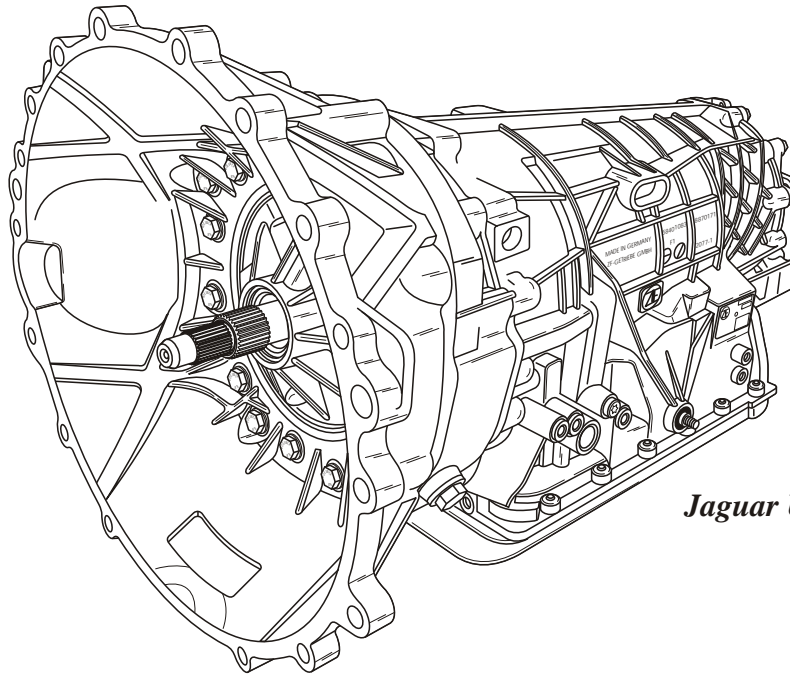


## ZF-5HP-24

### PRELIMINARY INFORMATION

BMW 5 Series E39, 7 Series E38, 8 Series E31 .....	95-Current
Jaguar XK8 (X100), .....	96-Current
Jaguar XJ8 (X300), .....	97-Current
Audi A8 (All Wheel Drive 5HP-24A) .....	96-Current

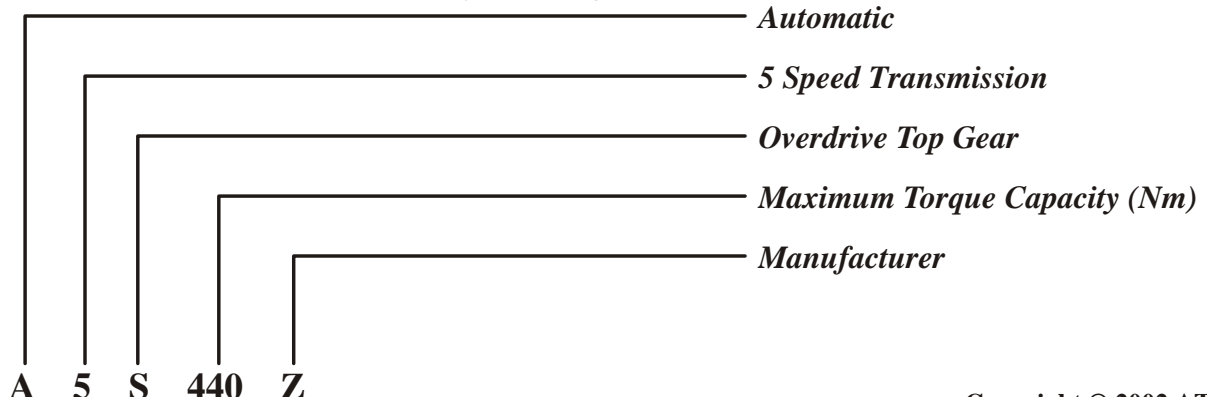


*Jaguar Unit Shown*

*This transmission is manufactured in Germany by ZF and carries the BMW designation A5S 440Z.*

The A5S 440Z is an electronically controlled, five speed automatic transmission with a lock-up clutch type torque converter. Three planetary gear sets (Wilson Gearing), three rotating multiple disc clutches, three multiple disc brake clutches, and one sprag clutch (Freewheel) are used to provide the five forward speeds and reverse.

Key to designation:



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Figure 1



## Technical Service Information

*Refer to Figure 2 for Clutch and Band Application Chart.*

*Refer to Figure 3 for Manual Shift Lever Operation, and Failsafe Operation.*

*Refer to Figures 4, and 5 for Solenoid identification and both MV Solenoid Operation and EDS Solenoid Operation and Tests.*

*Refer to Figure 6 for wiring harness identification, internal wiring schematic, and transmission case connector pin identification and functions.*

*Refer to Figure 7 for Shift Solenoid Application chart. Notice that EDS 1 Solenoid is used for line pressure control, and MV-4 is used for converter clutch.*

*Refer to Figure 8 for EDS Solenoid "Principles of Operation", as some are normally open and some are normally closed.*

*Refer to Figure 9 for internal components resistance chart, with the pins identified for both the transmission case connector and the Electronic Control Unit.*

*Refer to Figure 10 for Upper Valve Body exploded view and identification of valves.*

*Refer to Figure 11 for Lower Front Valve Body exploded view and identification of valves.*

*Refer to Figure 12 for Lower Rear Valve Body exploded view and identification of valves.*

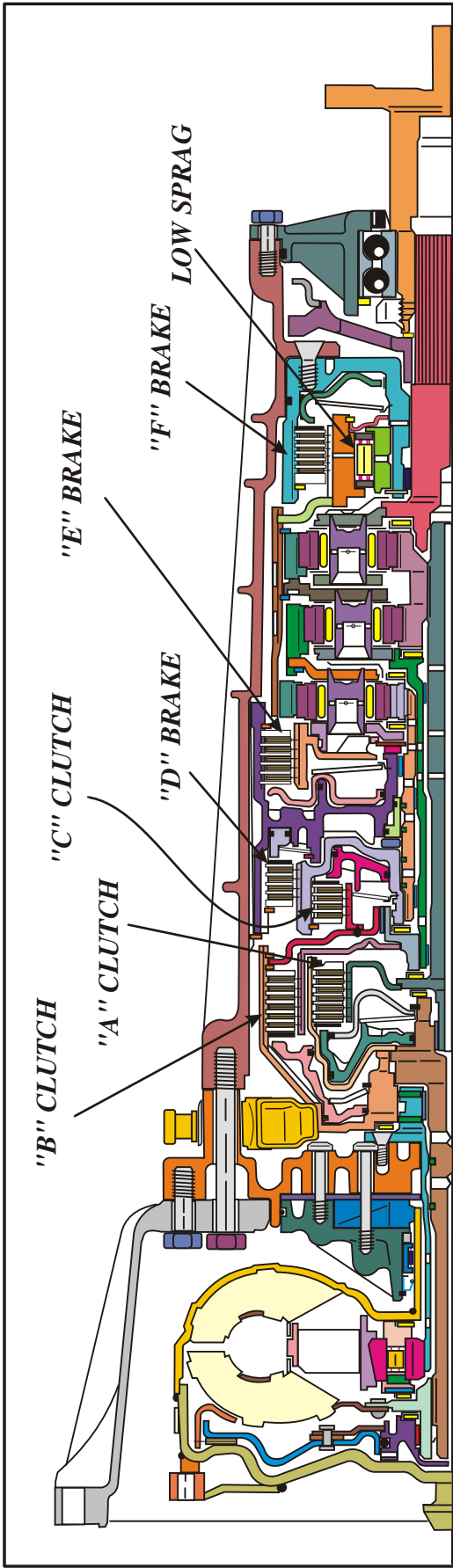
*Refer to Figures 13, 14, and 15 for valve body retainer locations in the various valve bodies.*

*Refer to Figure 16 for Channel Plate screen location on the upper side.*

*Refer to Figure 17 for the locations of the orifices, checkballs, screens, and the check valves and springs that are located in the channel plate.*

*Refer to Figure 18 for external pressure tap locations in the main case*

## ZF-5HP-24



### APPLICATION CHART

GEAR	"A" CLUT	"B" CLUT	"C" CLUT	"D" BRAK	"E" BRAK	"F" BRAK	LOW SPRAG	GEAR RATIO
PARK						ON		
REV			ON			ON		4.10:1
NEUT						ON		
D-1ST	ON						HOLD	3.57:1
D-2ND	ON				ON			2.20:1
D-3RD	ON			ON				1.51:1
D-4TH	ON	ON						1.00:1
D-5TH		ON		ON				0.80:1
M-1	ON					ON	HOLD	3.57:1

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Figure 2



# Technical Service Information

## **SELECTOR LEVER POSITIONS**

**P** = **Park**, and should only be selected when the vehicle is at a standstill. First apply the hand brake, and then select the Park position with the manual lever. Refer to Figure 3.

**R** = **Reverse**, and should only be selected when the vehicle is at a standstill with engine at idle. Refer to Figure 3.

**N** = **Neutral**, and may be selected when the vehicle is at a standstill, but first applying the handbrake. May also be selected while vehicle is moving, to restart the engine or to counteract a skidding concern. Refer to Figure 3.

**D** = **Drive**, is the standard position for normal driving in the XE program (AGS) and provides automatic upshifts from 1st to 5th and automatic downshifts from 5th to 1st gear. The adaptive transmission control (AGS) system contains various driving programs such as Stop and Go, Trailer Towing, Mountain Driving, City Driving and Highway Driving (constant speed). These programs are selected by the Electronic Control Unit (ECU), which automatically modifies the transmissions shift characteristics according to rolling resistance, engine load, accelerator pedal movement and vehicle speed. The standard "Drive" position is position "1", as shown in Figure 3.

### **"S" - Program**

The "S" Program is a performance oriented program, where the gear changing characteristics of the transmission are moved up to higher engine speeds. To select the "S" Program, the selector lever is shifted to the left-hand gate (position "2" in Figure 3), without moving shift lever towards plus or minus. The "S" Program provides automatic upshifts from 1st to 4th and automatic downshifts from 4th to 1st gear. 5th gear is inhibited when the "S" Program is selected.

### **"M" - Program**

The "M" Program is a manual shift program which is activated by simply pushing the selector lever towards the minus sign for sequential downshifts and towards the plus sign for sequential upshifts, while the shift lever is in the left-hand gate (position "2" in Figure 3). It is possible to drive off in 1st gear, 2nd gear or 3rd gear, however, 4th gear can be manually selected only at a speed of approximately 40 km per hour and 5th gear at approximately 60 km per hour.

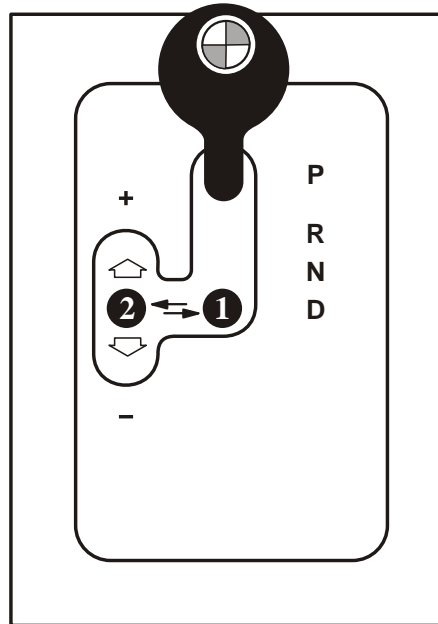
**4th Gear**, Select this position if the transmission tends to hunt between 5th-4th/4th-5th gears under certain driving conditions.

**3rd Gear**, Select this position if the transmission tends to hunt between 3rd and 5th gears under certain driving conditions. Also recommended for lengthy descents in mountainous areas.

**2nd Gear**, Select this position when driving over mountain passes with lengthy ascents and descents.

**1st Gear**, This position can be selected for engine braking effect, depending on vehicle speed.

*Typical BMW Shift Lever*



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Figure 3

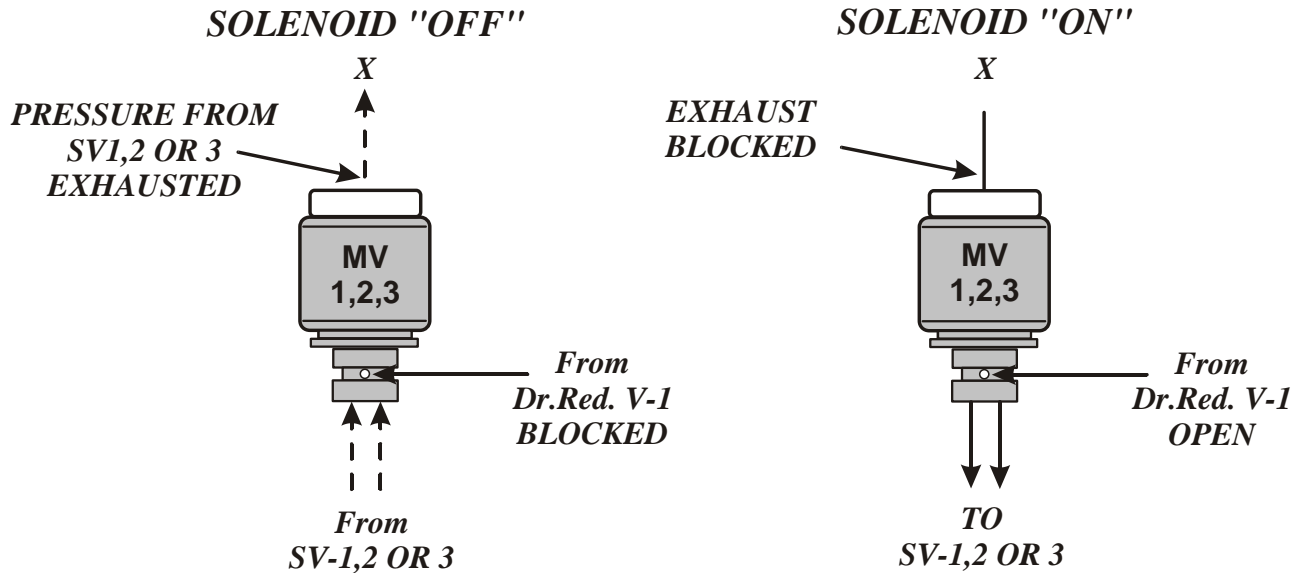
## FAILSAFE OPERATION:

When a system fault is detected which would impair normal reliable operation, the transmission control module interrupts the power supply to Pin 12 at the transmission case connector. The transmission control module also alerts the driver of any faults by signaling the vehicles "check control" system. To enable the vehicle to be driven to a repair shop, the following manual gear selections are permitted:

<i>Selector Lever Position</i>	<b>P R N D 4 3 2</b>
<i>Actual Gear Obtained</i>	<b>P R N 5 5 5 5</b>

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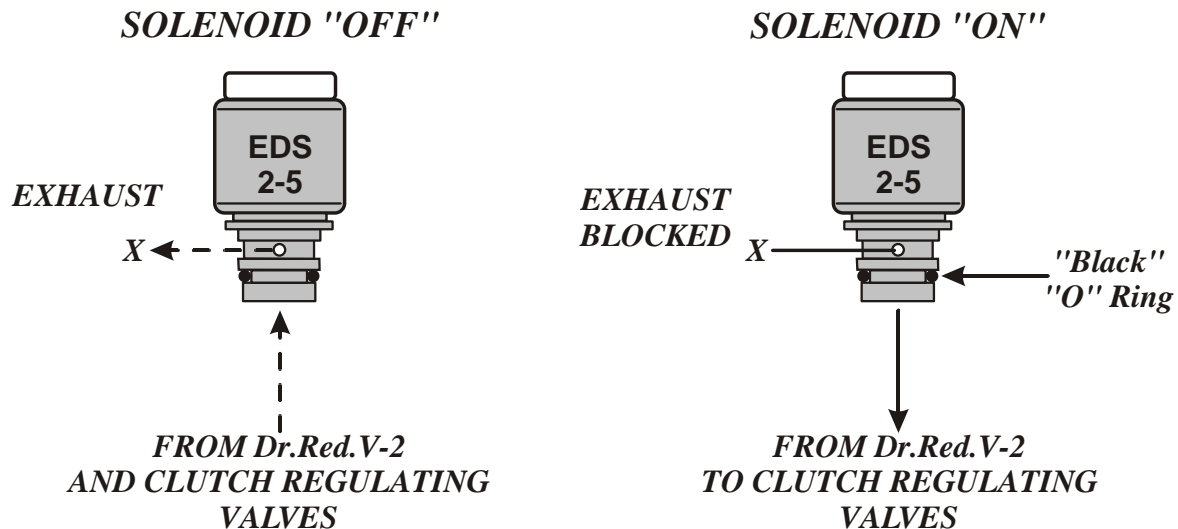
## MV1, 2 AND 3



### SUMMARY:

When MV 1, 2 or 3 is "OFF" Solenoid reducing pressure, from Dr.Red. V-1, is blocked by the solenoid and oil pressure from SV 1, 2 or 3 is exhausted at the rear of the solenoid.  
 When MV 1, 2 or 3 is "ON" Solenoid reducing pressure, From Dr.Red. V-1, is open through the solenoid and is applied to SV 1, 2 or 3. The exhaust at the rear of the solenoid is closed.

## EDS 2, 3, 4, 5,



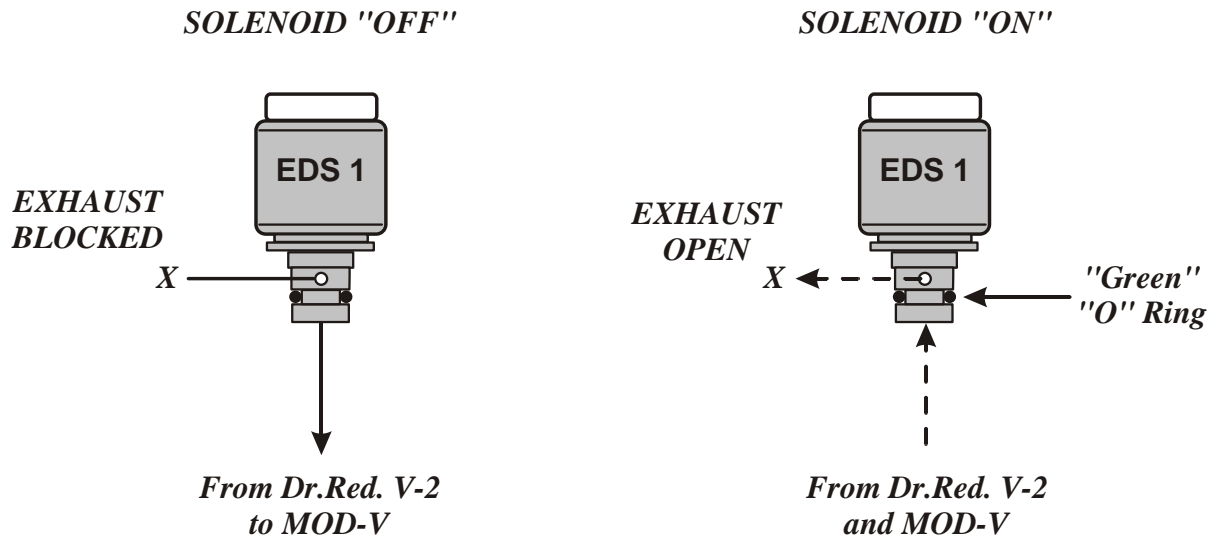
### SUMMARY:

When EDS 2 thru 5 solenoids are "OFF" they exhaust orificed solenoid reducing pressure, from Dr. Red. V-2, and the oil pressure from the clutch regulating valves releasing them.  
 When EDS 2 thru 5 solenoids are "ON" the exhaust is blocked by the solenoid and solenoid reducing pressure, from Dr. Red. V-2, is applied to operate clutch regulating valves.

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Figure 4

## EDS 1 (Line Pressure)



### SUMMARY:

*When EDS 1 solenoid is "OFF," solenoid reducing pressure, from Dr. Red. V-2, is high to MOD-V valve which creates high line pressure.*

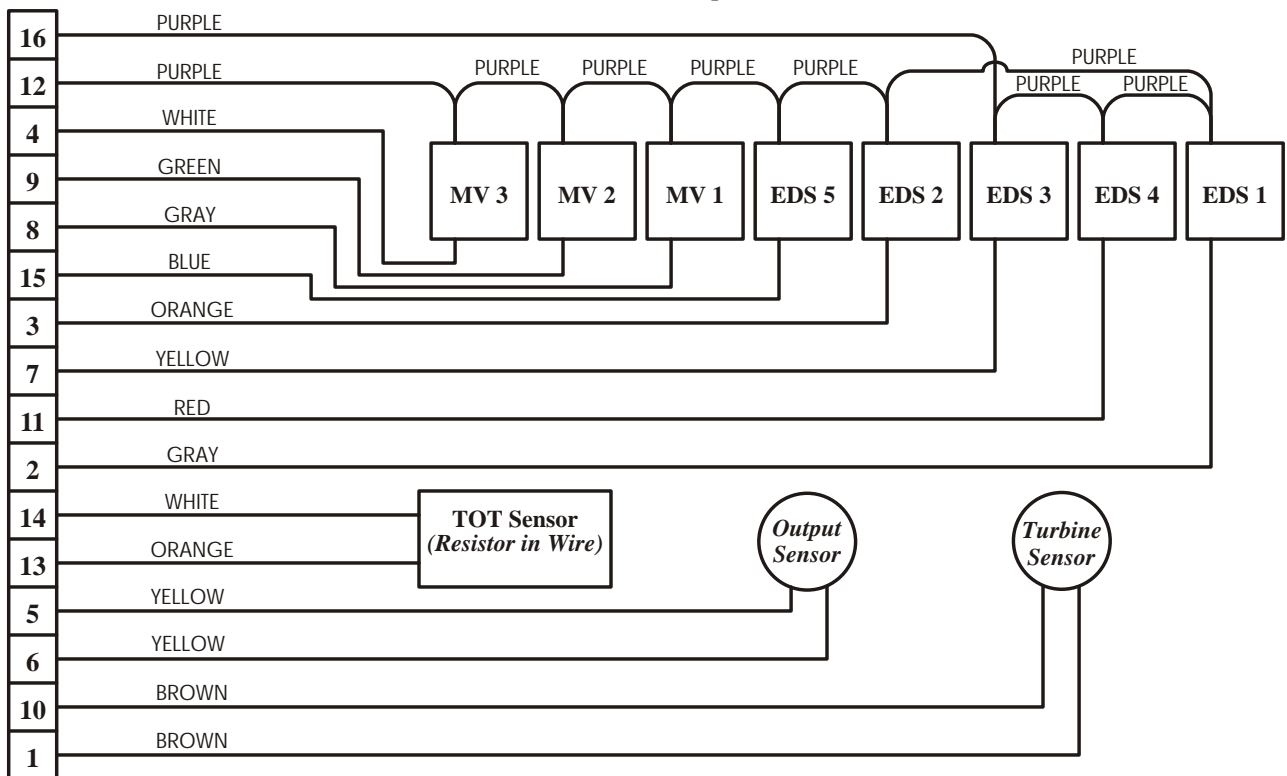
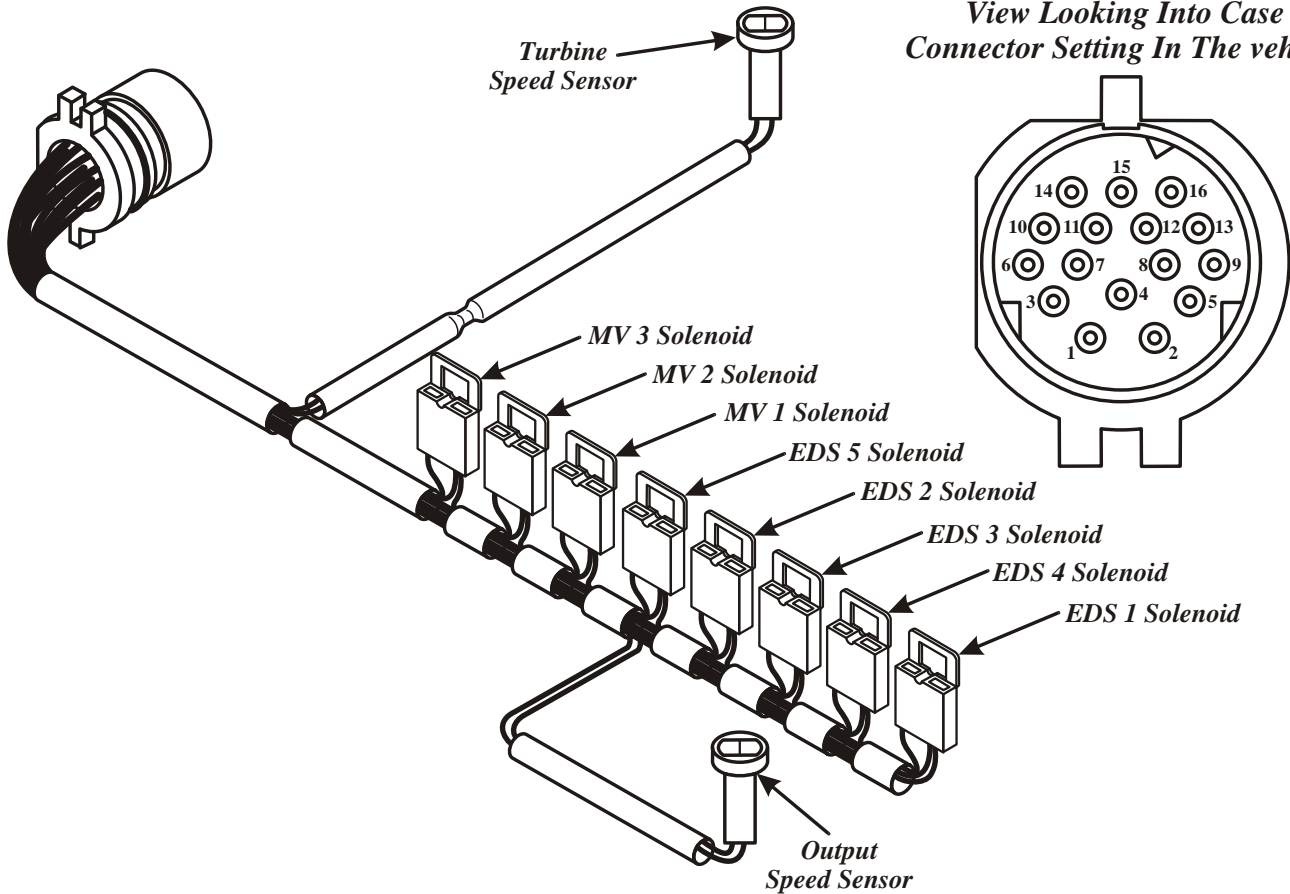
*When EDS 1 solenoid is "ON," solenoid reducing pressure, from Dr. Red. V-2, is low to*

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Figure 5

## ZF-5HP-24 INTERNAL WIRE SCHEMATIC

*View Looking Into Case  
Connector Setting In The vehicle*



**NOTE:** Some internal wire colors may vary.

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Figure 6



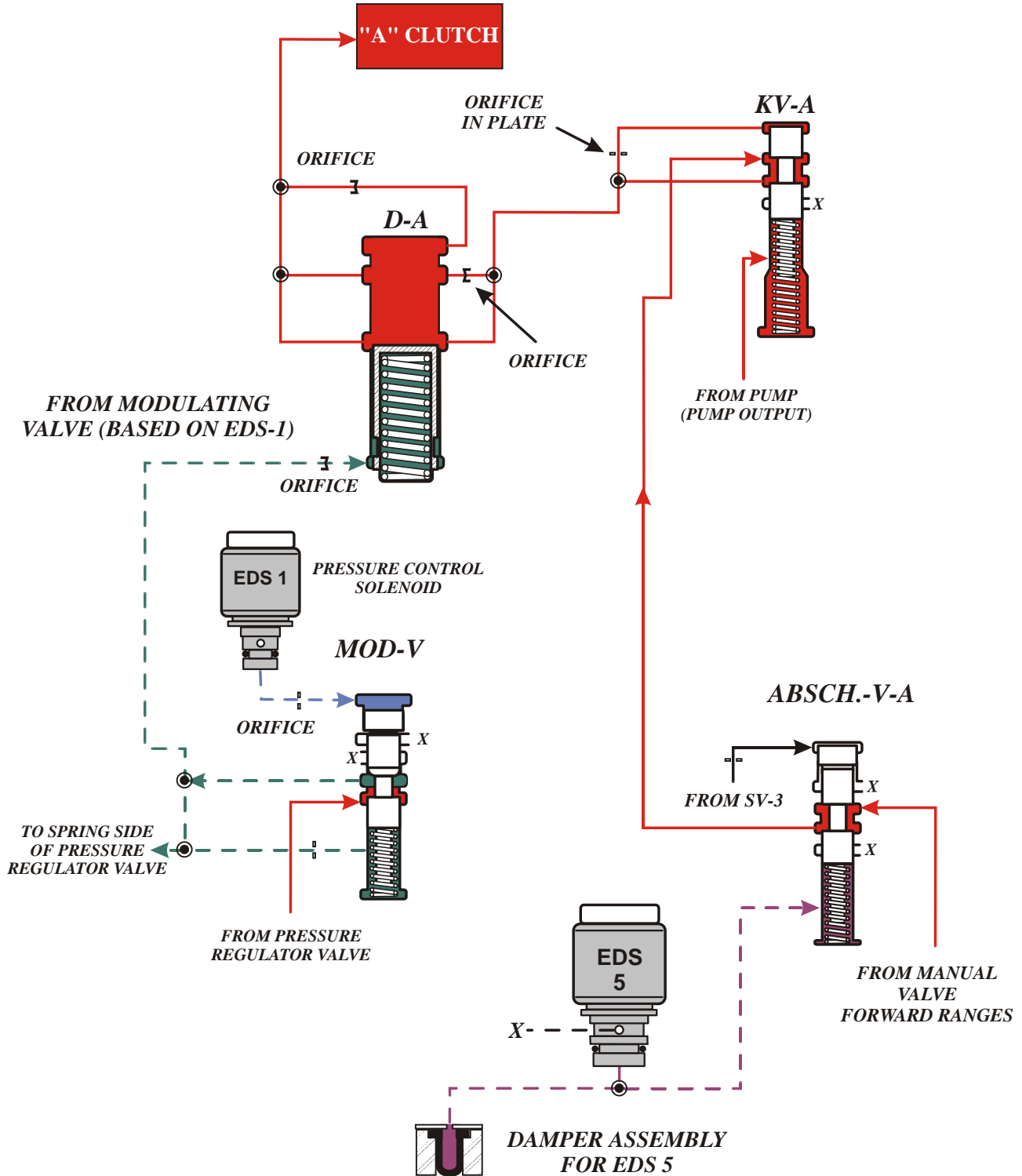
## ZF-5HP-24 SOLENOID APPLICATION CHART

<i>Selector Lever Position</i>	<i>MV 1 Solenoid</i>	<i>MV 2 Solenoid</i>	<i>MV 3 Solenoid</i>	<i>EDS 1 Solenoid</i>	<i>EDS 2 Solenoid</i>	<i>EDS 3 Solenoid</i>	<i>EDS 4 Solenoid</i>	<i>EDS 5 Solenoid</i>	<b>GEAR RATIO</b>
<b>PARK</b>	ON		ON	**	-*	*		-*	
<b>REVERSE</b>		ON	⊗	**	*-	*		*-	<b>4.10:1</b>
<b>NEUTRAL</b>	ON		ON	**	-*	*		-*	
<b>D-1ST</b>	ON			**	*-	*		*-	<b>3.57:1</b>
<b>D-2ND</b>	ON	ON		**		*		*	<b>2.20:1</b>
<b>D-3RD</b>		ON		**		*			<b>1.51:1</b>
<b>D-4TH</b>		ON		**			-*-		<b>1.00:1</b>
<b>D-5TH</b>				**			-*-		<b>0.80:1</b>
<b>D-5TH "TCC"</b>				**			*		<b>0.80:1</b>

## SOLENOID CHART LEGEND

Symbol	Description
<b>ON</b>	MV 1, MV 2 and MV 3 Solenoids are energized by the Electronic Transmission Control unit and have two functions. They are Open or Closed. Energized (On), there is pressure in circuit.
⊗	MV 3 is turned "ON" if reverse is selected at a high vehicle speed, to inhibit reverse engagement.
<b>**</b>	EDS 1 is used for line pressure control only, and operates from 0 to 0.8 amps. When the solenoid is "OFF" (0 amps), pressure is high. EDS 1 pressure is "Lowered" as the solenoid is modulated by the control unit.
<b>*</b>	EDS 2, EDS 3, EDS 4 and EDS 5 Solenoids are also pulse modulated but are exactly the opposite of EDS 1 Solenoid. When these solenoids are "ON" oil pressure in the hydraulic circuit is high, and when they are "OFF" pressure in the hydraulic circuit is low.
<b>-*</b>	Solenoid "OFF" (hydraulic pressure low), then Solenoid "ON" (hydraulic pressure high).
<b>*-</b>	Solenoid "ON" briefly (hydraulic pressure high), then Solenoid "OFF" (hydraulic pressure low). The pressure acts briefly on regulator valves to cushion clutch application.
<b>-*-</b>	EDS 4 Solenoid is used for Torque Converter Clutch apply and release only, and depends on throttle position and vehicle speed as to its application.

## EDS-5 SOLENOID OPERATION



*EDS 5 is used to prevent the ABSCH.-V-A, which is the switch valve for the A clutch, from stroking against its spring. Its use is mainly for forward engagement and a 5-4 downshift.*

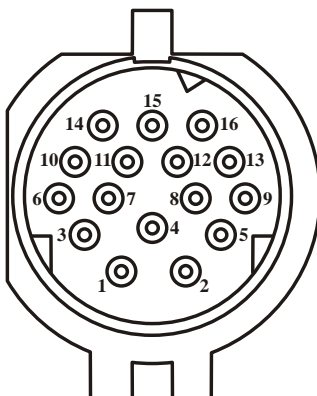
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Figure 8

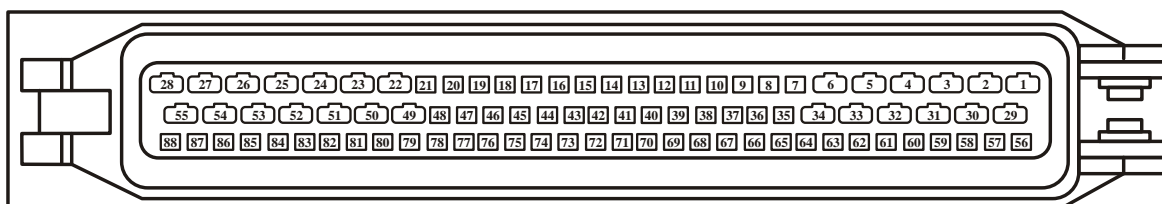
## SOLENOID AND SENSOR RESISTANCE CHART

<i>Solenoid</i>	<i>Case Connector Pin Numbers - +</i>	<i>Resistance In Ohms</i>
<b>MV 1</b>	<b>8 and 12</b>	<b>30 - 34 W</b>
<b>MV 2</b>	<b>9 and 12</b>	<b>30 - 34 W</b>
<b>MV 3</b>	<b>4 and 12</b>	<b>30 - 34 W</b>
<b>EDS 1</b>	<b>2 and 12</b>	<b>5.2 - 6.8 W</b>
<b>EDS 2</b>	<b>3 and 12</b>	<b>6.2 - 7.8 W</b>
<b>EDS 3</b>	<b>7 and 12</b>	<b>6.2 - 7.8 W</b>
<b>EDS 4</b>	<b>11 and 12</b>	<b>6.2 - 7.8 W</b>
<b>EDS 5</b>	<b>15 and 12</b>	<b>6.2 - 7.8 W</b>
<b>TOT</b>	<b>13 and 14</b>	<b>1000 W at 25° C</b>
<b>TSS</b>	<b>1 and 10</b>	<b>292 - 358 W</b>
<b>OSS</b>	<b>5 and 6</b>	<b>292 - 358 W</b>

*View Looking Into Case  
Connector Setting In The vehicle*



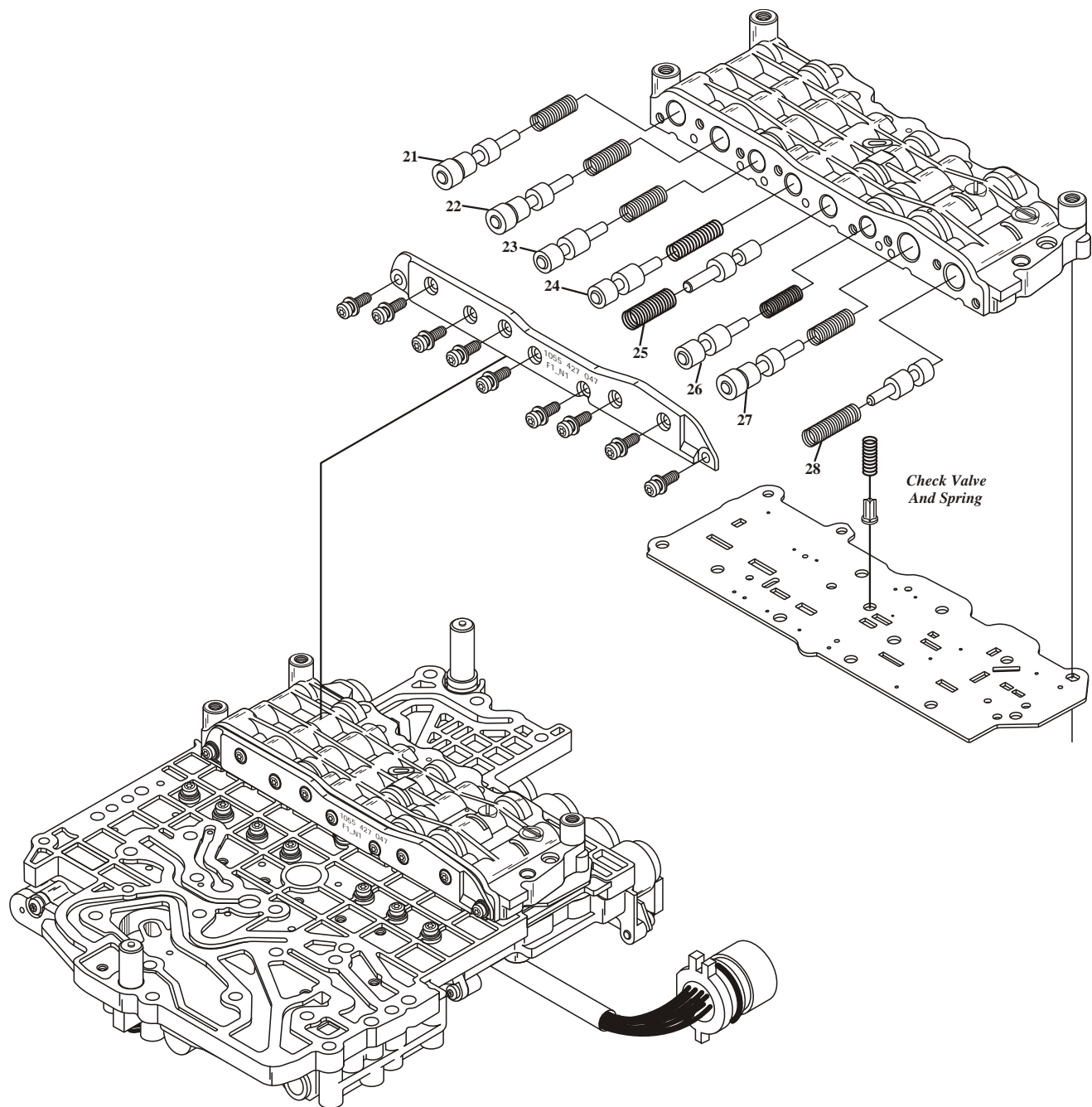
## *Electronic Control Unit Connector Pin Identification*



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Figure 9

## ZF-5HP-24 UPPER VALVE BODY

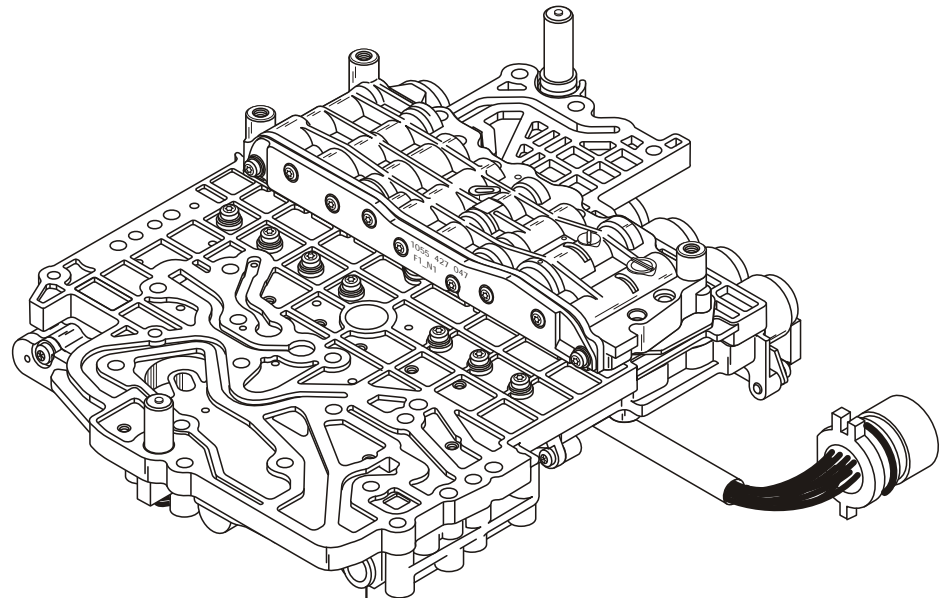


- 21. Clutch Valve "F" Line-Up (KV-F).
- 22. Clutch Valve "E" Line-Up KV-E).
- 23. Pressure Reducing Valve 1 (DR-V1).
- 24. Pressure Reducing Valve 2 (DR-V2).
- 25. Clutch Valve "B" Line-Up (KV-B).
- 26. Holding Valve "E" Line-Up (HV-E).
- 27. Switch Valve For "A" Clutch (ABSCH-V-A).

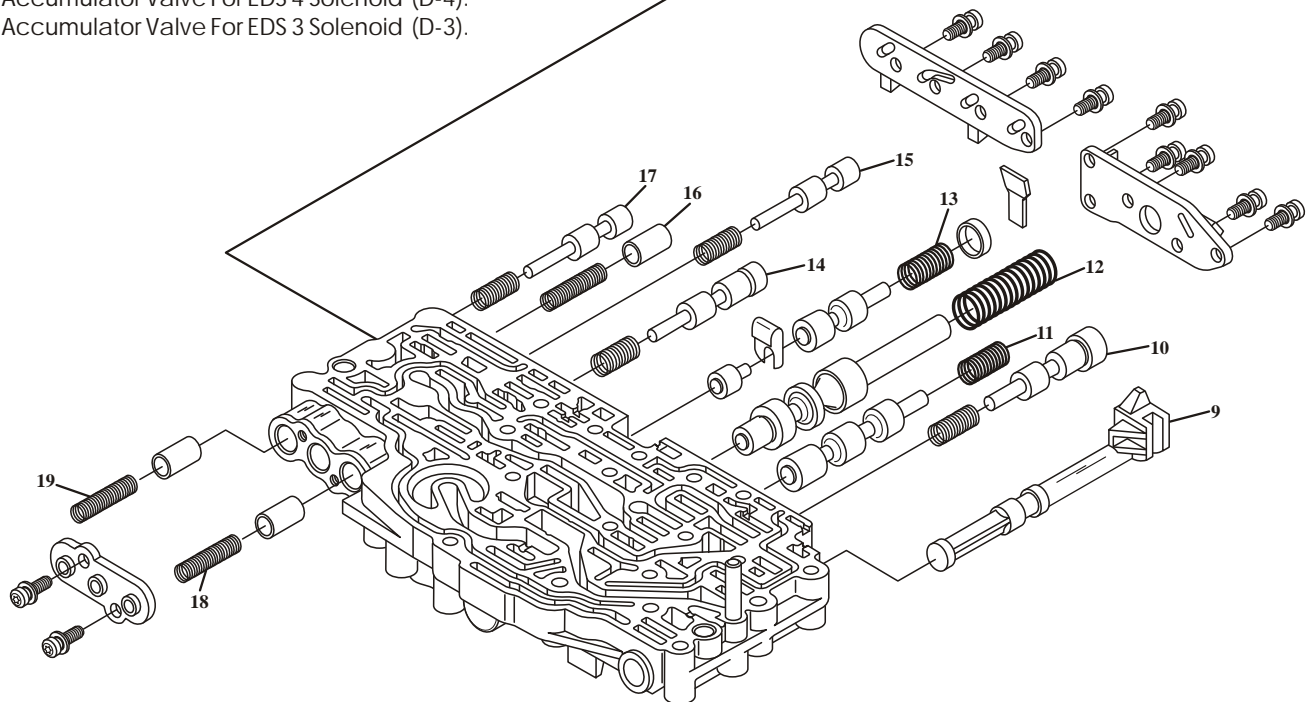
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Figure 10

## ZF-5HP-24 LOWER FRONT VALVE BODY



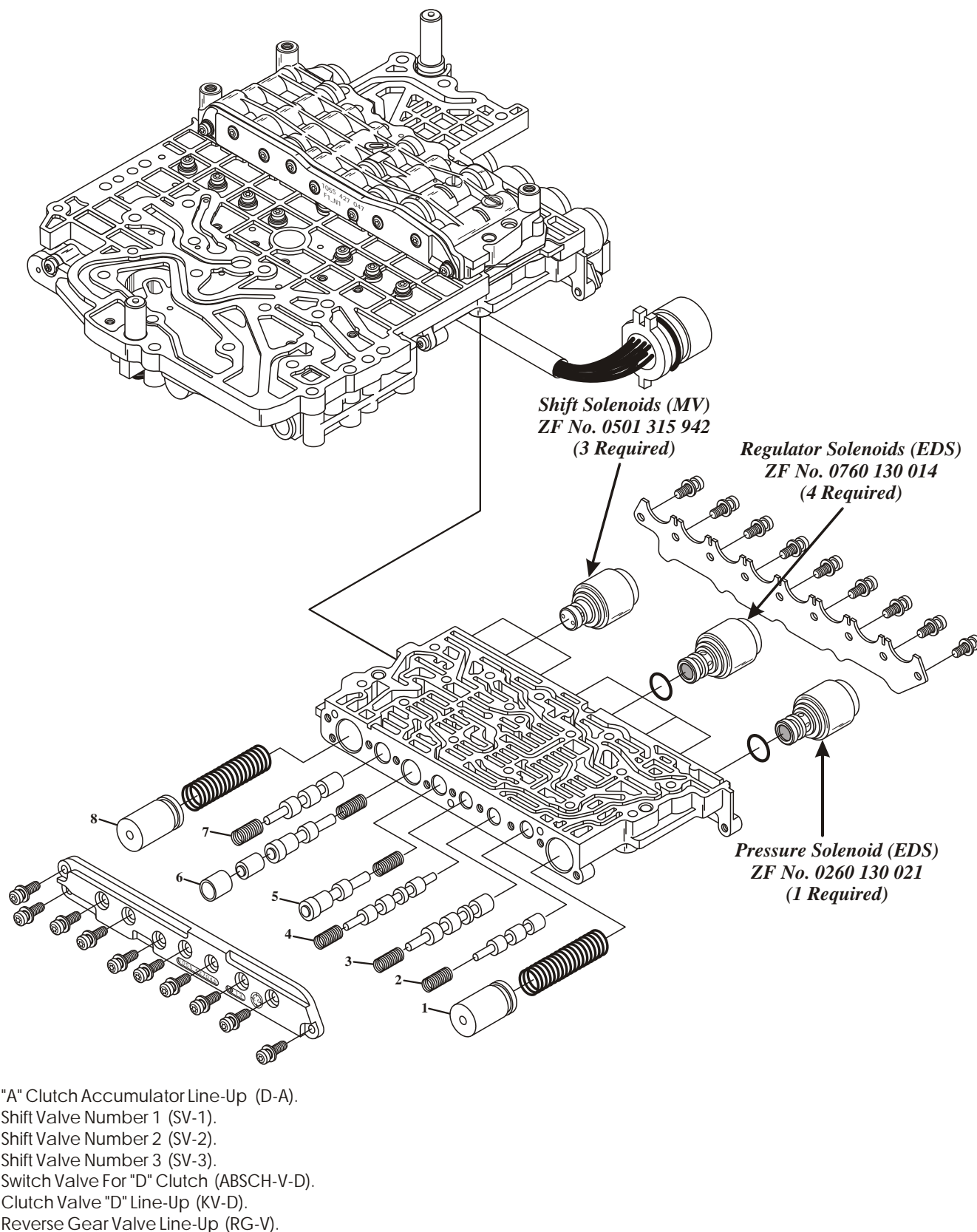
- 9. Manual Shift Valve (W-S).
- 10. Converter Clutch Apply Oil Control Valve (WK-V).
- 11. Converter Clutch Release Oil Control Valve (WD-V).
- 12. Main Pressure Regulator Valve Line-Up (HD-V).
- 13. Lubrication Valve (SCHM-V).
- 14. Modulating Valve Line-Up (MOD-V).
- 15. Holding Valve For "B" Clutch (HV-B).
- 16. Accumulator Valve For EDS 2 Solenoid (D-2).
- 17. Holding Valve For "D" Clutch (HV-D).
- 18. Accumulator Valve For EDS 4 Solenoid (D-4).
- 19. Accumulator Valve For EDS 3 Solenoid (D-3).



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Figure 11

## ZF-5HP-24 LOWER REAR VALVE BODY

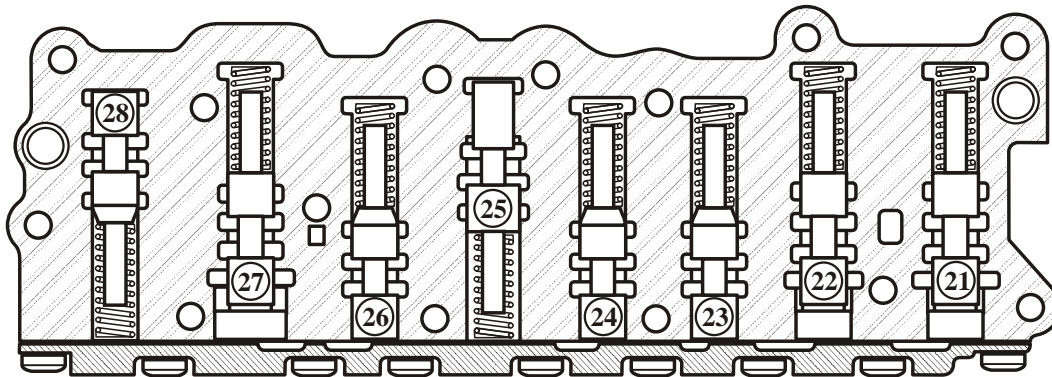


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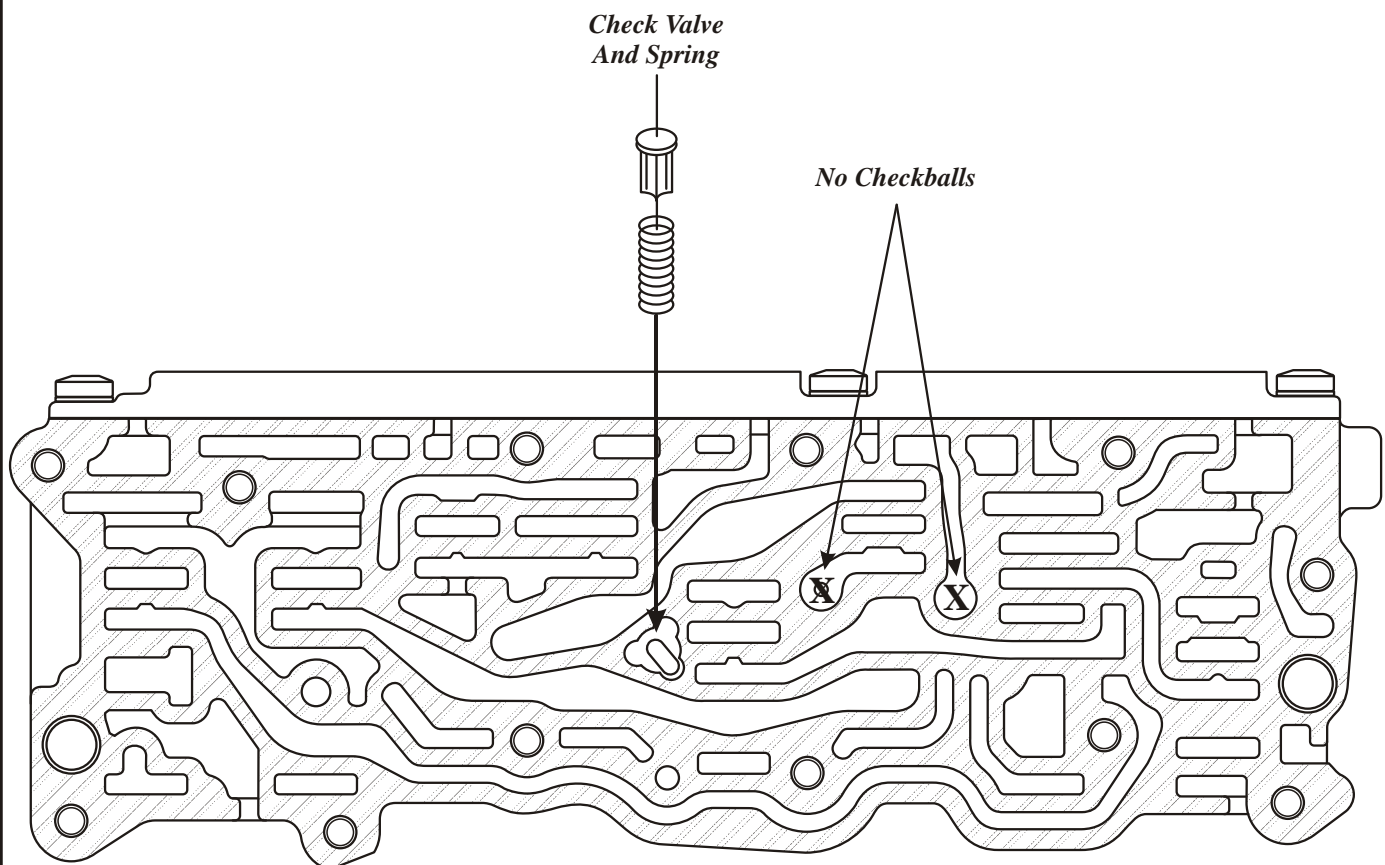
Figure 12



## ZF 5HP-24 UPPER VALVE BODY

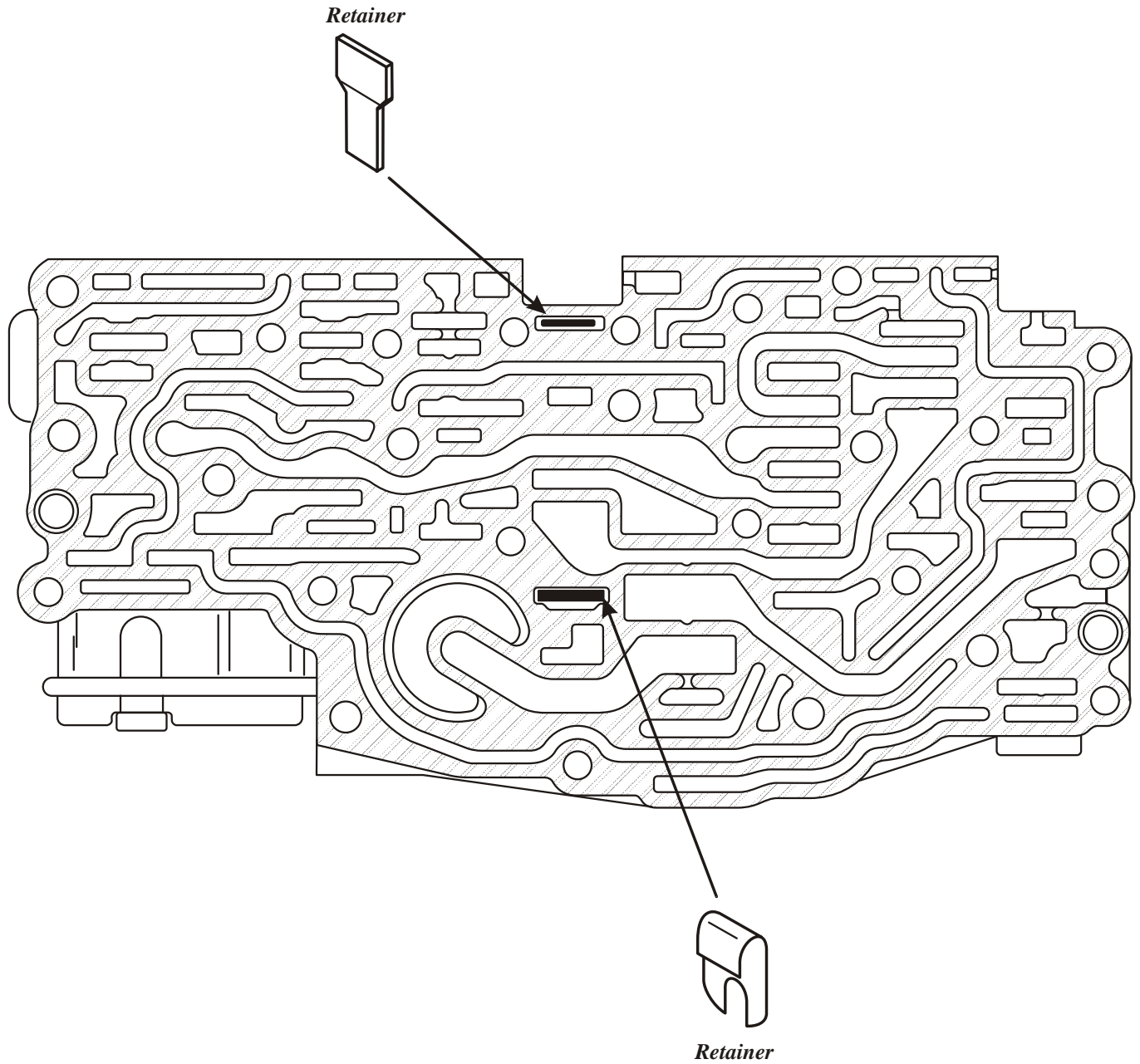


- 21. Clutch Valve "F" Line-Up (KV-F).
- 22. Clutch Valve "E2" Line-Up KV-E2).
- 23. MV Solenoid Regulator Valve (DR. Red.-V1).
- 24. EDS Solenoid Regulator Valve (DR. Red.-V2).
- 25. Clutch Valve "B" Line-Up (KV-B).
- 26. Clutch Valve "E1" Line-Up (KV-E1).
- 27. Switch Valve For "A" Clutch (ABSCH-V-A).



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Figure 13





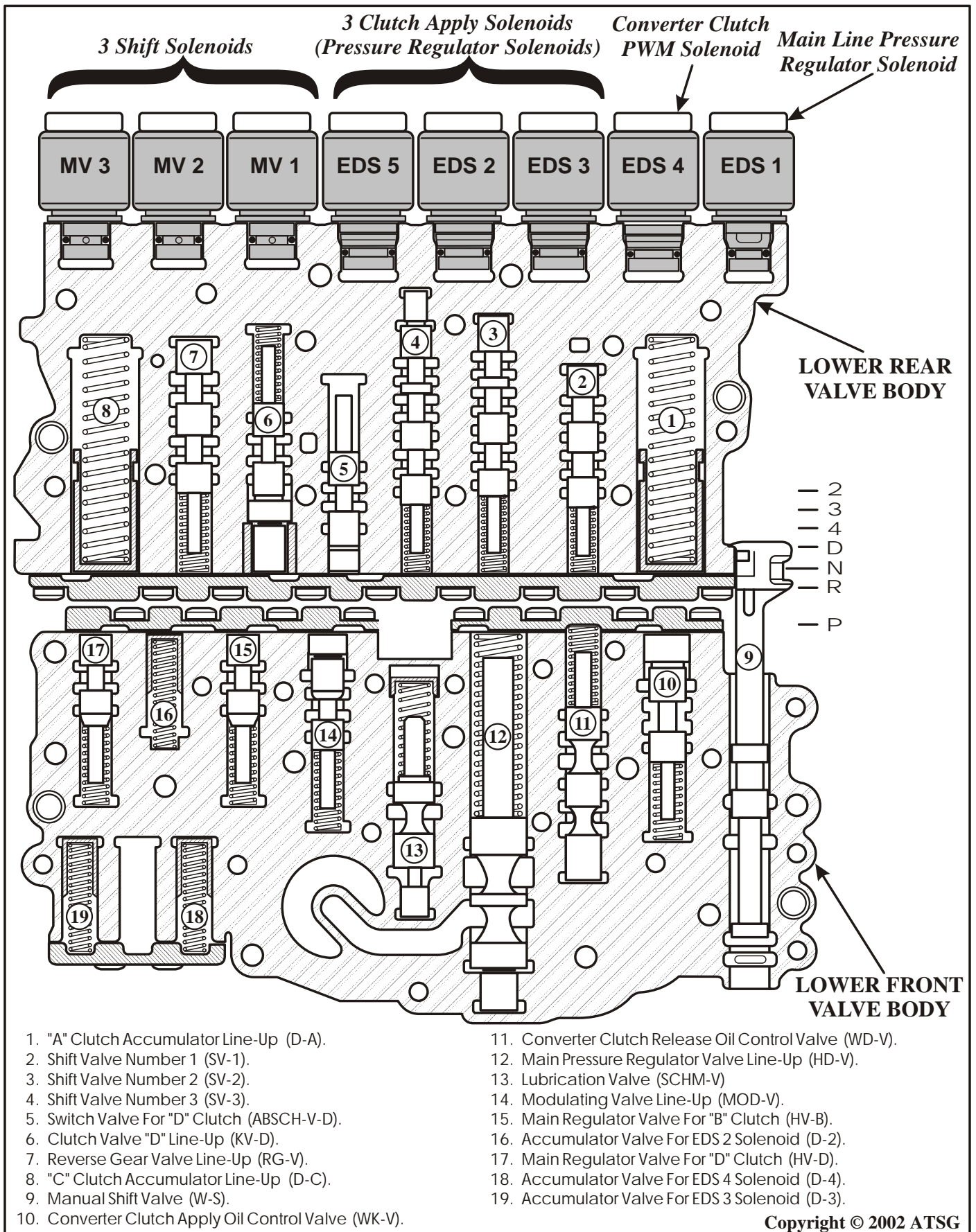
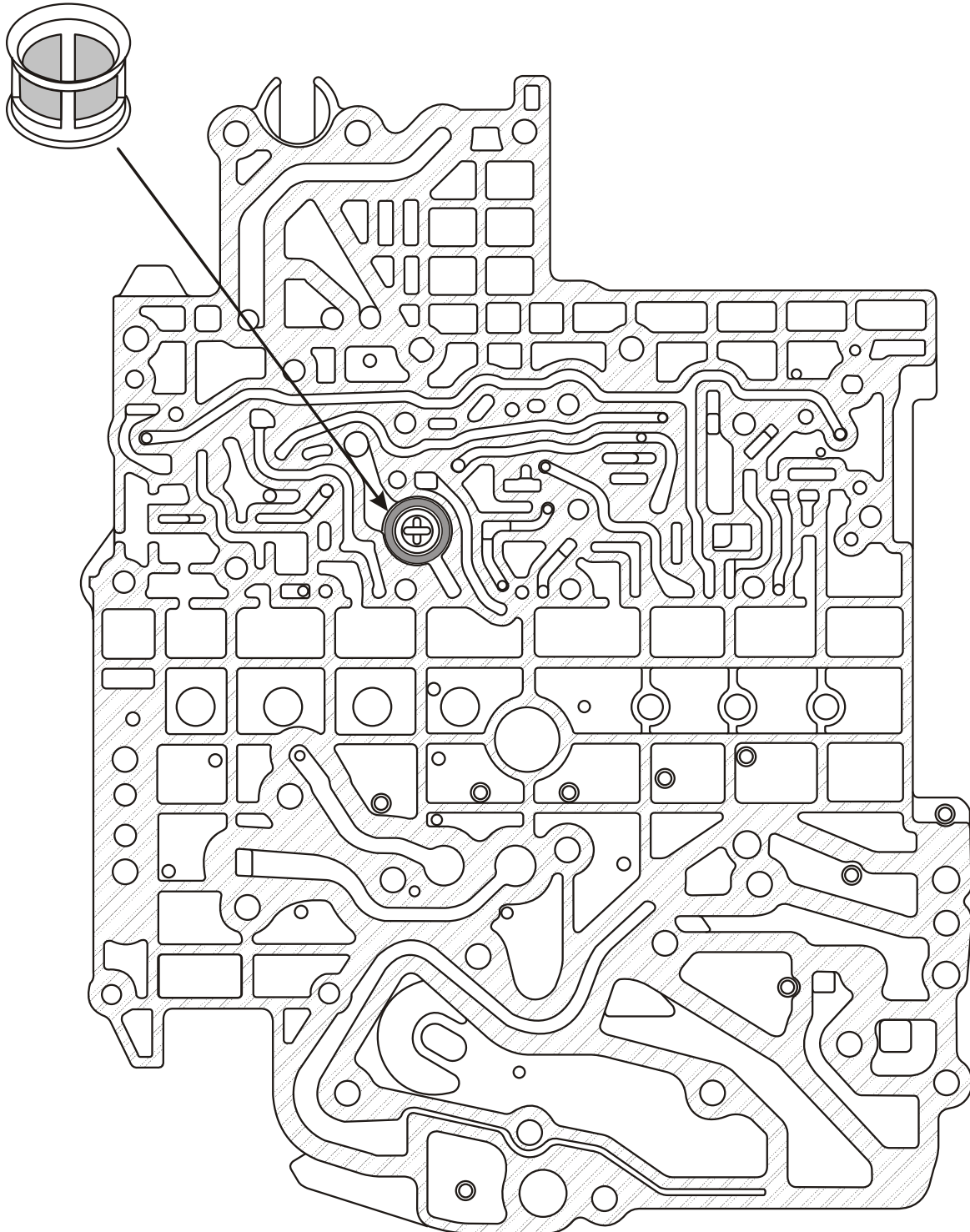


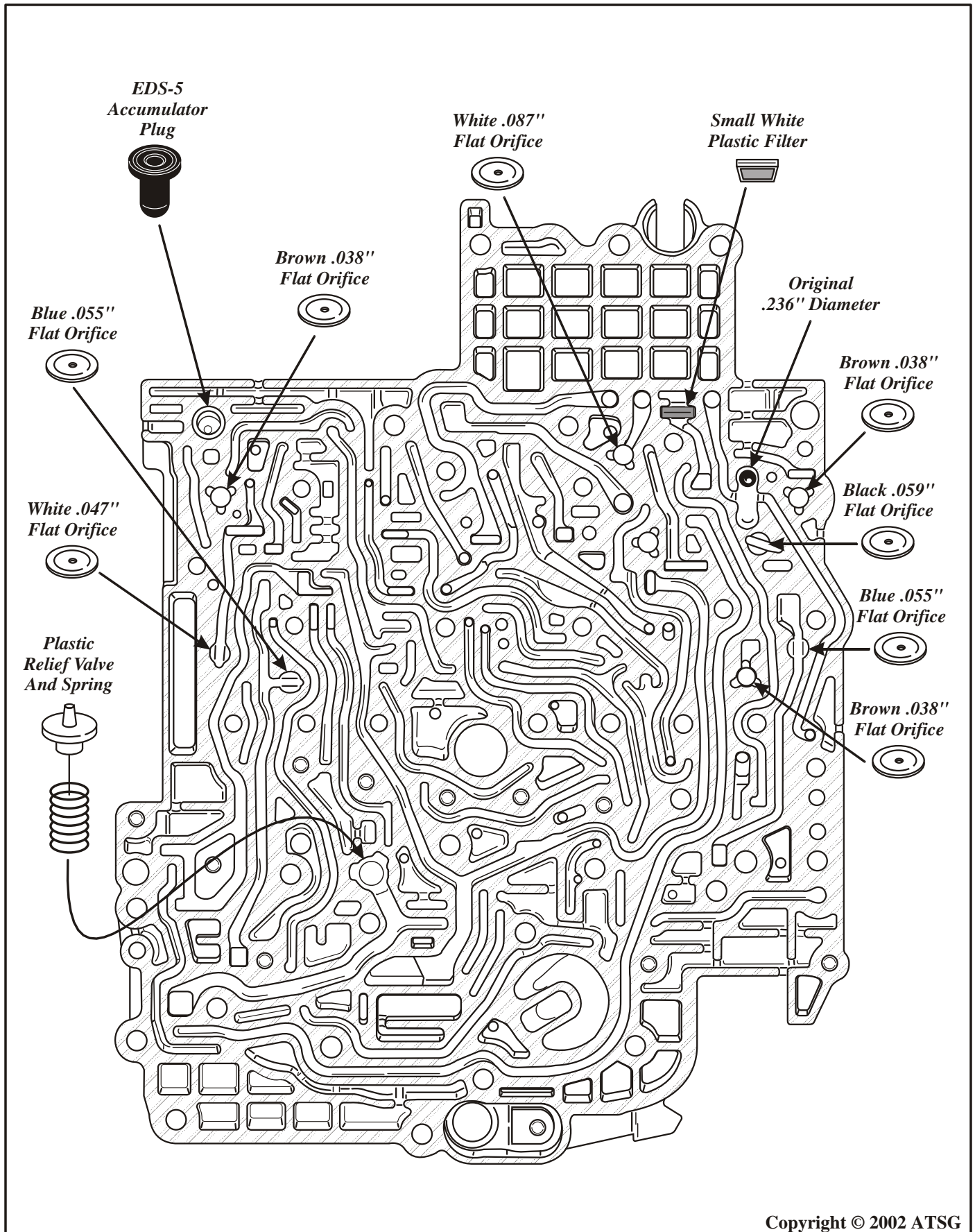
Figure 15

*Round Screen*



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Figure 16

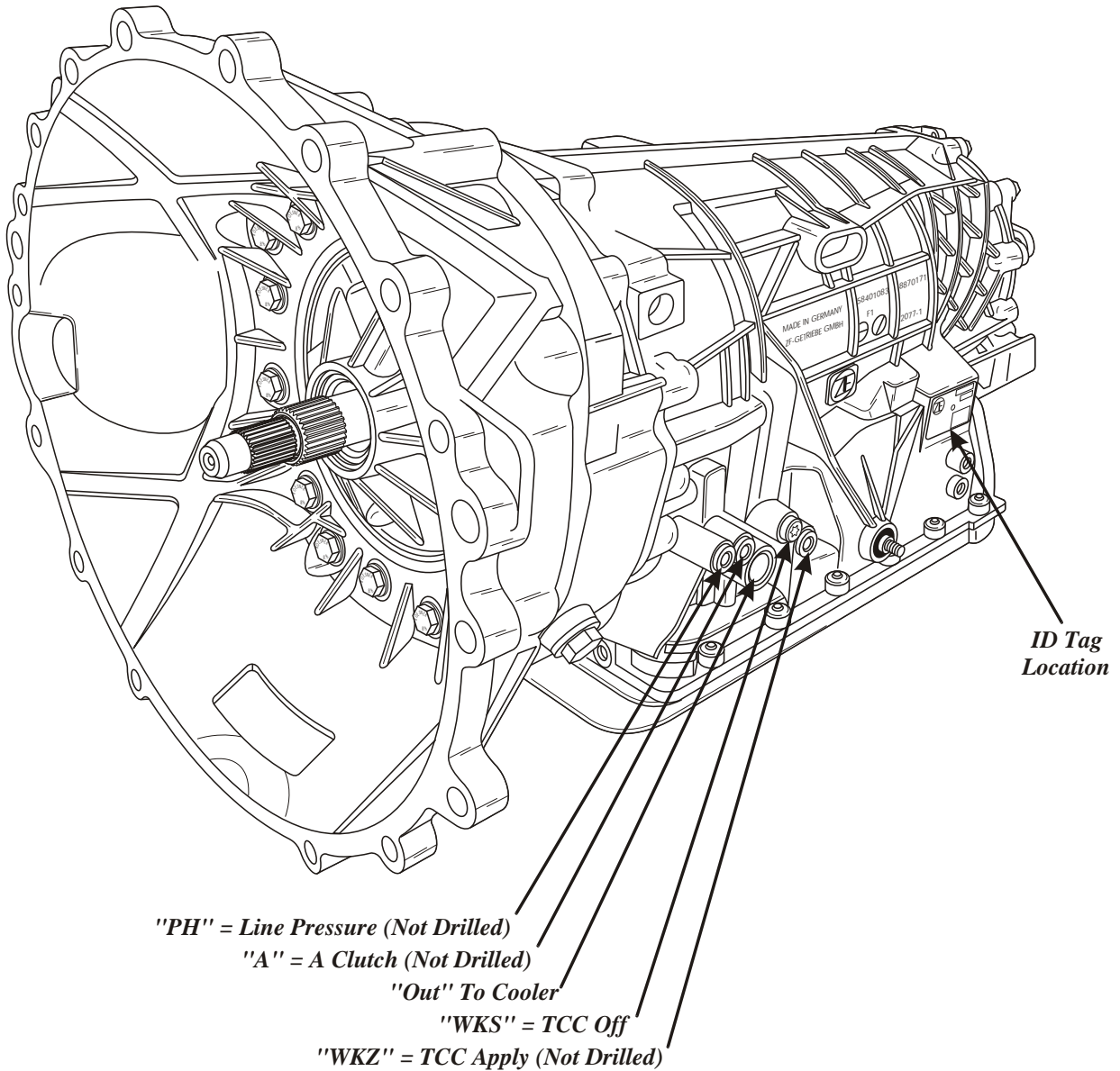


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Figure 17

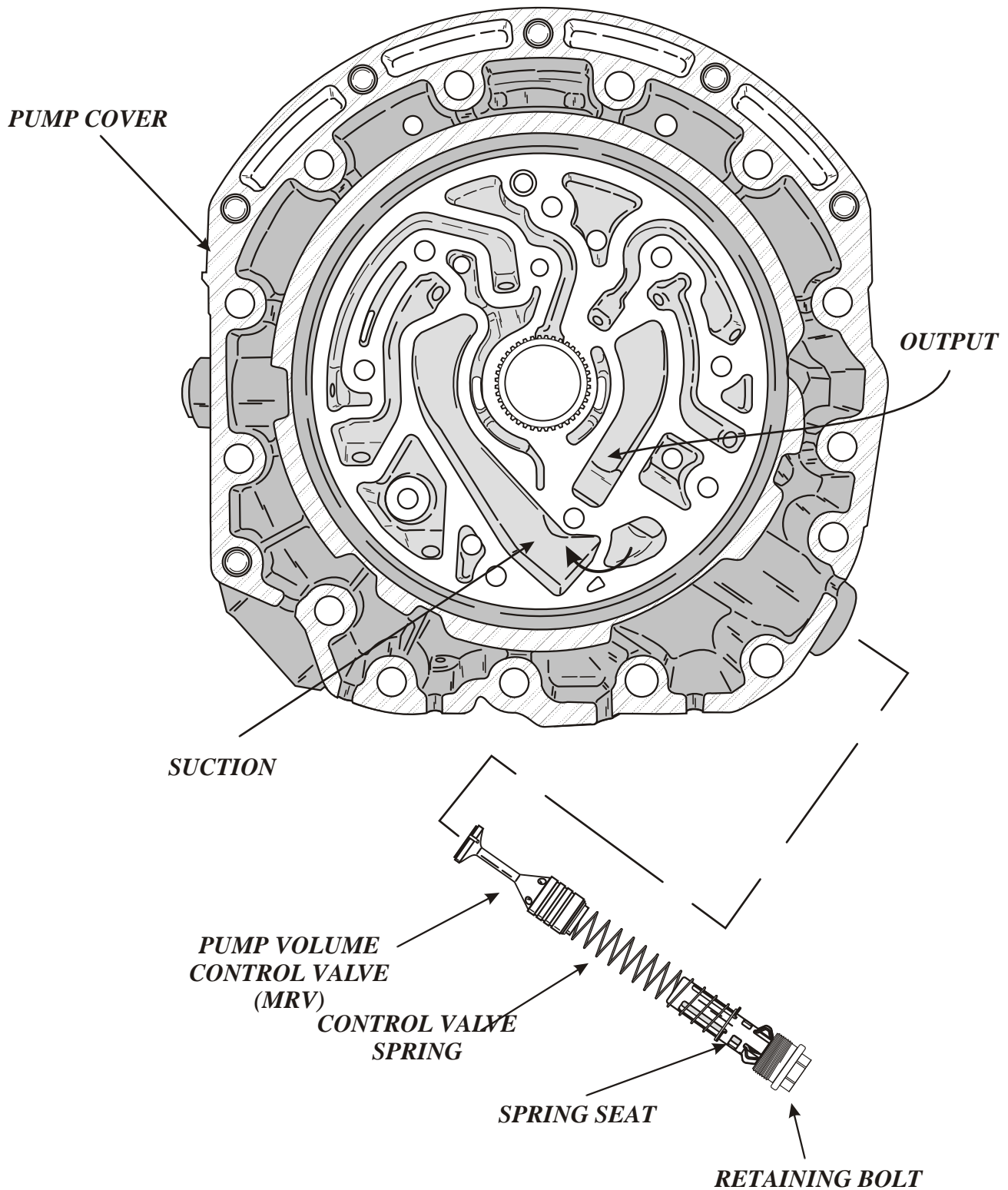
## PRESSURE TAP LOCATIONS AND IDENTIFICATION

*Jaguar Model Shown*





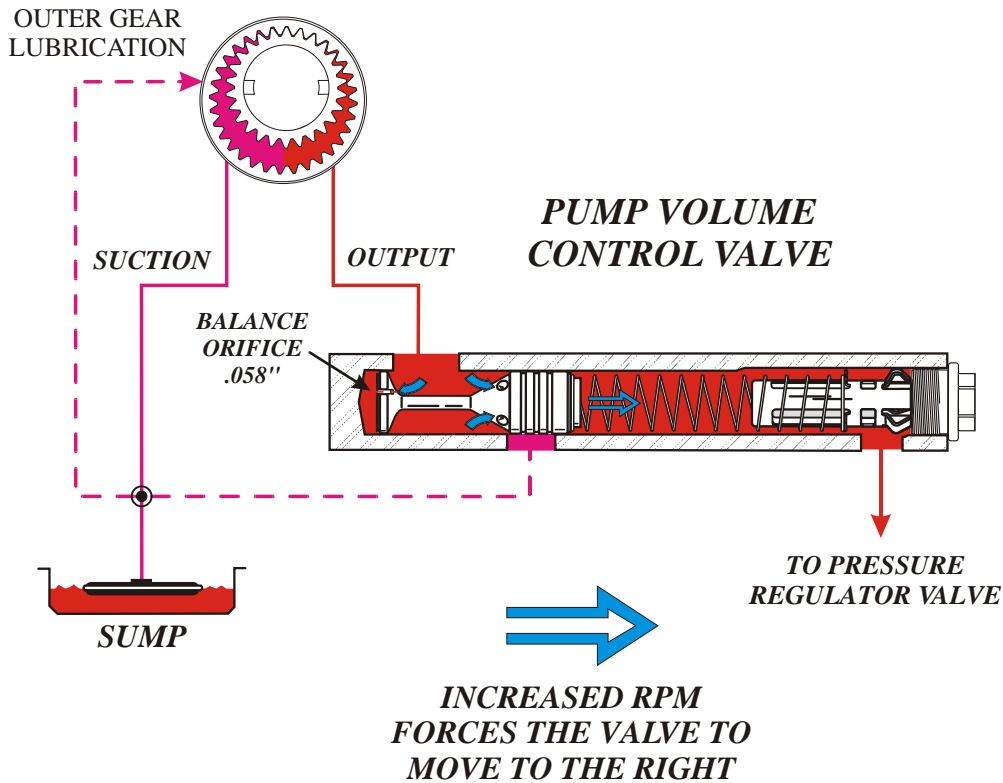
## PUMP VOLUME CONTROL VALVE LOCATION



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Figure 19

## PUMP VOLUME CONTROL VALVE OPERATION

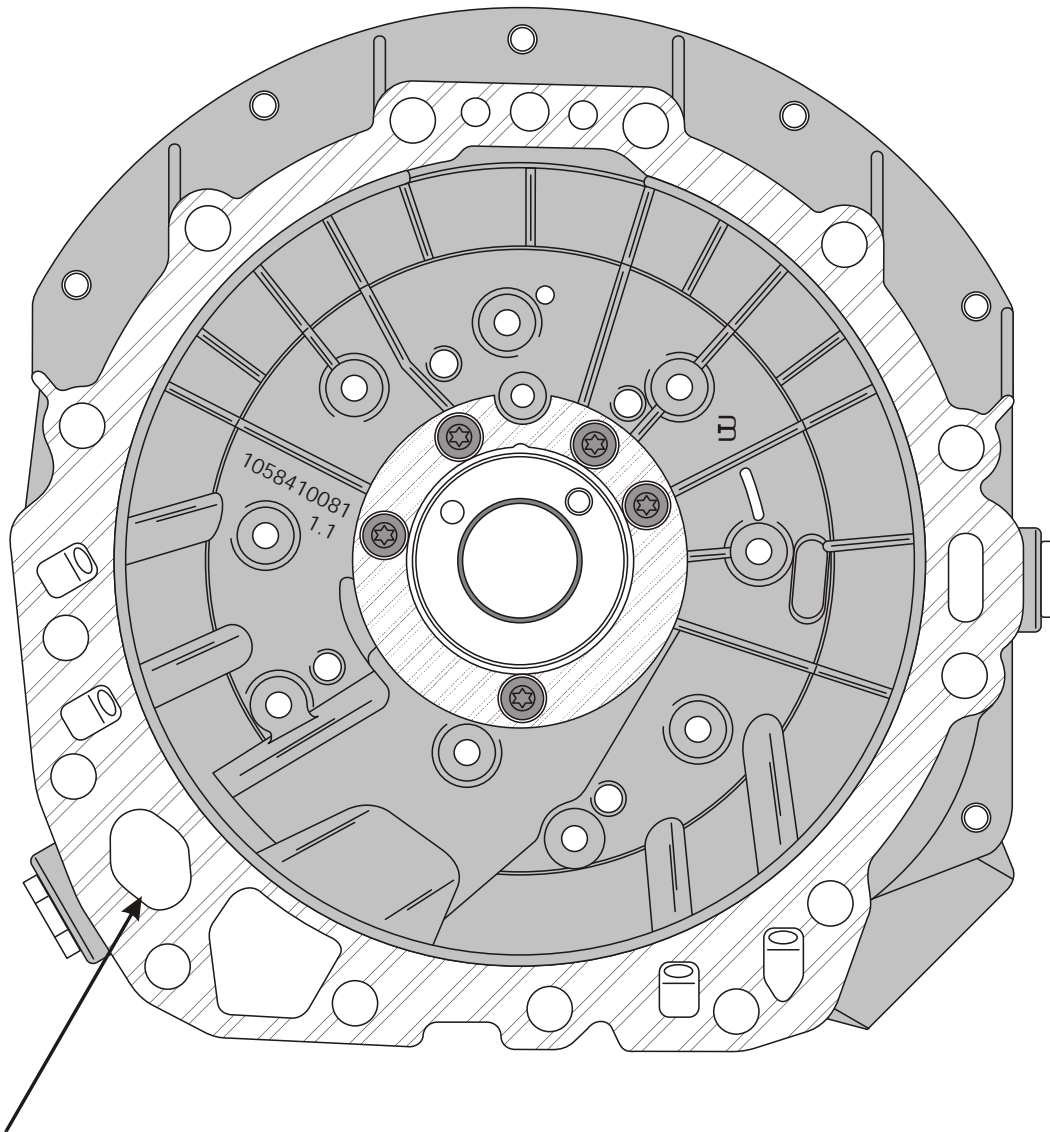


The Pump Volume Control Valve regulates the amount of oil volume to the Pressure Regulator Valve. As engine rpm. increases, pump output increases and forces the Pump Volume Control Valve to move to the right. This allows excess pump output to return to the sump, and a consistent amount of volume to be sent to the Pressure Regulator Valve.

The Pump Control Valve maintains 45 to 48 gallons per minute from 2000 to 6000 rpm.

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Figure 20

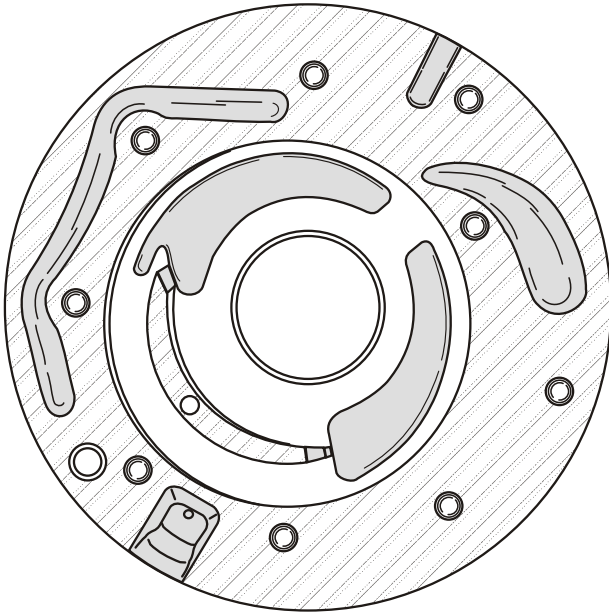


*Output to Pressure  
Regulator Valve*

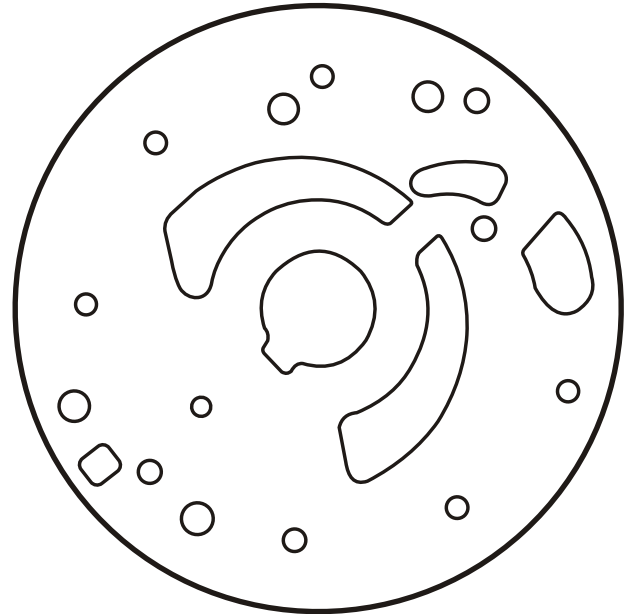
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Figure 21

## PUMP AND PUMP PLATE

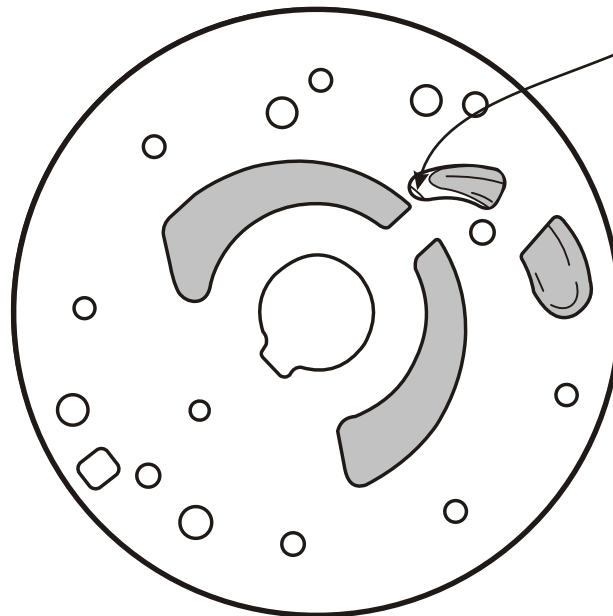


**PUMP BODY**



**PUMP PLATE**

*OUTER PUMP  
GEAR LUBRICATION*



**PUMP PLATE INSTALLED  
ON PUMP BODY**

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Figure 22