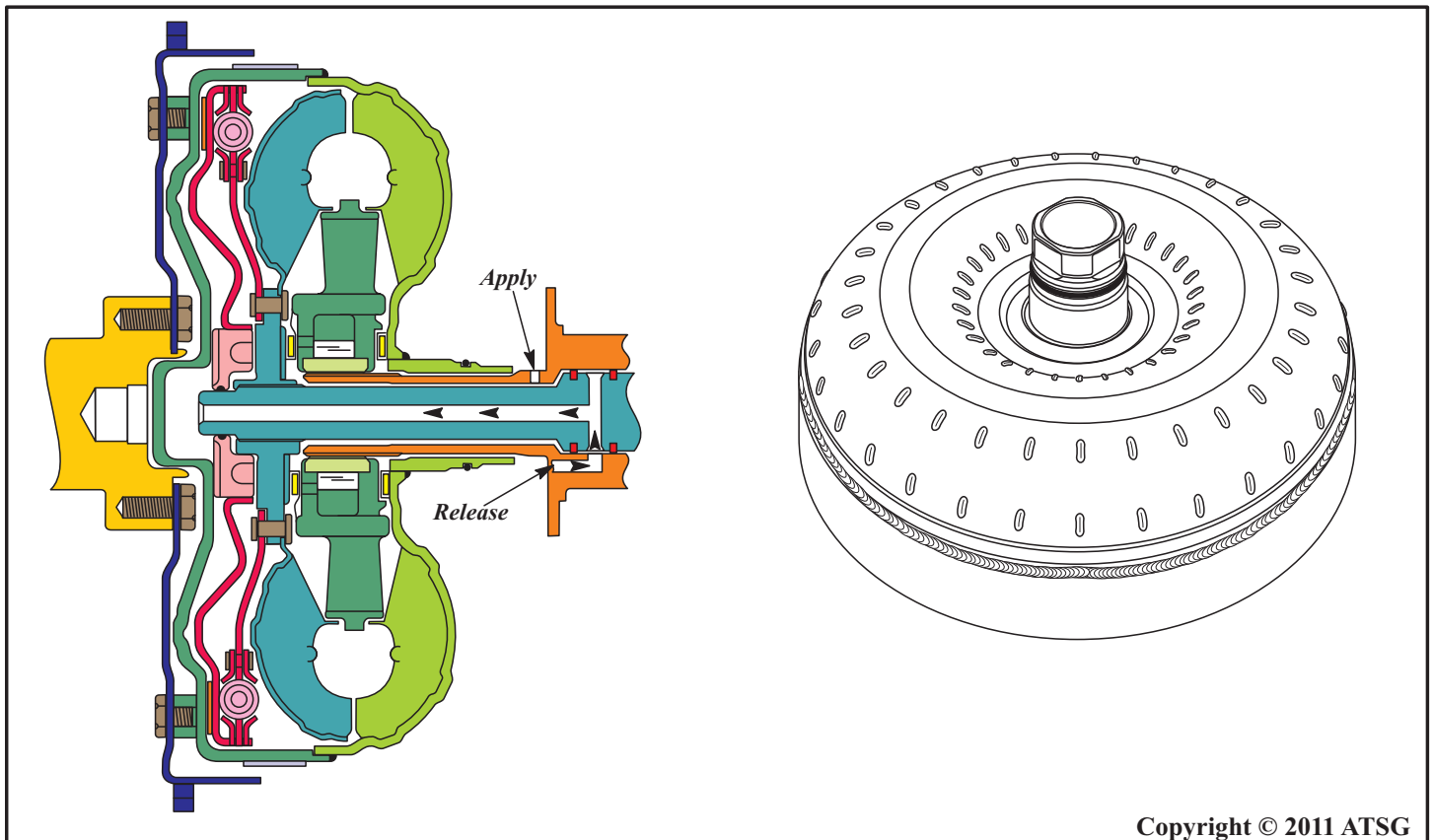
- *Shift Lever Position*
- *Current Gear Range*
- *Transmission Fluid Temperature*
- *Engine Coolant Temperature*
- *Input Speed*
- *Throttle Angle*
- *Engine Speed*
- *Switch Valve Position*

**NO EMCC** Under No EMCC conditions, the L/R-TCC Solenoid is Off. There are several things that can result in No EMCC operations. No EMCC can be initiated due to a fault in the transmission or because the TCM does not see the need for EMCC under current driving conditions

**PARTIAL EMCC** Partial EMCC operation will modulate the L/R-TCC Solenoid duty cycle to obtain partial converter clutch application. Partial EMCC operation is maintained until Full EMCC is called for and actuated. During Partial EMCC some slip does occur. Partial EMCC will usually occur at low speeds, low load and light throttle situations.

**FULL EMCC** During Full EMCC operation, the TCM increases the L/R-TCC Solenoid duty cycle to full On after Partial EMCC control brings the engine speed within the desired slip range of transmission input speed relative to engine RPM.

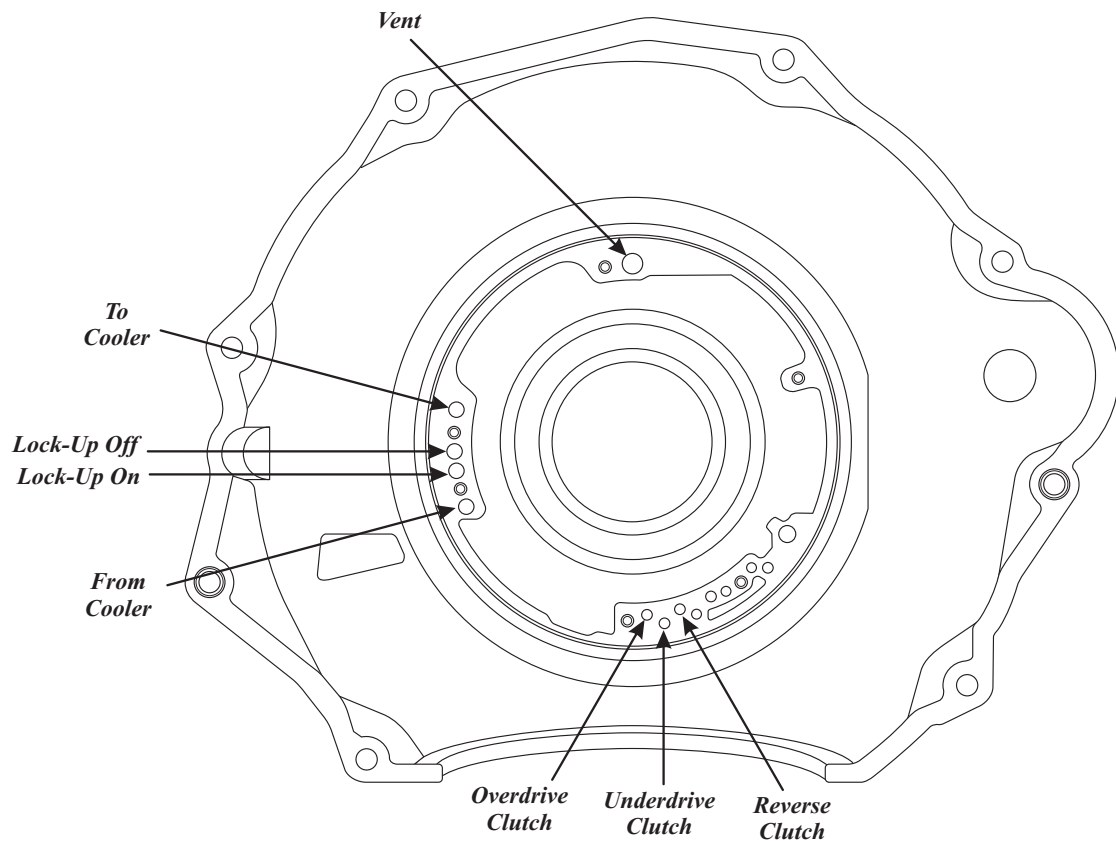
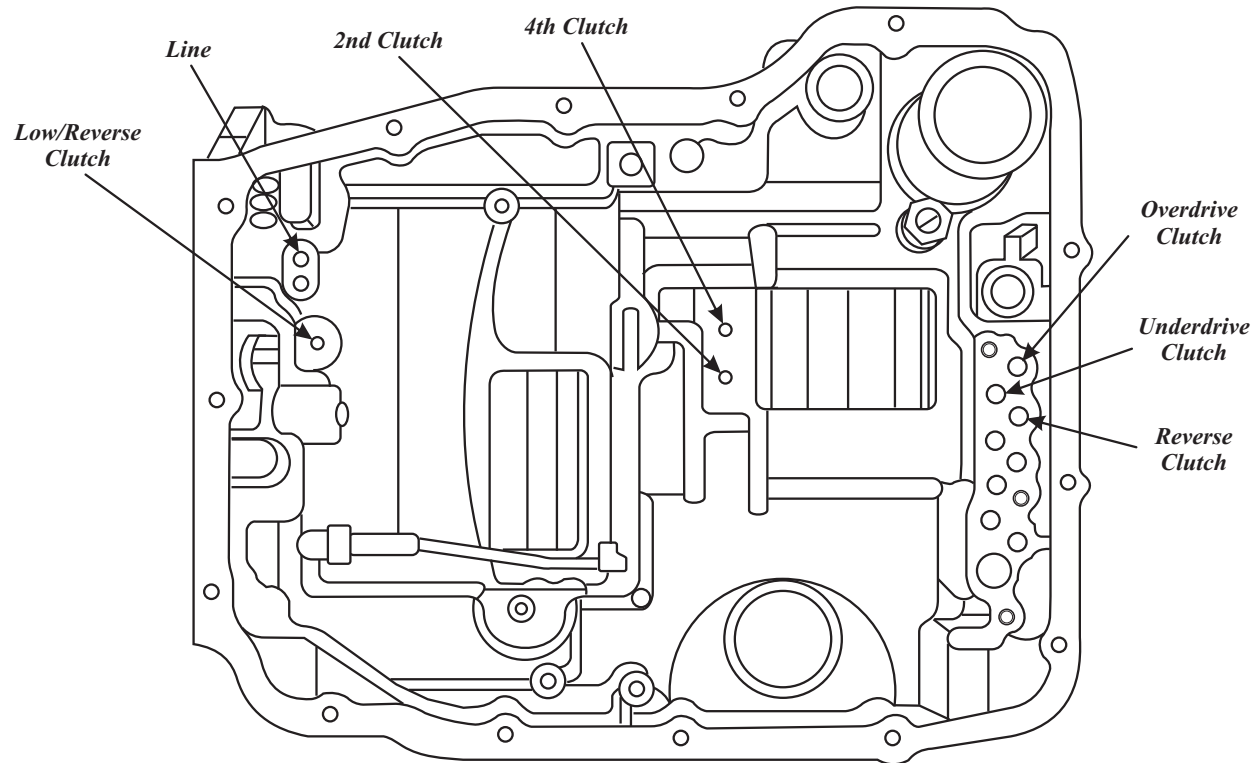
**GRADUAL EMCC RELEASE** This operation is to soften the change from Full or Partial EMCC down to No EMCC. This is done at mid-throttle by slowly decreasing the L/R-TCC Solenoid duty cycle.



Copyright © 2011 ATSG

Figure 29

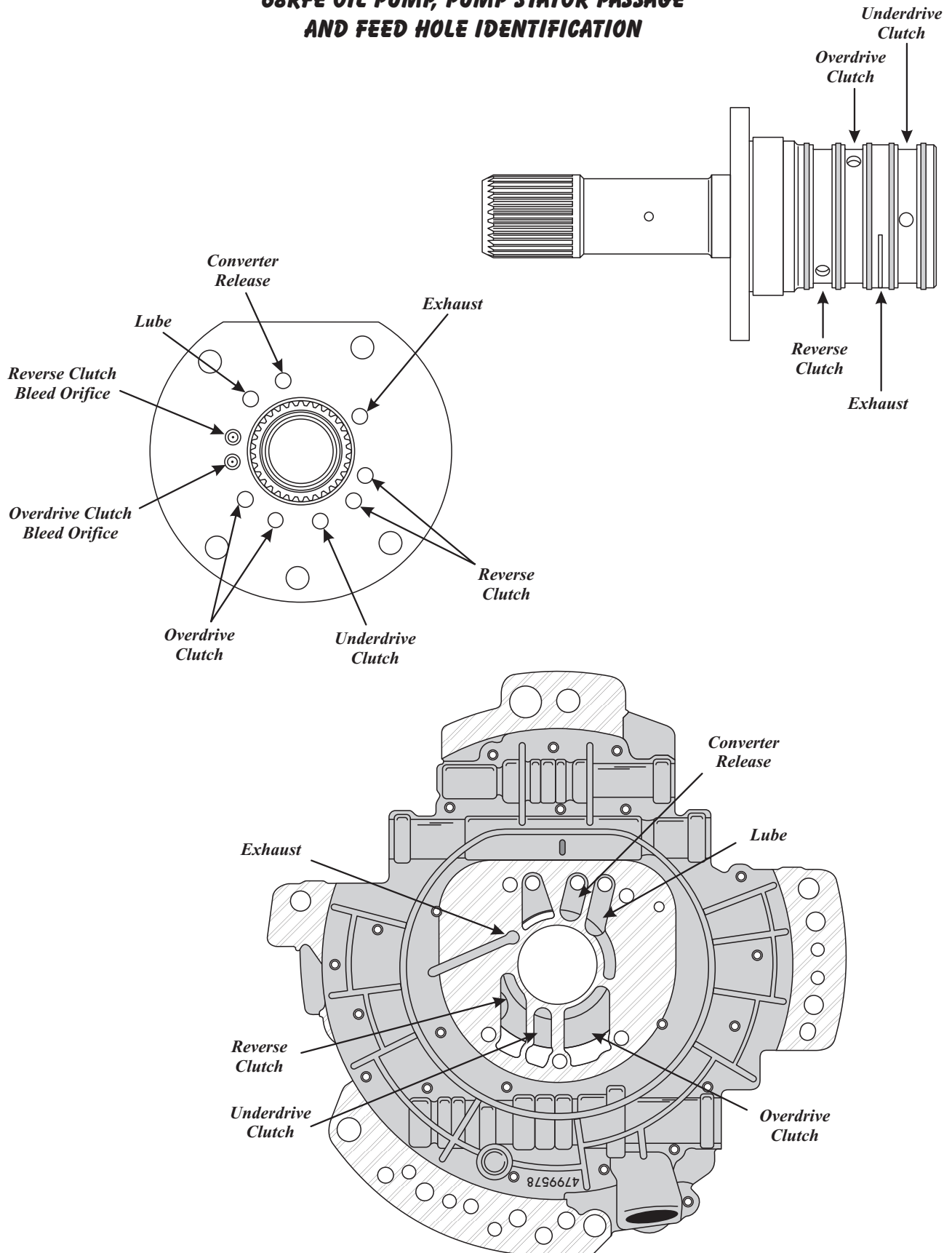
## 68RFE CASE PASSAGE IDENTIFICATION



Copyright © 2011 ATSG

Figure 30

## 68RFE OIL PUMP, PUMP STATOR PASSAGE AND FEED HOLE IDENTIFICATION



Copyright © 2011 ATSG

Figure 31

## SAFETY PRECAUTIONS

Service information provided in this manual by ATSG is intended for use by professional, qualified technicians. Attempting repairs or service without the appropriate training, tools and equipment could cause injury to you or others.

The service procedures we recommend and describe in this manual are effective methods of performing service and repair on this unit. Some of the procedures require the use of special tools that are designed for specific purposes.

This manual contains CAUTIONS that you must observe carefully in order to reduce the risk of injury to yourself or others. This manual also contains NOTES that must be carefully followed in order to avoid improper service that may damage the vehicle, tools and/or equipment.

## TRANSMISSION DISASSEMBLY

1. Drain fluid from the transmission.
2. Clean exterior of the transmission thoroughly with a suitable solvent or pressure washer.
3. Remove torque converter from the transmission, as shown in Figure 33.

**Caution:** Use care removing torque converter to prevent injury or damage as it is heavy.

4. Remove and discard the "O" ring from the converter hub, as shown in Figure 32.

Continued on Page 33

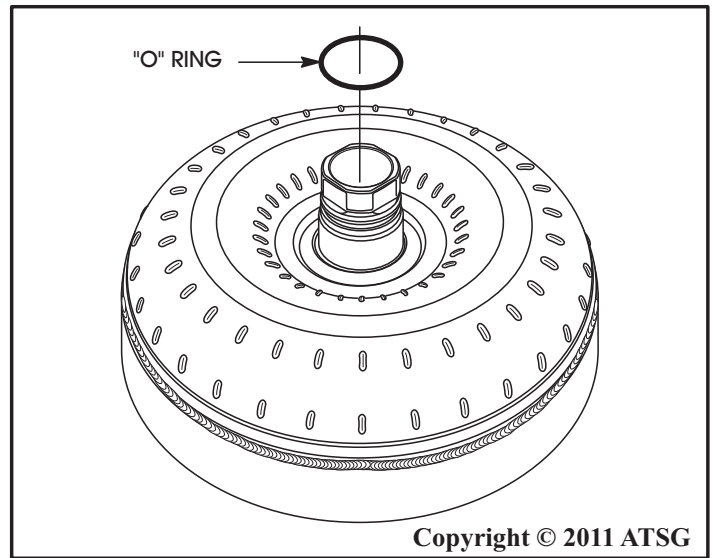


Figure 32

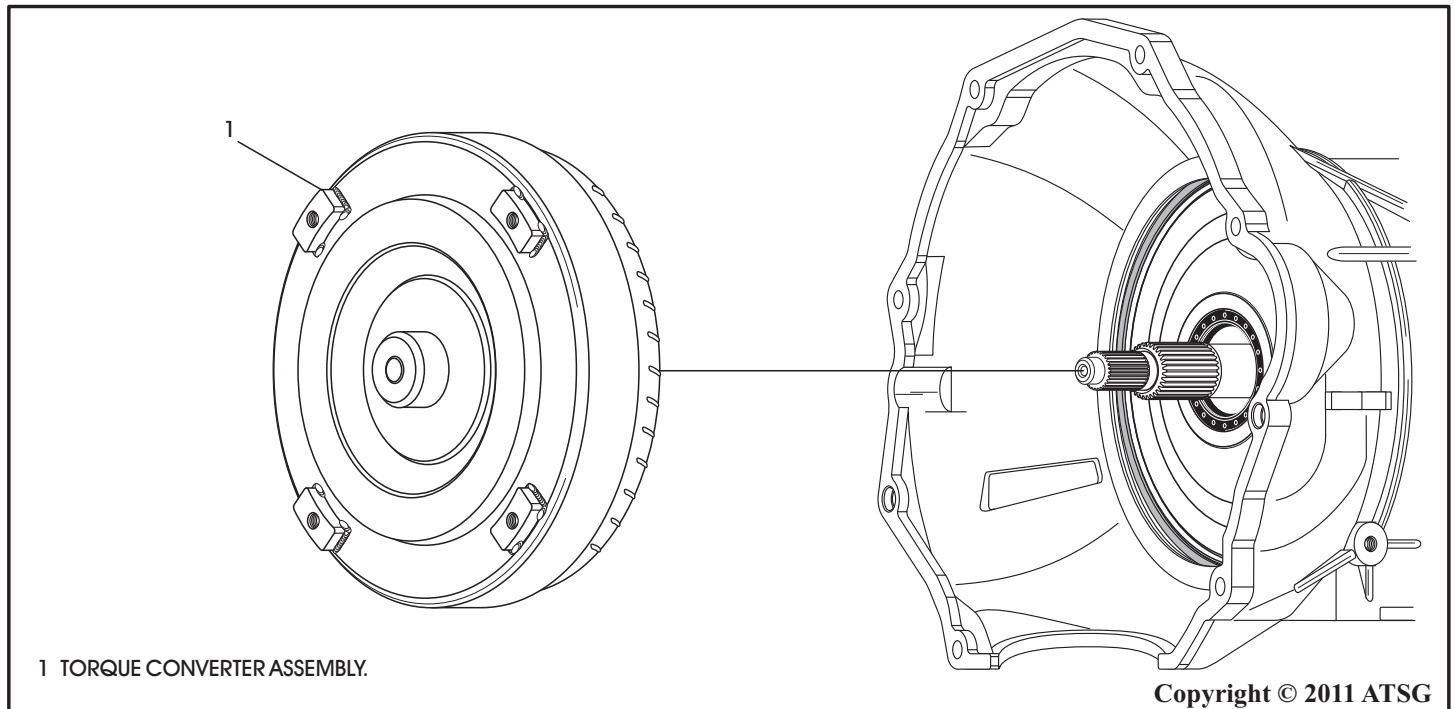


Figure 33

## TRANSMISSION DISASSEMBLY (CONT'D)

5. Remove the manual shift lever.
6. Remove both input and output speed sensors from the case, as shown in Figure 34, remove and discard both "O" rings.
7. Remove the line pressure sensor from the case, as shown in Figure 35, remove and discard the "O" rings.
8. Using a dial indicator, measure and record the input shaft end-play reading, as shown in Figure 36, for re-assembly reference.

**Note:** When measuring input shaft end-play, two "stops" will be felt. When input shaft is pushed inward and the dial indicator zeroed, the first stop felt when input shaft is pulled outward is the movement of the input shaft in the input clutch hub. This value should not be included in the end-play measurement and therefore must be recorded and subtracted from the total dial indicator reading.

Continued on Page 34

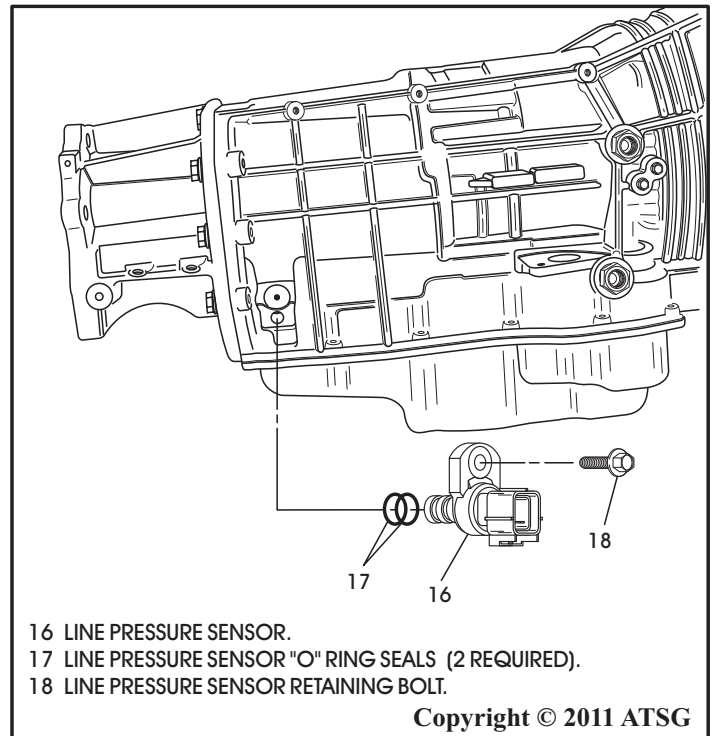


Figure 35

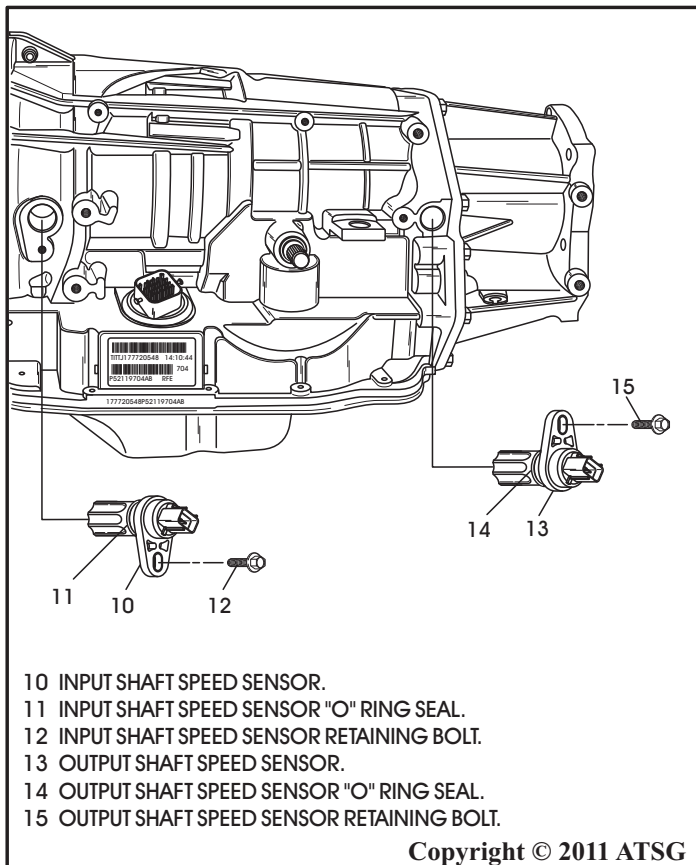


Figure 34

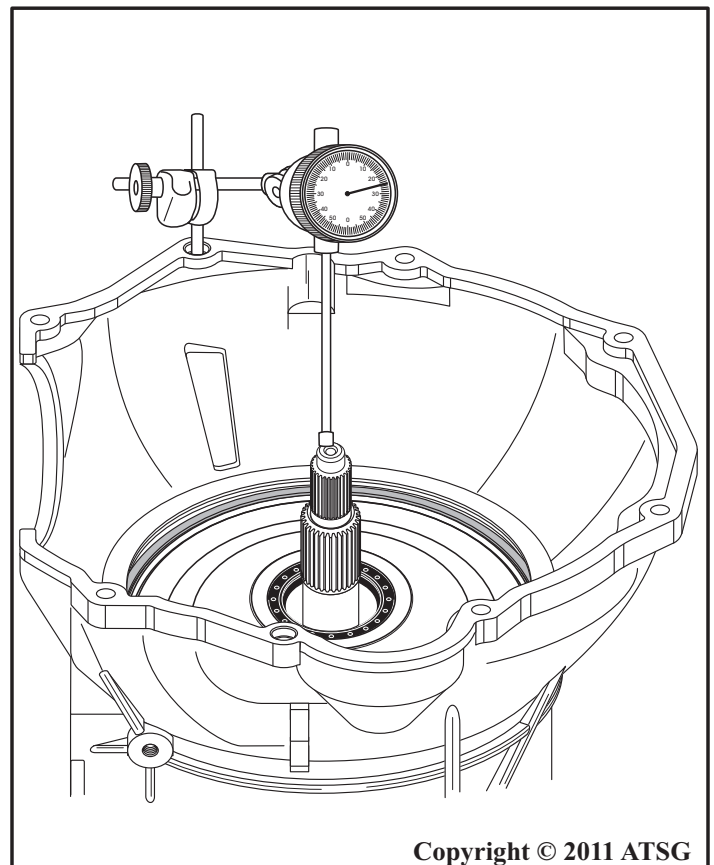


Figure 36



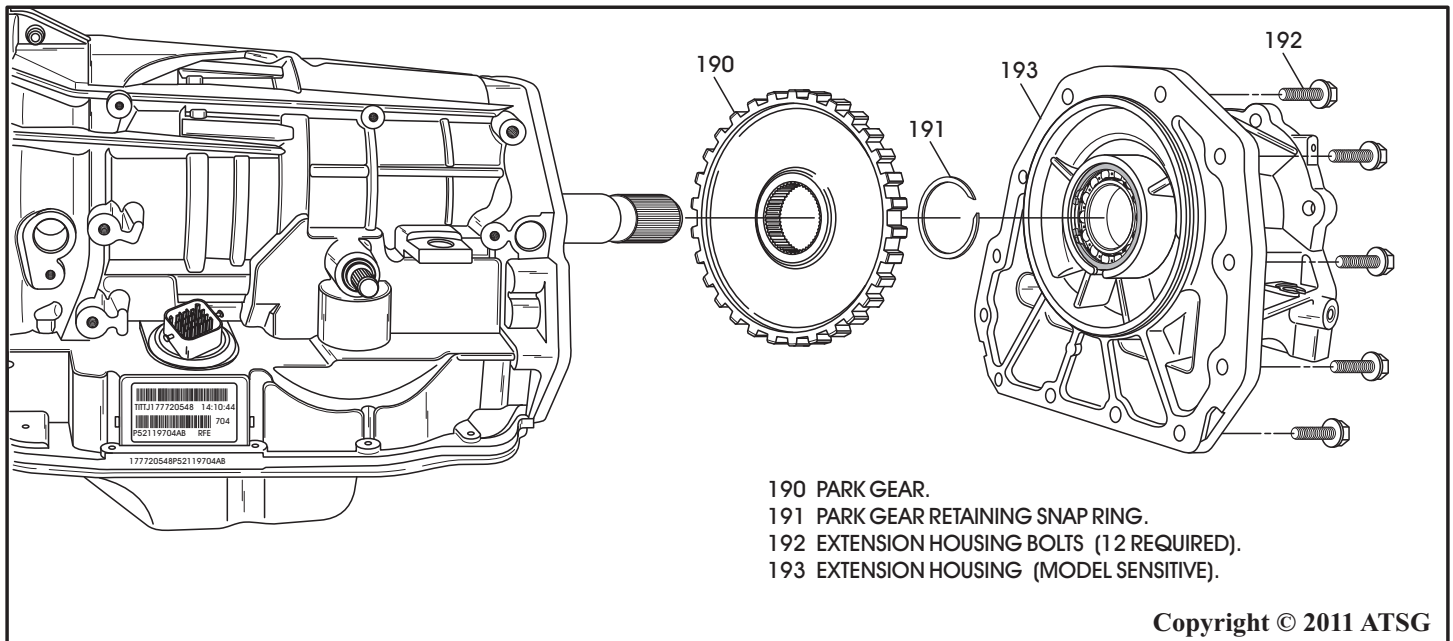


Figure 37

## TRANSMISSION DISASSEMBLY (CONT'D)

9. Remove the 12 extension housing to case retaining bolts using a 15mm socket and then remove the extension housing, as shown in Figure 37.
10. Remove the park gear snap ring from the output shaft and remove the park gear, as shown in Figure 37.
11. Using a dial indicator, measure and record the output shaft end-play reading, as shown in Figure 38, to use as a reference for re-assembly.  
**Note: Use screwdriver and small wood block to move gear train up and down, as shown in Figure 38.**

Continued on Page 35

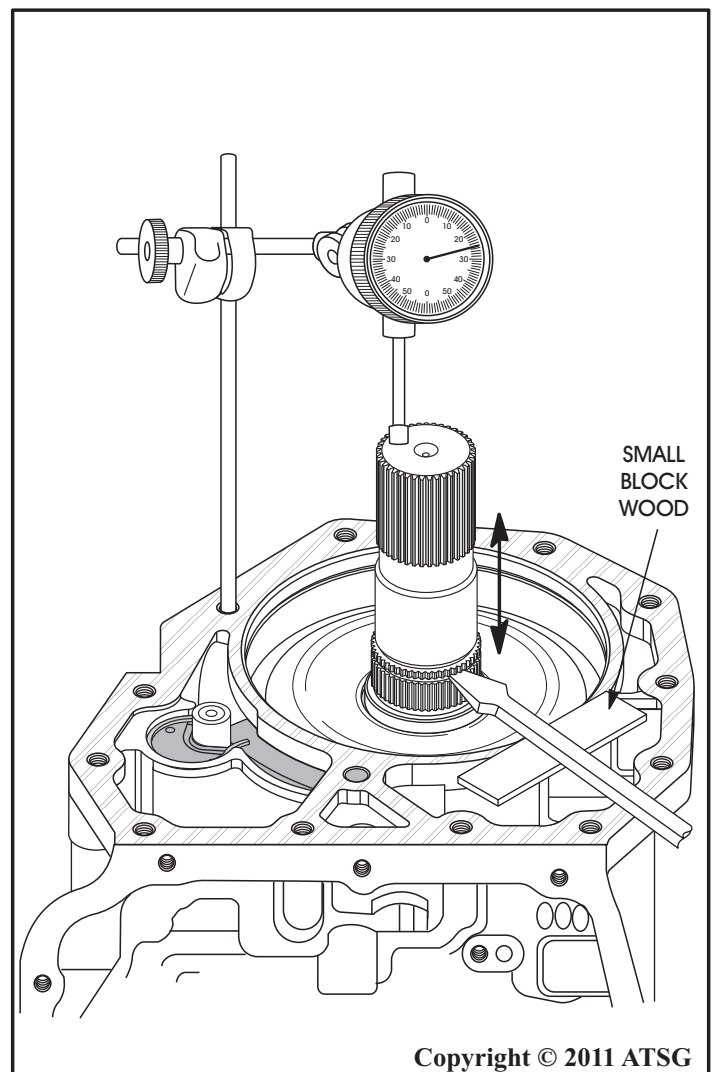


Figure 38

## TRANSMISSION DISASSEMBLY (CONT'D)

12. Remove the 15 bottom pan bolts, using an 8mm socket, as shown in Figure 39.

13. Remove bottom oil pan as shown in Figure 39.

**Note: The 68RFE uses no gaskets anywhere. The extension housing and pan are sealed with RTV**

14. Remove the bottom pan filter retaining screw, using a 25 Torx bit, as shown in Figure 40.

15. Remove and discard the bottom pan oil filter, as shown in Figure 40.

16. Remove the six valve body retaining bolts using 8mm socket, as shown in Figure 41.

17. Remove the complete valve body and the TRS/Solenoid body as an assembly, as shown in Figure 41, and set aside for component rebuild section.

**Note: The valve body to case retaining bolt locations are shown in Figure 42.**

Continued on Page 36

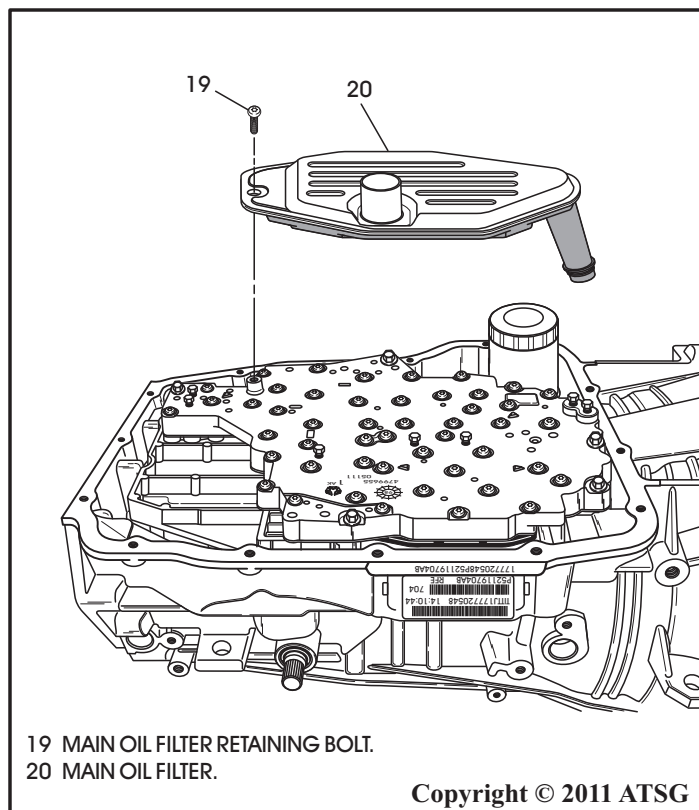


Figure 40

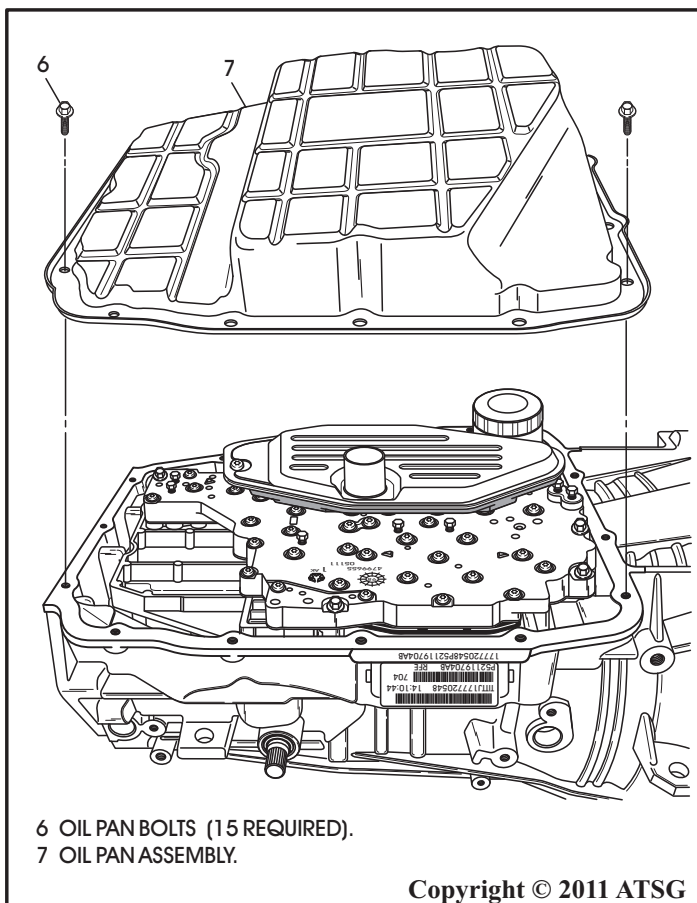


Figure 39

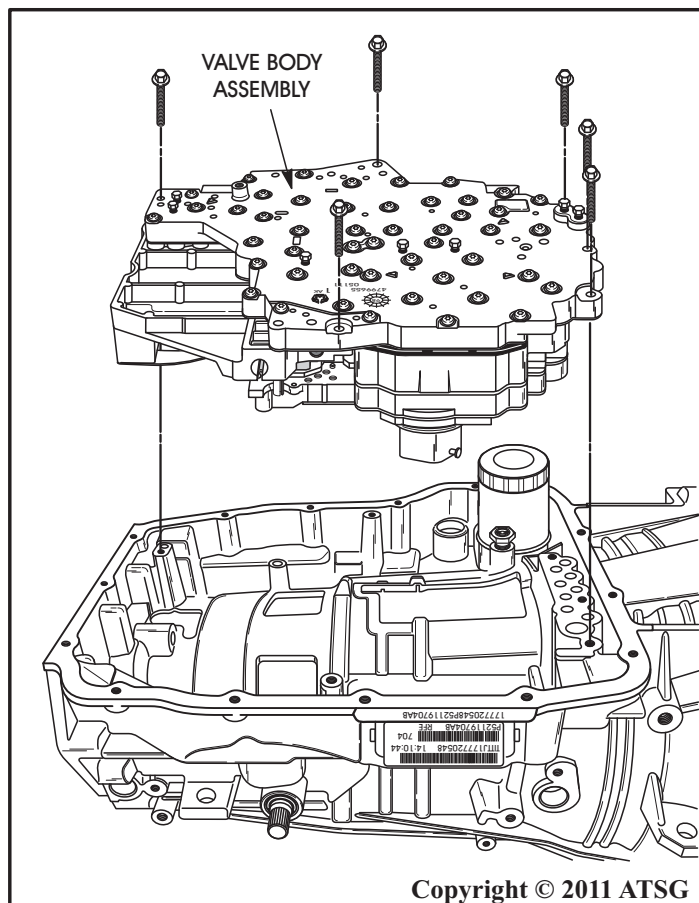


Figure 41

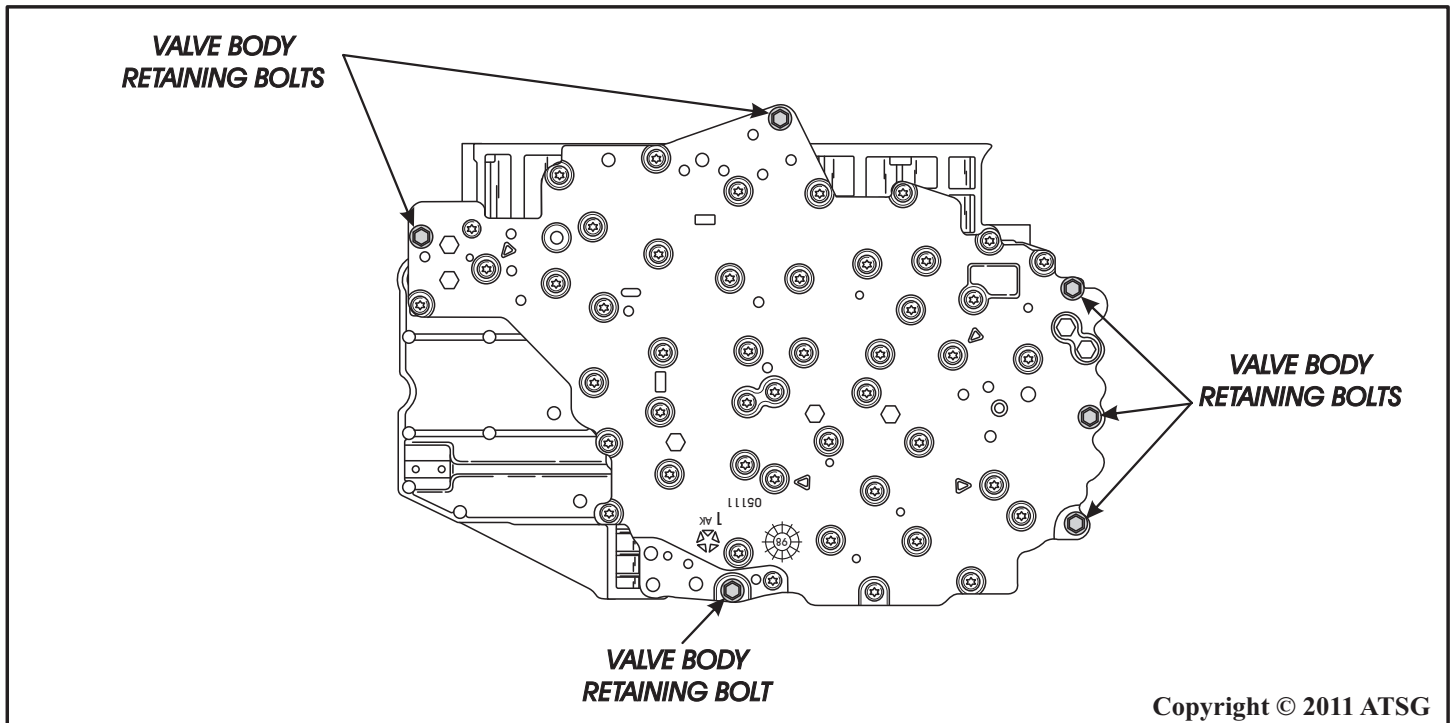


Figure 42

## TRANSMISSION DISASSEMBLY (CONT'D)

18. Remove and discard the cooler oil filter from the transmission case, as shown in Figure 43.
19. Remove the cooler by-pass valve assembly from the transmission case, as shown in Figure 43.

*Note: May need replacement depending on the degree of unit destruction and amount of debris that it contains.*

Continued on Page 37

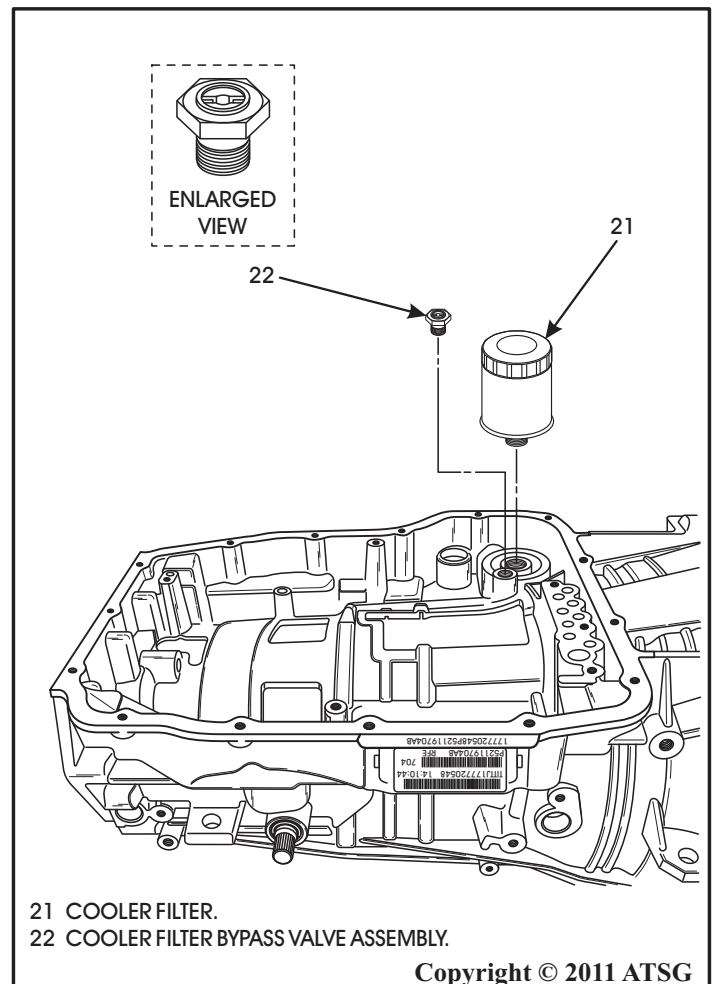


Figure 43

## TRANSMISSION DISASSEMBLY (CONT'D)

20. Remove the snap ring retaining the transmission front cover in the transmission case, as shown in Figure 44.

21. Reach through one of the case openings in the valve body area with a long blunted tool, and tap the transmission front cover from the case. Refer to Figure 44.

**Note:** In the 68RFE the torque converter hub seal is located in the front cover instead of the oil pump body, as in previous models.

22. Remove and discard the converter hub seal from front cover.

23. Remove and discard front cover to case "O" ring seal as it is included in after-market kits.

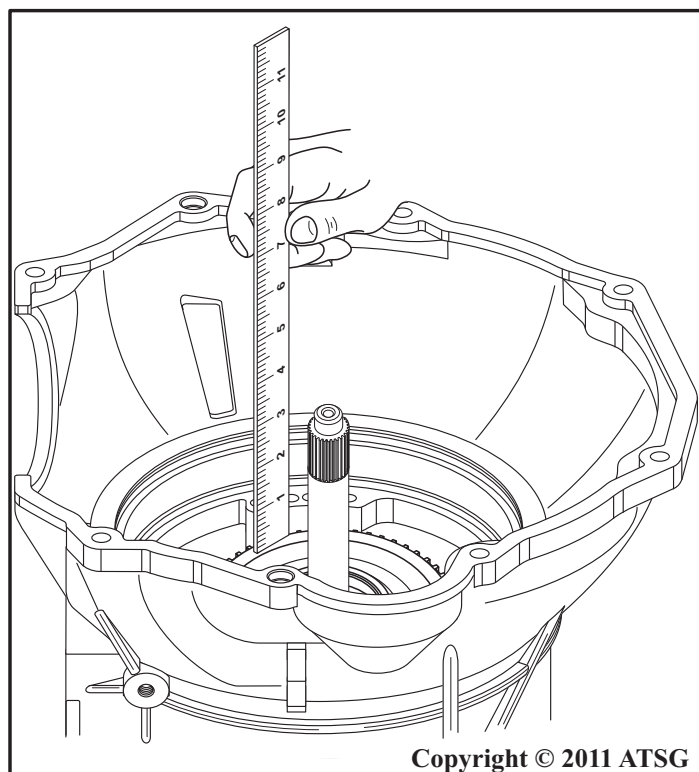
24. Remove the six bolts retaining the oil pump in the transmission case (See Figure 44).

25. Remove oil pump assembly from transmission case, as shown in Figure 44, and set aside for component rebuild section.

**Note:** Notice the oil pump body no longer has a pocket for the converter hub seal.

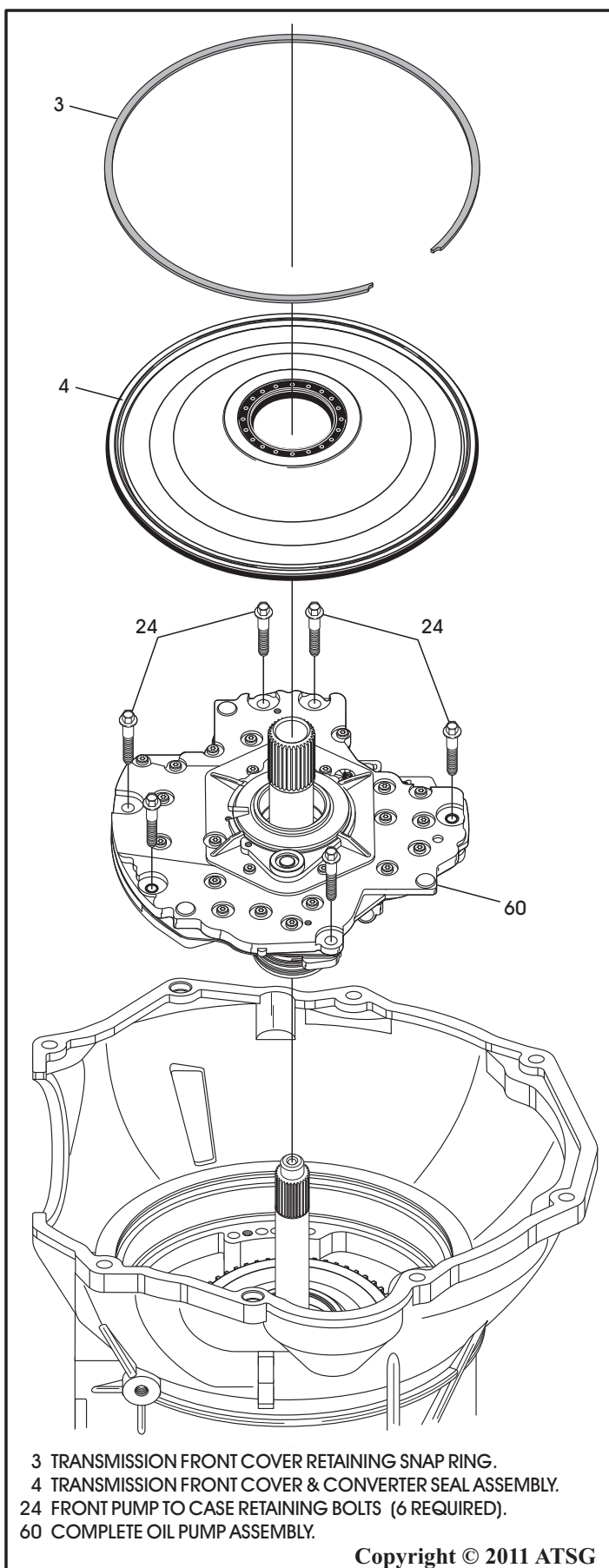
26. Before removing the input housing, measure and record the installed distance from input clutch hub to the case oil pump surface, as shown in Figure 45, for re-assembly verification.

Continued on Page 38



Copyright © 2011 ATSG

Figure 45



3 TRANSMISSION FRONT COVER RETAINING SNAP RING.  
4 TRANSMISSION FRONT COVER & CONVERTER SEAL ASSEMBLY.  
24 FRONT PUMP TO CASE RETAINING BOLTS (6 REQUIRED).  
60 COMPLETE OIL PUMP ASSEMBLY.

Copyright © 2011 ATSG

Figure 44



## TRANSMISSION DISASSEMBLY (CONT'D)

27. Remove the input clutch housing assembly by lifting straight up, as shown in Figure 46.
28. Remove the number 1 thrust bearing from inside the input housing, as shown in Figure 46.
29. Remove number 5 thrust bearing and "selective" thrust bearing spacer, as shown in Figure 46.  
*Note: Number 5 thrust bearing has 3 equally spaced "protrusions" around the outside diameter that snaps into the selective spacer, as shown in Figure 47. This selective spacer is used to set front transmission end-play.*
30. Set the input clutch housing assembly aside for component rebuild section.

Continued on Page 39

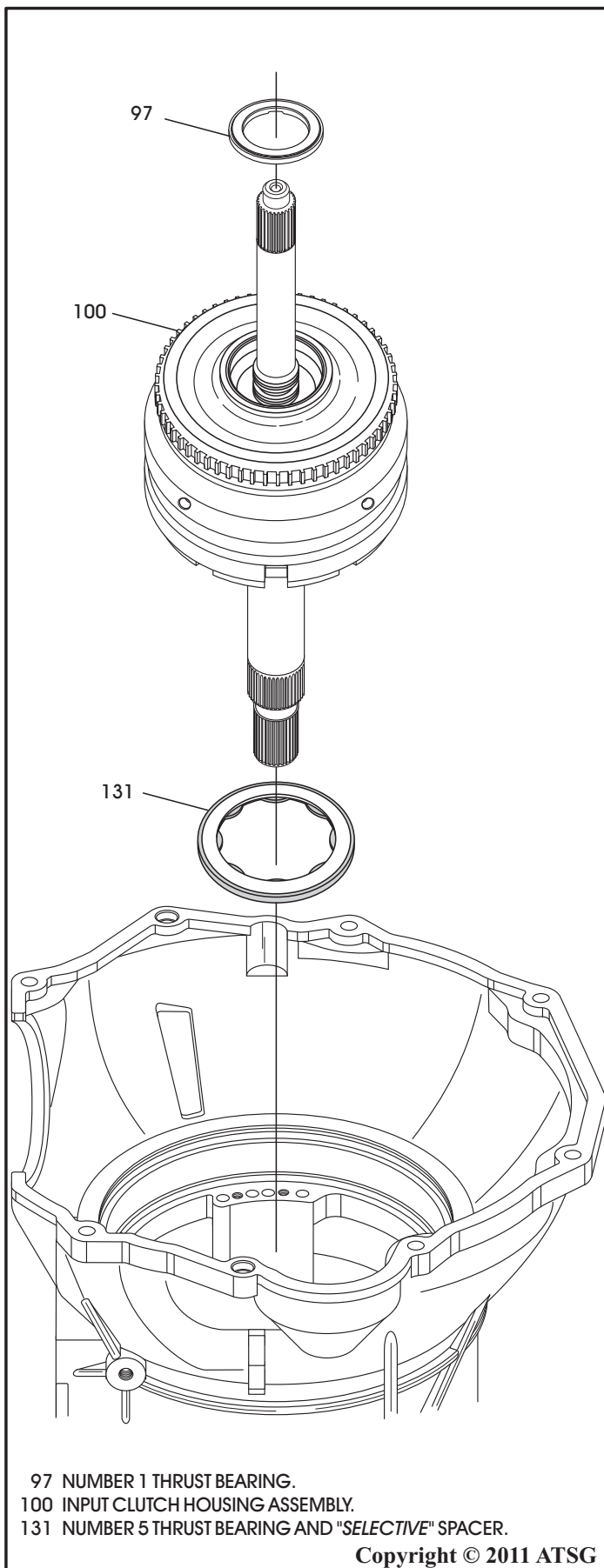


Figure 46

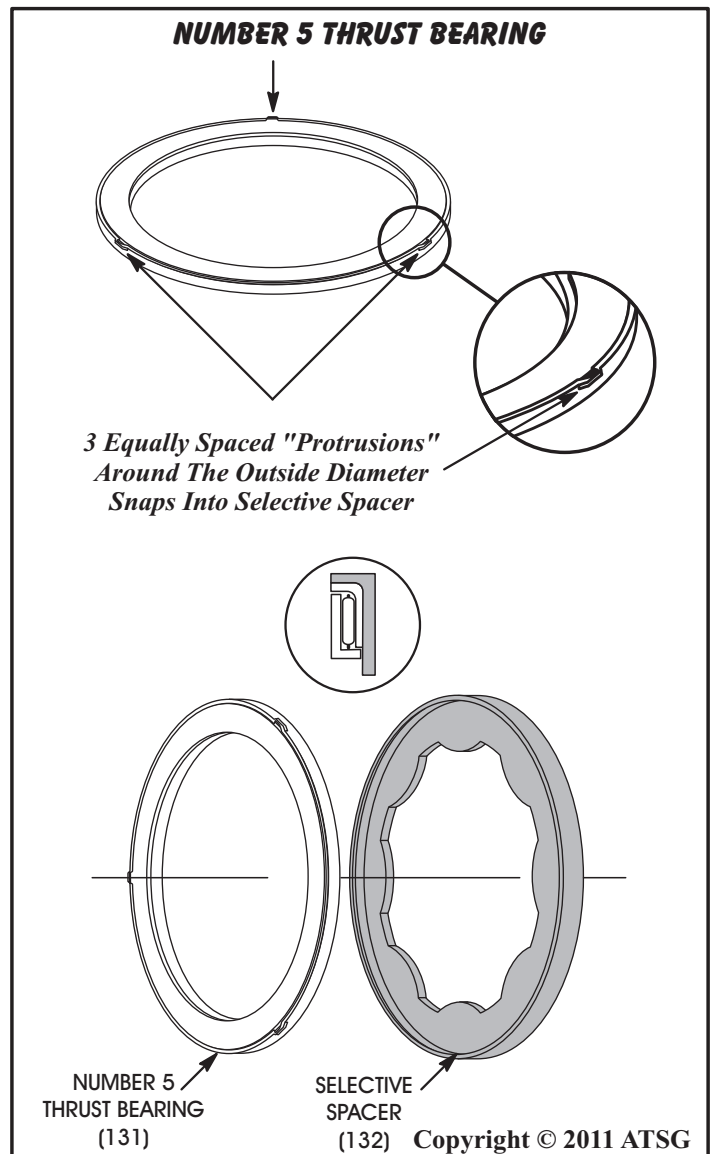


Figure 47



## TRANSMISSION DISASSEMBLY (CONT'D)

31. Remove the 2-4 clutch retainer front snap ring, which is a **tapered** snap ring, from case as shown in Figure 48.
32. Remove the 2-4 clutch retainer from the case, as shown in Figure 48, and set aside for component rebuild section.

33. Remove the 2-4 clutch retainer rear snap ring, which is a **flat** snap ring from the case, as shown in Figure 48.
34. Remove the 2nd clutch pack, 3 steel plates and 3 friction plates, as shown in Figure 49.
35. Remove the 2nd clutch backing plate from the case, as shown in Figure 49.

Continued on Page 40

ProCarManuals.com

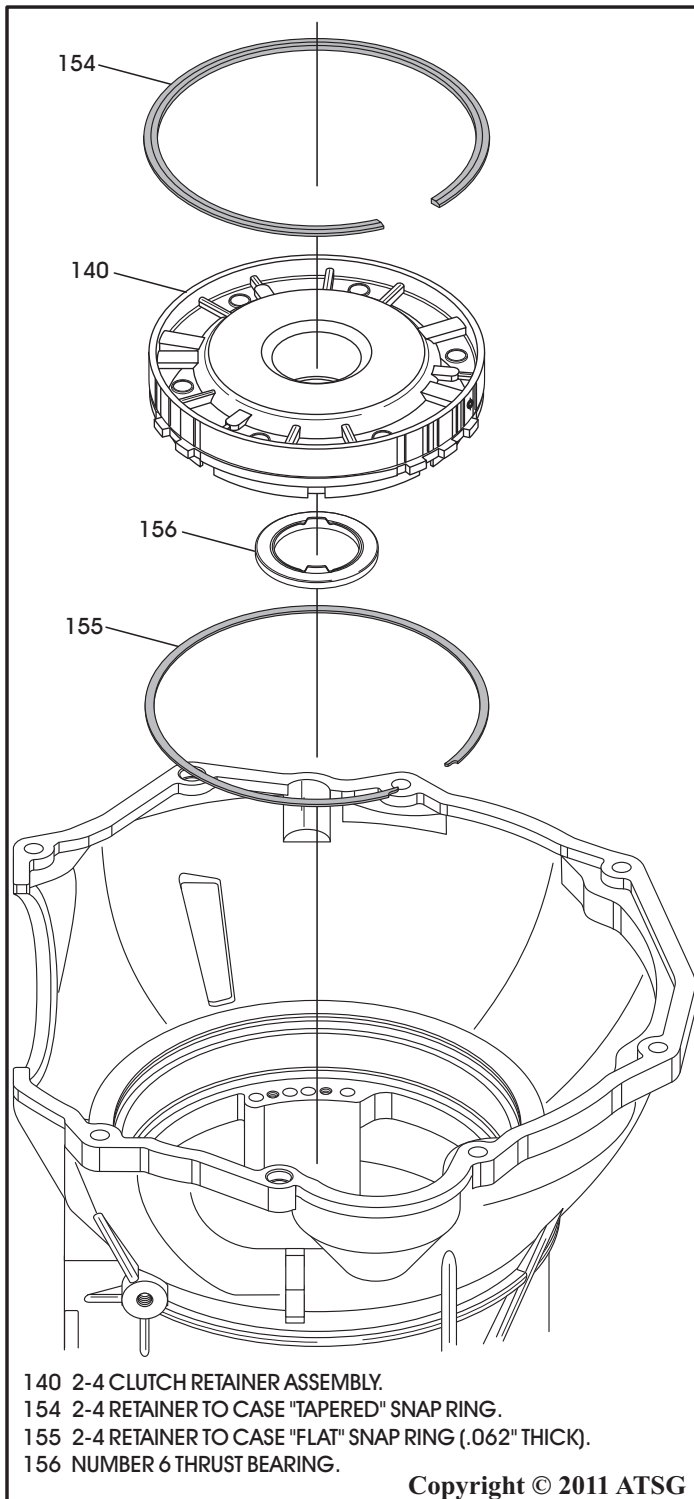


Figure 48

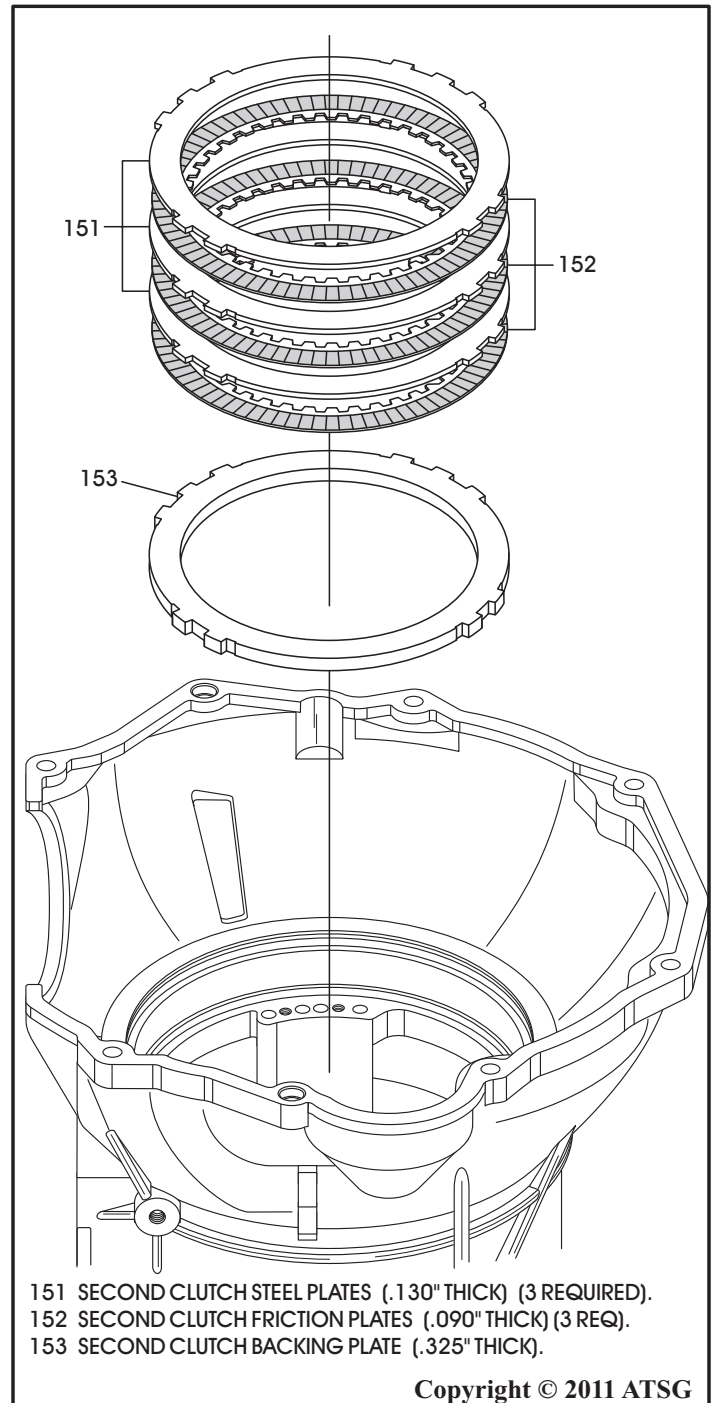


Figure 49

## TRANSMISSION DISASSEMBLY (CONT'D)

36. Remove number 6 thrust bearing if it is present, as shown in Figure 50. It may have been stuck to the 2-4 clutch retainer.
37. Remove the 4th clutch hub and reaction sun gear along with the number 7 thrust washer, as shown in Figure 50.

**Note:** 68RFE does not use a number 7 thrust "bearing" because the sun gear is now part of the 4th clutch hub. We have renumbered the washer to number 7 to keep the numbers in sequence and it is the selective for setting the transmission rear end-play.

38. Remove the number 8 thrust bearing and the reaction carrier/reverse sun gear, as shown in Figure 51.

**Note:** You will notice all planetary carriers are now 6 pinion carriers in this unit.

39. Remove the number 9 thrust bearing, as shown in Figure 51.

**Note:** Number 9 thrust bearing may be stuck back side of sun gear.

Continued on Page 41

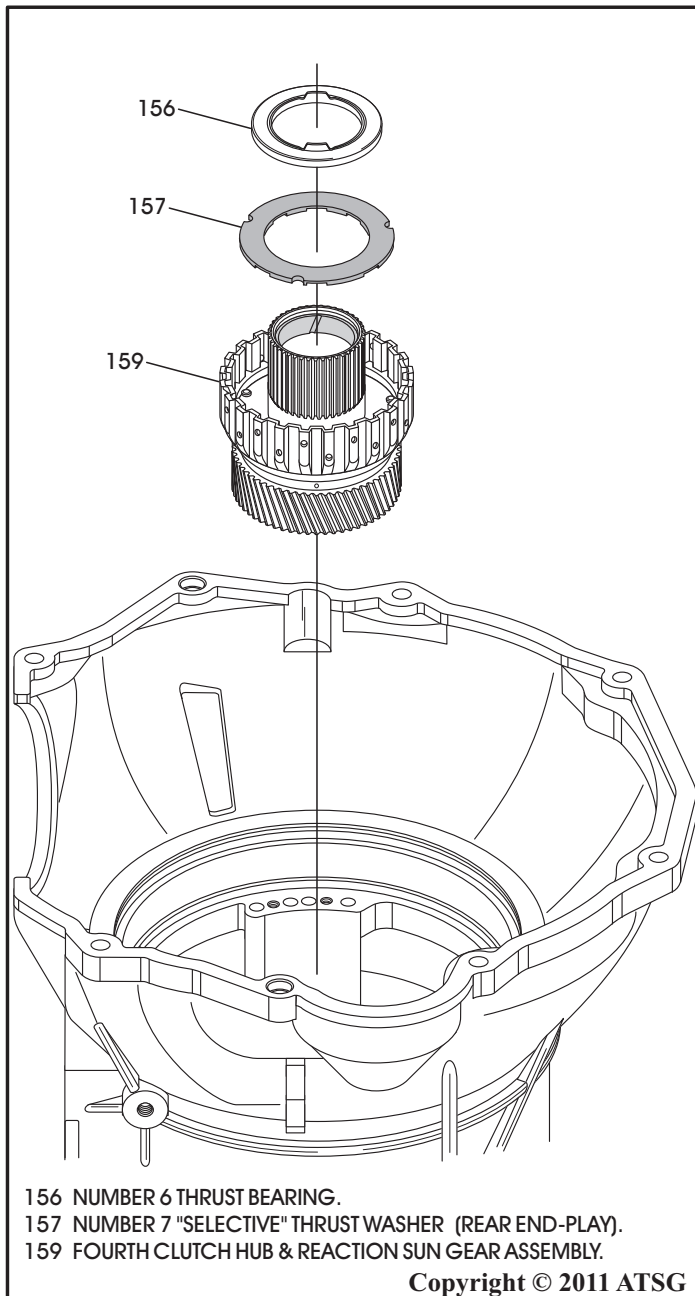


Figure 50

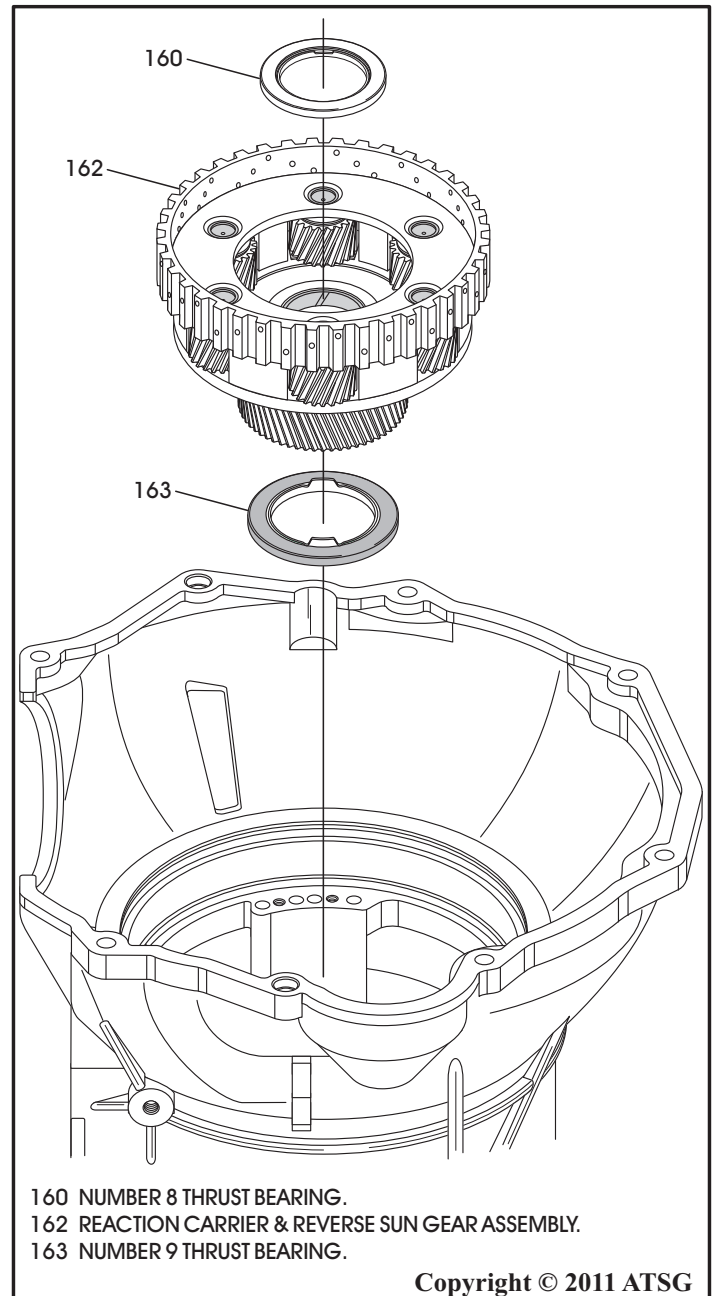


Figure 51

## TRANSMISSION DISASSEMBLY (CONT'D)

40. Remove the complete planetary geartrain as an assembly, as shown in Figure 52, and set aside for component rebuild section.
41. Remove the number 12 thrust bearing, as shown in Figure 53.

**Note:** Number 12 thrust bearing may be stuck to back side of output shaft.

42. Remove the low sprag assembly, as shown in Figure 53, and set aside for component rebuild section.

Continued on Page 42

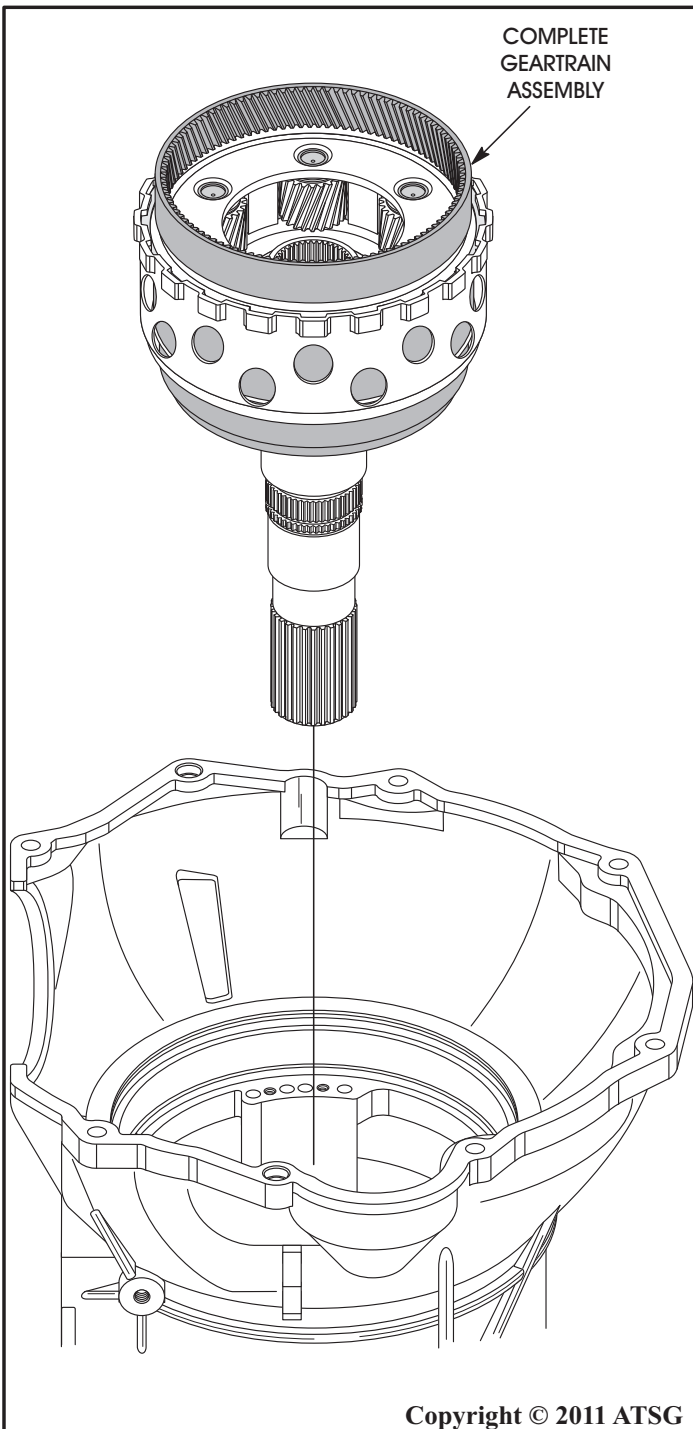


Figure 52

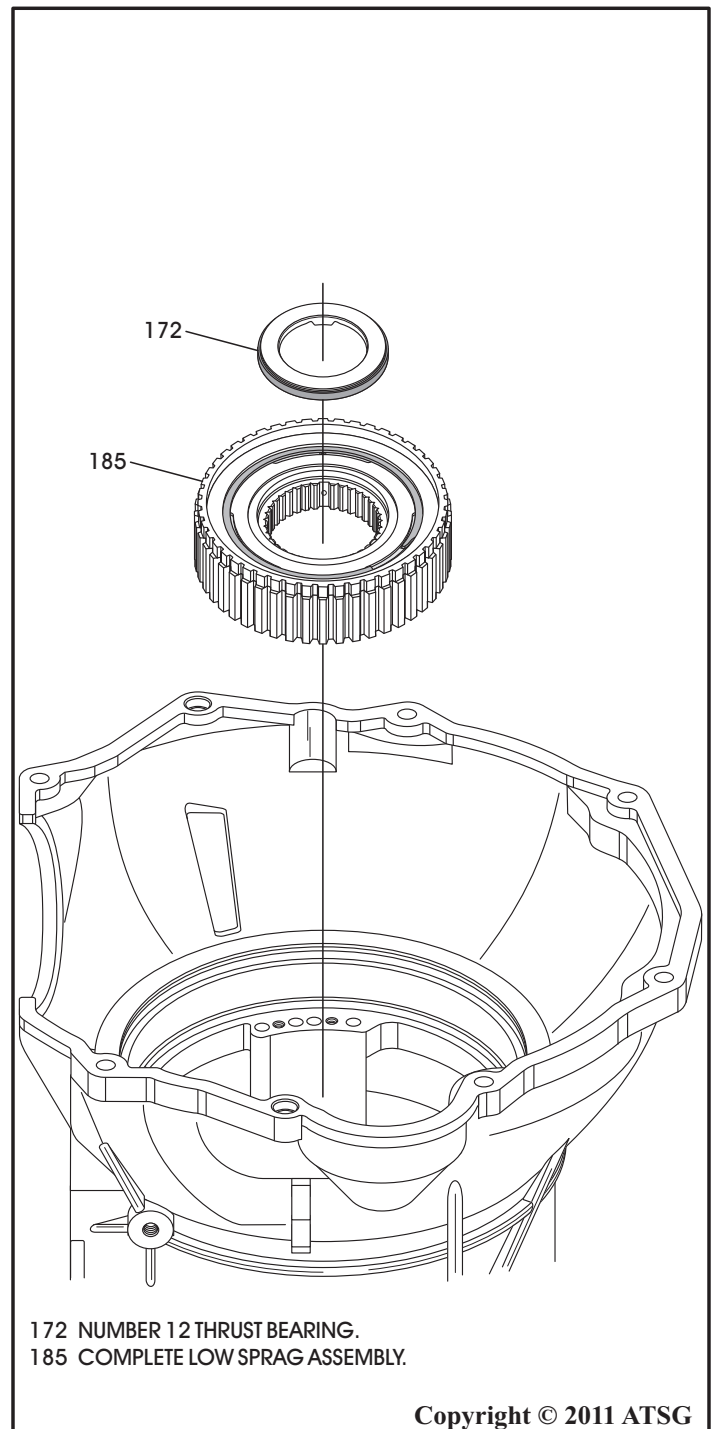


Figure 53

## TRANSMISSION DISASSEMBLY (CONT'D)

43. Remove the "tapered" snap ring from the case that retains the low/reverse clutch housing in transmission case, as shown in Figure 54.
44. Remove the complete low/reverse clutch housing from the case, as shown in Figure 54, and set aside for component rebuild.

45. Remove the park actuating rod "E" clip from the manual lever, as shown in Figure 55 and 56.
46. Remove the park actuating rod assembly from transmission, as shown in Figure 55 and 56.
47. Remove the manual shaft and lever assembly retaining pin bolt using a 30 Torx bit, as shown in Figure 55 and 56.
48. Remove the manual shaft and lever assembly through the inside of case (See Figure 55 & 56).

Continued on Page 43

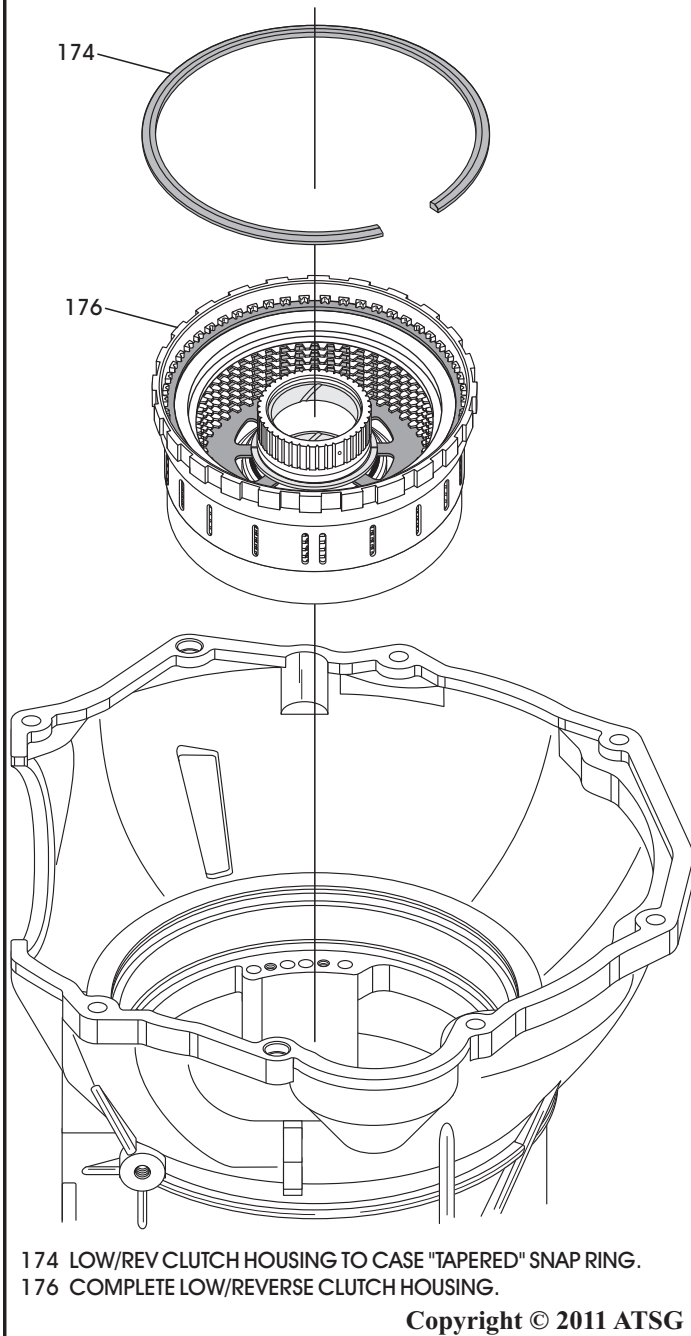


Figure 54

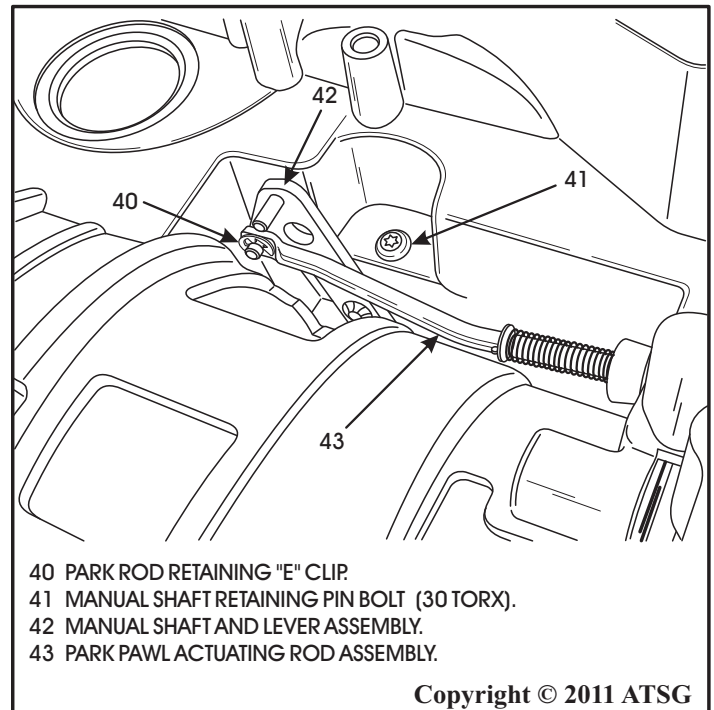


Figure 55

## TRANSMISSION DISASSEMBLY (CONT'D)

49. Remove and discard the manual shaft seal, as shown in Figure 56.
50. It is not normally necessary to remove the park pawl unless there is damage.
51. If it does become necessary, use an appropriate size pin punch through the access hole at rear of the case to push out the park pawl pivot pin, as shown in Figure 57.
52. Remove the park pawl and return spring through the inside of the case (See Figure 57).

**Component Rebuild  
Begins on Page 44**

ProCarManuals.com

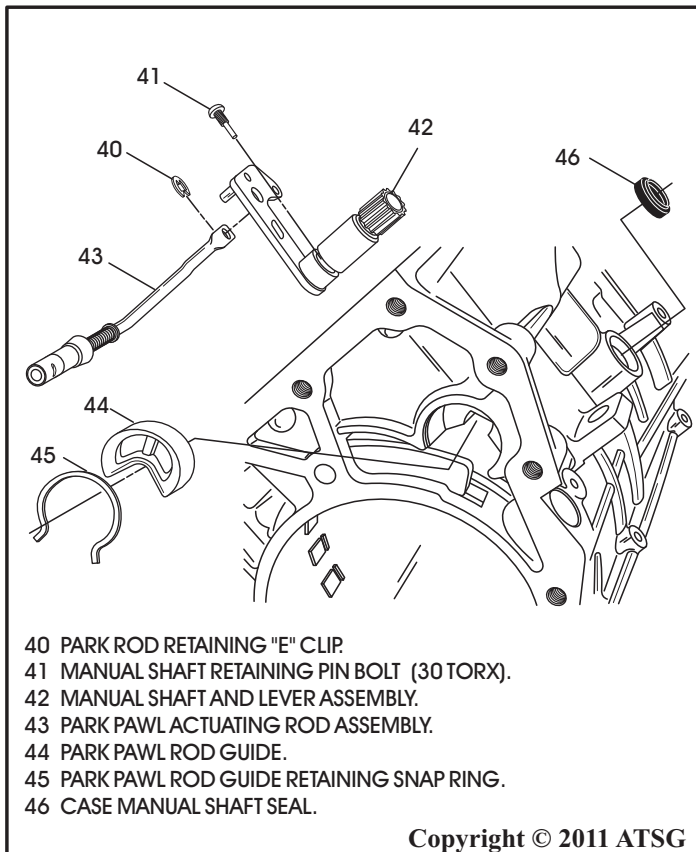


Figure 56

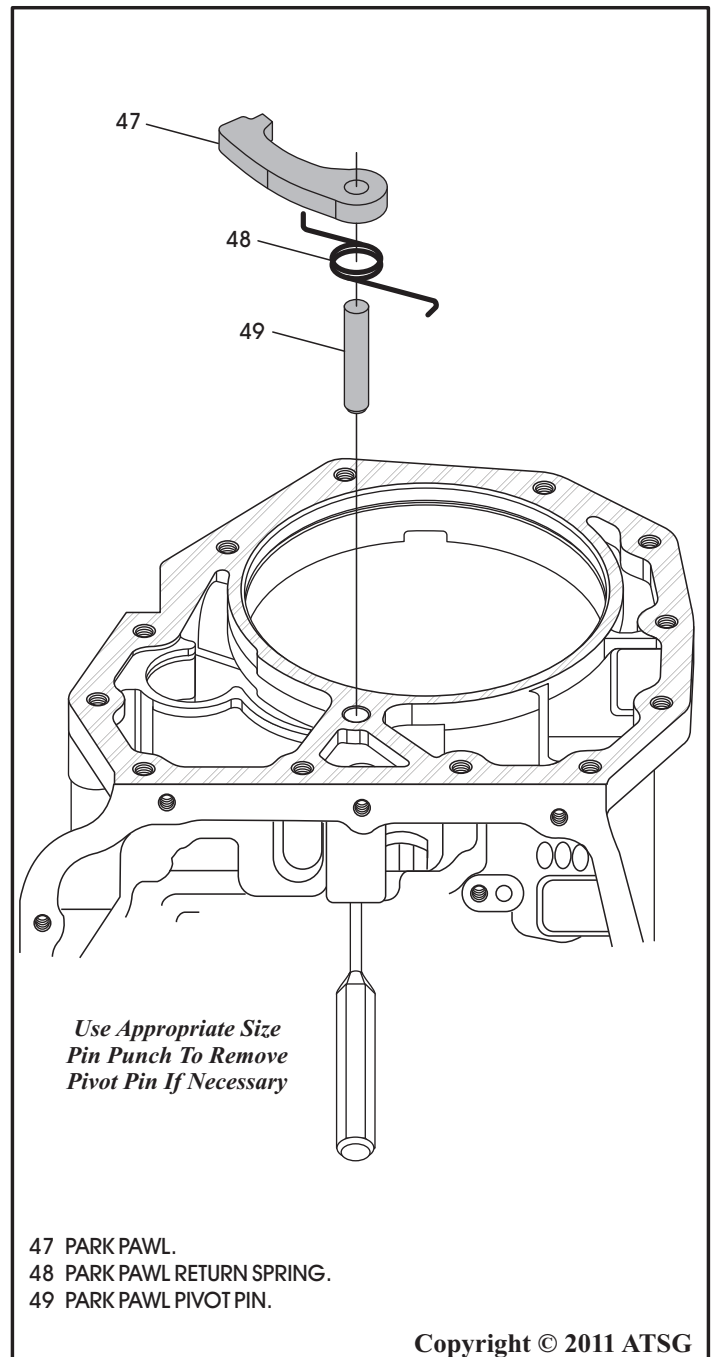


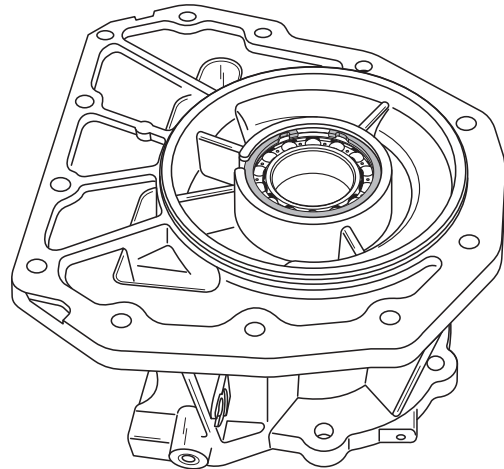
Figure 57



## COMPONENT REBUILD EXTENSION HOUSING OR 4WD ADAPTER

1. Install new extension housing seal, as shown in Figure 58, using the proper seal driver.
- Note: 4WD Adapter shown, but procedure is the same for 2WD models.*
2. Install new output shaft ball bearing assembly as necessary, as shown in Figure 58.
3. Install the ball bearing retaining snap ring, as shown in Figure 58.
4. Set the completed extension housing or 4WD adapter aside for the final assembly process.

## COMPLETED EXTENSION HOUSING



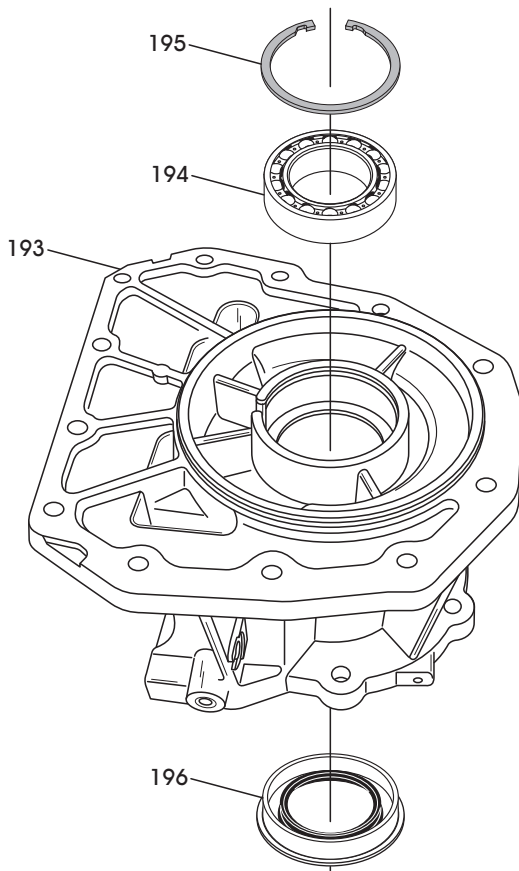
Copyright © 2011 ATSG

Figure 59

## TRANSMISSION CASE ASSEMBLY

1. Install new case manual shaft seal into the case, as shown in Figure 60, using the proper driver.
2. Lubricate the installed seal with a small amount of Trans-Jel®.

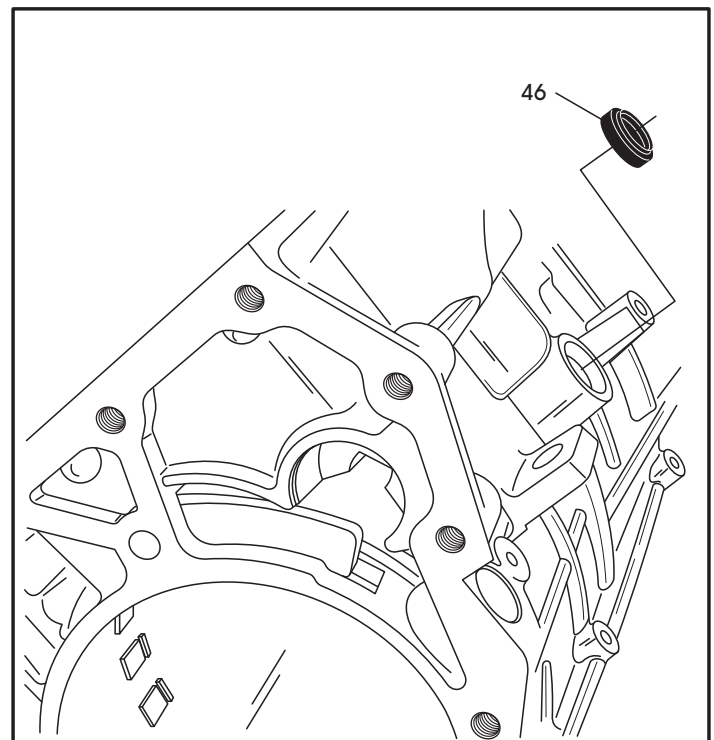
Continued on Page 45



193 EXTENSION HOUSING (MODEL SENSITIVE).  
194 OUTPUT SHAFT BALL BEARING.  
195 OUTPUT SHAFT BALL BEARING RETAINING SNAP RING.  
196 EXTENSION HOUSING SEAL (MODEL SENSITIVE).

Copyright © 2011 ATSG

Figure 58



46 CASE MANUAL SHAFT SEAL.

Copyright © 2011 ATSG

Figure 60

## TRANSMISSION CASE ASSEMBLY (CONT'D)

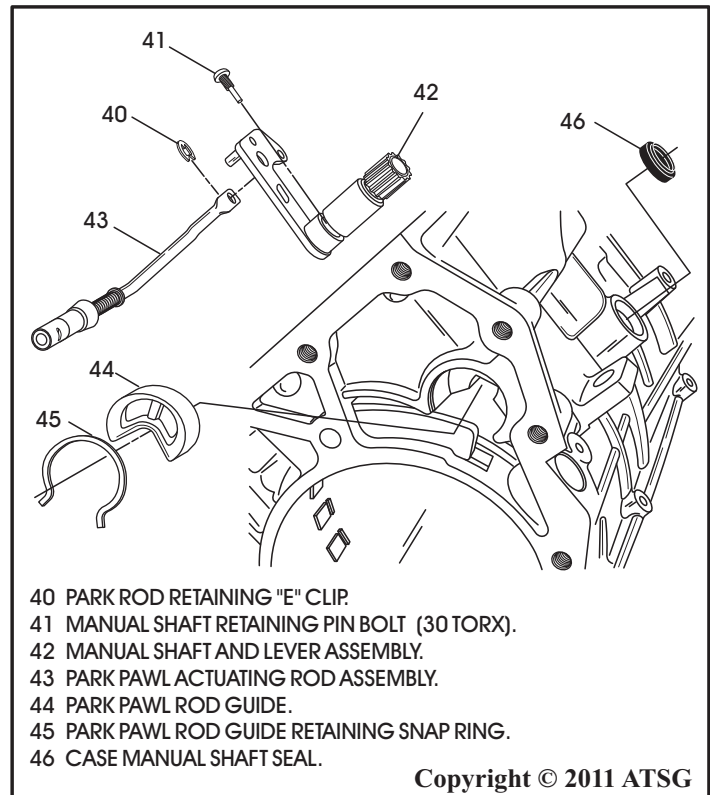
3. Install the park pawl and park pawl return spring through back of case into position, and insert the pivot pin, as shown in Figure 61.
4. Install the park rod guide into the transmission case, as shown in Figure 62.
5. Install the park rod guide retaining snap ring in case groove using a pair of pliers and ensure that it is fully seated (See Figure 62).
6. Install manual shaft and lever assembly through the inside of case and into the manual shaft case bore, as shown in Figure 62.
7. Install manual shaft and lever assembly retaining pin bolt, using a 30 torx bit and torque the bolt 28 N·m (20 ft.lb.). (See Figure 62 and 64).
8. Install park actuating rod assembly through park rod guide and parking pawl, and onto the pin on manual lever (See Figure 62 and 64).

**Note:** Ensure that park actuating rod is seated between park pawl and park guide, as shown in Figure 63.

9. Install the park rod retaining "E" clip and insure that it is fully seated, as shown in Figure 64.

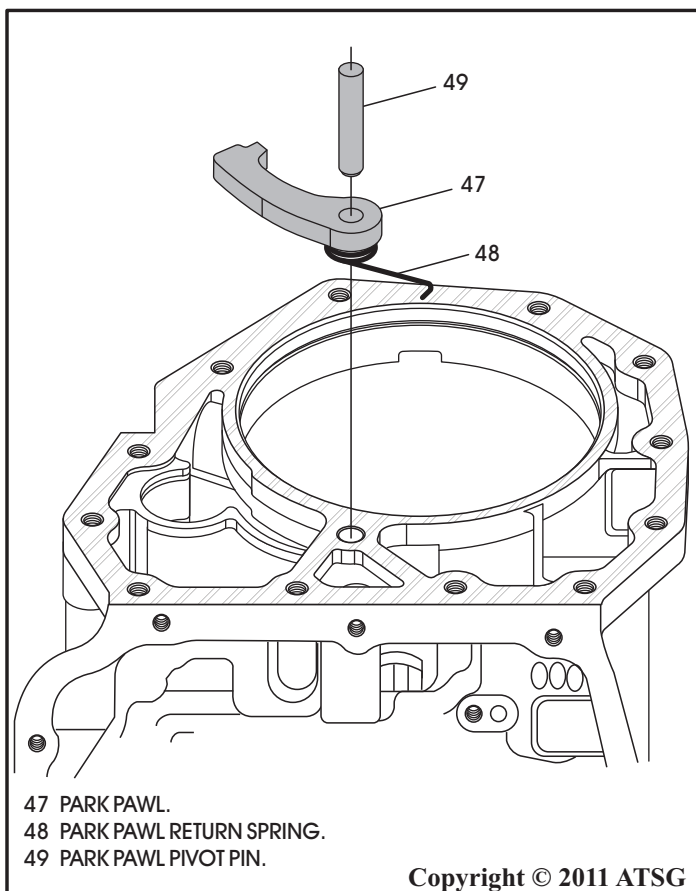
10. Ensure that parking linkage is working properly and set case aside for the final assembly process.

## Component Rebuild Continued on Page 46



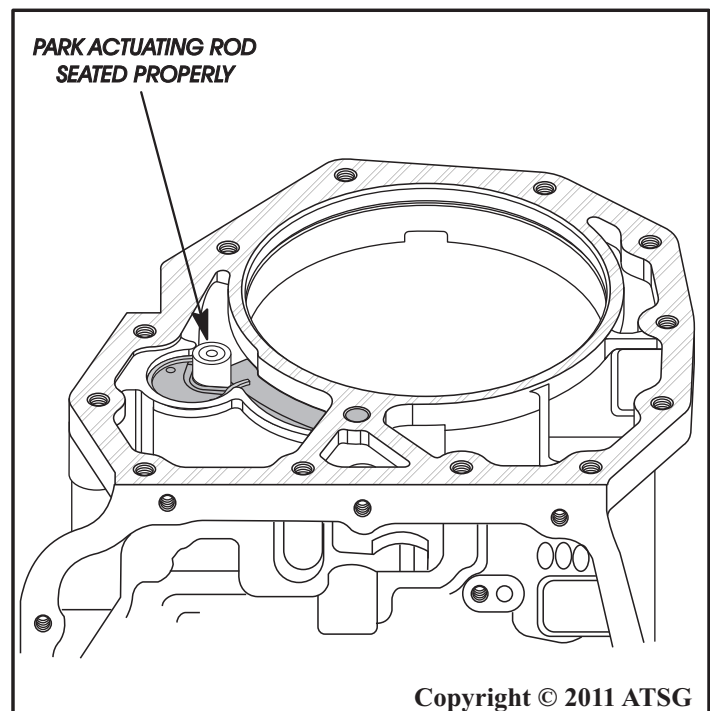
Copyright © 2011 ATSG

Figure 62



Copyright © 2011 ATSG

Figure 61



Copyright © 2011 ATSG

Figure 63

## COMPONENT REBUILD (CONT'D) LOW/REVERSE CLUTCH HOUSING

1. Separate the low sprag assembly from the low/reverse clutch housing (See Figure 65).
2. Disassemble the low sprag assembly and the low/reverse clutch housing assembly using Figure 66 as a guide.
3. Clean and inspect all low/reverse clutch parts thoroughly and dry with compressed air.
4. Replace any components that show evidence of wear and/or damage.

Continued on Page 48

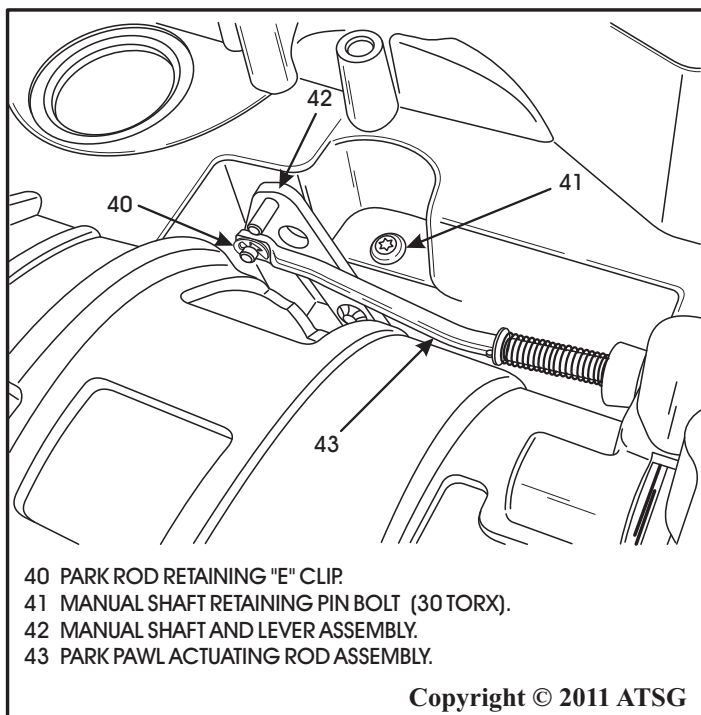


Figure 64

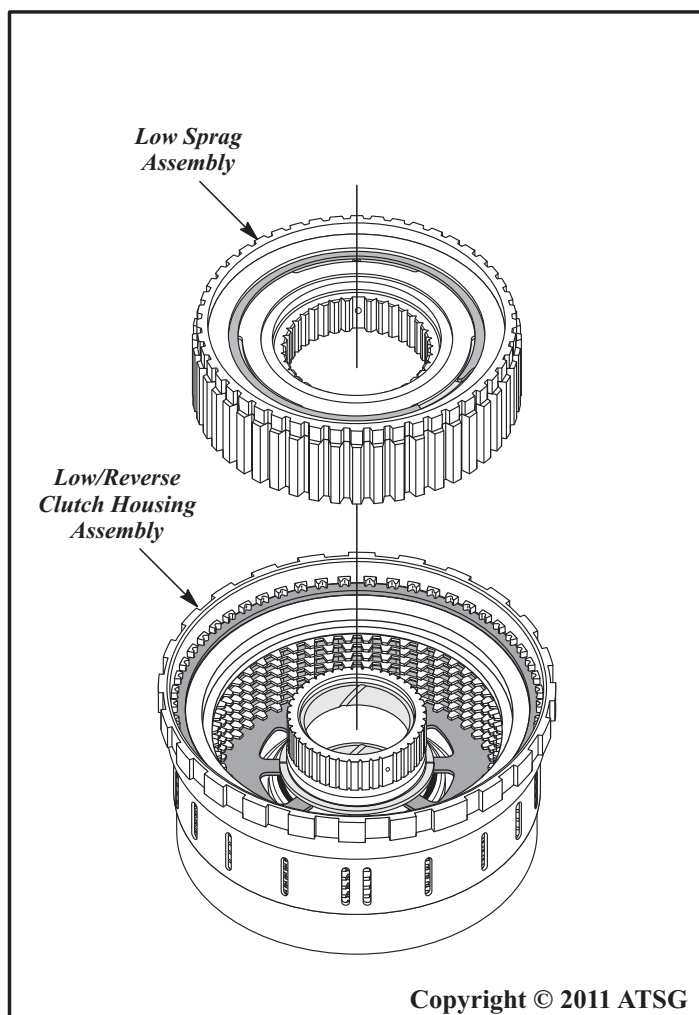
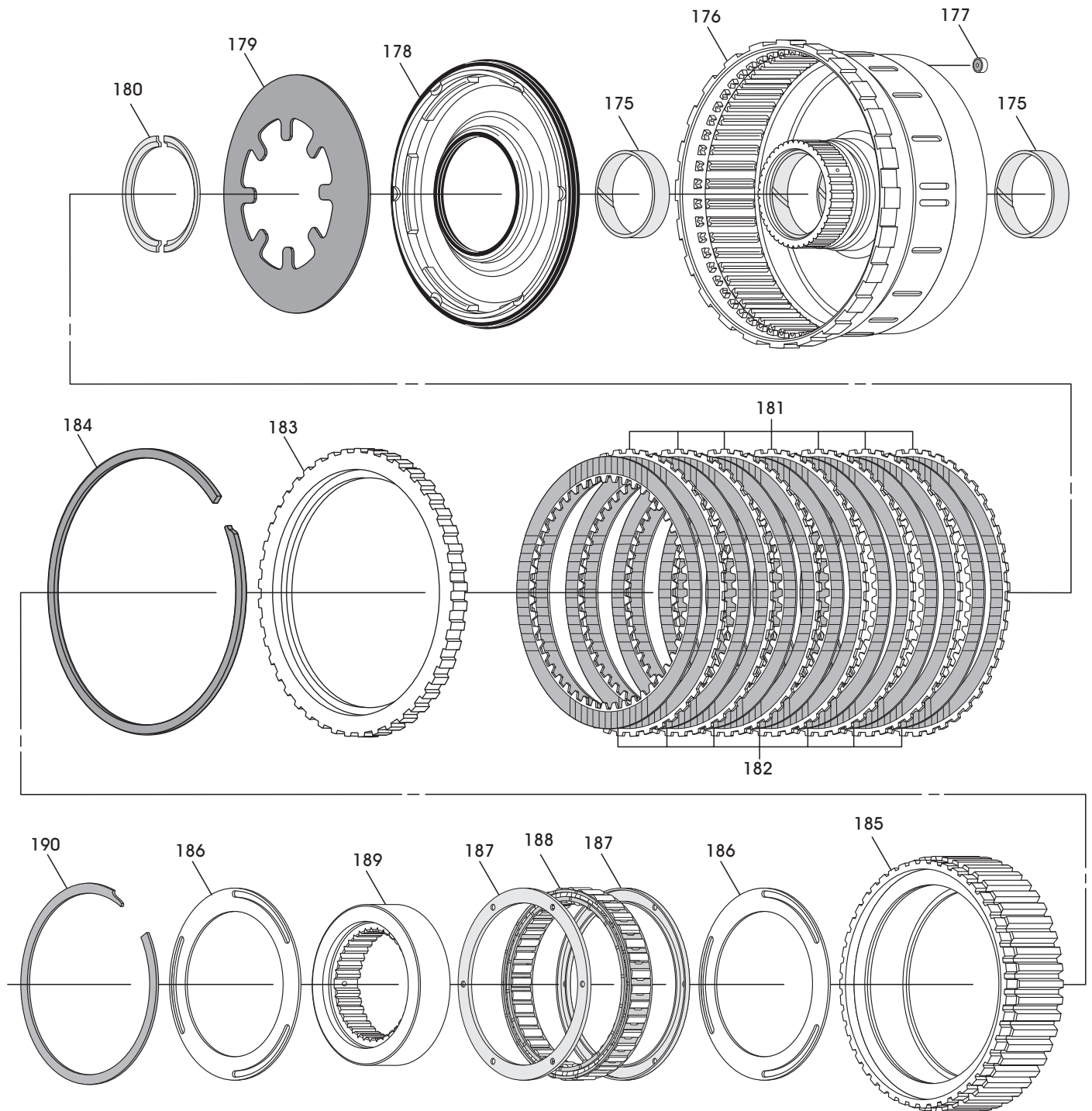


Figure 65

## LOW/REVERSE CLUTCH HOUSING AND LOW SPRAG, EXPLODED VIEW



- 175 LOW/REVERSE CLUTCH HOUSING BUSHINGS (2 REQUIRED).
- 176 LOW/REVERSE CLUTCH HOUSING.
- 177 LOW/REVERSE CLUTCH HOUSING BLEED ORIFICE.
- 178 LOW/REVERSE CLUTCH "MOLDED" APPLY PISTON.
- 179 LOW/REVERSE CLUTCH BELLVILLE PLATE.
- 180 LOW/REVERSE CLUTCH BELLVILLE PLATE "SPLIT" RETAINER.
- 181 L/R CLUTCH SINGLE SIDED *EXTERNAL* SPLINE PLATES (7 REQ.).
- 182 L/R CLUTCH SINGLE SIDED *INTERNAL* SPLINE PLATES (7 REQ.).

- 183 LOW/REVERSE CLUTCH BACKING PLATE.
- 184 LOW/REVERSE CLUTCH "SELECTIVE" SNAP RING.
- 185 LOW SPRAG OUTER RACE.
- 186 LOW SPRAG THRUST PLATES (2 REQUIRED).
- 187 LOW SPRAG END BEARINGS (2 REQUIRED).
- 188 LOW SPRAG ASSEMBLY (36 ELEMENTS).
- 189 LOW SPRAG INNER RACE.
- 190 LOW SPRAG RETAINING SNAP RING.

Copyright © 2011 ATSG

Figure 66



## LOW/REVERSE CLUTCH HOUSING (CONT'D)

### Low Sprag Assembly

5. Place the low sprag outer race on a flat work surface in the position shown in Figure 67.
6. Install one of the low sprag thrust plates on the inside of outer race, as shown in Figure 67.
7. Install one low sprag end bearing with the lips facing up, as shown in Figure 67.
8. Install the low sprag and cage assembly with the "windows" facing to the left and the channels in the cage facing up, as shown in Figure 68 & 69.
9. Install the second low sprag end bearing with the lips facing down, as shown in Figure 69.

Continued on Page 49

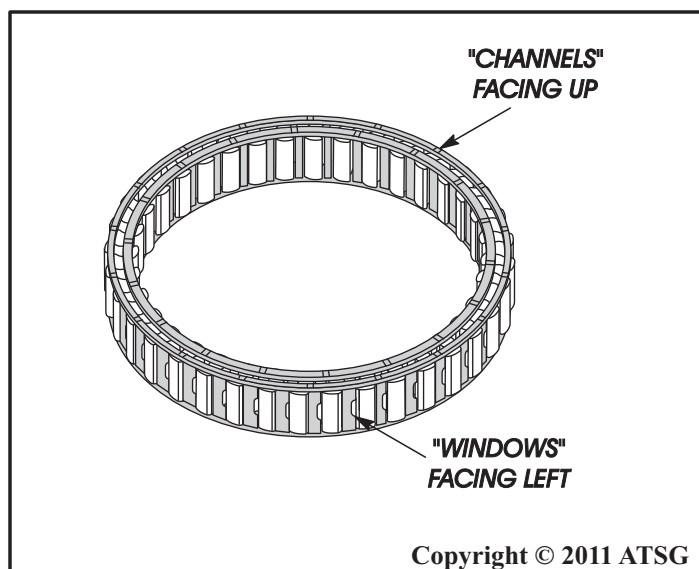


Figure 68

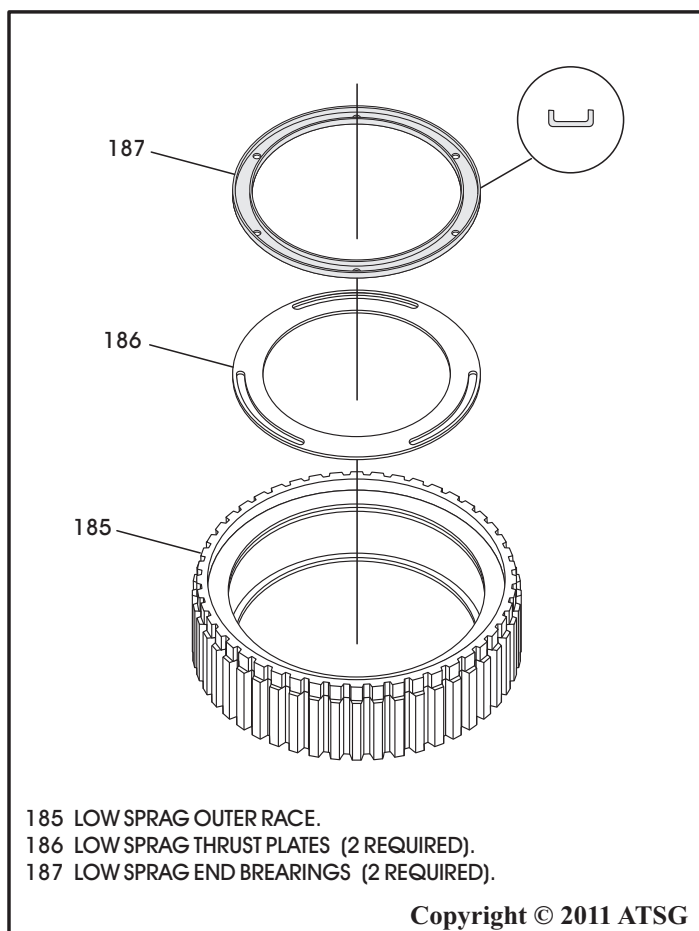


Figure 67

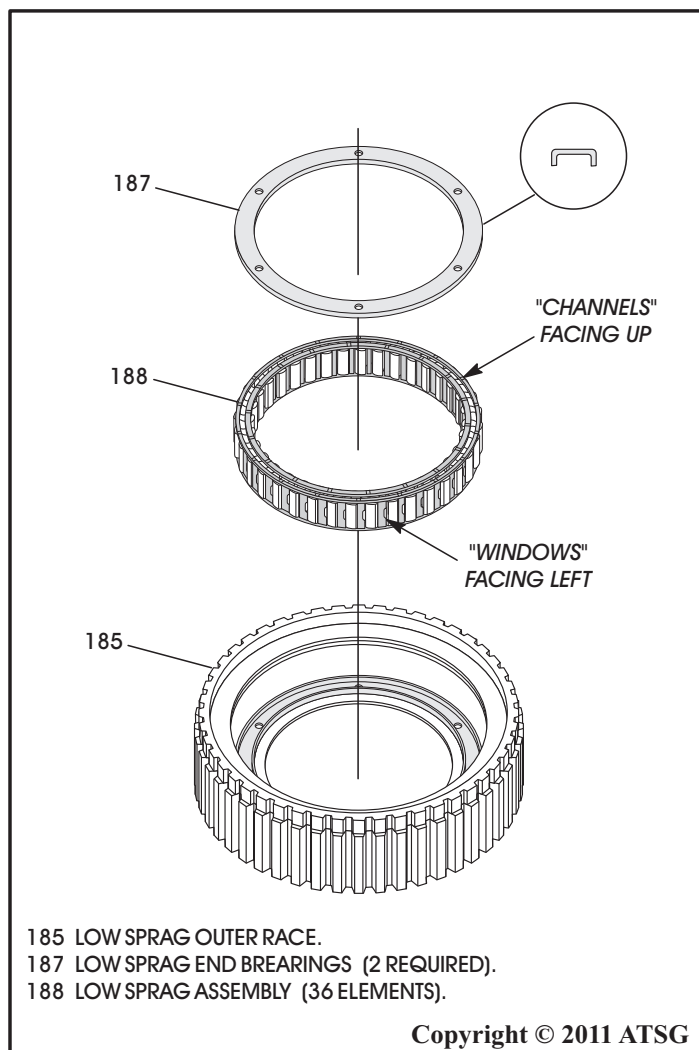


Figure 69

## LOW/REVERSE CLUTCH HOUSING (CONT'D)

### Low Sprag Assembly (Cont'd)

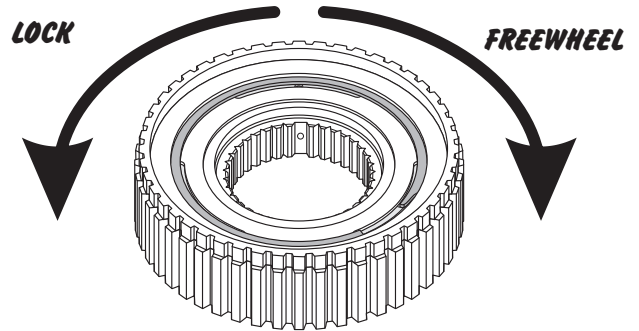
10. Lubricate the inner race with Mopar® +4 fluid and install with a counter-clockwise motion, as shown in Figure 70.

**Note:** The recess on inner race should face up as shown in Figure 70.

11. Install the second low sprag thrust plate, as shown in Figure 70.
12. Install the low sprag retaining snap ring, as shown in Figure 70.
13. Check the low sprag for the proper freewheel direction, as shown in Figure 71.
14. Set the completed low sprag assembly aside for final low/reverse housing assembly.

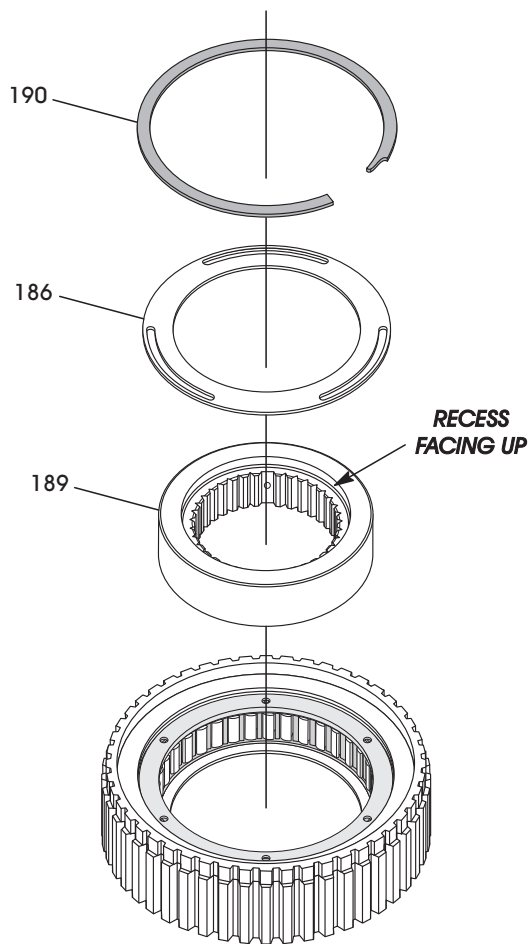
Continued on Page 50

**OUTER RACE SHOULD FREEWHEEL IN  
CLOCKWISE DIRECTION AND LOCK  
COUNTER-CLOCKWISE WHILE HOLDING  
THE INNER RACE**



Copyright © 2011 ATSG

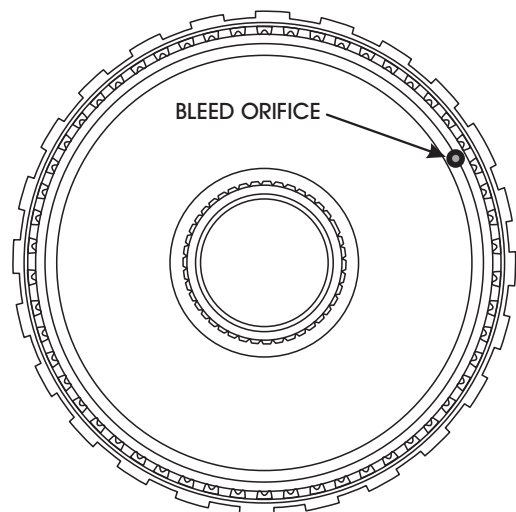
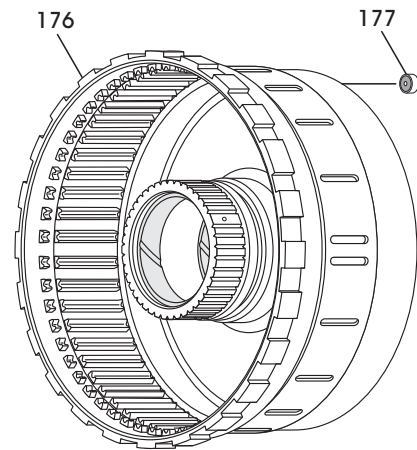
Figure 71



186 LOW SPRAG THRUST PLATES (2 REQUIRED).  
189 LOW SPRAG INNER RACE.  
190 LOW SPRAG RETAINING SNAP RING.

Copyright © 2011 ATSG

Figure 70



176 LOW/REVERSE CLUTCH HOUSING.  
177 LOW/REVERSE CLUTCH HOUSING BLEED ORIFICE.

Copyright © 2011 ATSG

Figure 72

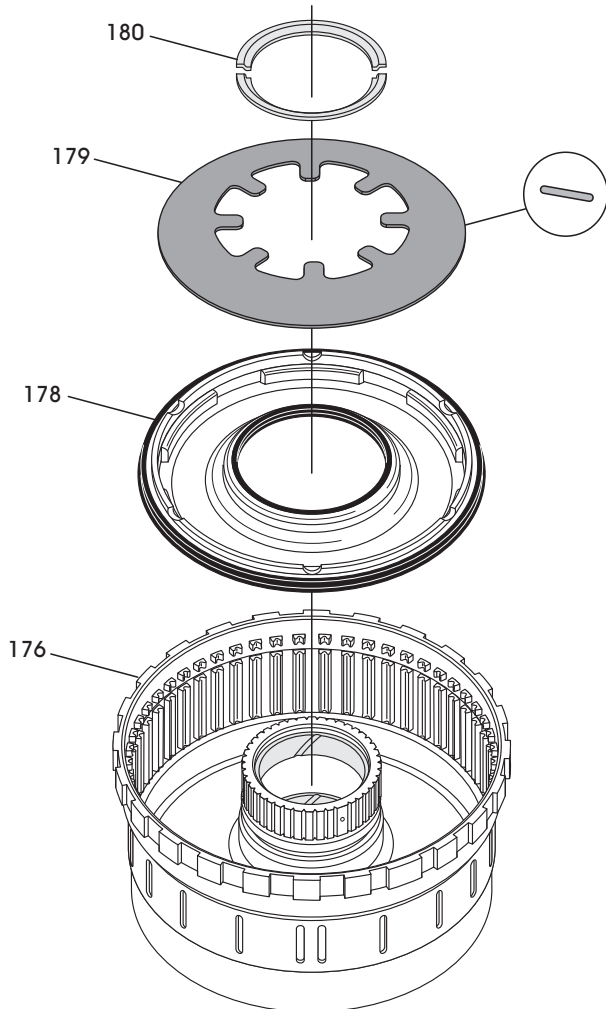


## LOW/REVERSE CLUTCH HOUSING (CONT'D)

15. Check the bleed orifice in the bottom of the low/reverse clutch housing to ensure that it is still there, as shown in Figure 72, and that it is not plugged, restricted or blown out.
16. Set the low/reverse clutch housing on a flat work surface, as shown in Figure 73.
17. Lubricate the inner and outer seal surfaces of the "molded" piston and the housing with small amount of Trans-Jel®.
18. Install low/reverse clutch piston into low/reverse clutch housing, as shown in Figure 73.
19. Install the bellville type return spring on top of the installed piston in the direction that is shown in Figure 73.
20. Compress bellville spring and install the "split" retainer into the groove of housing, as shown in Figure 73.
21. The "Drum-Buddy" from Adapt-A-Case works very well, on a wide variety of units, and is shown in Figure 74.

Continued on Page 51

ProCarManuals.com

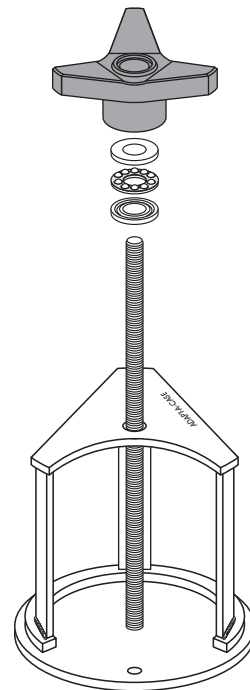


176 LOW/REVERSE CLUTCH HOUSING.  
178 LOW/REVERSE CLUTCH "MOLDED" APPLY PISTON.  
179 LOW/REVERSE CLUTCH BELLVILLE PLATE.  
180 LOW/REVERSE CLUTCH BELLVILLE PLATE "SPLIT" RETAINER RING.

Copyright © 2011 ATSG

Figure 73

## "THE DRUM BUDDY" BY ADAPT-A-CASE



Copyright © 2011 ATSG

Figure 74

## LOW/REVERSE CLUTCH HOUSING (CONT'D)

22. Install the "single-sided" low/reverse clutch plates beginning with an outside spline plate and alternate with inside spline plates, until you have installed 7 of each, as shown in Figure 75.

**Note:** All "single-sided" plates are installed with the lining facing up and should be soaked for 30 minutes in Mopar® +4 fluid before they are installed.

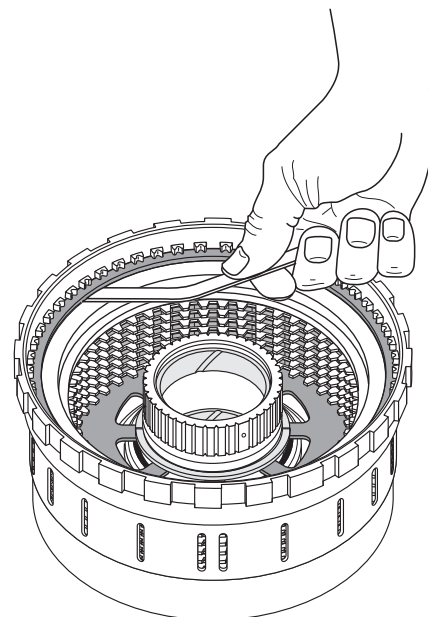
23. Install the low/reverse clutch backing plate with the step facing up, as shown in Figure 75.  
 24. Install the low/reverse clutch **selective** snap ring, as shown in Figure 75.  
 25. Turn completed housing over and tap on work bench to seat the snap ring at the top of groove.  
 26. Measure the low/reverse clutch clearance using a feeler gauge between the snap ring and backing plate, as shown in Figure 76.  
 27. The low/reverse clutch clearance should be 1.18-2.09mm (.046"-.082").  
 28. Change the selective snap ring as necessary to obtain the correct clutch clearance.

**Note:** We have no information on selectives available or their thickness.

29. Once the proper selective snap ring has been verified, remove the low/reverse clutch pack from the housing.

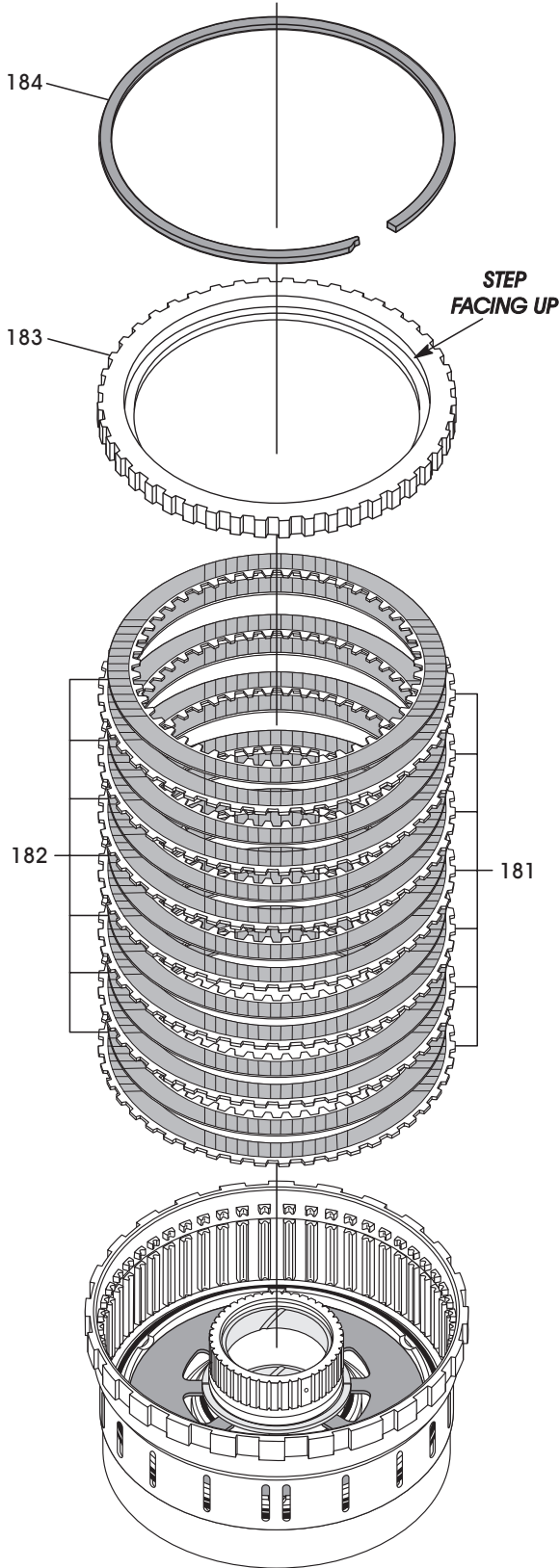
Continued on Page 52

**LOW/REVERSE CLUTCH CLEARANCE SHOULD BE  
1.18 - 2.09 MM (.046" - .082")**



Copyright © 2011 ATSG

Figure 76



- 181 L/R CLUTCH SINGLE SIDED EXTERNAL SPLINE PLATES (7 REQ.).  
 182 L/R CLUTCH SINGLE SIDED INTERNAL SPLINE PLATES (7 REQ.).  
 183 LOW/REVERSE CLUTCH BACKING PLATE.  
 184 LOW/REVERSE CLUTCH "SELECTIVE" SNAP RING.

Copyright © 2011 ATSG

Figure 75

## LOW/REVERSE CLUTCH HOUSING (CONT'D)

30. Install the completed low sprag assembly into the low/reverse clutch housing, as shown in Figure 77.

**Note:** The low/reverse clutch housing has one wider spline on the inner hub where the inner sprag race splines to it, and the inner race must be rotated to engage the splines, as shown in Figure 77. This is done to ensure alignment of the lube holes.

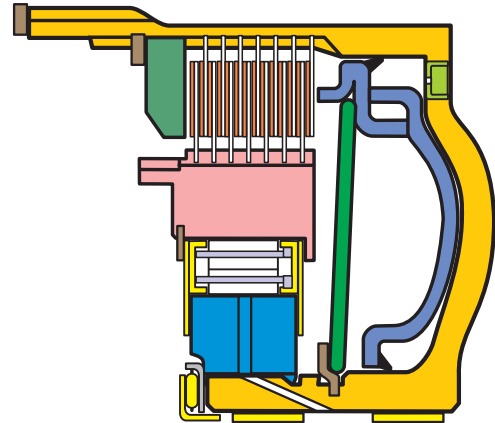
31. After installing the low sprag assembly, re-install low/reverse clutch pack as described on Page 51.

32. It is possible to rotate the low sprag assembly back and forth and install it with clutch plates in place, but it is much more difficult that the procedure described above because of the wide spline being in the equation.

**Note:** Low/Reverse sprag assembly is properly seated when the inner race spline stepped face is below face of L/R clutch housing inner hub.

33. Set the completed low/reverse clutch housing, as shown in Figure 79, aside for final assembly.

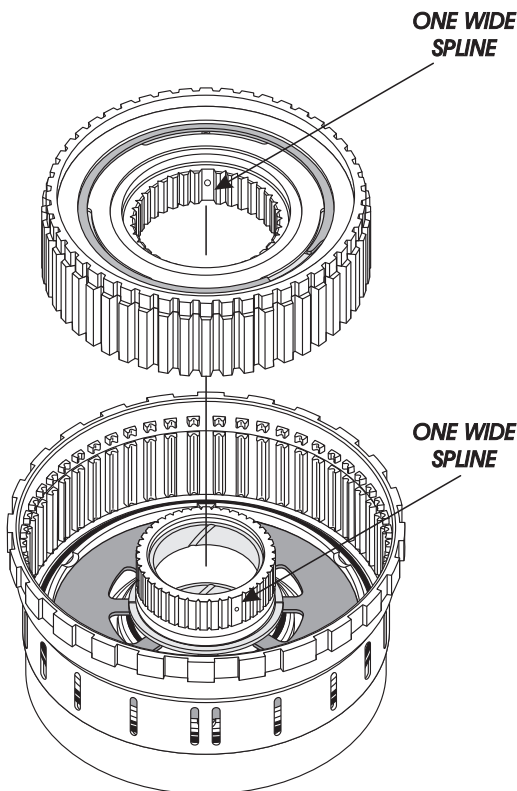
## LOW/REVERSE CLUTCH HOUSING CUT-AWAY



Copyright © 2011 ATSG

Figure 78

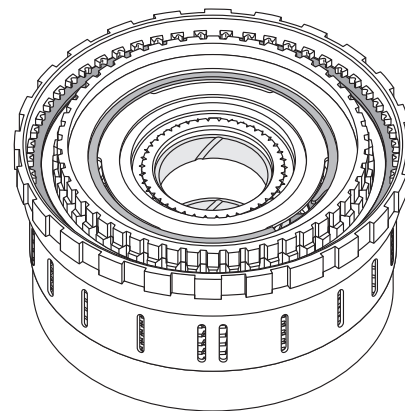
## Component Rebuild Continued on Page 53



Copyright © 2011 ATSG

Figure 77

## COMPLETED LOW/REVERSE CLUTCH HOUSING



Copyright © 2011 ATSG

Figure 79

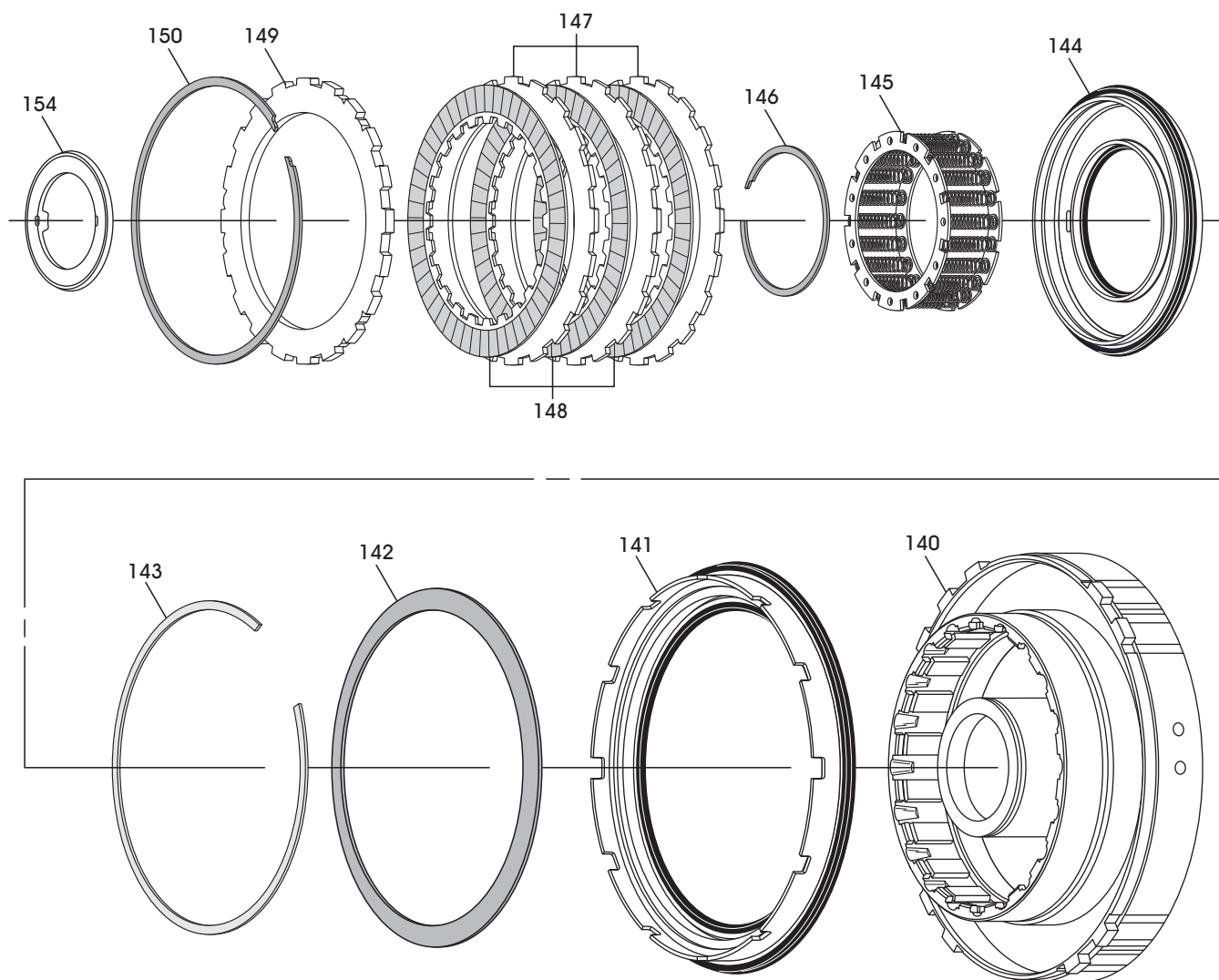
## COMPONENT REBUILD (CONT'D)

### 2-4 CLUTCH RETAINER ASSEMBLY

1. Disassemble the 2-4 clutch retainer assembly using Figure 80 as a guide.
2. Clean all 2-4 clutch retainer parts thoroughly and dry with compressed air.
3. Inspect all 2-4 clutch retainer parts thoroughly for any wear and/or damage and replace as necessary.

Continued on Page 54

### 2-4 CLUTCH RETAINER EXPLODED VIEW



- 140 2-4 CLUTCH RETAINER ASSEMBLY.
- 141 SECOND CLUTCH "MOLDED" APPLY PISTON ASSEMBLY
- 142 SECOND CLUTCH BELLVILLE PLATE.
- 143 SECOND CLUTCH BELLVILLE PLATE RETAINING SNAP RING.
- 144 FOURTH CLUTCH "MOLDED" APPLY PISTON ASSEMBLY.
- 145 FOURTH CLUTCH PISTON RETURN SPRING ASSEMBLY.

- 146 FOURTH CLUTCH RETURN SPRING SNAP RING.
- 147 FOURTH CLUTCH STEEL PLATES, (.101" THICK) (3 REQUIRED).
- 148 FOURTH CLUTCH FRICTION PLATES, (.087" THICK) (3 REQ.).
- 149 FOURTH CLUTCH BACKING PLATE, (.197" THICK).
- 150 FOURTH CLUTCH "SELECTIVE" BACKING PLATE SNAP RING.
- 154 NUMBER 6 THRUST BEARING.

Copyright © 2011 ATSG

Figure 80



## 2-4 CLUTCH RETAINER ASSEMBLY (CONT'D)

4. Lubricate seal surfaces of 2nd clutch piston and retainer with small amount of Trans-Jel®.
5. Install the "molded" 2nd clutch piston into the 2-4 clutch retainer, as shown in Figure 81.
6. Install the 2nd clutch piston bellville plate on top of the piston, as shown in Figure 80.
7. Using a suitable shop press, compress bellville spring until the snap ring is engaged into the snap ring groove in 2-4 retainer, and ensure that it is fully seated (See Figure 81).

8. Lubricate seal surfaces of 4th clutch piston and retainer with small amount of Trans-Jel®.
9. Install the "molded" 4th clutch piston into the 2-4 clutch retainer, as shown in Figure 82.
10. Install 4th clutch piston return spring assembly on top of piston, as shown in Figure 82.
11. Position the retaining snap ring on top of the return spring (See Figure 82).
12. Using a suitable shop press, compress the return spring and install the snap ring into the groove in the 2-4 retainer.
13. Ensure that the snap rings of 4th clutch and the 2nd clutch return springs are fully seated.

Continued on Page 55

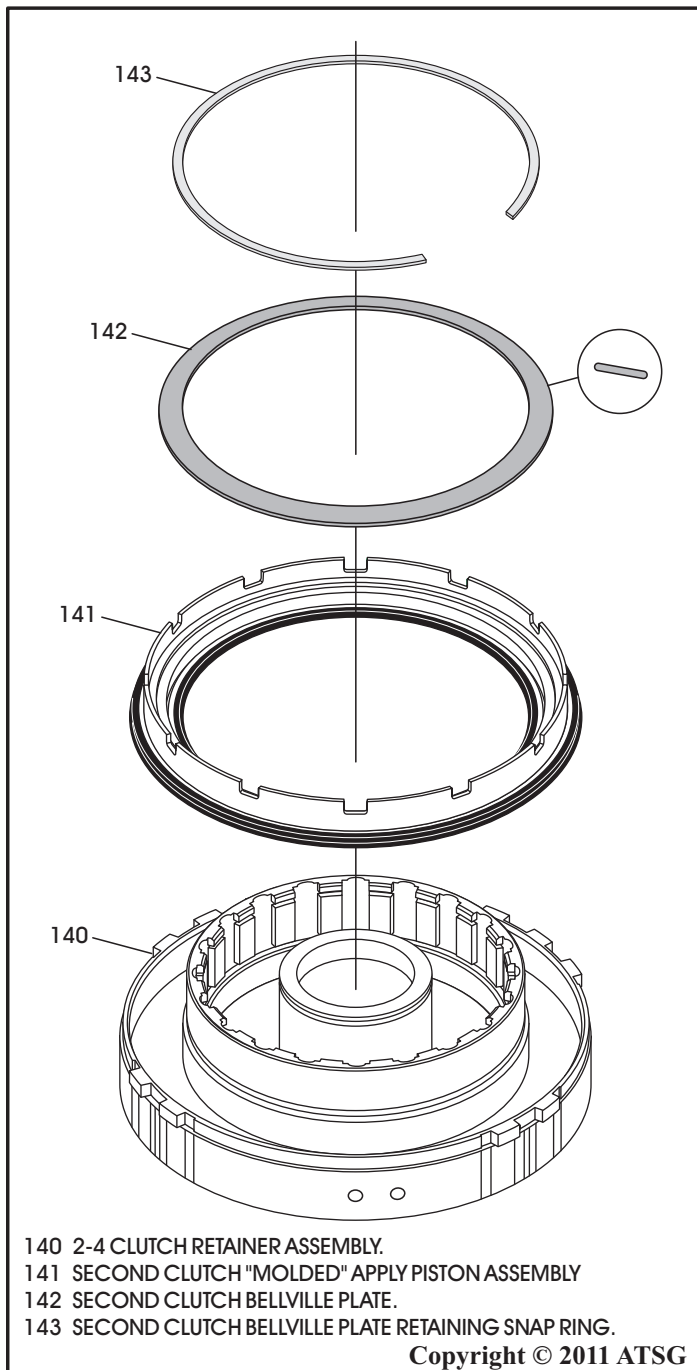


Figure 81

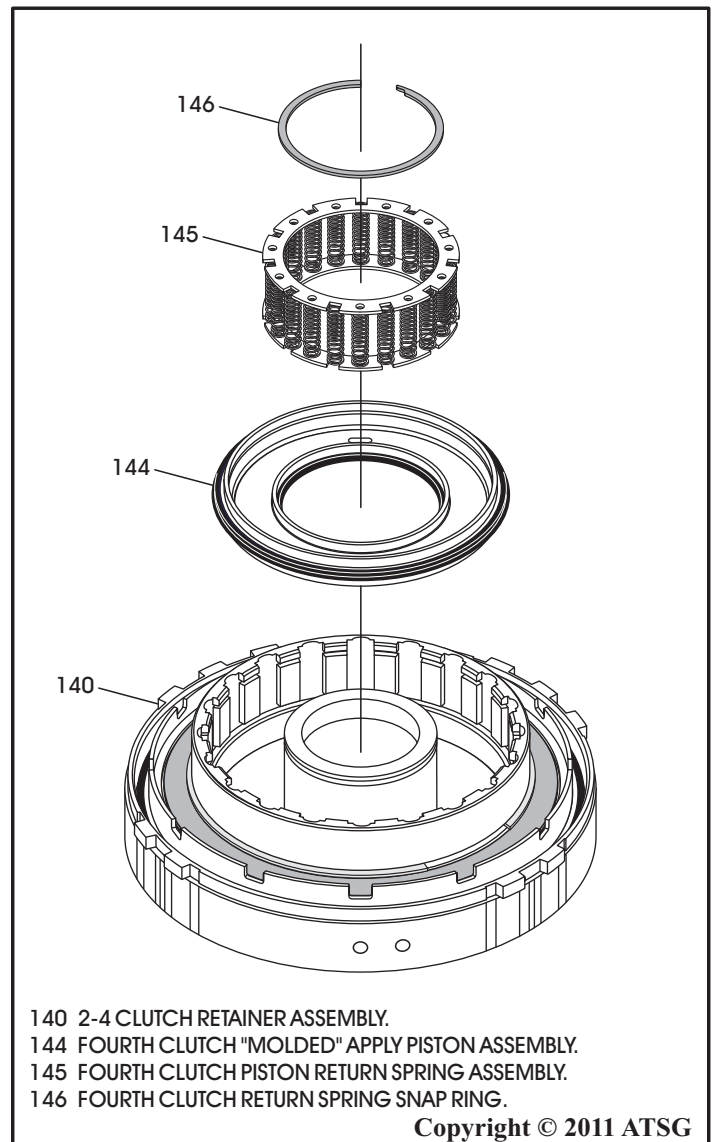


Figure 82



## 2-4 CLUTCH RETAINER ASSEMBLY (CONT'D)

14. Install the 4th clutch plates beginning with a steel plate and alternating with friction plates until you have installed three of each, as shown in Figure 83.

**Note:** All clutch plates should be soaked for 30 minutes in proper fluid before installing.

15. Install the 4th clutch backing plate, as shown in Figure 83.

**Note:** This plate is non-directional and will go either way.

16. Install the 4th clutch backing plate *selective* snap ring, as shown in Figure 83, and ensure that it is fully seated.

17. Measure with feeler gauge between the snap ring and backing plate, as shown in Figure 84.

18. Proper fourth clutch clearance should be; 0.770-1.390mm (.030"-.055").

19. Change the selective snap ring as necessary to obtain the correct clearance. The selective snap rings and their identification are as follows;

- 1 Butterfly End, 1 Square End ..... = 1.79mm (.070")
- Both Ends Butterfly Cut ..... = 2.20mm (.087")
- 1 Butterfly End, 1 Inverted Butterfly = 2.61mm (.103")

20. Set the completed 2-4 clutch retainer assembly aside for the final assembly process.

**Component Rebuild  
Continued on Page 56**

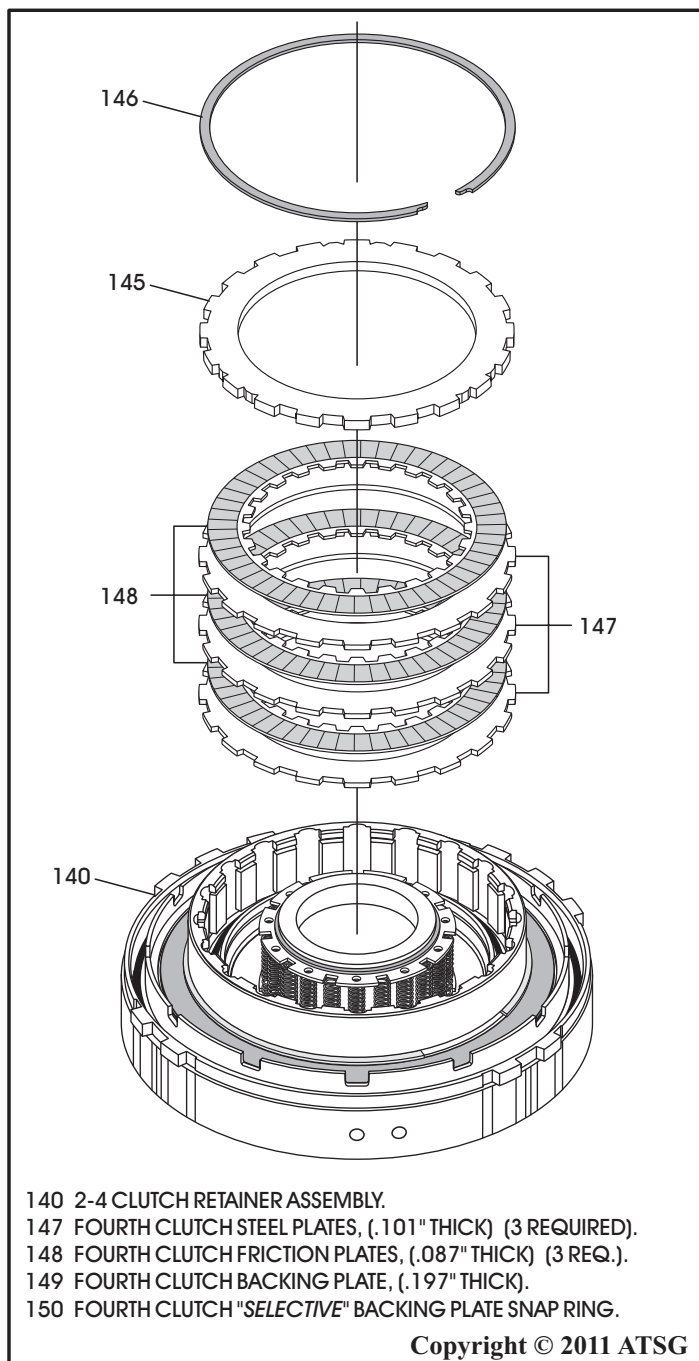


Figure 83

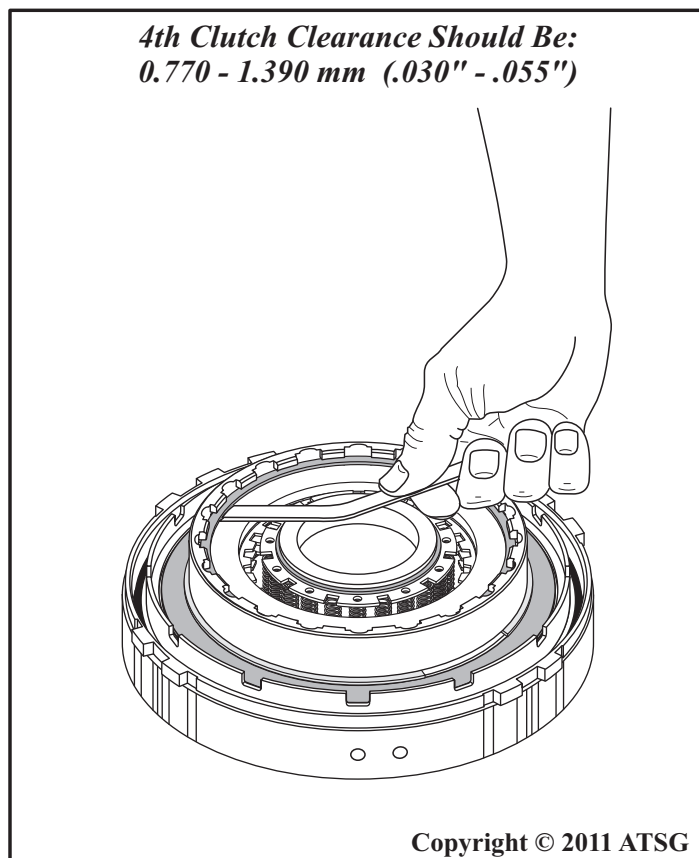


Figure 84

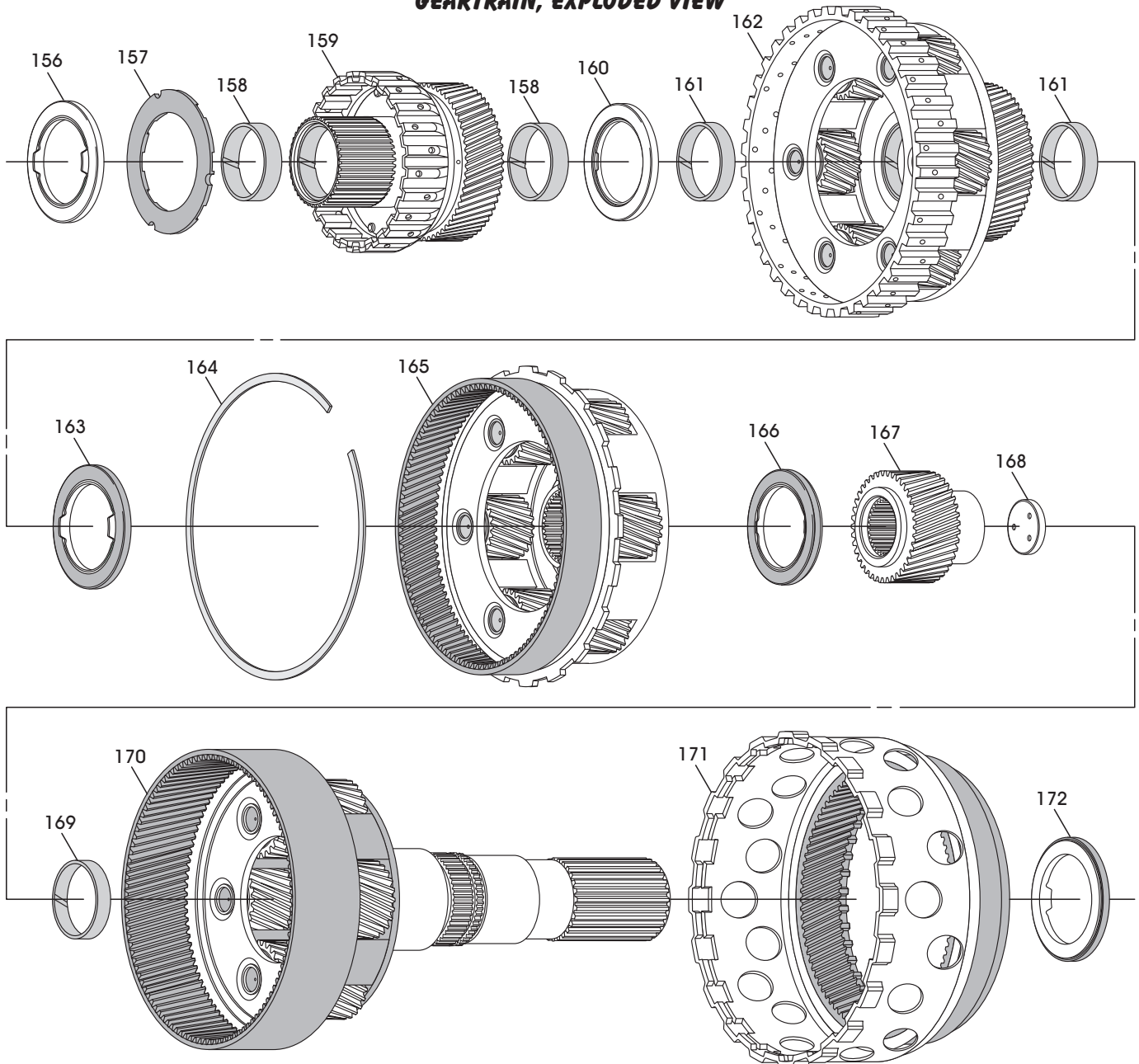
## GEARTRAIN ASSEMBLY

1. To disassemble rear geartrain you must remove the snap ring (164) shown in Figure 85.

2. Clean all geartrain parts thoroughly and dry with compressed air.

Continued on Page 57

### GEARTRAIN, EXPLODED VIEW



156 NUMBER 6 THRUST BEARING.  
 157 NUMBER 7 "SELECTIVE" THRUST PLATE (REAR END-PLAY).  
 158 FOURTH CLUTCH HUB & SUN GEAR BUSHINGS (2 REQUIRED).  
 159 FOURTH CLUTCH HUB & REACTION SUN GEAR ASSEMBLY.  
 160 NUMBER 8 THRUST BEARING.  
 161 REACTION CARRIER & REVERSE SUN GEAR BUSHINGS (2 REQ.).  
 162 REACTION CARRIER & REVERSE SUN GEAR ASSEMBLY.  
 163 NUMBER 9 THRUST BEARING.  
 164 REVERSE CARRIER RETAINING SNAP RING.

165 REVERSE CARRIER AND REACTION RING GEAR ASSEMBLY.  
 166 NUMBER 10 THRUST BEARING.  
 167 INPUT SUN GEAR ASSEMBLY.  
 168 INPUT SUN GEAR LUBE OIL BAFFLE.  
 169 INPUT PLANETARY CARRIER BUSHING.  
 170 INPUT PLANETARY CARRIER AND OUTPUT SHAFT ASSEMBLY.  
 171 INPUT RING GEAR ASSEMBLY.  
 172 NUMBER 12 THRUST BEARING.

Copyright © 2011 ATSG

Figure 85

## GEARTRAIN ASSEMBLY (CONT'D)

3. Inspect all geartrain parts thoroughly for any wear and/or damage and replace as necessary.  
*Note: Notice that all planetary carriers are now 6 pinion carriers to accommodate the Diesel engine.*
4. Install number 7 **selective** thrust washer into 4th clutch hub/reaction sun gear with the "grooved" side facing down, as shown in Figure 86, and ensure it is fully seated over the locating tabs.  
*Note: Because of the 68RFE design changes in the geartrain, engineers were able to eliminate the number 7 thrust bearing. ATSG has now assigned that number to this selective thrust washer which is used to set the transmission rear end-play.*
5. Retain the number 7 selective thrust washer with small amount of Trans-Jel®.

6. Install the number 6 thrust bearing on top of the number 7 selective thrust washer in the direction shown in Figure 86 and retain with small amount of Trans-Jel®.
7. Double check to ensure that number 7 selective thrust washer and number 6 thrust bearing are properly seated, as shown in Figure 87, and set the completed 4th clutch hub/reaction sun gear aside for the final assembly process.

Continued on Page 58

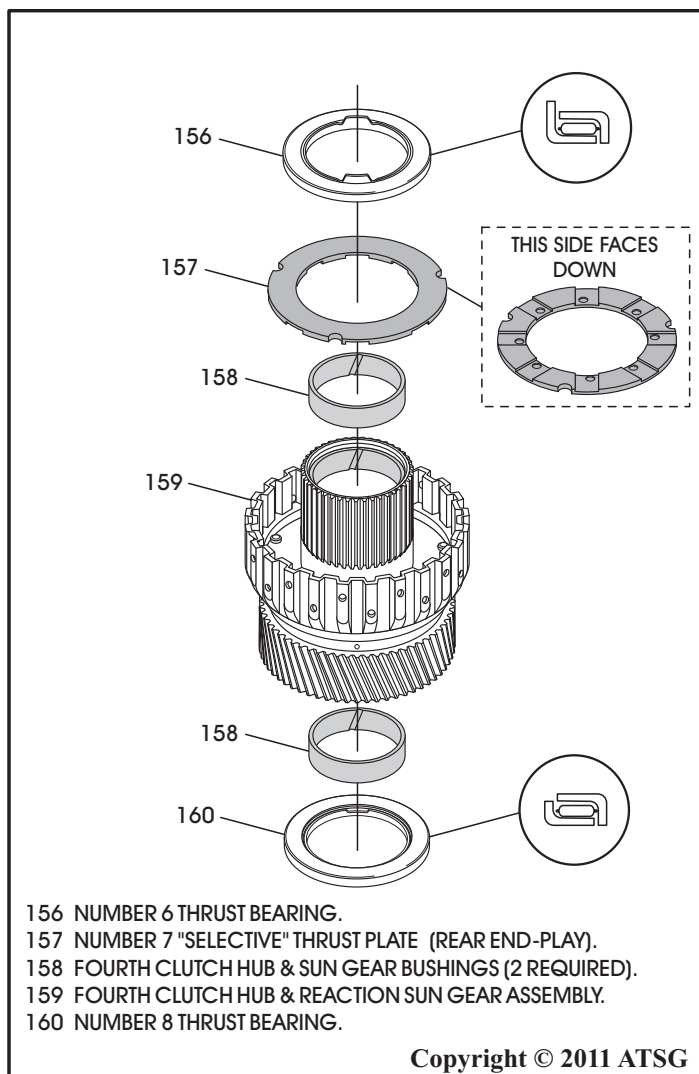


Figure 86

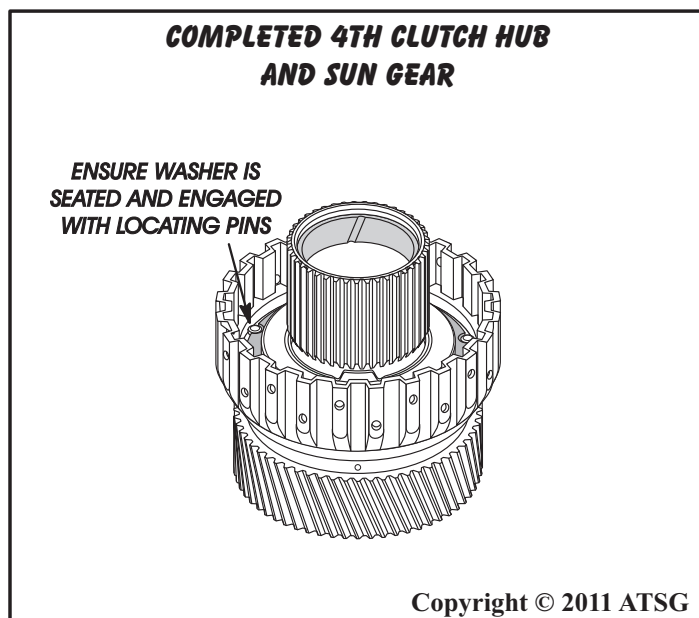


Figure 87

## GEARTRAIN ASSEMBLY (CONT'D)

8. Install the input ring gear assembly onto input planetary carrier and output shaft from the back side as shown in Figure 88, and engage onto the input carrier pinions.
  9. Place this assembly onto blocks and over a hole in your work bench, as shown in Figure 89, so the output shaft protrudes through the hole.
- Note:** This will hold the ring gear in place and allow you to complete the assembly.
10. Install the input sun gear in the direction that is shown in Figure 89, and engage it into the input planetary pinion gears.

11. Install the number 10 thrust bearing onto input sun gear with the black side facing up, as shown in Figure 89.

**Note:** The number 12 thrust bearing goes on back side of input planetary carrier and will be installed during the final assembly process. The number 11 thrust bearing is a captured bearing inside the input planetary carrier.

Continued on Page 59

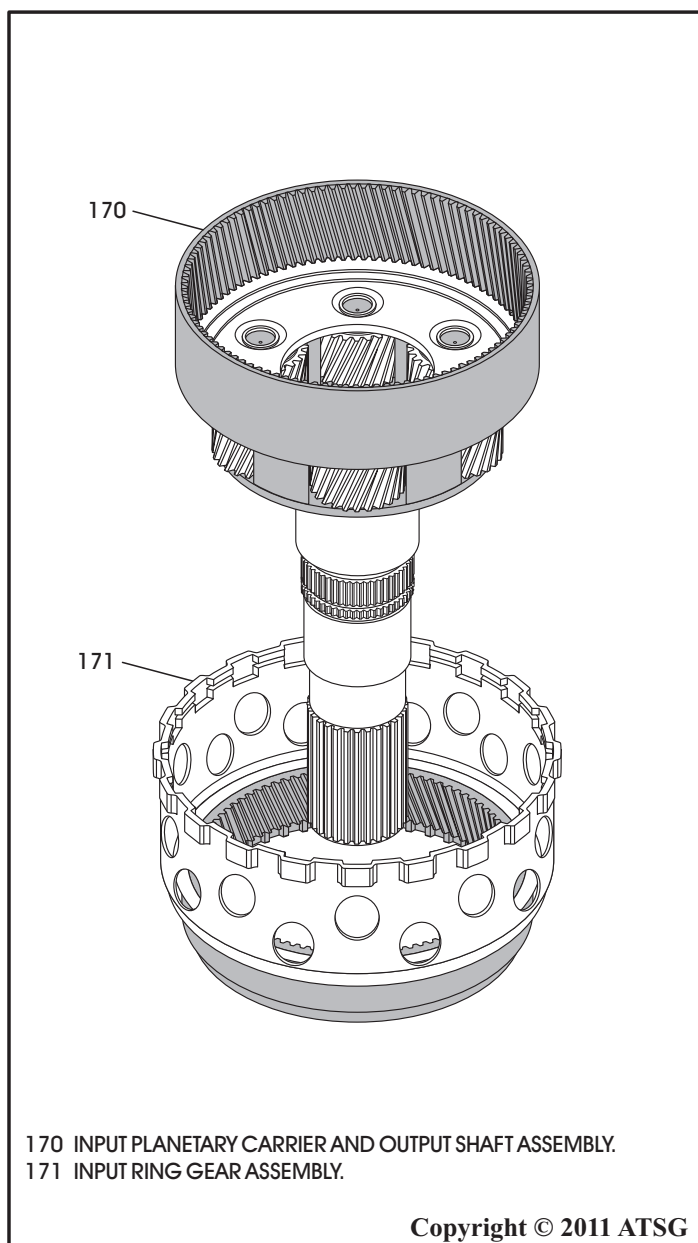


Figure 88

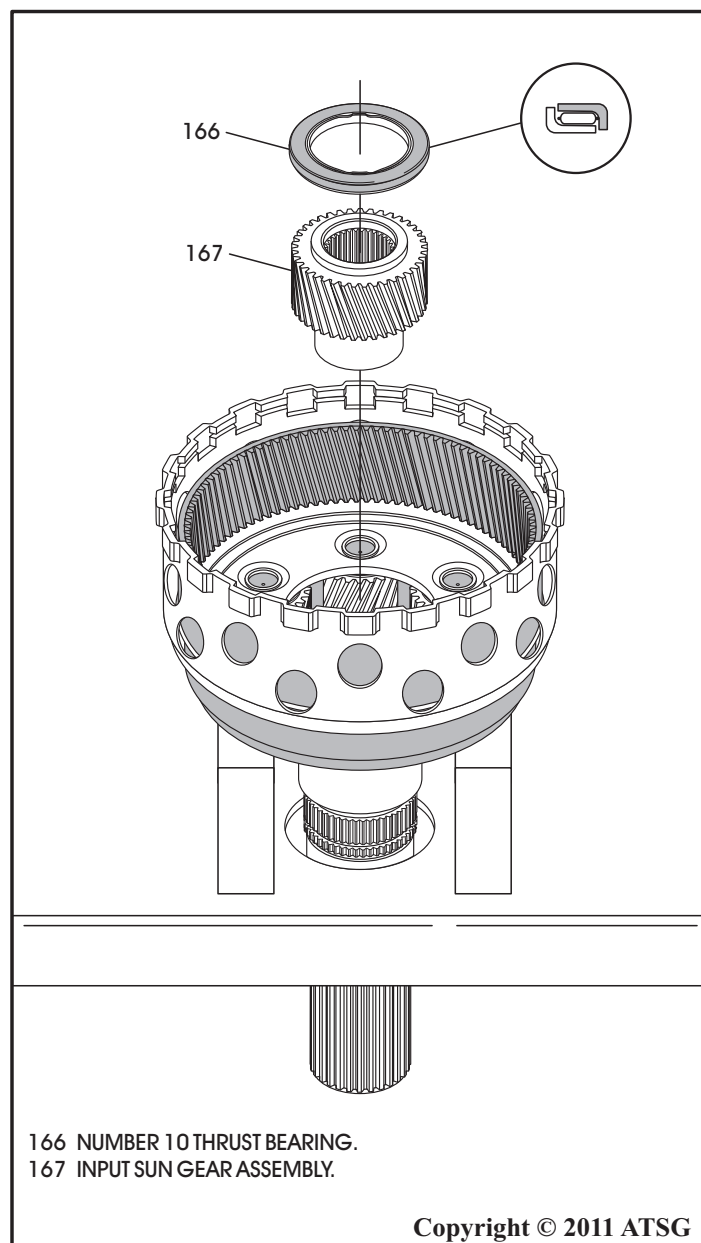


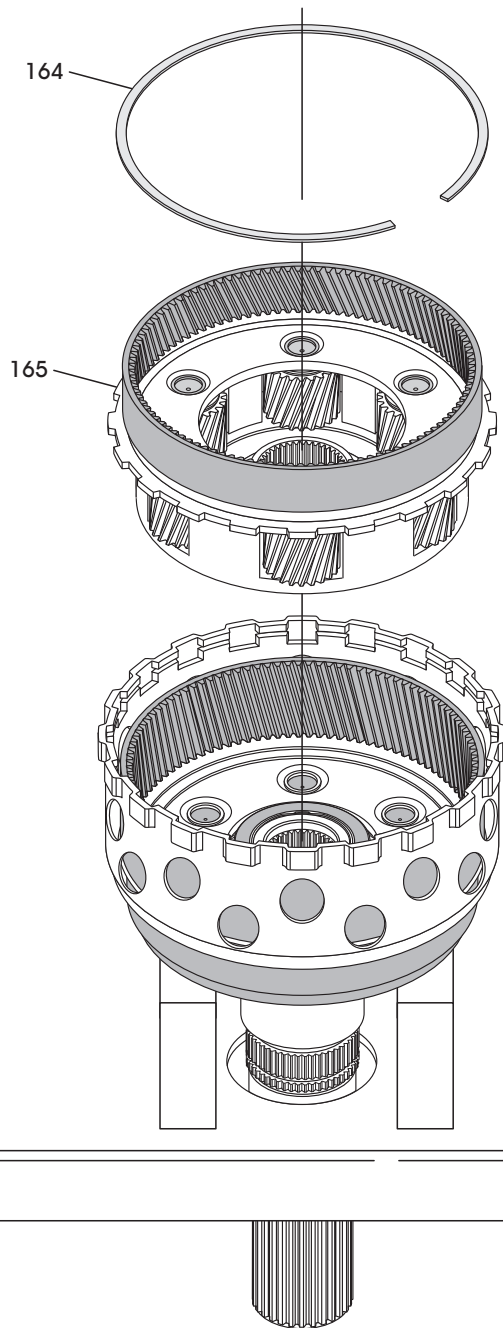
Figure 89



## GEARTRAIN ASSEMBLY (CONT'D)

12. Install the reverse planetary/reaction ring gear, as shown in Figure 90, and rotate into position.
13. Install the retaining snap ring into the groove in the input ring gear, as shown in Figure 90, and ensure that it is fully seated.
14. Set the completed geartrain assembly, as shown in Figure 91, aside for final assembly.

**Component Rebuild  
Continued on Page 60**

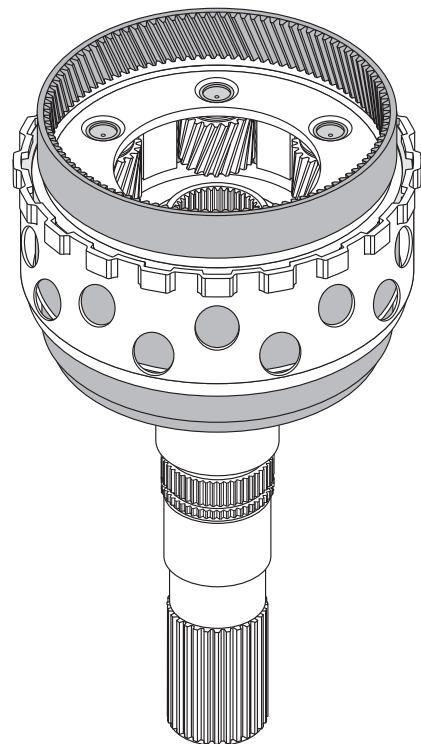


164 REVERSE CARRIER RETAINING SNAP RING.  
165 REVERSE CARRIER AND REACTION RING GEAR ASSEMBLY.

Copyright © 2011 ATSG

Figure 90

## COMPLETED GEARTRAIN ASSEMBLY

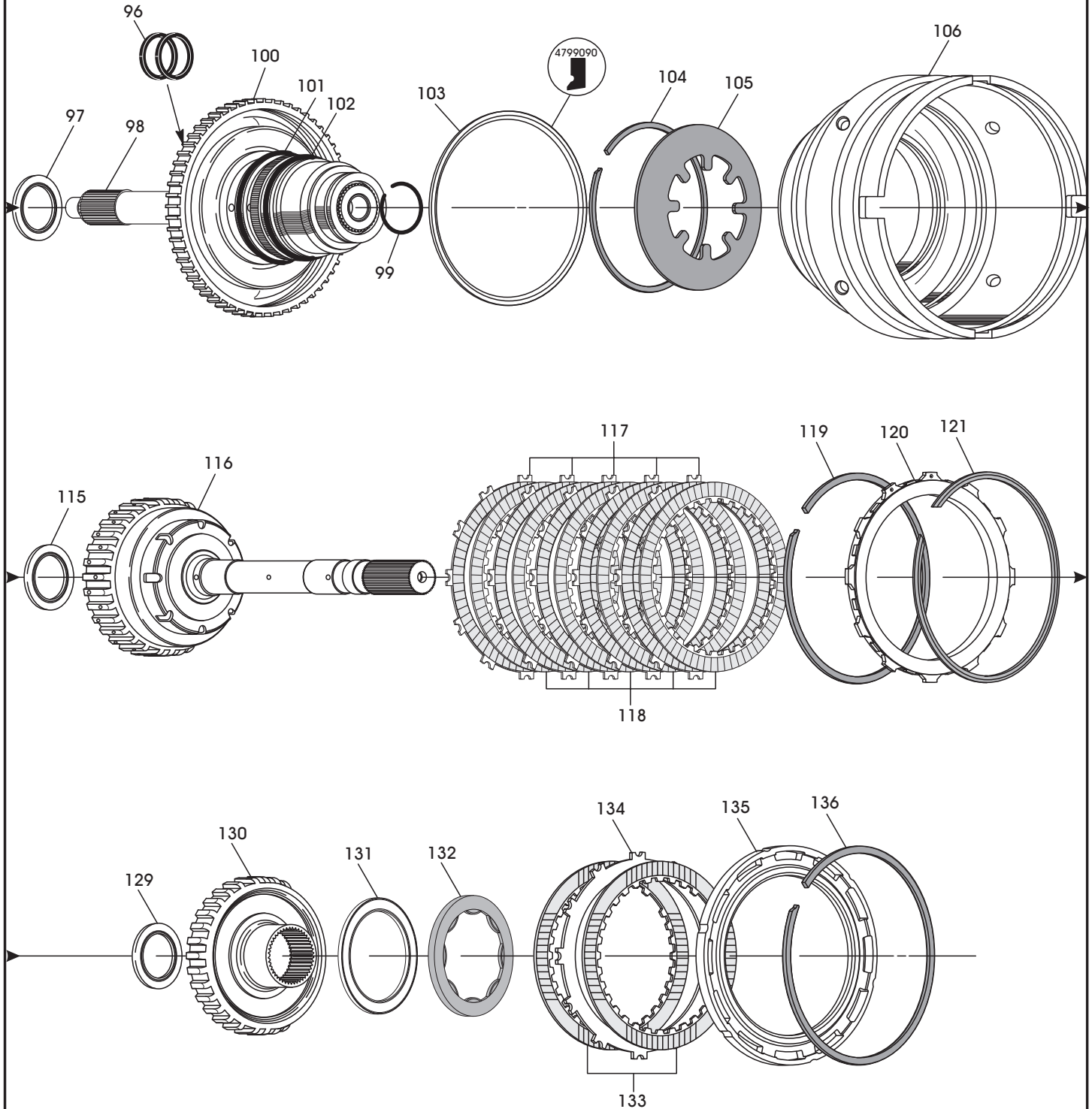


Copyright © 2011 ATSG

Figure 91



## INPUT CLUTCH HOUSING COMPONENTS EXPLODED VIEW

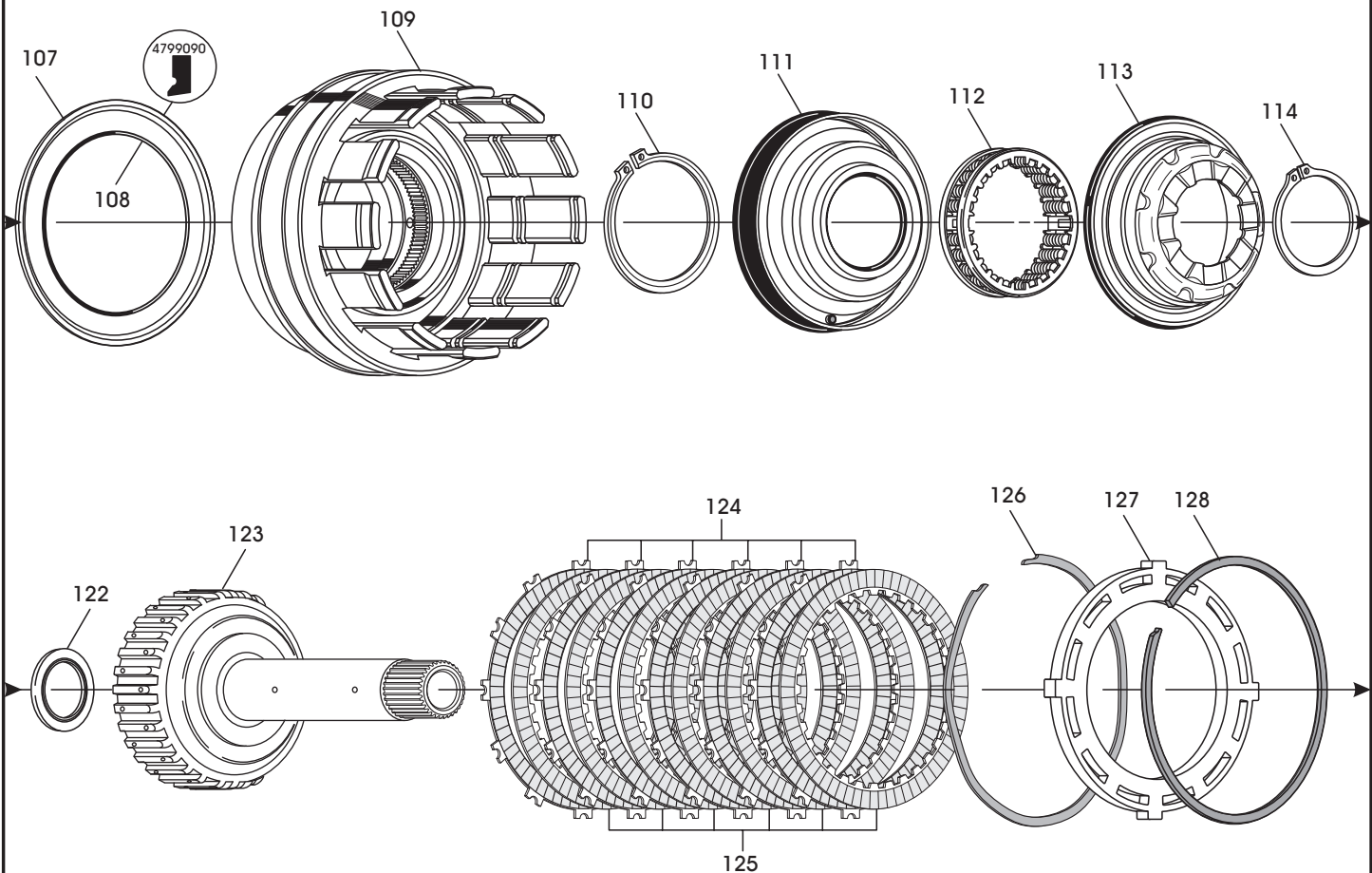


See Legend Figure 93

Copyright © 2011 ATSG

Figure 92

## INPUT CLUTCH HOUSING COMPONENTS EXPLODED VIEW



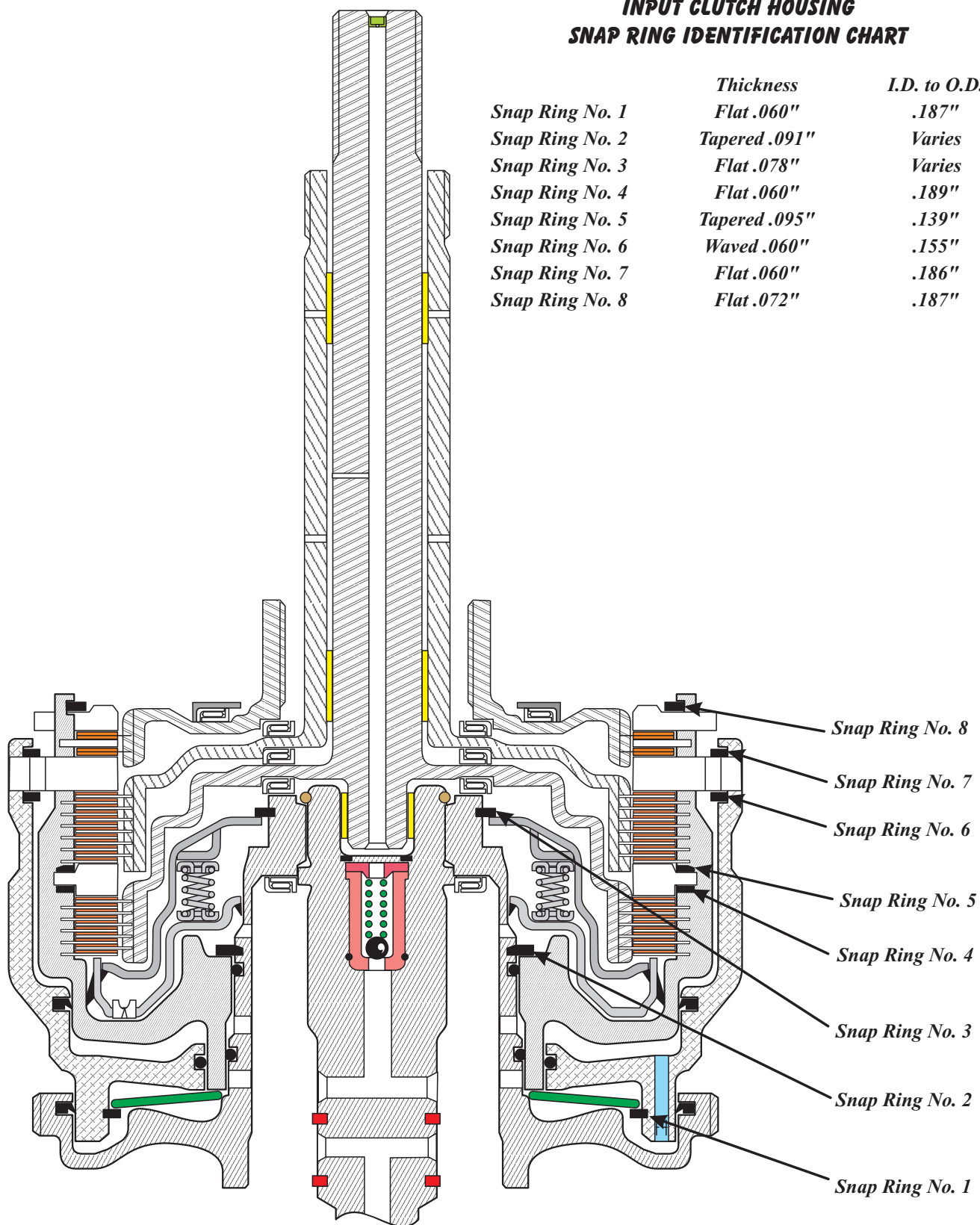
- |   |   |
|---|---|
| 96 INPUT SHAFT SEAL RINGS (2 REQUIRED).                             | 118 UD CLUTCH SINGLE-SIDED, <i>INTERNAL</i> SPLINE PLATES (5 REQ.). |
| 97 NUMBER 1 THRUST BEARING.   | 119 UNDERDRIVE/OVERDRIVE BACKING PLATE "FLAT" SNAP RING.            |
| 98 INPUT SHAFT.   | 120 UNDERDRIVE/OVERDRIVE BACKING PLATE.                             |
| 99 INPUT SHAFT RETAINING CIR-CLIP.                                  | 121 UNDERDRIVE/OD BACKING PLATE "TAPERED" SNAP RING.                |
| 100 INPUT CLUTCH HUB.   | 122 NUMBER 3 THRUST BEARING.  |
| 101 GREEN COLORED "O" RING SEAL.                                    | 123 OVERDRIVE CLUTCH HUB AND SHAFT ASSEMBLY.                        |
| 102 RED COLORED "O" RING SEAL.                                      | 124 OD CLUTCH SINGLE SIDED, EXTERNAL SPLINE PLATES (6 REQ.).        |
| 103 REVERSE OUTER LIP SEAL (INSIDE LIP).                            | 125 OD CLUTCH SINGLE SIDED, INTERNAL SPLINE PLATES (6 REQ.).        |
| 104 OVERDRIVE/REVERSE PISTON BELLVILLE SNAP RING.                   | 126 OVERDRIVE/REVERSE BACKING PLATE "WAVE" SNAP RING.               |
| 105 OVERDRIVE/REVERSE PISTON BELLVILLE PLATE.                       | 127 OVERDRIVE/REVERSE " <i>SELECTIVE</i> " BACKING PLATE.           |
| 106 OVERDRIVE/REVERSE PISTON ASSEMBLY.                              | 128 OVERDRIVE/REVERSE BACKING PLATE "FLAT" SNAP RING.               |
| 107 OVERDRIVE OUTER LIP SEAL (INSIDE LIP).                          | 129 NUMBER 4 THRUST BEARING.  |
| 108 OVERDRIVE/REVERSE INNER "O" RING SEAL.                          | 130 REVERSE CLUTCH HUB ASSEMBLY.                                    |
| 109 INPUT CLUTCH RETAINER.  | 131 NUMBER 5 THRUST BEARING.  |
| 110 "TAPERED" SNAP RING (INSIDE BEVEL).                             | 132 NUMBER 5 " <i>SELECTIVE</i> " THRUST BEARING SPACER.            |
| 111 UNDERDRIVE "MOLDED" CLUTCH PISTON ASSEMBLY.                     | 133 REVERSE CLUTCH FRICTION PLATES, .080" THICK (2 REQ.).           |
| 112 UNDERDRIVE CLUTCH RETURN SPRING ASSEMBLY.                       | 134 REVERSE CLUTCH STEEL PLATE, .067" THICK (1 REQUIRED).           |
| 113 RETURN SPRING RETAINER AND BALANCE PISTON ASSEMBLY.             | 135 REVERSE CLUTCH BACKING PLATE.                                   |
| 114 RETURN SPRING RETAINER "FLAT" SNAP RING.                        | 136 REVERSE CLUTCH BACKING PLATE " <i>SELECTIVE</i> " SNAP RING.    |
| 115 NUMBER 2 THRUST BEARING.  | 137 DRAIN BACK BALL CAPSULE RETAINING SNAP RING.                    |
| 116 UNDERDRIVE CLUTCH HUB AND SHAFT.                                | 138 DRAIN BACK BALL CAPSULE.  |
| 117 UD CLUTCH SINGLE-SIDED, <i>EXTERNAL</i> SPLINE PLATES (5 REQ.). | 139 DRAIN BACK BALL CAPSULE "O" RING SEAL.                          |

Copyright © 2011 ATSG

Figure 93

## INPUT CLUTCH HOUSING SNAP RING IDENTIFICATION CHART

	Thickness	I.D. to O.D.
<i>Snap Ring No. 1</i>	<i>Flat .060"</i>	<i>.187"</i>
<i>Snap Ring No. 2</i>	<i>Tapered .091"</i>	<i>Varies</i>
<i>Snap Ring No. 3</i>	<i>Flat .078"</i>	<i>Varies</i>
<i>Snap Ring No. 4</i>	<i>Flat .060"</i>	<i>.189"</i>
<i>Snap Ring No. 5</i>	<i>Tapered .095"</i>	<i>.139"</i>
<i>Snap Ring No. 6</i>	<i>Waved .060"</i>	<i>.155"</i>
<i>Snap Ring No. 7</i>	<i>Flat .060"</i>	<i>.186"</i>
<i>Snap Ring No. 8</i>	<i>Flat .072"</i>	<i>.187"</i>



Copyright © 2011 ATSG

Figure 94

## COMPONENT REBUILD (CONT'D) INPUT CLUTCH HOUSING ASSEMBLY

1. Disassemble the input clutch housing using the illustrations in Figures 92 and 93 as a guide.
2. Clean and inspect all components. Replace any parts that show evidence of wear or damage.
3. Remove the small "eyelet" snap ring from the input shaft as shown in Figure 95.
4. Remove the drain back ball capsule assembly from the input shaft using a pick tool. Remove and discard the "O" ring (See Figure 95).
5. Install a new "O" ring on the ball capsule and lubricate with small amount of TransJel®.
6. Install the drain back ball capsule back into the input shaft in the direction shown in Figure 95.
7. Install the "eyelet" snap ring and ensure that it is fully seated (See Figure 95).
8. Install new lip seal into the groove in the input clutch hub with the lip facing down as shown in Figure 95 and lubricate with a small amount of TransJel®.

**Note:** This is an "inside" lip seal.

9. The "O" rings on the input clutch hub are color coded. Install Green and Red colored "O" rings in the positions shown in Figure 96, and lube with a small amount of TransJel®.

Continued on Page 64

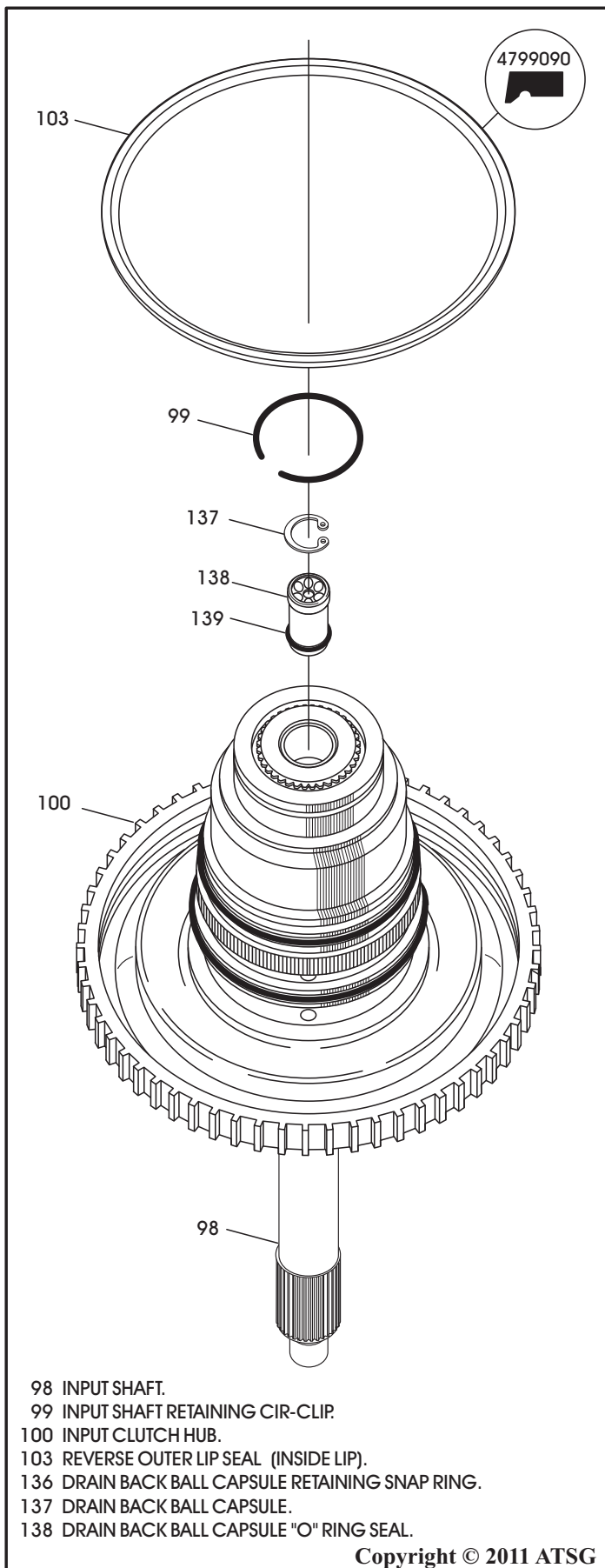


Figure 95

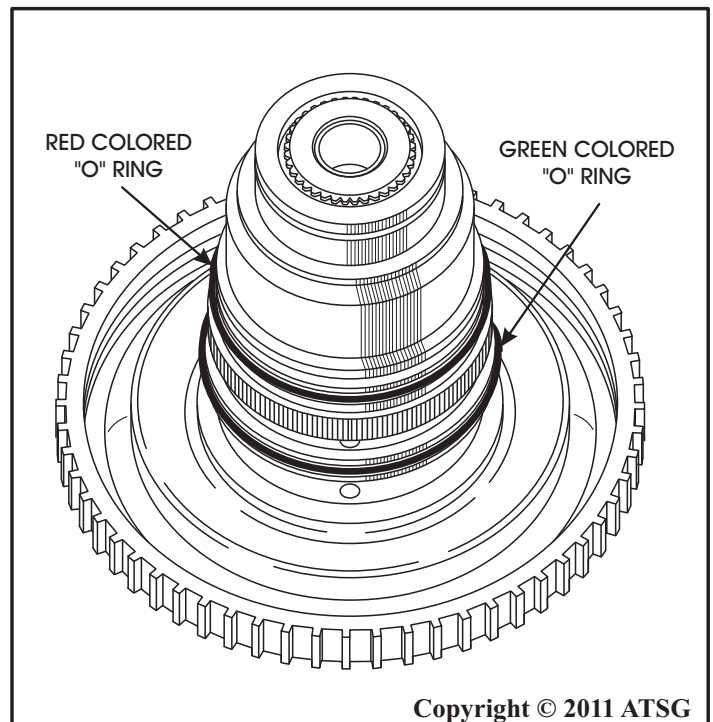


Figure 96



## INPUT CLUTCH HOUSING ASSEMBLY (CONT'D)

10. Install the overdrive/reverse bellville plate and the retaining snap ring as shown in Figure 97, if they were removed.
11. Install the overdrive outer lip seal into groove inside the overdrive/reverse piston, with the lip facing down, as shown in Figure 97.  
**Note: This is an "inside" lip seal.**
12. Install the overdrive/reverse inner "O" ring seal into the groove in the overdrive/reverse piston as shown in Figure 97.
13. Lubricate both seals with a small amount of TransJel®.
14. Install the input clutch retainer into overdrive/reverse piston by rotating into position, as shown in Figure 98.
15. Install input clutch retainer and OD/Reverse piston assembly onto the input clutch hub, as shown in Figure 99.
16. Install the input clutch retainer *tapered* snap ring, with the *tapered side facing up*, into the groove in the input clutch hub as shown in Figure 99.

**Note: We have provided you with a snap ring identification chart to identify the snap rings and their locations in Figure 94 on Page 62.**

Continued on Page 65

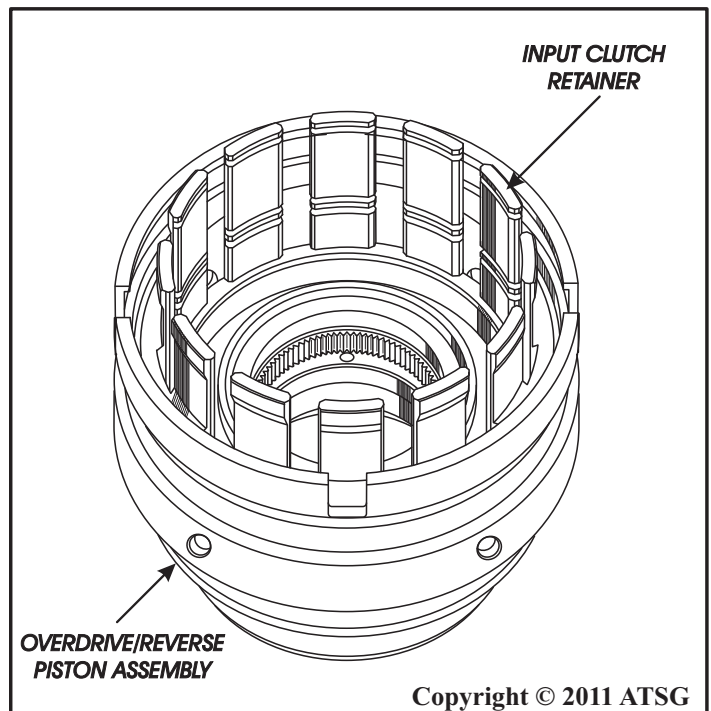


Figure 98

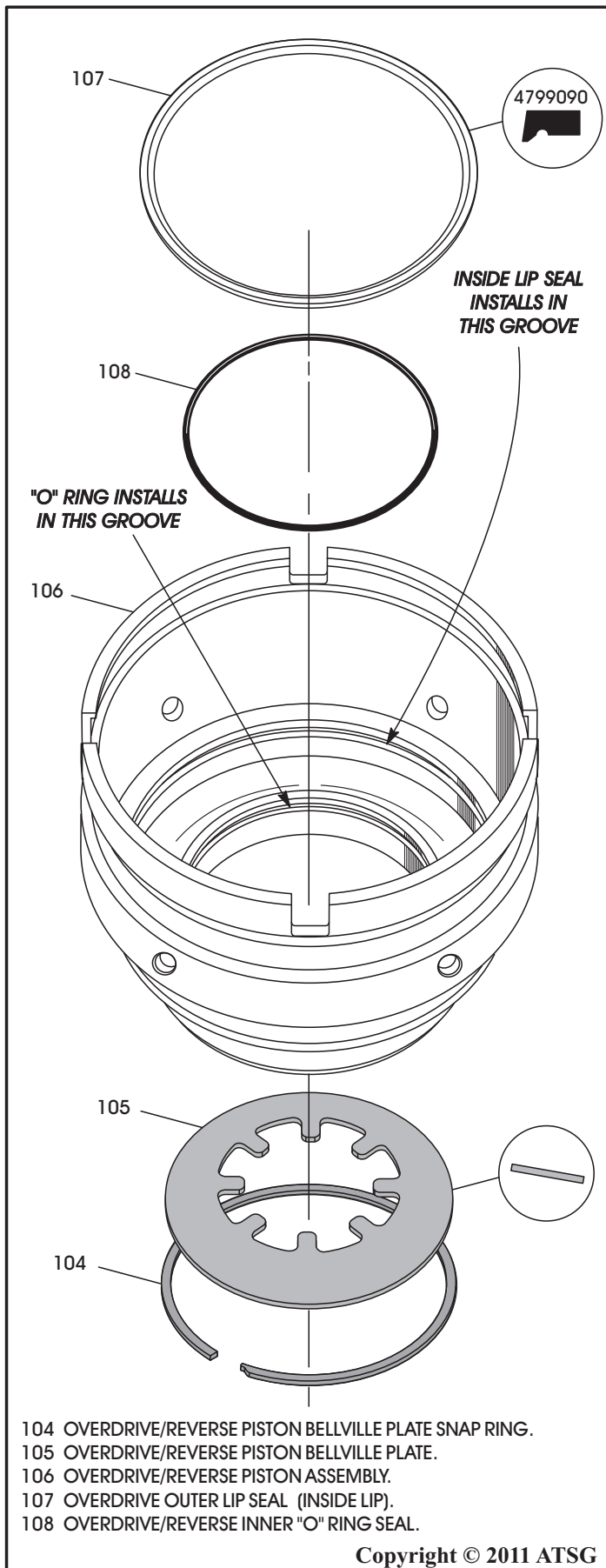


Figure 97



## INPUT CLUTCH HOUSING ASSEMBLY (CONT'D)

17. Install the input clutch "molded" rubber piston in the input clutch retainer, as shown in Figure 100.
18. Install the input clutch piston return spring on top of the input clutch piston (See Figure 100).
19. Install the spring retainer/balance piston, as shown in Figure 100. The balance piston also has a "molded" rubber seal.
20. Using a suitable shop press, compress return spring assembly and install the flat snap ring into the groove. Refer to Figure 100 and snap ring chart in Figure 94.

Continued on Page 66

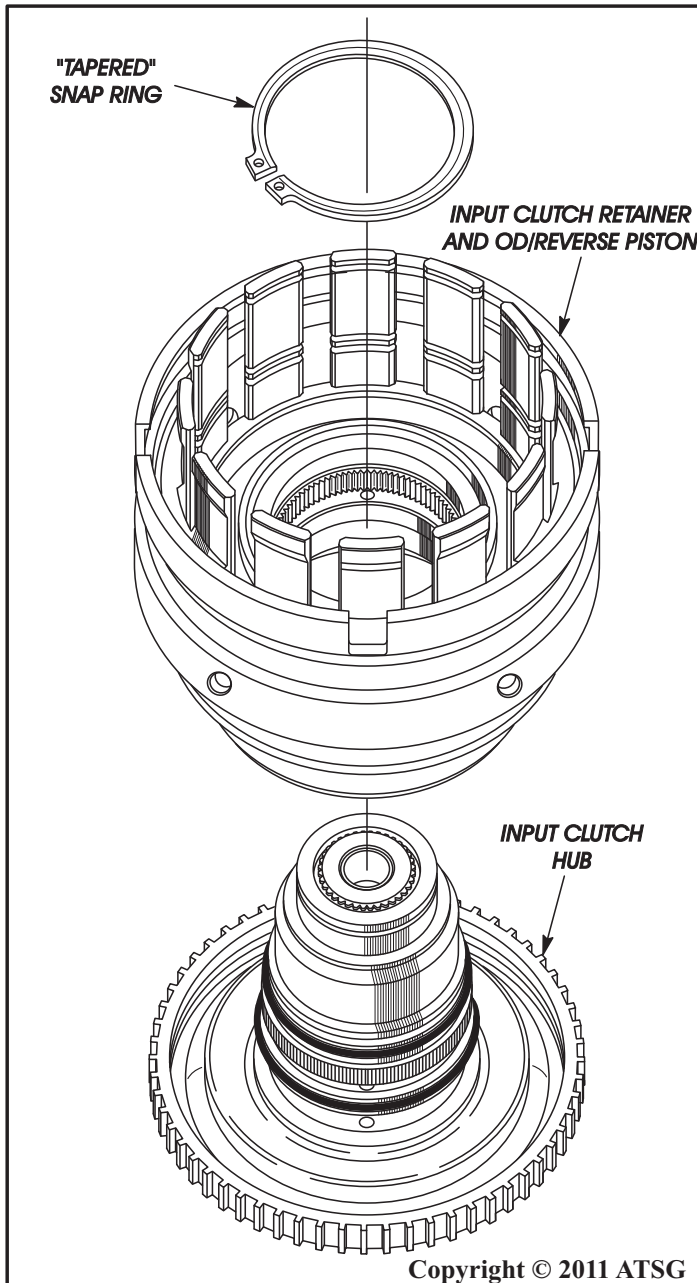


Figure 99

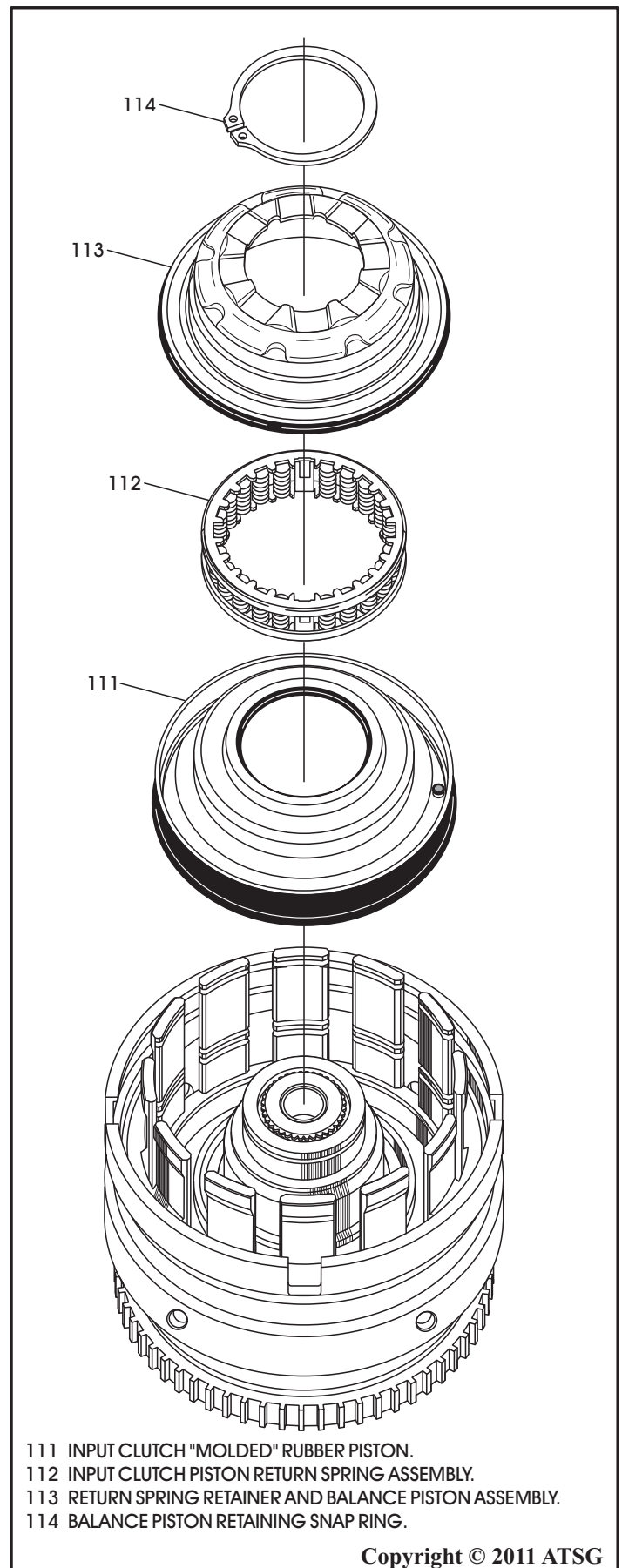


Figure 100

## INPUT CLUTCH HOUSING ASSEMBLY (CONT'D)

**Special Note:** The 68RFE underdrive plates, both inside and outside spline plates, can be identified by numbers "605/604" laser-burnt into friction material facings (See Figure 101).

The underdrive and overdrive plates are not the same, so do not mis-stack as binding and/or neutral shifts may occur.

21. Install the "single-sided" underdrive clutch pack beginning with an outside spline plate with the lining facing up and alternating with the inside spline plates with lining facing up, as shown in Figure 101 (5 of each are required).

**Note:** All clutch plates should be soaked for 30 minutes in proper fluid before assembly.

22. Install the underdrive/overdrive backing plate lower **flat** snap ring into the housing in the lower groove, as shown in Figure 101.

**Note:** We have provided you with a snap ring identification chart to identify the snap rings and their locations in Figure 94 on Page 62.

23. Install the underdrive/overdrive backing plate into the input clutch retainer, with the big step facing down, as shown in Figure 101.

24. Install the underdrive/overdrive backing plate upper **tapered** snap ring into the housing with the tapered side facing up (See Figure 100).

**Note:** We have provided you with a snap ring identification chart to identify the snap rings and their locations in Figure 94 on Page 62.

25. Mount a dial indicator to the assembly and zero the indicator against one tooth of the clutch friction disc. Apply 20 psi of air pressure to the underdrive clutch and record the dial reading.
26. The correct underdrive clutch clearance should be 1.02-1.72 mm (.040"-.068").
27. The backing plate **is not** selective for the 68RFE. **If clutch clearance is not within specification, replace the backing plate along with the entire clutch pack.**

Continued on Page 67

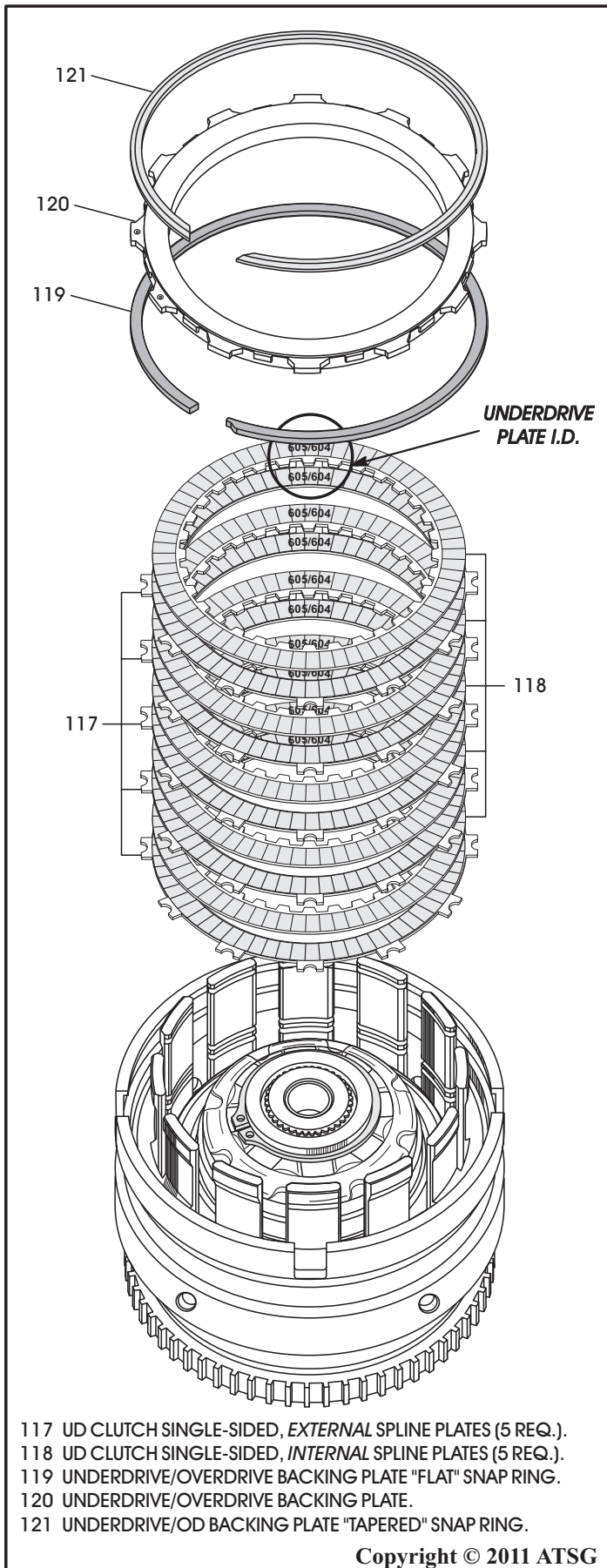


Figure 101

## INPUT CLUTCH HOUSING ASSEMBLY (CONT'D)

**Special Note:** The 68RFE underdrive plates, both inside and outside spline plates, can be identified by numbers "605/604" laser-burnt into friction material facings (See Figure 101).

The underdrive and overdrive plates are not the same so do not mis-stack as binding and/or neutral shifts may occur.

28. Install the "single-sided" overdrive clutch pack beginning with an outside spline plate with the lining facing up and alternating with the inside spline plates with lining facing up, as shown in Figure 102 (6 of each are required).

**Note:** All clutch plates should be soaked for 30 minutes in proper fluid before assembly.

29. Install the overdrive/reverse backing plate lower **wave** snap ring into the wide groove in the overdrive/reverse piston and push the snap ring to bottom of the groove (See Figure 102).

**Note:** We have provided you with a snap ring identification chart to identify the snap rings and their locations in Figure 94 on Page 62.

30. Install the overdrive/reverse backing plate into the retainer, with the stepped face toward the overdrive clutch, as shown in Figure 102.

31. Install the overdrive/reverse backing plate **flat** snap ring on top of the backing plate and into wide groove in overdrive/reverse piston, by pushing down on the backing plate to pre-load the wave snap ring (See Figure 102).

**Note:** We have provided you with a snap ring identification chart to identify the snap rings and their locations in Figure 94 on Page 62.

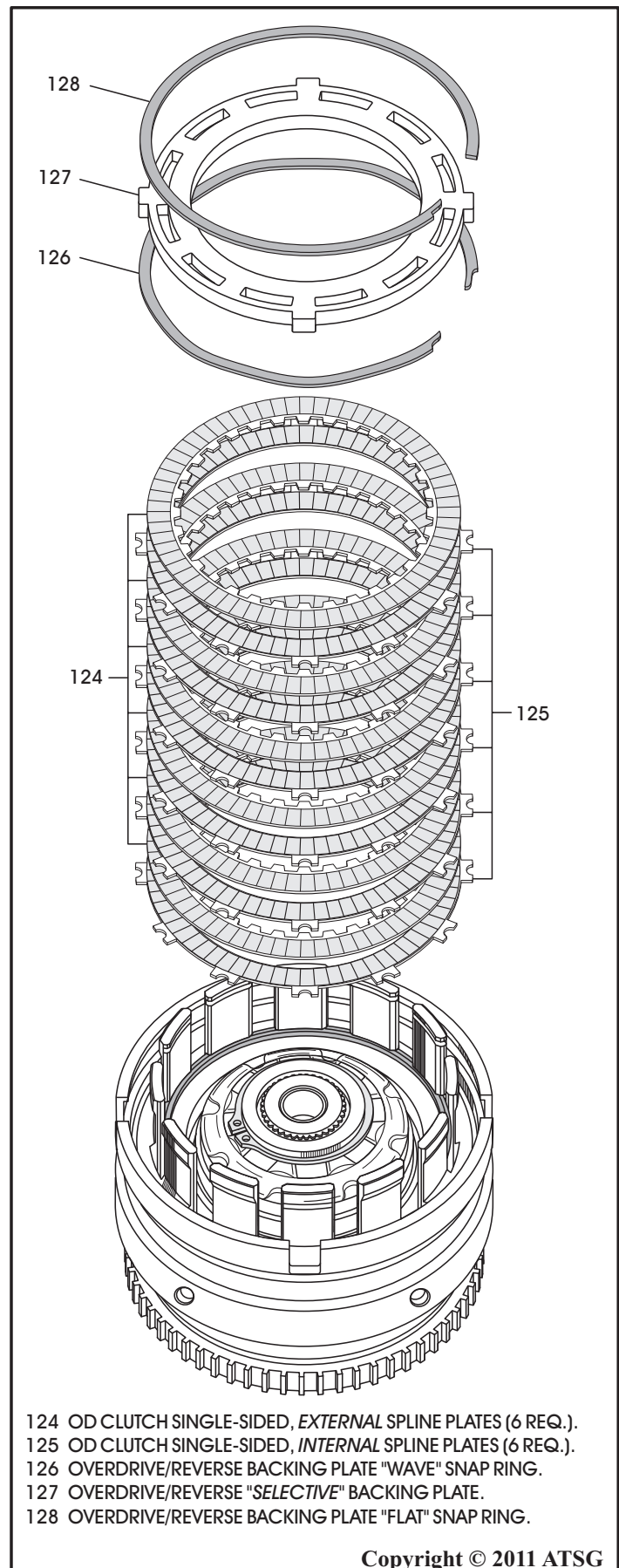
32. Mount a dial indicator to the assembly and zero the indicator against the OD/reverse backing plate. Apply 20 psi of air pressure to the overdrive clutch and record the indicator reading.
33. The correct overdrive clutch clearance should be 0.75-1.61 mm (.030"-.063").
34. Change the selective overdrive/reverse backing plate as necessary to obtain correct clearance.

### Selectable Overdrive/Reverse Backing Plates

- Both faces flat, ID No. none = 9.74mm (.383")
- 1 stepped face, ID No. 2 ..... = 9.34mm (.367")
- 1 stepped face, ID No. 1 ..... = 8.90mm (.350")

**Note:** ID No. is stamped into one tang on the stepped face side (bottom) of the backing plate.

Continued on Page 68



Copyright © 2011 ATSG

Figure 102



## INPUT CLUTCH HOUSING ASSEMBLY (CONT'D)

35. Temporarily install the reverse clutch pack beginning with a friction plate and alternating with steel plate until you have installed two friction plates and 1 steel plate, as shown in Figure 103.

**Note:** All clutch plates should be soaked for 30 minutes in proper fluid before assembly.

36. Install the reverse clutch backing plate with the flat side facing down, as shown in Figure 103.

37. Install reverse clutch backing plate *selective* snap ring as shown in Figure 103.

**Note:** We have provided you with a snap ring identification chart to identify the snap rings and their locations in Figure 94 on Page 62.

38. Mount a dial indicator to the assembly and zero the indicator against one tooth of the clutch friction disc. Apply 20 psi of air pressure to the reverse clutch and record the dial reading.

39. The correct reverse clutch clearance should be 0.58-1.47 mm (.023"-.058").

40. Change the selective snap ring as necessary to obtain the correct reverse clutch clearance.

- 1 Square End, 1 Butterfly cut = 1.55mm (.061")
- Both Ends Square Cut ..... = 1.85mm (.073")
- Both Ends Butterfly Cut ..... = 2.2mm (.087")

41. Now, remove the reverse clutch pack from the input housing assembly to install the 3 clutch hubs and shafts.

42. Install the number 2 thrust bearing into the underdrive clutch hub and shaft, in direction shown in Figure 104, and retain with TransJel®.

43. Install the underdrive clutch hub and shaft into input housing, by rotating until all underdrive clutches are engaged and it is fully seated.

44. Install the number 3 thrust bearing into the overdrive clutch hub and shaft, in the direction shown in Figure 105, and retain with TransJel®.

45. Install the overdrive clutch hub and shaft into input housing, by rotating until all overdrive clutches are engaged and it is fully seated.

Continued on page 70

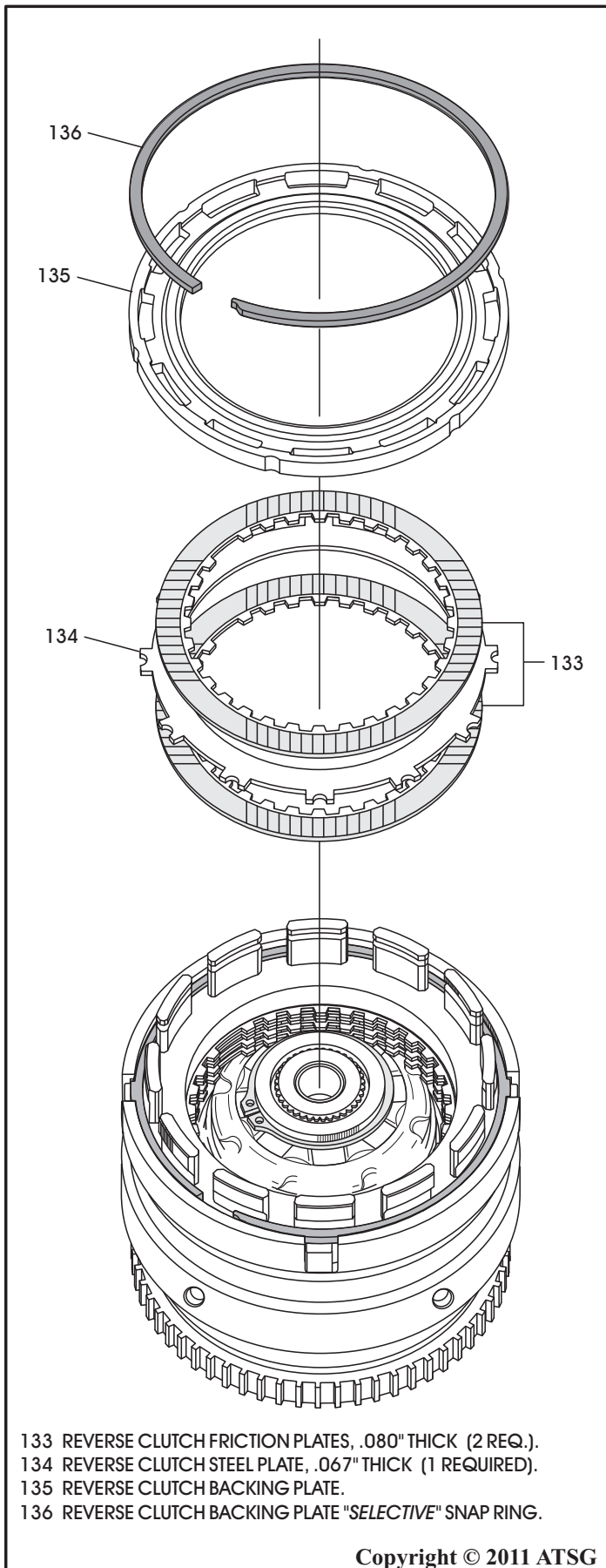
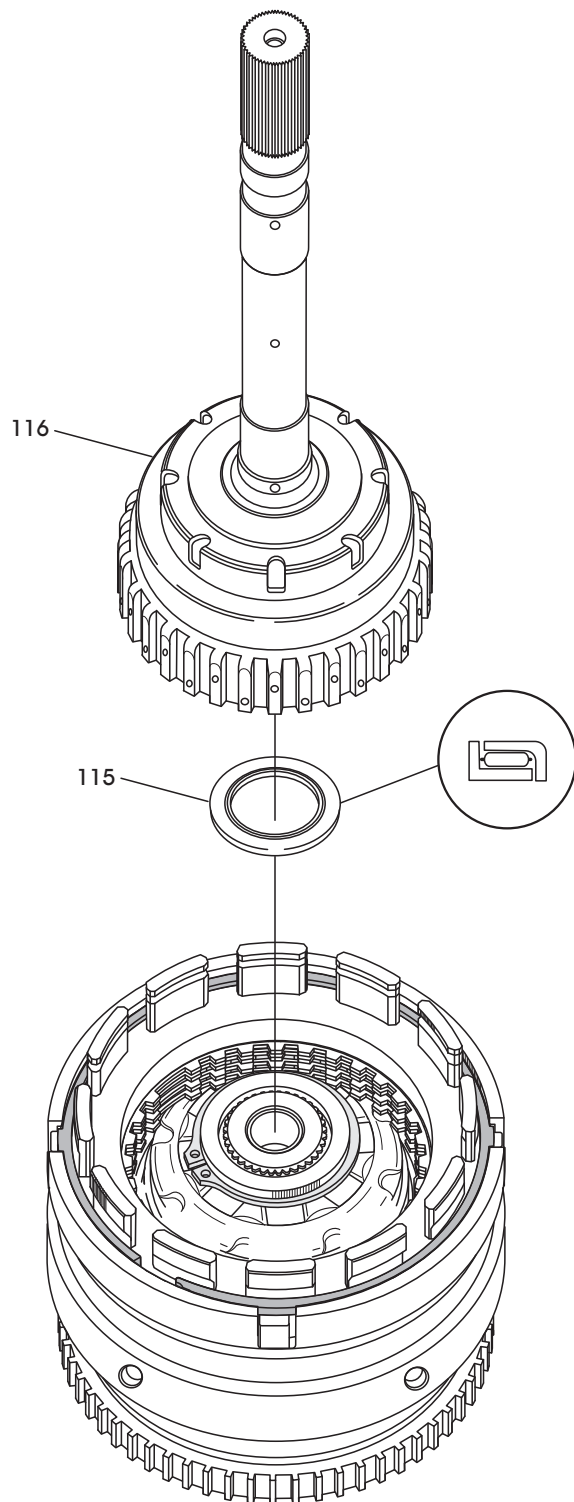


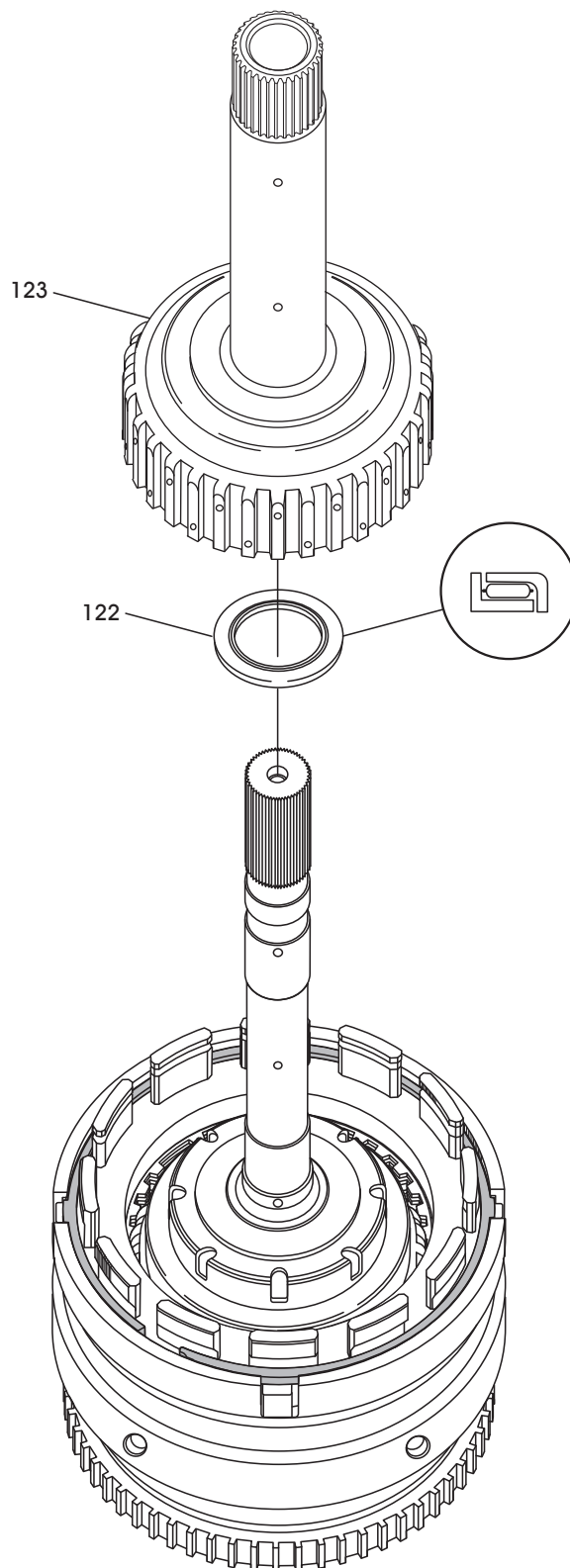
Figure 103



115 NUMBER 2 THRUST BEARING.  
116 UNDERDRIVE CLUTCH HUB AND SHAFT.

Copyright © 2011 ATSG

Figure 104



122 NUMBER 3 THRUST BEARING.  
123 OVERDRIVE CLUTCH HUB AND SHAFT ASSEMBLY.

Copyright © 2011 ATSG

Figure 105



## INPUT CLUTCH HOUSING ASSEMBLY (CONT'D)

46. Install the number 4 thrust bearing into reverse clutch hub, in the direction shown in Figure 106, and retain with small amount of TransJel®.
47. Install the reverse clutch hub assembly into the input housing over both shafts, as shown in Figure 106.

48. Re-install the reverse clutch pack completely, as described on Page 68, and illustrated in Figure 103.

**Note:** Pry up on backing plate to allow reverse clutch hub to turn freely.

49. The number 5 thrust bearing is equipped with a selective spacer that snaps onto the bearing, as shown in Figure 107, and is used to adjust front transmission end-play.

**Note:** Ensure that selective spacer is snapped onto number 5 thrust bearing properly.

Continued on Page 71

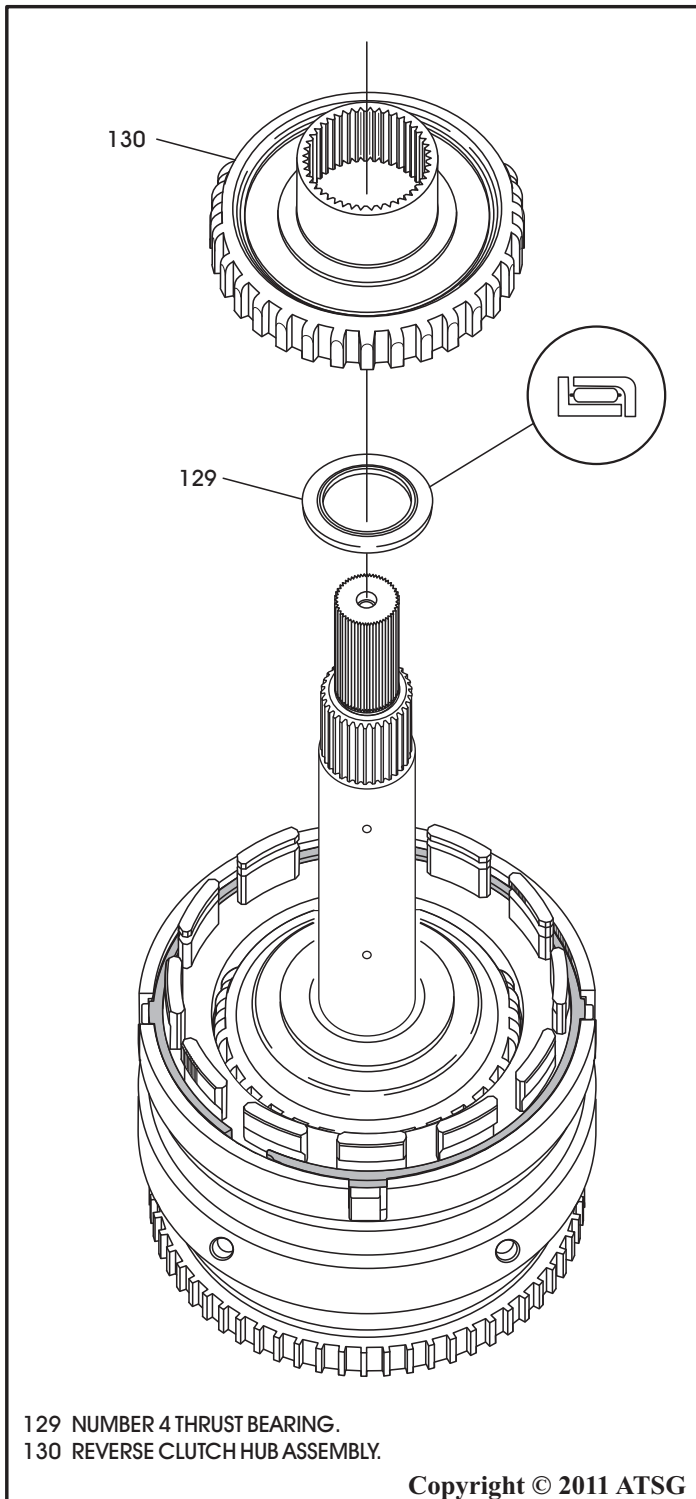


Figure 106

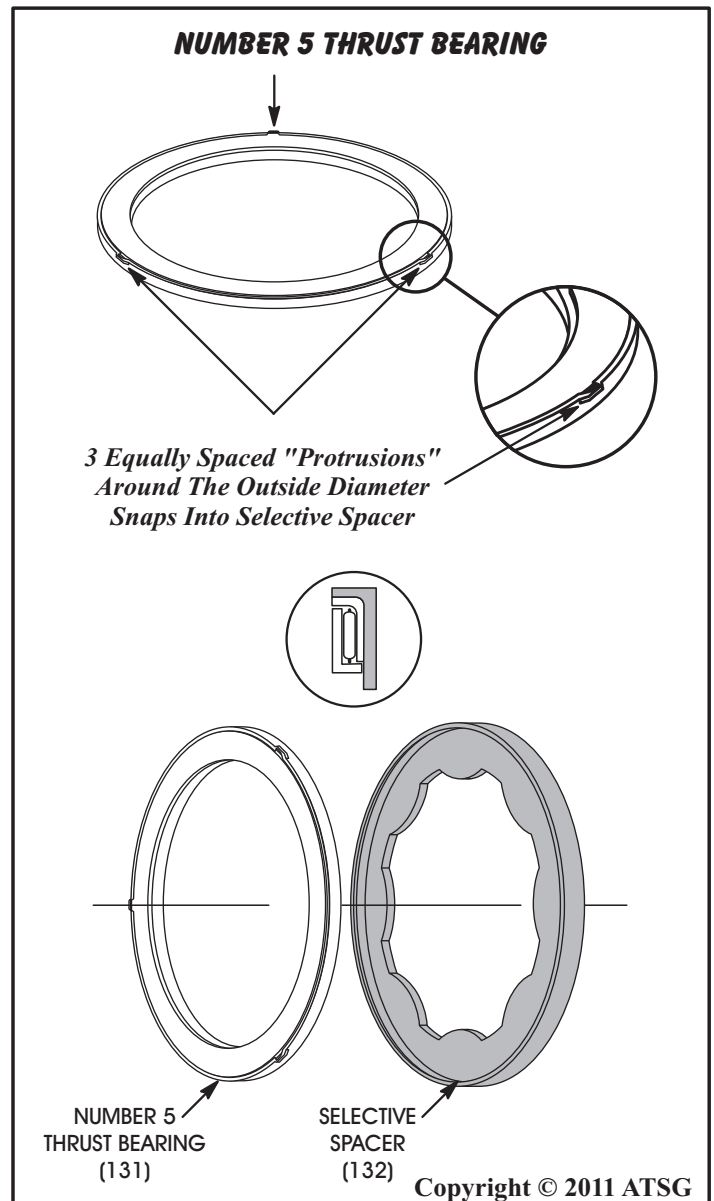


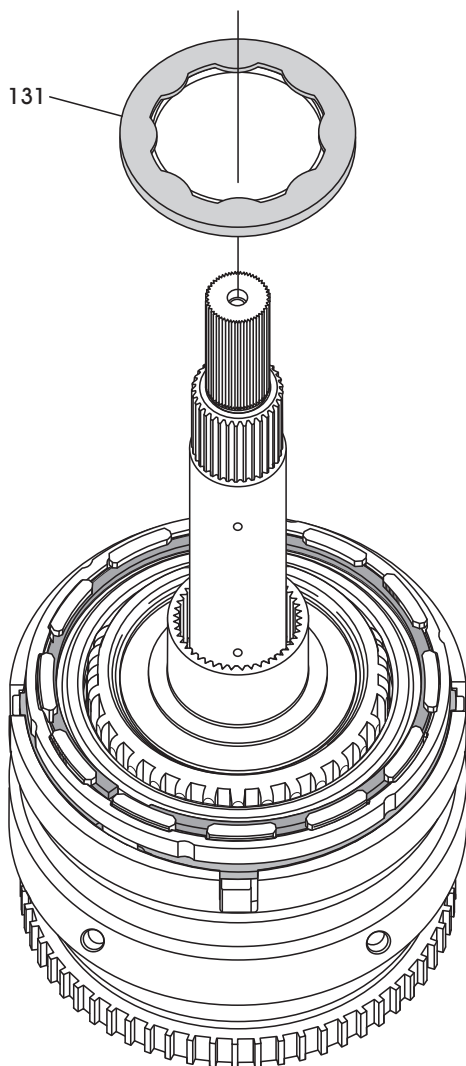
Figure 107

## INPUT CLUTCH HOUSING ASSEMBLY (CONT'D)

50. Install the number 5 thrust bearing and selective spacer on the back side of reverse clutch hub, as shown in Figure 108 and retain with TransJel®.
51. Install two new input shaft seals into the grooves on input shaft, as shown in Figure 109, ensure they are properly seated and rotate freely.
52. Set the completed input housing assembly aside for the final assembly process.

### Component Rebuild Continued on Page 72

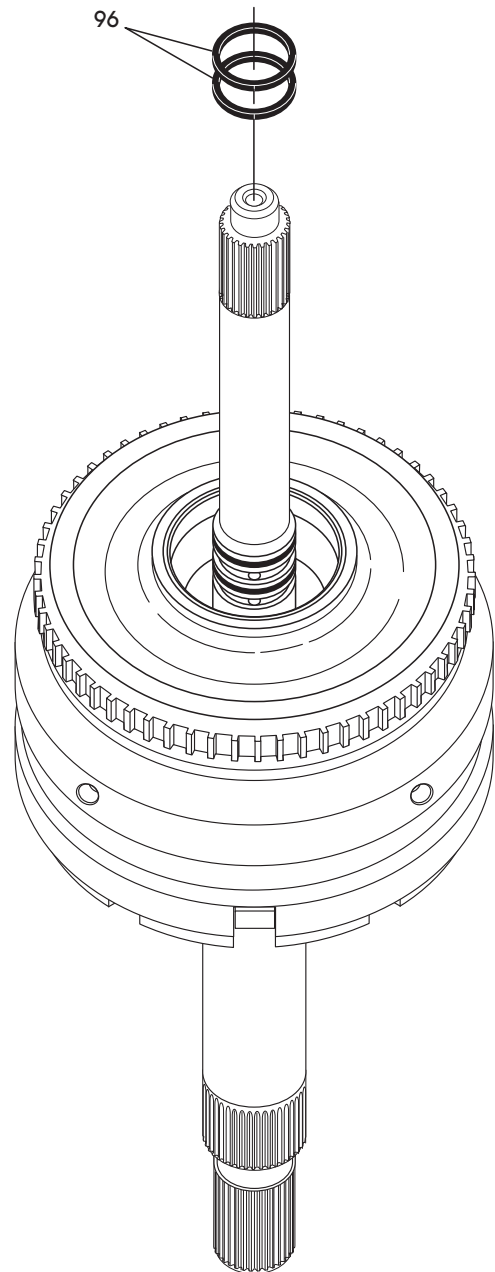
ProCarManuals.com



131 NUMBER 5 THRUST BEARING AND "SELECTIVE" SPACER.

Copyright © 2011 ATSG

Figure 108

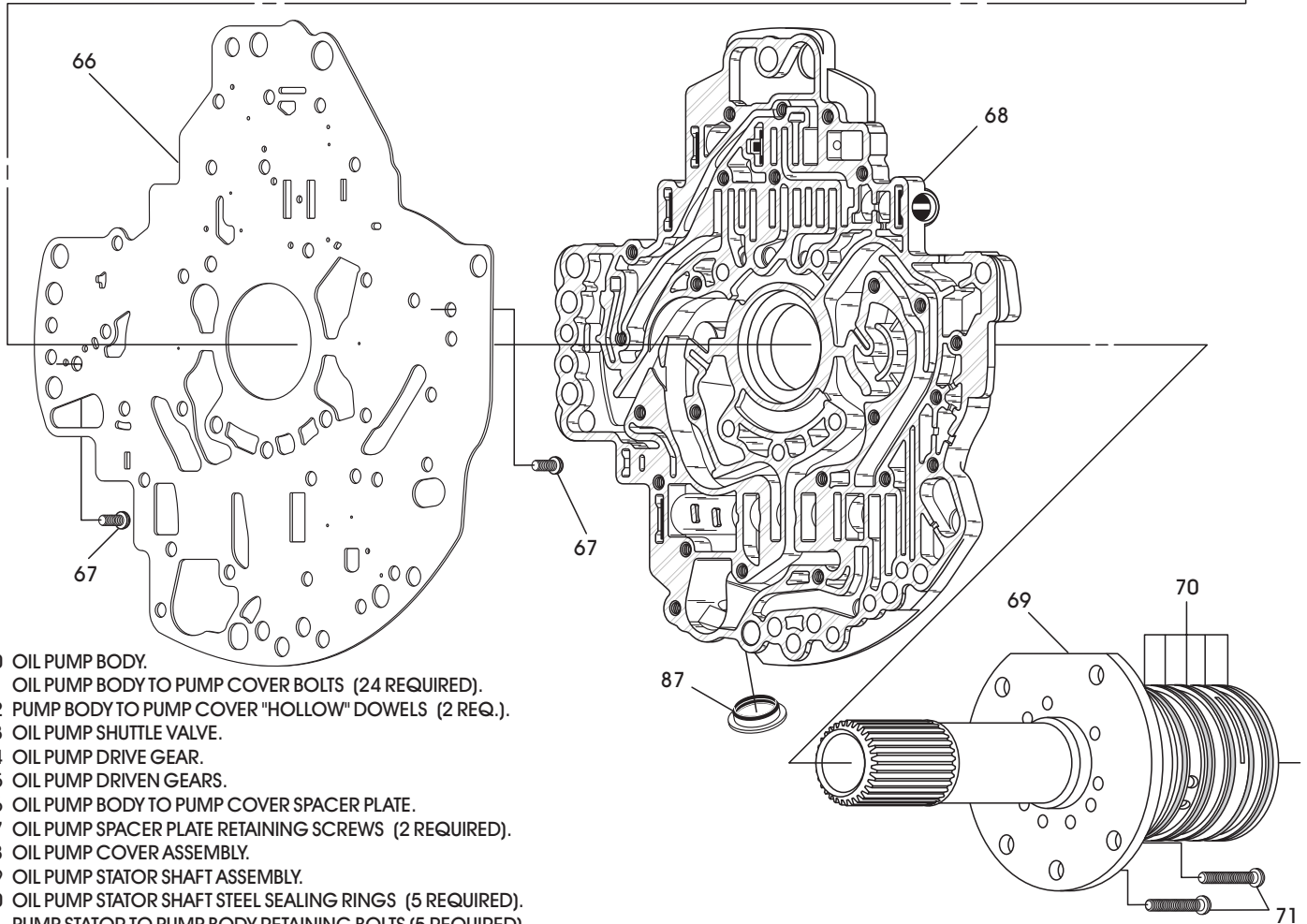
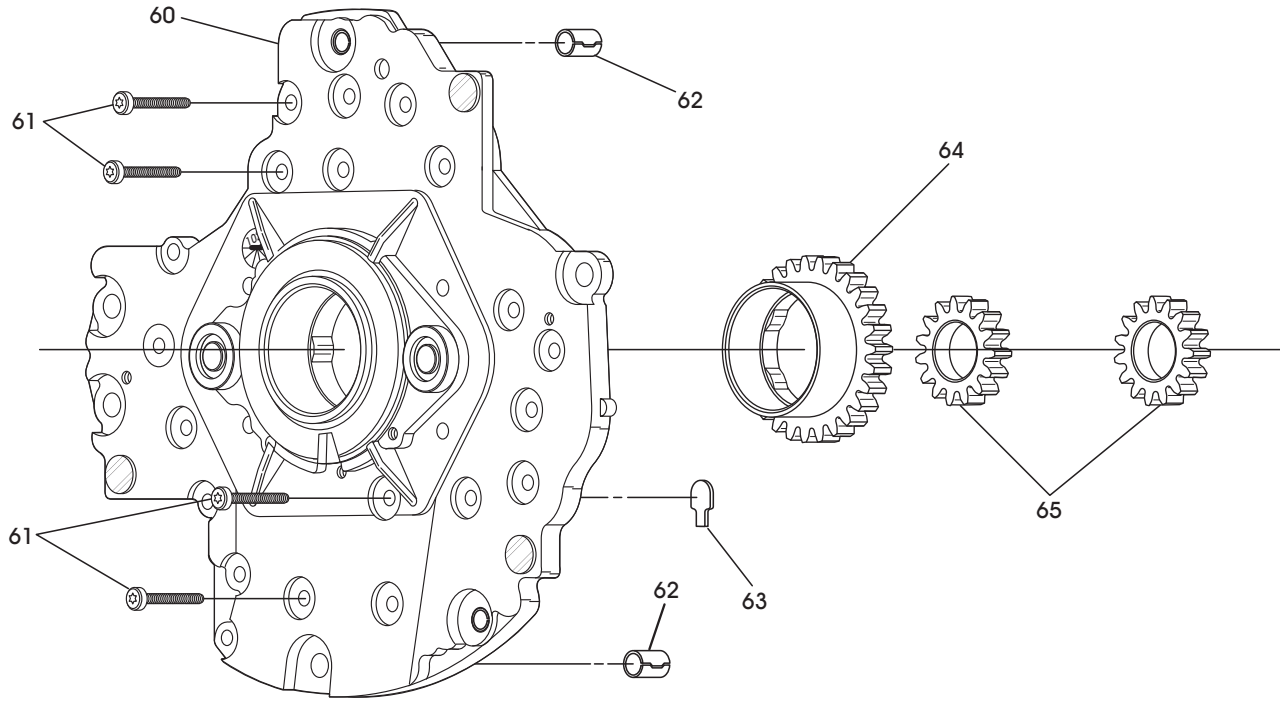


96 INPUT SHAFT SEAL RINGS (2 REQUIRED).

Copyright © 2011 ATSG

Figure 109

## OIL PUMP ASSEMBLY EXPLODED VIEW

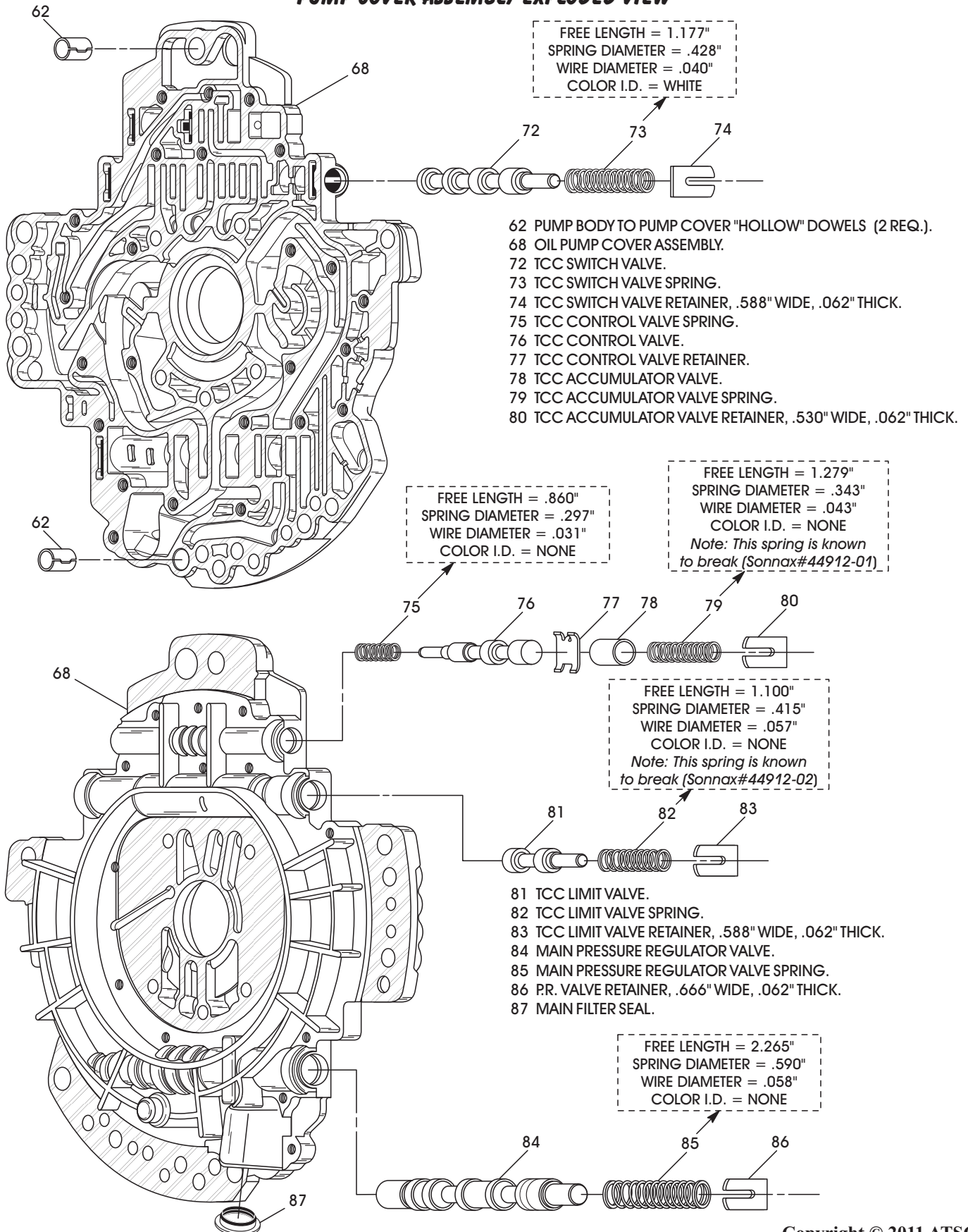


- 60 OIL PUMP BODY.
- 61 OIL PUMP BODY TO PUMP COVER BOLTS (24 REQUIRED).
- 62 PUMP BODY TO PUMP COVER "HOLLOW" DOWELS (2 REQ.).
- 63 OIL PUMP SHUTTLE VALVE.
- 64 OIL PUMP DRIVE GEAR.
- 65 OIL PUMP DRIVEN GEARS.
- 66 OIL PUMP BODY TO PUMP COVER SPACER PLATE.
- 67 OIL PUMP SPACER PLATE RETAINING SCREWS (2 REQUIRED).
- 68 OIL PUMP COVER ASSEMBLY.
- 69 OIL PUMP STATOR SHAFT ASSEMBLY.
- 70 OIL PUMP STATOR SHAFT STEEL SEALING RINGS (5 REQUIRED).
- 71 PUMP STATOR TO PUMP BODY RETAINING BOLTS (5 REQUIRED).
- 87 MAIN FILTER SEAL.

Copyright © 2011 ATSG

Figure 110

## PUMP COVER ASSEMBLY EXPLODED VIEW



Copyright © 2011 ATSG

Figure 111

## COMPONENT REBUILD (CONT'D)

### OIL PUMP ASSEMBLY

1. Disassemble the complete oil pump assembly using Figure 110 as a guide.  
*Note: Mark the oil pump gears so they can be installed in their original locations.*
2. Disassemble oil pump cover valves and springs using Figure 111 as a guide.
3. Clean all oil pump parts thoroughly and dry with compressed air.
4. Inspect all oil pump parts thoroughly for any wear and/or damage and replace as necessary.  
*Note: There is only one bushing in the stator to inspect and it is not serviced.*
5. Lubricate all valves that go into the oil pump cover with Mopar® +4 fluid, as well as the oil pump cover bores.

6. Install all springs, valves and retainers *exactly* as shown in Figure 111.  
*Note: The valve line-up retainers are different sizes for the different locations and the sizes are shown in Figure 112, along with the exact cavity locations for the various retainers.*
7. Install new main filter seal into the oil pump cover using the proper driver (See Figure 112).

Continued on Page 75

### PUMP COVER RETAINER LOCATIONS AND DEMENSIONS

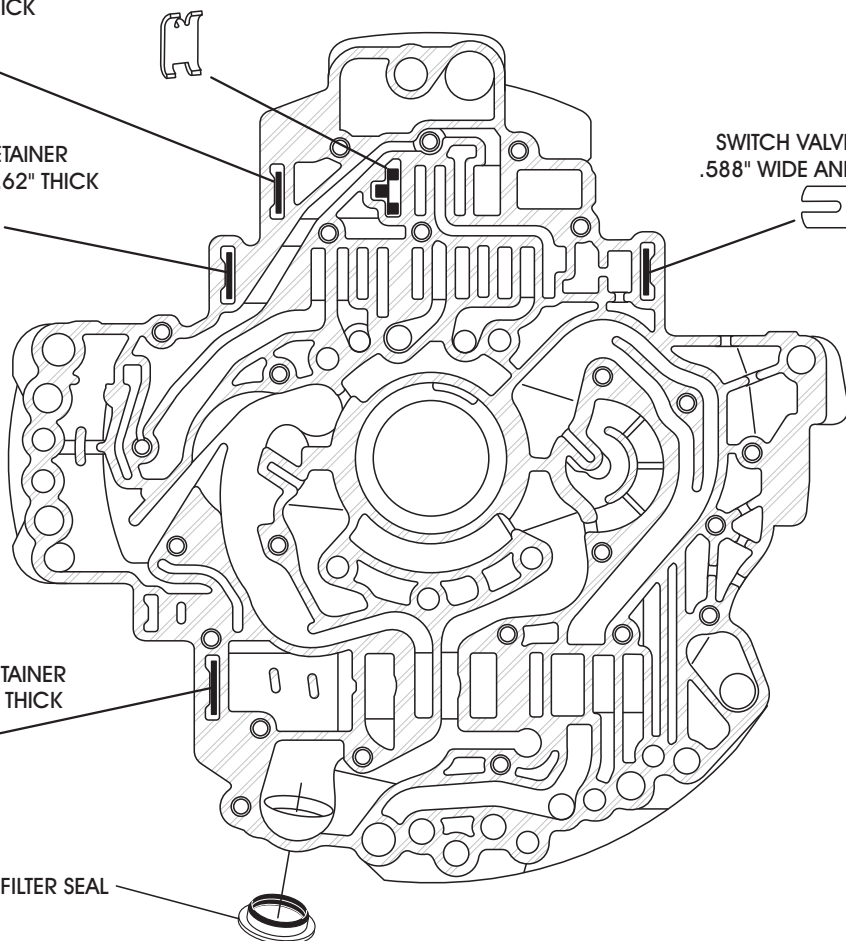
TCC ACCUM VALVE RETAINER  
.530" WIDE AND .62" THICK

LIMIT VALVE RETAINER  
.588" WIDE AND .62" THICK

SWITCH VALVE RETAINER  
.588" WIDE AND .62" THICK

REGULATOR VALVE RETAINER  
.666" WIDE AND .62" THICK

MAIN FILTER SEAL



Copyright © 2011 ATSG

Figure 112



## COMPONENT REBUILD (CONT'D)

### OIL PUMP ASSEMBLY (CONT'D)

8. Install the alignment dowels into oil pump body, if they were removed, as shown in Figure 113.
9. Dip all 3 of the pump gears into Mopar® +4 fluid and install them in their *original* locations, shown in Figure 113.
10. Install the shuttle valve into the oil pump body in the location shown in Figure 113.
11. Ensure the shuttle valve is seated and install the oil pump spacer plate over the alignment dowels, as shown in Figure 114.
12. Install the two spacer plate retaining screws, as shown in Figure 114, and torque the screws to 4.5N·m (40 in.lb.).

**Note:** Leaving these two screws out will create a "No Engagement" condition.

Continued on Page 76

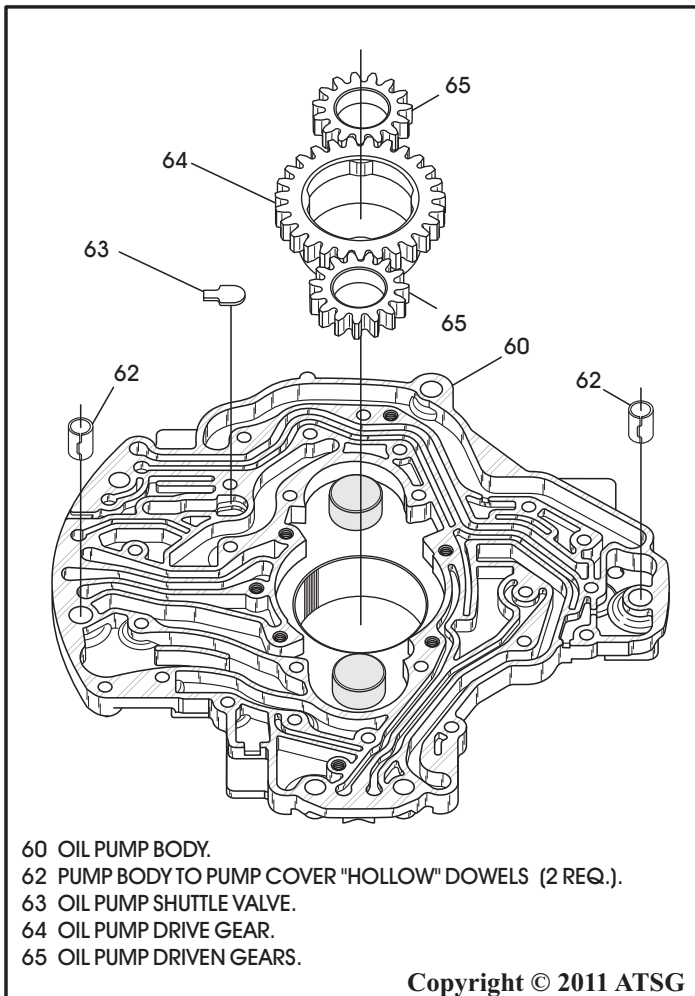


Figure 113

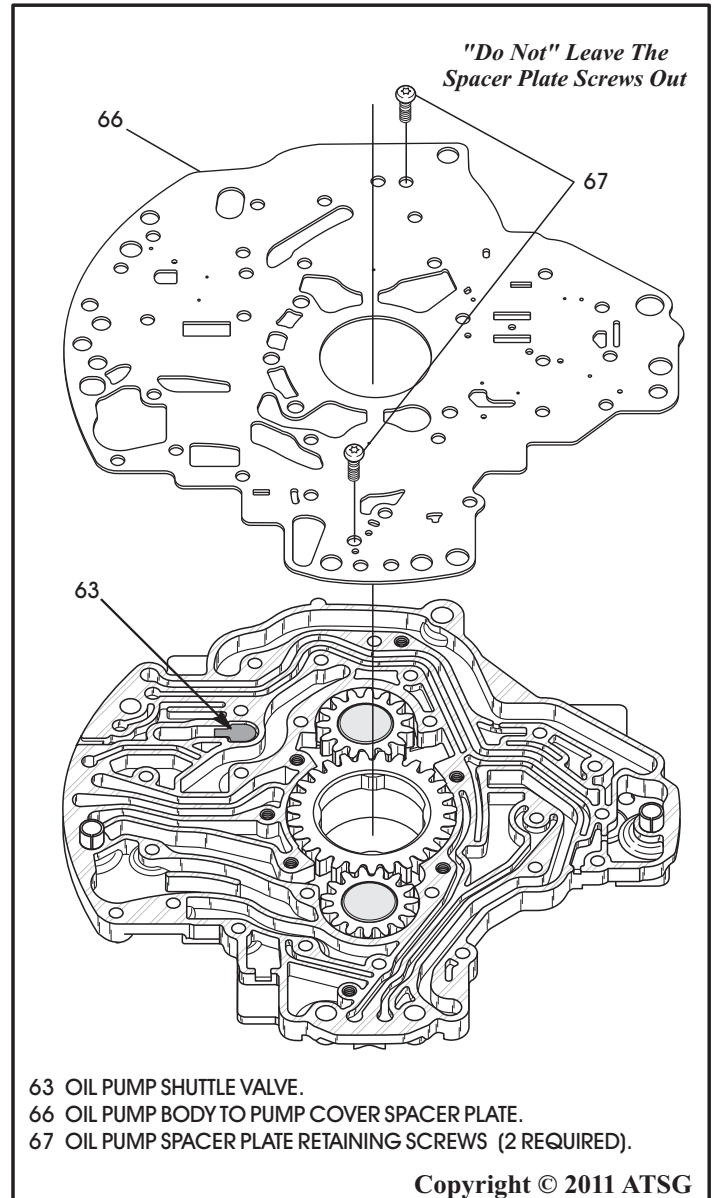


Figure 114

## OIL PUMP ASSEMBLY (CONT'D)

13. Install completed oil pump cover onto completed oil pump body and over the alignment dowels, as shown in Figure 115.
14. Seat the two halves together and very carefully turn the assembly over, as shown in Figure 116, and start all 24 screws finger tight.
15. Torque the pump screws to 4.5 N·m (40 in.lb.), starting in the center and working outward in a circle.
16. Install the stator shaft support into the oil pump assembly resting on blocks, as shown in Figure 117.
17. Install the five stator support bolts, as shown in Figure 117, and torque to 12 N·m (105 in.lb.).

Continued on Page 77

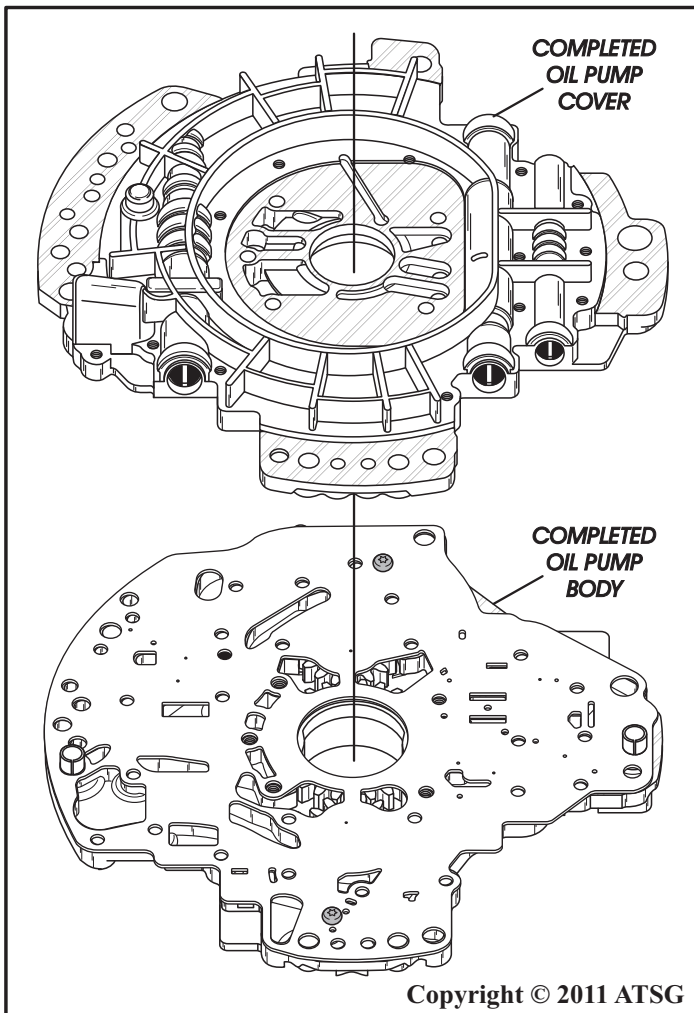


Figure 115

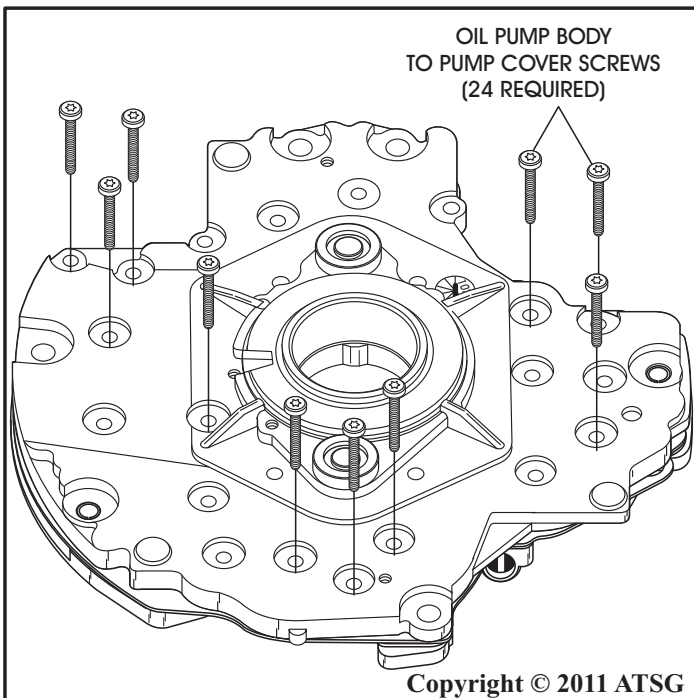


Figure 116

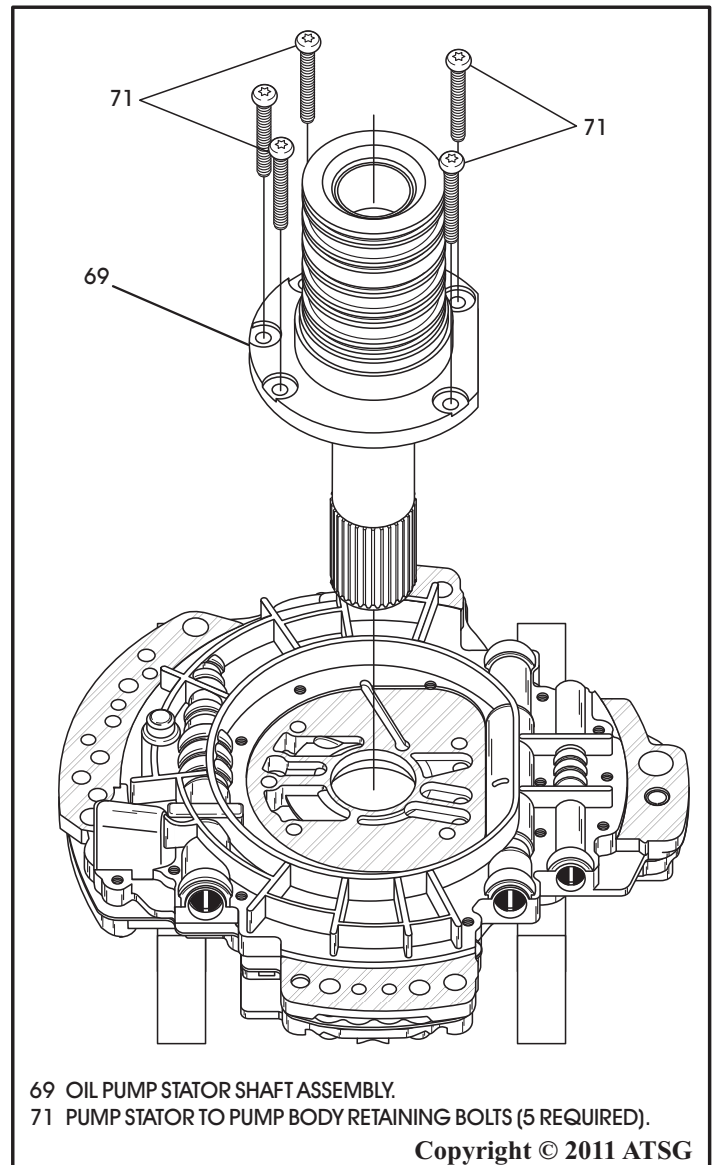


Figure 117

## OIL PUMP ASSEMBLY (CONT'D)

18. Install five new sealing rings on stator support in their respective grooves and ensure that they are properly hooked (See Figure 118).
19. Set the completed oil pump assembly, as shown in Figure 119, aside for final assembly.

**Note:** Notice that oil pump body has no pocket for the converter hub seal. The converter hub seal is now located in the front cover.

**Component Rebuild**  
Continued on Page 78

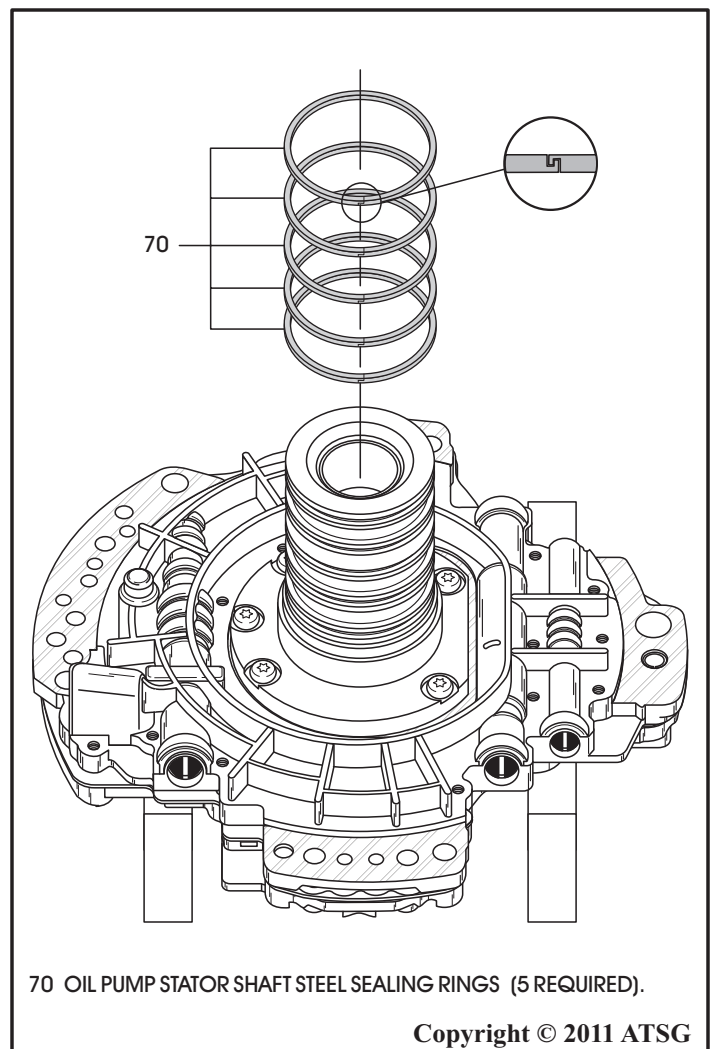


Figure 118

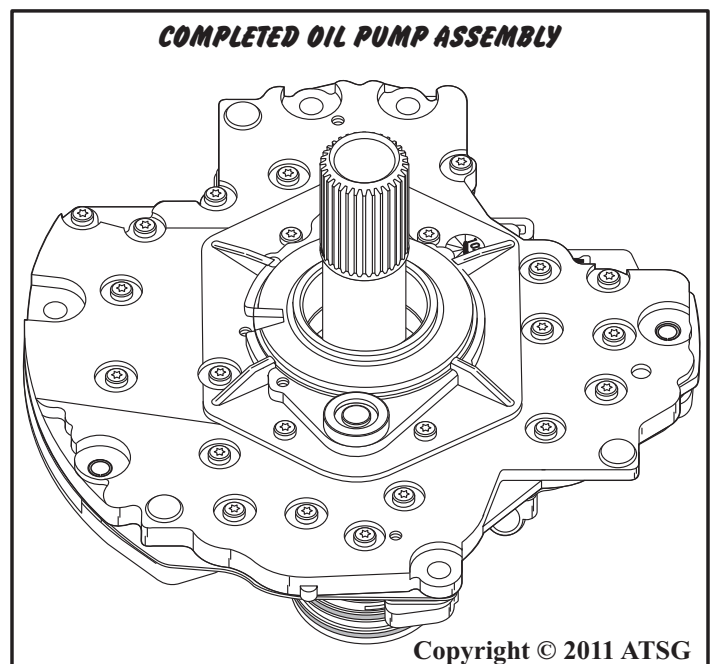
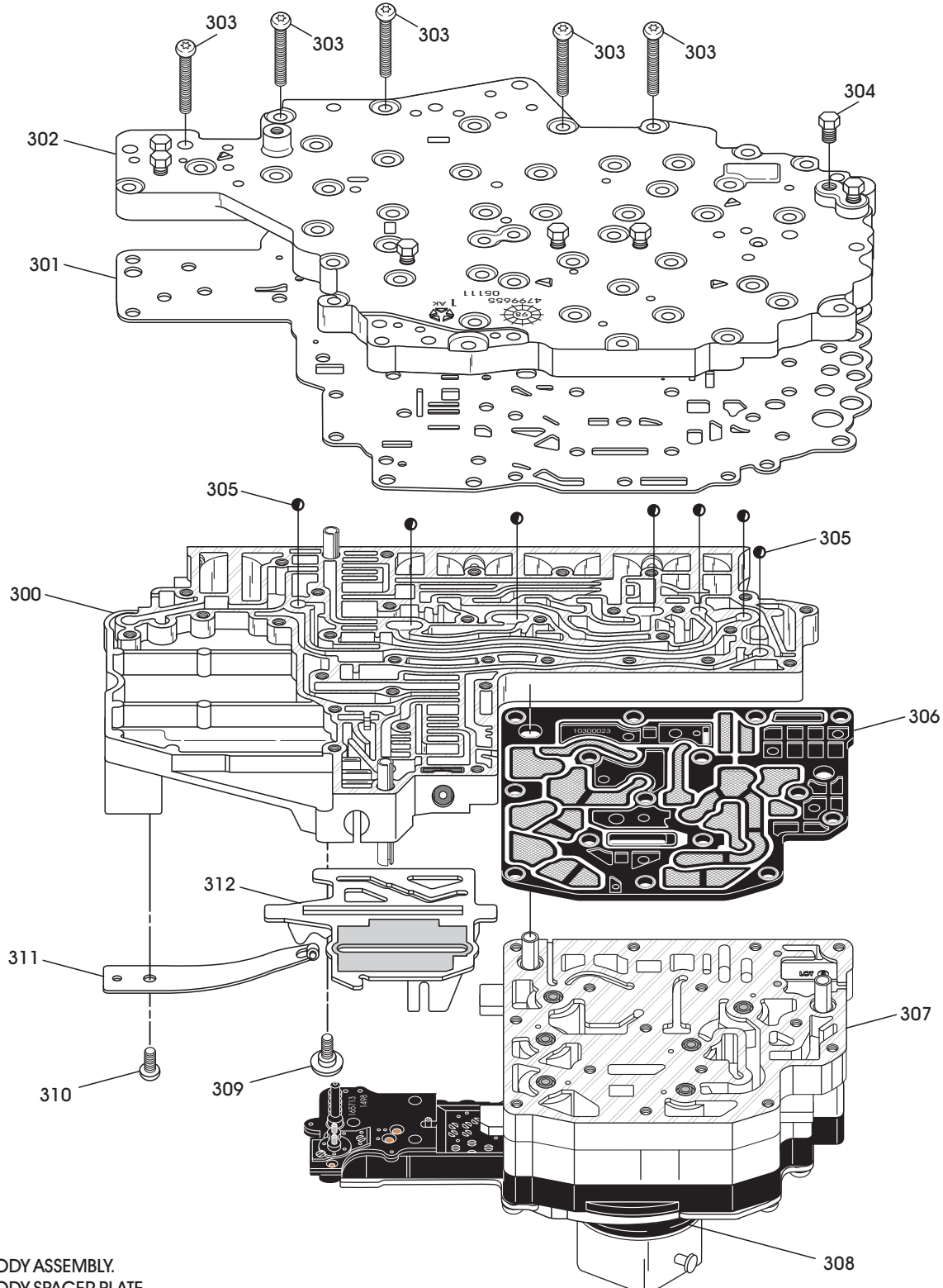


Figure 119

## VALVE BODY ASSEMBLY EXPLODED VIEW



- 300 VALVE BODY ASSEMBLY.
- 301 VALVE BODY SPACER PLATE.
- 302 VALVE BODY TRANSFER PLATE.
- 303 VALVE BODY ASSEMBLY SCREWS (50 REQUIRED).
- 304 1/16" PIPE PLUGS (7 REQUIRED).
- 305 1/4" VITON CHECK BALLS (7 REQUIRED).
- 306 TRS/SOLENOID BODY GASKET/SCREEN ASSEMBLY.
- 307 TRANSMISSION RANGE SENSOR/SOLENOID BODY ASSEMBLY.

- 308 TRS/SOLENOID BODY TO CASE SEAL.
- 309 TRS SELECTOR PLATE "SHOULDERED" RETAINING SCREW.
- 310 MANUAL VALVE DETENT SPRING RETAINING SCREW.
- 311 MANUAL VALVE DETENT SPRING.
- 312 TRANSMISSION RANGE SENSOR SELECTOR PLATE.

Copyright © 2011 ATSG

Figure 120



## VALVE BODY DISASSEMBLY

1. Remove the 15 screws that are shaded as shown in Figure 122. These screws must be removed **first**, so the TRS/Solenoid Body that contains most of the electrical components, will not be cleaned with any solvents.
2. **Do Not** remove the seven screws from the top of the TRS/Solenoid Body (See Figure 121).  
**Note: There is nothing on the inside of the TRS/Solenoid Pack that is serviced. It must be replaced as an assembly.**
3. Once the TRS/Solenoid Body is separated from the valve body assembly, continue disassembly of the valve body using Figure 120 as a guide.
4. Notice in Figure 120 that valve body contains seven checkballs. Care should be taken to keep the valve body in the position shown, when you are removing the transfer plate, so as not to lose any of the checkballs.

Continued on Page 81

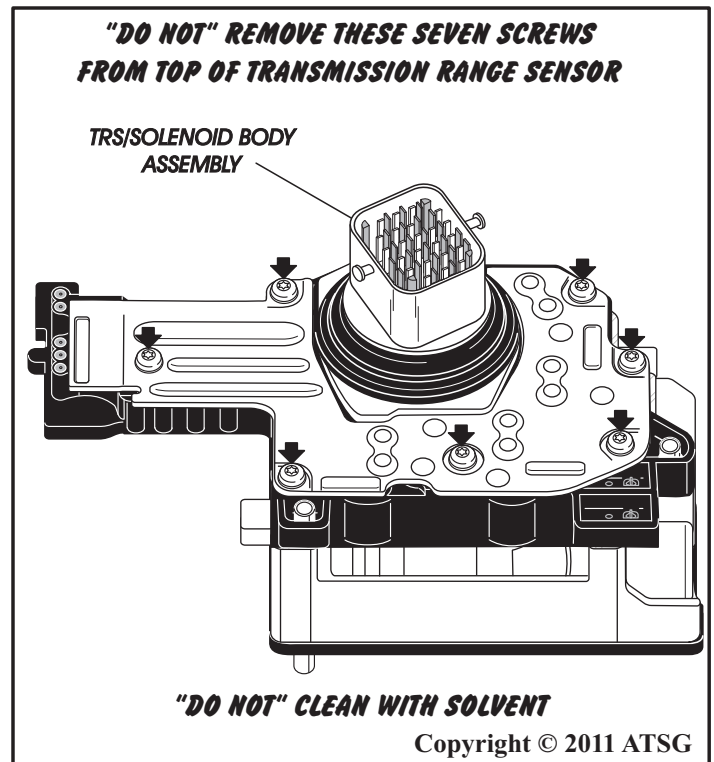


Figure 121

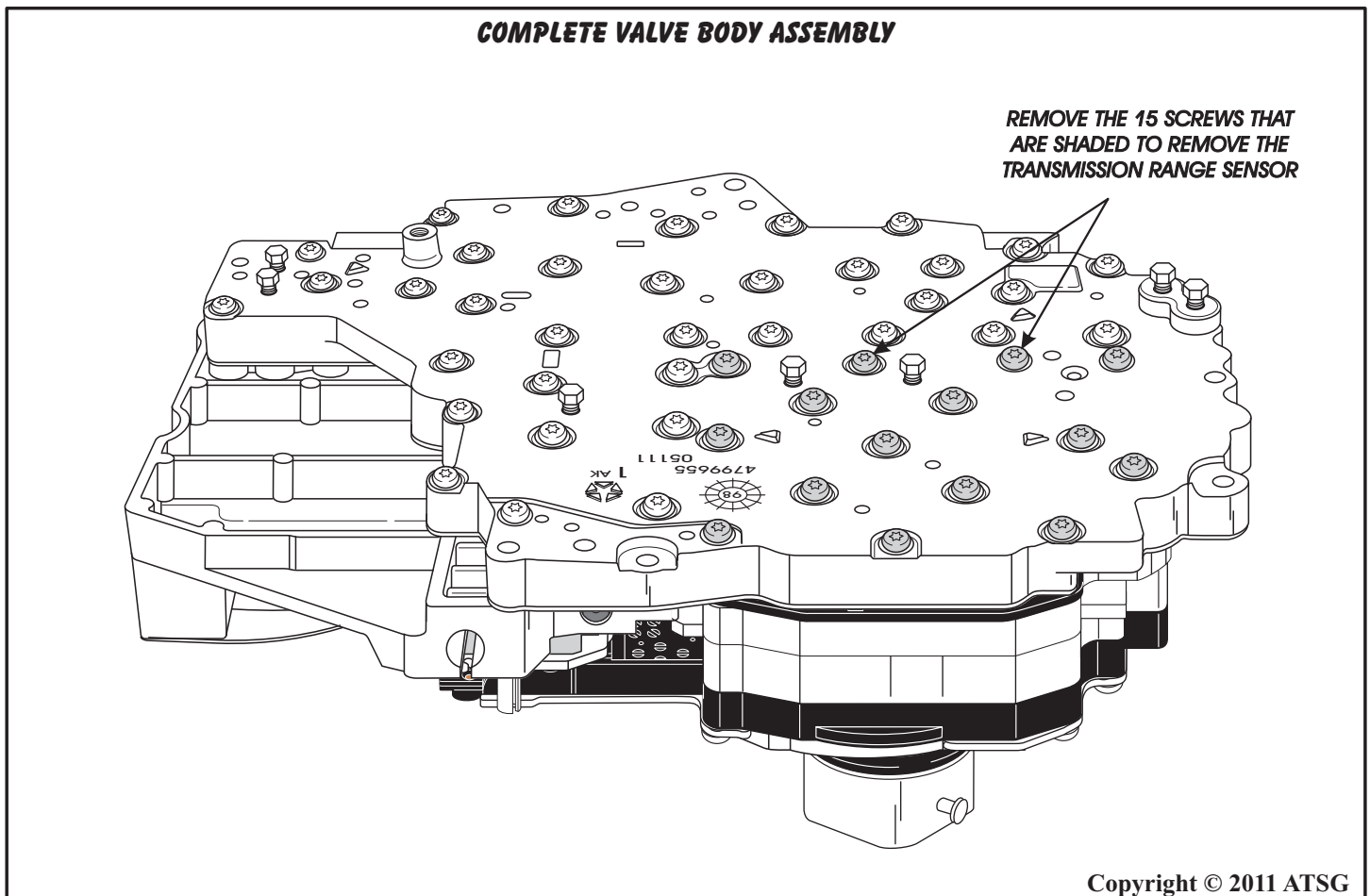
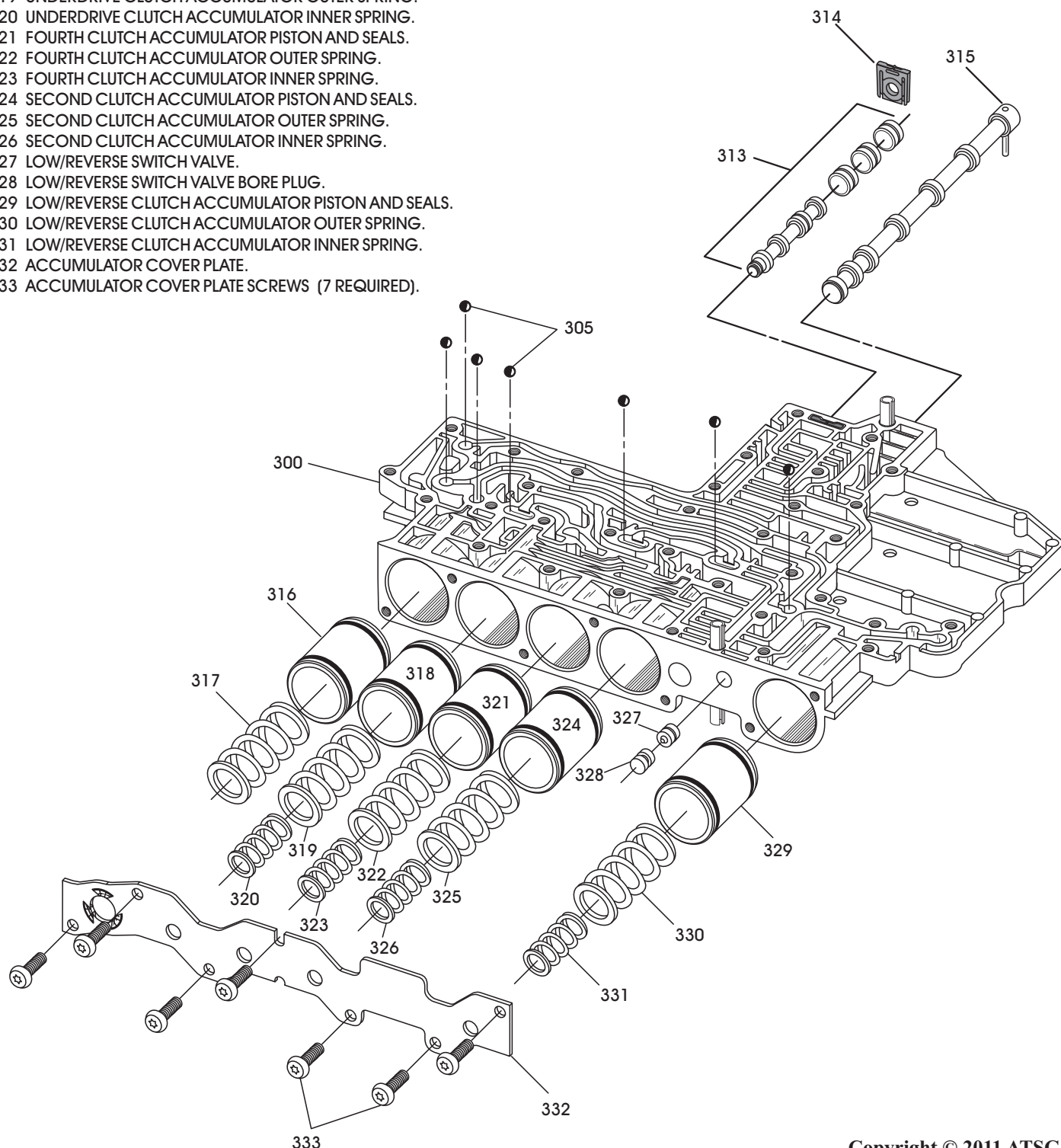


Figure 122



## MAIN VALVE BODY EXPLODED VIEW

- 300 VALVE BODY ASSEMBLY.
- 305 1/4" VITON CHECK BALLS (7 REQUIRED).
- 313 SOLENOID SWITCH VALVE LINE-UP.
- 314 SOLENOID SWITCH VALVE LINE-UP PLASTIC RETAINING CLIP.
- 315 MANUAL VALVE.
- 316 OVERDRIVE CLUTCH ACCUMULATOR PISTON AND SEALS.
- 317 OVERDRIVE CLUTCH ACCUMULATOR SPRING (SINGLE).
- 318 UNDERDRIVE CLUTCH ACCUMULATOR PISTON AND SEALS.
- 319 UNDERDRIVE CLUTCH ACCUMULATOR OUTER SPRING.
- 320 UNDERDRIVE CLUTCH ACCUMULATOR INNER SPRING.
- 321 FOURTH CLUTCH ACCUMULATOR PISTON AND SEALS.
- 322 FOURTH CLUTCH ACCUMULATOR OUTER SPRING.
- 323 FOURTH CLUTCH ACCUMULATOR INNER SPRING.
- 324 SECOND CLUTCH ACCUMULATOR PISTON AND SEALS.
- 325 SECOND CLUTCH ACCUMULATOR OUTER SPRING.
- 326 SECOND CLUTCH ACCUMULATOR INNER SPRING.
- 327 LOW/REVERSE SWITCH VALVE.
- 328 LOW/REVERSE SWITCH VALVE BORE PLUG.
- 329 LOW/REVERSE CLUTCH ACCUMULATOR PISTON AND SEALS.
- 330 LOW/REVERSE CLUTCH ACCUMULATOR OUTER SPRING.
- 331 LOW/REVERSE CLUTCH ACCUMULATOR INNER SPRING.
- 332 ACCUMULATOR COVER PLATE.
- 333 ACCUMULATOR COVER PLATE SCREWS (7 REQUIRED).



Copyright © 2011 ATSG

Figure 123

## VALVE BODY ASSEMBLY

1. Clean and inspect all components. Replace any parts that show evidence of wear or damage.
2. Lubricate the valves, springs and bore plugs with clean transmission fluid (Mopar® +4).
3. Install the solenoid switch valve and 3 plugs in the valve body, **exactly** as shown in Figure 123, and then install the plastic retainer.

**Note:** Use small amount of Trans-Jel® to keep plastic retainer in place.

4. Install the low/reverse switch valve into valve body as shown in Figure 123, followed by the bore plug.

**Note:** Some manuals illustrate a bore plug wire retainer for this location. Our unit did not have one, nor is it needed as the accumulator cover retains this valve train (See Figure 123).

5. Install the accumulator pistons and springs into the valve body in their proper locations, shown in Figure 123.

**Note:** All accumulators have two springs, except the overdrive, which has only one.

6. Install the accumulator cover onto valve body using the 7 retaining screws (See Figure 123).

7. Torque the screws to 4.5 Nm (40 in lbs).

8. Ensure that the solenoid switch valve and the 3 plugs are free in the bore, and that solenoid switch valve plastic retainer is still in place, as shown in Figure 124.

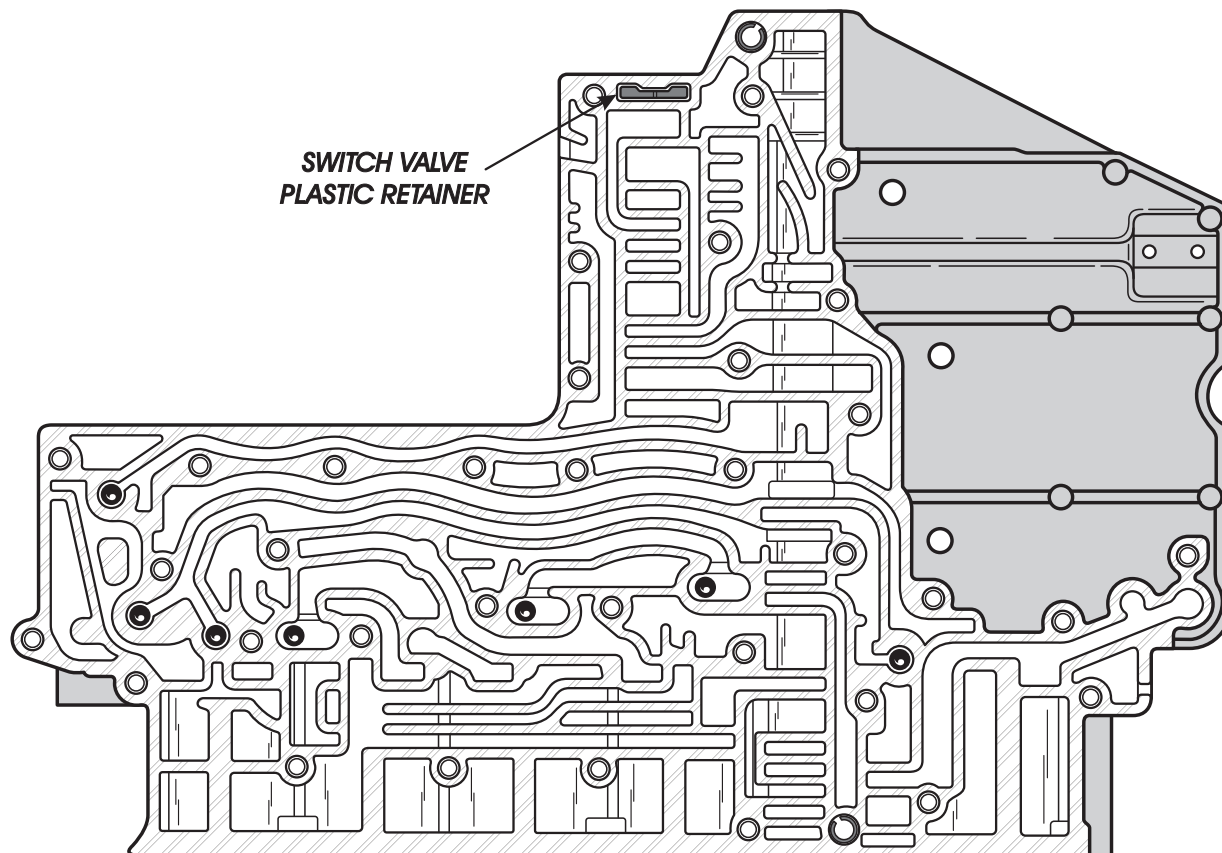
**Note:** This retainer can easily fall out while maneuvering the valve body as it is not spring loaded.

9. Ensure that low/reverse switch valve is free in its bore.

10. Lay the valve body down on a flat surface and install the 7 checkballs into the proper pockets as shown in Figure 124.

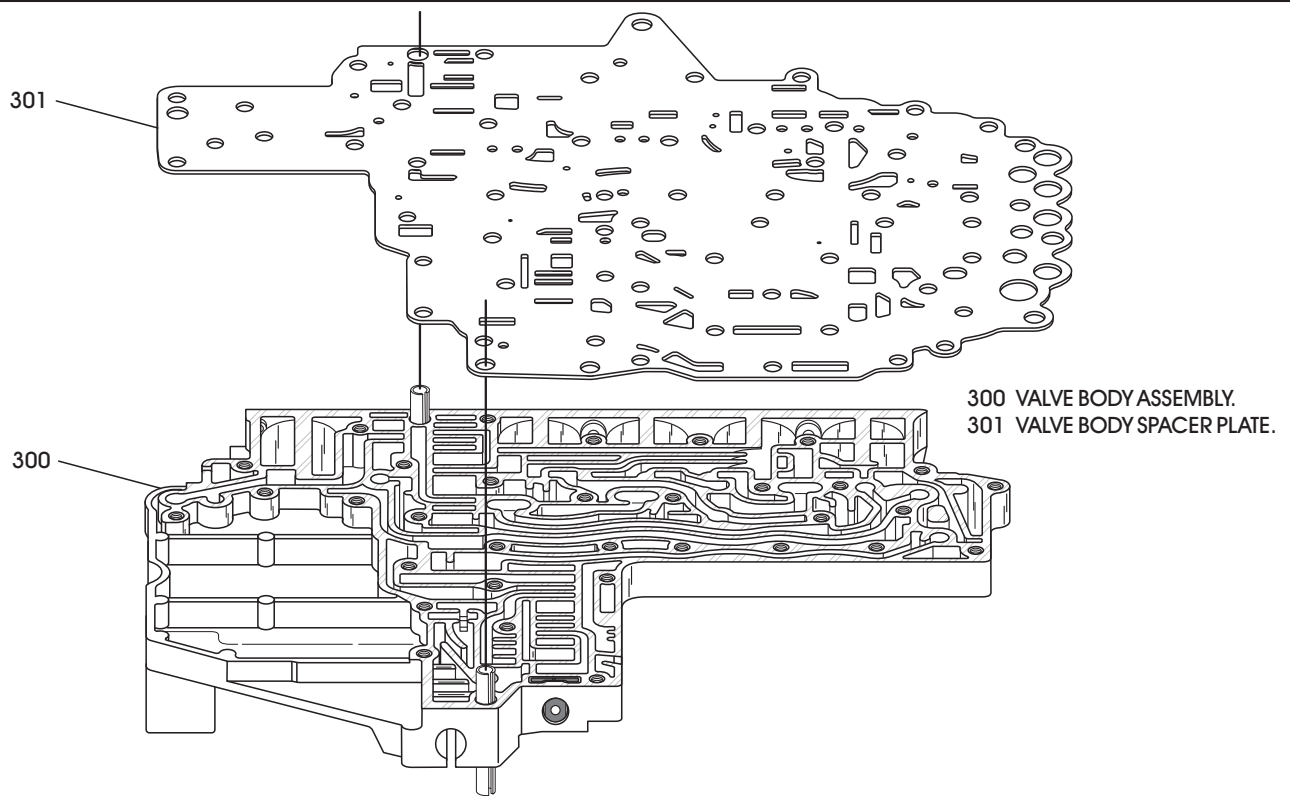
Continued on Page 83

### VALVE BODY CHECKBALL LOCATIONS



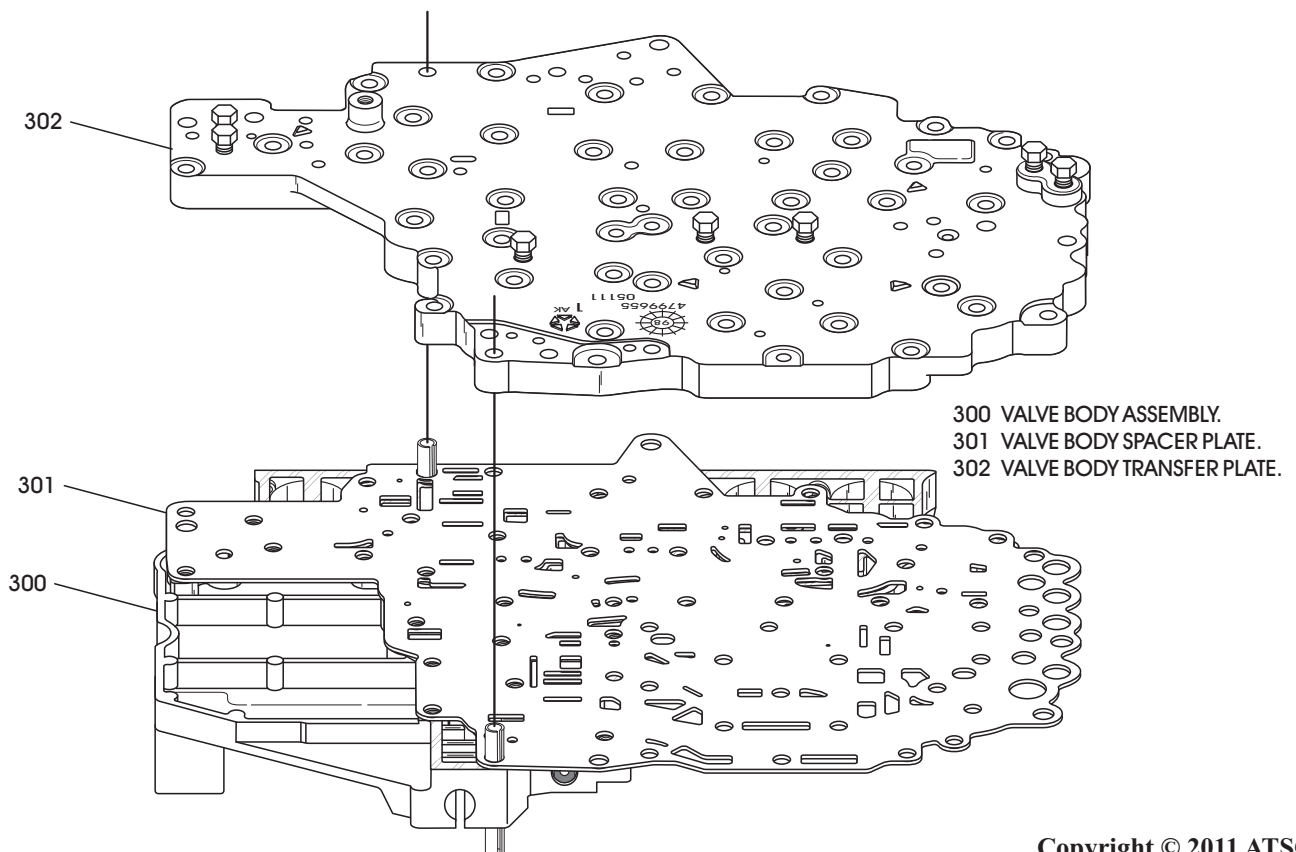
Copyright © 2011 ATSG

Figure 124



Copyright © 2011 ATSG

Figure 125



Copyright © 2011 ATSG

Figure 126

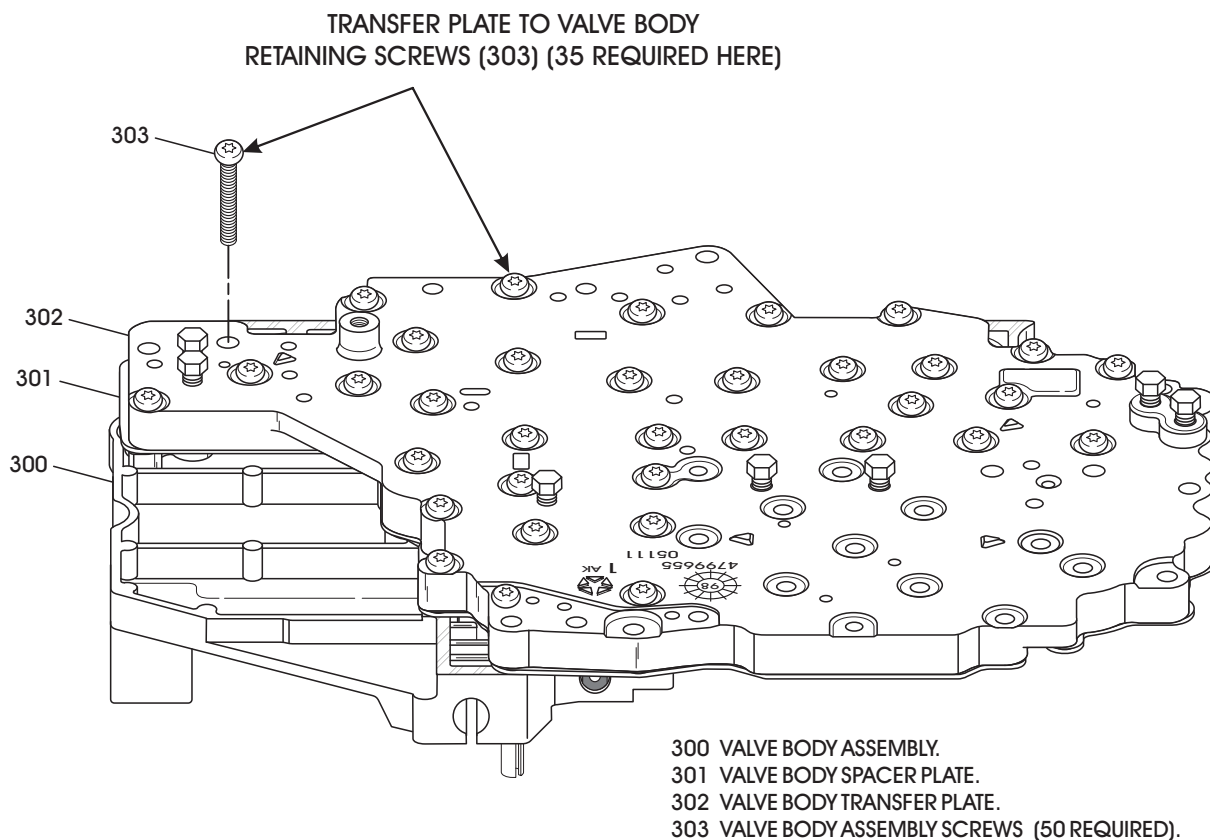
## VALVE BODY ASSEMBLY (CONT'D)

11. Install the valve body spacer plate over the locating dowels and onto the valve body as shown in Figure 125.
12. Install the transfer plate over locating dowels and onto the valve body as shown in Figure 126.
13. Install the 35 valve body to transfer plate bolts in the locations shown in Figure 127.
14. Torque the valve body to transfer plate bolts to 4.5 Nm (40 in lbs).

**Note:** Turn the assembly over to continue the assembly process.

Continued on Page 84

### TRANSFER PLATE TO VALVE BODY BOLT LOCATIONS



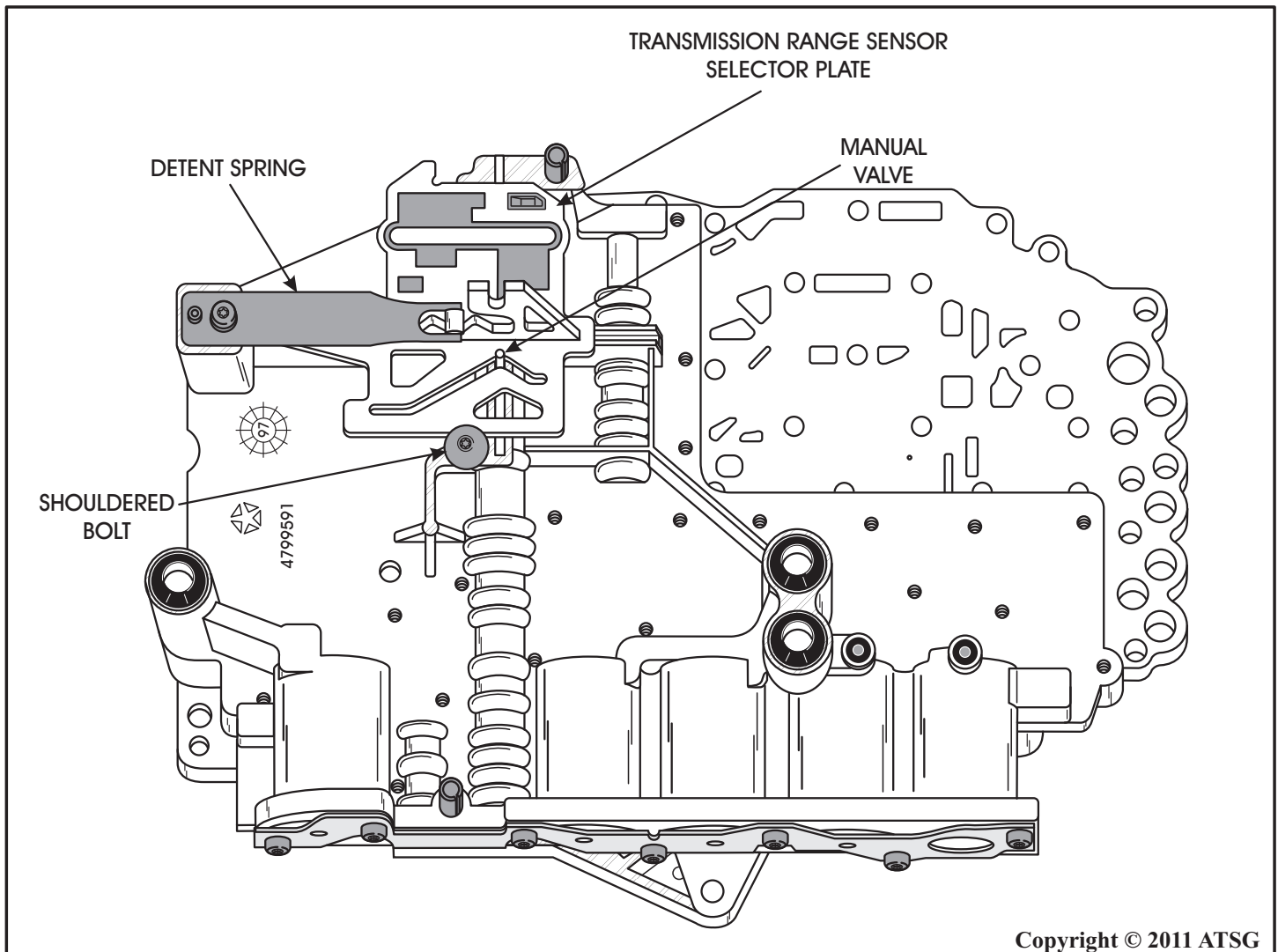
Copyright © 2011 ATSG

Figure 127

## VALVE BODY ASSEMBLY (CONT'D)

15. Install the manual valve into the manual valve bore in the valve body with the stem facing up and engaged in the groove (See Figure 128).
16. Install the transmission range sensor selector plate into the groove in the valve body and over the stem on the manual valve (See Figure 128).  
**Note: The Transmission Range Selector Plate will not interchange with the 45RFE plate, as shown in Figure 129.**
17. Install the shouldered retaining bolt for the transmission range sensor selector plate and torque the bolt to 4.5 Nm (40 in lbs). Refer to Figure 128.
18. Install the manual valve detent spring and bolt and torque bolt to 4.5 Nm (40 in lbs). Refer to Figure 128.
19. Install a new low/reverse seal into the valve body with the "house-top" facing up, as shown in Figure 130.
20. Install a new 2nd clutch seal into the valve body with the "house-top" facing up, as shown in Figure 130.
21. Install a new 4th clutch seal into the valve body with the "house-top" facing up, as shown in Figure 130.

Continued on Page 86



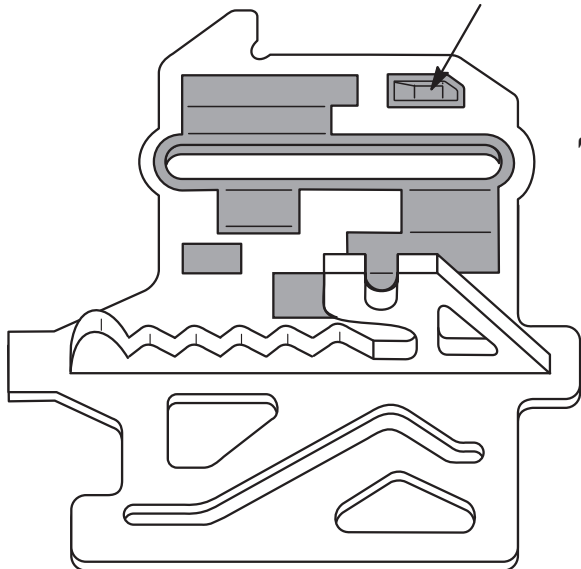
Copyright © 2011 ATSG

Figure 128

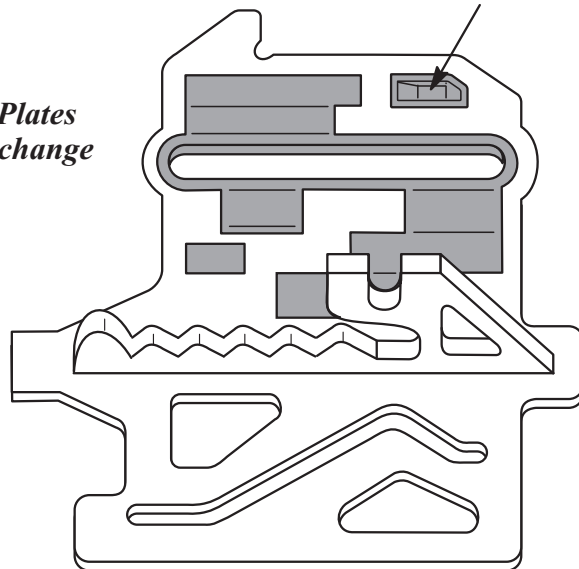


## TRANSMISSION RANGE SENSOR SELECTOR PLATE

45RFE  
POCKET FOR  
PIN T41 IS .118" DEEP



68RFE  
POCKET FOR  
PIN T41 IS .156" DEEP



*These Selector Plates  
"Will Not" Interchange*

Copyright © 2011 ATSG

Figure 129

L/R Clutch  
Seal



4799591

ALL 3  
SEALS

2nd Clutch  
Seal

4th Clutch  
Seal

Copyright © 2011 ATSG

Figure 130

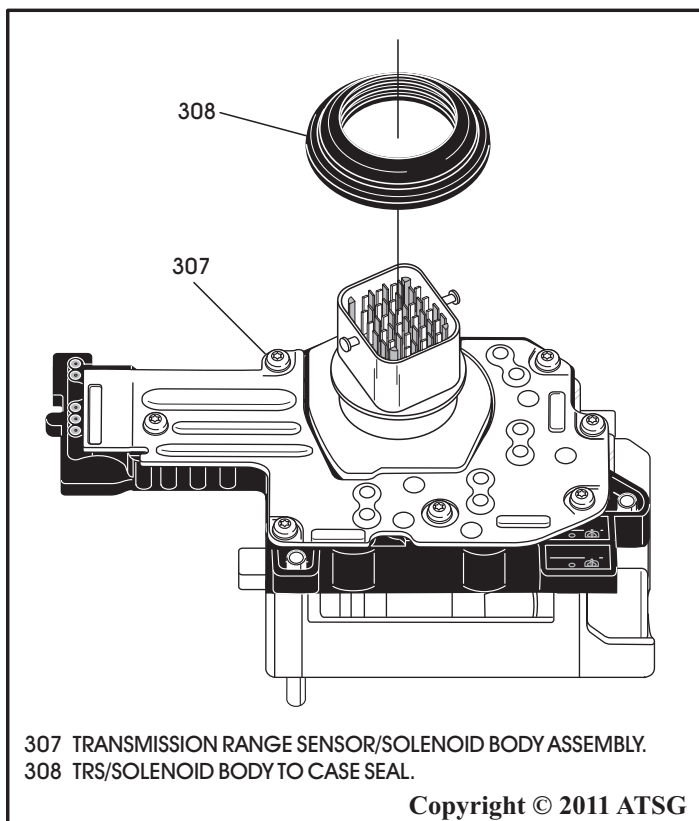


Figure 131

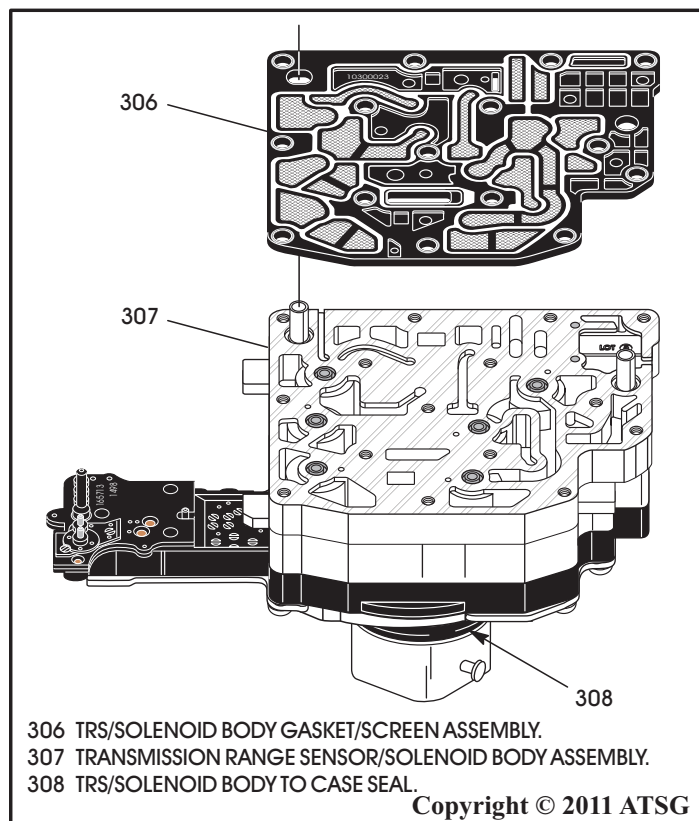


Figure 132

## VALVE BODY ASSEMBLY (CONT'D)

22. Install new TRS/Solenoid Body to transmission case seal over and onto the solenoid connector, as shown in Figure 131.

**Note:** TRS/Solenoid Body for the 45RFE and 68RFE are different and will not interchange.

23. Testing procedures for the TRS/Solenoid Body are found on Page 20 and 21.

24. Install new TRS/Solenoid Body to valve body gasket/screen assembly, as shown in Figure 132.

**Note:** The Gasket/Screen assembly is different between the 45RFE and 68RFE and "will not" interchange, as shown in Figure 133.

Continued on Page 87

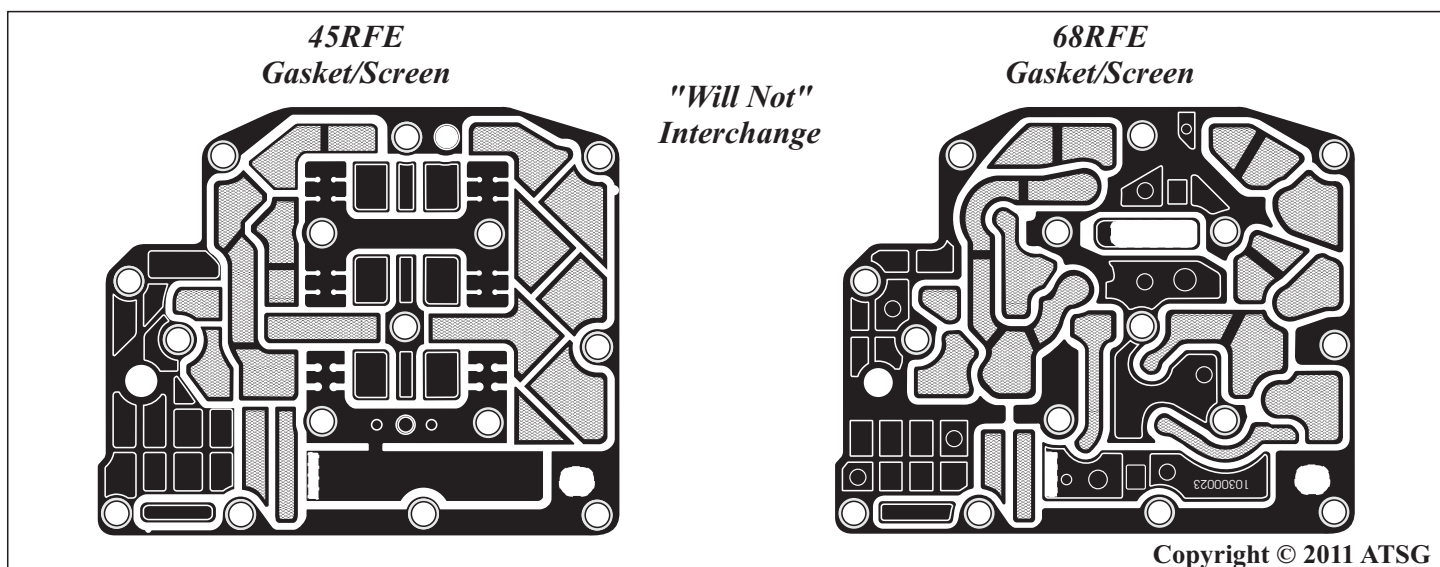


Figure 133

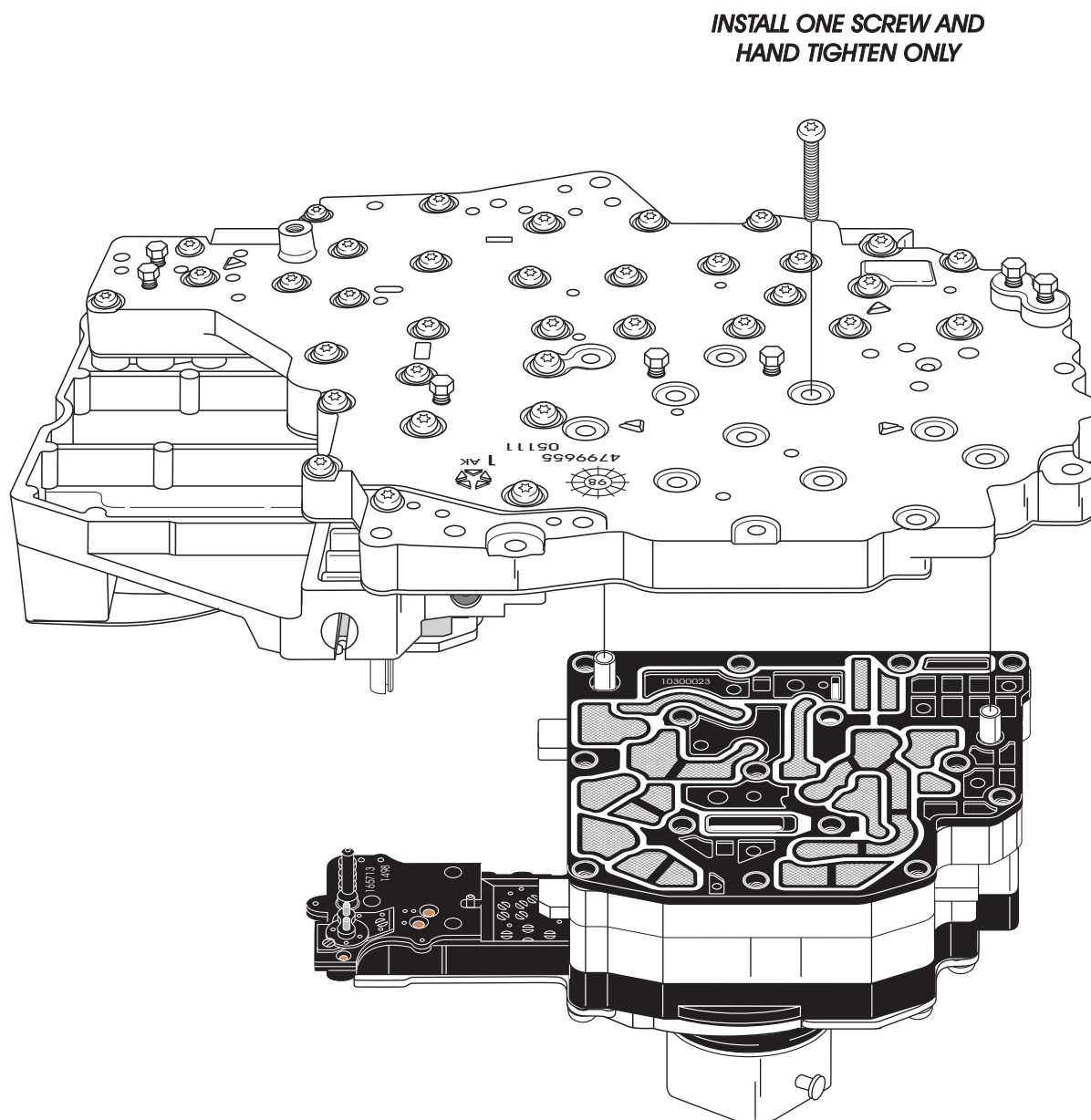
## VALVE BODY ASSEMBLY (CONT'D)

25. Install the TRS/Solenoid Pack assembly to the transfer plate, as shown in Figure 134.

**Note:** Use caution installing the TRS/Solenoid Pack as the assembly has locating dowels that must line up with bores in the transfer plate.

26. Install one screw and hand tighten only, as shown in Figure 134.

Continued on Page 88



Copyright © 2011 ATSG

Figure 134

## VALVE BODY ASSEMBLY (CONT'D)

27. Install the TRS/Solenoid Body onto the transfer plate using the remaining 14 valve body screws as shown in Figure 135.
28. Torque the TRS/Solenoid Body screws down to 5.7 Nm (50 in lbs).  
*Note: Tighten the screws nearest the range sensor selector plate first, and work toward the other end. Refer to Figure 135.*
29. Set the completed valve body assembly aside for the final assembly process.

## TRS/SOLENOID BODY

1. The TRS/Solenoid Body is serviced *only* as a complete assembly, which is why we told you not to remove the 7 screws on top that retain the cover plate.
2. However, if someone has not listened, we have provided you with an exploded view of the TRS/Solenoid Body in Figure 136.

*The illustrations in Figure 136 have been provided for reference only. We recommend that the TRS/Solenoid Body NOT be disassembled as none of the internal parts are serviced separately.*

**Final Transmission Assembly  
Begins on Page 90**

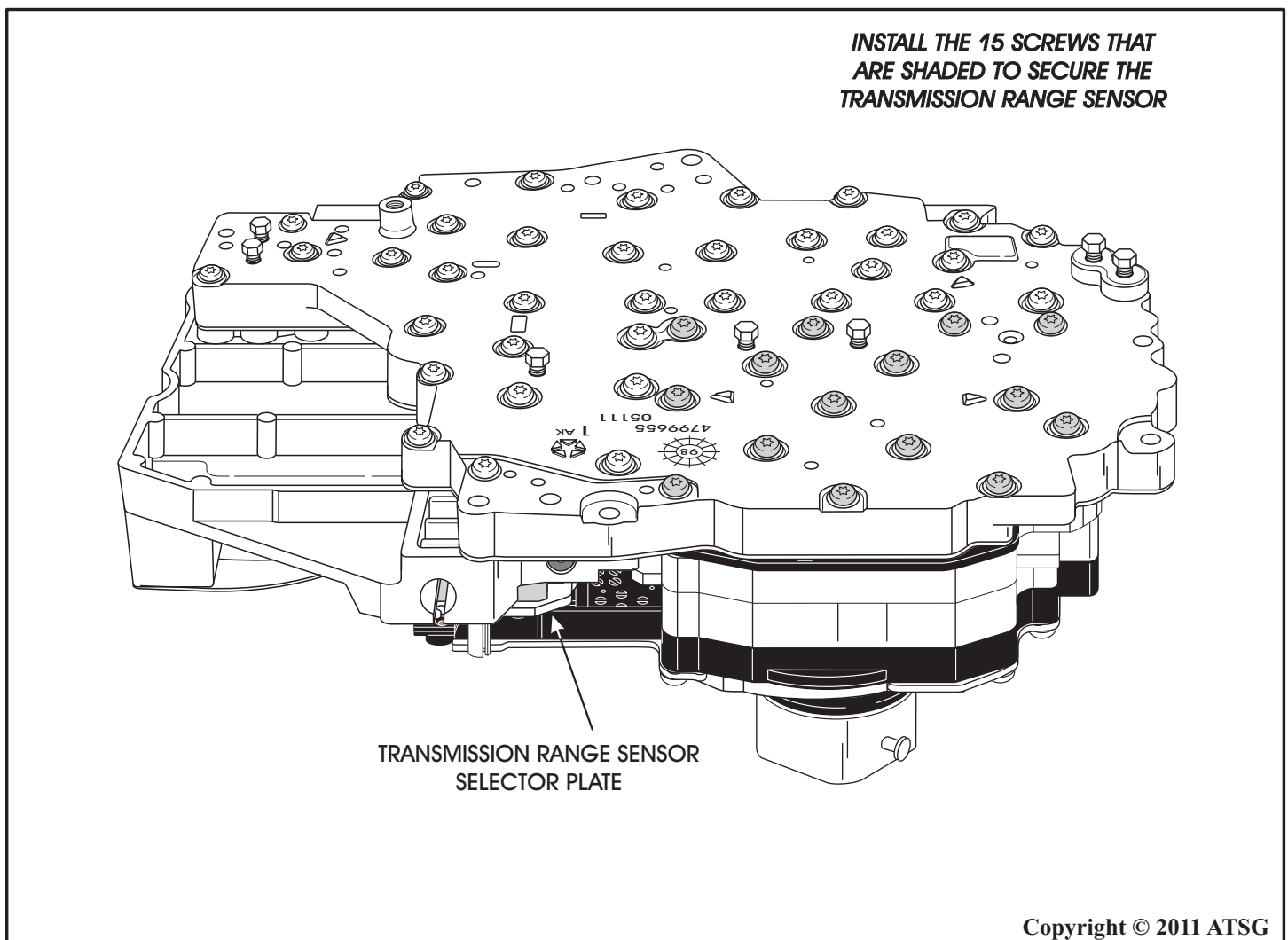
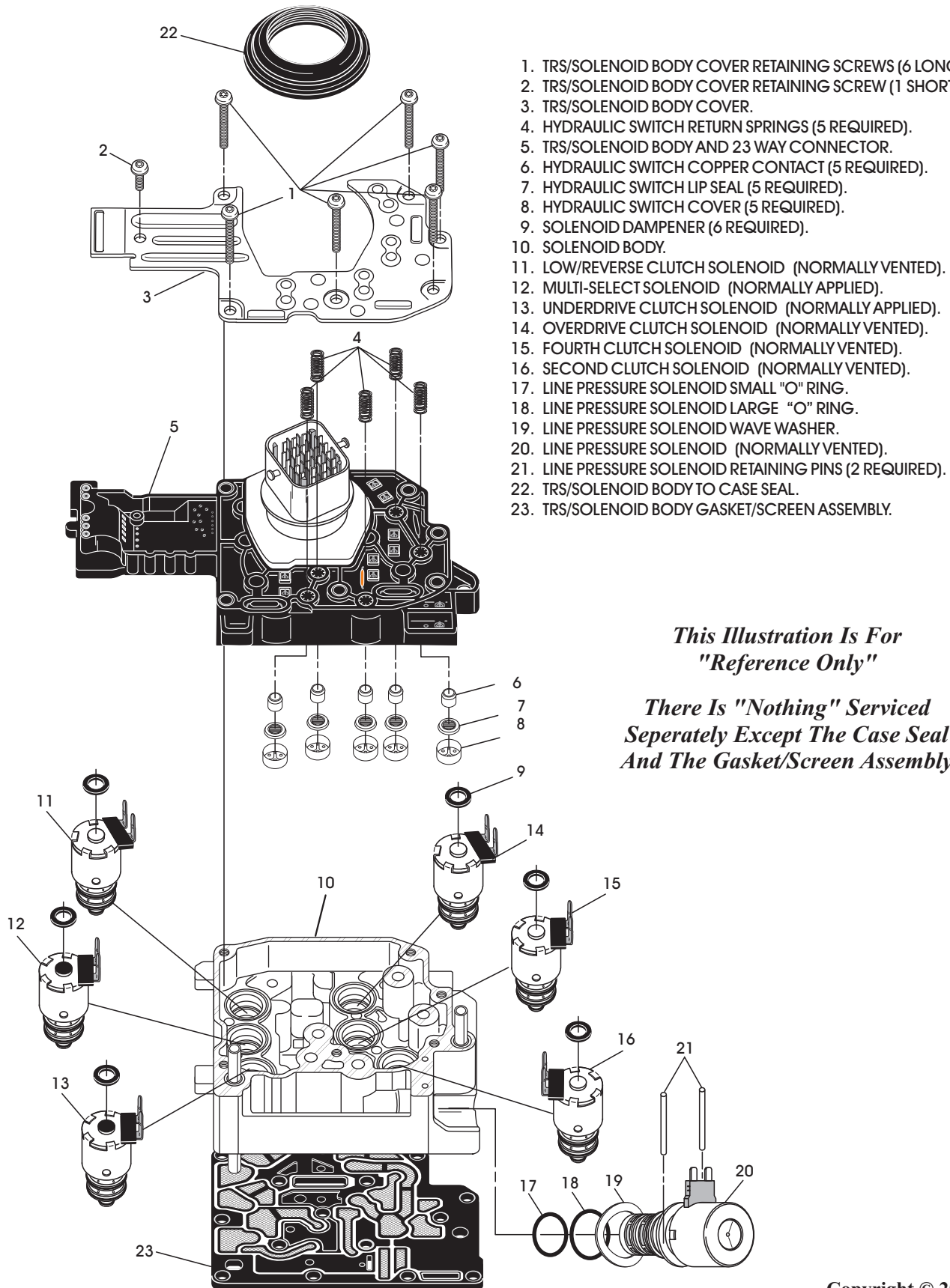


Figure 135

Copyright © 2011 ATSG

## TRANSMISSION RANGE SENSOR/SOLENOID BODY, EXPLODED VIEW



*This Illustration Is For  
"Reference Only"*

*There Is "Nothing" Serviced  
Seperately Except The Case Seal  
And The Gasket/Screen Assembly*

Copyright © 2011 ATSG

Figure 136



## TRANSMISSION ASSEMBLY

*Before final assembly of transmission, the second clutch pack complete and 2-4 retainer must be temporarily installed in the transmission case to measure for proper second clutch clearance.*

1. Install the 2nd clutch backing plate into the case, as shown in Figure 137.
2. Install 2nd clutch pack beginning with a friction plate and alternating with a steel plate until you have 3 of each installed, as shown in Figure 137.

3. Install the **flat** 2-4 retainer snap ring into case, as shown in Figure 138.
4. Install the 2-4 clutch retainer into case, as shown in Figure 138.
5. Install 2-4 clutch retainer **tapered** snap ring with taper facing up, as shown in Figure 138.

**Continued on Page 91**

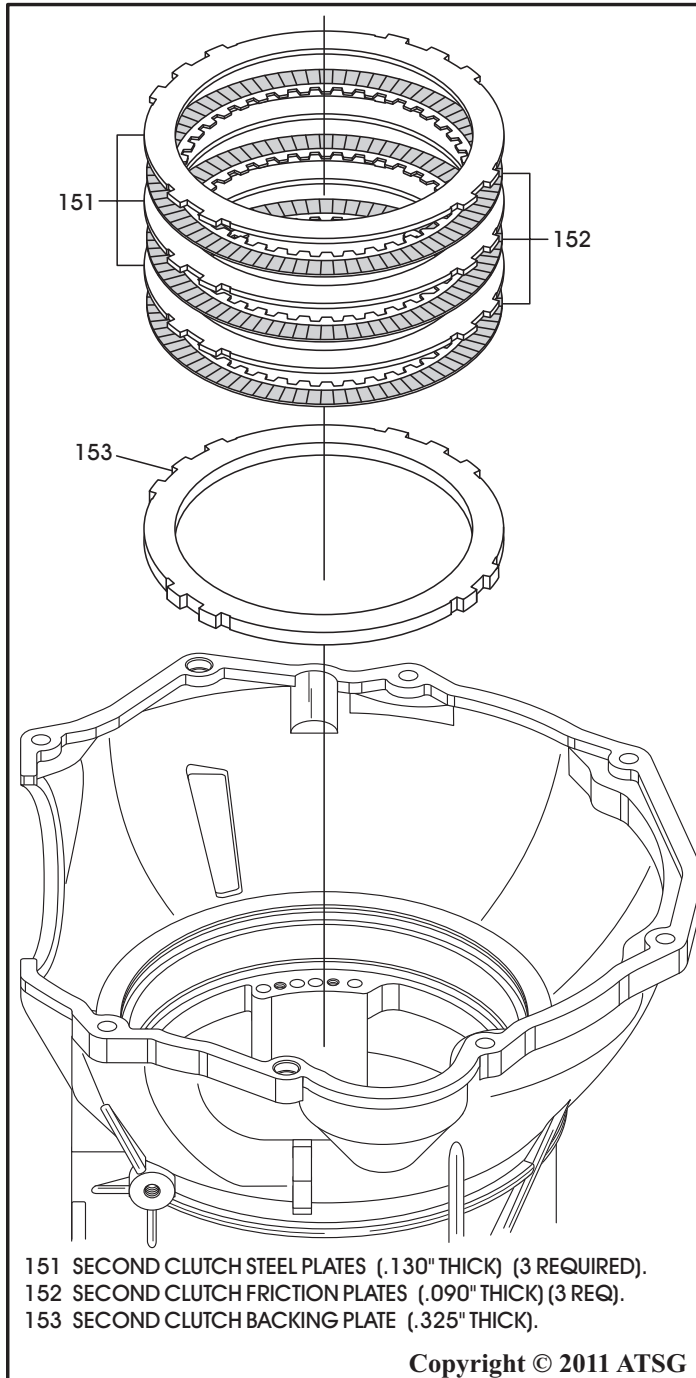


Figure 137

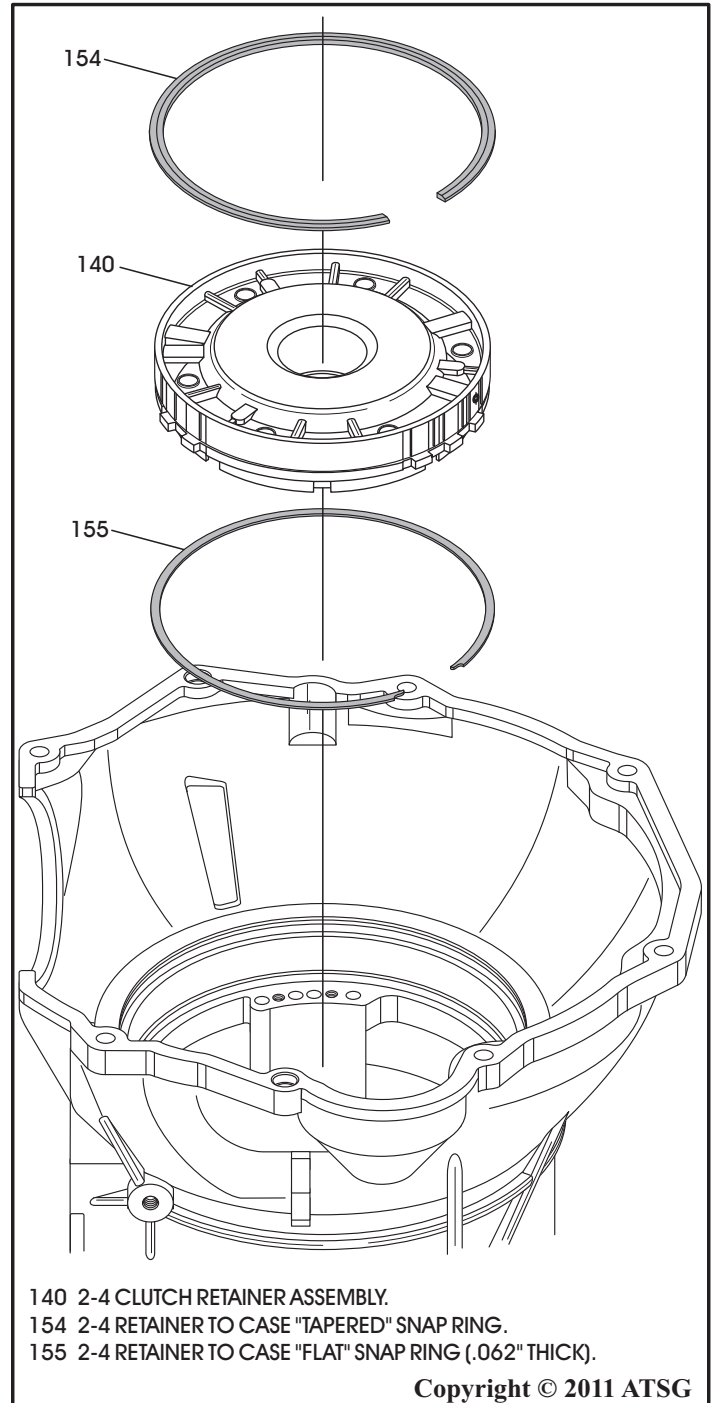


Figure 138

## TRANSMISSION ASSEMBLY (CONT'D)

6. Using a feeler gauge through rear case opening, measure between the backing plate and the case, as shown in Figure 139. Measure at 4 different points 90 degrees apart. The average of these measurements is the second clearance.

7. The correct second clutch clearance should be 0.99-1.65mm (.039"-.065").

**Note: The 2nd Clutch backing plate on 68RFE "Is Not" selective. If the 2nd clutch clearance is not within specification, the backing plate, all friction plates and all steel plates must be replaced.**

8. Remove the 2-4 retainer and all the 2nd clutch components from the transmission case.

9. Install the completed low/reverse clutch housing, as shown in Figure 140.

**Note: The low/reverse clutch housing has one lug that is wider than the rest to orient it in the case with the feed hole toward the valve body. The wider lug is at the 12-O-clock position in the transmission case (See Figure 140).**

10. Install the low/reverse clutch housing tapered snap ring into the case just above the housing, with the taper facing up, and ensure that it is fully seated (See Figure 140).

Continued on Page 92

### CHECKING 2ND CLUTCH CLEARANCE

**2nd Clutch Clearance Should Be;  
0.99-1.65 mm (.039"-.065")**

**The 2nd Clutch backing plate on the 68RFE "is not" selective. If the 2nd clutch clearance is not within specification, the backing plate, all the friction plates and steel plates must be replaced.**

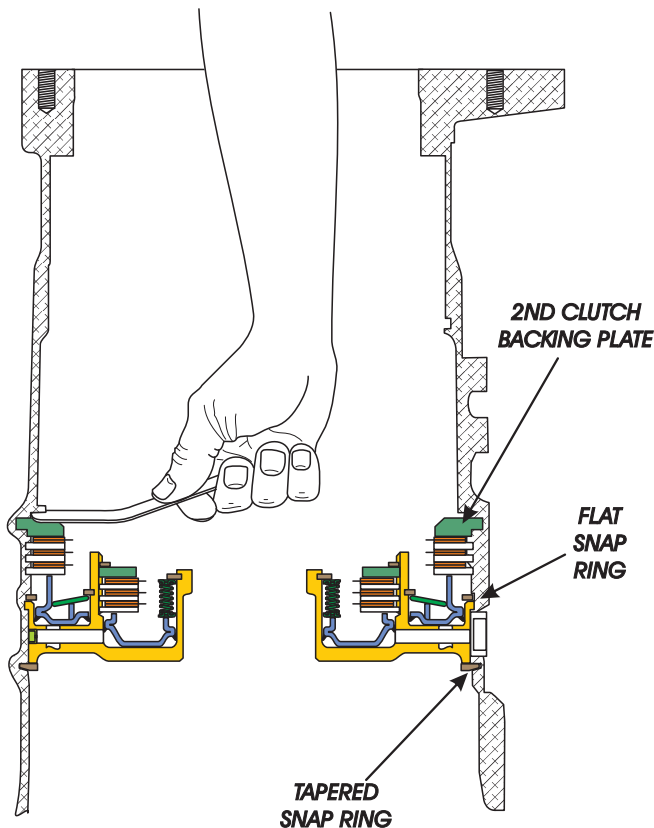


Figure 139

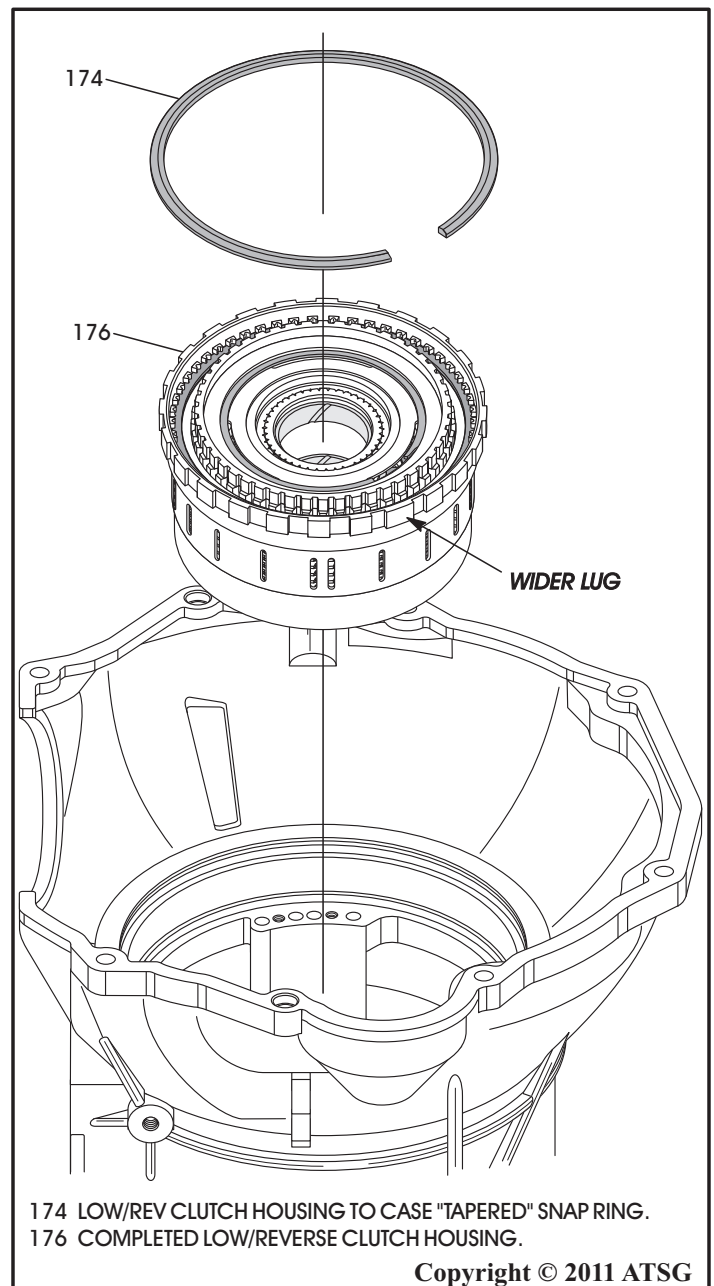


Figure 140

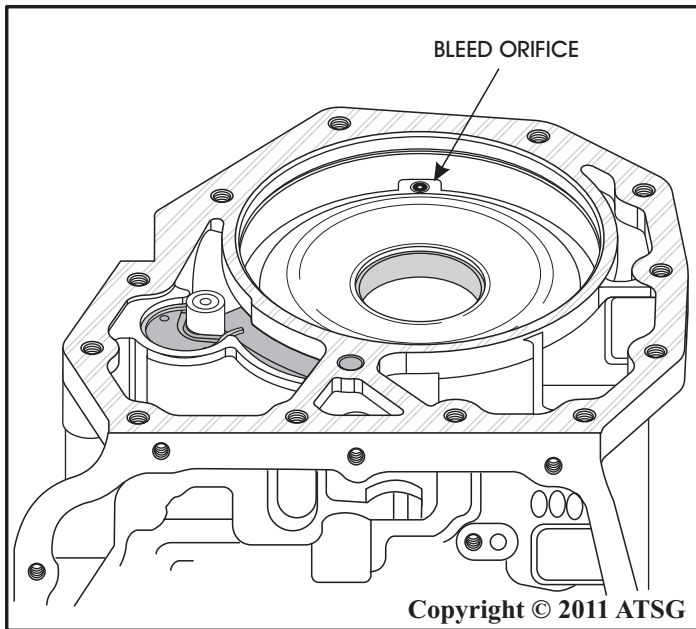


Figure 141

## TRANSMISSION ASSEMBLY (CONT'D)

6. You should be able to see the low/reverse clutch housing bleed orifice at the notch in rear of the case, as shown in Figure 141.
7. Install the number 12 thrust bearing onto the low/reverse clutch housing with the Black side facing down, as shown in Figure 142, and retain with small amount of Trans-Jel®.
8. Install the pre-assembled geartrain assembly, as shown in Figure 142, through the low/reverse clutch housing.

Continued on Page 93

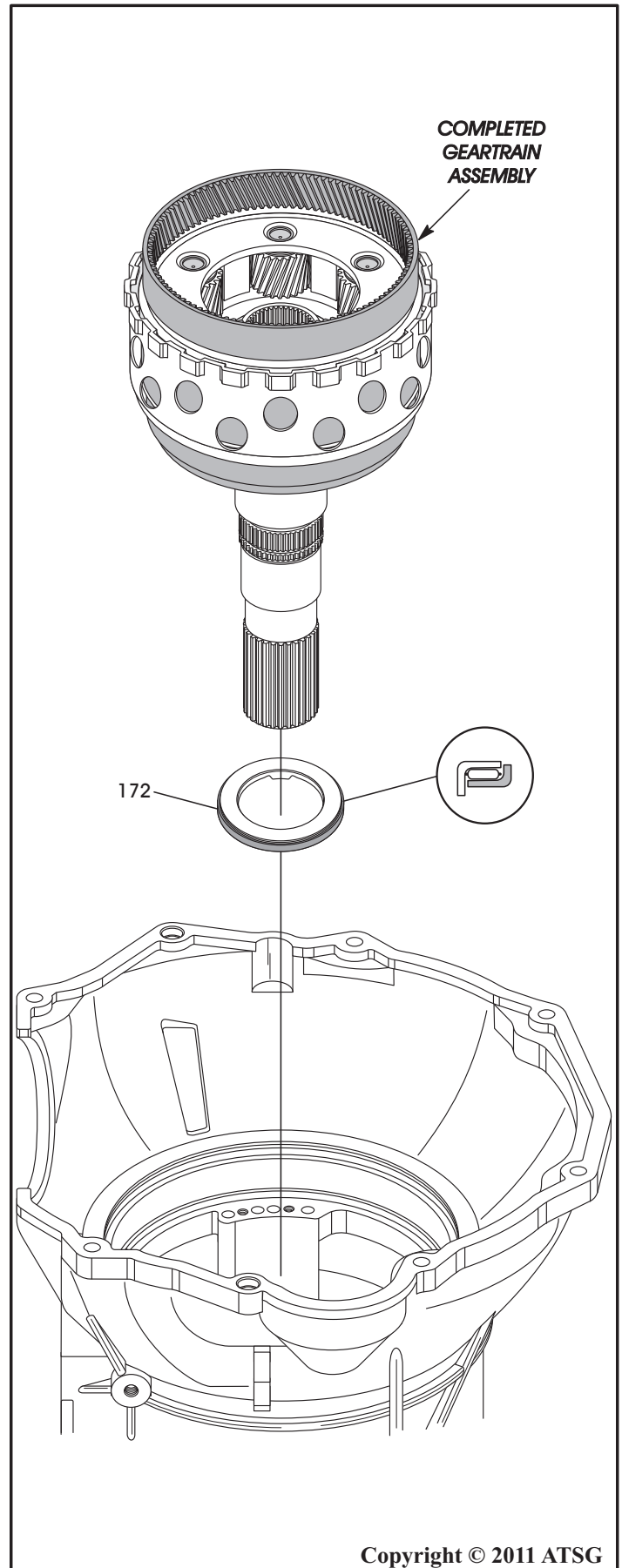


Figure 142

## TRANSMISSION ASSEMBLY (CONT'D)

9. Install the number 9 thrust bearing onto the back side of reaction carrier/reverse sun gear with the Black side of bearing facing sun gear, as shown in Figure 143, and retain with a small amount of Trans-Jel®.
10. Install the number 8 thrust bearing down inside the reaction carrier/reverse sun gear in direction shown in Figure 143.
11. Install the completed assembly into transmission by rotating into position (See Figure 143).

12. Ensure the number 7 selective thrust washer and number 6 thrust bearing on the pre-assembled 4th clutch hub/reaction sun gear are still seated properly and install assembly into transmission by rotating into position (See Figure 144).

**Continued on Page 94**

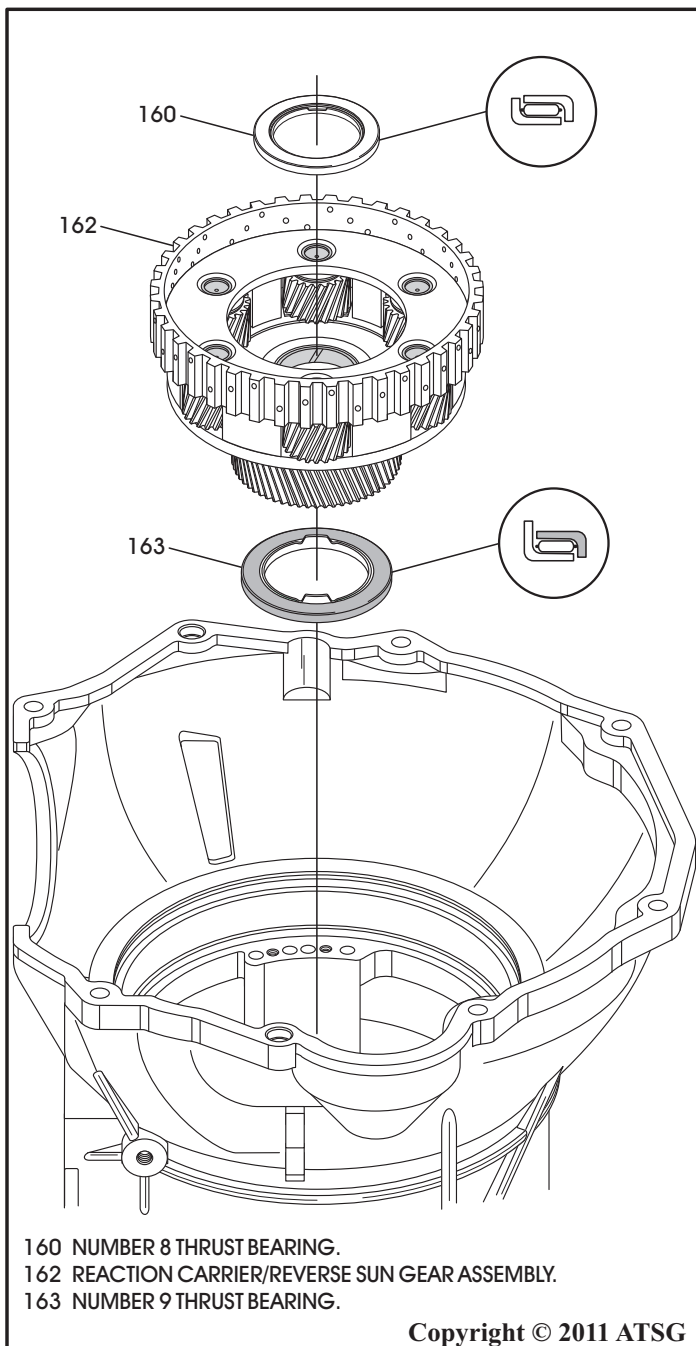


Figure 143

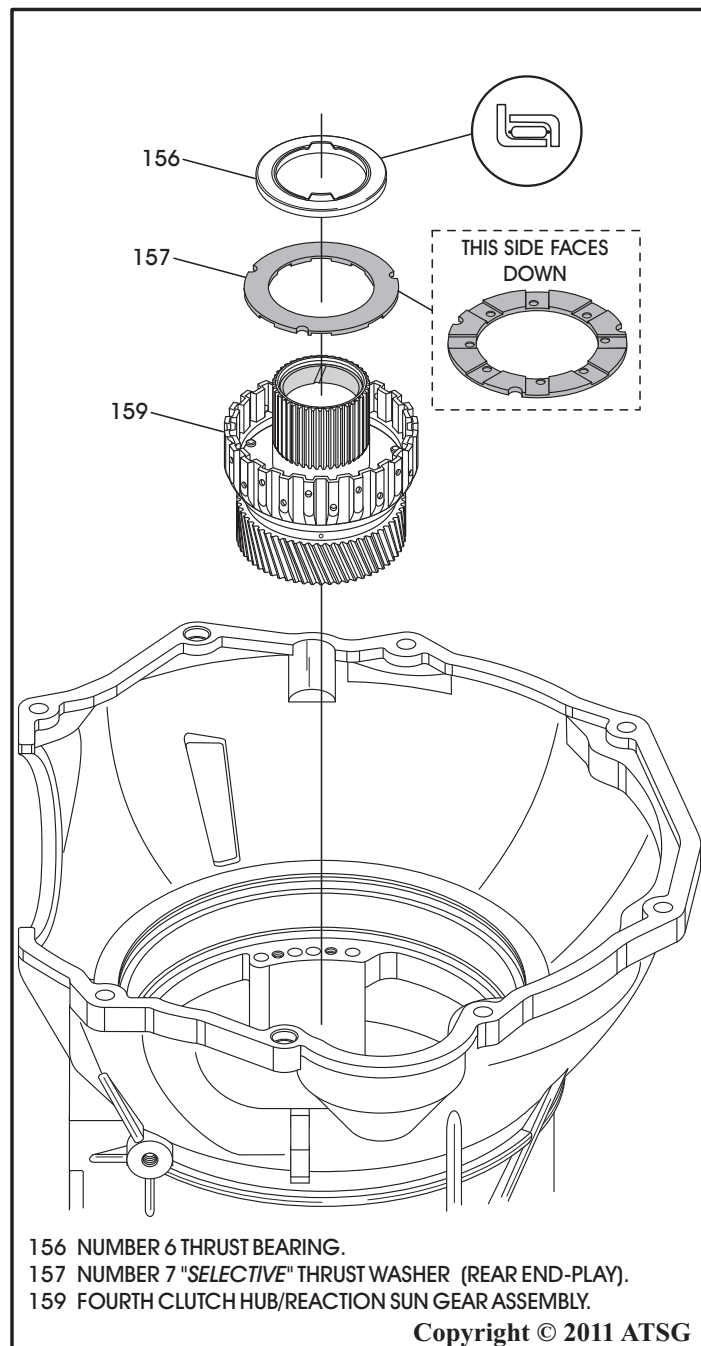


Figure 144



## TRANSMISSION ASSEMBLY (CONT'D)

13. Install the 2nd clutch backing plate into the case, as shown in Figure 145.

14. Install 2nd clutch pack beginning with a friction plate and alternating with a steel plate until you have 3 of each installed, as shown in Figure 145.

**Note:** All clutch plates should be soaked for 30 minutes in proper fluid before assembly.

15. Install the 2-4 clutch retainer **flat** snap ring into lower groove in the case with snap ring opening facing the valve body area (See Figure 146).

Continued on Page 95

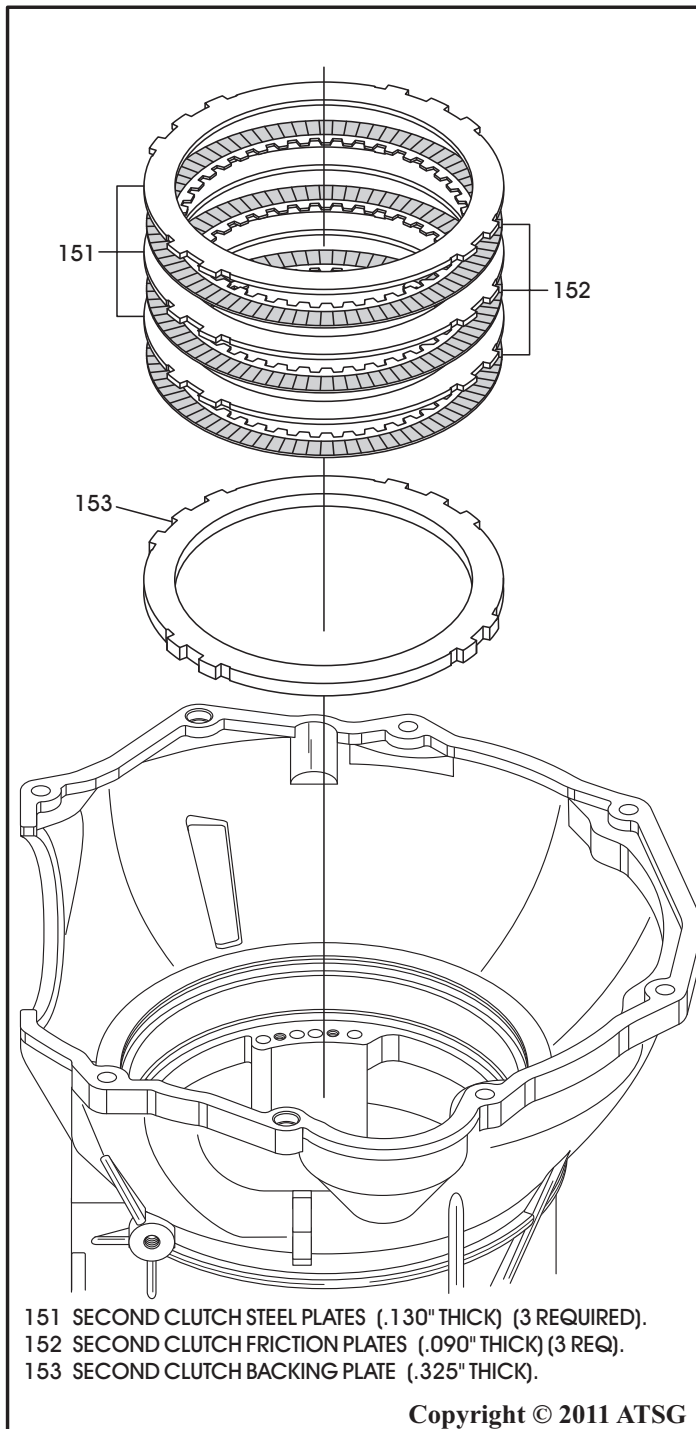


Figure 145

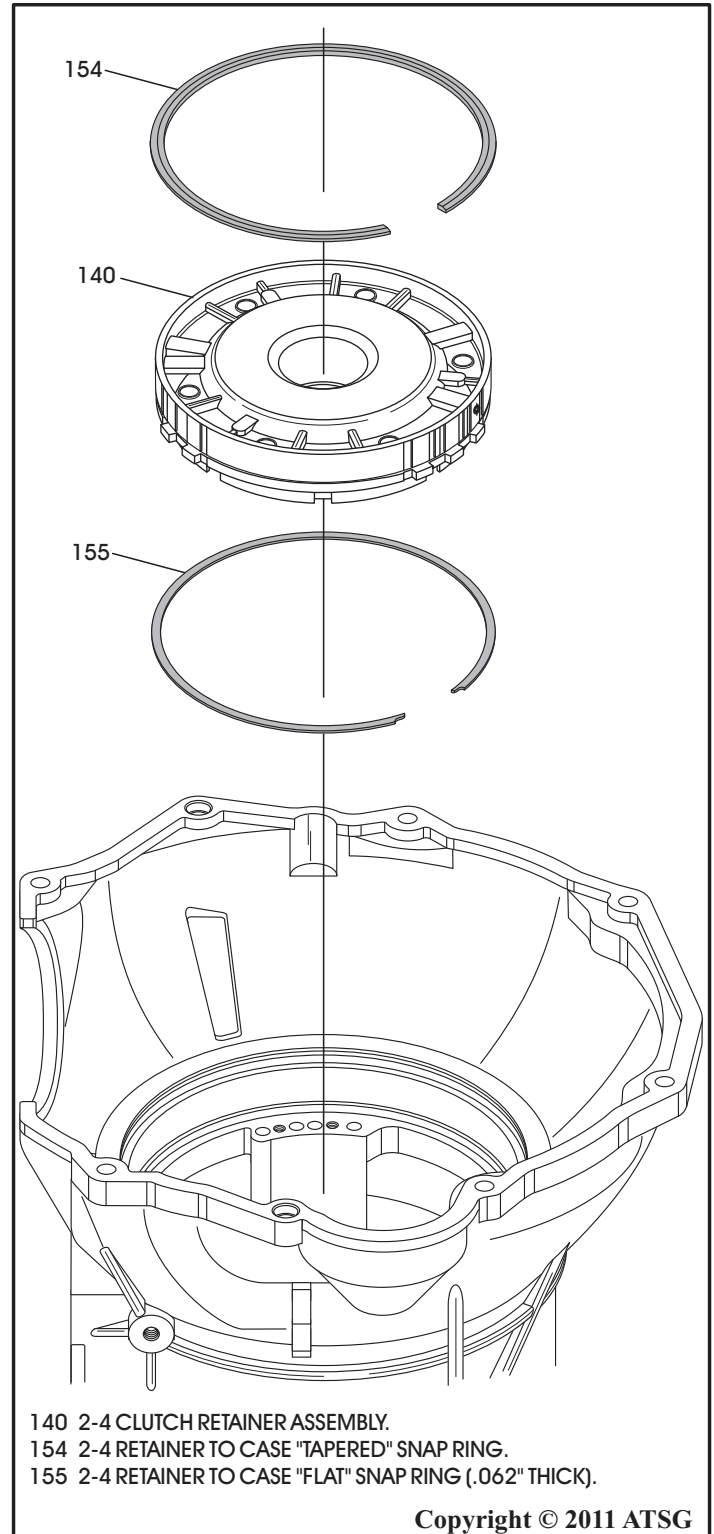


Figure 146



## TRANSMISSION ASSEMBLY (CONT'D)

16. Install the completed 2-4 clutch retainer into the case, as shown in Figure 146, with the feed holes facing the valve body area.

**Note: The 4th clutch hub must be rotated using the output shaft to engage the 4th clutch plates on the hub during the installation of 2-4 clutch retainer. Ensure it is fully seated.**

17. Install the 2-4 clutch retainer *tapered* snap ring into the case with taper facing up, as shown in Figure 146, and ensure it is fully seated.

**Note: Ensure the snap ring opening faces the valve body area.**

18. Install dial indicator on case and output shaft, as shown in Figure 147, and zero the indicator.

19. Measure the output shaft end-play, as shown in Figure 147, using a small piece of wood on case to prevent damage and move geartrain up and down using a screwdriver.

20. Transmission output shaft end-play should be; 0.25-0.52 mm (.010"-.020").

21. Change the number 7 *selective* thrust washer, shown in Figure 148, to obtain the correct rear end-play and re-measure to verify.

22. Number 7 *selective* thrust washers available and their thickness are shown in Figure 148.

**Note: The selectable thrust washer thickness is identified by a number molded or stamped into the washer, as shown in Figure 148.**

Continued on Page 96

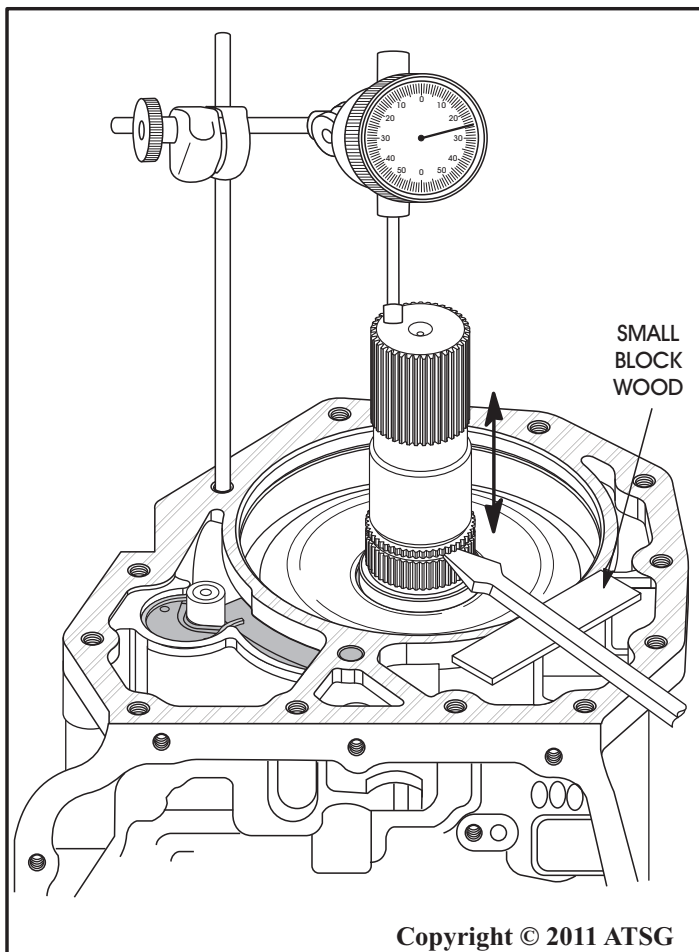
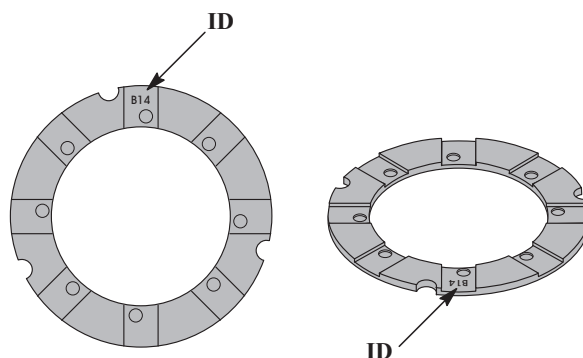


Figure 147

"REAR END-PLAY" SELECTIVE THRUST WASHER		
ID	THICKNESS MM	THICKNESS INCH
09	2.18 mm	0.086"
10	2.33 mm	0.092"
11	2.48 mm	0.098"
12	2.63 mm	0.103"
14	2.69 mm	0.106"
13	2.78 mm	0.109"
43	3.08 mm	0.121"
16	3.23 mm	0.127"
17	3.38 mm	0.133"
18	3.53 mm	0.139"
19	3.68 mm	0.145"

**Note: The selectable thrust washer thickness is identified by a number molded or stamped into the washer.**



Number 7 Selective Thrust Washer  
For Transmission Rear End-Play

Copyright © 2011 ATSG

Figure 148

## TRANSMISSION ASSEMBLY (CONT'D)

23. Install the number 5 thrust bearing and selective spacer onto back side of reverse clutch hub, as shown in Figure 149, and retain with Trans-Jel®. **Note: Ensure that number 5 thrust bearing is fully snapped into selective spacer, as shown in Figure 150. This spacer is used to set front transmission end-play.**
24. Install the number 1 thrust bearing, in direction shown in Figure 149, down into the pocket of the completed input housing.
25. Install the completed input housing and bearings into transmission case, as shown in Figure 149, by rotating back and forth until fully seated. **Note: The input housing is fully seated when the teeth on input clutch hub are centered in the input speed sensor bore (See Figure 151).**

Continued on Page 97

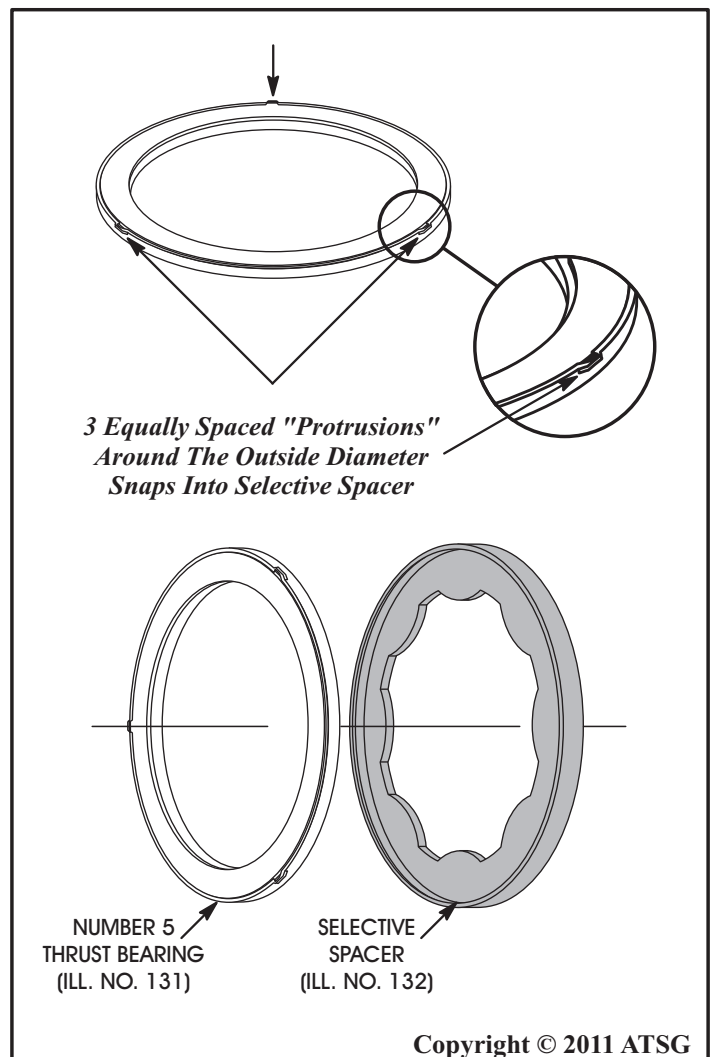


Figure 150

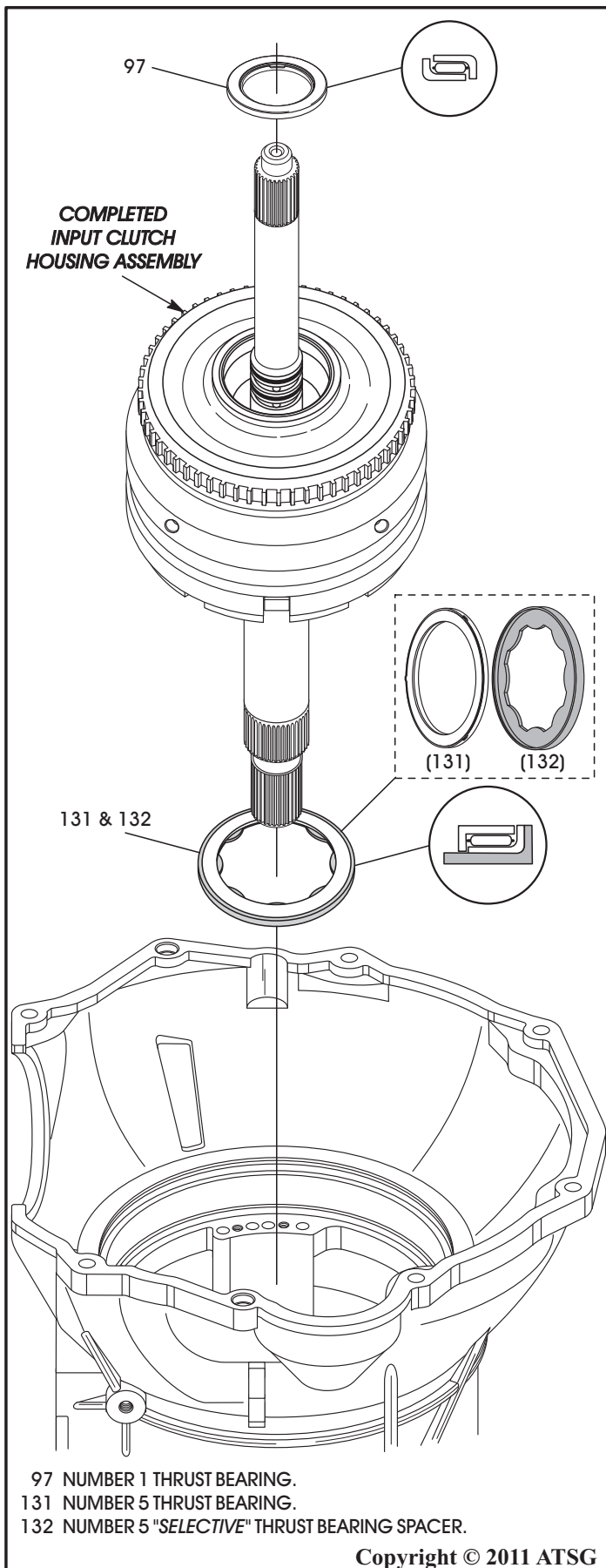


Figure 149

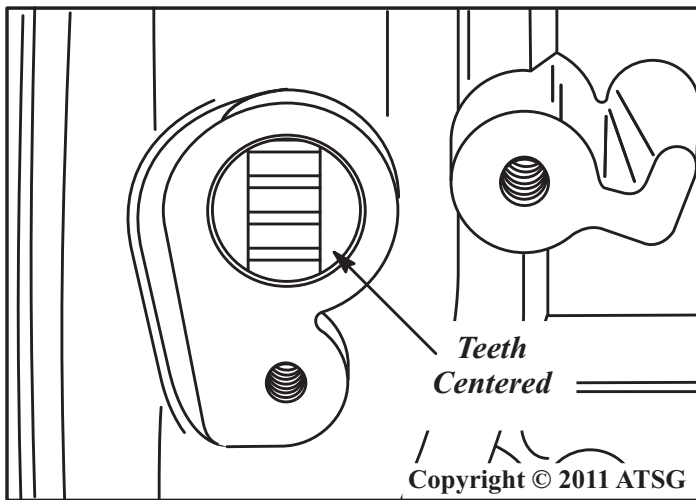


Figure 151

## TRANSMISSION ASSEMBLY (CONT'D)

26. Install the completed oil pump assembly into the transmission case, as shown in Figure 152.
27. Install the 6 retaining bolts and torque them to 28 N·m (20 ft.lb.).
28. Remove one pump bolt to install dial indicator, as shown in Figure 153, and zero dial indicator.
29. Front transmission end-play should be 0.52-0.74 mm (.020"-.029").

**Note:** When measuring input shaft end-play, two "stops" will be felt. When input shaft is pushed inward and the dial indicator zeroed, the first stop felt when input shaft is pulled outward is the movement of the input shaft in the input clutch hub. This value should not be included in the end-play measurement and therefore must be recorded and subtracted from the total dial indicator reading.

30. Change the Number 5 thrust bearing selective spacer as necessary to obtain the correct front transmission end-play.

**Note:** The number 5 thrust bearing selective spacer is identified by a number molded or stamped into spacer, as shown in Figure 154.

31. Remove the dial indicator, re-install the oil pump retaining bolt and torque to 28 N·m (20 ft.lb.).

Continued on Page 98

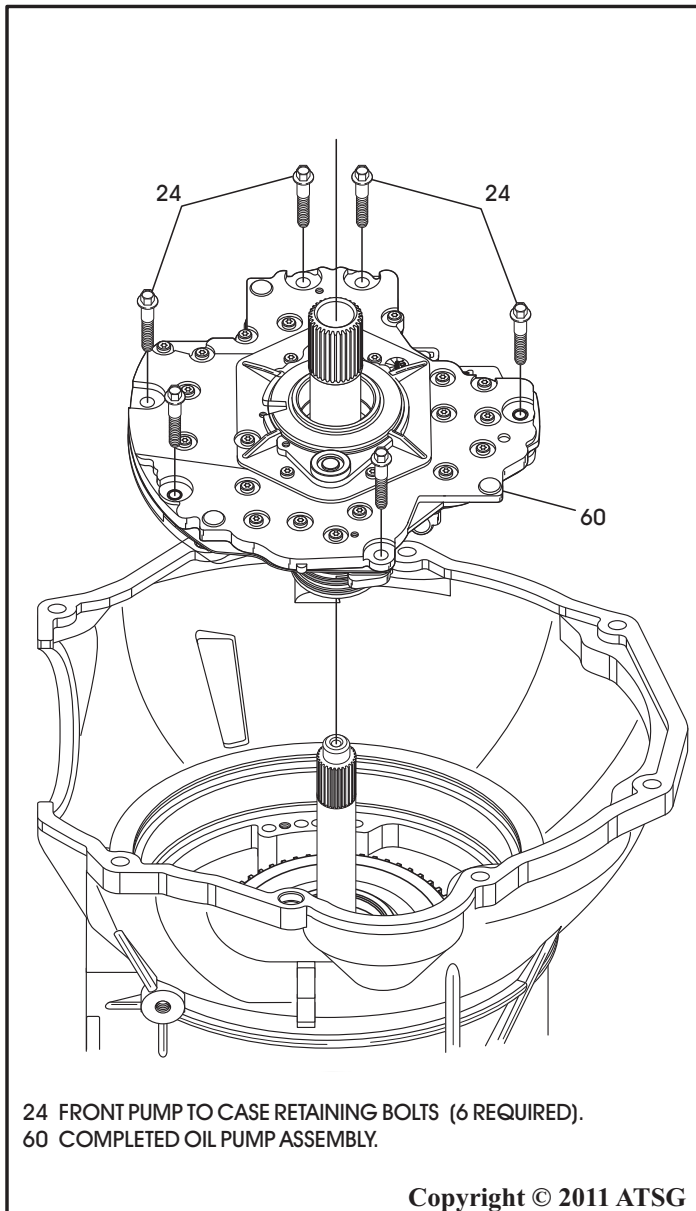


Figure 152

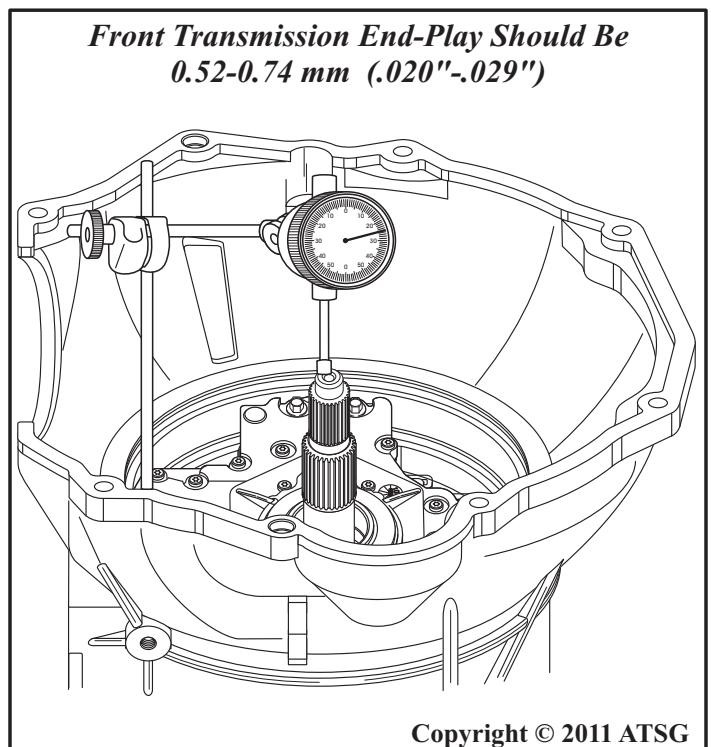


Figure 153

## TRANSMISSION ASSEMBLY (CONT'D)

32. Install new converter hub seal into the front cover, as shown in Figure 155, using the proper driver and support for the cover.
33. Install new front cover to case "O" ring seal on front cover, as shown in Figure 155.
34. Lubricate both seals with a small amount of Trans-Jel®.

Continued on Page 99

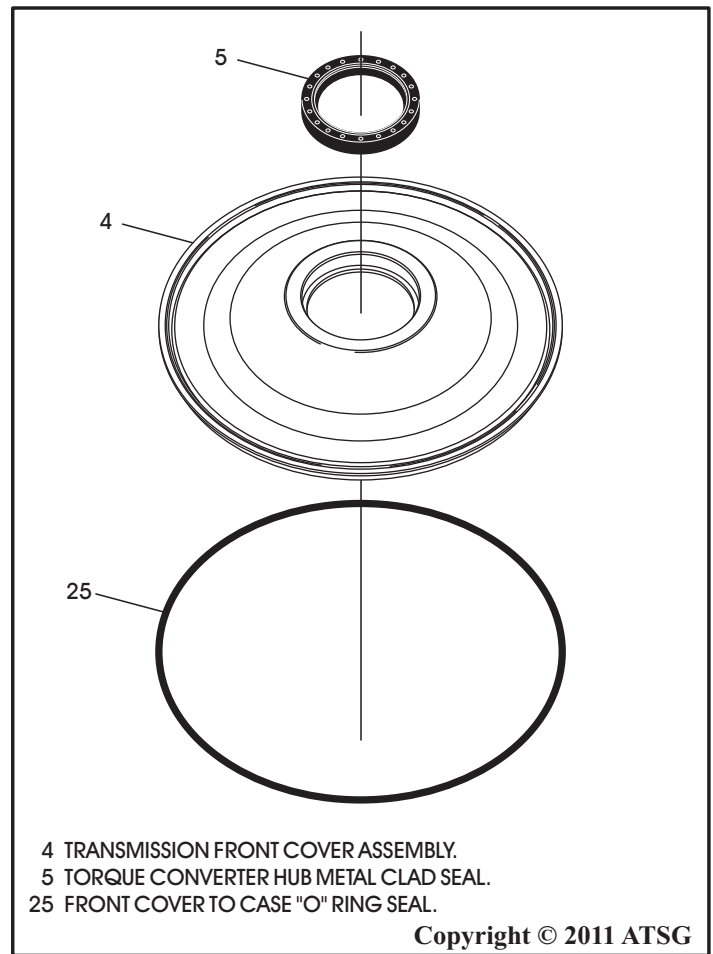
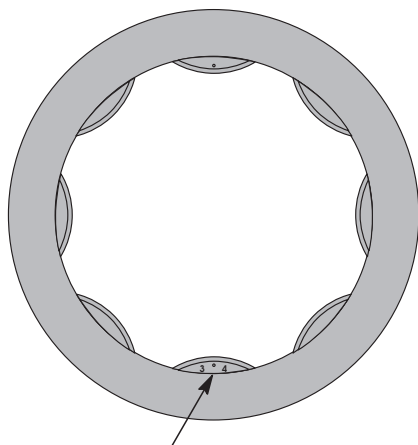


Figure 155

"FRONT END-PLAY" SELECTIVE THRUST PLATE		
ID	THICKNESS MM	THICKNESS INCH
27	1.57 mm	0.062"
28	1.71 mm	0.067"
29	1.85 mm	0.073"
30	1.99 mm	0.078"
31	2.13 mm	0.084"
32	2.27 mm	0.089"
33	2.41 mm	0.095"
34	2.55 mm	0.100"
35	2.69 mm	0.106"
36	2.83 mm	0.111"
37	2.97 mm	0.117"
38	3.11 mm	0.122"
39	3.25 mm	0.128"
40	3.39 mm	0.133"
41	3.67 mm	0.144"



**Note:** The selectable bearing spacer thickness is identified by a number molded or stamped into the spacer.

Copyright © 2011 ATSG

Figure 154

## TRANSMISSION ASSEMBLY (CONT'D)

35. Install the front cover and seal assembly into the transmission case, as shown in Figure 156.

**Note:** Dodge has an installation tool available that allows this to be done without any damage to the front cover, as shown in Figure 157.

36. Install the front cover retaining snap ring into the groove in the case, as shown in Figure 156, and ensure it is fully seated.

Continued on Page 100

ProCarManuals.com

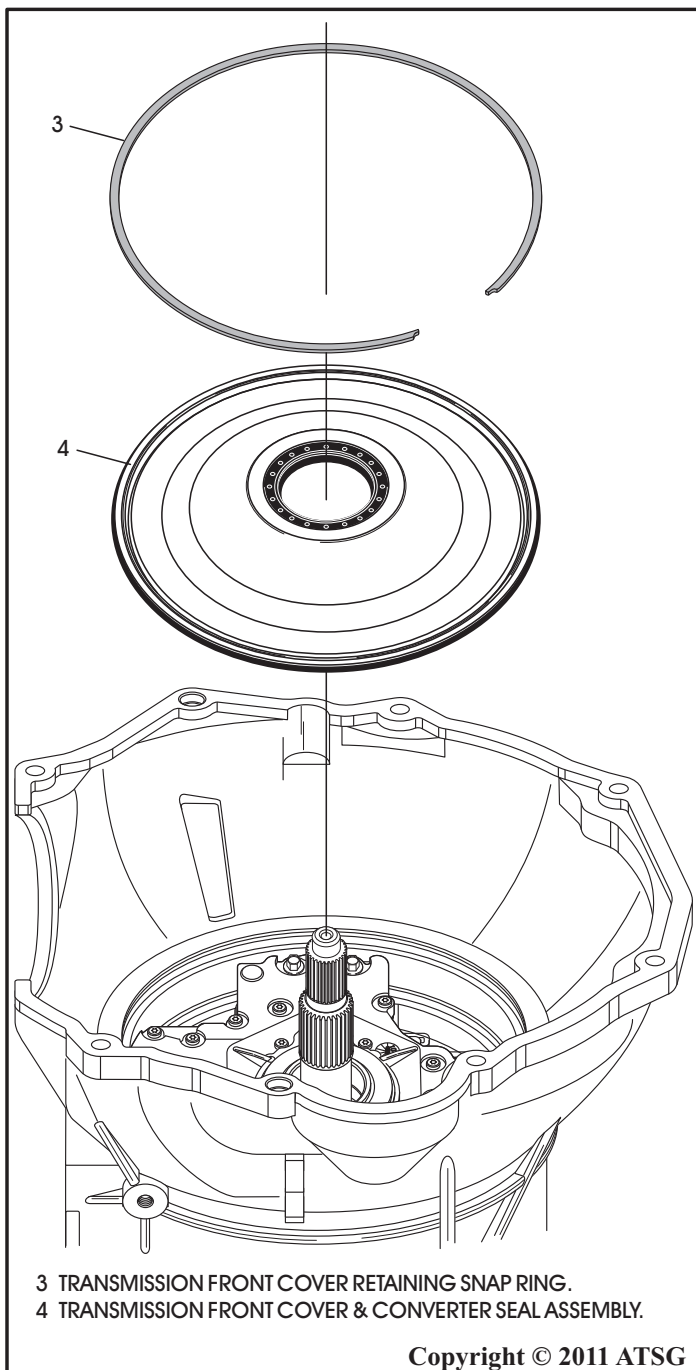


Figure 156

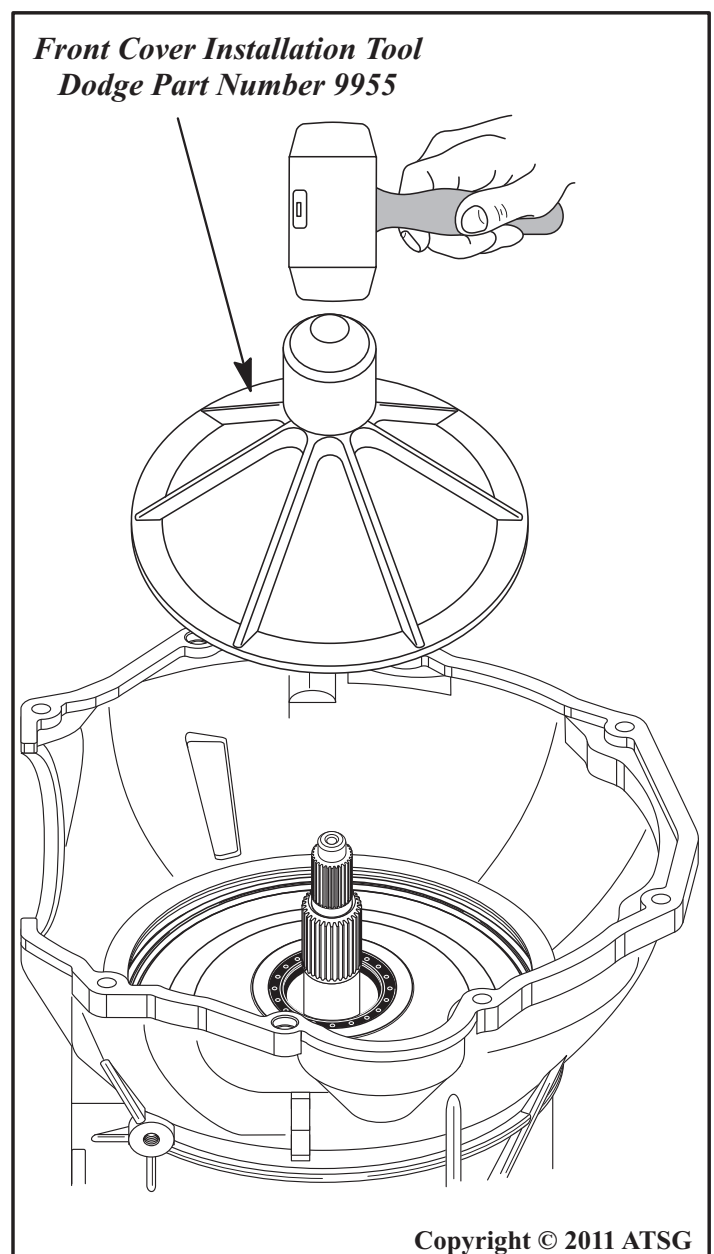


Figure 157



## TRANSMISSION ASSEMBLY (CONT'D)

37. Install the cooler filter by-pass valve into the transmission case, as shown in Figure 158, and torque to 11.3 N·m (100 in.lb.).

**Note: Do Not Over-Torque!**

38. Install the cooler filter in transmission case and use filter wrench to tighten (See Figure 158). The official torque spec is 9.5 N·m (84 in.lb.).
39. Air pressure test all clutch components at this time, before the valve body is installed, using Figure 159 as a guide.
40. Lubricate the case connector seal, and the case connector case bore, with a small amount of Trans-Jel®.
41. Install the completed valve body assembly, as shown in Figure 160.
- Note: Use caution installing the valve body as the assembly has locating dowels that must line up with bores in case, and the 23-way electric connector seal must not be damaged**
42. Install the 6 valve body retaining bolts and torque to 12 N·m (105 in.lb.).

Continued on Page 101

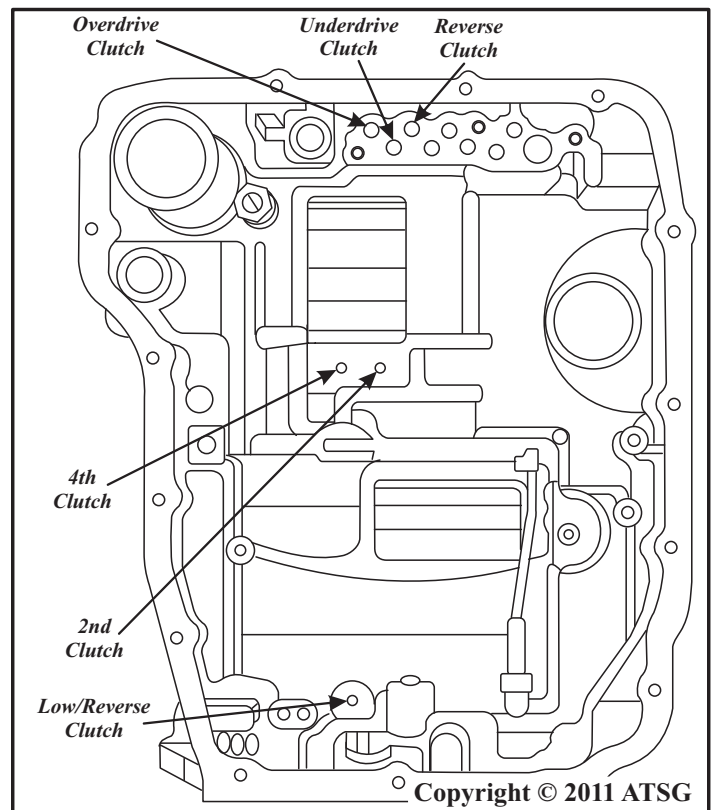


Figure 159

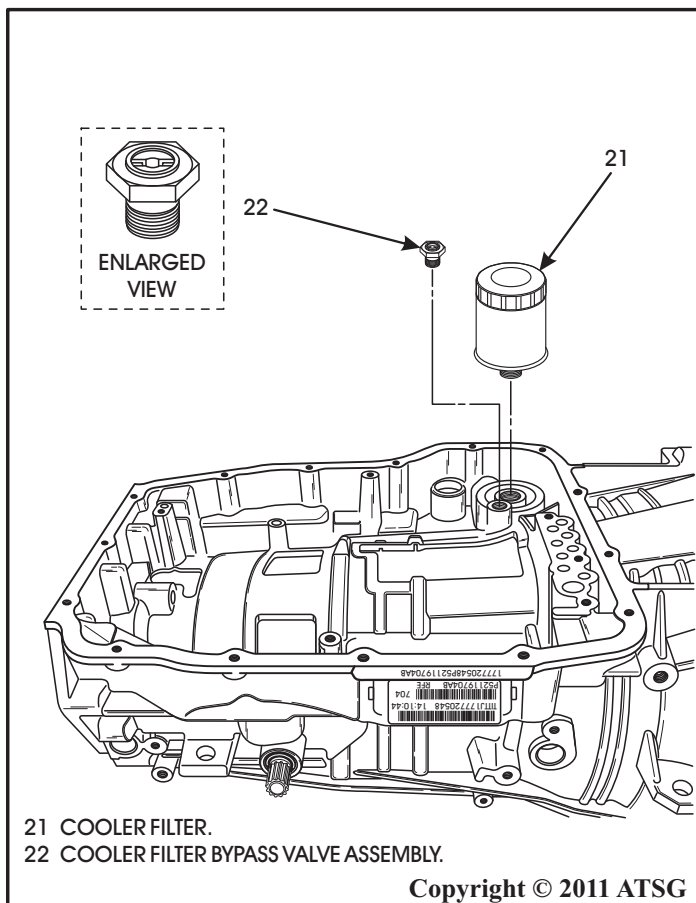


Figure 158

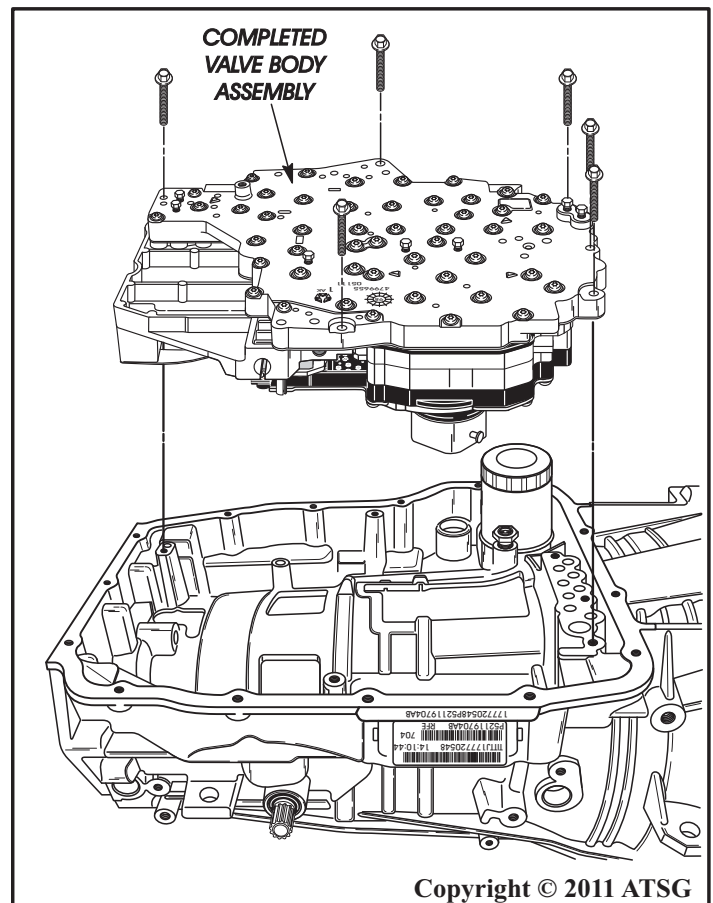


Figure 160

## TRANSMISSION ASSEMBLY (CONT'D)

43. Lube new main oil filter neck with small amount of Trans-Jel®, and install the main oil filter into the filter seal, as shown in Figure 161.
44. Install the oil filter retaining screw, as shown in Figure 161, and torque to 4.5 N·m (40 in.lb.).  
*Note: Some aftermarket filters are known to come out of the filter seal during operation. ATSG recommends using OEM (Filtran) for all rebuilds. Some Technicians are using the filter retaining clip from the 606 transmission, as shown in Figure 162. "Not necessary" with the OEM (Filtran) filter.*
45. You may want to add this 606 filter retaining clip to your unit as a precaution, as shown in Figure 162.

Continued on Page 102

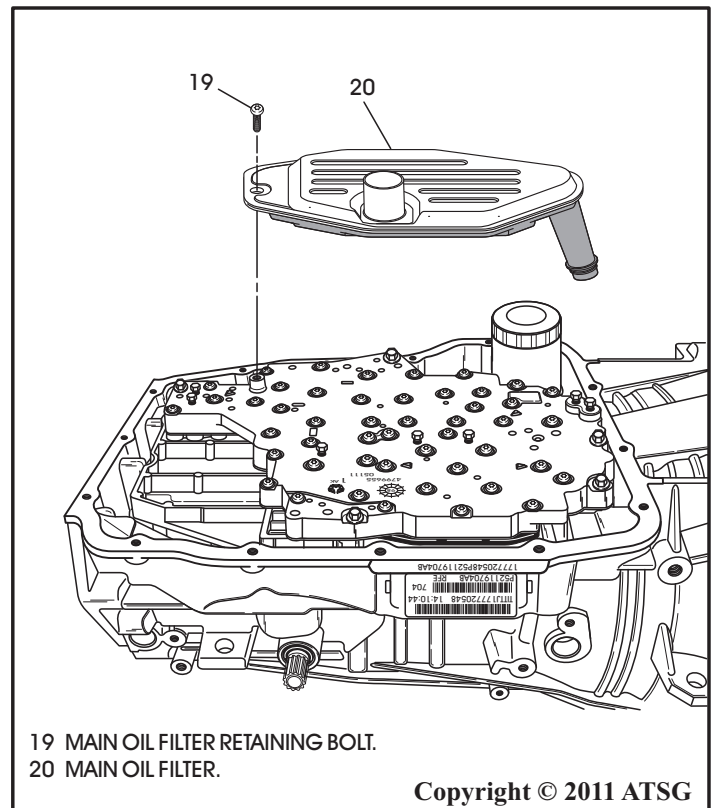


Figure 161

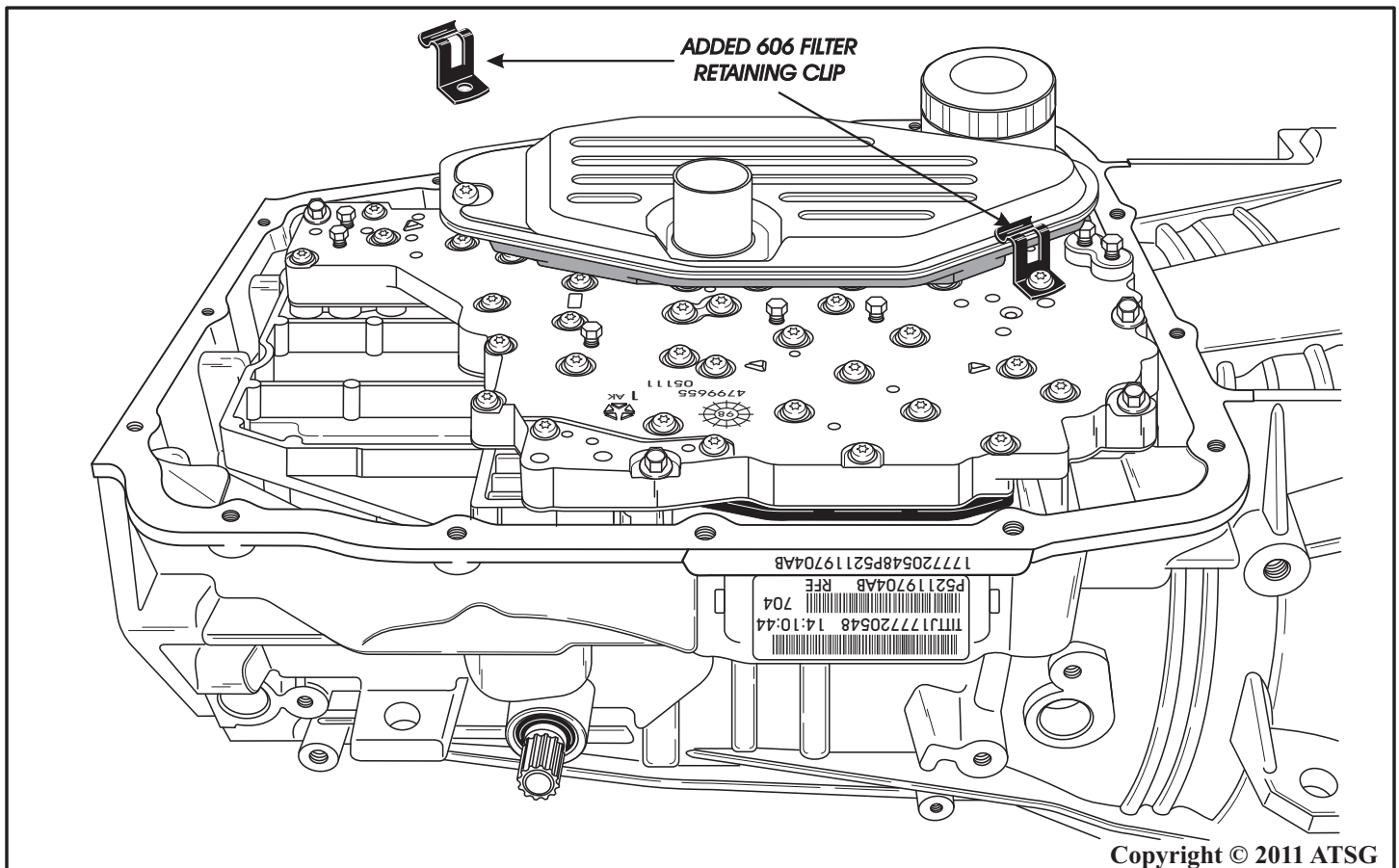


Figure 162

## TRANSMISSION ASSEMBLY (CONT'D)

46. Apply a bead of RTV silicone to oil pan gasket surface and install oil pan on the transmission case, as shown in Figure 163.

**Note:** Ensure that magnet is inside the oil pan and properly positioned before installation.

47. Install the 15 oil pan retaining bolts, as shown in Figure 163, and torque to 12 N·m (105 in.lb.).

48. Turn the transmission over onto the oil pan and install the park gear and retaining snap ring, as shown in Figure 164.

49. Apply a bead of RTV silicone to the extension housing and install it onto the transmission, as shown in Figure 164.

50. Install the 12 extension housing bolts, as shown in Figure 164.

51. Torque the 12 extension housing bolts down to 54 N·m (40 ft.lb.).

Continued on Page 103

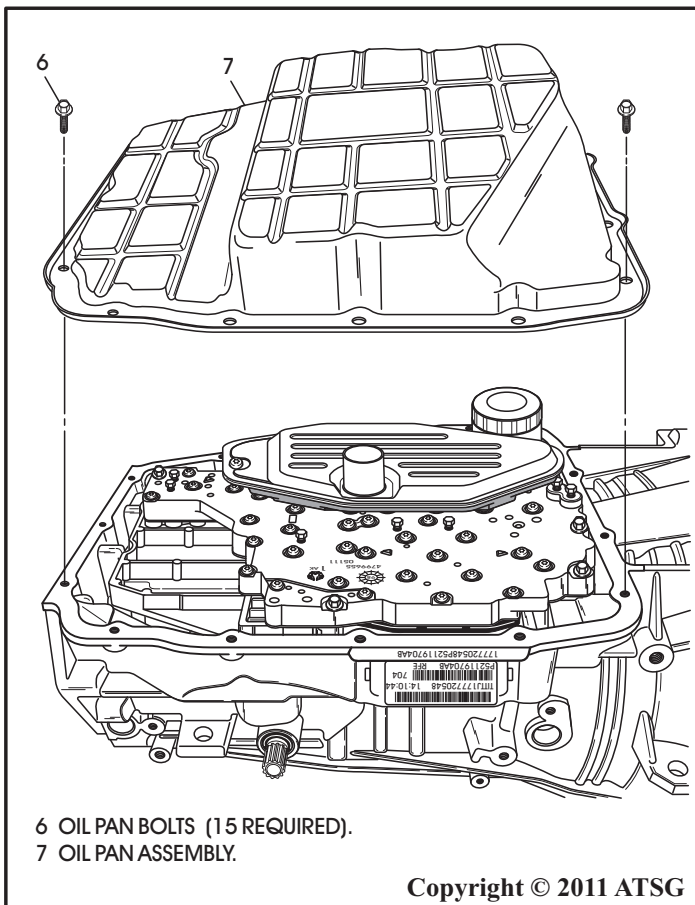


Figure 163

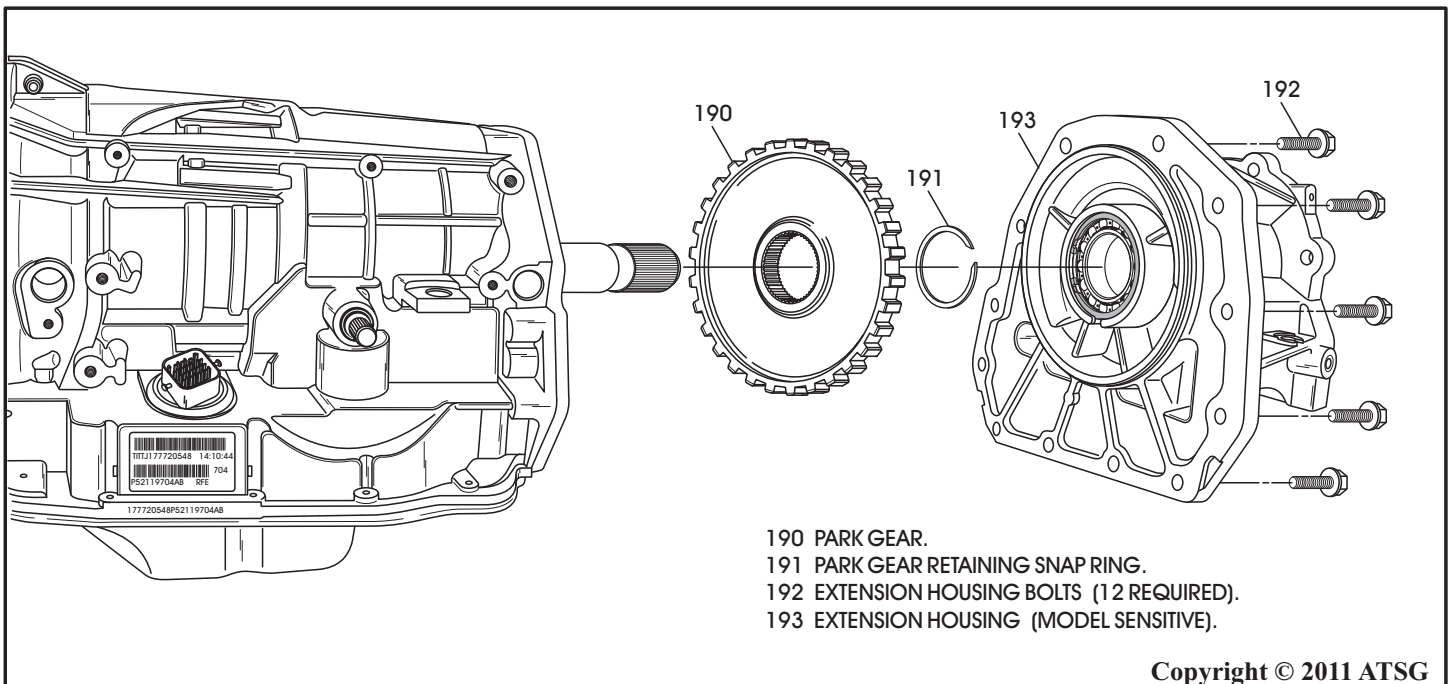


Figure 164

## TRANSMISSION ASSEMBLY (CONT'D)

52. Install new "O" ring seals on both input and output speed sensors, as shown in Figure 165, and lube with small amount of Trans-Jel®.
53. Install both speed sensors into transmission case, as shown in Figure 166.
54. Torque both of the speed sensor bolts down to 12 N·m (105 in.lb.).
55. Install two new "O" ring seals on line pressure sensor & lube with small amount of Trans-Jel®, as shown in Figure 167.
56. Install line pressure sensor into the case bore, as shown in Figure 167, and torque the retaining bolt to 12 N·m (105 in.lb.).

Continued on Page 104

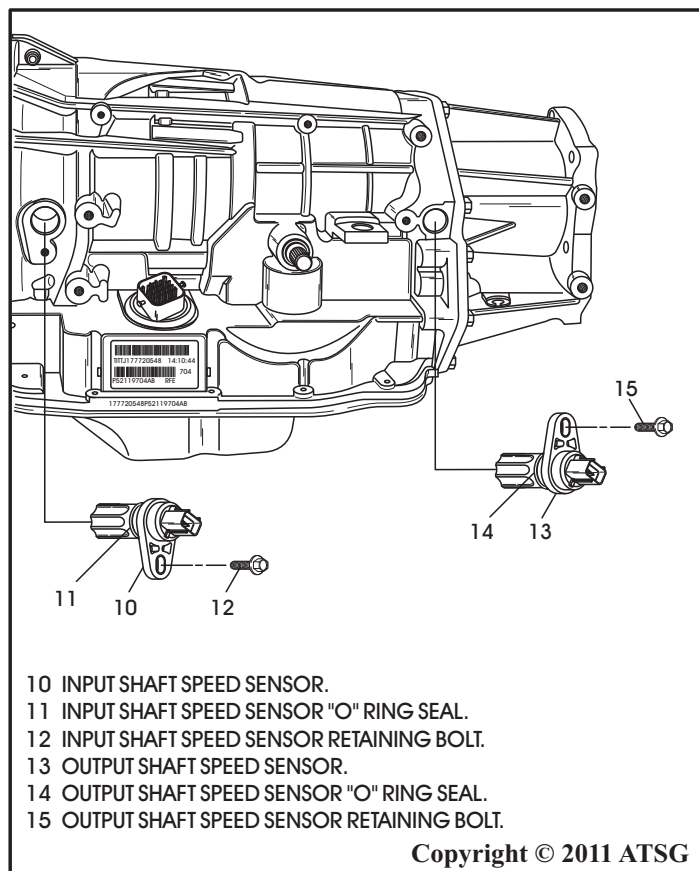


Figure 166

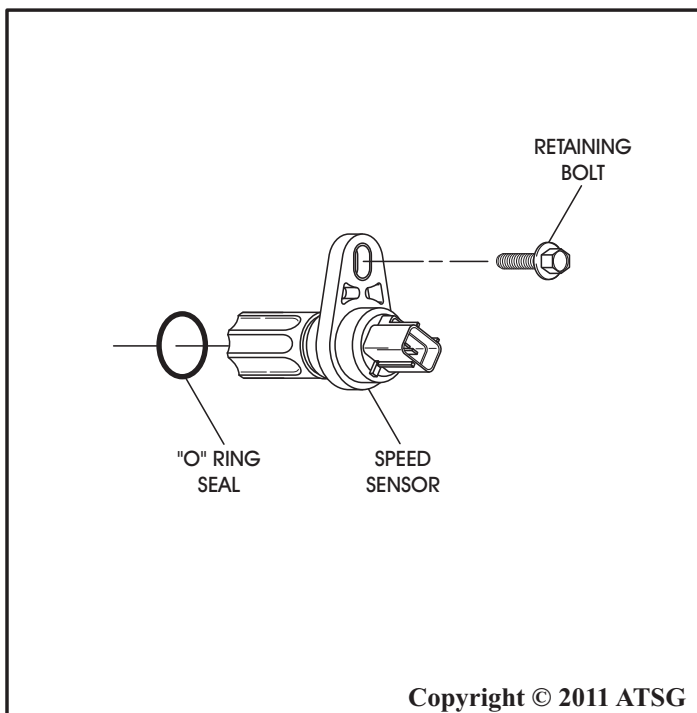


Figure 165

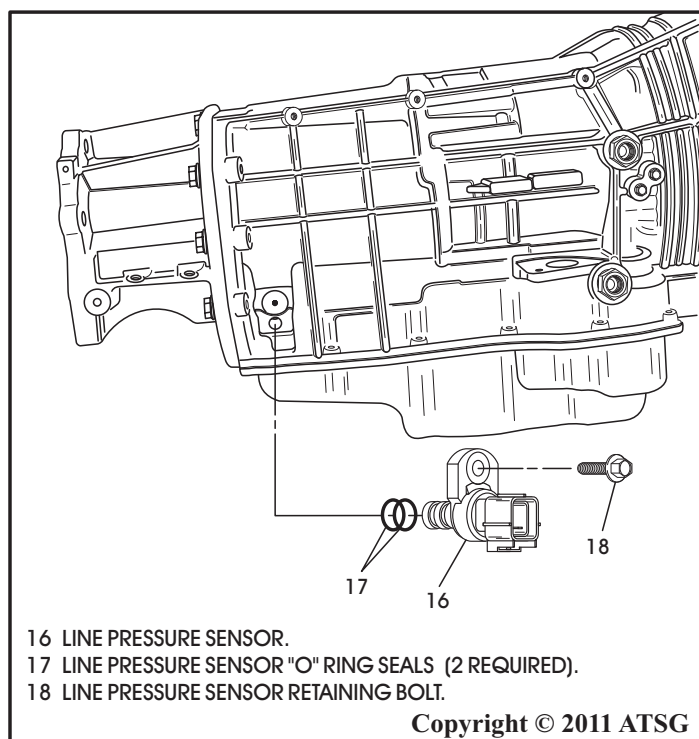


Figure 167



## TRANSMISSION ASSEMBLY (CONT'D)

57. Install a new dipstick tube seal into transmission case bore, as shown in Figure 168.
58. If they were removed, install both cooler line fittings into case, as shown in Figure 168, and torque to 17.5 N·m (13 ft.lb.).
59. Install new "O" ring seal on torque converter hub as shown in Figure 169, and lube hub with ATF.
60. Install torque converter, as shown in Figure 170, and while pushing in rotate converter until fully seated in pump gears.

61. Verify with straight edge and scale, as shown in Figure 171, face of converter lugs should be at least 25 mm (1.000") from face of case.

**CONGRATULATIONS  
YOU ARE FINISHED!**

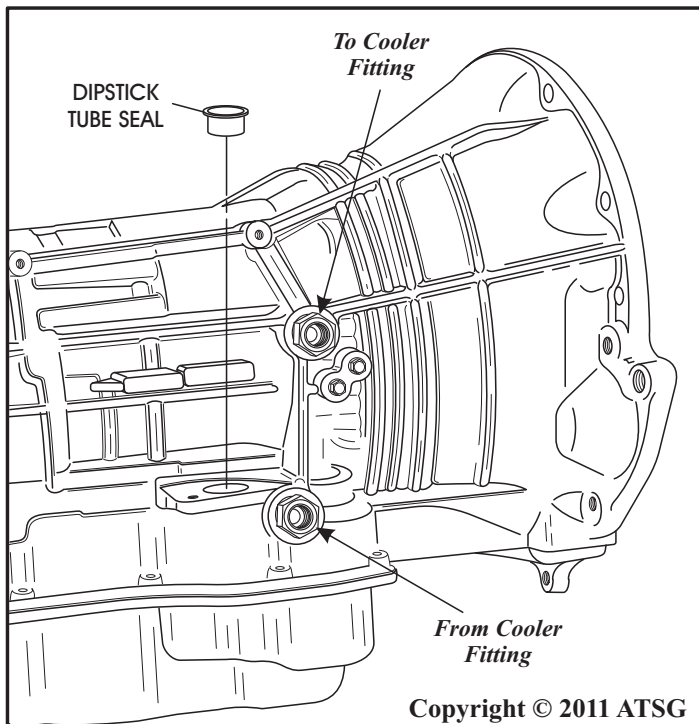


Figure 168

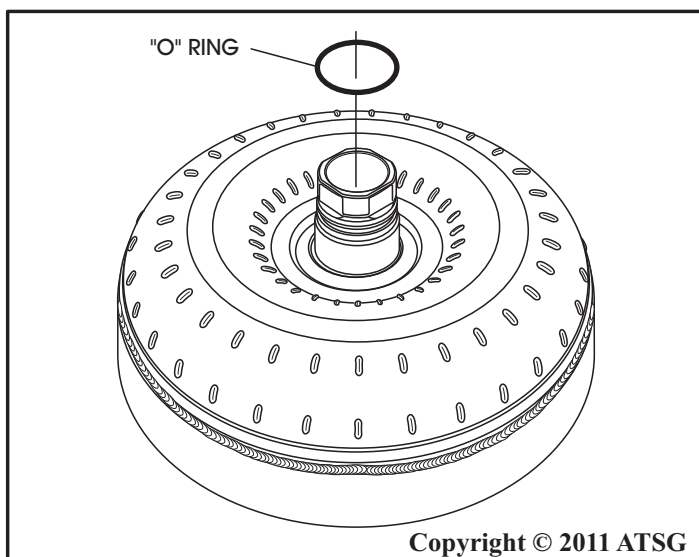


Figure 169

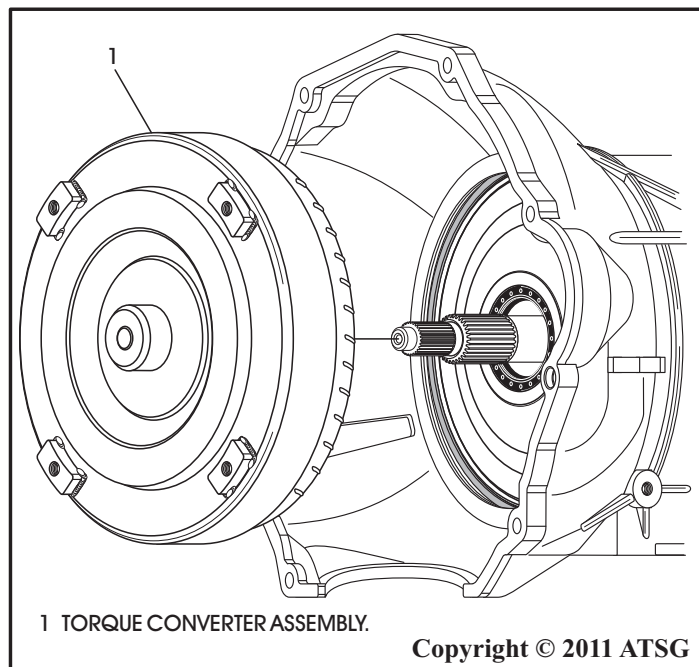


Figure 170

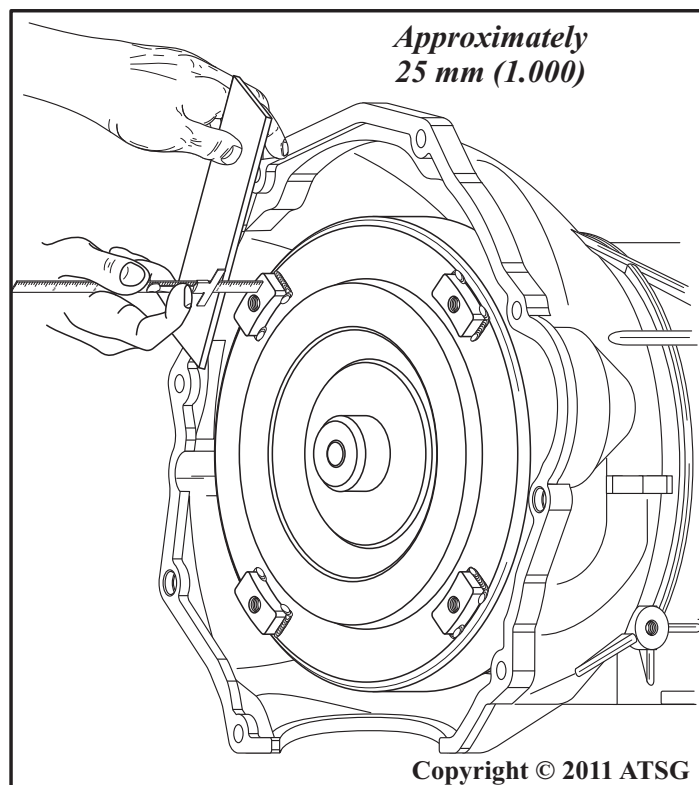


Figure 171



## END-PLAY SPECIFICATIONS

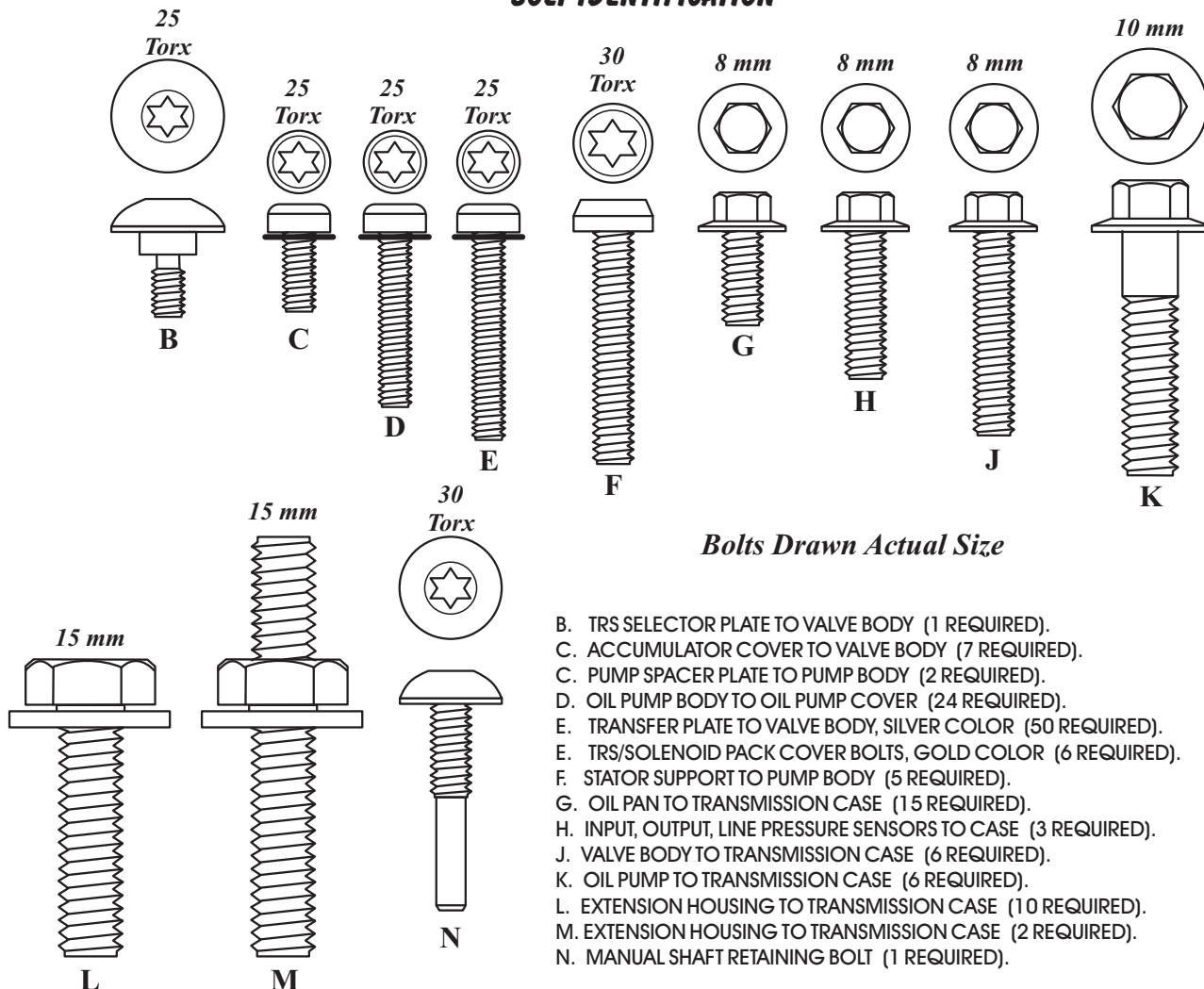
Output Shaft End-Play .....	0.25-0.52 mm (.010"-.020")
Input Shaft End-Play .....	0.52-0.74 mm (.020"-.029")
Second Clutch Clearance .....	0.99-1.65 mm (.039"-.065")
Fourth Clutch Clearance .....	0.77-1.39 mm (.030"-.055")
Low/Reverse Clutch Clearance .....	1.18-2.09 mm (.046"-.082")
Overdrive Clutch Clearance .....	0.75-1.61 mm (.030"-.063")
Underdrive Clutch Clearance .....	1.02-1.72 mm (.040"-.068")
Reverse Clutch Clearance .....	0.58-1.47 mm (.023"-.058")

Figure 172

## RECOMMENDED FLUID

**Mopar® ATF Plus 4**

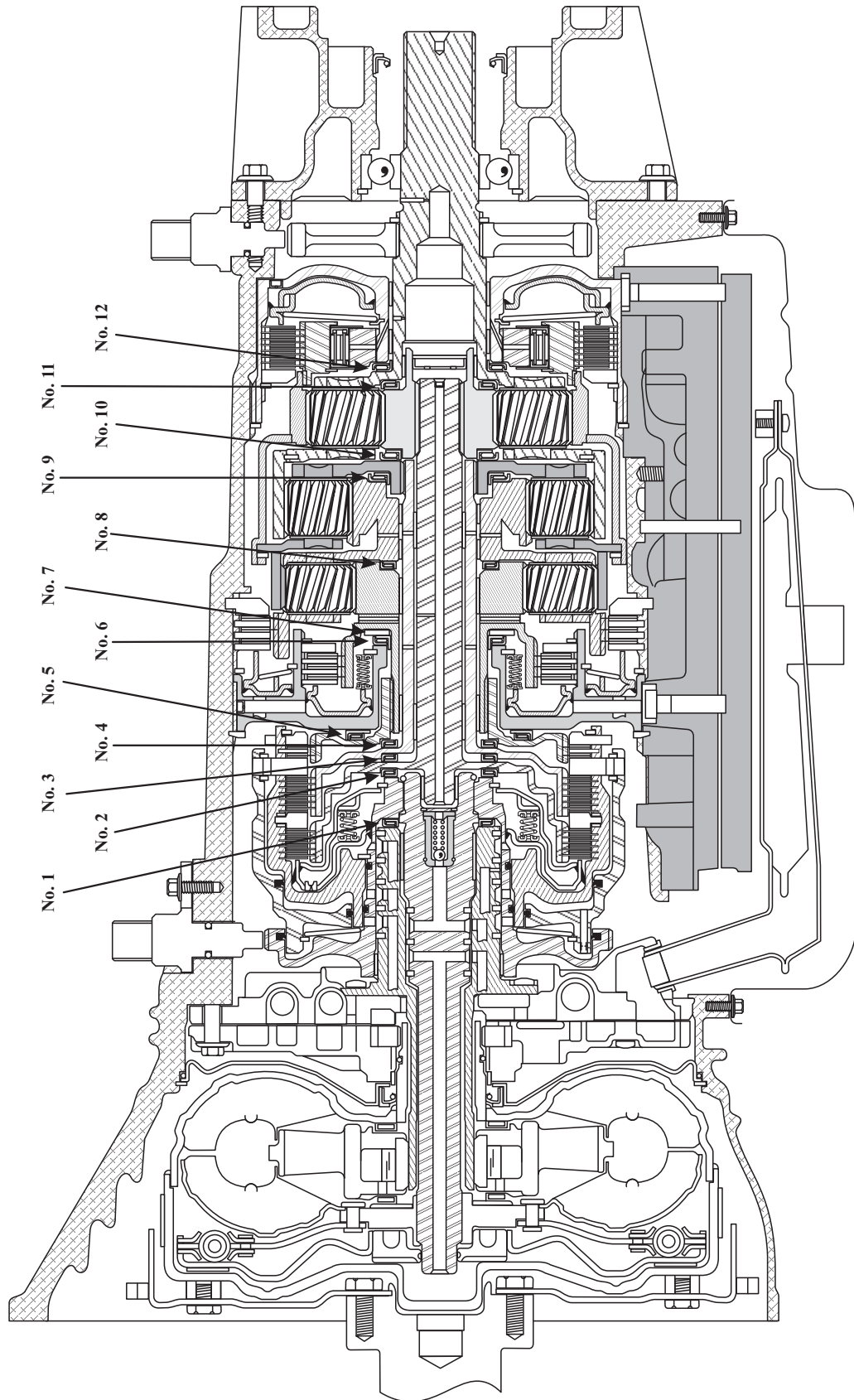
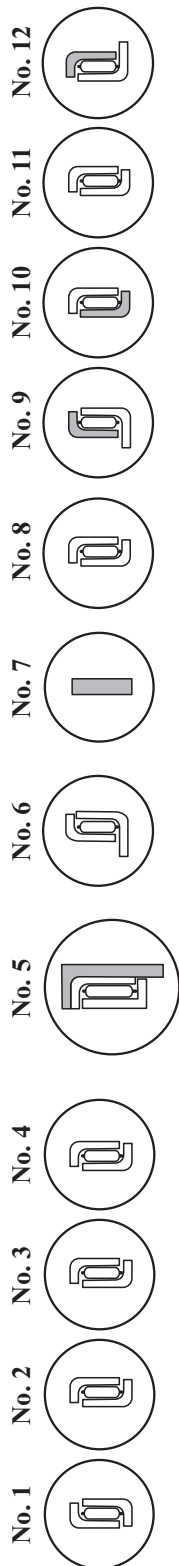
## BOLT IDENTIFICATION



Copyright © 2011 ATSG

Figure 173

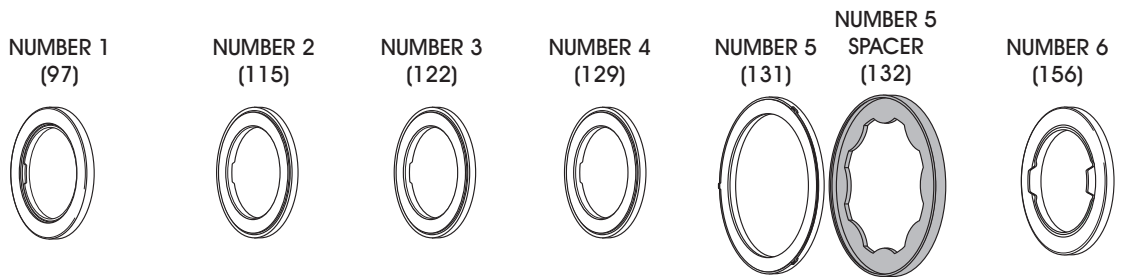
## 68RFE THRUST WASHER AND THRUST BEARING LOCATION



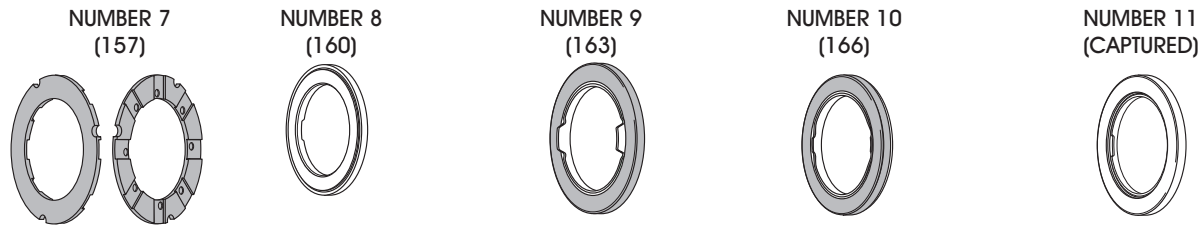
Copyright © 2011 ATSG

Figure 174

## 68RFE THRUST WASHER AND THRUST BEARING IDENTIFICATION



*Note: Numbers in parentheses are illustration numbers for identification.*



NUMBER 12  
(172)



BEARINGS NUMBER 1, 2, 3, 4, AND 8 ARE THE SAME BEARING, BUT INSTALL DIFFERENTLY.  
BEARING NUMBER 5 SPACER (132) IS THE SELECTIVE FOR FRONT END-PLAY.  
WASHER NUMBER 7 IS THE SELECTIVE FOR REAR END PLAY.  
BEARINGS NUMBER 9 AND NUMBER 12 ARE THE SAME BEARING, BUT INSTALL DIFFERENTLY  
BEARING NUMBER 11 IS "CAPTURED" IN THE INPUT CARRIER.

- NO. 1 THRUST BEARING, STATOR SUPPORT TO INPUT CLUTCH HUB.
- NO. 2 THRUST BEARING, INPUT CLUTCH HUB TO UNDERDRIVE CLUTCH HUB AND SHAFT.
- NO. 3 THRUST BEARING, UNDERDRIVE CLUTCH HUB AND SHAFT TO OVERDRIVE CLUTCH HUB AND SHAFT.
- NO. 4 THRUST BEARING, OVERDRIVE CLUTCH HUB AND SHAFT TO REVERSE CLUTCH HUB.
- NO. 5 THRUST BEARING, REVERSE CLUTCH HUB TO NO. 5 "SELECTIVE" SPACER.
- NO. 5 "SELECTIVE" SPACER, NO. 5 THRUST BEARING TO 2-4 CLUTCH RETAINER (SETS FRONT TRANSMISSION END-PLAY).
- NO. 6 THRUST BEARING, 2-4 RETAINER TO NO. 7 "SELECTIVE" THRUST WASHER (SETS REAR TRANSMISSION END-PLAY).
- NO. 7 "SELECTIVE" THRUST WASHER, NO. 6 THRUST BEARING TO 4TH CLUTCH HUB/REACTION SUN GEAR.
- NO. 8 THRUST BEARING, 4TH CLUTCH HUB/REACTION SUN GEAR TO REACTION CARRIER/REVERSE SUN GEAR.
- NO. 9 THRUST BEARING, REACTION CARRIER/REVERSE SUN GEAR TO REVERSE CARRIER/REACTION RING GEAR.
- NO. 10 THRUST BEARING, REVERSE CARRIER/REACTION RING GEAR TO INPUT SUN GEAR.
- NO. 11 THRUST BEARING, IS A "CAPTURED" BEARING IN THE INPUT CARRIER/OUTPUT SHAFT.
- NO. 12 THRUST BEARING, INPUT CARRIER/OUTPUT SHAFT TO LOW/REVERSE CLUTCH HOUSING.

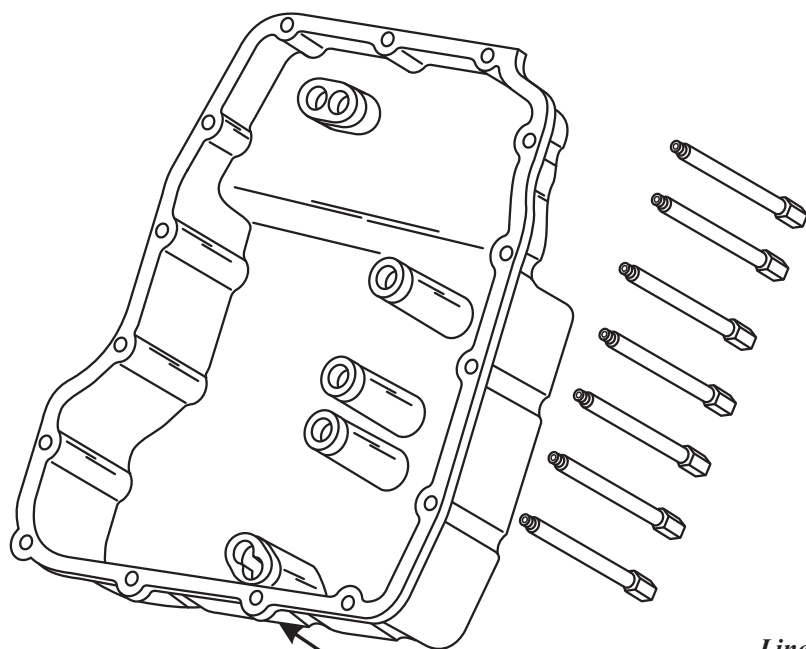
## TORQUE SPECIFICATIONS

Component	N•m	Ft.Lb.	In.Lb.
Oil Pump Assembly to Case	28	20	
Oil Pump Cover to Oil Pump Body Screws	4.5		40
Oil Pump Spacer Plate to Pump Body Screws	4.5		40
Stator Shaft Support to Pump Cover	11.8		105
Oil Pan to Case	11.8		105
Transfer Plate to Valve Body Screws	4.5		40
Transfer Plate to TRS/Solenoid Pack Screws	5.7		50
Valve Body to Case Bolts	12		105
TRS Selector Plate to Valve Body Screw	4.5		40
Accumulator Cover to Valve Body Screws	4.5		40
Detent Spring to Valve Body Screw	4.5		40
Input Speed Sensor to Case	11.8		105
Output Speed Sensor to Case	11.8		105
Line Pressure Sensor to Case	11.8		105
Extension Housing to Case	54	40	
Pressure Test Plugs	5.1		45
Main Oil Filter Screw	4.5		40
Cooler Filter	9.5		84
Cooler Filter By-Pass Valve Assembly	11.3		100
Cooler Line Fittings to Case	17.5	13	
Manual Shaft Retaining Bolt/Pin	28	20	

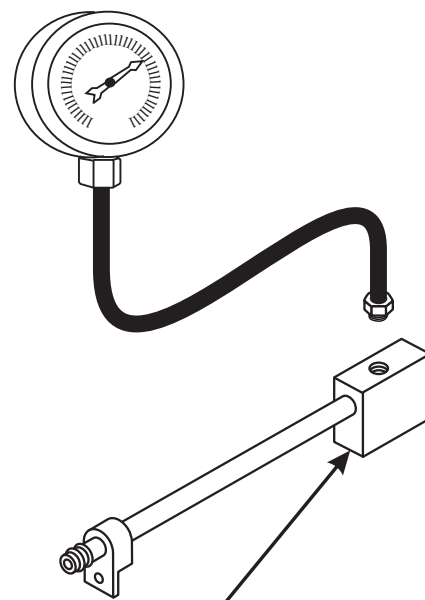
Copyright © 2011 ATSG

Figure 176

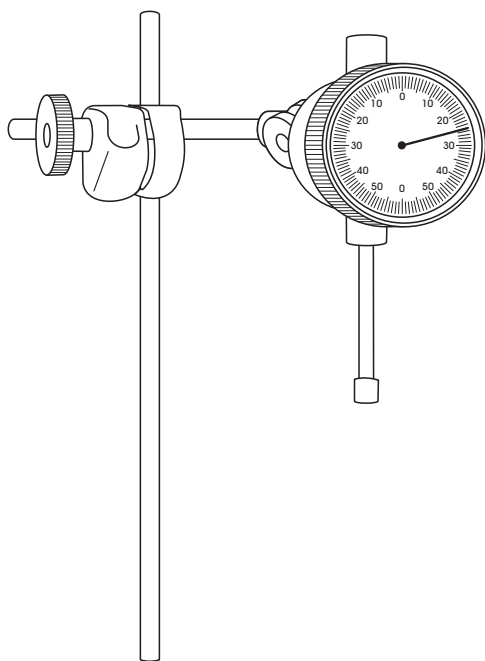
## 68RFE TRANSMISSION SPECIAL TOOLS



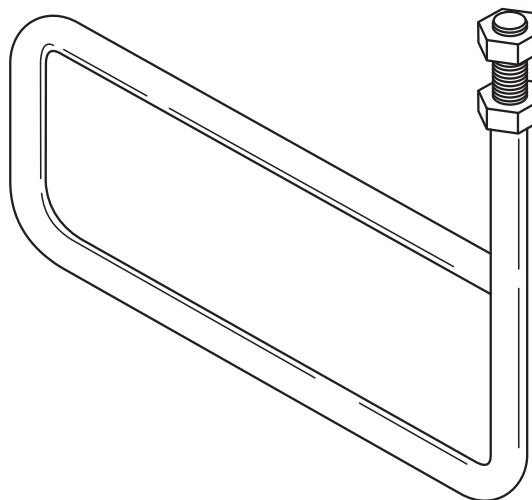
*Pressure Tap Adapter Tool No. 8258, to check oil pressures through the valve body taps.*



*Line Pressure Adapter Tool No. 8259, to install into the line pressure sensor circuit, and then reinstall the sensor and pressure gage.*



*Universal Dial Indicator*



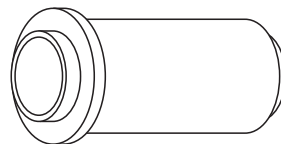
*Transmission Case  
Support Fixture - 8257*



## 68RFE TRANSMISSION SPECIAL TOOLS



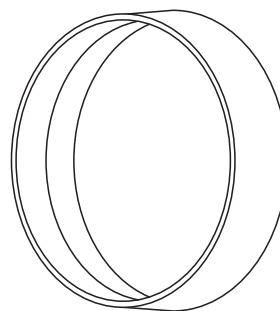
*Dipstick Tube  
Seal Installer - 8254*



*Oil Pump Seal  
Installer - C-3860-A*



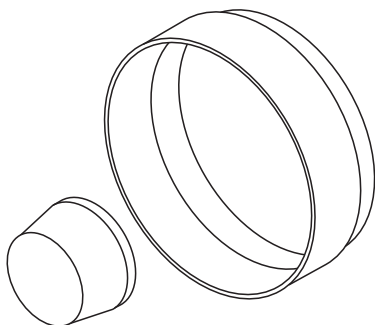
*Front Cover Inner  
Sna Ring Installer - 8255*



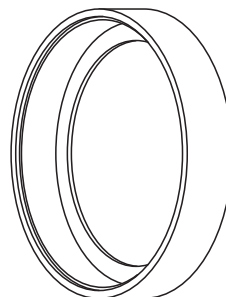
*UD/OD Balance Piston  
Seal Protector - 8252*



*Manual Shaft  
Seal Installer - 8253*

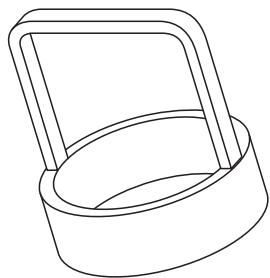


*Input Clutch Piston  
Lip Seal Protector - 8504*

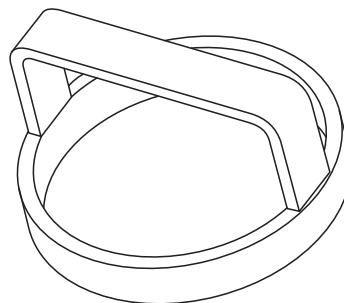


*2nd Clutch Bellville Spring  
and Snap Ring Installer - 8249*

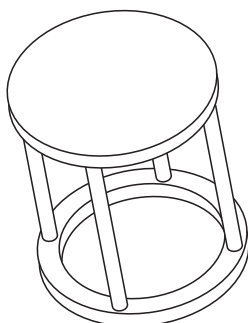
## 68RFE TRANSMISSION SPECIAL TOOLS



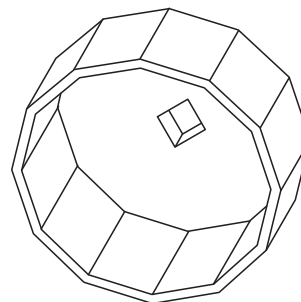
*4th Clutch Piston Return  
Spring Compressor - 8250*



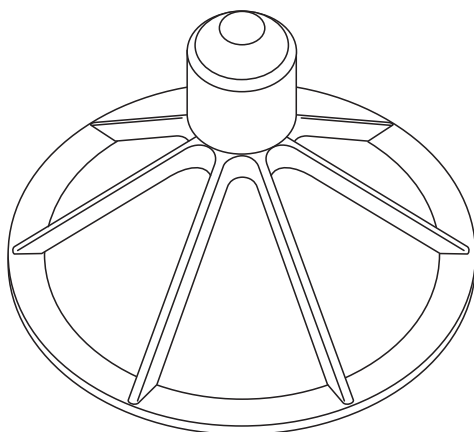
*UD/OD Balance Piston  
Spring Compressor - 8251*



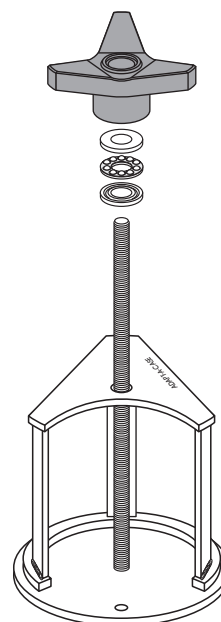
*Low/Reverse Bellville  
Spring Compressor - 8285*



*Cooler Filter  
Wrench - 8321*



*Front Cover Installation  
Tool - 9955*



*The "Drum Buddy"  
By Adapt-A-Case*

Copyright © 2011 ATSG

Figure 179

## HEAVY DUTY LOW ROLLER CLUTCH

There have been reports that the rear sprag has a tendency to "Flip" if any type of engine performance products have been installed.

There is available from Suncoast Products a heavy duty low roller clutch to replace the low sprag and comes complete, ready to install. We have provided you with the dimensions of both so that you can make the decision of whether or not it is needed for your application.

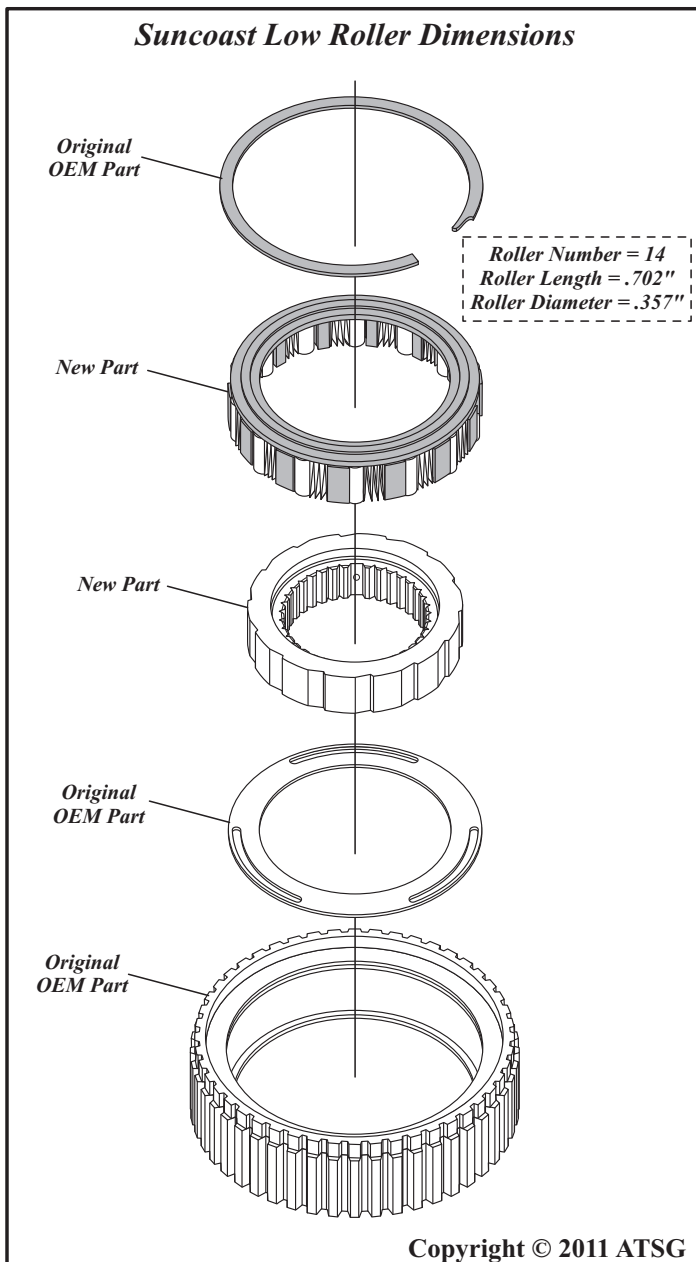


Figure 180

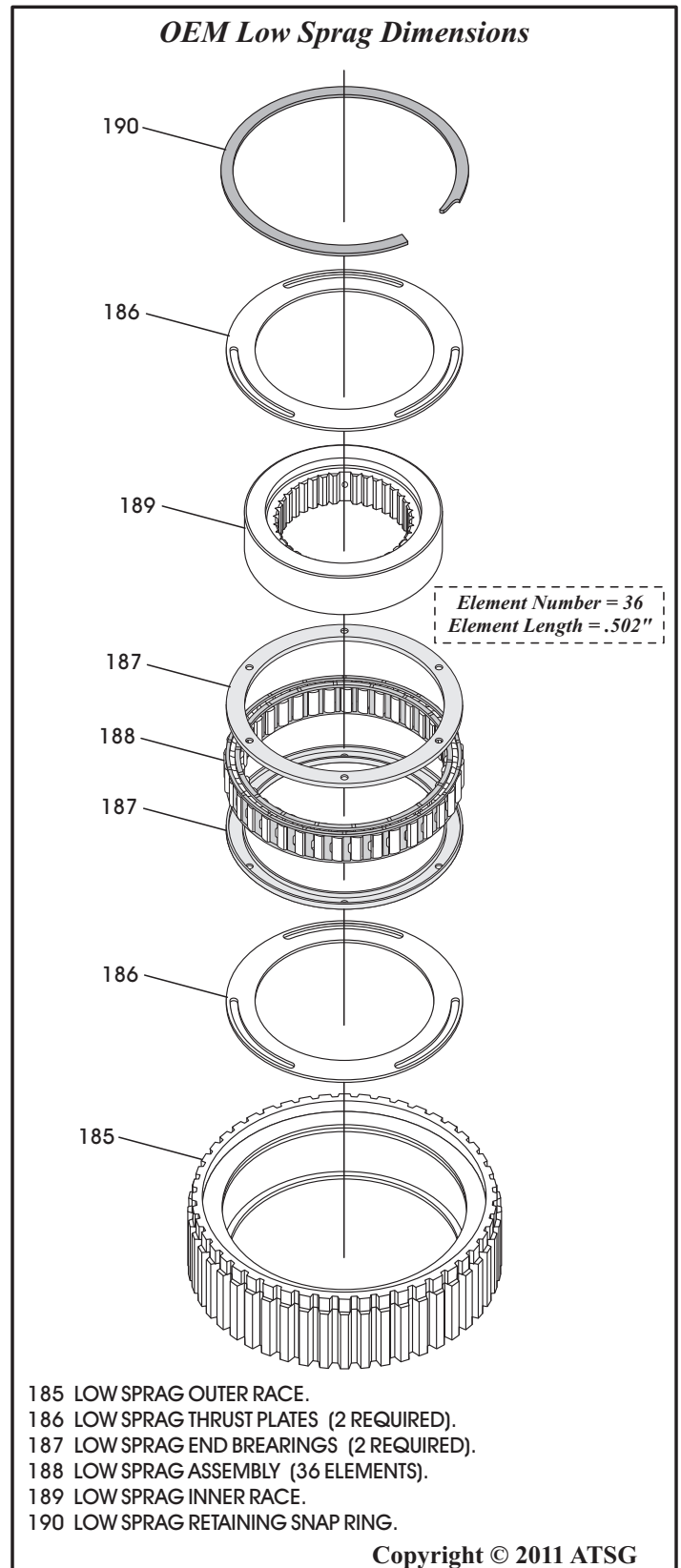


Figure 181