



BY APPOINTMENT TO
HER MAJESTY QUEEN ELIZABETH II
MANUFACTURERS OF DAIMLER AND JAGUAR CARS
JAGUAR CARS LIMITED COVENTRY



BY APPOINTMENT TO
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THE QUEEN MOTHER
MANUFACTURERS OF DAIMLER AND JAGUAR CARS
JAGUAR CARS LIMITED COVENTRY



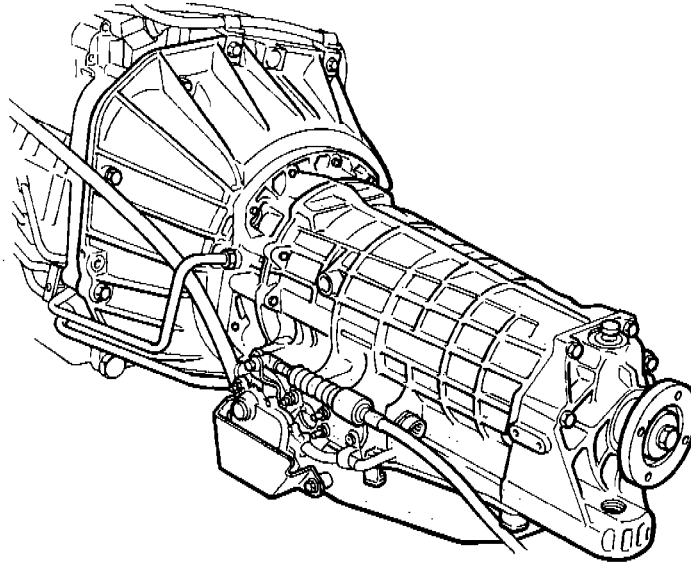
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HIS ROYAL HIGHNESS THE PRINCE OF WALES
MANUFACTURERS OF DAIMLER AND JAGUAR CARS
JAGUAR CARS LIMITED COVENTRY



JAGUAR



Automatic Transmissions Service Manual



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Part of set – JJM 10 04 12 / 50



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FOREWORD

This manual provides information relevant to the servicing of ZF Automatic Transmission Units 4 HP 22 and 4 HP 24 E (irrespective of the vehicle range to which the unit is fitted). The manual should be used in conjunction with the relevant Vehicle Service Manual (VSM) and Electrical Diagnostic Manual (EDM).

It assumes that the transmission has been removed from the vehicle, in accordance with the Vehicle Service Manual, and is in a clean condition and all service tools and materials are available.

The manual is divided into two sections covering the ZF 4 HP 22 and ZF 4 HP 24 E and each section is divided into sub-sections covering:

- Service Information
- General Description
- Hydraulic Circuit Diagrams
- Fault Diagnosis
- Service Repair Operations.

An index can be found at the rear of the manual.

Note: For information relating to in-vehicle operations, refer to the Vehicle Service Manual.



I. SERVICE TOOLS & EQUIPMENT

Illustration	Jaguar Number	Description	Notes
To be issued			

II. TORQUE TIGHTENING SPECIFICATIONS

Fixing	Tightening Torque (Nm)
To be issued	

III. SERVICE MATERIALS

Description	Uses	Notes
To be issued		

IV. SERVICE DATA

Item	Description	Data
Data for ZF 4 HP 22 Transmission		
Transmission fluid:	Capacity	8,0 Liters
Transmission fluid type:	Fill	Dexron IID or equivalent
	Top-up	Dexron IID or equivalent
Transmission weight: (including torque converter)		74,75 kg
Transmission Ratios:	1st	2,48:1
	2nd	1,48:1
	3rd	1,00:1
	4th	0,73:1
	Reverse	2,09:1
Torque Converter:	Stall speed	2100 RPM \pm 150 RPM
Transmission unit pressures:	Drive: Idle (stationary)	630 – 710 kPa
	Drive: Full Throttle (stall)	780 – 950 kPa
	Reverse: Idle (stationary)	1070 – 1150 kPa
	Reverse: Full Throttle (stall)	1620 – 1780 kPa



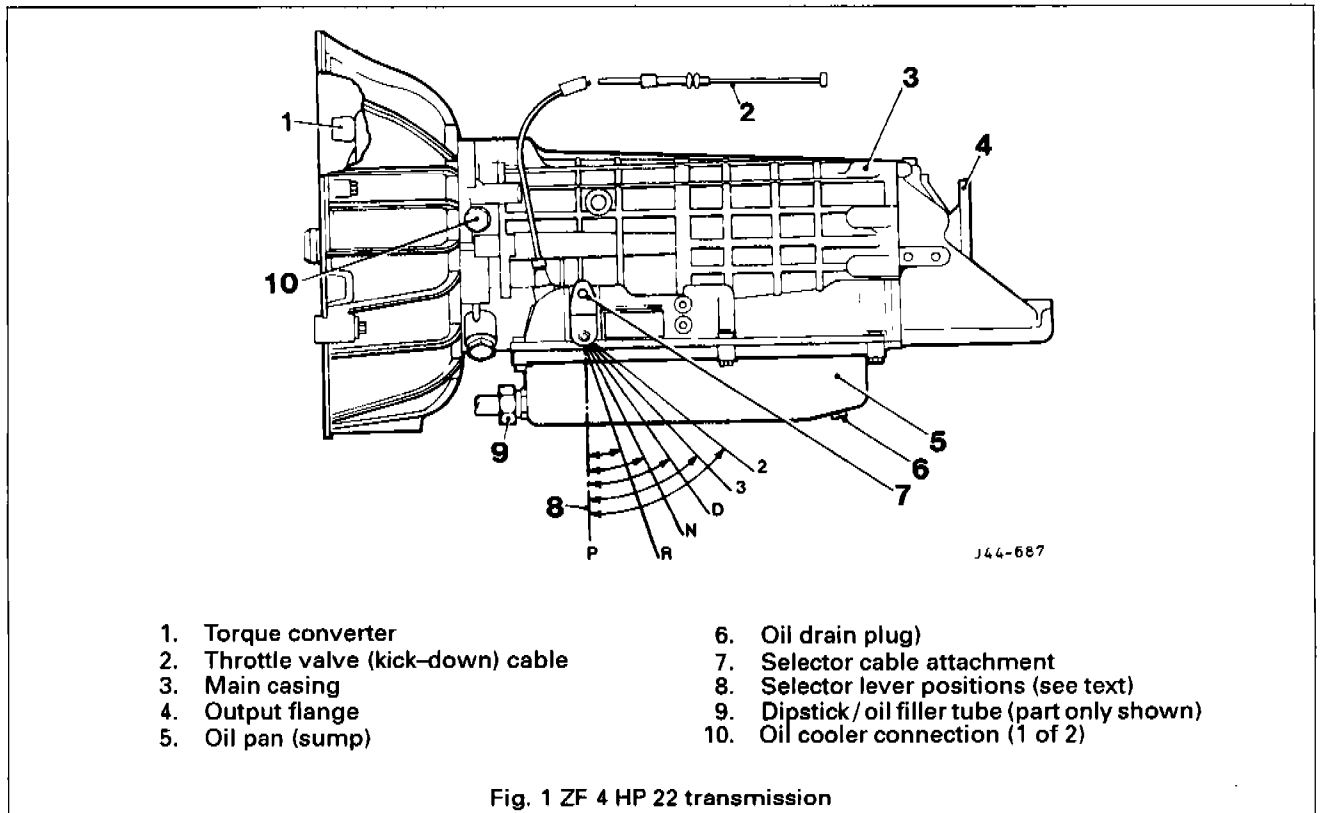
IV. Service Data (continued)

Item	Description	Data	
Data for ZF 4 HP 24 E Transmission			
Transmission fluid:	Capacity	9,5 Liters	
Transmission fluid type:	Fill	Dexron IID or equivalent	
	Top-up	Dexron IID or equivalent	
Transmission weight: (including torque converter)		79,65 kg	
Transmission Ratios:	1st	2,48:1	
	2nd	1,48:1	
	3rd	1,00:1	
	4th	0,73:1	
	Reverse	2,09:1	
	Final drive	3,58:1	
Torque converter:	Nominal size (diameter)	280mm	
	Torque	322 Nm @ 2000 RPM	
	Stall speed	UK Specification	2000 RPM (+ 150 RPM)
		Federal Specification	1900 RPM (+ 150 RPM)
Ratio		2,12:1 @ Stall	
Gear train end-float		0,2mm to 0,4mm	
Electrical data			
Solenoid valves;	MV1, MV2 and MV3	28 – 60 ohms (33,5 ohms @ 20C)	
	Pressure regulator solenoid valve	5 – 7 ohms	
	Output shaft sensor	300 ohms (± 10%)	
	Sensor air gap	0,5mm to 1,0mm	



1.1 ZF 4 HP 22 TRANSMISSION, GENERAL DESCRIPTION

The ZF Automatic Transmission covered in this section comprises a hydrodynamic torque converter, four speed gear train and a hydraulic transmission control unit.



The transmission provides six gearshift positions:

- Position 'P': Park – in this position the driven wheels are mechanically locked at the transmission.
- Position 'R': Reverse – reverse gear selected.
- Position 'N': Neutral – engine disconnected from drive-line and wheels.
- Position 'D': Drive – all four gears are selected automatically with lock-up available in top gear only.
- Position '3': automatic selection of the lowest three gears only.
- Position '2': automatic selection of the lowest two gears only, transmission is prevented from shifting up to the third and top gears.

Immediate selection of a lower ratio is also available by 'kick-down' (pressing the accelerator down beyond the normal full throttle position) for example when overtaking.

1.1.1 Torque Converter

The torque converter serves two main functions: it acts as a fluid coupling between engine and transmission gear train and it provides multiplication of engine torque when required.

The torque converter consists of an impeller, a turbine and a stator which is mounted on a one-way clutch. The converter cover is fixed to the impeller to seal the three elements within a common housing through which oil flows when the transmission is in operation. The impeller is therefore connected to the engine and rotates at engine speed when the engine is operating.

Torque multiplication is at its greatest when the vehicle is driven away from standstill. The stator bears against the housing through its one-way clutch and deflects the oil so that the flow is accelerated. As road speed builds up, the impeller and turbine wheels turn at almost the same speed, so that the stator ceases to accelerate the oil flow and instead is disengaged from the housing and turns freely in the flow of oil. At this stage, the torque converter acts as a fluid coupling.



The torque converter acts in all four forward gears and in reverse. The converter lock-up clutch closes in 4th gear at a point depending on road speed and accelerator position; engine power is then transmitted by purely mechanical means.

A low-loss oil pump in the front of the transmission housing supplies the converter, the epicyclic gear train, the hydraulic control system and the lubrication circuit; oil is drawn from a sump in the bottom of the gear train housing through a filter. The pump drive gear is keyed to the converter impeller hub and therefore turns when the engine is running, thereby pressurizing the oil.

1.1.2 Four-speed Epicyclic Gear Train

The torque converter drives a mechanical epicyclic gear train providing four forward ratios and reverse. Individual ratios are obtained by coupling together the various parts of the gear train by means of hydraulically actuated multi-disc clutches and brakes; built in freewheels permit gear shifts without any interruption of the power flow. Operation of the clutches and gear sets is described in sub-section 1.1.3.

Each epicyclic (or planetary) gear set comprises a central sun gear, an annulus and a planetary carrier which supports three or four small planet gears or pinions. Two gear sets are used in this transmission. A compound gear set comprising front annulus and planet carrier, rear annulus and planet carrier and a common sun gear transmits the drive in all gears except REVERSE; a single planetary carrier, annulus and sun gear transmits the fourth gear drive. The table below shows the resulting clutch operation in the selected gear ratios.

Selected ratios	Resulting clutch operation
D ₁ , 3 ₁ , 2 ₁	A Clutch drives annulus clockwise E Clutch & OWC drives output shaft clockwise D Clutch & OWC holds front carrier against annulus clockwise
D ₂ , 3 ₂ , 2 ₂	A Clutch drives annulus clockwise C1 Clutch holds sun gear against anti-clockwise C Clutch & OWC holds sun gear against anti-clockwise E Clutch & OWC holds front carrier against annulus clockwise
D ₃ , 3 ₃ , 2 ₃	A Clutch drives annulus clockwise B Clutch drives sun gear clockwise C Clutch & OWC holds sun gear against anti-clockwise E Clutch & OWC holds front carrier against annulus clockwise
D ₄	A Clutch drives annulus clockwise B Clutch drives sun gear clockwise C Clutch & OWC holds sun gear against anti-clockwise F Clutch holds sun gear (4th gear set)
R	B Clutch drives sun gear clockwise D Clutch holds carrier against clockwise E Clutch & OWC drives output shaft anti-clockwise
Park, Neutral	E Clutch & OWC applied (hydraulics)

OWC = one way clutch



1.1.3 Operation Of Gear Train Clutches

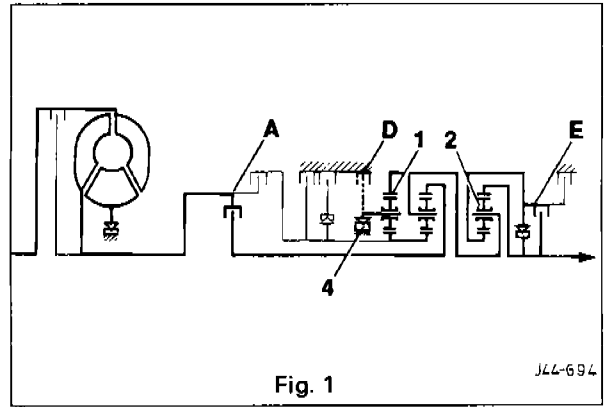
1st Gear

Clutches 'A' and 'E' are engaged.

The front planet gear carrier of gear set '1' is locked against the housing through freewheel '4' when the engine is pulling, but is over-run when the engine is coasting.

Epicyclic gear set '2' rotates as a solid block with the second planet set.

There is no engine braking in first gear.

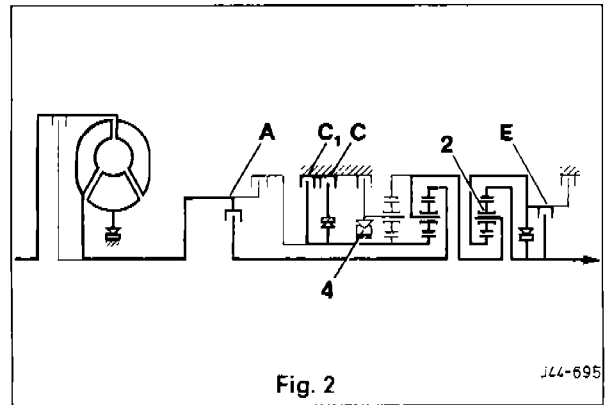


2nd Gear

Clutches 'A', 'C1', 'C' and 'E' are engaged.

Freewheel '4' over-runs.

Clutches 'C1' and 'C' lock the sun gear to the housing.

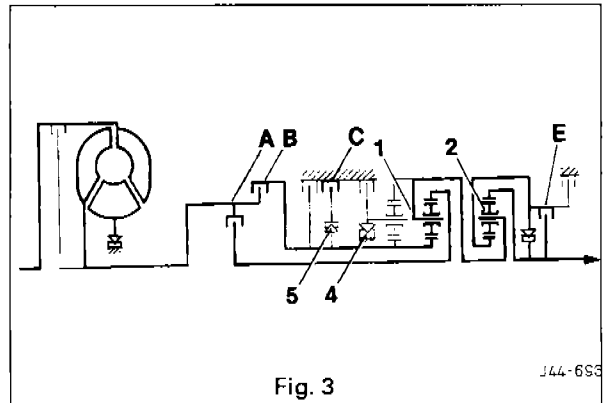


3rd Gear

Clutches 'A', 'B', 'C' and 'E' are engaged.

Freewheels '4' and '5' are over-run.

Epicyclic gear sets '1' and '2' rotate as a solid block at a ratio of 1:1.



4th Gear

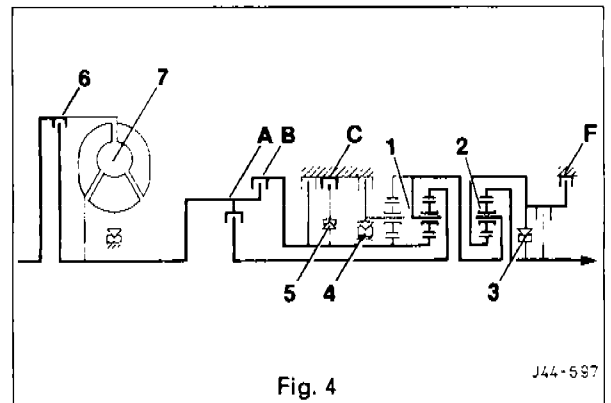
Clutches 'A', 'B', 'C' and 'F' are engaged.

Freewheels '3', '4' and '5' are over-run.

Epicyclic gear set '1' rotates as a solid block.

The sunwheel of epicyclic gear set '2' is locked via clutch F to the housing.

Above a predetermined road speed, lock-up clutch '6' locks torque converter '7' solid to prevent slip.



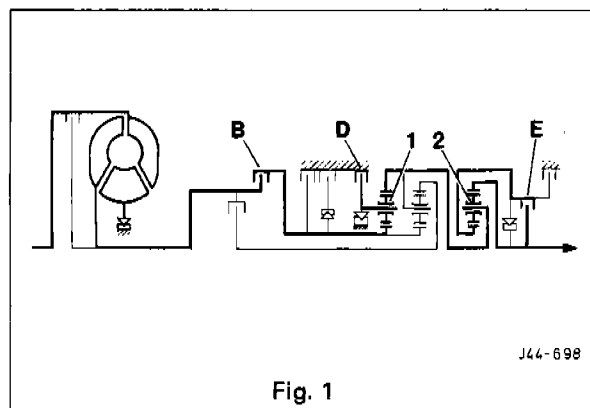


Reverse Gear

Clutches 'B', 'D' and 'E' are engaged.

As the front planet gear carrier of epicyclic gear set '1' is locked, the direction of output shaft rotation is reversed.

Epicyclic gear set '2' also rotates as a solid block.



1.1.4 Transmission Output Shaft Extension Housing

This housing contains the output shaft and speed governor and the parking lock mechanism. The governor comprises two spring loaded valves, a spindle and a weight; the governor is influenced by centrifugal and hydraulic forces and supplies a varying hydraulic pressure.

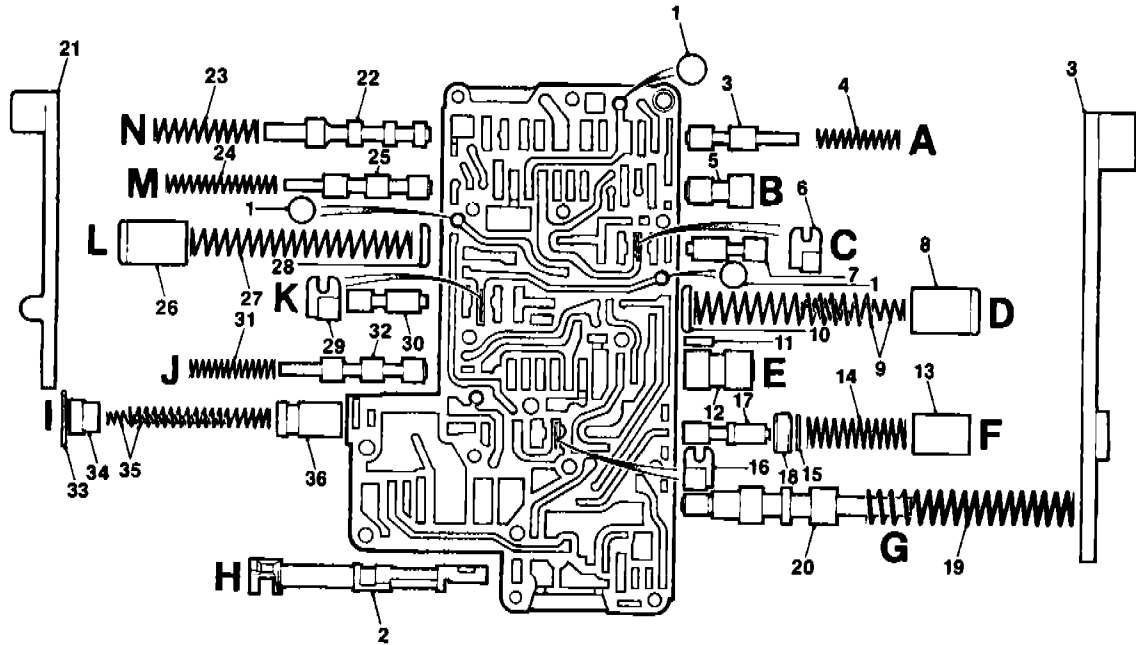
The parking lock pawl operates on a toothed wheel attached to the output shaft speed governor; the mechanism is operated from the selector (position 'P') by an actuator rod.

1.1.5 Transmission Control Unit

The hydraulic control unit, comprising a series of valve blocks housing the manual (selector) valve, control pistons and pressure valves, is attached to the underside of the transmission housing; the unit controls the operation of the gear train clutches and directs oil pressure to the appropriate system components (refer to illustrations, pages 5 to 7) to operate the transmission. The valve blocks are connected to a main gallery plate.

The function of each of the valves in the control unit and the governor valve is summarised in the table below.

Valve	Summary of function
Manual (selector) valve	Line pressure to valves appropriate to selected range
Pressure regulating valve	Varies line pressure as required
1-2 shift valve	Line pressure to C & C1 clutch valves and dampers (2nd)
2-3 shift valve	Line pressure to C1 clutch (2nd); line pressure to B clutch (3rd)
2nd gear inhibit	Line pressure to 2-3 shift valve, prevents shift into 3rd
3-4 shift valve	Line pressure to E clutch (3rd); line pressure to F clutch (4th)
Throttle valve	Throttle pressure to modulator and shift valves
Modulator	Modulated throttle pressure fed to clutch dampers and valves
Combined converter & Lockup	Line pressure to lock-up clutch; lubrication oil to cooler
Reverse inhibit	Blocks line pressure to B & D clutches when vehicle is in forward motion
F Clutch inhibit	Governor pressure to 3-4 shift valve inhibited in reverse
Converter clutch hysteresis	Controls lock-up on/ off speeds
Converter clutch lock-up valve	Line pressure to converter pressure valve (D4 selected)
Converter clutch damper valve	Aids quality of converter clutch application
Clutch valves & Dampers	Aids quality of clutch application relevant to modulator & line pressures
Governor	Varies pressure in accordance with road speed

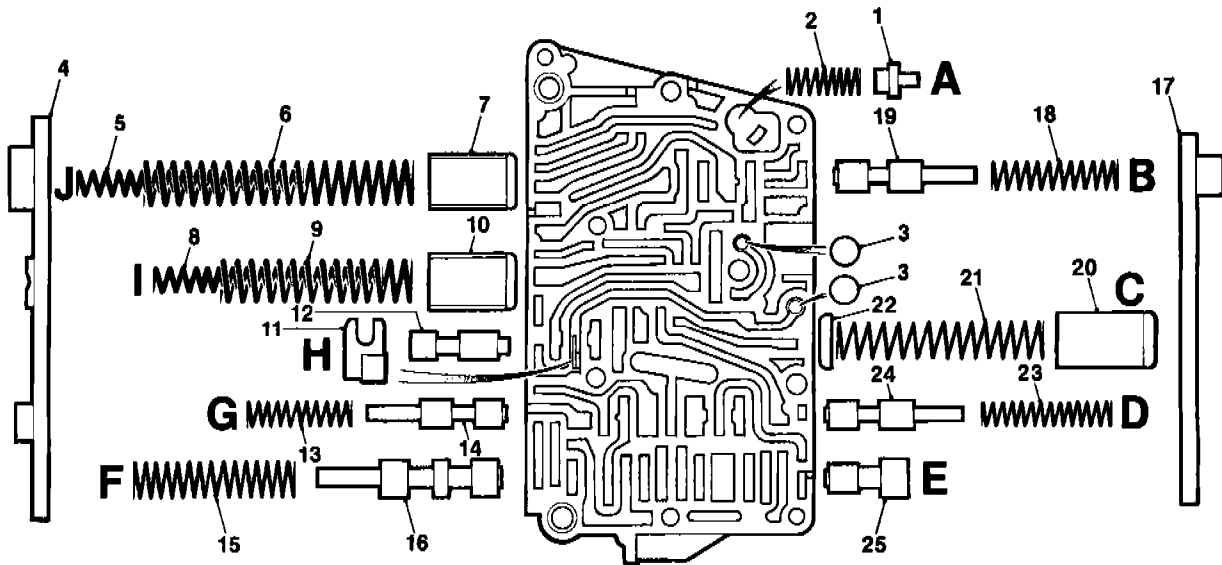


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- | | |
|------------------------------|-----------------------------|
| A. C1 Clutch valve | H. Manual (selector) valve |
| B. 2-3 shift valve piston | I. A clutch damper |
| C. C clutch damper valve | J. 1-2 shift valve |
| D. B clutch damper | K. B clutch damper valve |
| E. 1-2 shift valve piston | L. C clutch damper |
| F. D clutch valve and piston | M. 2-3 shift valve |
| G. Pressure regulating valve | N. Converter pressure valve |

Note: Numerical annotations are not used in this application.

Fig. 1 Manual Valve Block

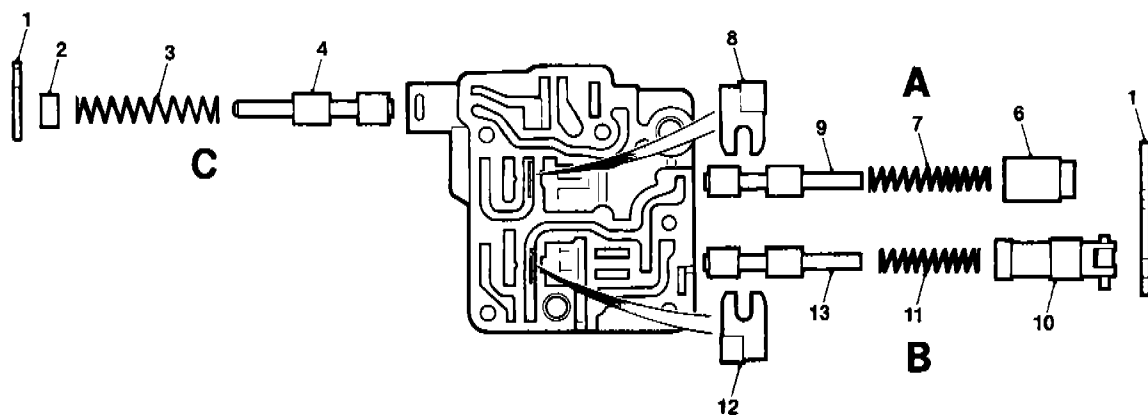


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- | | |
|-------------------------------------|---------------------------|
| A. One way valve (lubrication) | F. 3-4 shift valve |
| B. 2nd gear inhibit valve | G. 1st gear inhibit valve |
| C. F clutch damper | H. F clutch valve |
| D. F clutch inhibit valve (reverse) | I. E clutch damper |
| E. 3-4 shift valve piston | J. C1 clutch damper |

Note: Numerical annotations are not used in this application.

Fig. 1 Rear Valve Block



- A. Modulator valve
- B. Throttle / Kick-down valve
- C. Reverse inhibit valve

Note: Numerical annotations are not used in this application.

J44-701

Fig. 1 Throttle Valve Block



1.1.6 Gearshift Selection

Gearshift selection is by movement of the shift lever which through a selector cable causes repositioning of the manual (selector) valve to direct oil pressure to the required shift valve. The automatic shift points are determined by accelerator position and road speed: throttle movement moves a cam on the throttle valve, directing oil pressure to the shift valves and modulator valve, road speed modulates hydraulic pressure through a centrifugal governor driven by the transmission output shaft. Operation of the hydraulic control system is shown diagrammatically in the circuit diagrams on the following pages.

1.1.7 Throttle Valve Mechanism (kick-down)

The throttle valve or 'kick-down' mechanism comprises a cable connected between the throttle body quadrant on the engine and the throttle valve cam valve shaft; the cam operates the throttle valve housed within the throttle valve block. The travel of the valve is proportional to throttle positions and alters shift speeds and pressures during gearshifts to take account of throttle position.

The mechanism also provides for immediate selection of a lower ratio (eg when overtaking) by depressing the accelerator beyond the normal full-throttle position. 'Kick-down' is operated by movement of the throttle cable into the 'kick-down' position causing full movement of the throttle valve and directing oil flow to the shift valves.

1.1.8 Starter Inhibit Switch

The starter inhibit switch prevents the starter motor from being operated when the shift lever is not in position 'P' – Park or position 'N' – Neutral. The switch is located in the gear selector housing.

1.1.9 Gearshift Interlock

A brake pedal / shift lever interlock is incorporated in the gear selector mechanism. The shift lever may only be moved from the 'P' – Park position if the ignition key switch is in position 'II', and the foot brake pedal is applied. The ignition key cannot be removed from the ignition switch unless the shift lever is in the 'P' – Park position. Once the ignition key has been removed, the shift lever is locked in the park position.

The gearshift interlock is operated by an electrical solenoid located adjacent to the selector; an override latch is incorporated into the mechanism to enable the gearshift interlock to be manually overridden in the event of electrical failure or when towing.



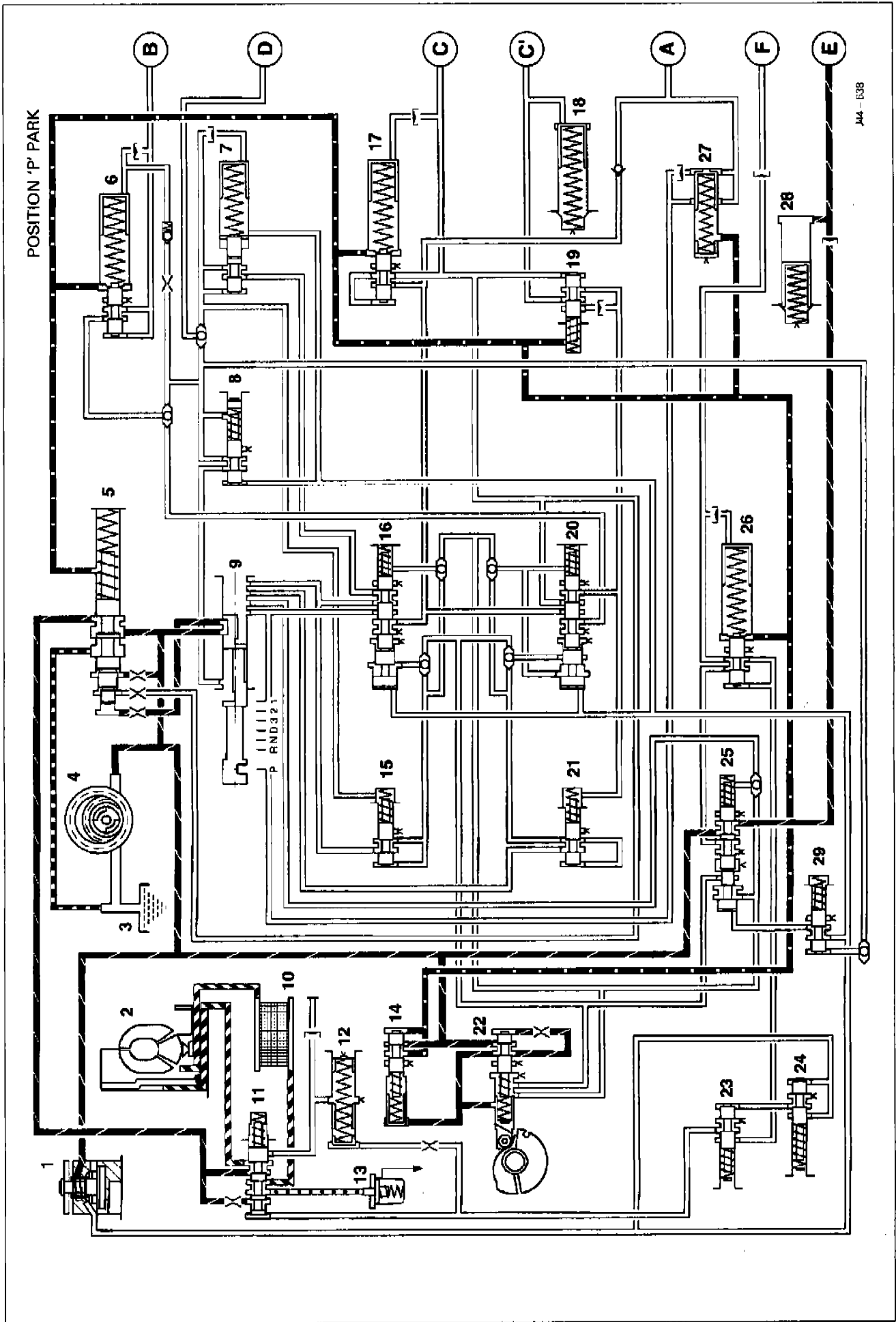
1.2 HYDRAULIC CIRCUIT DIAGRAMS

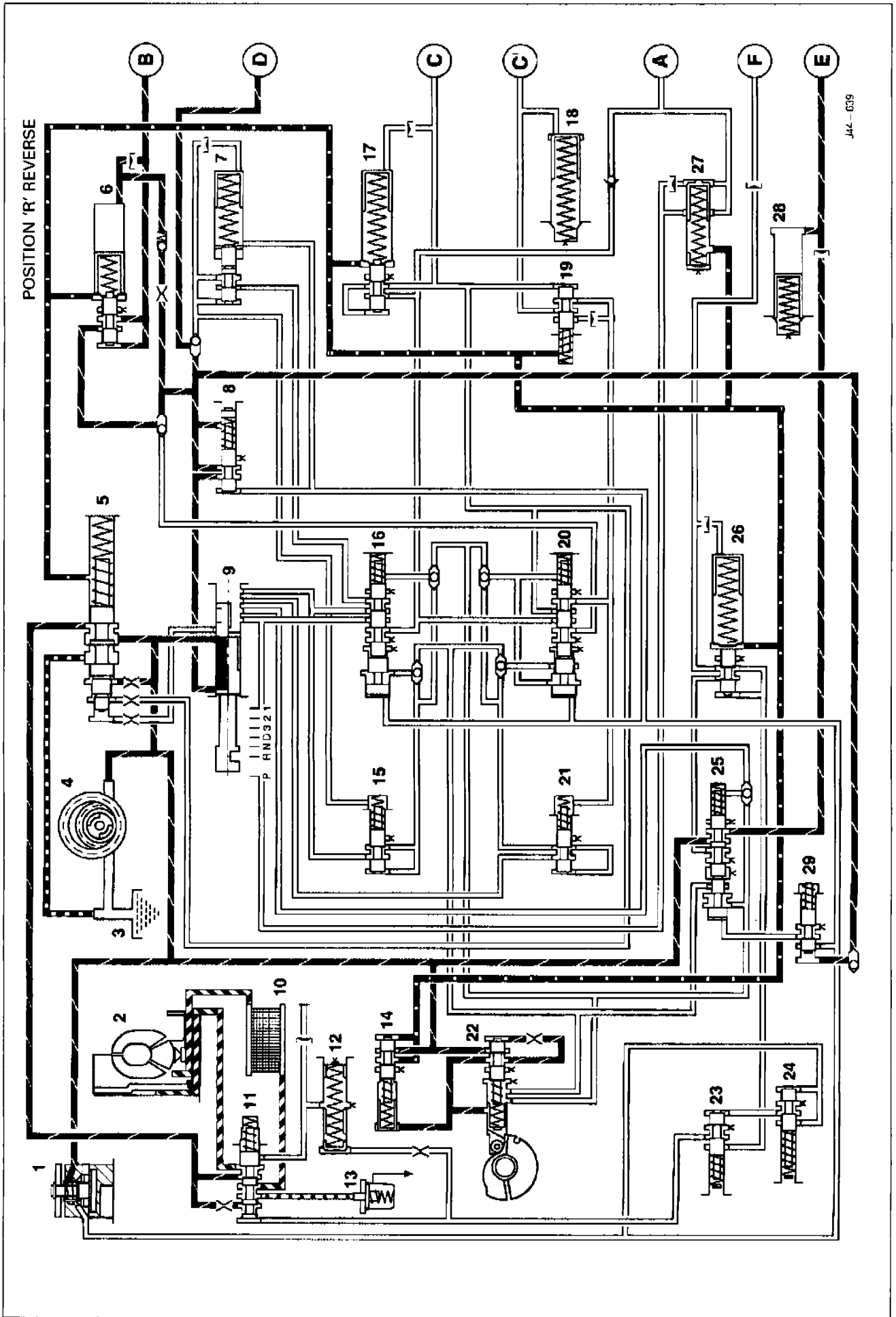
Key To Hydraulic Circuit Diagrams (commencing on page 10)

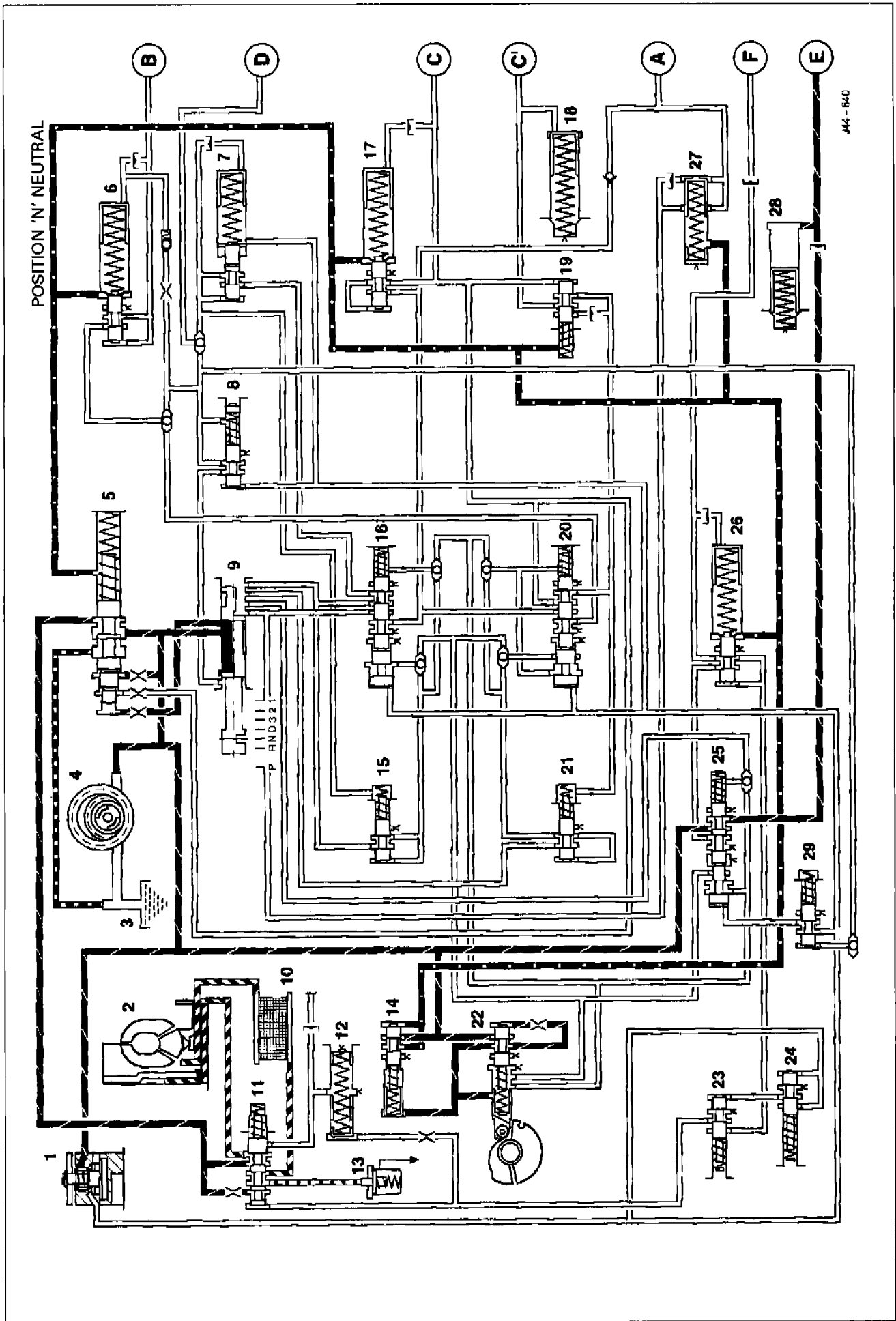
- | | |
|-----------------------------------|--|
| 1. Governor | 16. 1 – 2 Shift Valve |
| 2. Torque Converter | 17. Clutch 'C' Valve |
| 3. Sump | 18. Clutch 'C ¹ ' Damper |
| 4. Pump | 19. Clutch 'C ¹ ' Valve |
| 5. Pressure Regulating Valve | 20. 2 – 3 Shift Valve |
| 6. Clutch 'B' Valve And Damper | 21. 2nd Gear Inhibit |
| 7. Clutch 'D' Valve And Damper | 22. Throttle Valve |
| 8. Reverse Gear Inhibit | 23. Converter Clutch Lock-up Control Valve |
| 9. Manual Valve | 24. Converter Clutch Hysteresis Valve |
| 10. Oil Cooler | 25. 3 – 4 Shift Valve |
| 11. Converter And Reversing Valve | 26. Clutch 'F' Valve And Damper |
| 12. Converter Clutch Damper | 27. Clutch 'A' Damper |
| 13. One-way Valve | 28. Clutch 'E' Damper |
| 14. Modulator Valve | 29. Clutch 'F' Inhibit Valve (Reverse) |
| 15. 1st Gear Inhibit | |

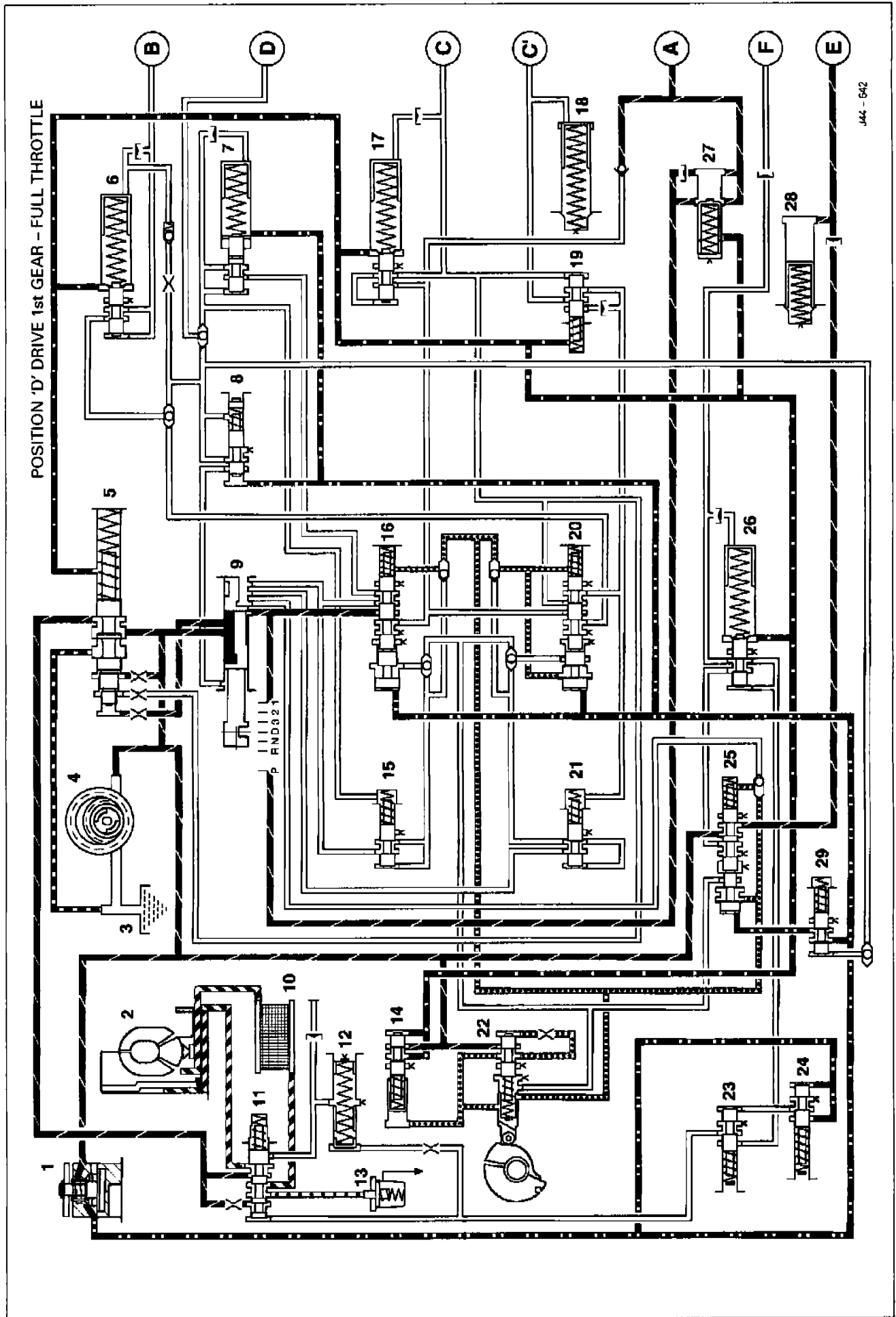
- A Clutch 'A'
- B Clutch 'B'
- C Clutch 'C'
- C¹ Clutch 'C¹'
- D Clutch 'D'
- E Clutch 'E'
- F Clutch 'F'

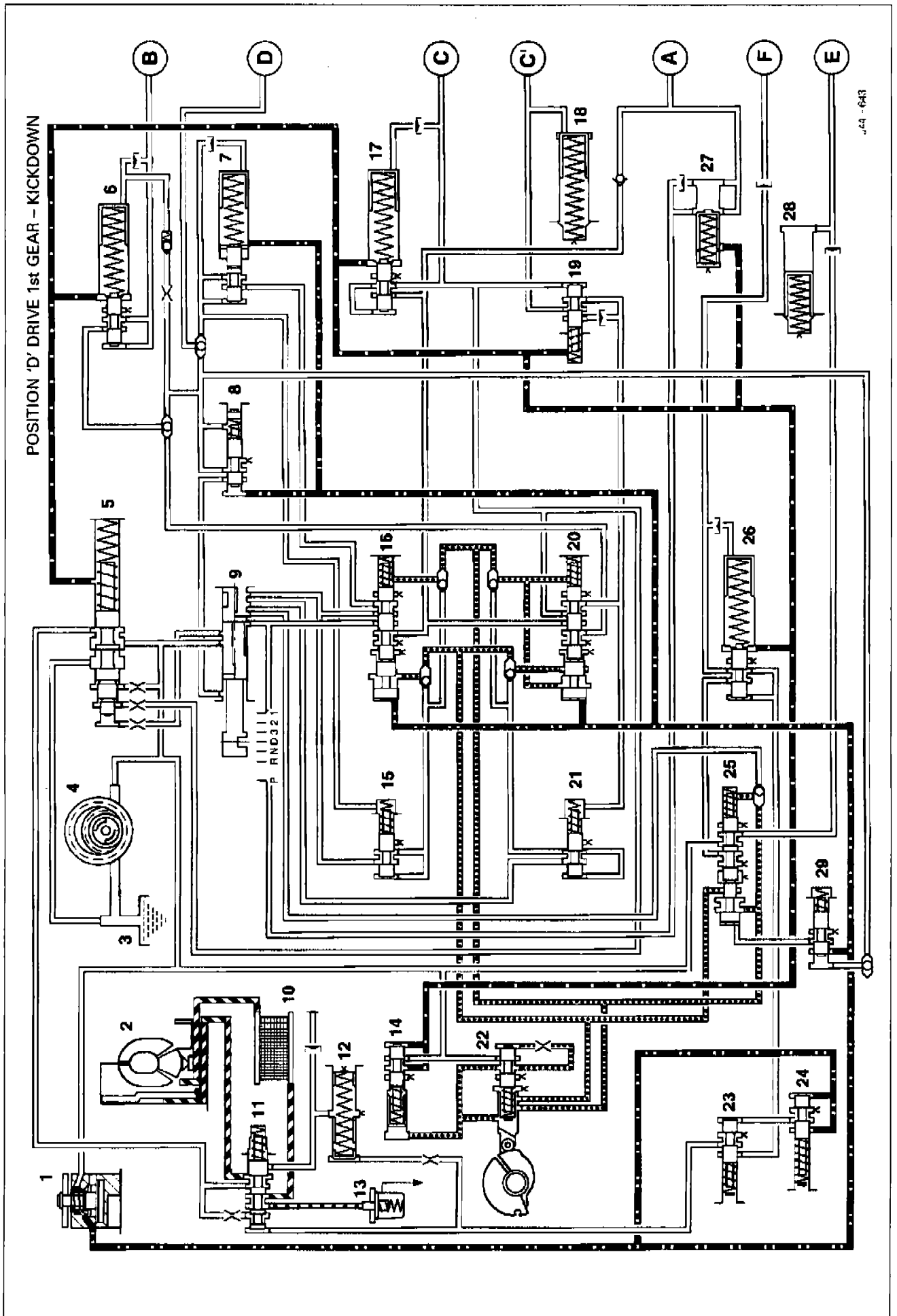
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|-----|--|--------------------|------|--|----------------------|
| I | | Exhaust | VIII | | Governor Pressure |
| II | | Throttle | IX | | Locking Pressure |
| III | | Orifice | X | | Modulation Pressure |
| IV | | Branch | XI | | Pump Pressure |
| V | | Main Pressure | XII | | Lubrication Pressure |
| VI | | Converter Pressure | | | |
| VII | | Throttle Pressure | | | |

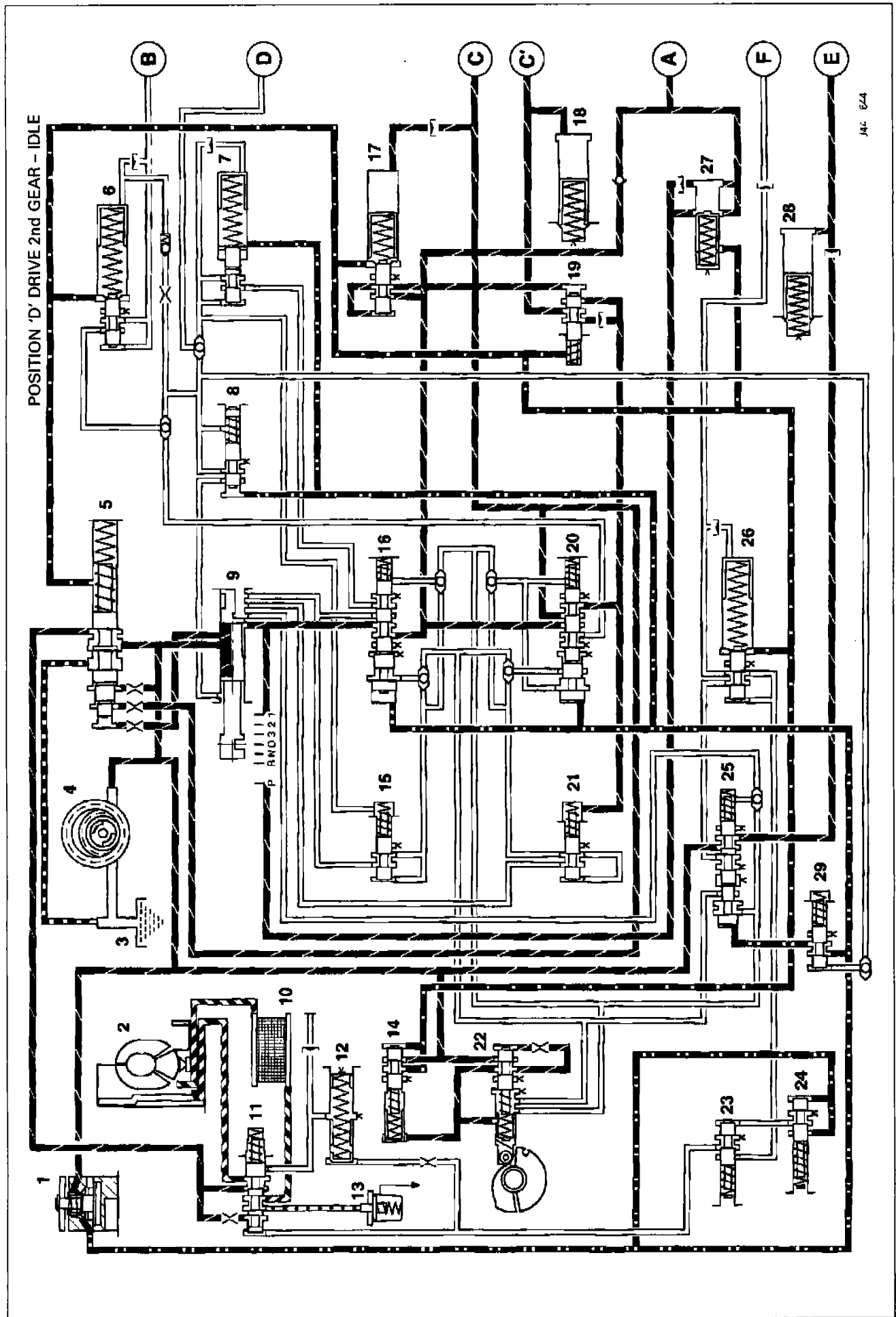




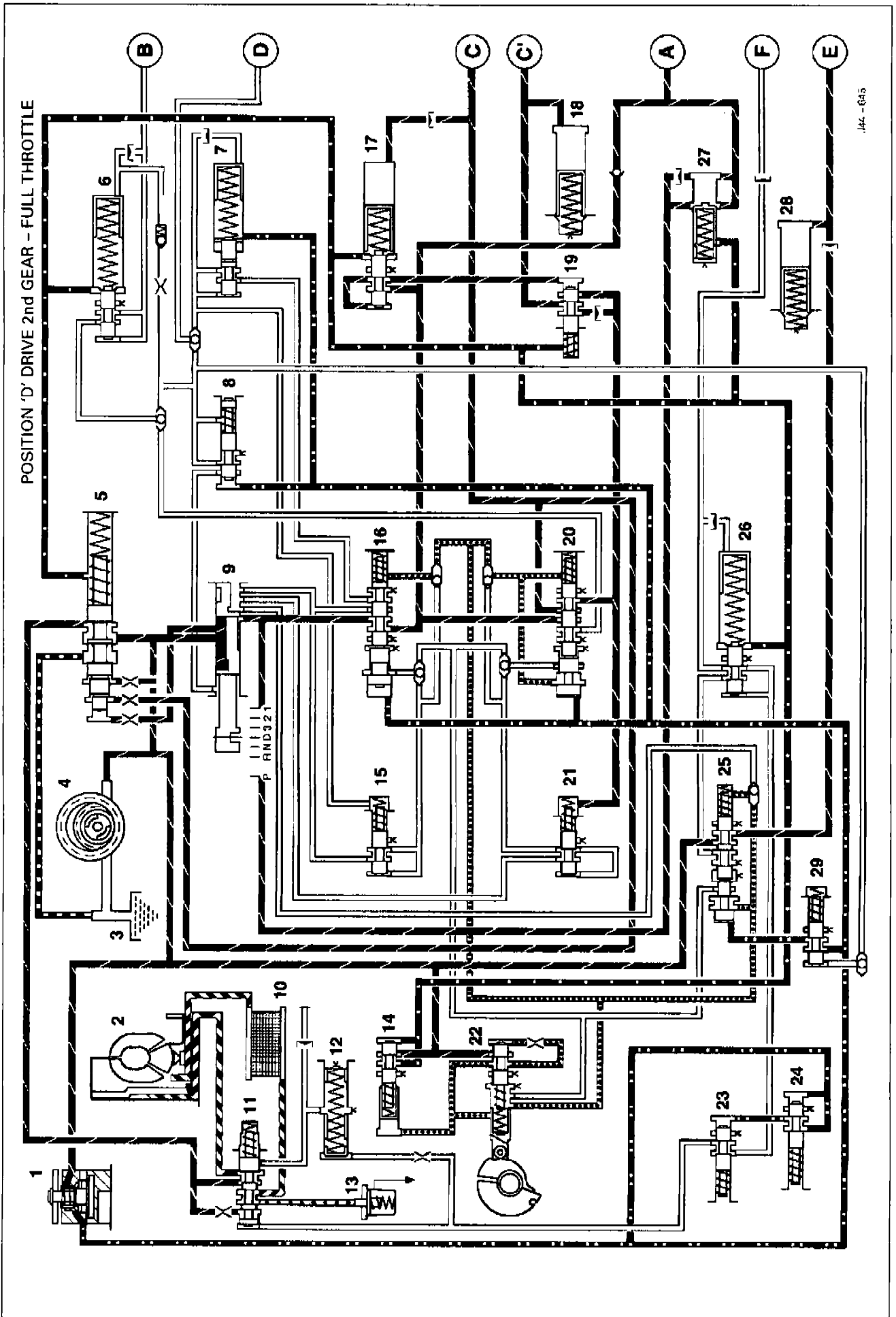


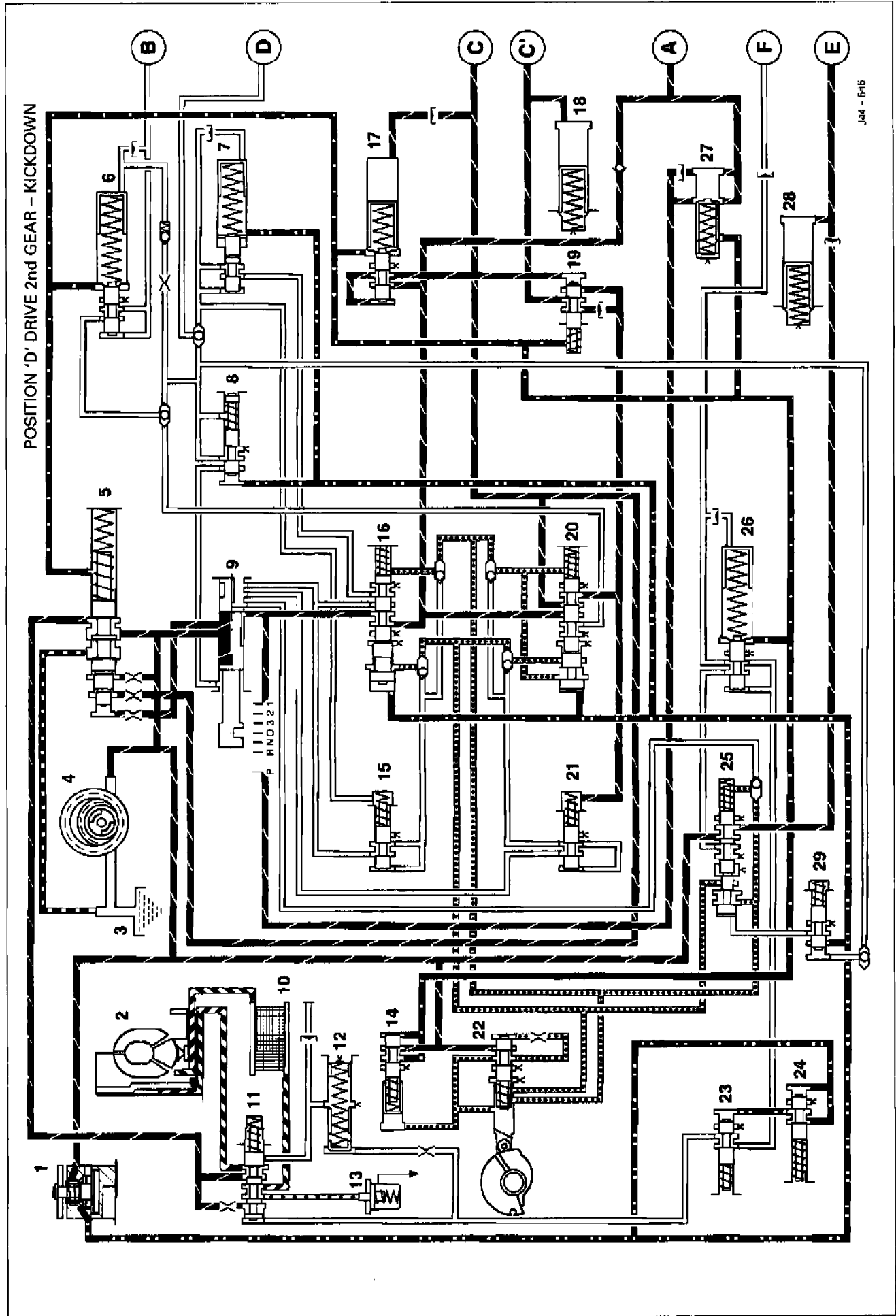




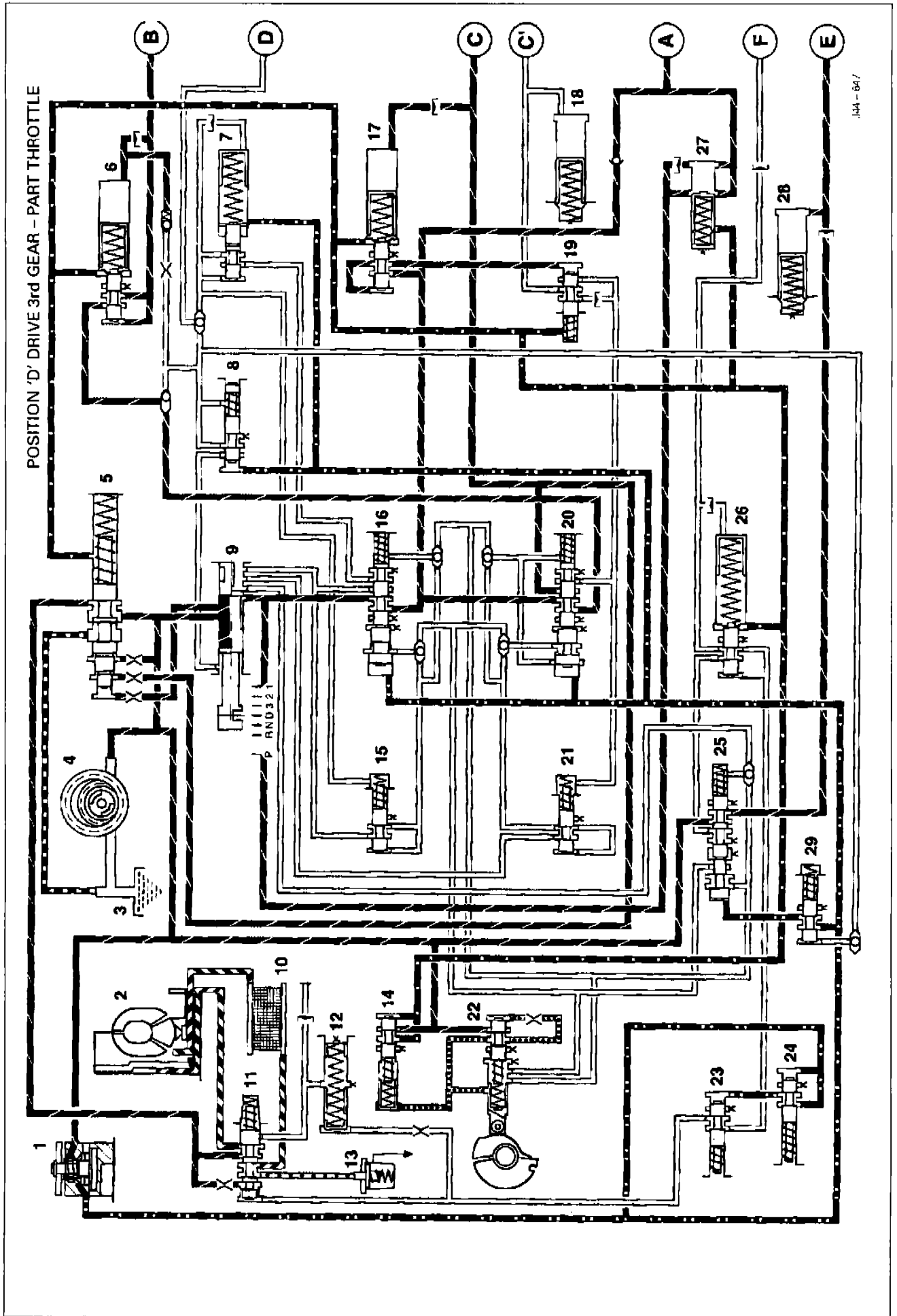


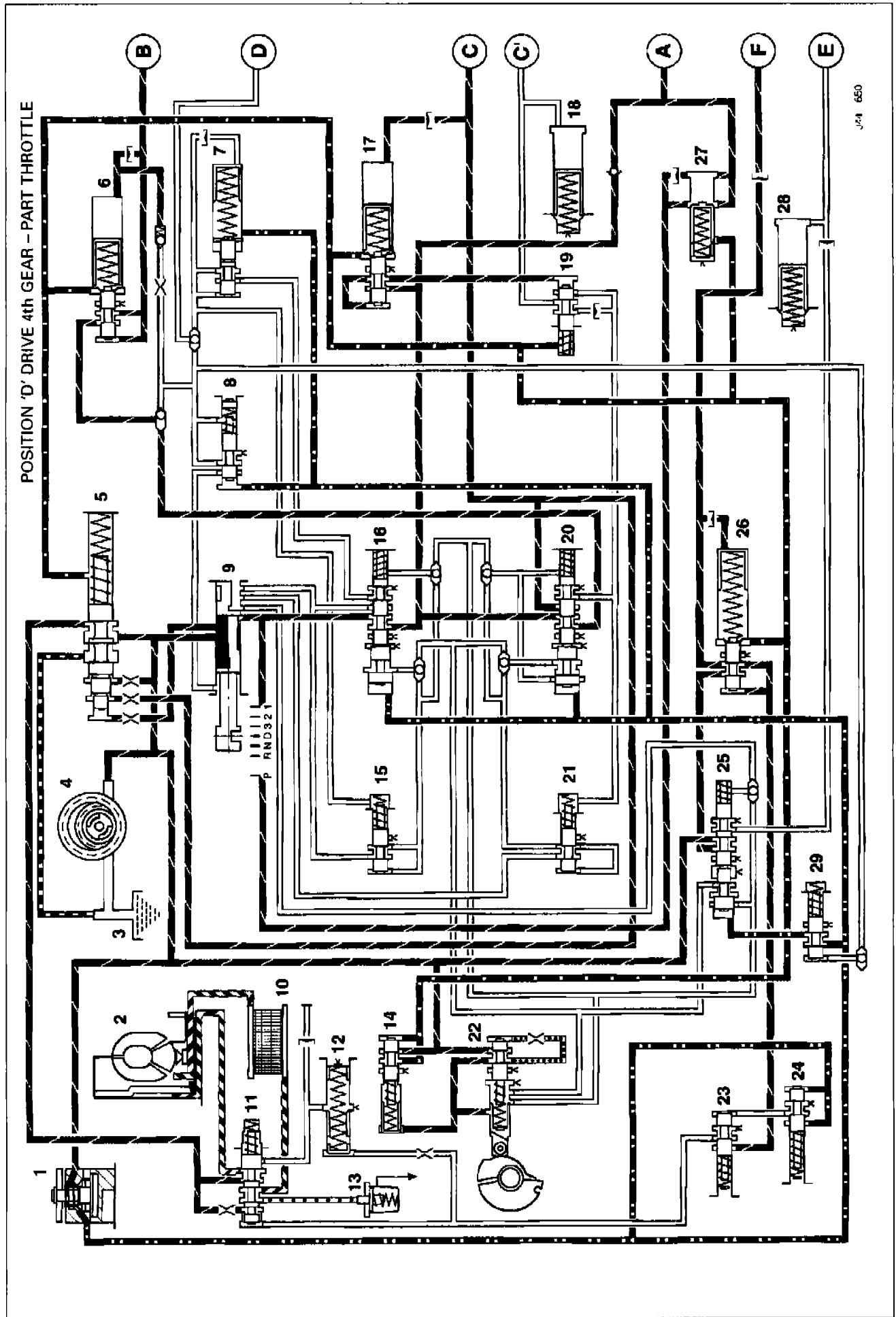
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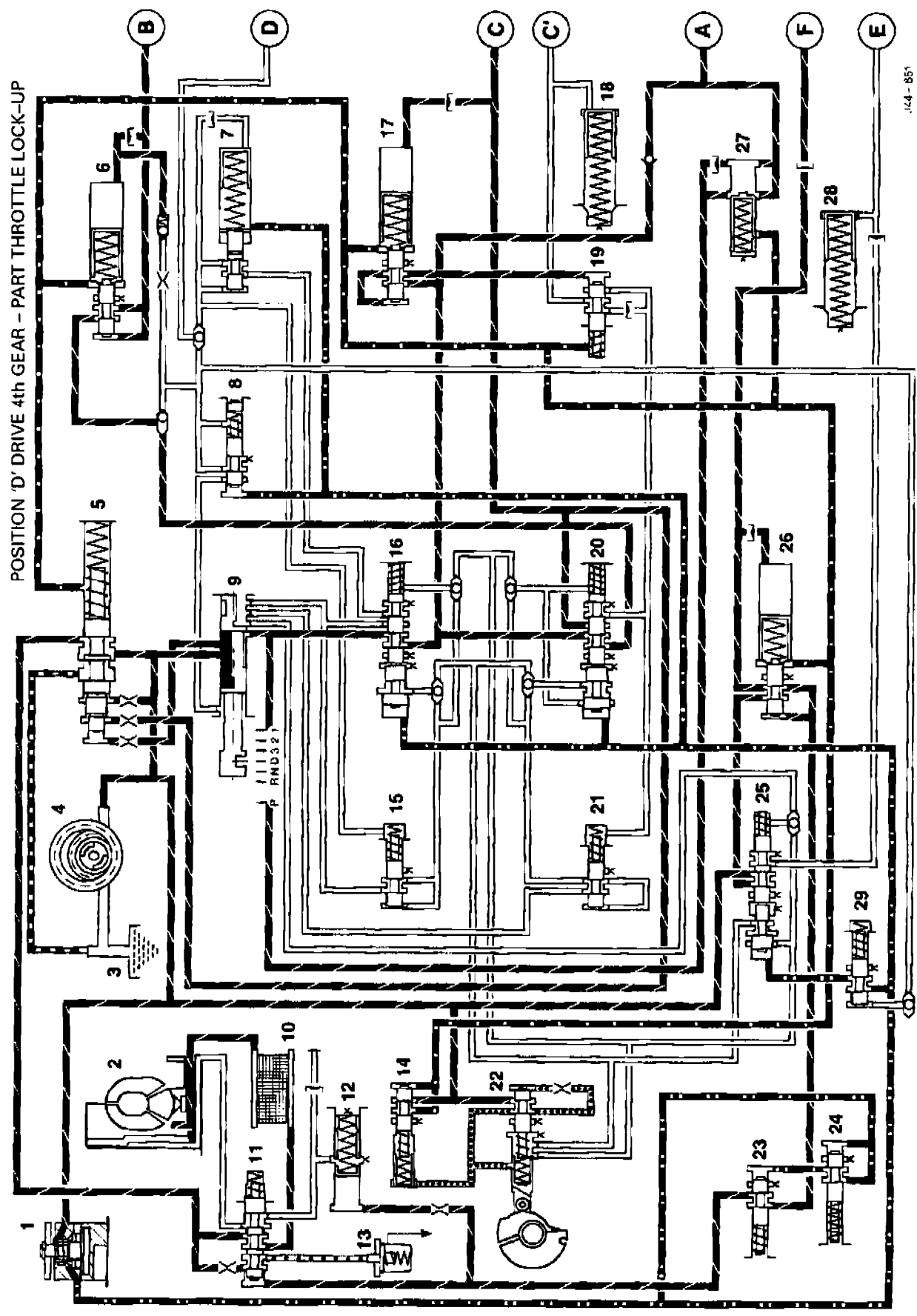
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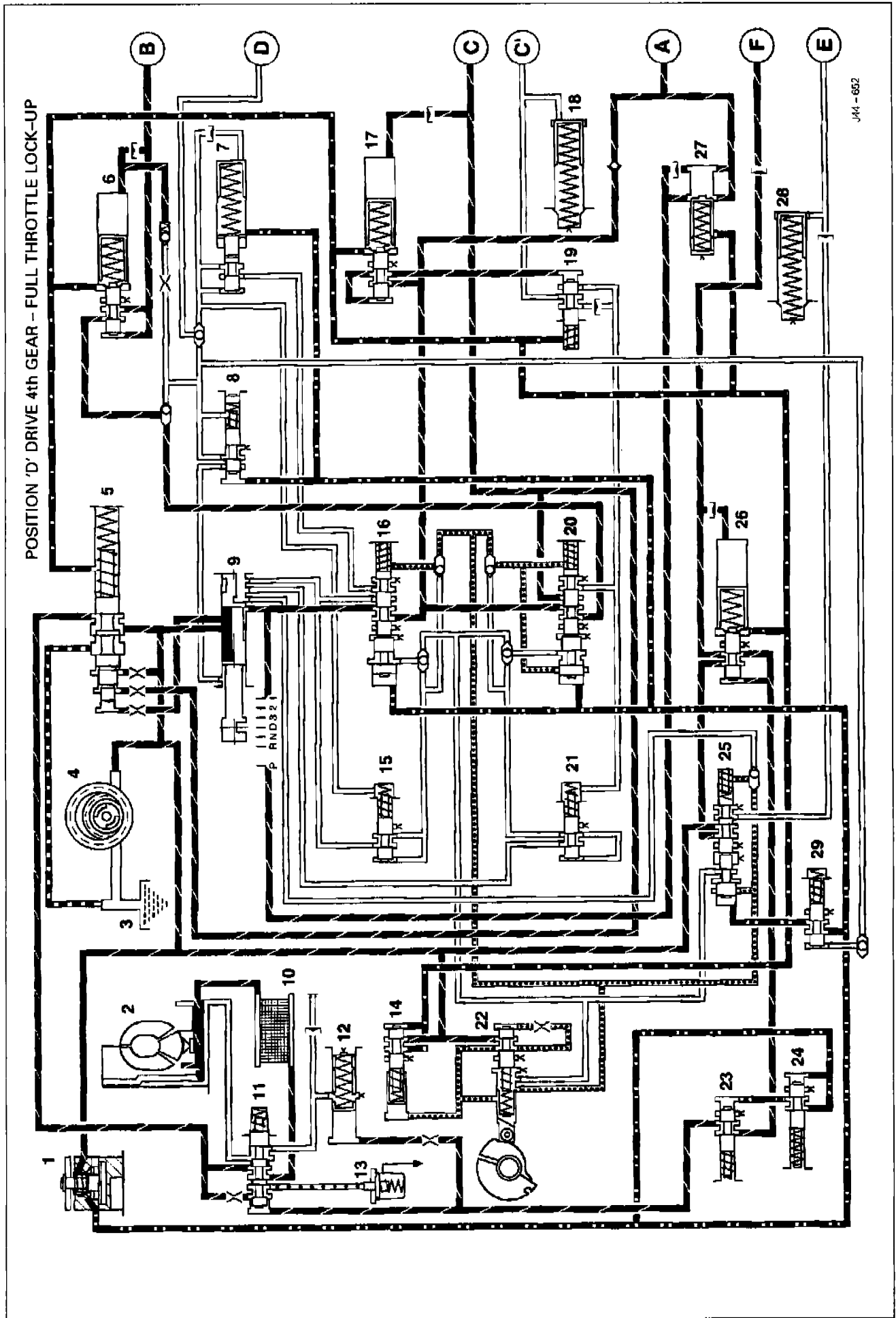




POSITION 'D' DRIVE 4th GEAR - PART THROTTLE LOCK-UP

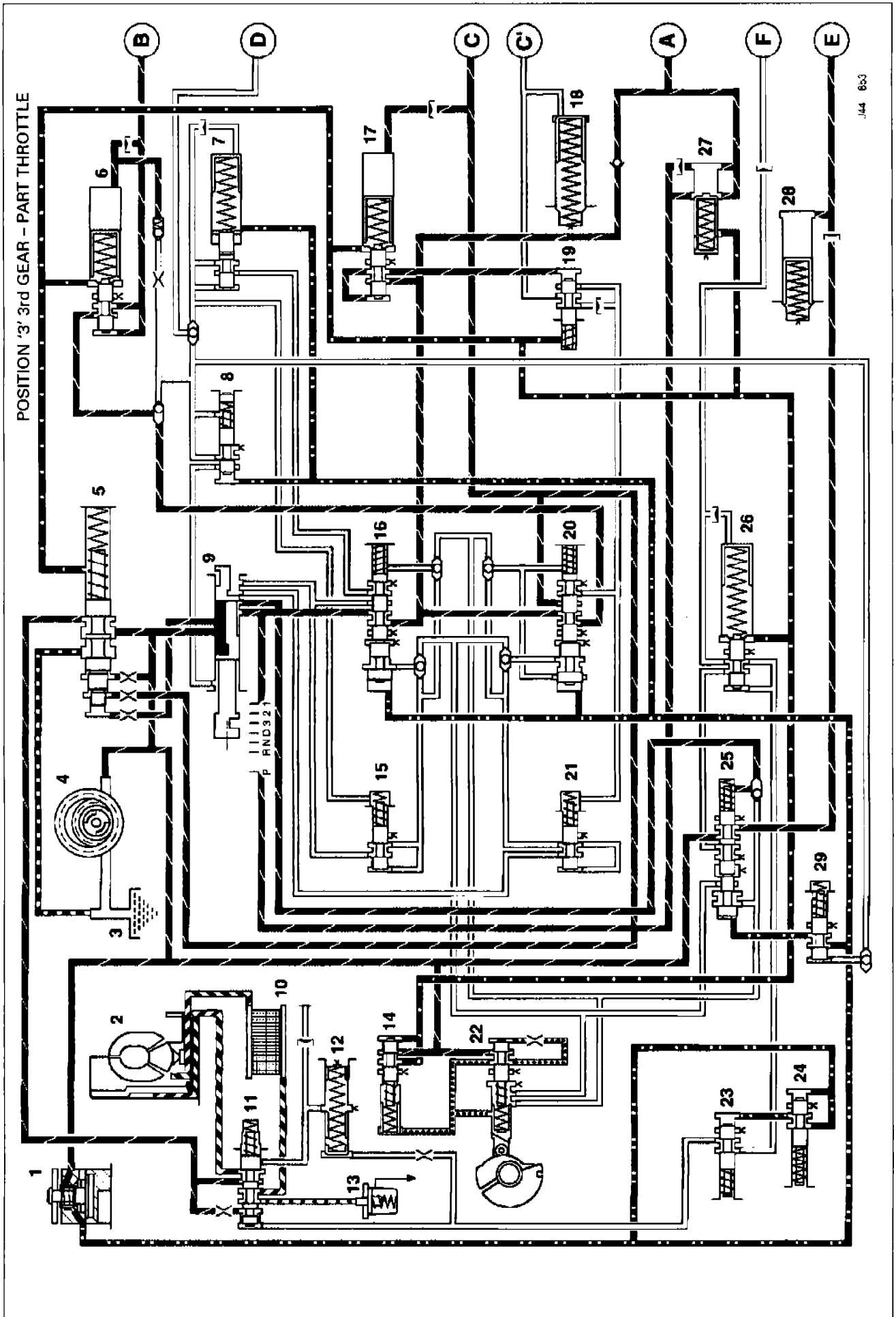


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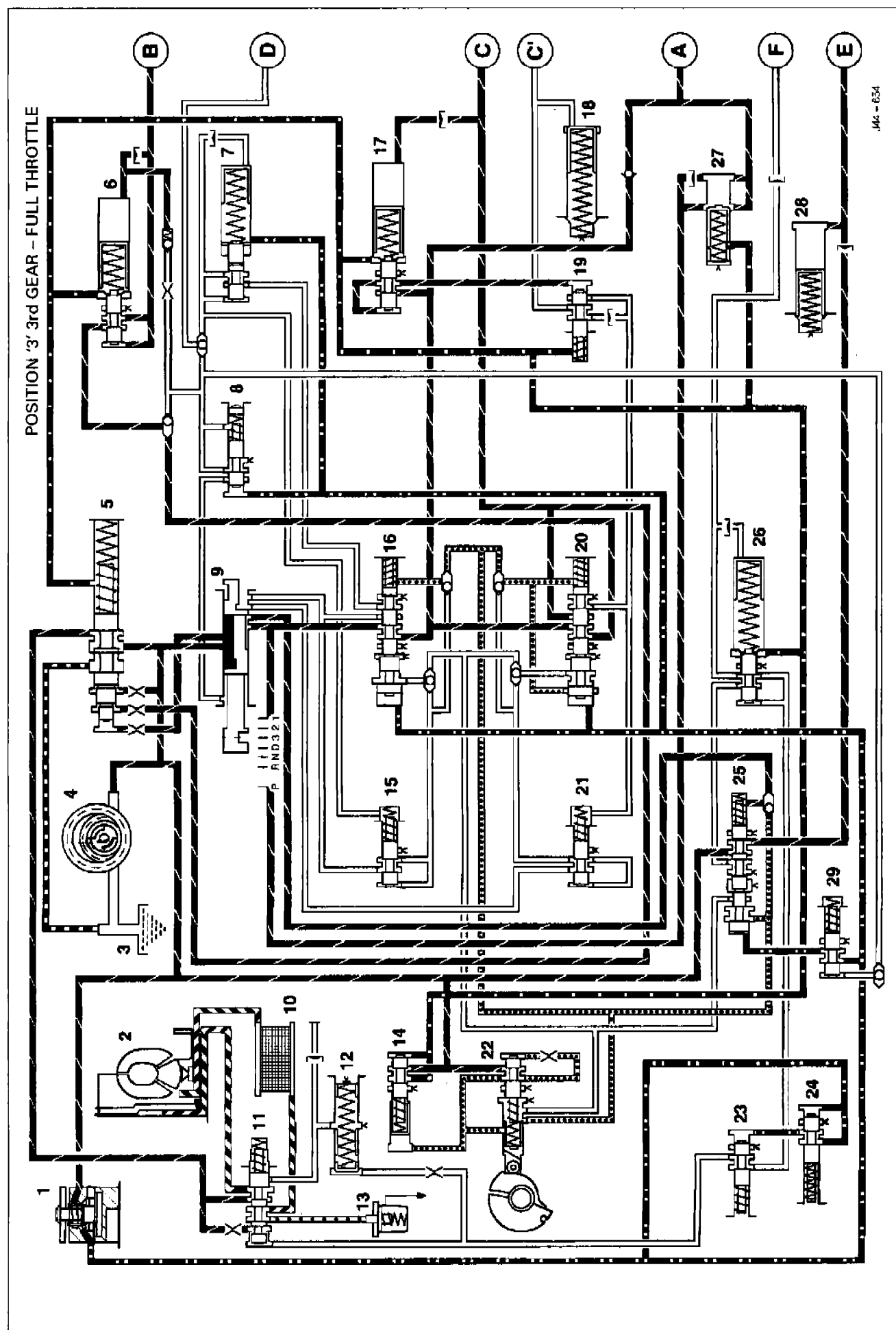


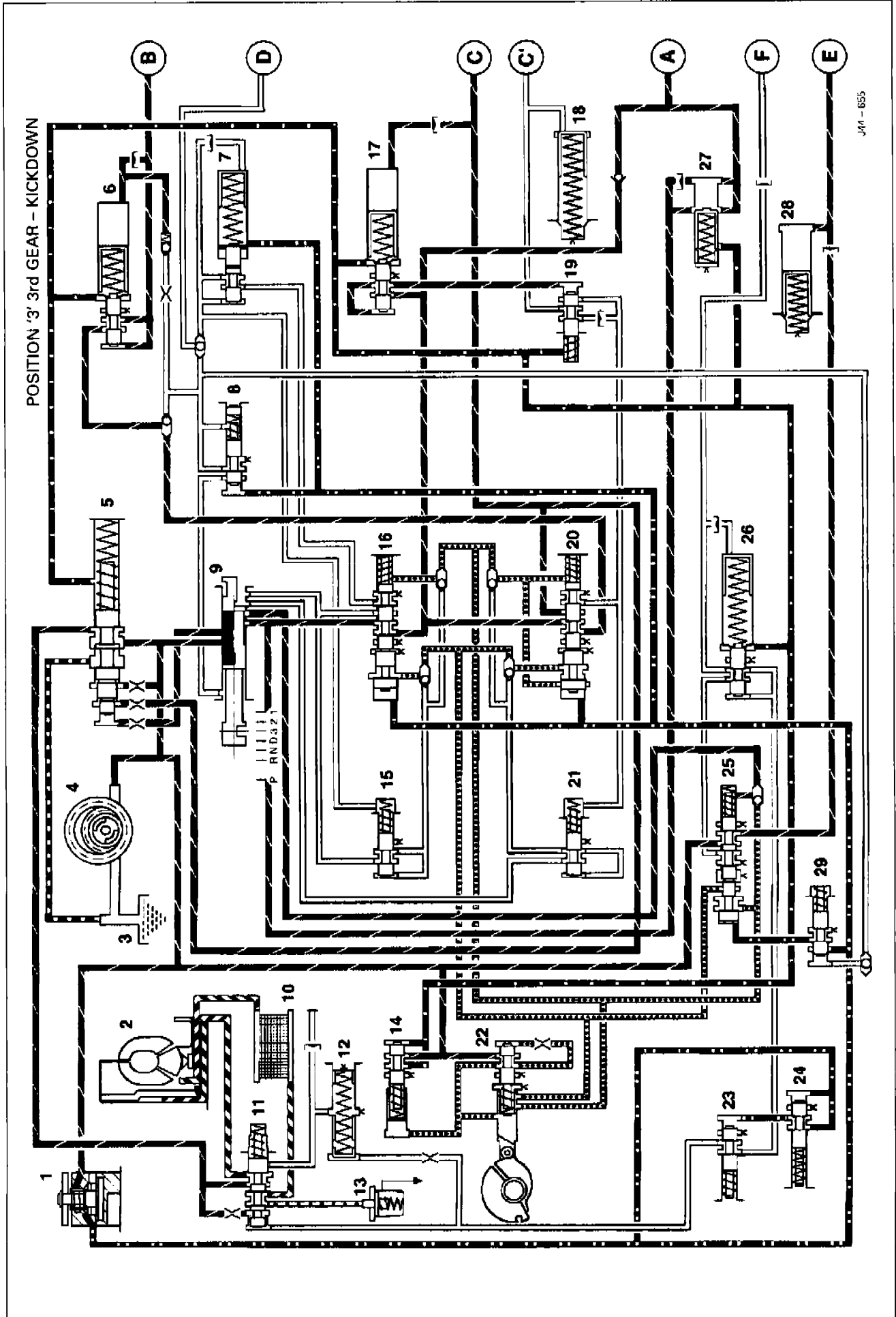


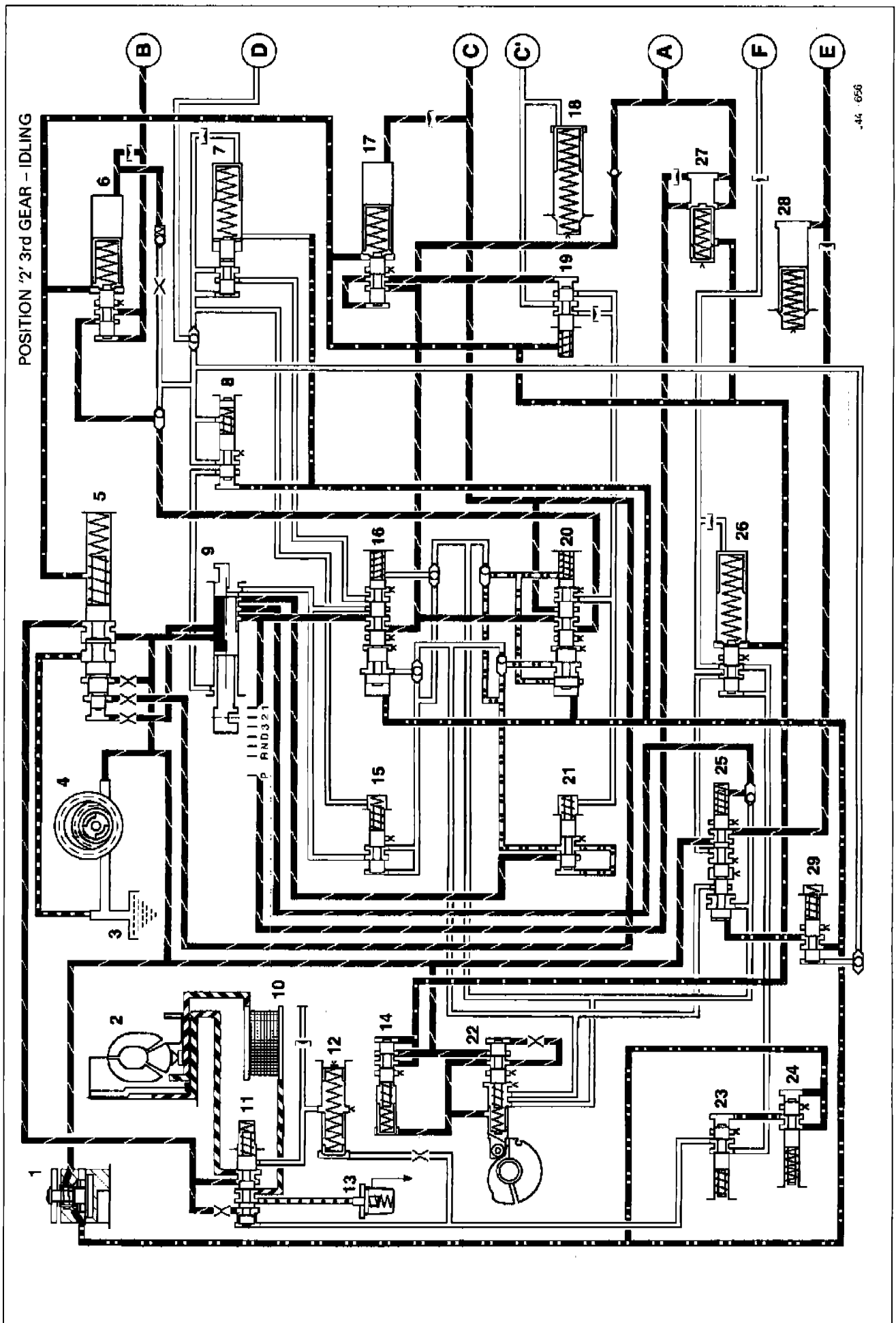
POSITION '3' 3rd GEAR - PART THROTTLE

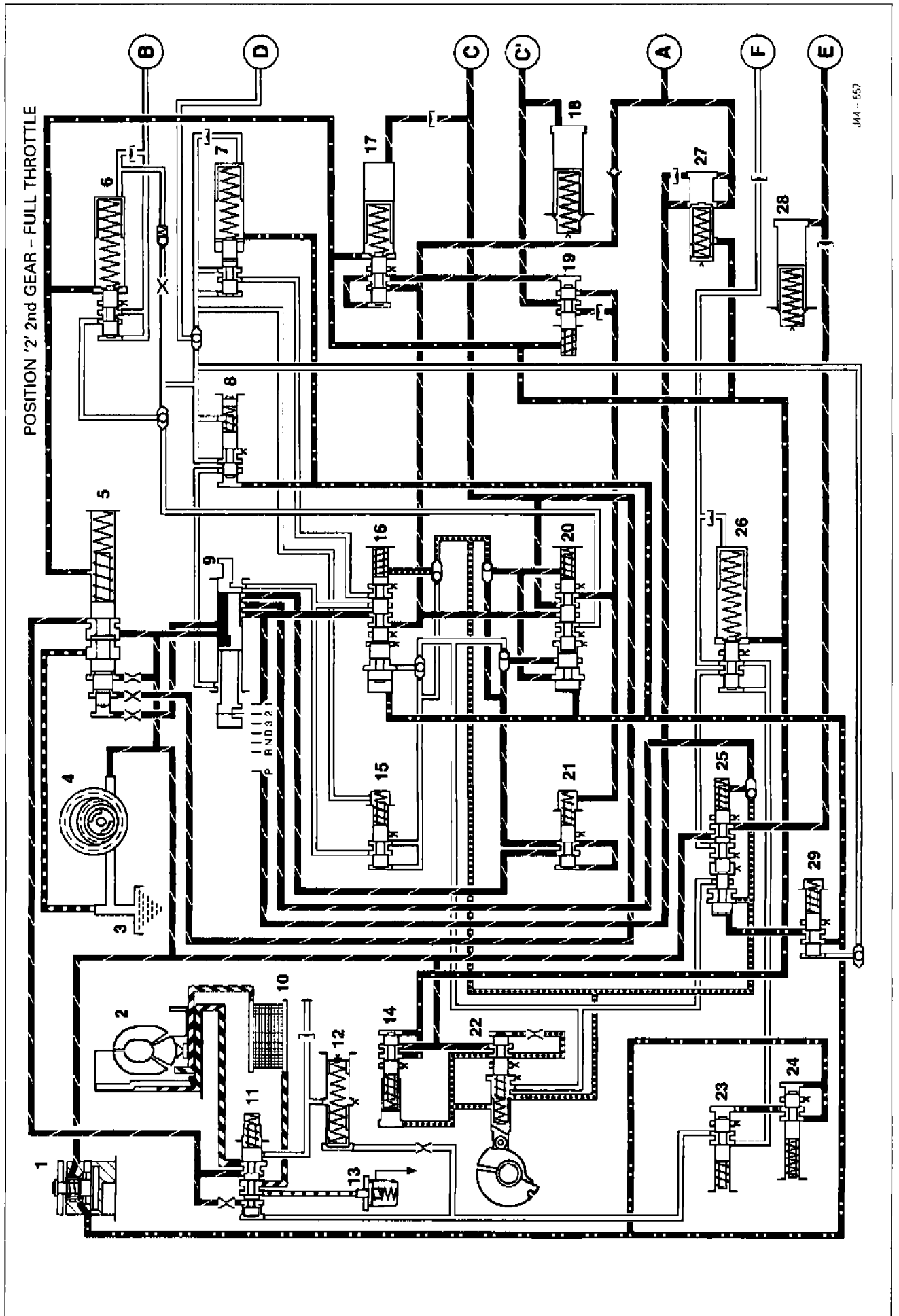


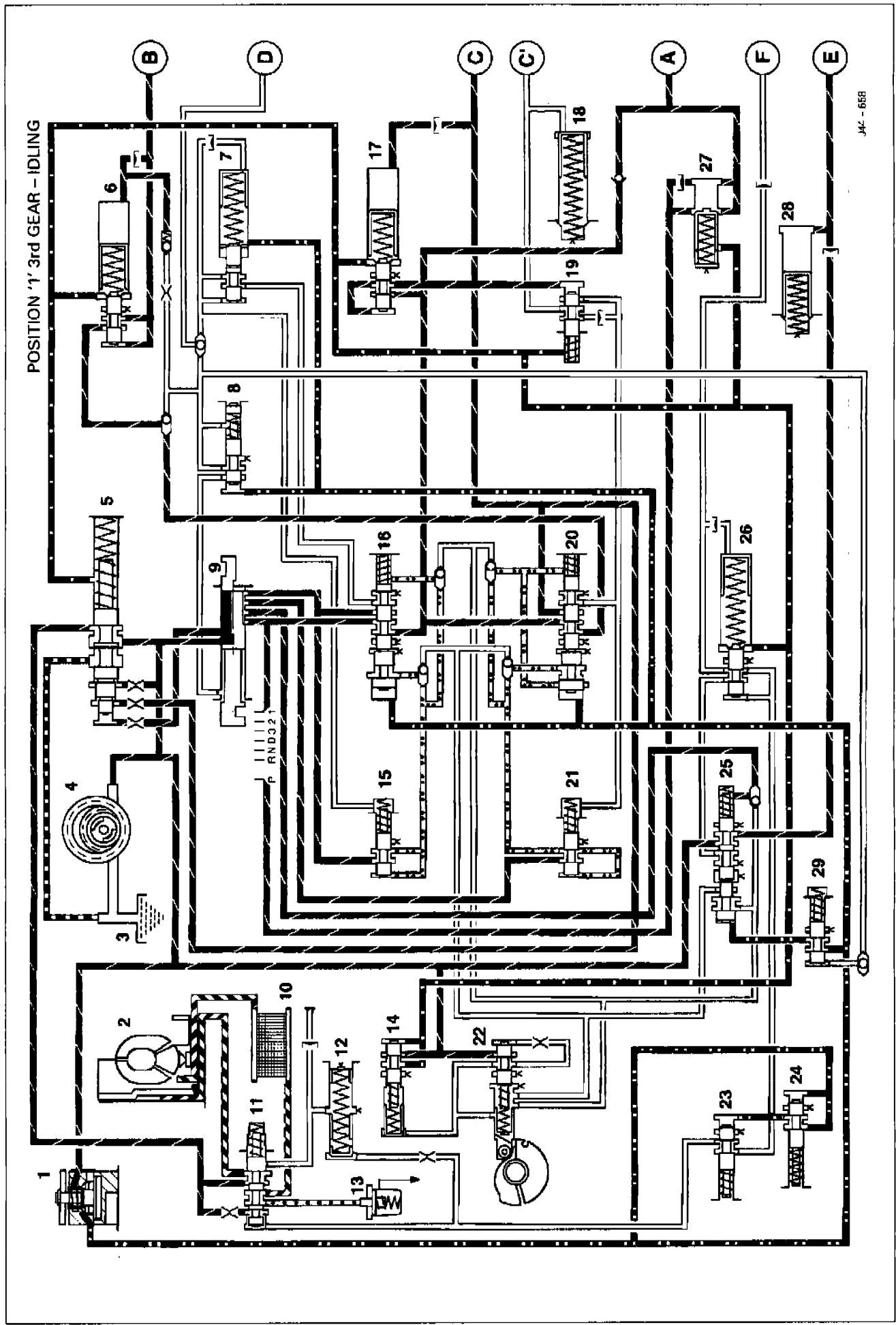
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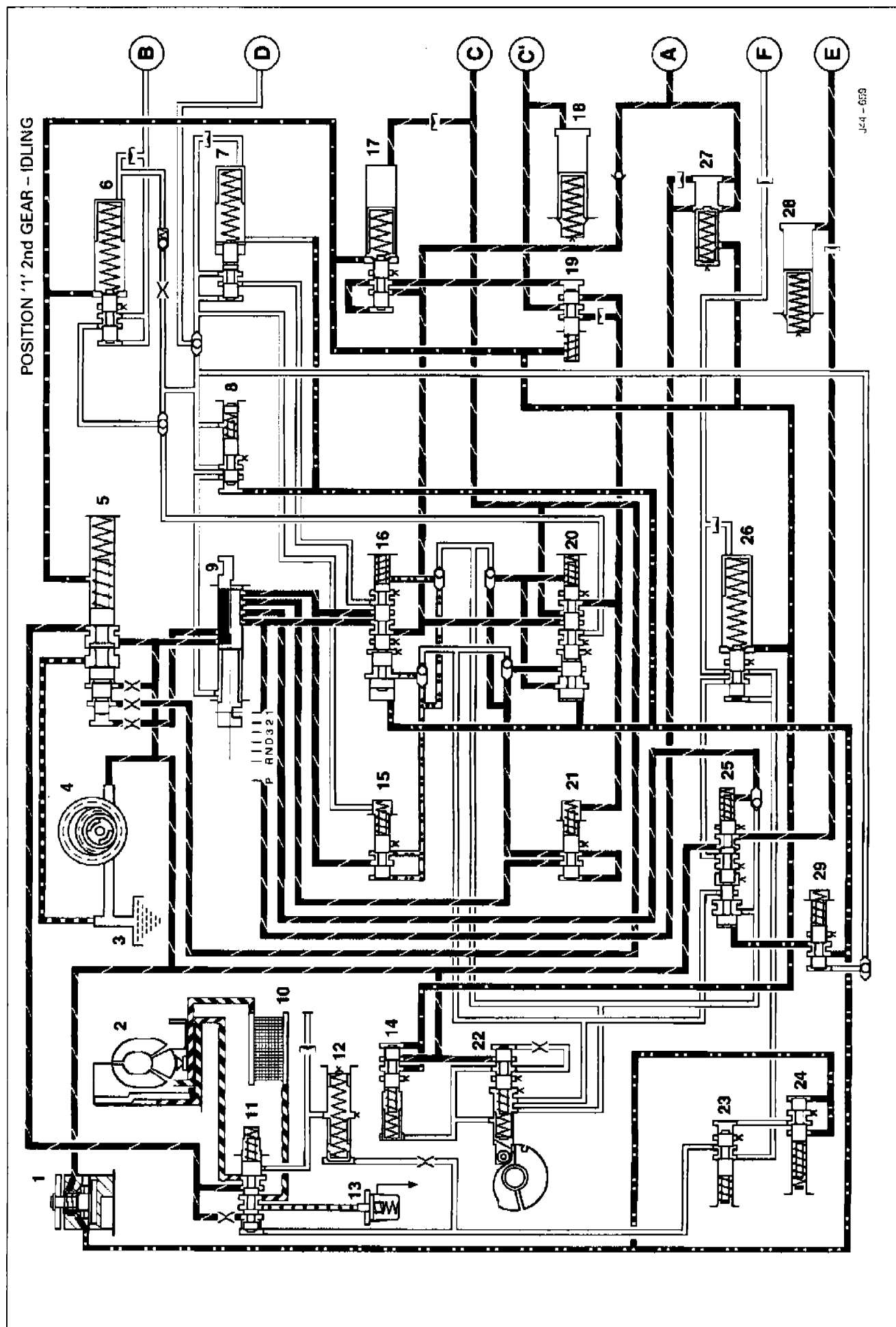


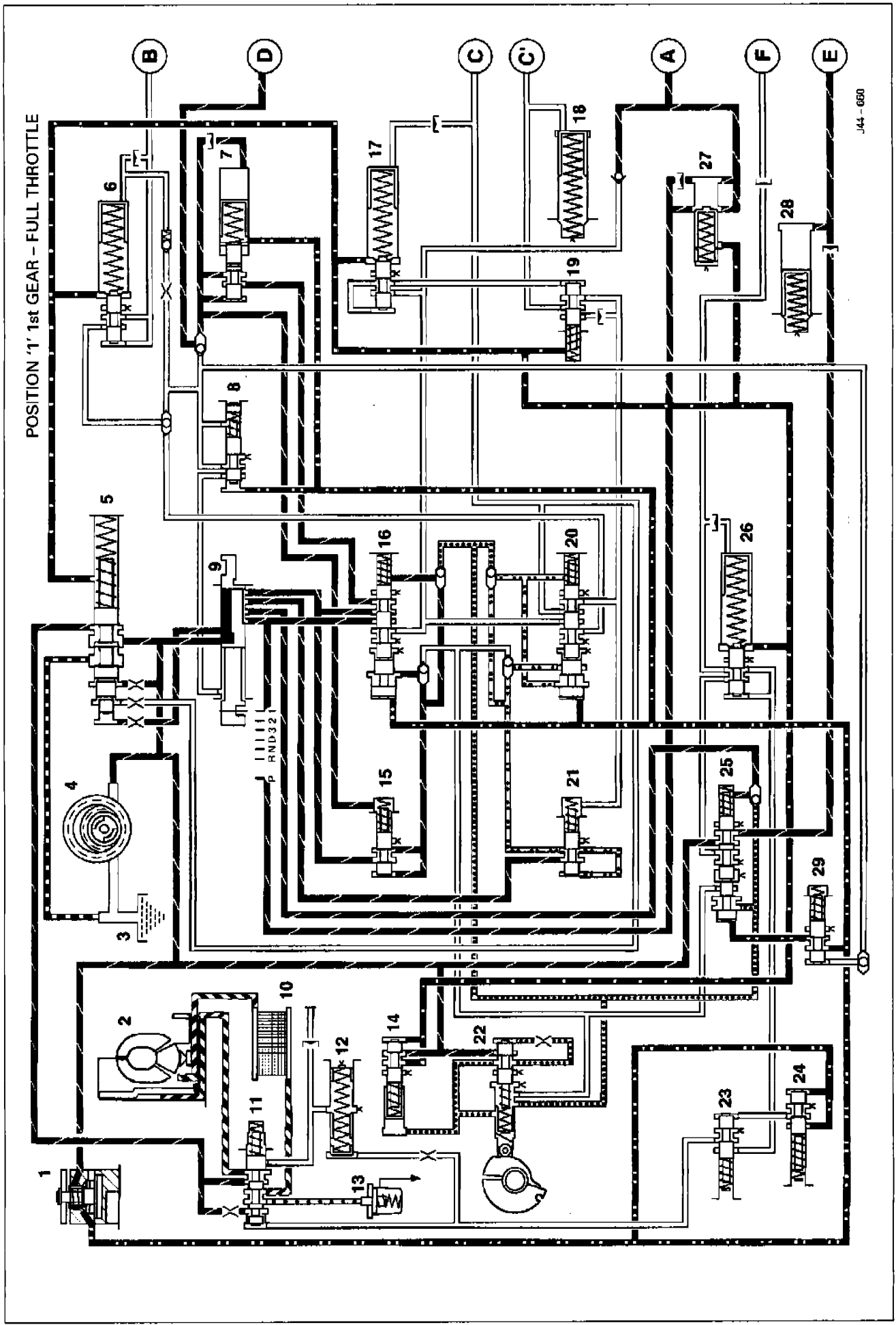














1.3 FAULT DIAGNOSIS

The following tables are intended as a guide to diagnosis of possible faults in the ZF 4 HP 22 transmission. When the fault involves a leak, it is recommended that it is located by the use of a crack detection fluid, eg Met-L-Check, which is available in spray form and permits the leak to be located after a short test drive.

1.3.1 Initial Checks

Note: Before attempting diagnosis, ensure that the following settings are checked:

Transmission oil level.

- Ensure that the transmission is at normal operating temperature, eg by conducting a road test of 15 – 20 miles of mixed driving. If starting from cold, check for presence of oil on dipstick at idle in Park to the 'Cold' fill mark before start of road test.
- Check that the vehicle is on level ground.
- Firmly apply the parking and foot brakes and run the engine at idle speed.
- To ensure that the system is primed, slowly move the selector lever through all the gear positions.
- With the engine still running, engage 'P' Park, withdraw the dipstick and wipe with a lint free cloth.
- Replace the dipstick slowly and withdraw it noting the level.
- Top up as required and recheck the level.

1.3.2 Selector Cable Adjustment

- Check gear selection in all selector positions.
- Adjust as necessary, see Vehicle Service Manual.
- Kick-down cable adjustment, see Vehicle Service Manual.

1.3.3 Stall Test

- Ensure the transmission is at normal running temperature.
- Fully apply the parking brake.
- Start the engine.
- Fully depress the footbrake.
- Select position 'D'– Drive.
- Fully depress the accelerator('kick-down' detent fully depressed).
- Note the tachometer reading.
- Compare the tachometer reading to the specification.

CAUTION: This test must not last more than 5 seconds. Always allow the engine to idle for at least 2 minutes between tests to allow the transmission fluid to cool down. Do not carry out more than three tests in any half-hour.

1.3.4 Road Test

Fully check all shift speeds and note. Compare the results with the specification in addition to general observations of transmission behaviour, noises, leaks etc., and consult the following Fault Finding Chart.

CAUTION: When renewing the transmission, ALWAYS flush out the oil cooler and feed and return pipes.



1.3.5 Fault Finding Chart

Problem	Possible Cause	Action
Converter		
Stall speed too low	Stator freewheel faulty allowing stator to revolve	Renew torque converter.
	Engine out of tune	Check engine tune.
Stall speed too high and keeps rising	Transmission slip	Check oil level, check mechanical failure, renew transmission as necessary.
	Engine out of tune	Check engine tune.
Acceleration below specification	Torque converter freewheel faulty allowing stator to revolve	Renew torque converter.
	Engine out of tune	Check engine tune.
Top speed below specification	Torque converter freewheel seized	Renew torque converter.
	Engine out of tune	Check engine tune.
Position 'P' - Park		
Will not move out of Park	Gearshift interlock failure	Rectify. Renew fuse, check circuits, renew relay and solenoid.
Does not engage Park	Parking pawl mechanism sticking	Renew park pawl components: connecting bar, pawl pin, tension spring, guide piece & guide sheet
	Cable out of adjustment	Adjust cable as necessary.
Does not hold	Parking pawl mechanism damaged	Replace park pawl components.
	Cable out of adjustment	Adjust cable as necessary.
Starter motor does not operate	Starter inhibit switch faulty	Replace switch.
	Faulty selector lever	Replace lever.
	Position 'P' or 'N' not selected	Select 'P' or 'N'.
	Cable out of adjustment	Adjust cable as necessary.
Position 'R' - Reverse		
No reverse gear or severely delayed engagement	Dirty oil filter	Renew oil filter.
	Jammed governor	Replace governor.
	Jammed reverse inhibit valve	Replace valve block.
	Low oil level	Check oil.
High pitched squeaking noise	'B' clutch destroyed (also no 3rd gear in Drive)	Service / renew transmission.
	'D' clutch destroyed	Service / renew transmission.
	'E' clutch destroyed (no engine braking in 2nd & 3rd gears)	Service / renew transmission.
	Reverse gear safety valve faulty	Service / renew valve block.



1.3.5 Fault Finding Chart (continued)

Problem	Possible Cause	Action
Slipping or shaking from start in reverse gear	'B', 'E' or 'D' clutch defective	Service / renew transmission.
Strong jerk, or distinct double jerk, when engaging positions 'P-R', or 'N-R' (below 1500RPM engine speed)	Damper 'B' defective (will give the same symptoms when changing from 2nd to 3rd gears)	Service / renew valve block.
Note: A double thump may be a feature of 'R' - Reverse engagement		
Reverse lamp does not illuminate (bulbs, fuses and cables functioning correctly)	Starter inhibit switch faulty	Renew switch.
	Faulty selector lever	Renew lever.
	Position 'R' not selected	Select 'R'.
Position 'D' - Drive (1st to 4th)		
No drive or severe delay	Dirty oil filter	If there is no debris in sump, renew the oil filter and oil; if debris is present in the sump, renew the transmission.
	Oil level incorrect	Check oil level.
	'A' clutch defective	Service / renew transmission.
	'D' clutch one-way clutch faulty	Service / renew transmission.
Slipping or shaking during initial forward movement	'A' clutch damaged	Service / renew transmission.
Strong jerk 'N-D' (below 1500 RPM engine speed)	'A' clutch faulty	Service / renew transmission.
	'A' clutch damper faulty	Service / renew valve block.
Gear change functions faulty (in cold or warm state)		
Change 1st to 2nd / 2nd to 1st	Governor dirty	Renew governor.
	Shift valve 1-2 sticking	Renew valve block.
Change 1st to 2nd	Brake 'C1' and / or 'C' faulty	Service / renew transmission.
Change 2nd to 3rd / 3rd to 2nd	Governor dirty	Renew governor.
	Shift valve 2-3 sticking	Renew valve block.
Change 2nd to 3rd	'B' clutch faulty	Service / renew transmission.
Change 3rd to 4th / 4th to 3rd	Governor dirty	Renew governor.
	Shift valve 3-4 sticking	Renew valve block.
Sudden shifts	Dampers sticking	Service / renew valve block.
Vehicle starts in 2nd gear	Governor sleeve sticking	Renew governor.
	Shift valve 1-2 sticking	Renew valve block.
Vehicle starts in 3rd gear	Governor sleeve sticking	Renew governor.
	Shift valves 1-2 and 2-3 sticking	Service / renew valve block.
Gearbox changes 1st to 3rd	Shift valve 2-3 sticking	Service / renew valve block.
No shifts	Governor sticking	Change governor.
	Dampers sticking	Service / renew valve block.



1.3.5 Fault Finding Chart (continued)

Problem	Possible Cause	Action
Shift speeds		
No changes at light throttle setting	Dirty governor	Renew governor.
	Shift valves sticking	Service / renew valve block.
Change points incorrect at full throttle setting	'Kick-down' cable setting incorrect	Adjust setting.
No changes at 'kick-down' - 1st to 2nd / 2nd to 1st	'Kick-down' cable setting incorrect	Adjust setting.
No changes at 'kick-down' - 2nd to 3rd / 3rd to 2nd	'Kick-down' cable setting incorrect	Adjust setting.
Gear change quality		
Poor changes	Throttle valve ('kickdown') cable setting incorrect	Adjust setting.
Harsh changes at low throttle	Defective damper	Service / renew valve block.
	Modulation pressure too high	Service / renew valve block.
	'Kick-down' cable setting incorrect	Adjust setting.
	Clutch plates damaged	Service / renew transmission.
Soft changes at full throttle and 'kick-down'	Defective damper	Service / renew valve block.
	'Kick-down' cable setting incorrect	Adjust setting.
	Modulation pressure too low	Service / renew valve block.
	Clutch plates damaged	Service / renew transmission.
Harsh changes at full throttle and 'kick-down'	Incorrect modulation pressure	Service / renew valve block.
	'Kick-down' cable setting incorrect	Adjust setting.
	Defective damper	Service / renew valve block.
Position '3' - 1st to 3rd - limited automatic shifts		
No engine braking (2nd, 3rd only)	'E' clutch damaged	Service / renew transmission
Position '2' - 1st to 2nd - limited automatic shifts		
Manual change 3rd to 2nd faulty	Locking valve '2' sticking	Service / renew valve block / governor.
	Governor faulty	Service / renew valve block / governor.
No engine braking	Brake 'C' or 'E' damaged	Service / renew transmission.



1.3.5 Fault Finding Chart (continued)

Problem	Possible Cause	Action
'Lock-up' Shifts		
Change points at incorrect speeds	'Lock-up' safety valve sticking	Service / renew valve block / governor.
	'Kick-down' cable setting incorrect	Adjust setting.
	No 4th gear	Check cable adjustment, service / renew valve block / governor.
	Governor pressure incorrect	Service / renew valve block / governor.
General		
'Kick-down' cable sticking	Nipple in throttle cam is worn	Replace cable.
	Too much friction in sleeve of 'kick-down' cable	Replace cable.
	Throttle pressure piston sticking	Service / renew valve block.
Noisy and no drive after a long journey	Oil filter on valve block faulty	If there is no burnt lining in the sump, renew the filter and oil. If debris is present, renew the transmission.
Very noisy and no drive	Drive plate is worn or broken	Renew the drive plate.
Oil leaks		
Oil dripping from the bell housing	Seal ring in pump housing damaged	Renew seal.
	Defective pump O-ring	Renew O-ring.
	Pump housing porous	Renew pump housing.
	Converter leaking from welded seam	Renew converter.
Leakage between transmission and oil sump	Bolts incorrectly torqued	Tighten bolts to specified torque.
	Sump gasket damaged	Renew sump gasket.
Leakage between intermediate plate and main housing (especially at pump pressure point)	Bell housing bolts loose	Tighten bolts to specified torque.
	Gasket damaged	Renew gasket.
Oil leak at output	Output oil seal damaged	Renew seal.
Leakage from cooler pipes	Loose connections	Tighten connections.
	Pipes damaged	Renew pipes.
	Cooler leaks	Renew cooler.
Leakage between main housing and tail housing	Loose bolts	Tighten bolts.
	Gasket damaged	Renew gasket.
Oil leak from 'kick-down' cable at transmission end	O-ring connection damaged	Renew O-ring or complete cable.



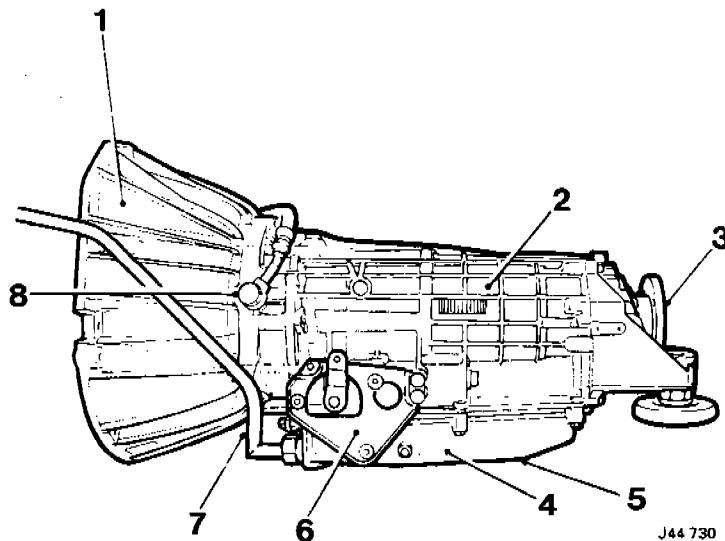
1.3.5 Fault Finding Chart (continued)

Problem	Possible Cause	Action
Loss of oil through breather	Oil level too high	Check level.
	Incorrect oil	Drain oil, flush system and refill with correct oil
	Breather blocked	Change breather, check for foul condition of foam insulation pad.
	No breather cap	Fit cap or renew breather.
	O-ring breather damaged	Remove tail housing and replace O-ring.
	Securing clip faulty	Renew clip.
Oil leak at intermediate plate	Blanking plug loose	Tighten plugs. Renew sealing washers.
Leakage between gearbox and extension housing	Fastening screws loose	Tighten screws to specified torque.
	Gasket faulty	Renew gasket.
Noises		
High pitched squeaking noise, dependant on engine RPM, in all gears, when oil is warm and accompanied by intermittent drive after a long journey	Dirty filter	If there is no debris in the sump, renew the filter and oil. If debris is present, renew the transmission.
High pitched noise in all positions, especially if oil is cold. Sucking noise from pump.	Low oil level	Top-up as necessary.
	Filter not sealing	Check / renew O-ring.
	Leaking valve block	Service / renew valve block.
	Filter damaged	Check filter.
Very noisy in 'lock-up'	Torsion damper faulty	Renew torque converter.
Torsional vibrations from engine when in 'lock-up'	Engine RPM is too low, 'lock-up' shift point incorrect	Service / renew valve block.
Loud noise when converter clutch engages	Torsion damper defective	Renew converter.
Engine vibrations when converter clutch engaged	Change point too low	Check valve block.



2.1 ZF 4 HP 24 E TRANSMISSION, GENERAL DESCRIPTION

The ZF Transmission covered in this section comprises a hydrodynamic torque converter, four speed gear train and electronic-hydraulic transmission control unit.



- | | |
|-----------------------------|---|
| 1. Torque converter housing | 5. Oil outlet (drain plug) |
| 2. Main casing | 6. Rotary switch mounting plate |
| 3. Output flange | 7. Dipstick / oil filler tube |
| 4. Oil pan (sump) | 8. Oil cooler connection (one only shown) |

Fig. 1 ZF 4 HP 24 E Transmission

The automatic transmission provides six gearshift positions:

- Position 'P': Park – in this position the driven wheels are mechanically locked at the transmission.
- Position 'R': Reverse – reverse gear selected.
- Position 'N': Neutral – engine disconnected from drive-line and wheels.
- Position 'D': Drive – all four gears are selected automatically with lock-up available in top gear only.
- Position '3': automatic selection of the lowest three gears only.
- Position '2': automatic selection of the lowest two gears only, transmission is prevented from shifting up to the third and top speed ranges.

Immediate selection of a lower ratio is also available by 'kick-down' (pressing the accelerator down beyond the normal full throttle position) for example when overtaking.

2.1.1 Torque Converter

The torque converter serves two main functions: it acts as a fluid coupling between engine and transmission gear train and it provides multiplication of engine torque when required.

The torque converter consists of an impeller, a turbine and a stator which is mounted on a one-way clutch. The converter cover is fixed to the impeller to seal the three elements within a common housing through which oil flows when the transmission is in operation. The impeller is therefore connected to the engine and rotates at engine speed when the engine is operating.

Torque multiplication is at its greatest when the vehicle is driven away from standstill. The stator bears against the housing through its one-way clutch and deflects the oil so that the flow is accelerated. As road speed builds up, the impeller and turbine wheels turn at almost the same speed, so that the stator ceases to accelerate the oil flow and instead is disengaged from the housing and turns freely in the flow of oil. At this stage, the torque converter acts as a fluid coupling.



The torque converter acts in all four forward gears and in reverse. The converter lock-up clutch closes in 4th gear at a point depending on road speed and accelerator position; engine power is then transmitted by purely mechanical means.

A low-loss oil pump in the front of the transmission housing supplies the converter, the epicyclic gear train, the hydraulic control system and the lubrication circuit; oil is drawn from a sump in the bottom of the gear train housing through a filter. The pump drive gear is keyed to the converter impeller hub and therefore turns when the engine is running, thereby pressurizing the oil.

2.1.2 Four-speed Epicyclic Gear Train

The torque converter drives a mechanical epicyclic gear train providing four forward ratios and reverse. Individual ratios are obtained by coupling together the various parts of the gear train by means of solenoid-operated, hydraulically actuated multi-disc clutches and brakes; built in freewheels permit gear shifts without any interruption of the power flow.

For information on the operation of the solenoids, clutches, brakes and freewheels, refer to the table below and the schematic diagrams shown overleaf.

A parking lock pawl is provided at the rear of the gear train, operating on a toothed wheel attached to the output shaft; the parking lock is operated from the selector (position 'P') by actuator rod.

An electro-magnetic sensor detects output shaft revolutions by means of a toothed disc attached to the shaft; one revolution of the shaft is equal to 36 pulses. The electrical signal from the sensor is passed, via a screened cable, to the TCM.

Selected ratios	Solenoid	Resulting clutch operation
D ₁ , 3 ₁ , 2 ₁	MV2	A Clutch drives annulus clockwise D Clutch OWC holds F carrier against shaft clockwise E Clutch & OWC drives output shaft clockwise
D ₂ , 3 ₂ , 2 ₂ , 1 ₂	MV1, MV2	A Clutch drives annulus clockwise C1 Clutch holds sun gear against anti-clockwise C Clutch & OWC holds sun gear against anti-clockwise E Clutch & OWC drives output shaft clockwise
D ₃ , 3 ₃ , 2 ₃	MV1, MV3	A Clutch drives annulus clockwise B Clutch drives sun gear clockwise C Clutch & OWC holds sun gear against anti-clockwise E Clutch & OWC drives output shaft clockwise
D ₄	MV2	A Clutch drives annulus clockwise B Clutch drives sun gear clockwise C Clutch & OWC holds sun gear against anti-clockwise F Clutch holds the sun gear (4th gear only)
R	-	B Clutch drives sun gear clockwise D Clutch holds carrier against clockwise E Clutch & OWC drives output shaft anti-clockwise
Park, Neutral	MV2	E Clutch & OWC applied (hydraulics)

OWC = one way clutch



2.1.3 Operation Of Gear Train Clutches

Operation of the gear train clutches to provide the five gear ratios is as follows:

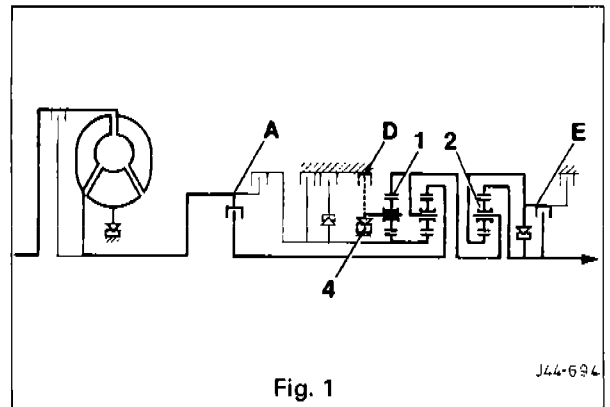
1st Gear

Clutches 'A' and 'E' are engaged.

The front planet gear carrier of gear set '1' is locked against the housing through freewheel '4' when the engine is pulling, but is over-run when the vehicle is coasting.

Epicyclic gear set '2' rotates as a solid block with the second planet set.

There is no engine braking in 1st gear.

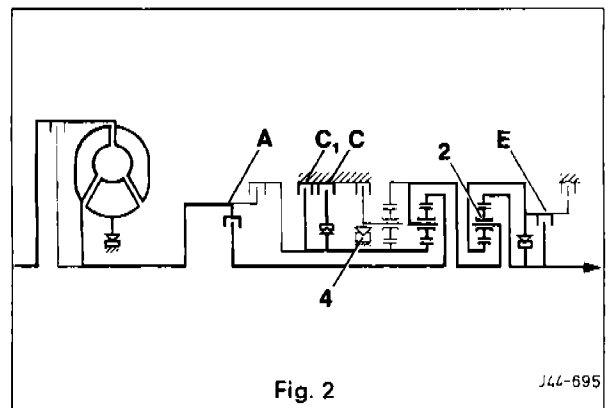


2nd Gear

Clutches 'A','C1','C' and 'E' are engaged.

Freewheel '4' over-runs.

Clutches 'C1' and 'C' lock the sun gear to the housing.

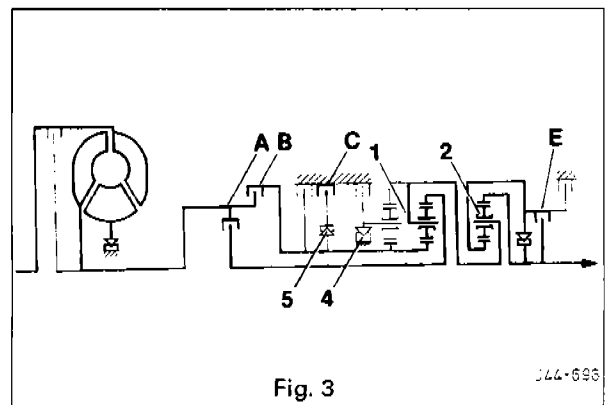


3rd Gear

Clutches 'A','B','C' and 'E' are engaged.

Freewheels '4' and '5' are over-run.

Epicyclic gear sets '1' and '2' rotate as a solid block at a ratio of 1:1.



4th Gear

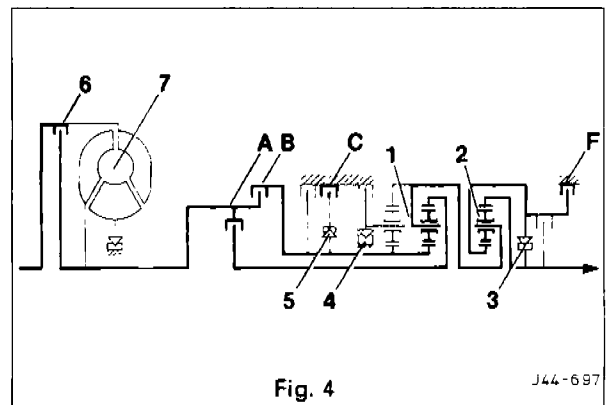
Clutches 'A','B','C' and 'F' are engaged.

Freewheels '3','4' and '5' are over-run.

Epicyclic gear set '1' rotates as a solid block.

The hollow shaft with the sun wheel of epicyclic gear set '2' is locked via clutch 'F' to the housing.

Above a predetermined road speed, lock-up clutch '6' locks torque converter '7' solid to prevent slip.



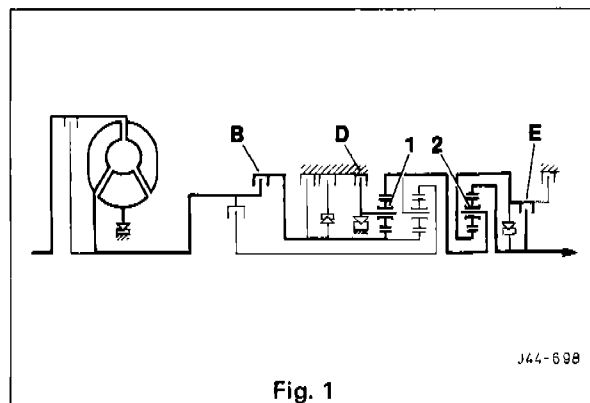


Reverse Gear

Clutches 'B', 'D' and 'E' are engaged.

As the front planet gear carrier of epicyclic gear set '1' is locked, the direction of output shaft rotation is reversed.

Epicyclic gear set '2' also rotates as a solid block.



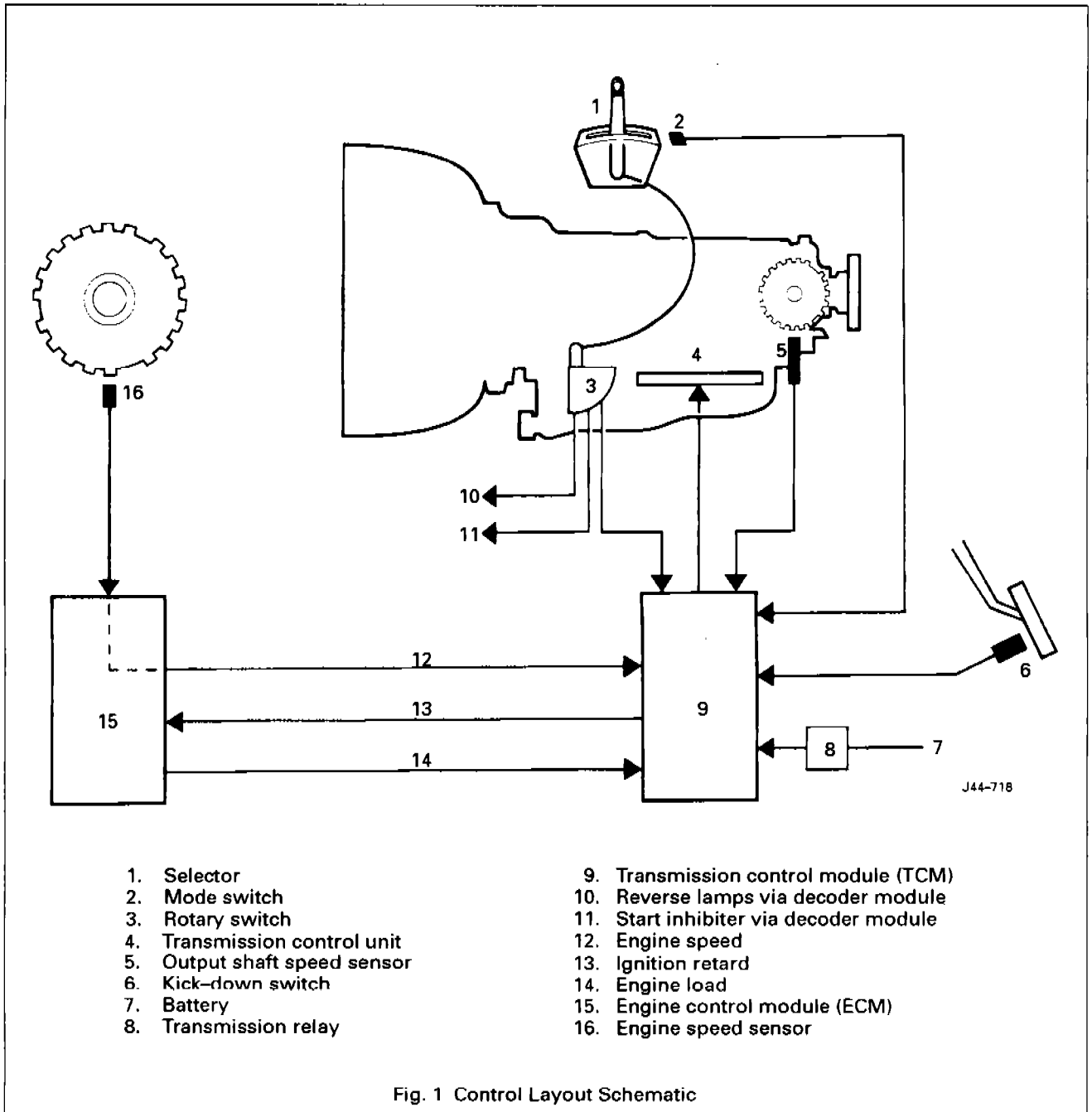
2.1.4 Transmission Control Unit – (Valve Body)

The electronic-hydraulic control unit comprising a series of valve blocks housing a cable-operated manual valve, control pistons and pressure valves is attached to the underside of the transmission housing; the unit controls the operation of the gear train clutches and directs oil pressure to the appropriate system components (refer to illustrations, pages 43 to 46) to understand the operation of the transmission.

The four valve blocks in which the control valves, pistons etc are located, are mounted and connected through a main gallery plate. The three solenoid valves MV1, MV2 and MV3 and the pressure regulator operating solenoid are located on the upper surface of the plate; electrical connections between the solenoids and the transmission and transmission control unit are via cable harnesses (refer to relevant diagrams and tables for details of the various pin connections).

Operation of the transmission control unit is through an electronic Transmission Control Module (TCM) which on receipt of electrical signals from transmission and engine management sources, activates the hydraulic pressure regulating and shift valves via the solenoid valves located on the valve block.

The gear selector in the vehicle transmits movement, via the selector cable, to the selector lever on the side of the gear-box; this rotates the selector shaft which controls the manual selector valve. The rotary position of the shaft is monitored by the rotary switch.



2.1.5 Transmission Control Module (TCM)

The Transmission Control Module (TCM) is an electronic control unit located in the front passenger footwell behind the underscuttle pad. It is electrically connected to the transmission and other components through a cable harness and multiple pin plug.

The TCM continuously monitors the gear lever position selected by the driver (via the rotary transmission switch), the speed of the output shaft (by speed sensor on the output shaft) and throttle position ('kick-down' switch). This information plus input from the Engine Control Module (ECM) of throttle angle and engine speed and load in conjunction with a pre-programmed control map, enables the most suitable gear to be selected.

The TCM, by operating solenoid valves MV1, MV2 and MV3, controls which gear is selected, and in conjunction with the solenoid operated pressure control valve, controls the gear shift quality. Gear shift quality on upshifts is improved by the TCM momentarily retarding the ignition to reduce the torque input as the gear change takes place. Information is fed to the TCM from sensors and if any electronic component fails, the basic shift changes will be performed by the hydro-mechanical system, ie Park, Reverse, Neutral, D3 or D4.



2.1.6 *Transmission Rotary Switch*

This switch is located on a square extension of the transmission selector shaft, which is linked to the shift lever via the selector cable. The switch comprises a selector bar which moves across a series of copper segments located on the switch quadrant. The copper segments are set out in seven bands, each band providing an electrical output or combination of outputs to the TCM.

The electrical outputs to the TCM are in the form of a three-digit code which takes up three of the seven bands of the quadrant; the remaining four bands are used for reverse, ground and start inhibit.

2.1.7 *Decoder Module*

The decoder module, located on the right hand side of the J-gate assembly, is used to translate the three-digit codes from the rotary transmission switch into single-line functions to feed the illumination module and to provide the following information:

- Cruise control, ie when cruise control can or cannot be engaged.
- Indication when the vehicle is not in 'P' Park.
- Provide the ECM with a Park / Neutral signal.

2.1.8 *Performance Mode Switch*

This switch, located on the shift lever surround, provides two alternative shift patterns:

- 'Normal Mode' – for everyday use,
- 'Sport Mode' – gear changes take place at higher road speeds in order to enhance performance.

Note: Torque converter 'lock-up' occurs in fourth gear in each mode.

2.1.9 *'Kick-down' Mechanism*

'Kick-down' is activated by the final travel of the accelerator pedal which contacts a floor-mounted switch located behind the pedal. Operation of the switch provides a signal to the TCM that a downward change is required. The switch is adjustable to ensure that the pedal does not overtravel and stretch the cable.

2.1.10 *Reverse Safety Inhibit*

If 'R' Reverse is selected when the vehicle is travelling forwards at more than 5 mile / h, solenoid valve MV2 will be energised to prevent engagement of reverse gear.

2.1.11 *Gearshift Interlock*

A brake pedal / gearshift interlock is incorporated in the gear selector mechanism. The gear selector lever may only be moved from the P – Park position if the ignition key switch is in position II and the foot brake is applied.

The ignition key cannot be removed from the ignition switch unless the shift lever is in the 'P' – Park position. Once the ignition key has been removed, the shift lever is locked in the park position.

2.1.12 *Starter Inhibit Function*

The starter inhibit function prevents the starter motor from being operated when the shift lever is not in position 'P' – Park or position 'N' – Neutral. The signal is generated from the rotary switch position.



2.1.13 Harness Connections

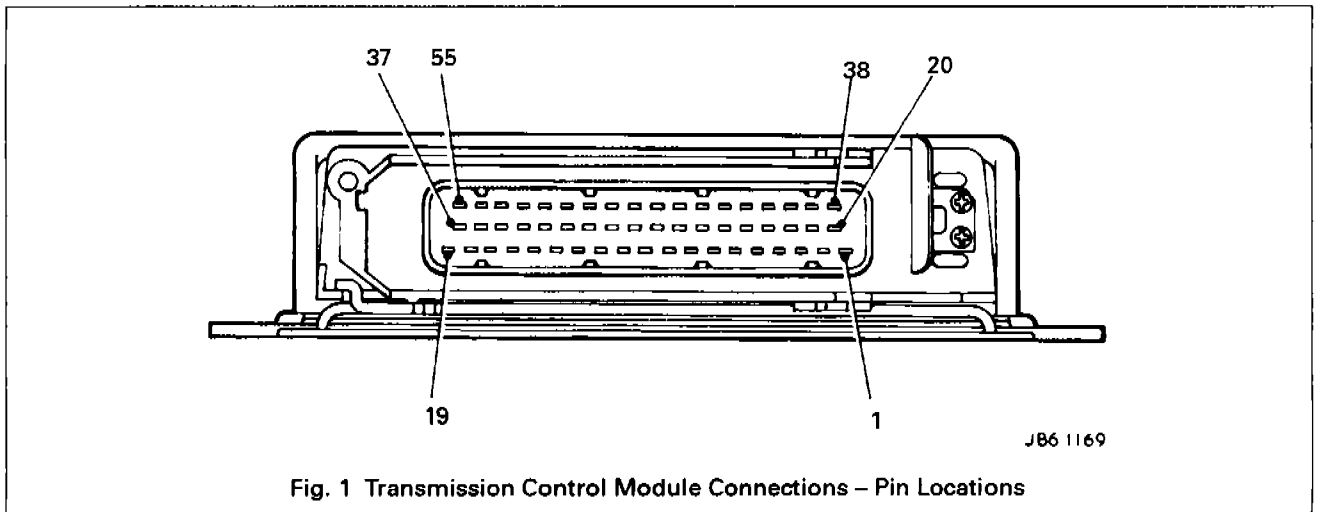


Fig. 1 Transmission Control Module Connections – Pin Locations

Pin	Function	Pin	Function
1	Power supply input	29	Program switch / Traction control input
2	Vehicle speed sensor plus input	30–31	not used
3	Engine speed input	32	Torque reduction T (I) output
4	Program switch input	33	Position code Z input
5	Solenoid valve MV1 output	34–37	not used
6	Pressure control valve PCV output	38	Vehicle speed sensor minus input
7	Digital ground input	39–40	not used
8–13	not used	41	Kick down switch input
14	Position code Y output	42	Solenoid valve lock-up MV WK output
15	Diagnostic L-line	43	not used
16	Transmission malfunction indicator lamp output	44	Oil temperature sensor ground
17–18	not used	45	not used
19	Solenoid valves plus input	46	Oil temperature sensor input
20	Vehicle speed sensor screen	47	Throttle position input
21	Engine torque signal T(T) input	48	not used
22–23	not used	49	Sport mode indicator output
24	Solenoid valve MV2 output	50	Position code X input
25	not used	51	Diagnostics K-line
26	Power ground input	52–55	not used
27–28	not used		



2.1.14 Rotary Switch Harness

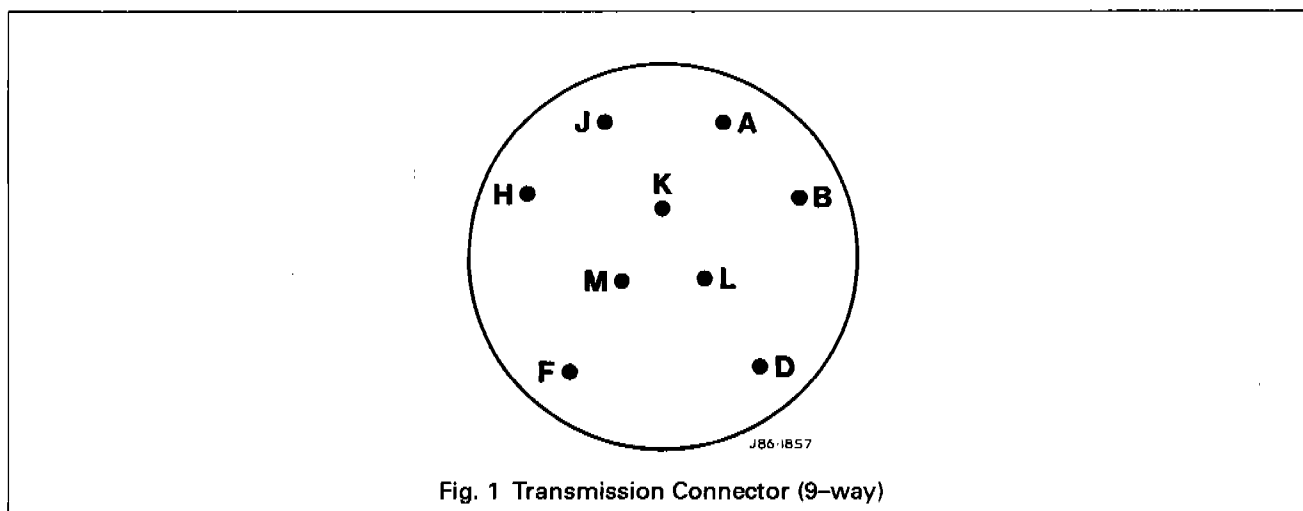


Fig. 1 Transmission Connector (9-way)

Pin	Color	Size (mm ²)	Function
A	UIN	0.5	Speed sensor (-)
B	OG	0.5	Pressure regulator solenoid valve
D	YG	0.5	Oil temperature sensor input
F	RIN	0.5	Speed sensor (+)
H	YB	1.0	Solenoid valve 1 (MV1)
J	BG	0.5	Oil temperature sensor ground
K	YP	1.0	Solenoid valve 2 (MV2)
L	YU	1.0	Lock-up solenoid (MVK)
M	RY	1.0	Solenoid supply

Color Code

N	Brown	Y	Yellow
B	Black	O	Orange
W	White	S	Slate
K	Pink	L	Light
G	Green	P	Purple
R	Red	U	Blue
I	Indigo		



2.1.15 Main harness connectors – 12 way & 8 way

Pin	Size (mm ²)	Function
12-way connector		
1A	0.5	Switch common
2A	0.5	Code X output
3A	0.5	Code Y output
4A	0.5	Code Z output
5A	-	N / C
6A	-	N / C
7A	-	N / C
8A	0.5	Oil temperature signal
9A	0.5	Oil temperature ground
10A	0.5	Road speed screen
11A	0.5	Road speed sensor
12A	0.5	Road speed sensor

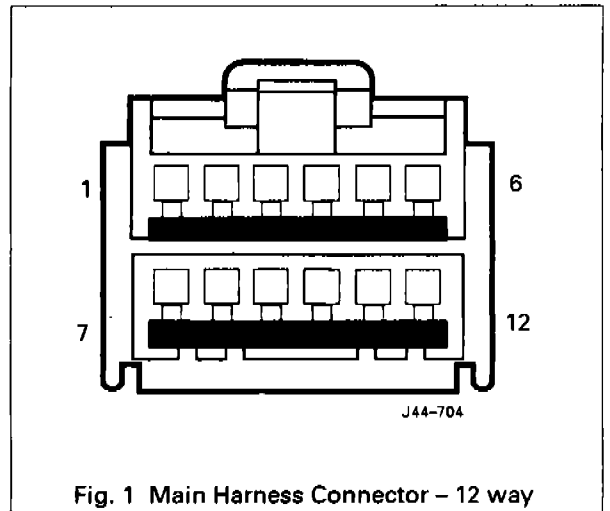


Fig. 1 Main Harness Connector – 12 way

Pin	Size (mm ²)	Function
8-way connector		
1B	1.0	Solenoids output
2B	1.0	MV1 solenoid
3B	1.0	MV2 solenoid
4B	1.0	MV WK solenoid
5B	0.5	Pressure regulator
6B	0.5	Start inhibit output
7B	0.5	Start inhibit ground
8B	0.5	Reverse lights output

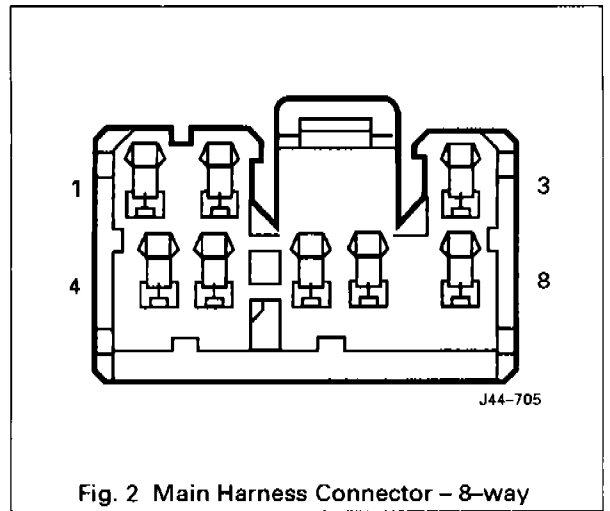


Fig. 2 Main Harness Connector – 8-way



2.2 HYDRAULIC CIRCUIT DIAGRAMS

Component Engagement

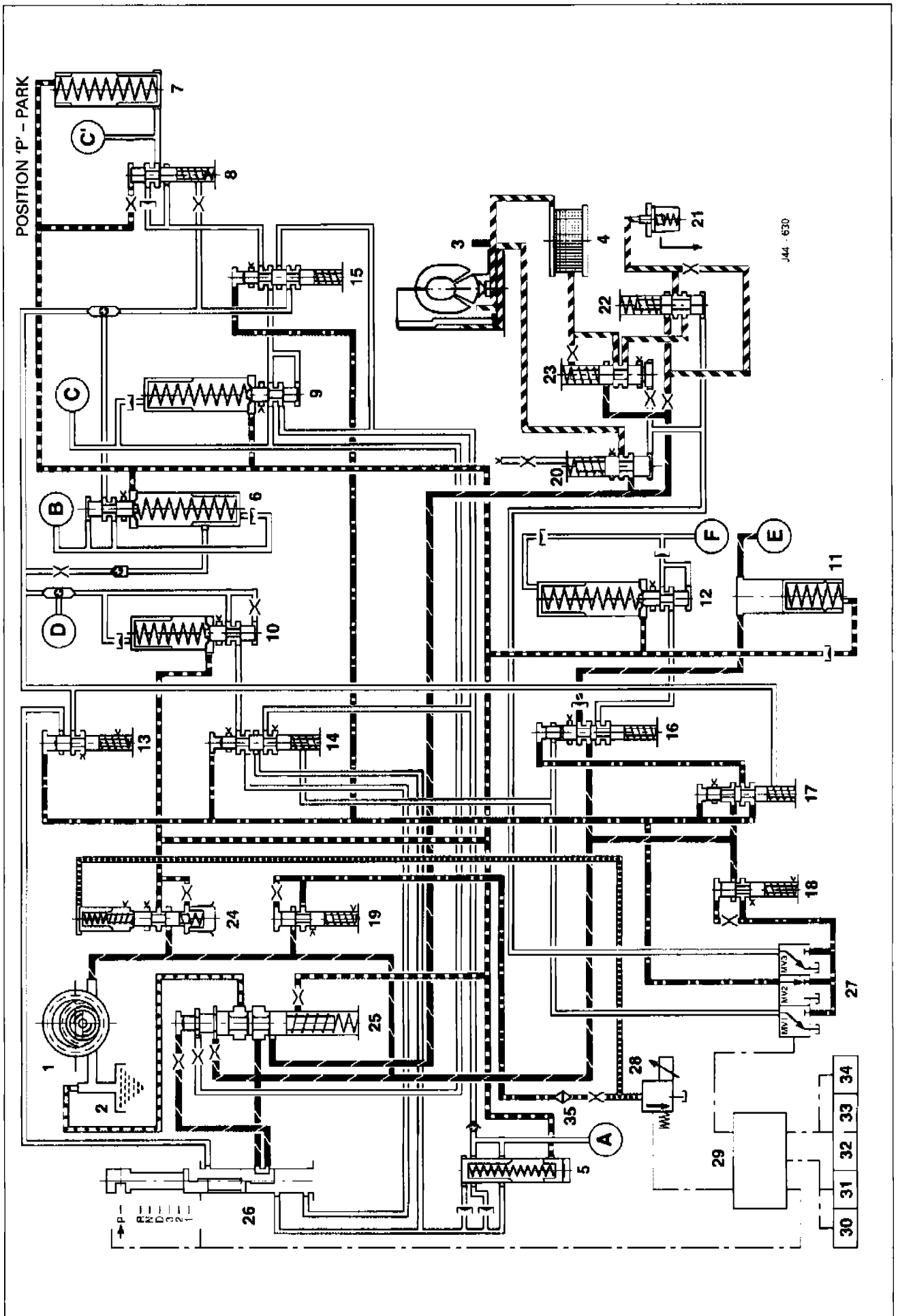
Selector Position	Gear	Solenoid Valves			Clutches							Free-wheel				Converter Clutch
		MV 1	MV 2	MV 3	A	B	E	C ¹	C	D	F	G	H	J	K	
P			*				*									
R	R					*	*			*		*				
N			*				*									
D	1		*		*		*					*		*	*	
D	2	*	*		*		*	*	*			*	*		*	
D	3	*			*	*	*		*			*			*	
D	4				*	*			*		*	*				
D	4			*	*	*			*		*	*				*
3	1		*		*		*					*		*	*	
3	2	*	*		*		*	*	*			*	*		*	
3	3	*			*	*	*		*			*			*	
2	1		*		*		*					*		*	*	
2	2	*	*		*		*	*	*			*	*		*	

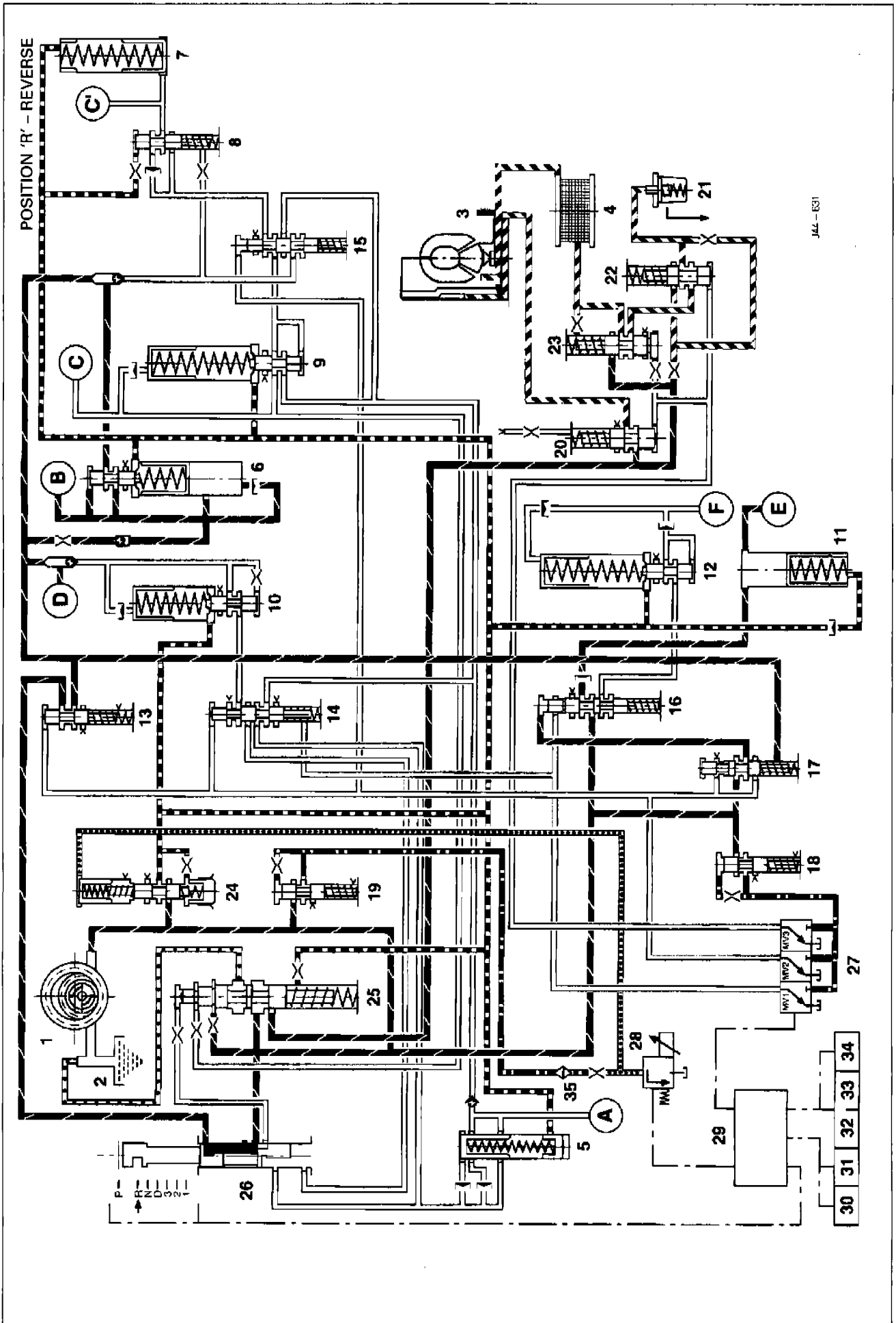
Key To Hydraulic Diagrams (commencing on page 52)

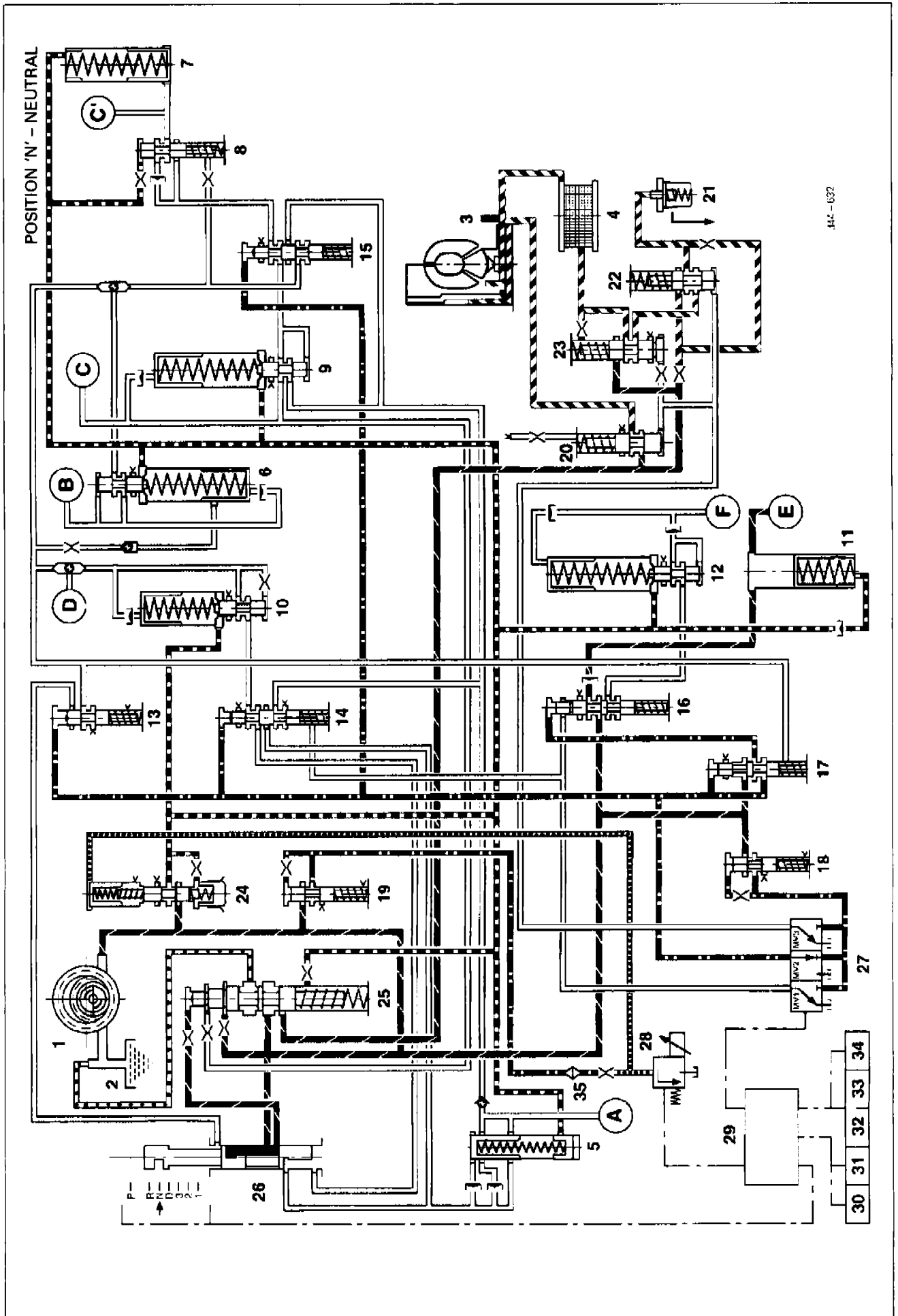
- | | |
|------------------------------------|-------------------------------------|
| 1. Oil pump | 19. Pressure valve 2 |
| 2. Sump | 20. Torque converter pressure valve |
| 3. Torque converter | 21. Lubrication valve |
| 4. Oil cooler | 22. Lubrication valve |
| 5. Clutch 'A' damper | 23. Lock-up control valve |
| 6. Clutch 'B' valve and damper | 24. Modulation pressure valve |
| 7. Clutch 'C ¹ ' damper | 25. Main pressure valve |
| 8. Clutch 'C ¹ ' valve | 26. Gear change valve |
| 9. Clutch 'C' valve and damper | 27. Solenoid valves MV1/MV2/ MV3 |
| 10. Clutch 'D' valve and damper | 28. Pressure regulator |
| 11. Clutch 'E' damper | 29. ECM - inputs and outputs |
| 12. Clutch 'F' valve and damper | 30. Engine torque |
| 13. Reverse locking valve | 31. Throttle valve |
| 14. Shift valve 1 - 2 | 32. Engine speed (RPM) |
| 15. Shift valve 2 - 3 | 33. Transmission speed (RPM) |
| 16. Shift valve 3 - 4 | 34. Transmission rotary switch |
| 17. Safety valve | 35. Oil filter |
| 18. Pressure valve 1 | |

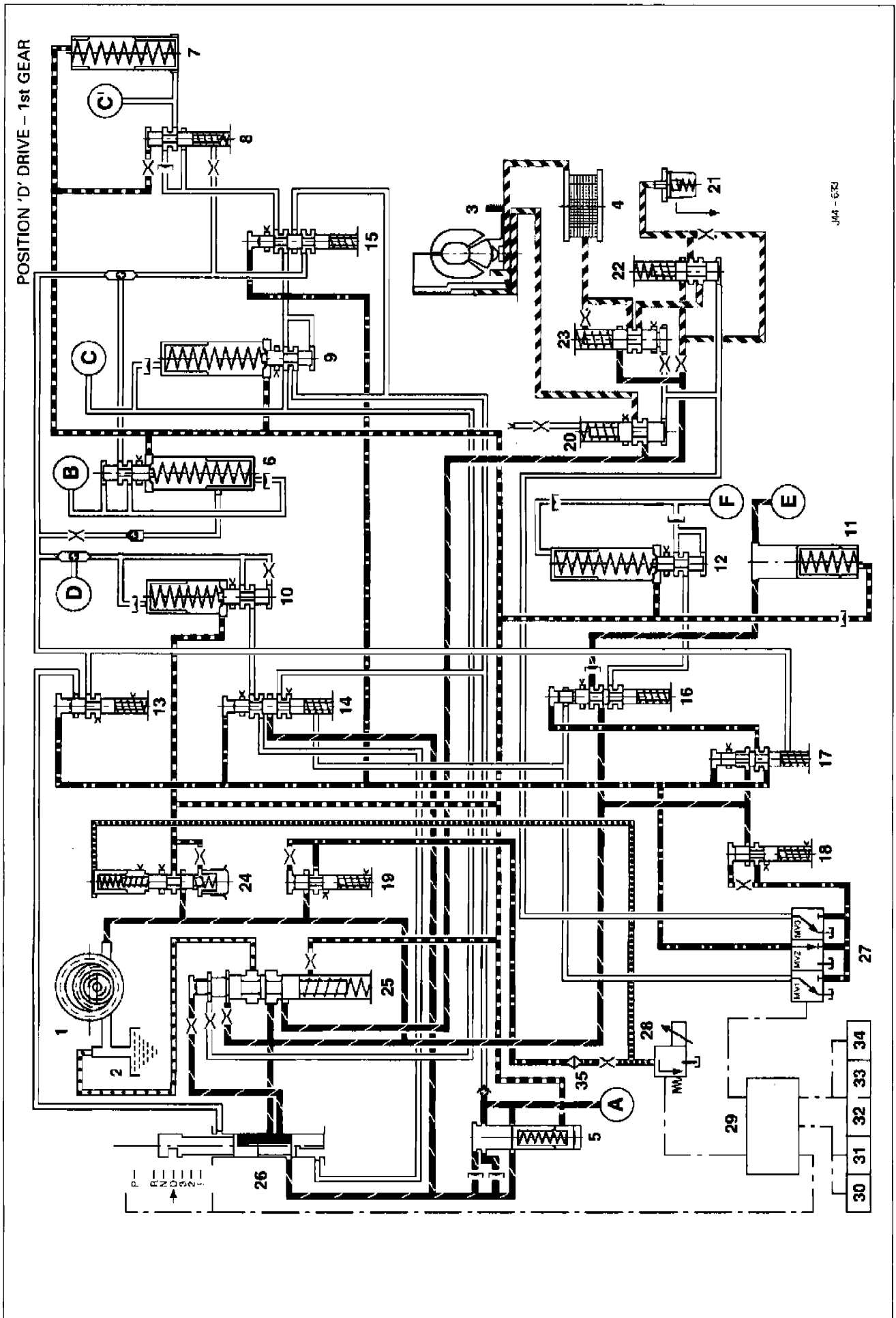
- | | | | | | |
|----------------|--------------------------|---|------------|---|----------------------------|
| A | Clutch 'A' | D | Clutch 'D' | G | Torque converter freewheel |
| B | Clutch 'B' | E | Clutch 'E' | H | (C) Clutch freewheel |
| C | Clutch 'C' | F | Clutch 'F' | J | (D) Clutch freewheel |
| C ¹ | Clutch 'C ¹ ' | | | K | (E) Clutch freewheel |

- | | | | |
|--|--------------------|--|----------------------|
| | Exhaust | | Reduced pressure |
| | Throttle | | Modulation pressure |
| | Orifice | | Sump |
| | Main pressure | | Lubrication pressure |
| | Converter pressure | | |
| | Throttle pressure | | |



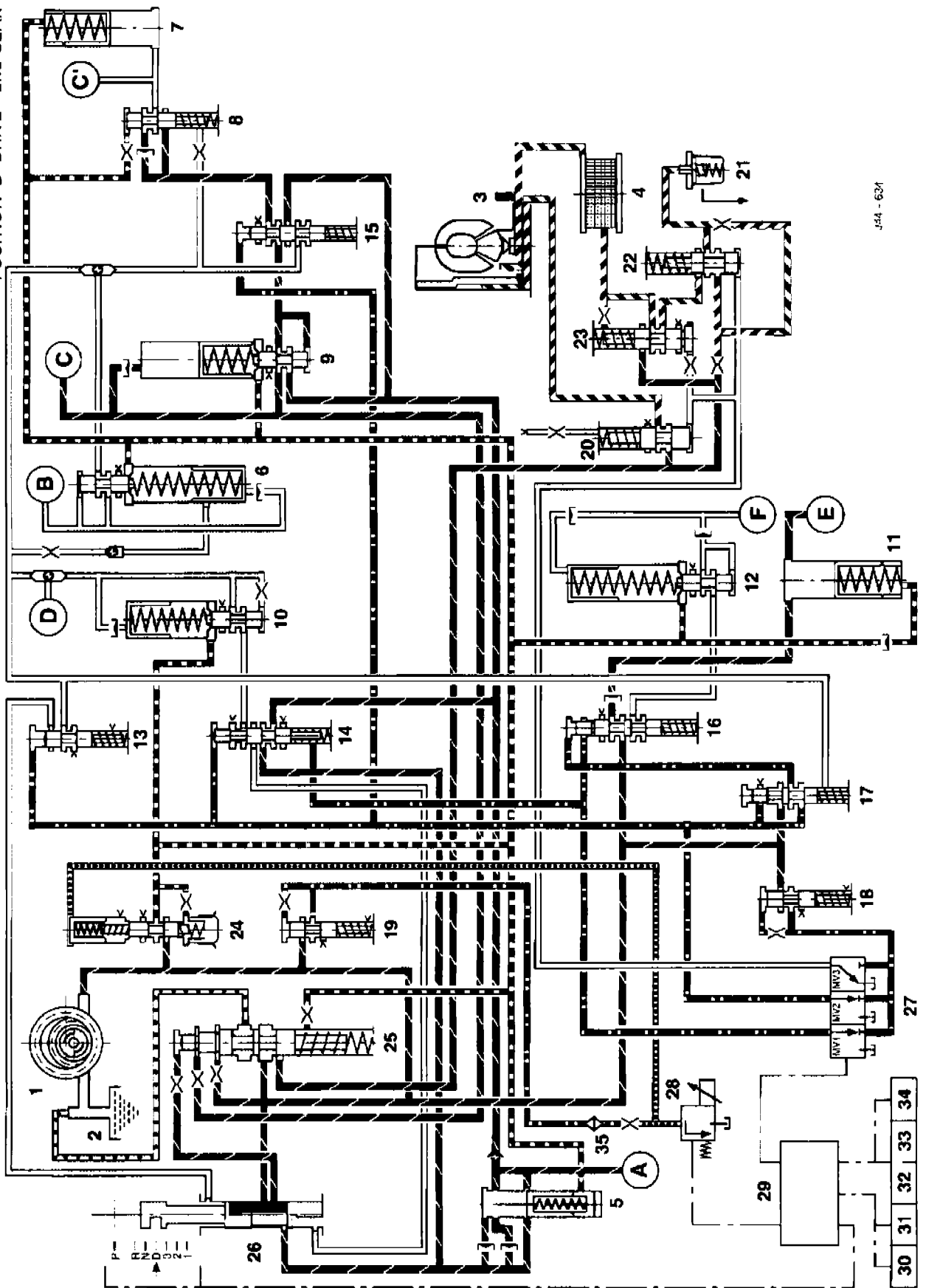




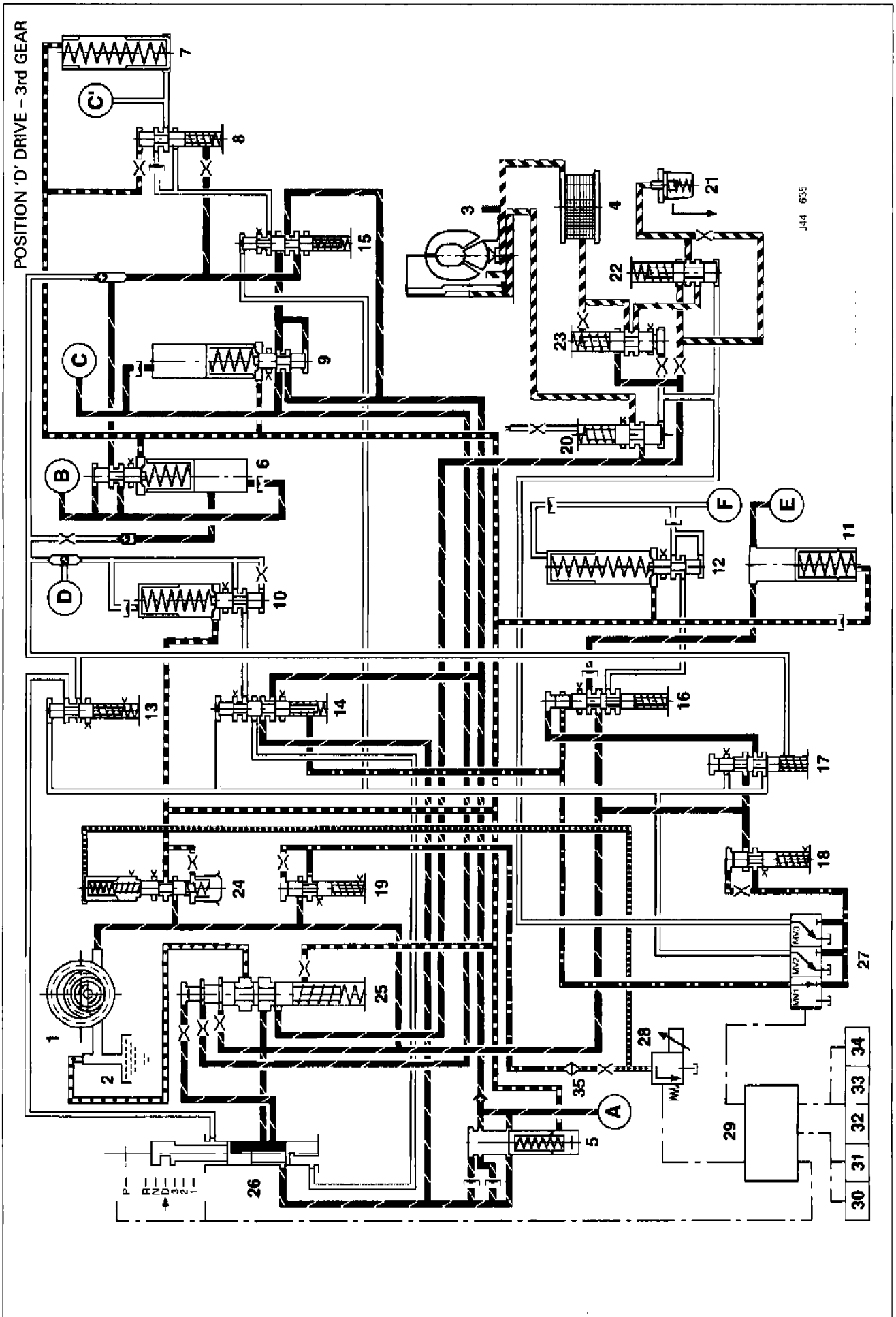


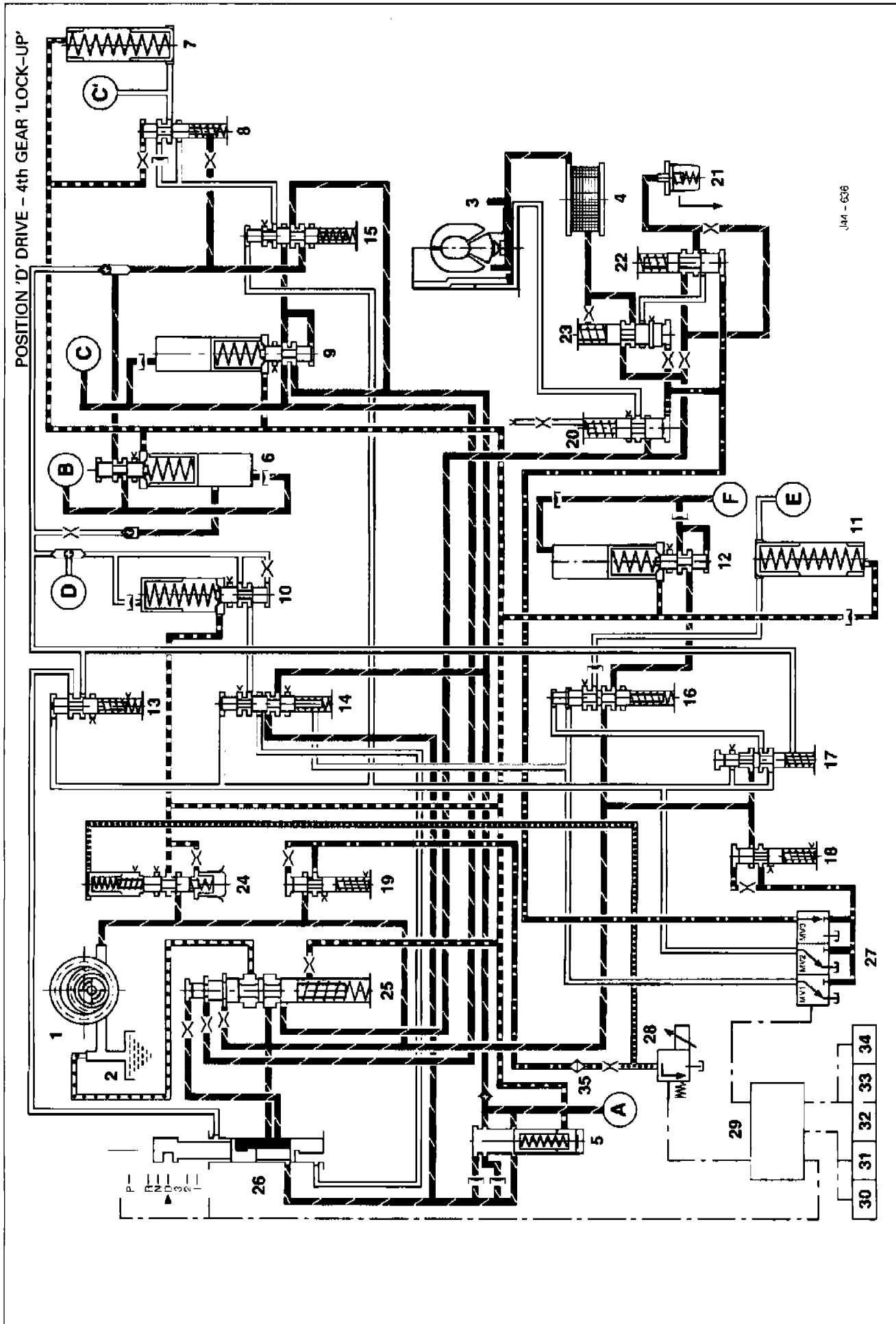


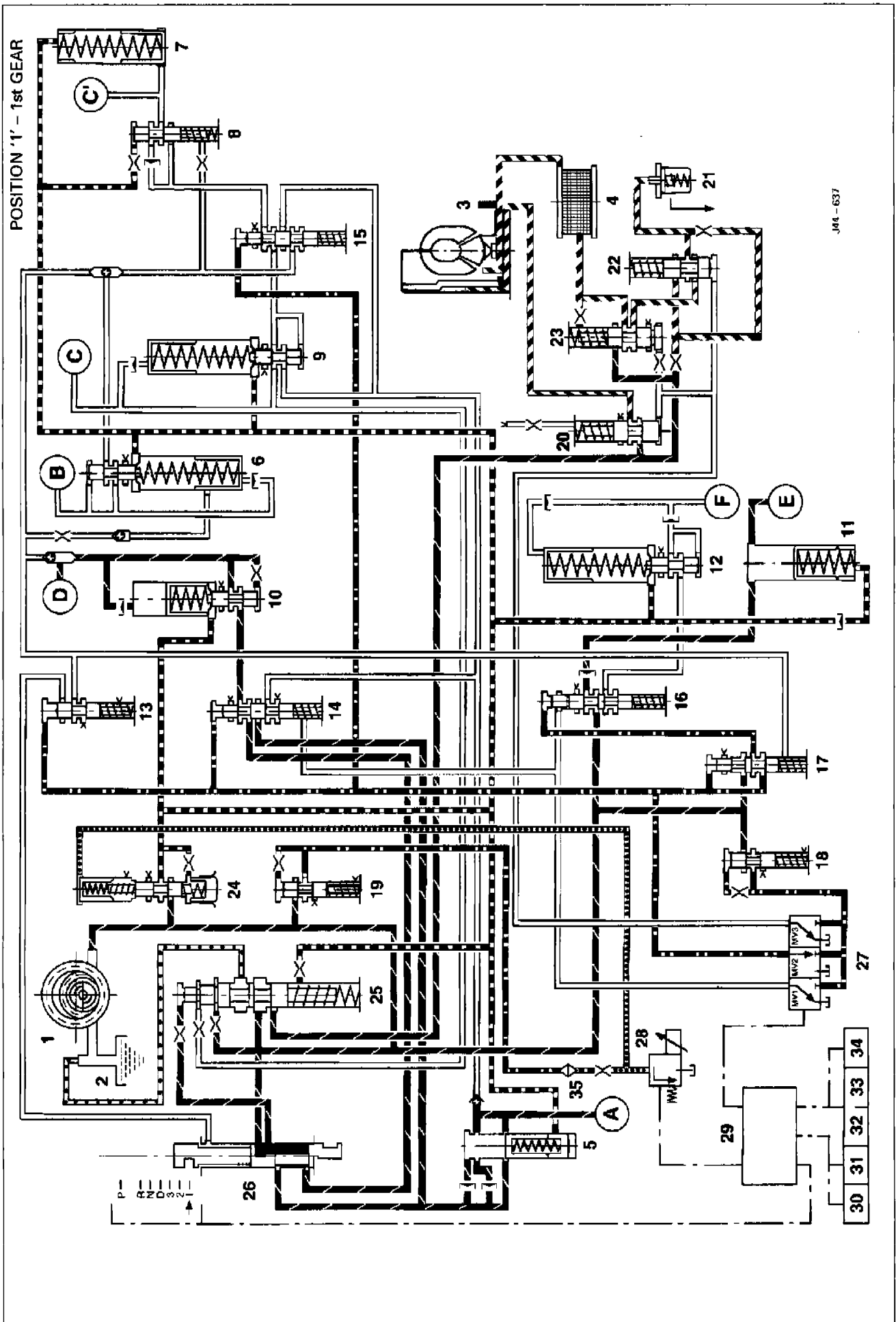
POSITION 'D' DRIVE - 2nd GEAR



J44 - 634









2.3 FAULT DIAGNOSIS

The following tables are intended as a guide to diagnosis of possible faults in the ZF 4 HP 24 E transmission. When the fault involves a leak, it is recommended that it is located by the use of a crack detection fluid, eg. Met-L-Check, which is available in spray form and permits the leak to be located after a short test drive.

2.3.1 Initial Checks

Note: Before attempting fault diagnosis, ensure that the following settings are checked:

Transmission oil level

- Ensure that the transmission is at normal operating temperature, e.g. by conducting a 20 mile road test. If starting from cold: check for presence of oil on dipstick at idle in 'P' Park to the 'Cold' fill mark before setting off.
- Check that the vehicle is on level ground.
- Firmly apply the parking and foot brakes and run the engine at idle speed.
- To ensure that the system is primed, slowly move the selector lever through all the gear positions.
- With the engine still running, engage 'P' Park, withdraw the dipstick and wipe with a lint free cloth.
- Replace the dipstick slowly and withdraw it noting the level.
- Top up as required and recheck the level.

Note: The oil level can only be accurately checked when at normal temperature – approximately 20 miles at moderate speeds.

2.3.2 Selector Cable Adjustment

- Check gear selection in all selector positions.
- If in doubt, select 'N', disconnect the cable at the gearbox selector lever, check that the gearbox lever is in 'N' position (third detent from the rear) and refit the selector cable ball pin to the lever.
- Adjust as necessary at the selector lever inside the vehicle.

2.3.3 Stall Test

- Ensure the transmission is at normal running temperature.
- Fully apply the parking brake.
- Start the engine.
- Fully depress the footbrake.
- Select position 'D'– Drive.
- Fully depress the accelerator ('kick-down' switch fully depressed).
- Note the tachometer reading.
- Compare the tachometer reading to the specification.

CAUTION: This test must not last more than 5 seconds. Always allow the engine to idle for at least 2 minutes between tests to allow the transmission fluid to cool down. Do not carry out more than three tests in any half-hour.

Jaguar Diagnostic Equipment (JDE) must be interrogated and any faults identified and rectified (see JDS Manual / Instructions). Check mode switch and gear selector positions using JDE.



2.3.4 Road Test

- Fully check all shift speeds and note. Compare the results with the specification in addition to general observations of transmission behaviour, noises, leaks etc., and consult the following Fault Finding Chart.

CAUTION: When renewing the transmission, ALWAYS flush out the oil cooler and feed and return pipes.

2.3.5 Electrical Checks

- Check 'Kick-down'.
- If any electrical component fault is suspected, refer to Electrical Diagnostic Manual (EDM) to verify the failure mode before a repair or replacement is attempted.

2.3.6 Fault Finding Chart

Problem	Possible Cause	Action
Converter		
Stall speed too low	Stator freewheel faulty allowing stator to revolve	Renew torque converter.
	Engine out of tune	Check engine tune.
Stall speed too high and keeps rising	Transmission slip	Check oil level, check mechanical failure, renew transmission as necessary.
	Engine out of tune	Check engine tune.
Acceleration below specification	Torque converter freewheel faulty allowing stator to revolve	Renew torque converter.
	'Kick-down' switch defective	Refer to EDM, rectify / renew 'Kick-down' switch.
	Transmission in 'Limp Home' mode	Check.
	Engine out of tune	Check engine tune.
Top speed below specification	Torque converter freewheel seized	Renew torque converter.
	Engine out of tune	Check engine tune.
Position 'P' - Park		
Will not move out of Park	Gearshift interlock failure	Refer to EDM, rectify – renew fuse, check circuits, renew relay and solenoid if necessary. Check central 'P', check Park switch, check Brake switch.
	Cable out of adjustment	Adjust to correct setting.
Does not engage Park	Parking pawl mechanism sticking	Renew park pawl components: connecting bar, pawl pin, torsion spring, pawl, guide piece and guide sheet.
	Cable out of adjustment	Adjust to correct setting.
Does not hold	Parking pawl mechanism damaged	Replace park pawl components.
	Cable out of adjustment	Adjust to correct setting.



2.3.6 Fault Finding Chart (continued)

Problem	Possible Cause	Action
Starter motor does not operate	Rotary switch adjustment	Adjust switch.
	Rotary switch wiring fault	Rectify.
	Rotary switch faulty	Rectify or renew.
	Position 'P' or 'N' not selected	Select 'P' or 'N'.
Position 'R' – Reverse		
Reverse gear inoperative	MV2 faulty	Renew valve block.
	Wire to MV2 earthed	Renew harness.
	Oil filter dirty	Clean / replace filter and flush out the oil cooler and pipes.
	Damper 'B' faulty	Renew valve block.
	Clutch 'B' faulty (also no 3rd gear)	Renew transmission.
	Clutch 'D' faulty	Renew transmission.
	Clutch 'E' faulty (also no engine braking in 2nd and 3rd gears)	Renew transmission.
	Pressure regulator valve 1, spring binding	Fit new spring.
	Rotary switch wiring fault	Rectify.
	Rotary switch faulty	Rectify or renew.
Reverse gear inhibit valve activated	Check for electrical faults – renew valve block.	
Main pressure control valve seized (also no forward drive in 'D' Drive)	Renew valve block.	
Slipping and juddering	'B' Clutch, 'D' Clutch or 'E' Clutch faulty	Renew transmission.
	Pressure regulator valve 1, spring binding	Fit new spring.
	'F' Clutch drum sealing rings faulty causing loss of 'E' Clutch pressure	Renew transmission.
Harsh engagement 'P-R' change, 'N-R' change (below 1500RPM engine speed)	Damper 'B' faulty (also no 2nd to 3rd shift)	Renew valve block.
	Pressure regulator valve 1 binding	Renew valve block.
	Modulation pressure too high	Check TCM Fault Codes.
	Rotary switch faulty	Rectify or renew.
Reverse lamp does not illuminate (bulbs, fuses and cables functioning correctly)	Rotary switch setting incorrect	Adjust setting.
	Rotary switch faulty	Renew.
	Rotary switch wiring fault	Rectify.



2.3.6 Fault Finding Chart (continued)

Problem	Possible Cause	Action
Position 'N' - Neutral		
Starter will not operate	Rotary switch faulty or incorrect setting	Rectify or renew.
	Rotary switch wiring fault	Rectify Check Security System.
Vehicle moves	'A' Clutch seized	Renew transmission.
Position 'D' - Drive		
Drive not transmitted (neutral condition)	Oil filter dirty	Clean / replace filter.
	Main pressure control valve seized	Renew valve block.
	Low oil level	Check oil level.
	'A' Clutch faulty	Renew transmission.
	'D' Clutch one-way clutch slips	Renew transmission.
Slipping and juddering at start	'A' Clutch faulty	Renew transmission.
	Low oil level	Check oil level.
Harsh engagement 'N'-'D'(under 1500RPM engine speed)	'A' Clutch faulty	Renew transmission.
	'A' Clutch damper faulty (5)	Renew valve block.
	Throttle pot. volts high	Check throttle pot. volts.
	Rotary switch faulty / out of adjustment	Rectify or renew.
No 1st to 2nd upshift or 2nd to 1st downshift	MV1 wire earthed(remains in 2nd gear)	Renew harness.
	MV1 faulty	Renew valve block.
	Control circuit fault	Check TCM Diagnostics / rectify.
	Shift valve 1-2 seized	Renew valve block.
	Pressure reducing valve 1 seized	Renew valve block.
	Speed sensor or connectors faulty	Check connections, rectify or renew.
No upshift 1st to 2nd	Clutches 'C1' and 'C' faulty	Renew transmission.
No upshift 2nd to 3rd or downshift 3rd to 2nd	MV2 wire earthed (remains in 2nd gear)	Renew harness.
	MV2 faulty	Renew valve block.
	Shift valve 2-3 seized	Renew valve block.
	Speed sensor faulty	Rectify or renew.
No upshift 2nd to 3rd	'B' Clutch faulty	Renew transmission.



2.3.6 Fault Finding Chart (continued)

Problem	Possible Cause	Action
No upshift 3rd to 4th or downshift 4th to 3rd	Shift valve 3-4 seized	Renew valve block.
	MV1 wire earthed	Renew harness.
	MV1 faulty	Renew valve block.
	Speed sensor faulty	Rectify or renew.
No upshift 3rd to 4th	'F' Clutch faulty	Renew transmission.
Downshift 4th to 3rd too hard	Drain orifice 'F' partially blocked	Renew valve block.
	Damper 'E' faulty	Renew valve block.
Manual gearshift D to 3rd too hard	Damper 'E' faulty	Renew valve block.
	Drain orifice 'F' partially blocked	Renew valve block.
Manual gearshift 3rd to 2nd too hard	Damper 'C1' faulty	Renew valve block.
No 1st gear; 2nd gear start only.	Speed sensor faulty	Check or renew speed sensor.
	MV1 faulty	Renew valve block.
	MV1 wire earthed	Renew harness.
	Shift valve 1-2 seized	Renew valve block.
	'1st Gear Inhibit' circuit operated or 'Performance Mode' switch faulty	Operate 'Performance Mode' switch to correct function or renew switch.
No 1st or 2nd gear; 3rd gear start only	Transmission 'Limp Home' mode	Check Diagnostics / JDS.
	Speed sensor faulty	Renew speed sensor.
	MV1 or MV2 faulty	Renew valve block.
	Shift valves 1-2 and 2-3 seized	Renew valve block.
No 2nd gear; transmission shifts 1st to 3rd gear	Speed sensor faulty	Check or recheck Diagnostics, renew speed sensor.
	Shift valve 2-3 seized	Renew valve block.
Light throttle gear change speeds incorrect	Shift valves sticking	Renew valve block.
	Speed sensor faulty	Check or renew speed sensor.
	Throttle pot. volts incorrect	Check voltage - JDS.
	Transmission Control Module (TCM)	Check TCM Diagnostics.
Up to 'kick-down' detent, gear change speeds not to specification	'Kick-down' switch out of adjustment	Re-adjust 'kick-down' switch.



2.3.6 Fault Finding Chart (continued)

Problem	Possible Cause	Action
No 'kick-down' change	'Kick-down' switch out of adjustment / full throttle stop adjustment	Adjust as per Engine Set Up procedure on JDS.
	'Kick-down' switch faulty	Renew 'kick-down' switch.
	'Kick-down' switch connector or wiring faulty	Rectify.
Light throttle speeds only	TCM faulty	Check TCM.
Light throttle gear change too hard	Valve block bolt torque incorrect	Reset to correct torque.
	Modulation pressure too high	Renew valve block.
	Damper faulty	Renew valve block.
	Clutch plates faulty	Renew gear unit.
1st to 2nd, 2nd to 3rd and 3rd to 4th changes too long	Valve block bolt torque incorrect	Reset to correct torque.
	Damper faulty	Renew valve block.
	PRSV faulty	Renew valve block.
	PRSV wire earthed	Renew harness.
	Modulation valve seized	Renew valve block.
	Pressure regulator valves 1 and 2 seized	Renew valve block.
Full load and 'kick-down' changes too long	Valve block bolt torque incorrect	Reset to correct torque.
	Modulation pressure too low	Renew valve block.
	Clutch plates faulty	Renew transmission.
Full load and 'kick-down' changes too hard	Valve block bolt torque incorrect	Reset to correct torque.
	Modulation pressure too low	Renew valve block.
	Clutch plates faulty	Renew transmission.
Position '3' - 3rd gear		
No engine braking	Clutch 'E' faulty	Renew transmission.
Position '2' - 2nd gear		
No engine braking	Clutch 'C1' or Clutch 'E' faulty	Renew transmission.
Manual gear change 3rd to 2nd inoperative	Speed sensor faulty	Check TCM Diagnostics / renew speed sensor.
	MV2 faulty	Renew valve block.



2.3.6 Fault Finding Chart (continued)

Problem	Possible Cause	Action	
Converter clutch			
Clutch engagement speed incorrect	Control circuit fault	Check TCM Diagnostics / rectify fault.	
	Speed sensor faulty	Check TCM Diagnostics / renew speed sensor.	
Engagement too hard	Valve body problem	Renew valve body.	
	Converter unit faulty	Renew converter unit.	
No clutch engagement	Control circuit fault	Check TCM Diagnostics / rectify fault.	
	MV3 faulty	Renew valve block.	
	Converter clutch valve seized	Renew valve block.	
	Converter faulty	Renew converter.	
Converter clutch engaging at idle (engine will not idle in 'D')	Pressure reducing valve 1 seized	Renew valve block.	
	Incorrect oil level	Check oil level.	
	Oil filter not sealing	Check O-ring etc..	
	Control circuit fault	Check TCM Diagnostics / rectify fault.	
	MV3 faulty	Renew valve block.	
Leaks	MV3 wire earthed	Renew harness.	
	Converter clutch valve sticking	Renew valve block.	
	Oil in bell housing	Oil pump seal leaking	Renew oil pump seal.
		Oil pump O-ring leaking	Renew O-ring.
		Pump housing leaking	Renew oil pump.
		Converter seam leaking	Renew converter.
	Leakage between gearbox and sump	Loose fastening screws	Torque tighten.
		Sump gasket faulty	Renew gasket.
Leakage between intermediate plate and gearbox	Bell housing to gearbox screws loose	Torque tighten.	
Leakage at harness plug connector	Connector O-ring faulty	Renew O-ring.	
Leakage at drive flange	Rear oil seal faulty	Renew oil seal.	



2.3.6 Fault Finding Chart (continued)

Problem	Possible Cause	Action
Leakage at breather	Oil level too high	Rectify.
	Incorrect oil specification	Change oil and flush system.
	Breather cover missing	Replace breather cover.
	Breather cover O-ring faulty	Renew O-ring.
	Breather cover loose	Renew lockwasher.
Leakage from oil cooler circuit	Pipe lock nuts loose	Torque tighten.
	Pipe line faulty	Renew relevant pipes.
	Oil cooler leaking	Renew oil cooler.
Leakage at intermediate plate	Intermediate plate plug leaking	Torque tighten plug. Renew sealing washer.
Leakage between gearbox and extension housing	Fastening screws loose	Torque tighten.
	Gasket faulty	Renew gasket.
General		
Noise and associated interruption of power	Oil filter dirty	Clean / replace filter. If clutch debris found, renew transmission, flush cooling system.
Loud noise with no drive forward or reverse	Drive plate to converter connection damaged	Renew drive plate and converter as necessary.
	Pump drive damaged	Renew transmission.
Groaning or buzzing noise (can sound like mechanical damage) in all selector positions, especially when cold. Sucking noise from pump.	Oil level too low	Rectify.
	Valve block leaking	Renew valve block.
Loud noise on converter clutch engagement	Torsion damper defective	Renew converter.
Engine vibrations when converter clutch engaged	Change point too low	Check TCM.



2.4 SERVICE OPERATIONS

2.4.1 ZF 4 HP 22 Transmission

[SROs to be added when available]

2.4.2 ZF 4 HP 24 E Transmission

[SROs to be added when available]



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