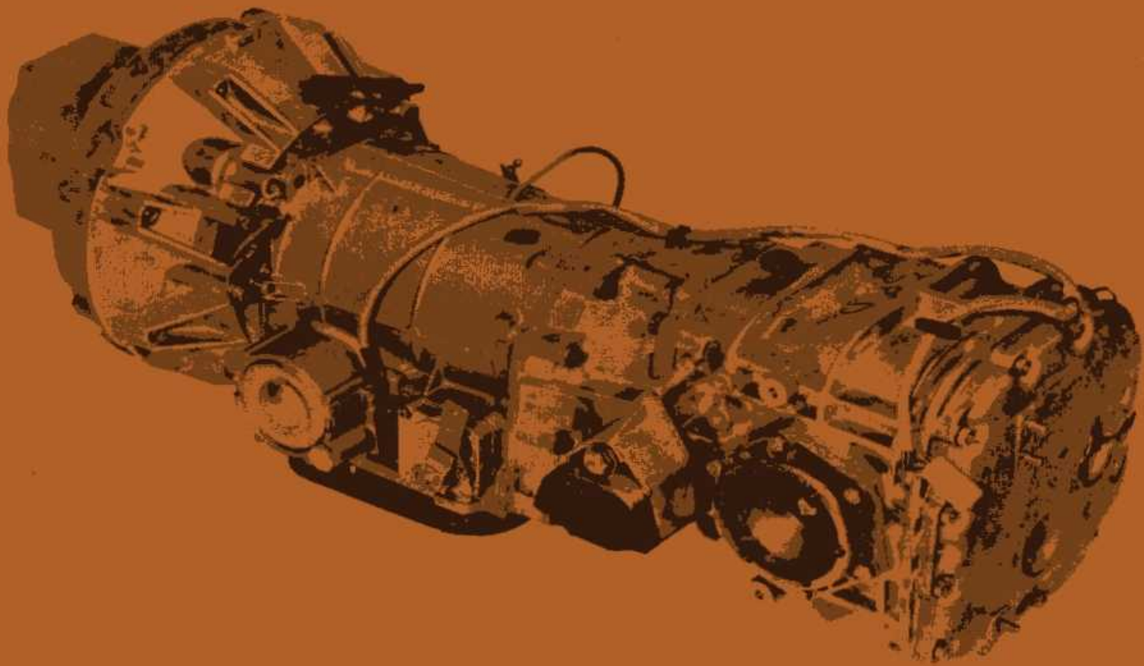
PORSCHE

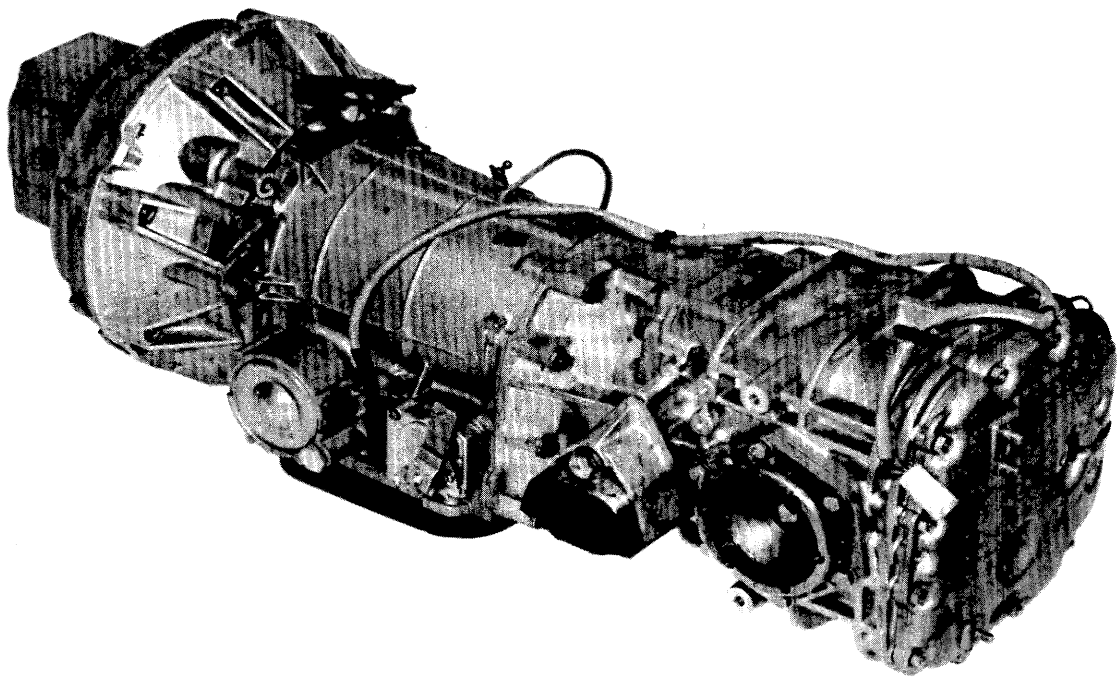
928



Automatic Transmission A22

Description of Function

4568.21



This brochure will provide you with information on the design and operation of the automatic transmission in the Porsche 928.

The description is divited into two separate parts.

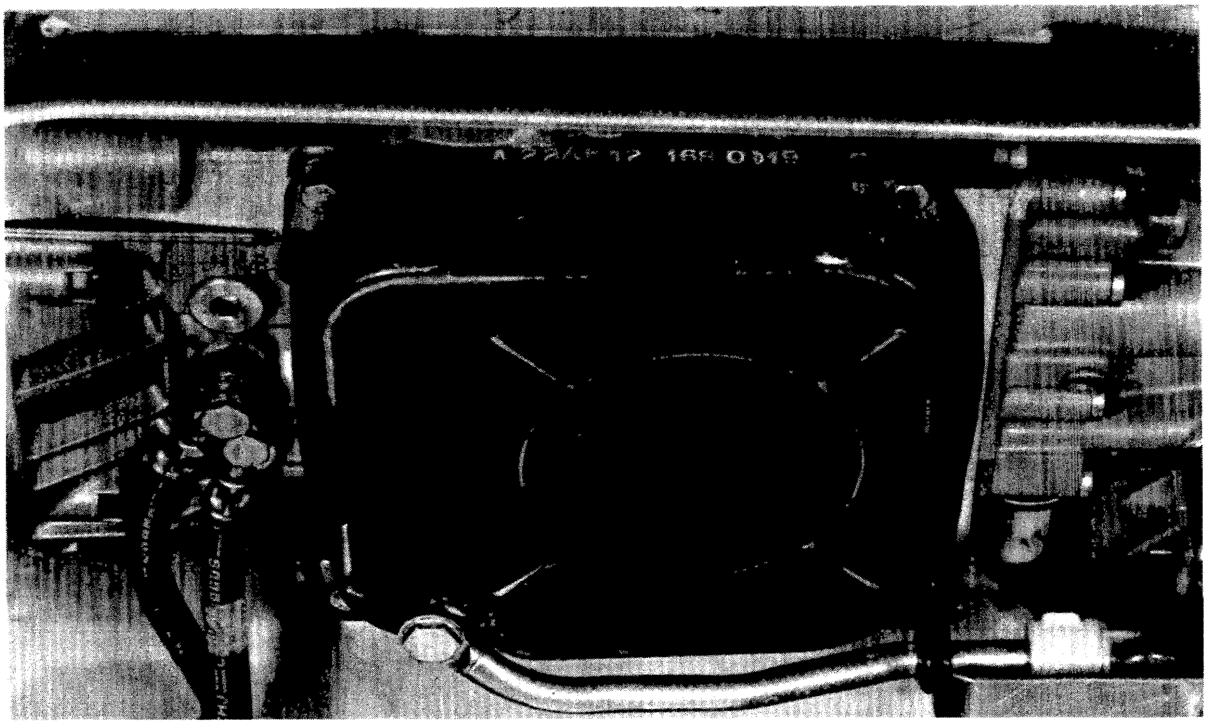
1. Specifications and Design
2. Operation of Hydraulic System

Refer to Volume II (Transmission) of Repair Manual 928 for instructions on adjustments, service and repairs.

A special brochure (Order No. 4569.21) "Automatic Transmission A 22, Troubleshooting Guide", deals with the diagnosis of possible automatic transmission defects.

Contents

Explanation of Transmission, Identification Numbers



Transmission Identification Numbers are stamped on the **left** side of the center transmission case, above the ATF pan.

The figures stamped on the **right** side are for production control only.

A 22 / 01 / 12 / 1 6 8   0019

- 0019 — Serial number
- 8 — Model year (78)
- 6 — Transmission version
- 1 — Unit version
- 12 = locking differential 40 %
- 01 — Country code (01 = Rest of World, 02 = USA)
- A 22 — Transmission type
  - A 22 = Automatic
  - G 28 = 5-speed manual

	USA
Transmission designation	A 22 / 02
Number of gears	3 forward 1 reverse
Ratios: 1st range 2nd range 3rd range Reverse	2.306 1.460 1.000 −1.836
Final drive	Spiral bevel drive without hypoid offset/Oerlikon Spiroflex System
Ratio (no. of teeth)	2.750 (12 : 33)
Torque converter Converter ratio	2.00 : 1
Stall speed (rpm)	2350 ± 200
Allocated engine	M 28.04 (169 kW)
Performance Figures:	
Max. speed (km/h)	225
Acceleration 0 . . . 100 km/h (s) *	8.5
Acceleration 1/4 mile (s)	16.0
Acceleration 1000 m (s) *	29.0
Hill climbing ability in % * 1st range	approx. 42 briefly 68
2nd range	approx. 23 briefly 37
3rd range	approx. 12 briefly 24
* DIN curbweight + 1/2 payload (kg)	1720
Weight of automatic transmission with converter, without oil (kg)	100

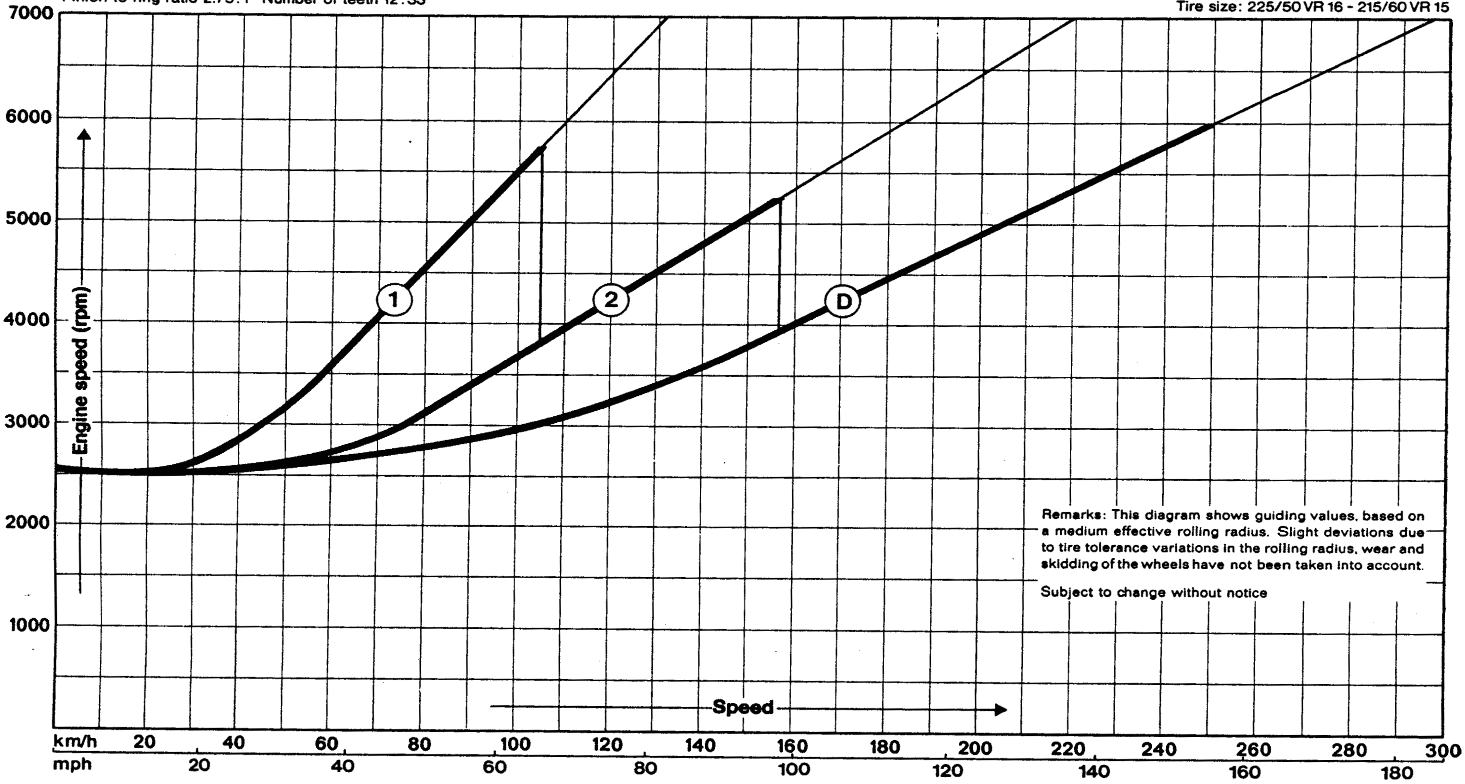
		USA
Capacities		
A. Final Drive		
Hypoid gear lube GL 5 (MIL-L 2105 B) Viscosity: SAE 90	(ltr.)	approx. 1.9
B. Automatic Box		
ATF Dexron		
Total volume including torque converter	(ltr.)	approx. 5.4
For ATF change, also in converter	(ltr.)	approx. 5
Note marks on dipstick, never add too much oil !		
Service Information		
Checking ATF level		at 1000 miles, then at 15,000 mile intervals
Draining ATF and also torque converter, replacing ATF filter		30,000 mile intervals
Checking hypoid oil level in final drive		at 1000 miles, then at 15,000 mile intervals
Changing hypoid oil in final drive		30,000 mile intervals

Transmission Diagram

Automatic

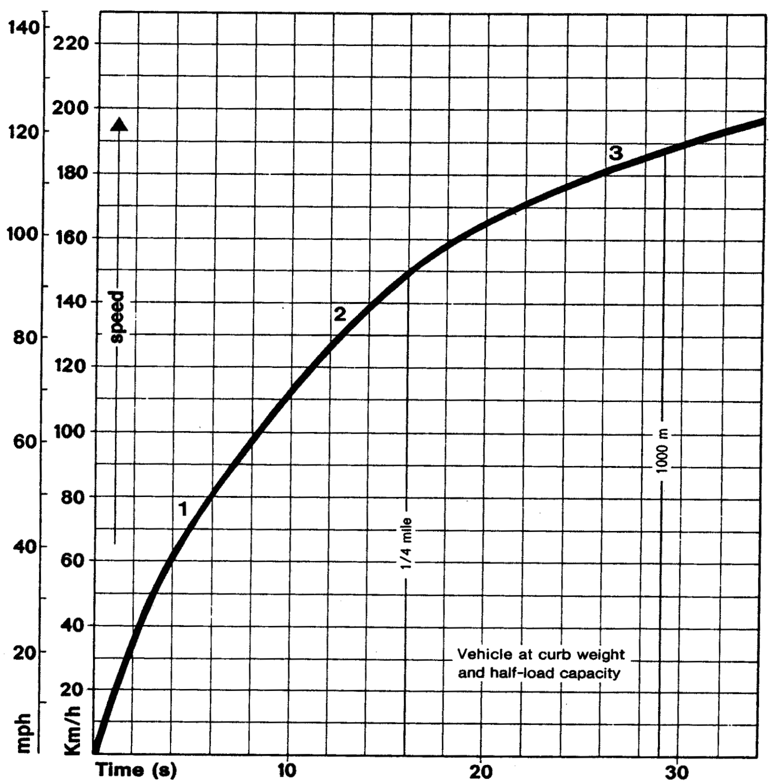
Pinion to ring ratio 2.75:1 - Number of teeth 12:33

Tire size: 225/50 VR 16 - 215/60 VR 15

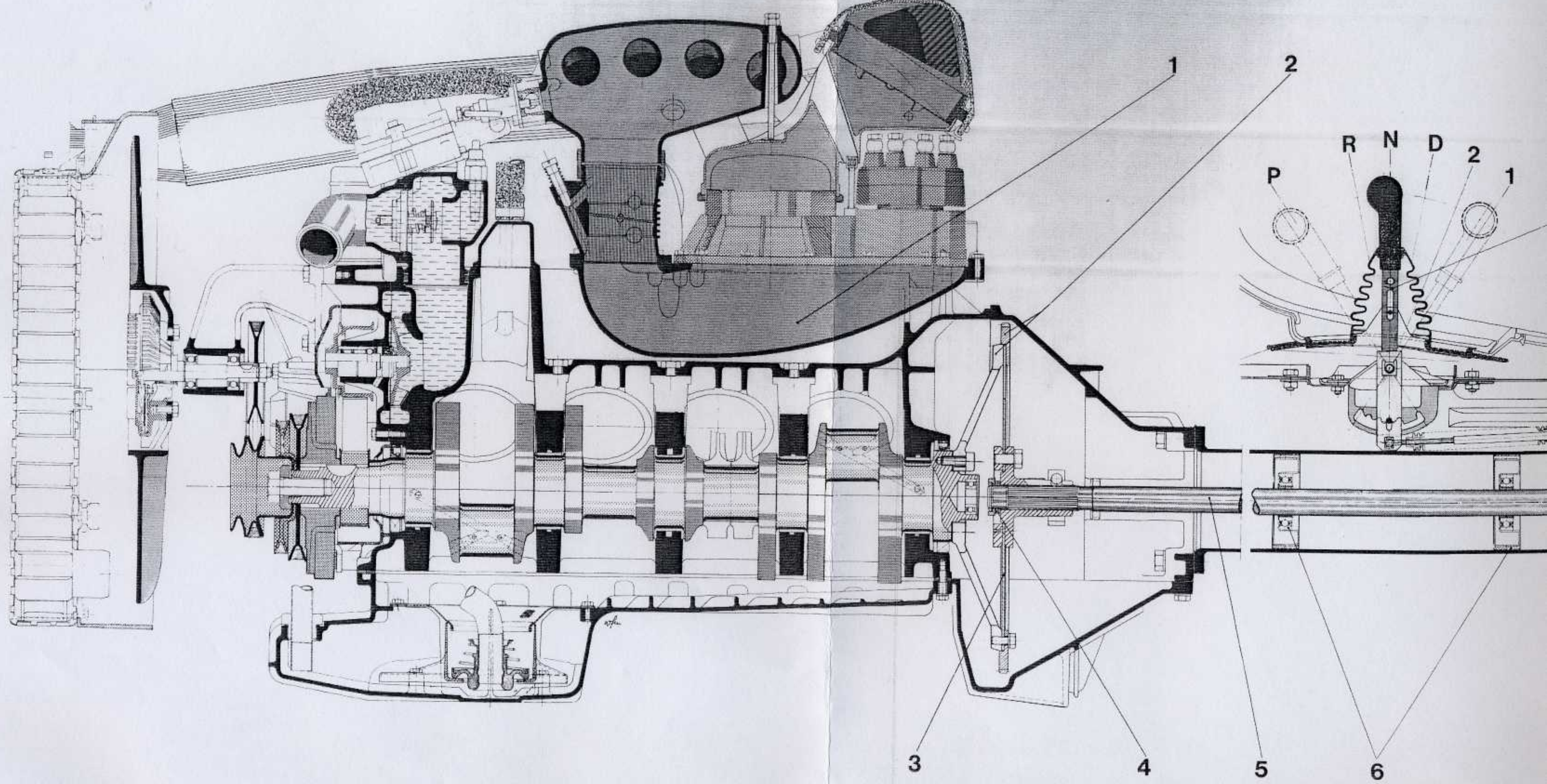


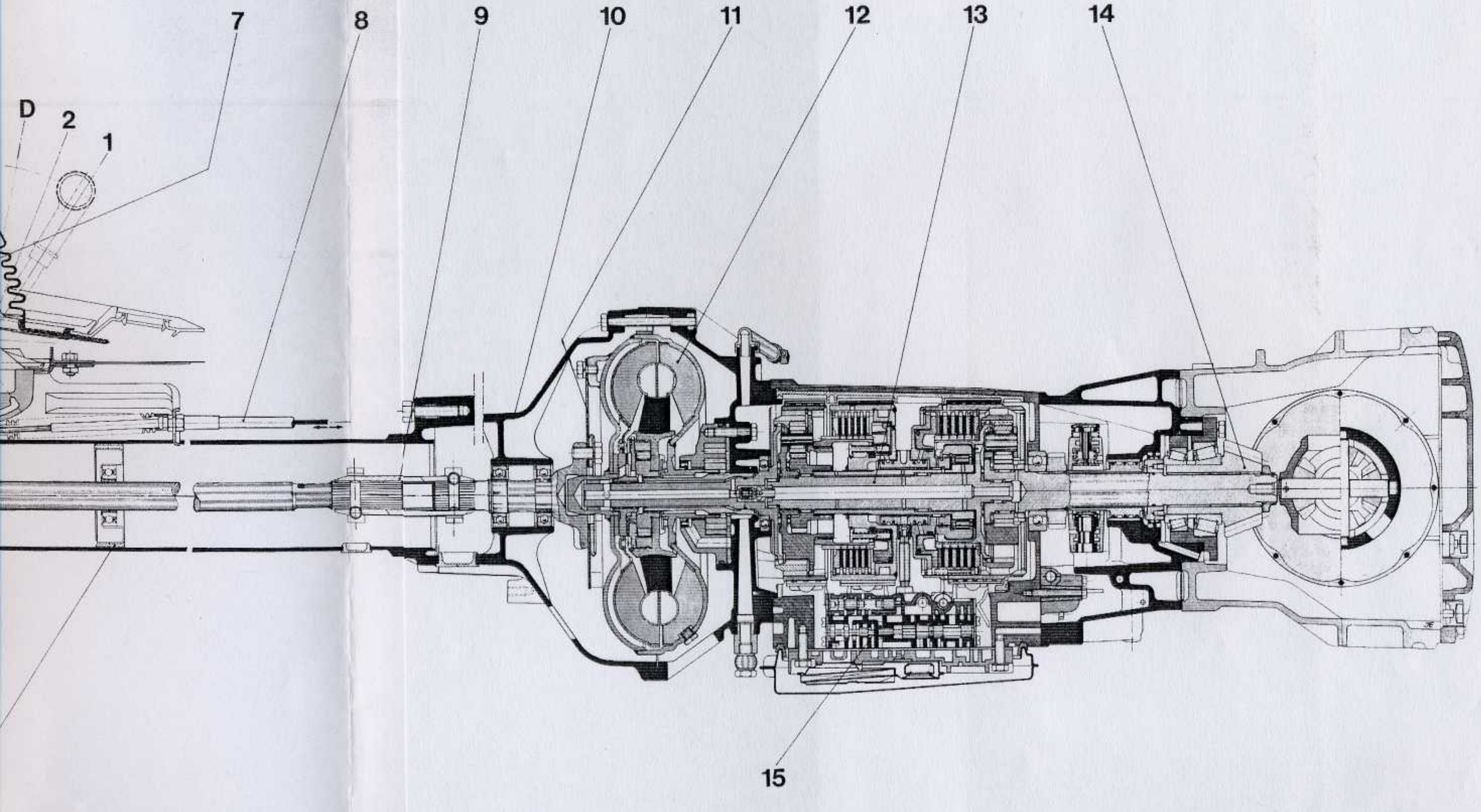
Acceleration Curve

Automatic-transmission



KRAFTÜBERTRAGUNG – Transaxle-System
TRANSMISSION – Transaxle System
TRANSMISSION – Système Transaxle
TRANSMISSIONE DELLA FORZA – Sistema Transaxle





7
8
9
10
11
12
13
14
D
2
1
15

The Porsche 928 was designed with a transaxle system. The front-mounted 8 cylinder engine is connected to the rear-mounted automatic transmission/final drive via a rigid central tube.

This type of drive provides an ideal distribution of axle loads, namely almost 50 % each to the front and rear axles, and improved directional stability.

The entire transaxle assembly, consisting of engine, central tube and automatic transmission, is connected to the body at four points with rubber/metal mounts.

The drive shaft (5) is driven by the engine's flywheel (2) via a drive plate (3).

Since the drive plate (3) does not permit axial adjustment, shims (4) must be used between drive shaft (5) and drive plate (3) when assembling engine (1) and the central tube.

The drive shaft (5) runs in the central tube on two permanently lubricated and sealed ball bearings (6).

The drive plate on torque converter (11) is driven by the coupling (9). This drive plate has double bearings in the front of the converter bell housing (10) and is bolted to the converter (12) with 6 bolts. The torque converter drives the automatic transmission (13) via its turbine.

The output shaft of the automatic transmission (13) is connected directly with the final drive (14).

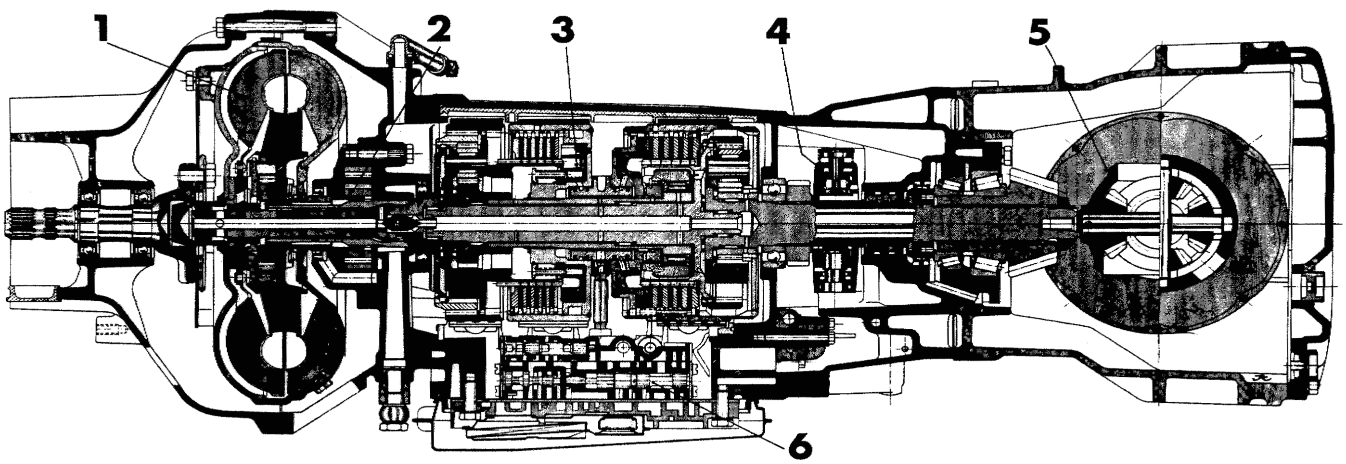
1 — V-8 engine with fuel injection
2 — Flywheel with starter ring gear
3 — Drive plate
4 — Shims for axial adjustment of drive shaft
5 — Drive shaft
6 — Drive shaft mounts with sealed ball bearings
7 — Selector lever
8 — Selector lever cable
9 — Drive shaft coupling
10 — Converter bell housing
11 — Converter drive plate
12 — Torque converter
13 — Automatic transmission
14 — Final drive without hypoid offset, with its own oil supply
15 — Valve body

Fundamental Parts of Automatic Transmission

The automatic transmission can be divided into several fundamental parts. The first two case sections house the **torque converter** (1) and **pump** (2).

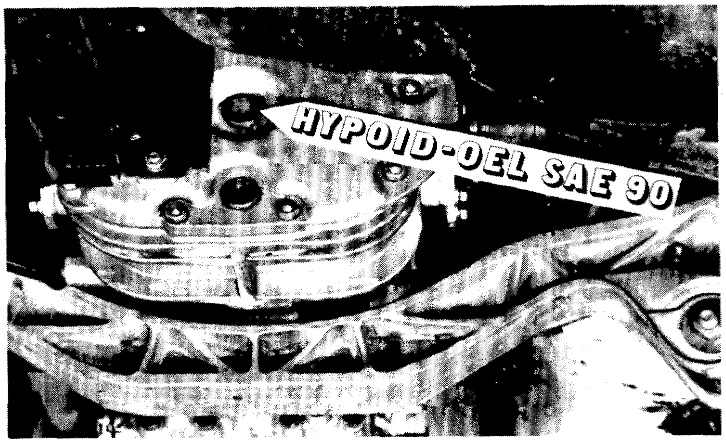
The actual **three speed automatic transmission** (3) with both of its planetsgear sets and valve body (6) is located in the main case section.

A **centrifugal governor** (4) is located on the output shaft. The **final drive** (5) is located in a separate housing behind the transmission section like the 928 manual transmission.



1 — Torque converter
2 — ATF pump
3 — 3-speed automatic transmission
4 — Centrifugal governor
5 — Final drive
6 — Valve body

The final drive, a bevel gear Oerlikon Spiroflex system without hypoid offset, is lubricated and cooled with approx. 2 liters of high-alloy hypoid gear lube of API Classification GL 5 (MIL-L 2105 B).

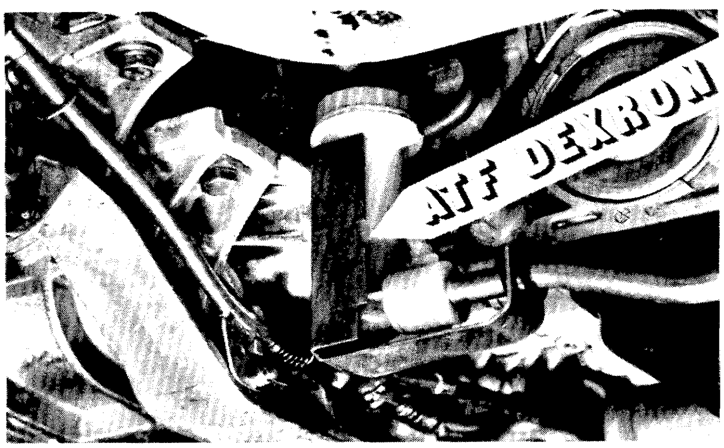


Operation of the transmission section parts requires ATF Dextron (automatic transmission fluid.

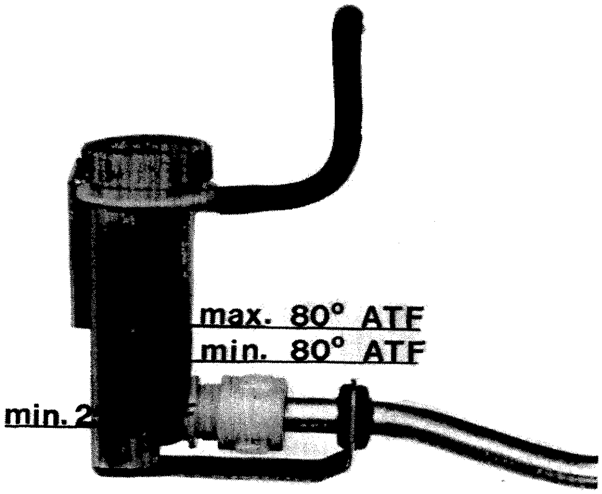
This fluid is used to lubricate and cool the planet gears as well as plain and roller type bearings.

ATF is also used to transmit power in the torque converter, as a hydraulic fluid in cylinders, control lines and valves, and to obtain the correct coefficent of friction between the plates of clutches and three brake bands.

Controlled coefficent of friction, during cold and warm operation is extremely important to ensure smooth shifting.



The ATF level can be checked on either a **cold** transmission (ATF temperature approx. 25°C) or on a transmission at **operating temperature** (ATF temperature approx. 80°C).



The difference in the ATF level between the **min. mark at approx. 80°C** and the **max. mark at approx. 80°C** is only about 200 ml (0.2 ltr.).

If too much ATF is added, it is **absolutely essential** to drain the excessive amount.

When the ATF level is too high, internal parts rotate in the ATF and produce foam.

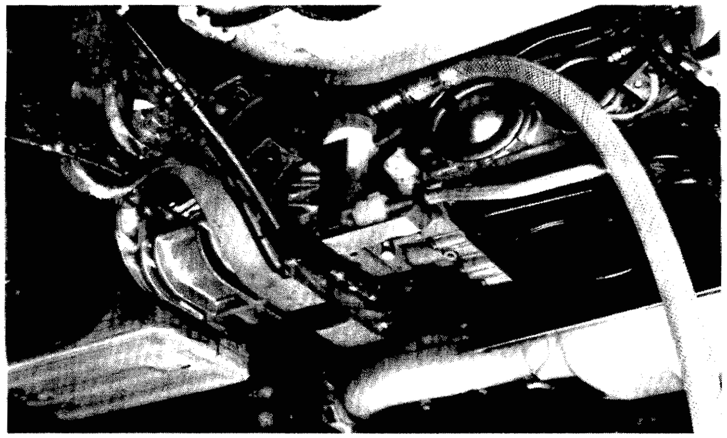
Air bubbles in hydraulic lines lead to unwanted shifts, which could cause damage to the transmission.

It would only be advantageous to check the ATF level of a cold transmission prior to a test drive or when changing the ATF.

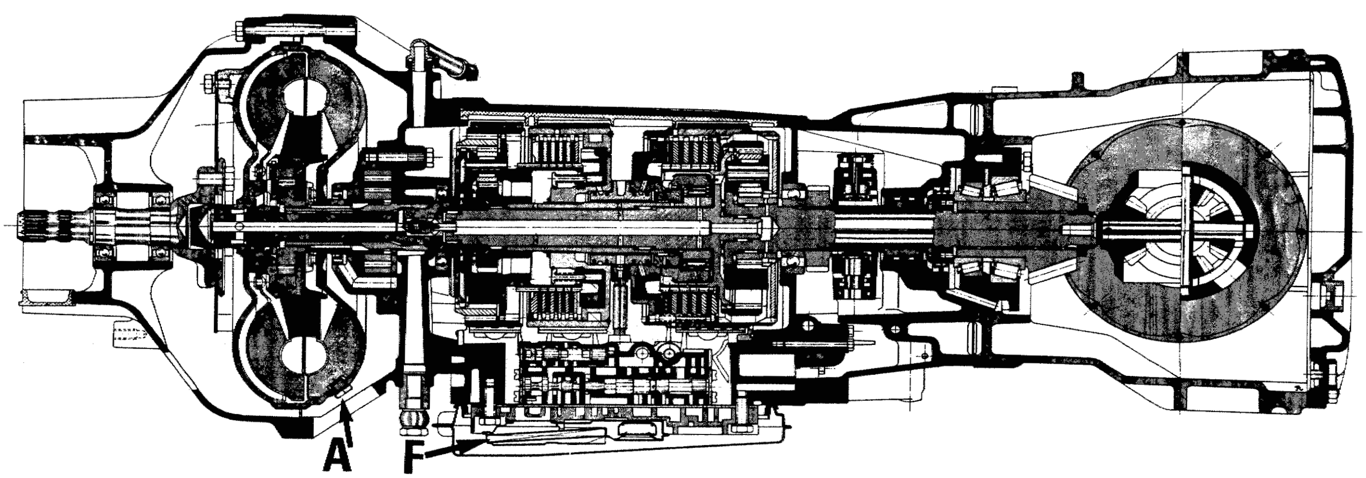
Since only the minimum level is shown, the ATF level must always be rechecked after transmission has reached its operating temperature.

Both lubricants, hypoid gear lube and ATF, must never be replaced by other lubricants or mixed with each other.

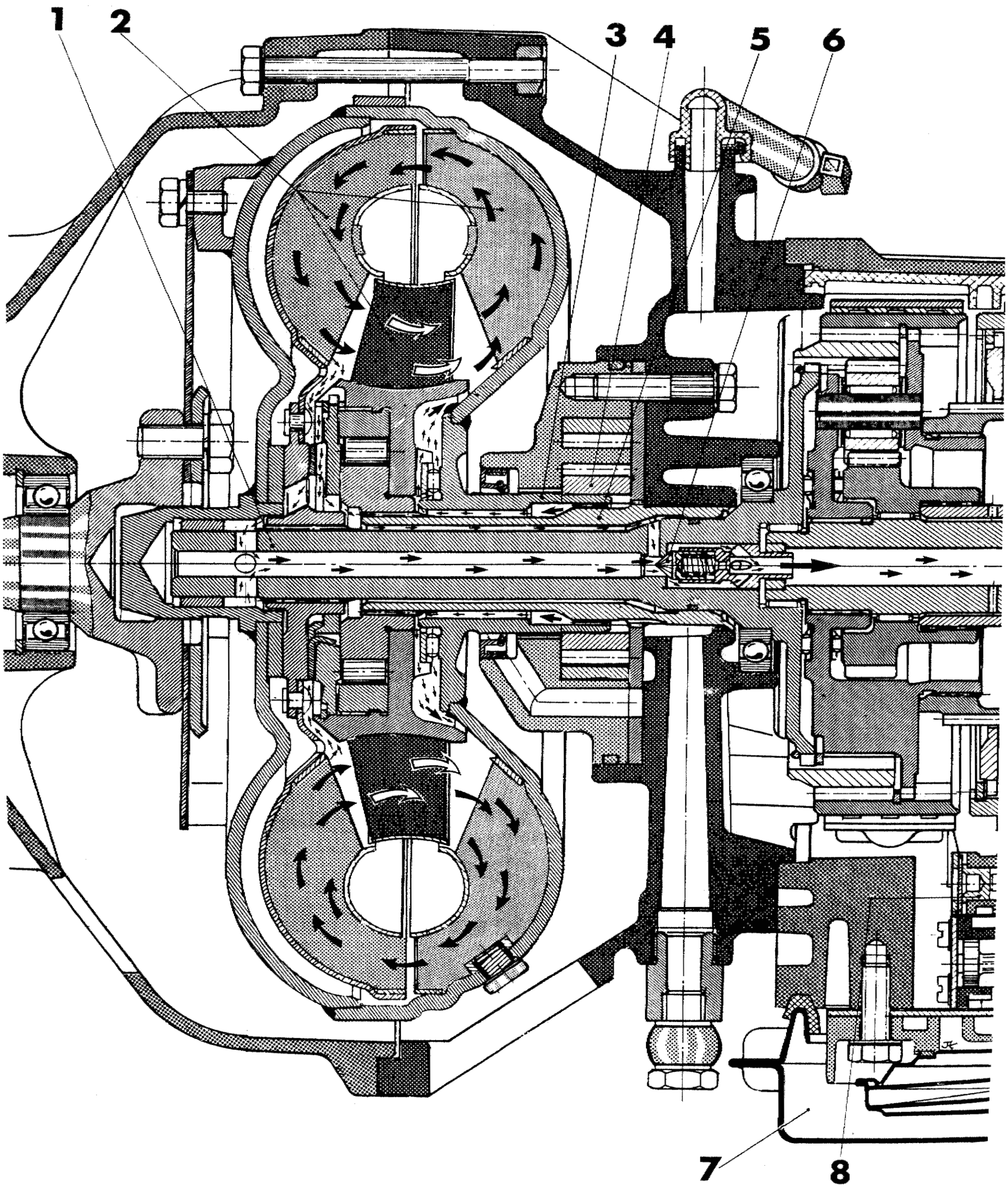
Absolute cleanliness is essential when filling or adding ATF Dexron. Minute particles of sand or lint from a cloth could impair the automatic transmission controls and cause expensive repairs. The oil filler and level inspection tank is located on the right side of the transmission.
It is best to raise car on a lift to check oil levels, check ATF (every 15,000 mi.).



When changing ATF at 30,000 mi. intervals, make sure that fluid is also drained from torque converter.
Converter has a drain plug (A) for this purpose.
The filter (F) underneath the valve body must also be replaced each time the ATF is changed.



The ATF level, must be checked when the **engine is idling** and the selector lever is in "P" or "N".


1
2
3
4
5
6
7
8

ATF Supply to Torque Converter

Pump (4) takes fluid from ATF oil pan (7). After building up pressure for lubrication in the valve body (8), the fluid passes through an annular gap between the stator shaft support (5) and pump drive flange (3) to the torque converter (2).

The ATF returns through a bore in the turbine shaft (1) and the check valve (6).

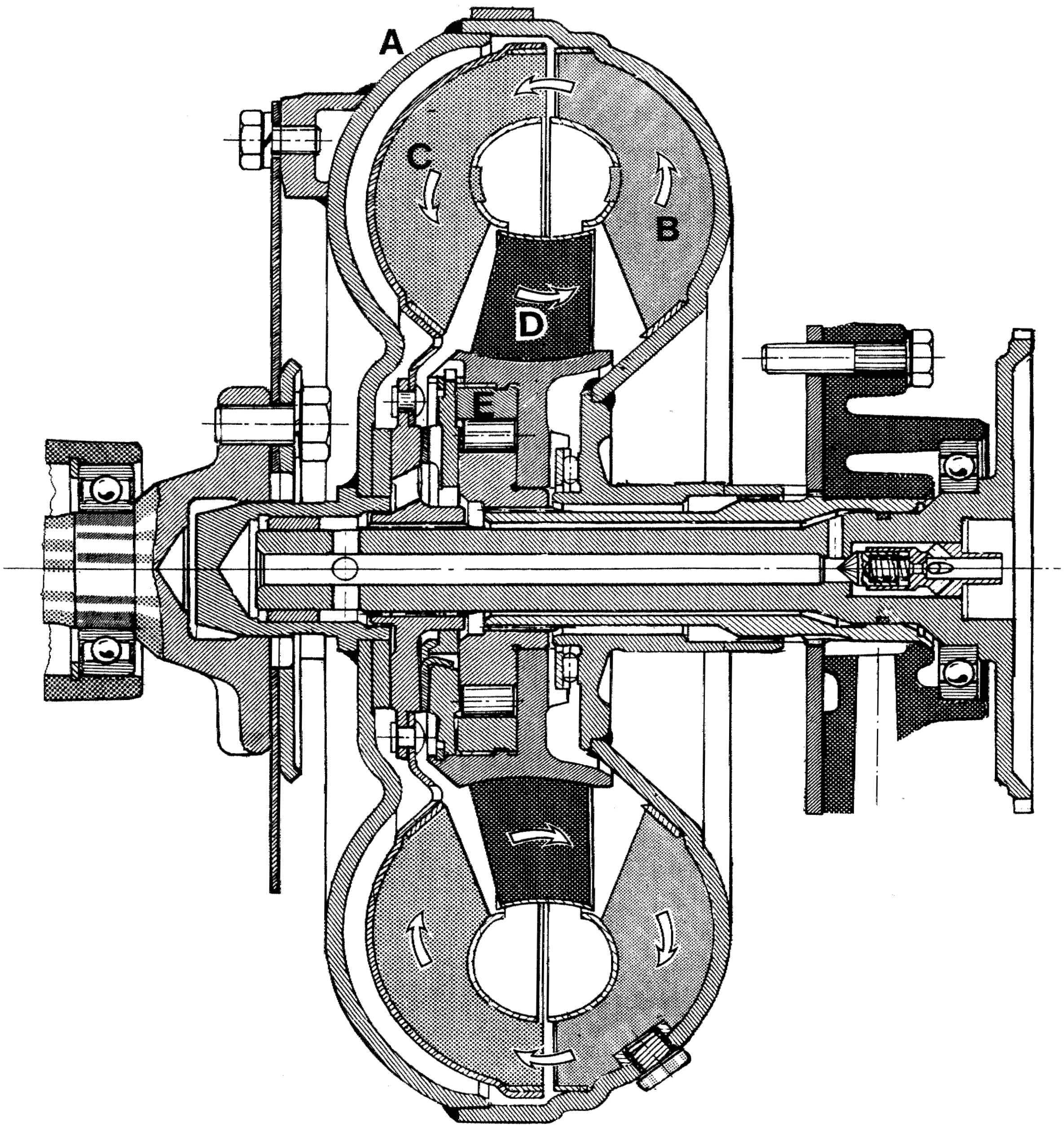
The spring-loaded check valve has two functions

— Control pressure in the converter.

— Prevent drainage of converter when engine is stopped.

ATF leaving check valve (b) flows into the transmission intermediate shaft and lubricates the bearings in the transmission.

1 — Turbine shaft
2 — Torque converter
3 — Pump drive flange
4 — ATF pump
5 — Stator support
6 — Check valve
7 — ATF oil pan
8 — Valve body

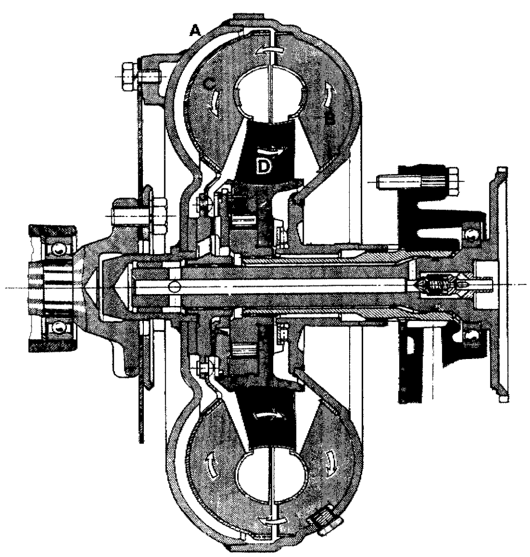

A
C
B
D
E

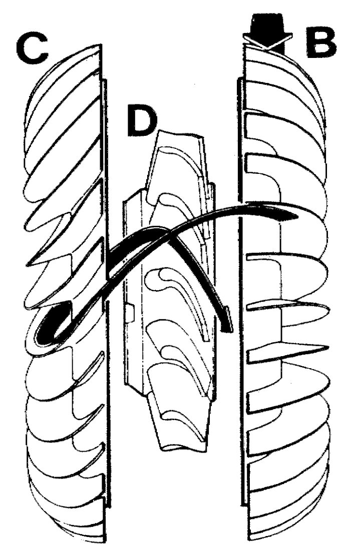
Most Important Parts of The Torque Converter

Converter Shell (A)	consists of oil-proof, welded sheet metal and deep drawn steel parts.
Impeller (B)	is welded to converter shell (A).
Turbine (C)	is connected to the turbine shaft via a spline, and drives the transmission.
Stator (D)	is supported on transmission case by way of one-way clutch (E).

Operation of Torque Converter

When the converter shell (A) is driven by the engine via the drive shaft, the impeller vanes (B) connected to the housing spin the ATF in the converter in the direction of the arrow.





The impeller vanes (B) will have now given the fluid dynamic flow energy, which in turn will rotate turbine (C).

The angle of the turbine vanes will cause the fluid to change it's direction of flow, so that it flows inward to the stator (D). In so doing the ATF passes on the **flow energy** received from the impeller to the turbine in the form of **torque**.

The direction of fluid flow is changed considerably and accelerated in the stator (D), and is directed against the vanes of impeller (B) again.

The change of direction can only take place when the impeller is turning faster then the turbine, since the stator is supported on the transmission case via the one-way clutch (E).

The flow of fluid is subjected to a moment of reaction, which can be compared with backpressure. This moment of reaction while moving off from a standstill increases the torque on the turbine to a value above the torque supplied by the engine.

The design of the converter parts in the automatic transmission A 22 provides a **conversion** of the engine torque to twice the normal value when moving off.

The **torque conversion** reduces constantly as the turbine speed increases. In so doing the direction of fluid flow to the stator and the change of flow direction in the stator itself will change continuously.

At a speed ratio of 1 : 0.85 between the **engine** (impeller) and **turbine speed** the flow at the end of the turbine vanes will have changed to such an extent, that the flow of fluid now hits the **backs** of the **stator vanes**.

The stator starts to turn in the same direction as the impeller and turbine, since the one-way clutch permits rotation in this direction.

This operating state is known as the **coupling point**. As the ratio between the impeller speed (always same as engine speed) and turbine speed comes closer to 1 : 1, the torque converter will function as a **hydraulic clutch** and reaches a degree of efficiency of about 98 %.

If the turbine speed is higher than that of the impeller (while coasting), the torque converter will again function as a hydraulic clutch. The turbine now drives the impeller and thus the engine. In this manner the engine can be used to brake the power wheels of the car when driving downhill or slowing down on level roads.

Hydraulic torque converters with a stator on the oneway clutch are employed successfully in automatic transmissions of cars on a worldwide scale.

The present, almost perfect design (98 % efficiency) can be traced back to an invention of a German engineer, Hermann Foettinger, who received a patent from the Royal Patent Office on June 24, 1905 for a **"hydraulic transmission wich one or more driving and one or more driven turbines for the transmission of power between neighboring shafts".**

The stall speed can be tested to troubleshoot and check condition of the automatic transmission system. The stall speed is that engine speed reached with the accelerator pedal floored, a driving range engaged and the car **held by applying the brakes**. It is not important, which driving range is selected.

However an accurate evaluation of the automatic transmission's condition can only be made from a stall speed test if:

— engine tuning has been checked and is okay,

— ATF level has been checked and is okay,

— engine/transmission oils are at operating temperature,

— car is held firmly by brakes

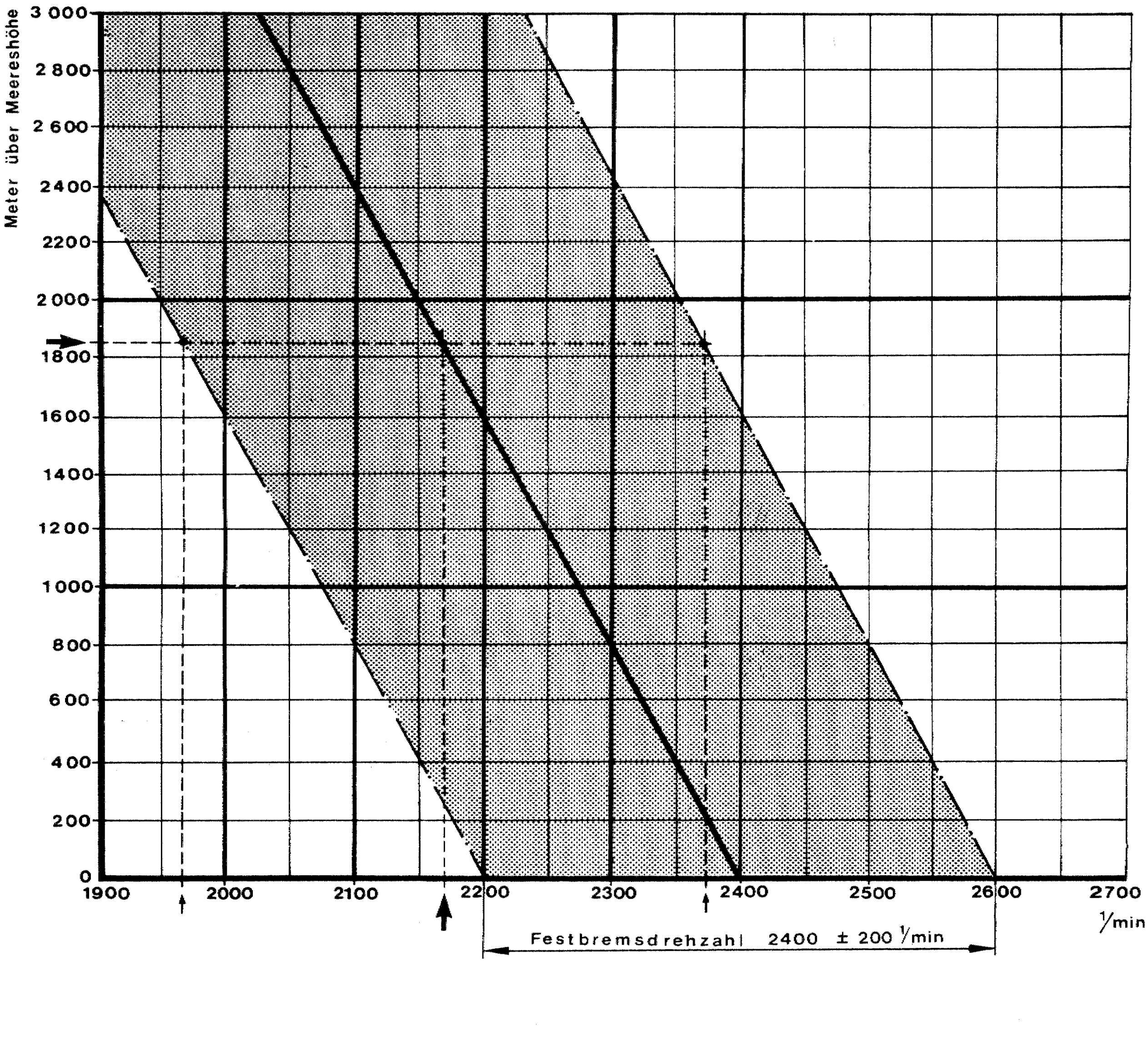
— and the throttle is wide open.

Never keep throttle wide open for longer than 5 seconds, because of the great heat produced in a stall speed test. Also never move off from "stall speed", since the lubricating film will have been squeezed off of the stationary gear wheels and bearings during the test and these parts could be subjected to excessive wear or damage.

The stall speed for Porsche 928 should be 2350 ± 200 rpm. The stall speed will drop in accordance with the altitude at which the car is operated, since the engine power will also be less at high altitudes. The drop will be approx. 125 rpm for every increase of 1000 meters (3,300 ft.) in altitude.

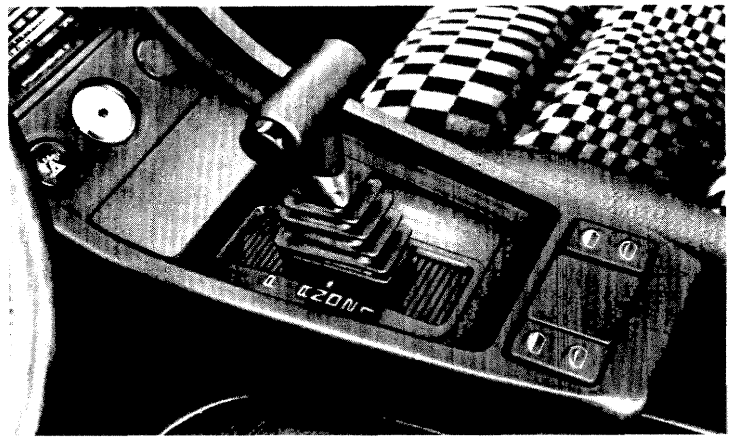
Explanation of Diagram

A Porsche 928 car tested at an altitude of 1850 meters above sea level (for example, at Porsche Dealer in St. Moritz, Switzerland) will only reach a stall speed of 2170 ± 200 rpm because of a loss in engine power at this altitude (broken line in diagram).



The automatic shifting of the transmission is influenced by

position of selector lever,
position of accelerator pedal,
road speed and
engine vacuum.



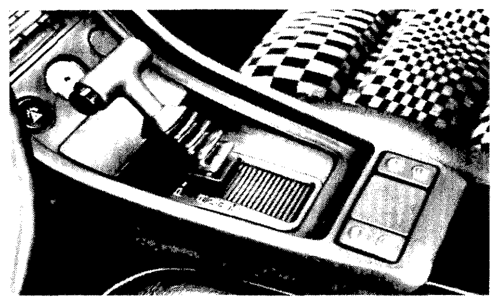
Selector Lever

The selector lever mounted on the center console, is connected to the transmission with a cable.

This cable is used to transmit the position of the selector lever to the valve body, the transmission's "hydraulic brain".

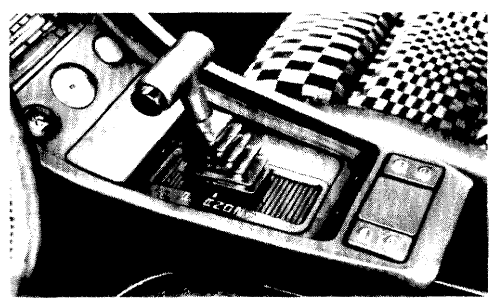
Selector Lever Positions to be Chosen by Driver:

P = Park



The parking lock is applied in this position to stop the transmission's output mechanically. The car cannot be rolled. Position "P" should only be engaged when the vehicle is stopped. A hydraulic lock out device will not allow the selector lever to be moved into position "P" above 10 km/h (6 m. p. h.). A safety button on the selector lever has to be pressed to engage "P". The engine can be started in this position.

R = Reverse



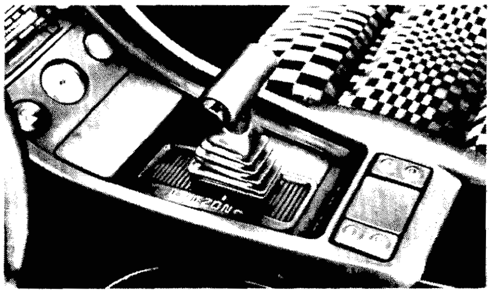
The selector lever will be locked hydraulically/ mechanically at forward speeds above 10 km/h (6 m.p.h.). A safety button on the selector lever must be pressed to move lever into "**R**".
The engine cannot be started in this position.

N = Neutral

The flow of power between the engine and rear axle is interrupted. The engine can be started in this position.

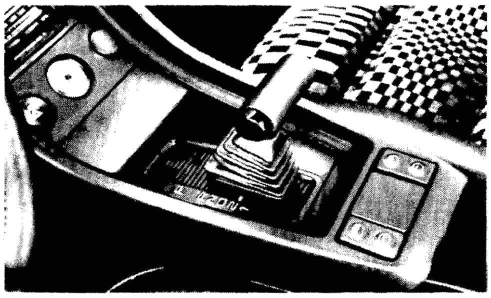
D = Drive

In this position the transmission will automatically shift between all forward gears depending on the road speed and position of the accelerator pedal. It will downshift automatically as the road speed decreases. It is not possible to start the engine.



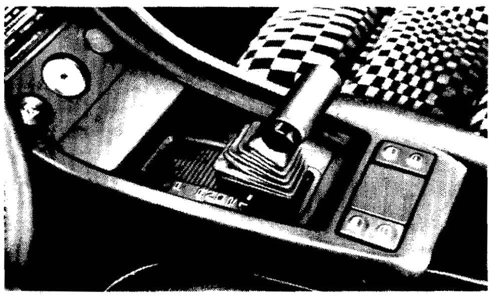
2

The transmission will not upshift into 3rd gear. The engine cannot be started. Do not downshift from position "D" to "2" above 150 km/h (95 m.p.h.).



1

There will be no upshifts into 2nd or 3rd gear. The transmission remains in 1st gear.
A safety button on the selector lever has to be pressed to move lever into "**1**".
The selector lever can be moved into "1" when car is stationary or moving forward up to speeds of 60 km/h (35 m.p.h.). It is not possible to start engine.



An electric switch on the transmission prevents the starter from operating in any selector position except "P" or "N" as a safety precaution.

Trying to engage reverse gear while the car is in forward motion or the engine is running at high speed will be just as harmfull to the automatic transmission, as to any manual transmission.

The service life of the clutch plates will be impaired if the transmission is shifted to N while the car is moving fast. The hydraulically operated clutches cannot be released and will slip in partially loaded state. This causes heat from friction and in turn premature wear of clutch plates.

The engine of a Porsche 928 with automatic transmission cannot be started by towing or pushing.

Initial Drive with Automatic Transmission A 22

Start engine with selector lever in N or P.
Now move selector lever to **D = Drive**.

For moving off the transmission always engages in 1st gear and changes automatically to 2nd gear as the road speed increases, and if warranted by the road speed, into 3rd gear.

As the road speed decreases downshifts will also take place automatically when the selector lever is at D. Under certain driving conditions, for example, driving in mountainous regions with a fully loaded car or a car hauling a trailer, the selector lever should be moved to "**2**", which will prevent upshifts into 3rd gear.

Position "1" can be selected for driving down steep gradients. In this position the transmission remains in 1st gear under all driving situations, for maximum engine braking effect.

If the selector lever of a moving car is moved down to 2 or 1, downshifts will take place after a delay of 1 to 2 seconds so that the downshift will be smooth.

Accelerator Pedal Position

With the selector lever at "D" the transmission will automatically upshift and downshift. Now we will examine the influence of the accelerator pedal position on the shift points.

Fig. A shows on a moving car, with just slight acceleration (for example, downhill), the transmission shifts from 1st into 2nd gear at low speeds to improve economy and reduce noise (between 26 and 33 km/h, 16 and 20 m.p.h.) and how it changes to 3rd gear (between 42 and 48 km/h, 26 and 30 m.p.h.).

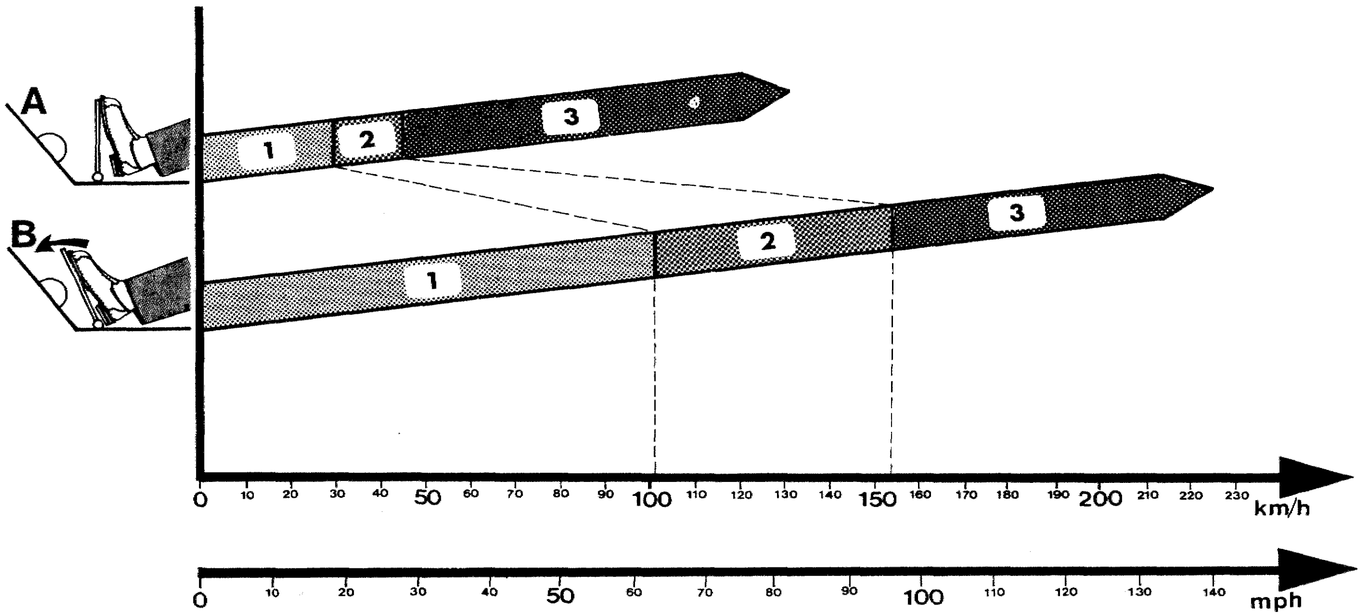
In comparison to moderate acceleration (A), Fig. (B) demonstrates how the transmission will shift at higher speed ranges when accelerating at full throttle.

Upshift Points at Full Throttle

From 1st to 2nd gear between 97 and 105 km/h (60 and 65 m.p.h.)
From 2nd to 3rd gear between 150 and 158 km/h (94 and 98 m.p.h.)

The shift points vary between the lower partial throttle range and the full throttle position depending on accelerator position. Upshift points are the same at full throttle and "kickdown".

Upshift Points



Kickdown

The accelerator pedal can be pressed past its full throttle point against additional resistance. This position of the accelerator pedal is known as **kickdown**. A solenoid on the transmission is actuated by way of an electric switch behind the accelerator pedal.

Pressing the accelerator to the kickdown position will cause automatic downshifts by one or two gears, e. g. for fast passing maneuvers or on gradients (selector lever in D or 2).

The **downshift points** of a moving car **without pressure on the accelerator pedal**, for example when car is rolling to a stop sign, are in the low speed ranges (Figure A). Automatic shifts from 3rd to 2nd gear are made between 37 and 32 km/h (23 and 20 mph). The downshift from 2nd to 1st gear takes place between 23 and 16 km/h (4 and 10 mph).

The **full throttle downshift points** (Figure B) are at higher speed ranges.

Automatic shifts from 3rd to 2nd gear are made between 85 and 57 km/h (53 and 36 mph). The down shift from 2nd to 1st gear takes place between 52 and 45 km/h (32 and 28 mph).

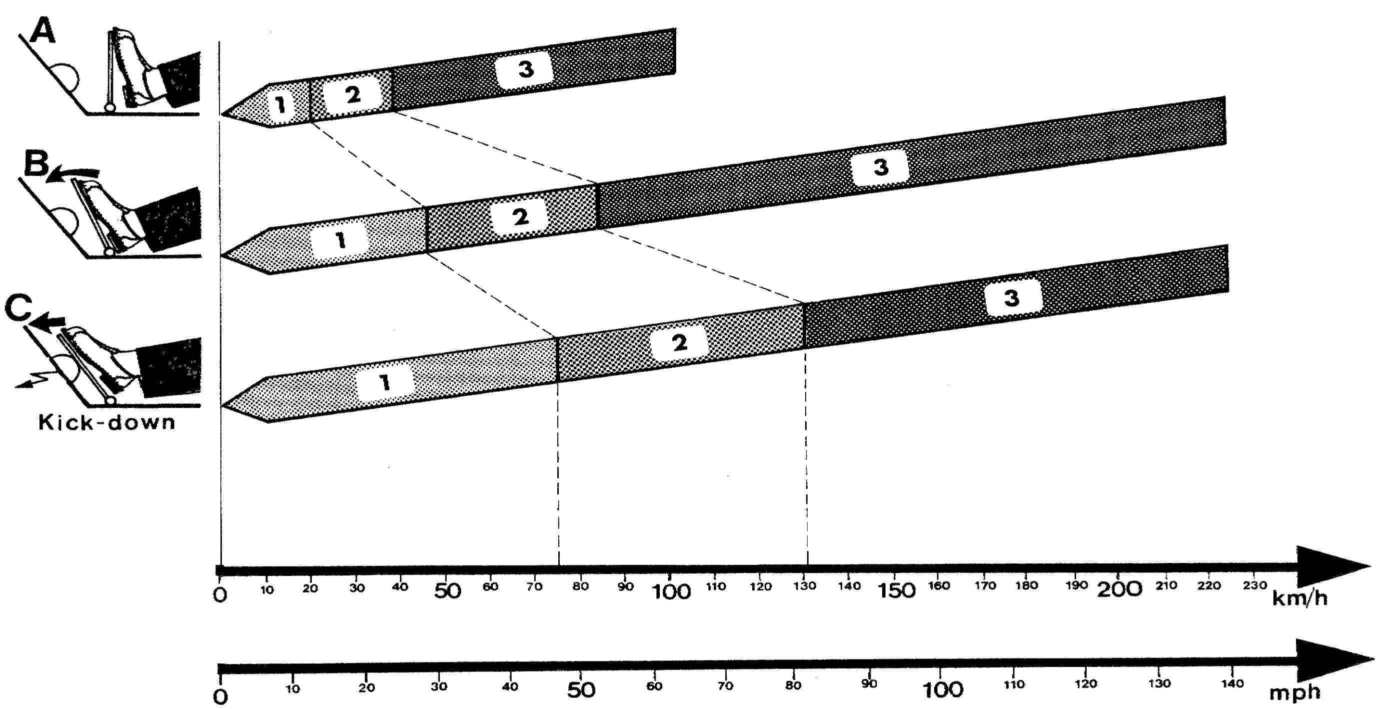
To improve acceleration the downshifts can be made in even higher speed ranges with **kickdown**.

Automatic downshifts from 3rd to 2nd gear can take place between 133 and 122 km/h (82 and 76 mph) or from 2nd to 1st gear between 78 and 58 km/h (48 and 36 mph).

Please note that the diagrams always show the theoretical shift points. The shift points will, however, be subjected to tolerances caused by deviations in manufacturing, temperature of components and ATF.

The downshift or upshift points can be corrected to a certain extend by adjusting the modulation pressure.

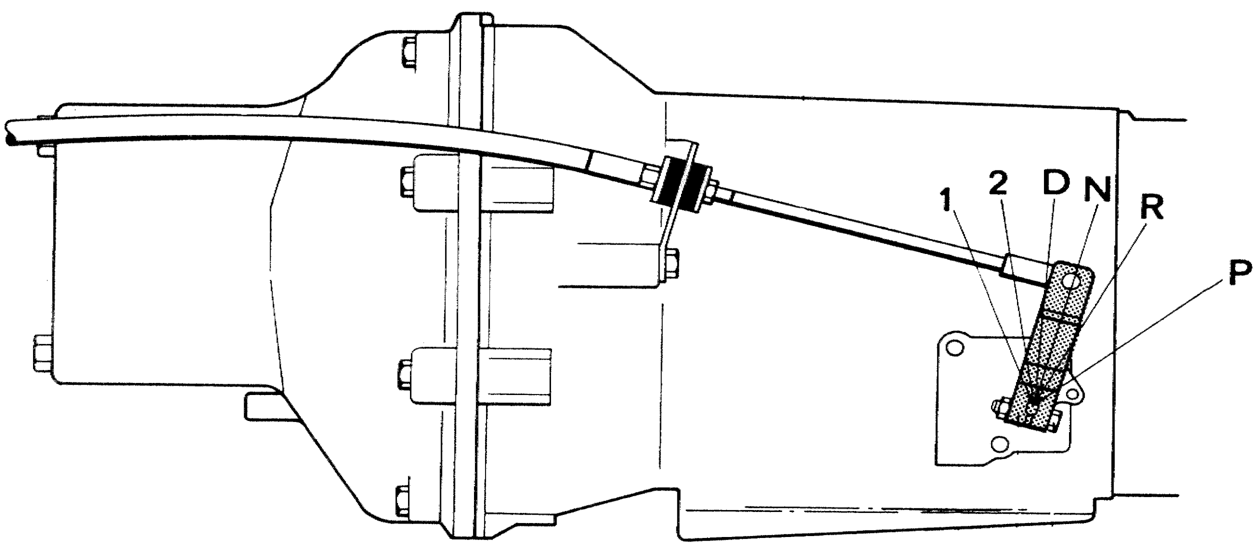
Downshift Points



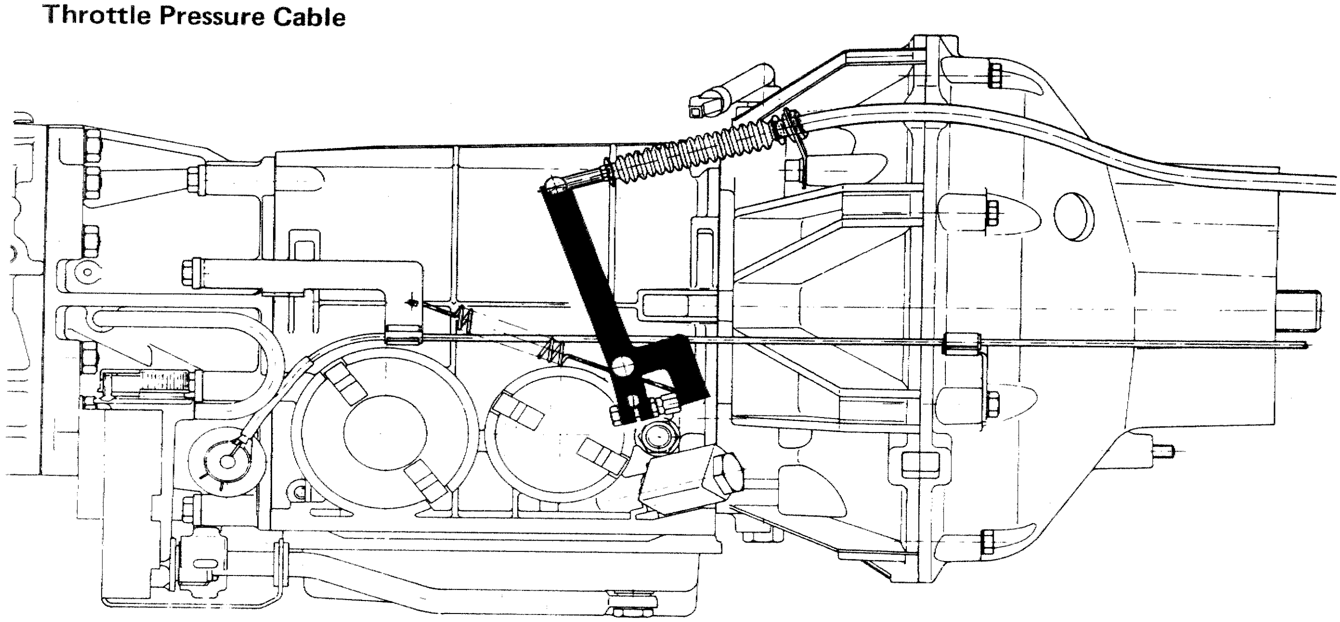
The selector lever and accelerator pedal are connected to the automatic transmission with cables.

Movements of the selector lever and accelerator pedal are transmitted to levers located on the sides of the transmission and converted into hydraulic values in the valve body.

Selector Lever Cable

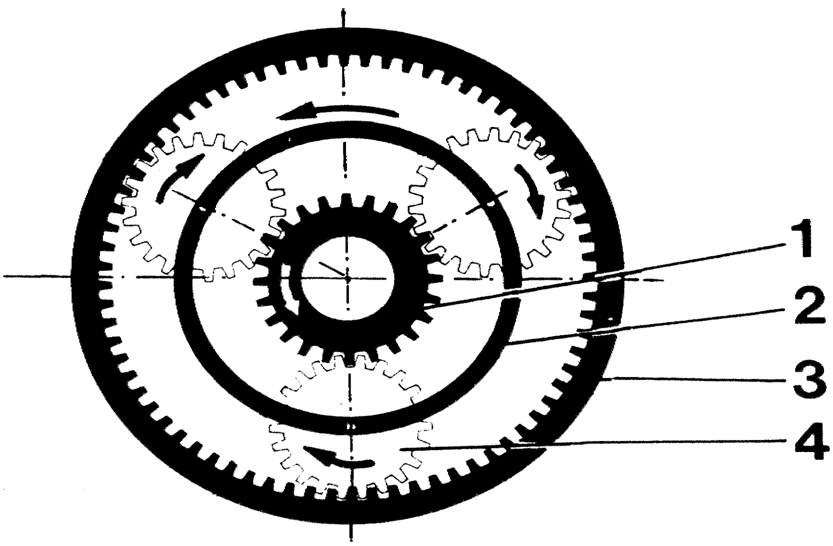


Throttle Pressure Cable



The increase of engine torque by the torque converter to twice the normal value while moving off will not be sufficient to produce the necessary power for all driving situations, which is why two planetary gear sets are connected between the torque converter and final drive.

Planet gears are in constant mesh with each other, allowing shifts without interruption of power flow.



1 — Sun gear
2 — Planet gear carrier
3 — Ring gear
4 — Planet gear

A planet gear set of simple design will consist of the sun gear (1) and two or more planet gears (4), which are mounted on the planet gear carrier (2) and orbit around the sun gear.

The ring gear with internal teeth (3) is arranged cocentric to the sun gear and is engaged with the planet gears. Thus all gears are permanently engaged. By driving and holding different parts various ratios or even changes in direction of rotation, can be achieved without having to interrupt the power flow between the engine and final drive.

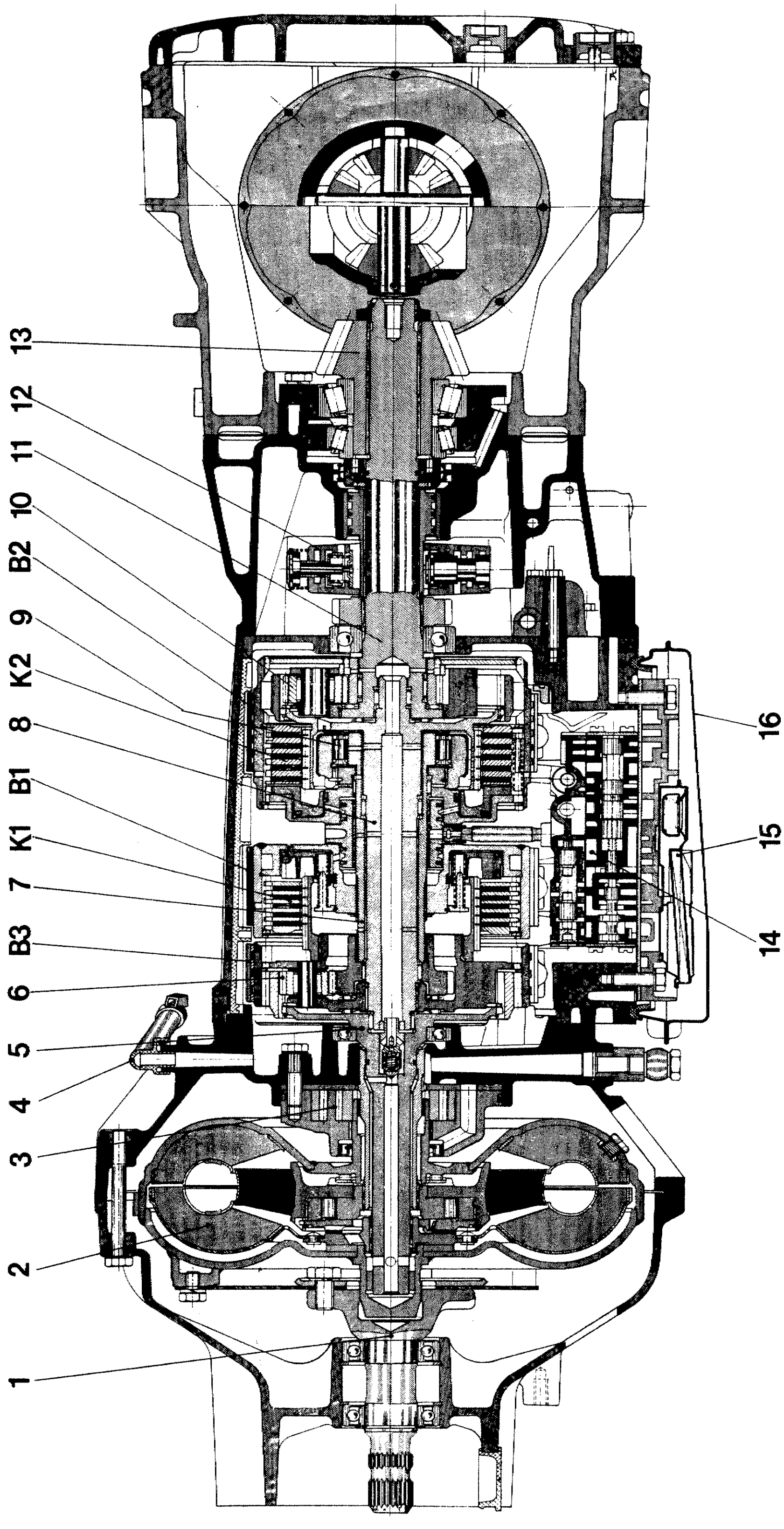
Variations with One Planetary Gearset

	Input	Output	Held Tight	Result
A	Sun gear (1)	Planet carrier (2)	Ring gear (3)	Ratio low
B	Sun gear (1)	Ring gear (3)	Planet carrier (2)	Reverse rotation (low ratio)
C	Planet carrier (2)	Sun gear (1)	Ring gear (3)	Ratio high
D	Planet carrier (2)	Ring gear (3)	Sun gear (1)	Ratio high
E	Ring gear (3)	Planet carrier (2)	Sun gear (1)	Ratio low
F	Ring gear (3)	Sun gear (1)	Planet carrier (2)	Reverse rotation
G	Ring gear (3) sun gear (1)	Planet carrier (2)	—	Direct ratio (1 : 1)

The automatic transmission A 22 has **two** sets of planet gearsets, which because of their location are known as the **front planetary gearset** and the **rear planetary gearset.**

The variations explained above are applied as follows.

Range 1: variations E + E (2 x low ratio)
Range 2: variations G + E (1 : 1 and low ratio)
Range 3: variations G + G (2 x 1 : 1)
Range R: variations F + A (reversed direction of rotation and low ratio)


1
2
3
4
5
6
B3
7
K1
B1
8
K2
9
B2
10
11
12
13
14
15
16

1 **Drive flange** transmits engine torque to automatic transmission.

2 **Torque converter** doubles the engine torque value for moving off.

3 **Pump** delivers ATF to automatic transmission and converter for lubrication and operation.

4 **Transmission vent** equalizes pressure as temperatures fluctuate.

5 **Turbine shaft** is in power flow between torque converter and automatic transmission.

6 **Front planetary gear** set transmits and converts speed of turbine shaft and changes direction of rotation for reverse.

7 **Hollow shaft** connects sun gear of front planet gear set (6) with one-way clutch (9).

8 **Intermediate shaft** connects planet gear carrier of front planet gear set (6) with ring gear of rear planet gear set (10).

9 **One-way clutch** locks in 1st gear and reverse.

10 **Rear planet gear set** transmits and converts speed of front planet gear set (6) again.

11 **Output shaft** transmits power (forward or reverse) from automatic transmission to final drive.

12 **Centrifugal governor** provides hydraulic pressure which changes according to changes in road speed.

13 **Drive pinion** is mounted on output shaft (11) and is in mesh with ring gear.

14 **Valve body** controls the automatic transmission.

15 **ATF filter** stops dirt from entering bores/passages of valve body.

16 **Sump** contains ATF Dexron.

B1 **Brake band 1**

B2 **Brake band 2**

B3 **Brake band 3**

K1 **Clutch pack 1**

K2 **Clutch pack 2**

To be able to shift with a planet gear set, the

sun gear,

planet gear carrier

and ring gear

have to be either driven or held, i. e. braked to a stop and held tight.

In this transmission there are two clutch packs, three brake bands and one one-way clutch.

The **clutch** packs **connect** or **disconnect** rotating parts.

Brake bands stop or release parts.

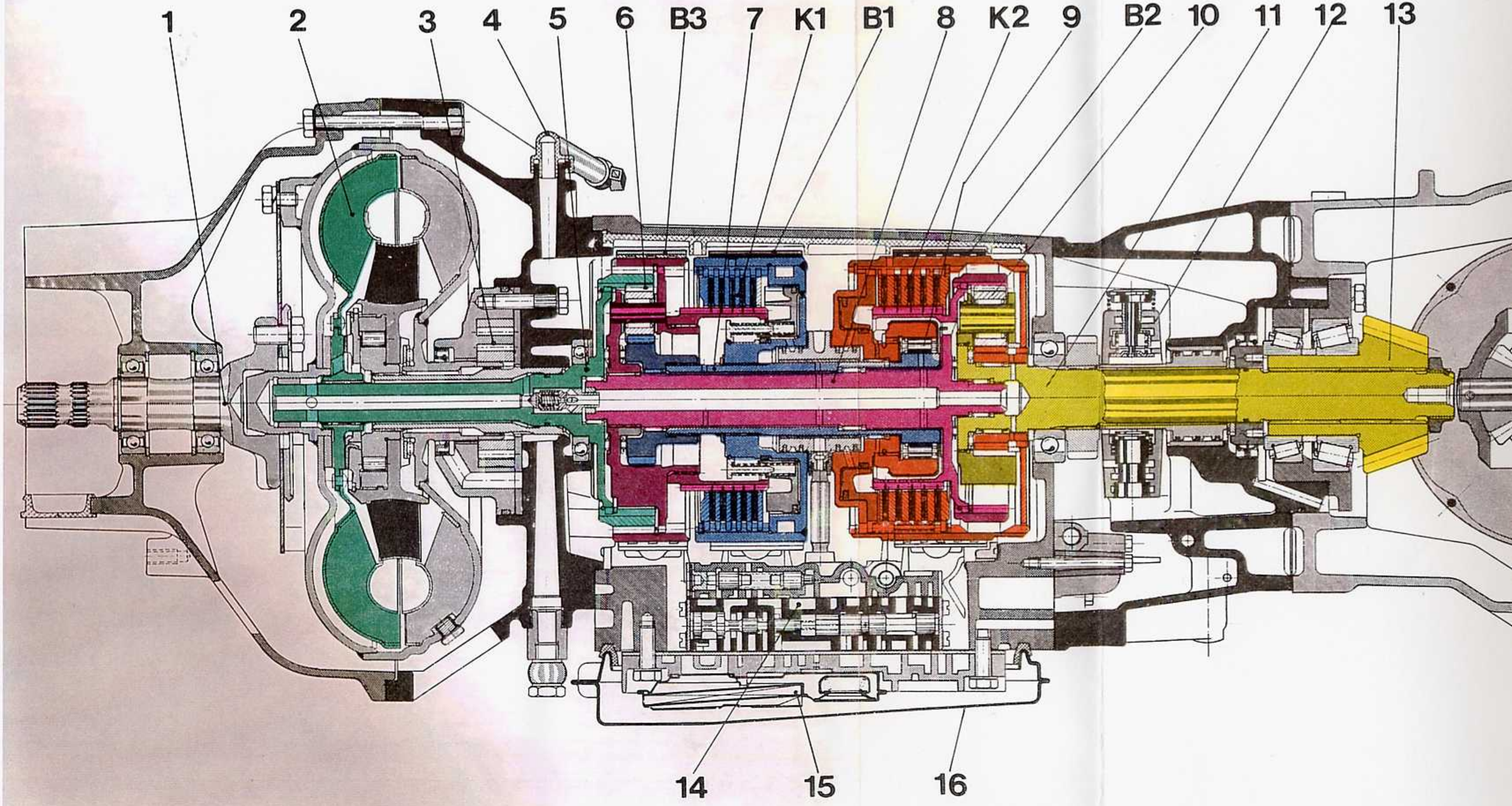
Operating Parts of Automatic Transmission A 22:

K1	Clutch pack
K2	Clutch pack
B1	Brake band
B2	Brake band
B3	Brake band

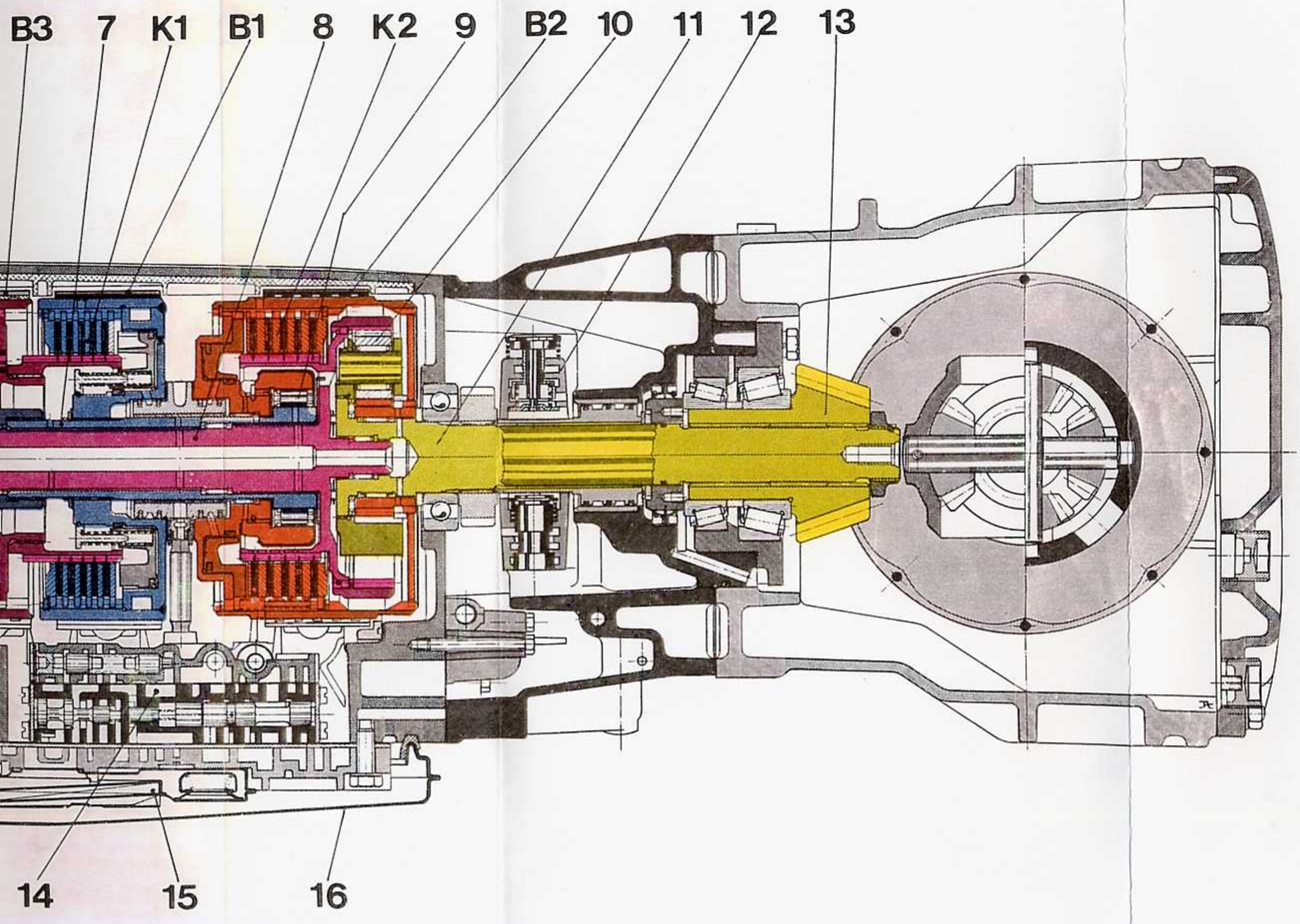
An important rule for an automatic transmission is that **basically two operating parts must be applied for each forward driving range.**

Note!
With range 1 the one-way clutch will also be locked; when engaging reverse brake band 3 **and** the one-way clutch will lock.

Gear	K1	K2	B1	B2	B3	One Way Clutch
1			*	*		*
2	*		*			
3	*	*				
R					*	*



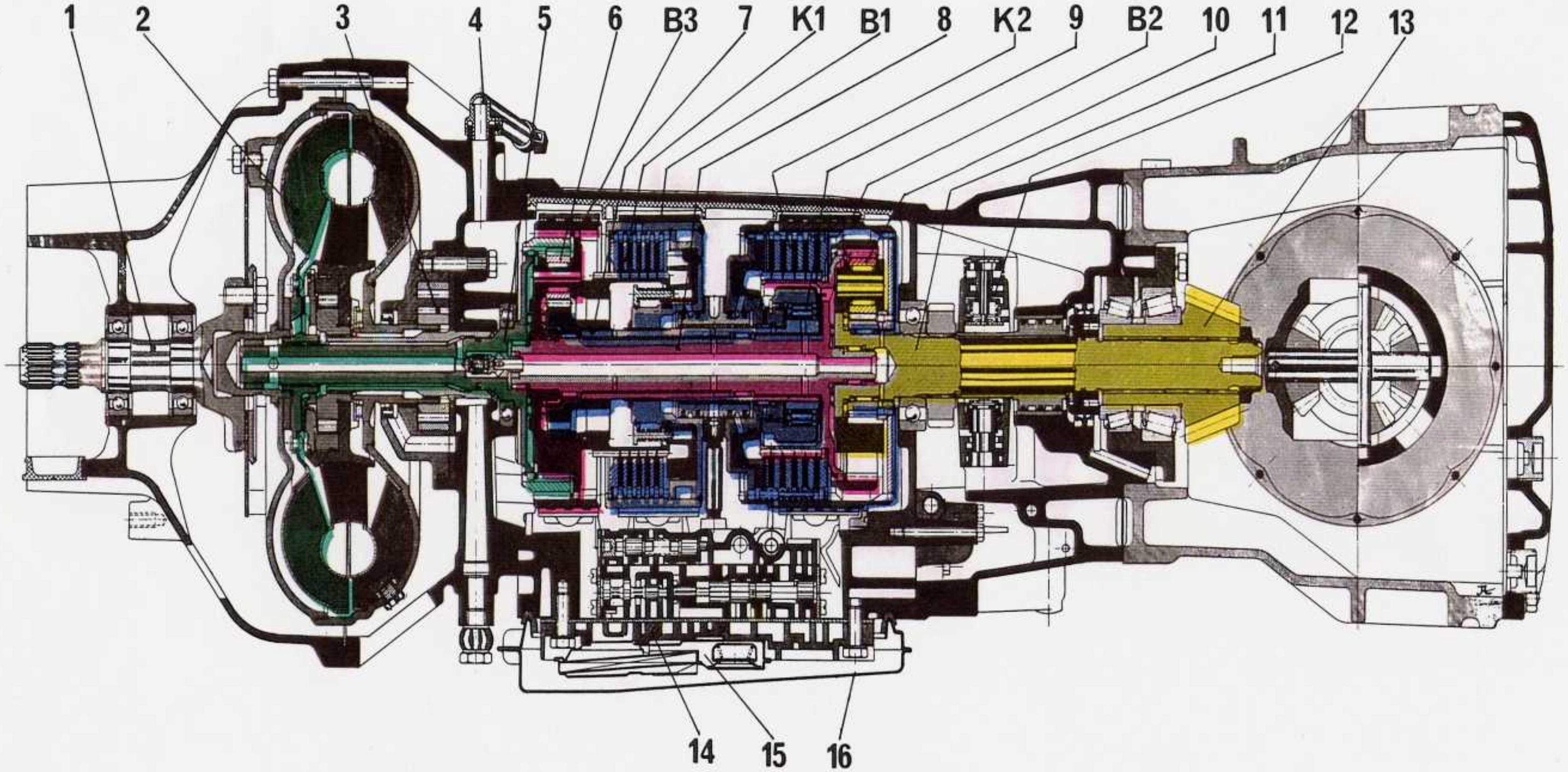
36



36

The following parts are connected with each other.

- Turbine of torque converter (2) with turbine shaft (5) and ring gear of front planet gear set (6). (green)
- Brake band drum B3 with inner plate carrier of clutchpack K1 and planet gear carrier of front planet gear set by way of intermediate shaft (8) with ring gear of rear planet gear set (10) and inner plate carrier of clutch pack K2. (red)
- Brake band drum B1 with outer plate carrier of clutch pack K1 and sun gear of front planetary gear set (6) via hollow shaft (7) with inner race of one-way clutch (9). (blue)
- Brake band drum B2 with outer plate carrier of clutch K2, sun gear of rear planet gear set (10) and outer race of one-way clutch (9). (orange)
- Planet gear carrier of rear planet gear set (10) with output shaft (11) and drive pinion (13). (yellow)



Turbine wheel speed	green
Reduced speed	red
Blocked parts	blue
Speed reduced/once again	yellow

1st Gear

Applied Components

Gear	K1	K2	B1	B2	B3	One Way Clutch
1			*	*		*

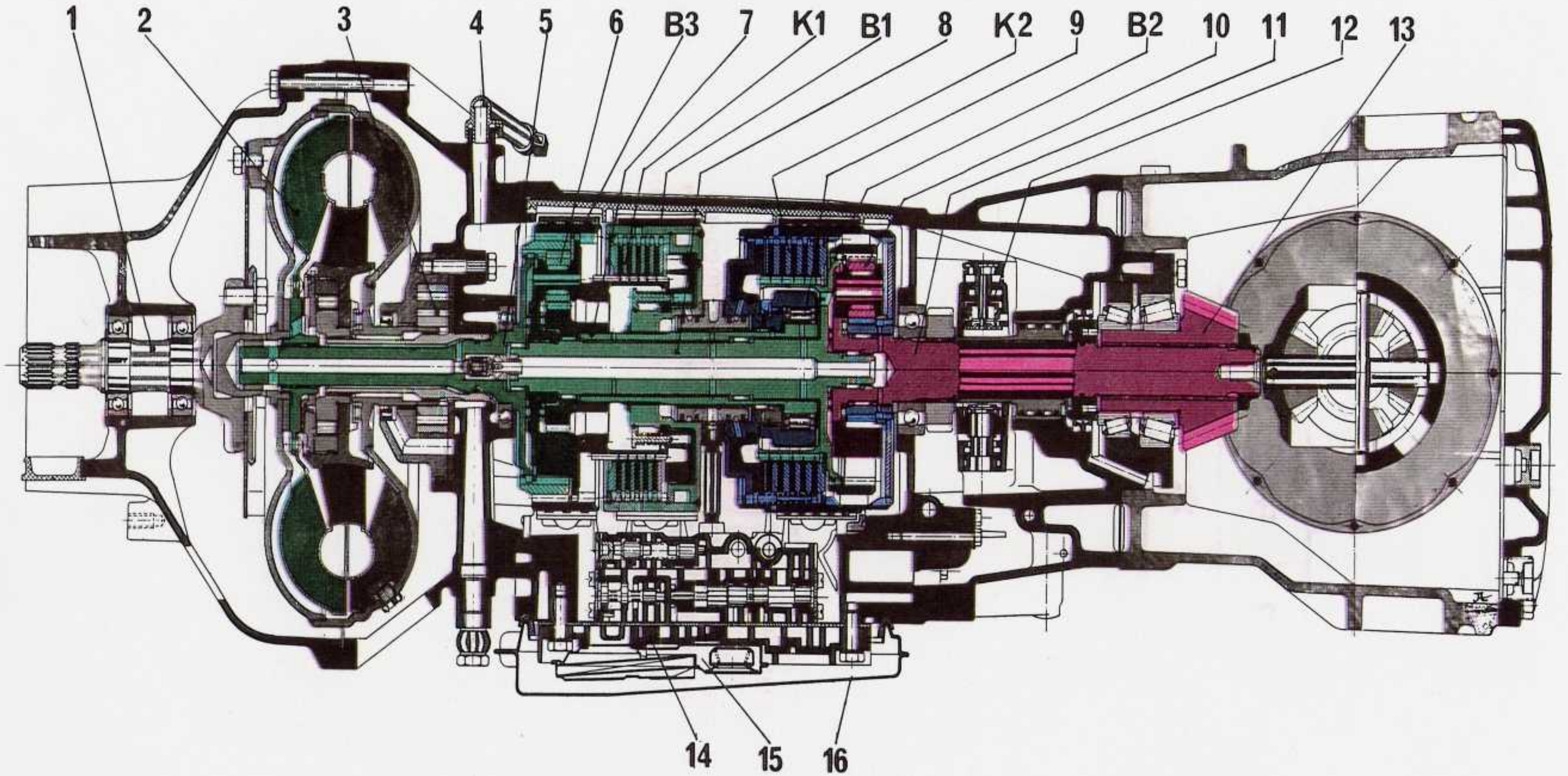
Brake band B1 holds via hollow shaft (7) the sun gear of front planetary gear set (6) and brake band B2 holds the sun gear of rear planetary gear set (10).

By supporting one part of each planetary gear set against the transmission case a low ratio is reached in each gear set.
By driving the ring gear of the front planetary gear set (6), the planet gears orbit around the held sun gear, so that the planet gear carrier with intermediate shaft (8) rotates in the same direction at a low ratio. The ratio in the front planetary gear set is 1.58 : 1.

The ring gear of the rear planetary gear set (10) is connected with intermediate shaft (8). Consequently the ring gear will turn at output speed of the front planet gear set (6) and drives the planet gears, which orbit around the held sun gear. Output shaft (11) is connected with the planet gear carrier and rotates in the same direction as the ring gear, but at normal speed ratio. The ratio in the rear planetary gear set is 1.46 : 1.

Total 1st Gear Ratio:

1.58 x 1.46 = 2.306 : 1



Turbine wheel speed	green
Reduced speed	red
Blocked parts	blue
Speed reduced/once again	yellow

2nd Gear

Applied Components

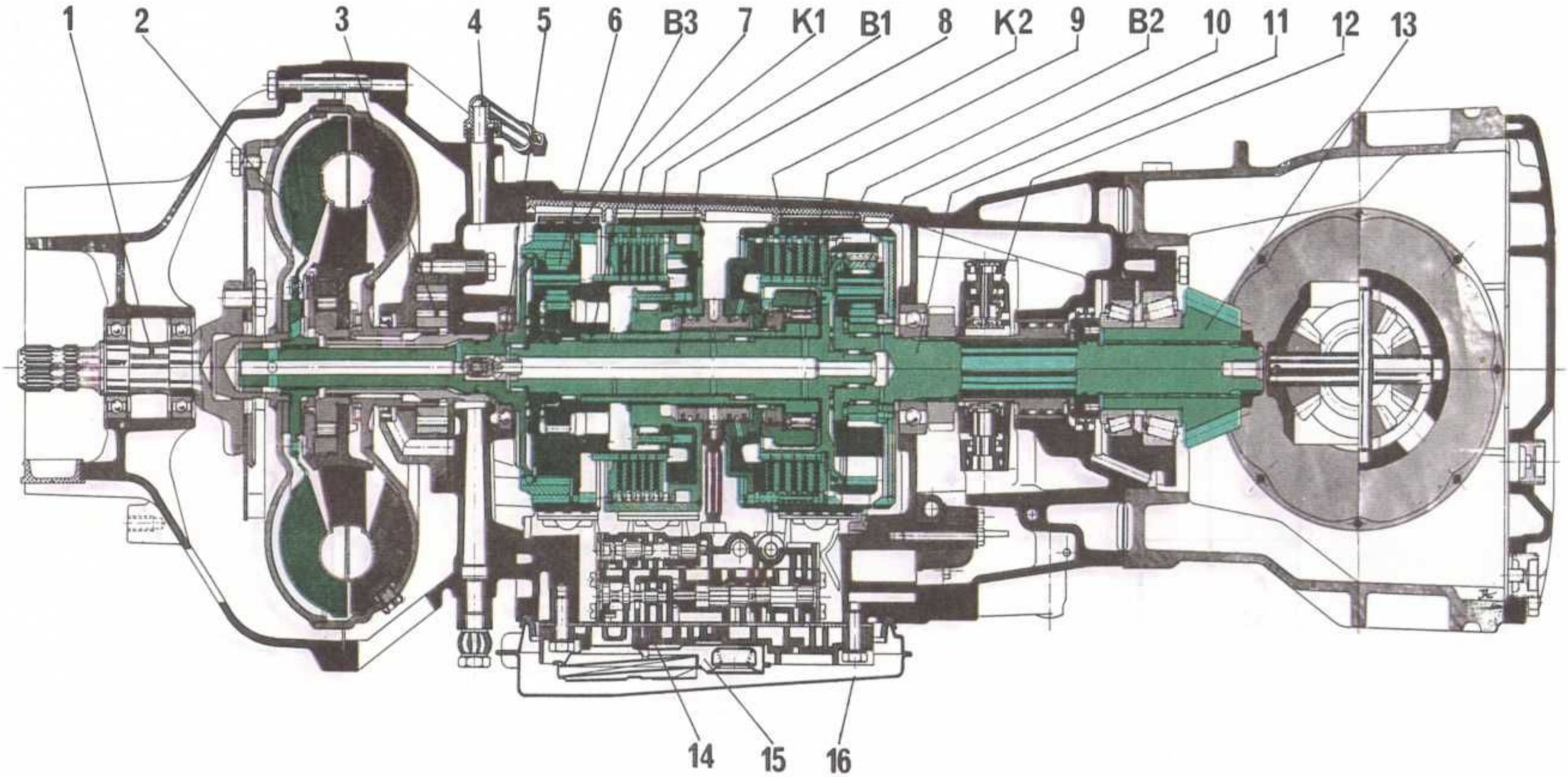
Gear	K1	K2	B1	B2	B3	One Way Clutch
2	*			*		

The applied clutch K 1 unites the front planetary gear set (6) (planet gear carrier and sun gear are connected).
The united planet gear set now rotates as a whole, without an orbiting of the gears and without a reduction ratio.
The intermediate shaft (8) connected with the planet gear carrier rotates at turbine speed, so does the hollow shaft (7) connected with the sun gear, which overcomes one-way clutch (9).
The ratio in the front planet gear set is 1 : 1.

The ring gear of the rear planetary gear set (10) connected with intermediate shaft (8) drives the planet gears, which orbit around the sun gear held by brake band B2. The planet gear carrier and output shaft rotate in the same direction as the ring gear, but at a different ratio. The ratio in the rear planet gear set is 1.46 : 1.

Total 2nd Gear Ratio:

1.00 x 1.46 = 1.46 : 1



Turbine wheel speed	green
Reduced speed	red
Blocked parts	blue
Speed reduced/once again	yellow

3rd Gear

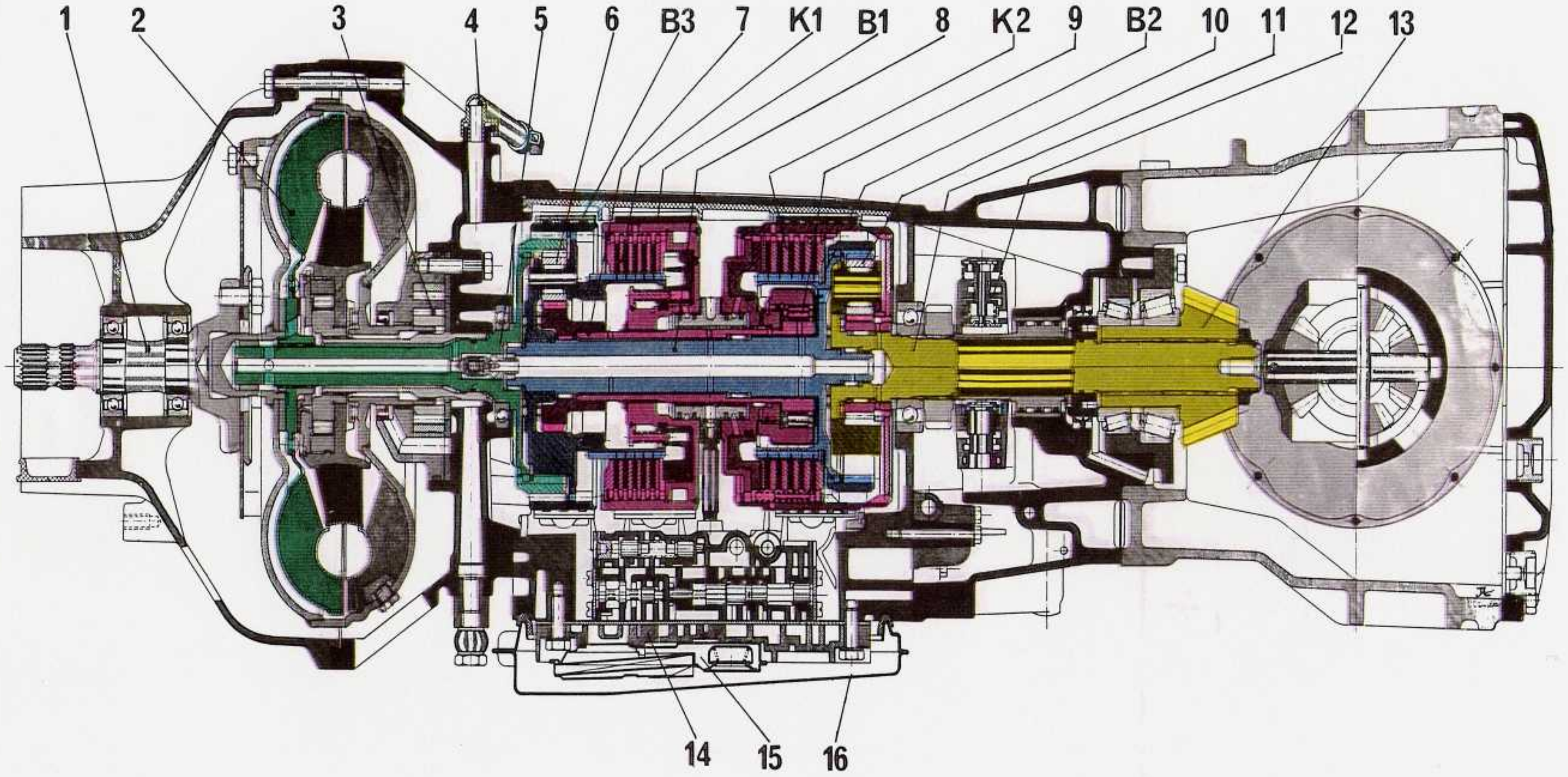
Applied Components

Gear	K1	K2	B1	B2	B3	One Way Clutch
3	*	*				

Both clutch packs K 1 and K 2 are applied. Both front (6) and rear (10) planet gear sets are connected and rotate as a whole, without a reduction ratio. The entire gear set assembly, from the turbine shaft (5) to the output shaft (11), turns at turbine speed.

Total 3rd Gear Ratio:

1.0 x 1.0 = 1 : 1



Turbine wheel speed	green
Reduced speed	red
Blocked parts	blue
Speed reduced/once again	yellow

Reverse Gear

Applied Components

Gear	K1	K2	B1	B2	B3	One Way Clutch
R					*	*

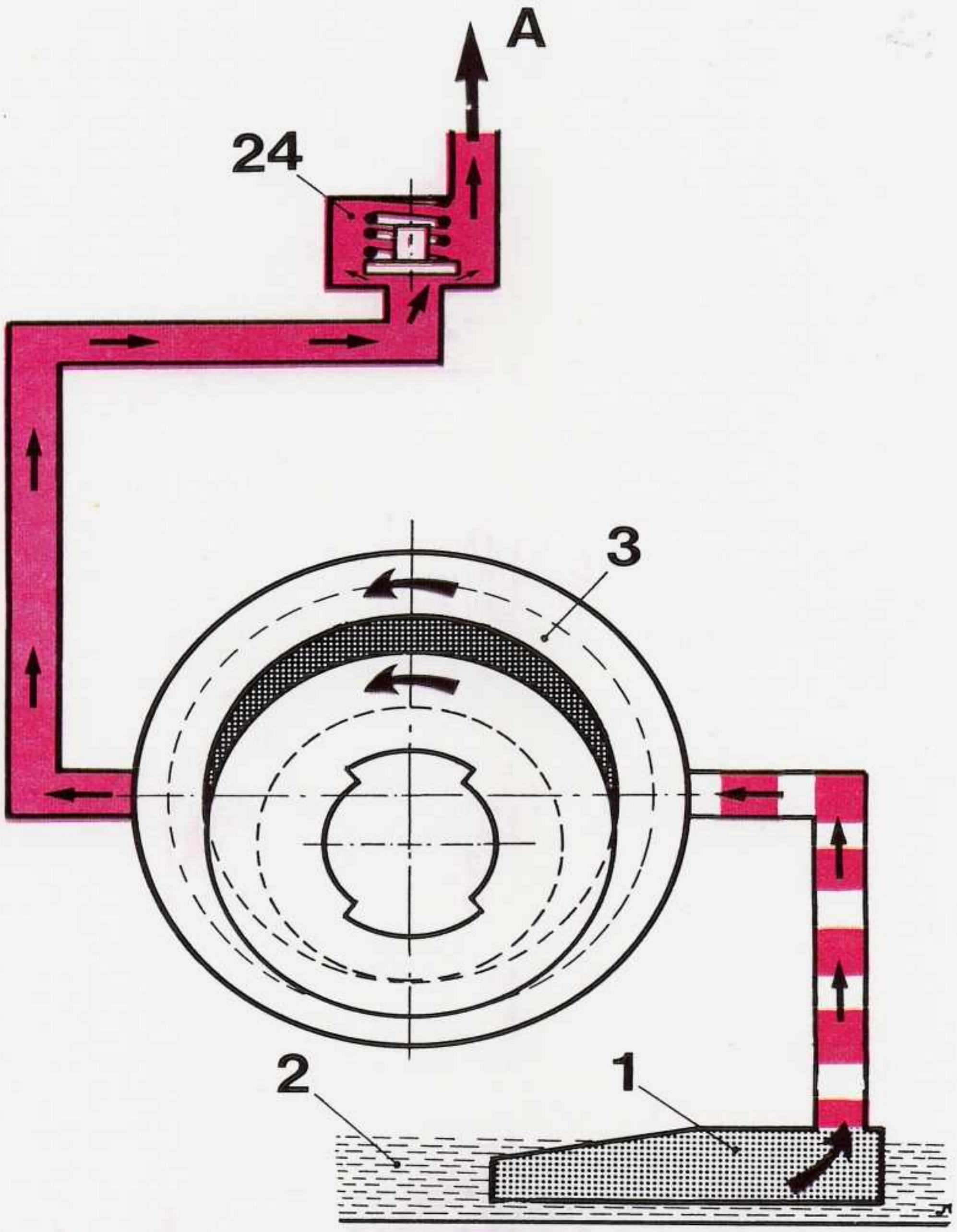
Brake band B3 holds the planet gear carrier of front planetary gear set (6) and the connected intermediate shaft (8) with ring gear of rear planetary gear set (10). The planet gears produce a **reverse direction of rotation**. The ring gear drives the sun gear in opposite direction of rotation at a high ratio. The ratio in the front planetary gearset is 1 : 0.58.

The sun gear of front planetary gear set (6) is connected with the sun gear of rear planetary gear set (10) by way of hollow shaft (7) and locked one-way clutch (9), so that it also rotates in reverse direction.

The driven planet gears of rear planetary gear set (10) orbit around the held ring gear, so that the planet gear carrier and input shaft rotate in the same direction at low ratio.
The ratio in the rear planet gear set is 3.17 : 1.

Total Reverse Gear Ratio:

0.58 x 3.17 = 1.84 : 1



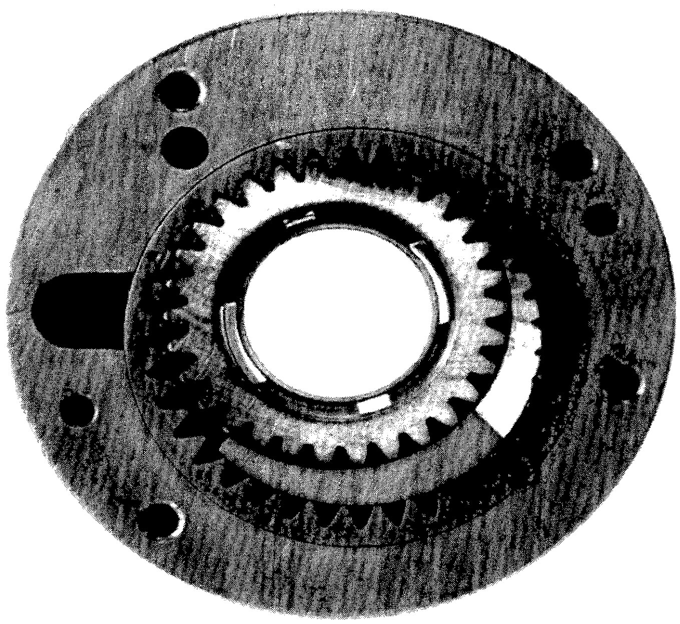
1 – ATF filter
2 – ATF sump
3 – ATF pump
24 – ATF pump check valve
A – Main pressure

The A 22 automatic transmission in a Porsche 928 has only one ATF pump, which is driven at engine speed by the shell of the housing of torque converter.
Since there is no secondary pump, the car with an automatic transmission cannot be started by towing or pushing.
Towing the car requires certain precautionary measures.

If the car has to be towed the rear wheels must be off the ground or the rear axle shafts removed.

The ATF pump is a crescent pump located in the front transmission case cover. This pump makes up the fundamental basis for the entire automatic transmission hydraulic system. It delivers the **hydraulic pressure** required for operating brake bands and clutch packs.

ATF is filtered through a fine mesh filter (1) from the sump (2) and pumped to the automatic transmission through a check valve (24).



The following pressures are required to control the hydraulic system and apply the operating parts.

A	**Main pressure** to operate the clutch packs and brake bands. The main pressure can be measured.
RA	**Reduced main pressure.**
SR	**Lubricating pressure** to fill and flow through the torque converter, and lubricate automatic transmission parts.
M	**Modulator pressure** to control the main pressure. It can be measured and adjusted.
S	**Throttle pressure** acts on the command valve in opposition to the governor pressure and influences downshifts.
RS	**Reduced throttle pressure** to cause downshifts and kickdown downshifts.
R	**Governor pressure** to cause upshifts. The governor pressure can be measured.
O	**Line without pressure** for return flow to ATF sump.

1. Main Pressure

The main pressure has to operate the brakes and clutches. This pressure can be regulated by the main pressure control valve (21), which is located in the valve body lower section.

When the throttle is closed, the left main pressure control valve piston (L) will be against its left stop. Basic spring (e) then regulates the main pressure to its lowest value, the **basic main pressure**. With partial or full throttle the **main pressure** will depend on the **modulating pressure** (M) on the left side as well as the main pressure (A), which is applied to the face surface (a) and annular surface (b) to counteract the modulating pressure.

Only the annular surface (b) has main pressure in 1st and reverse gears or with selector lever at "1", which provides a higher main pressure.

The modulating pressure dependent main pressure control means:

low modulating pressure / low main pressure

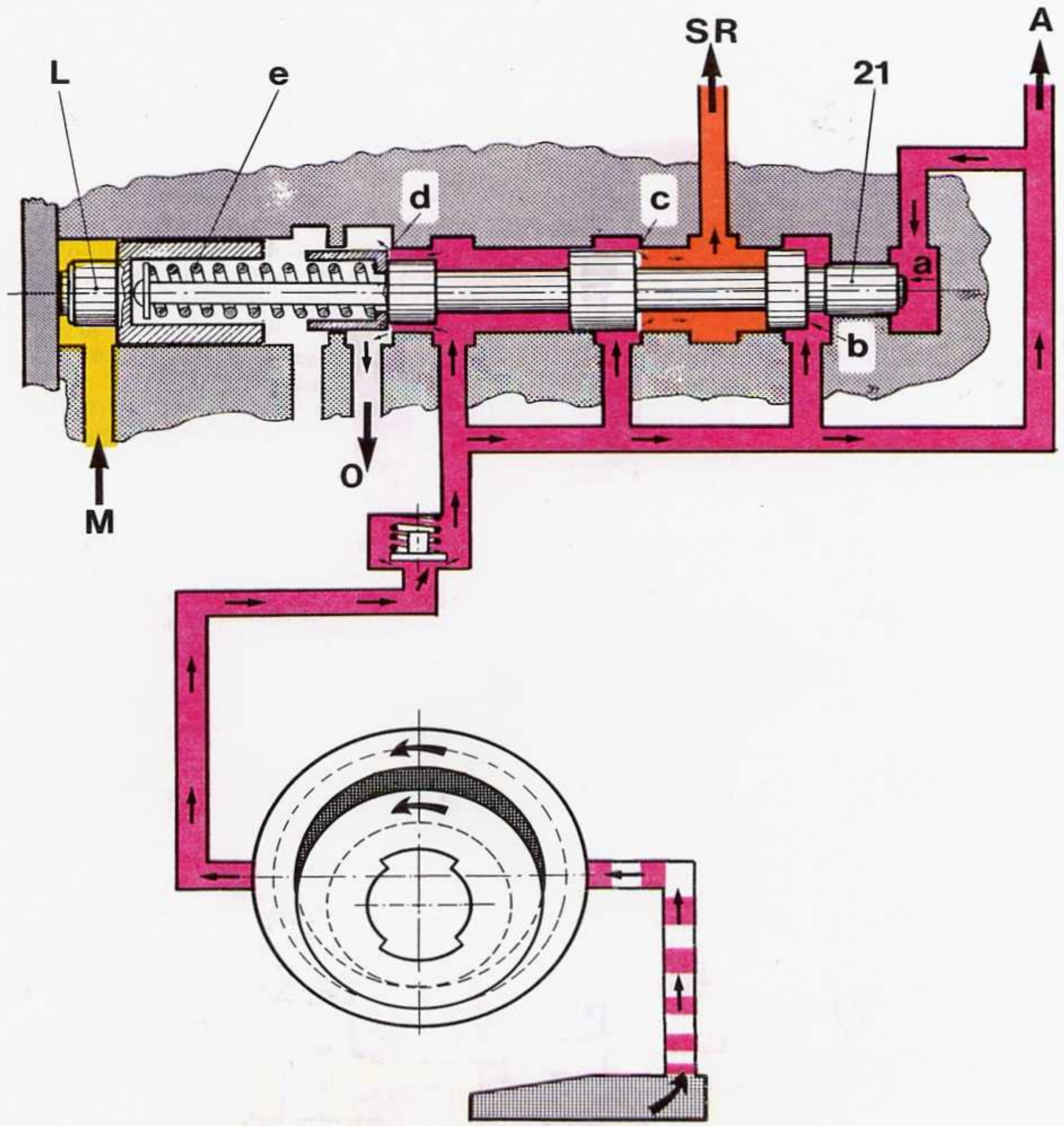
high modulating pressure / high main pressure

The differing amount of excessive ATF, depending on engine speed and ATF temperature, flows at first through "c" into the **lubricating system**, and any additional ATF flows through "d" into the ATF sump.
The main pressure can be measured, but not adjusted.

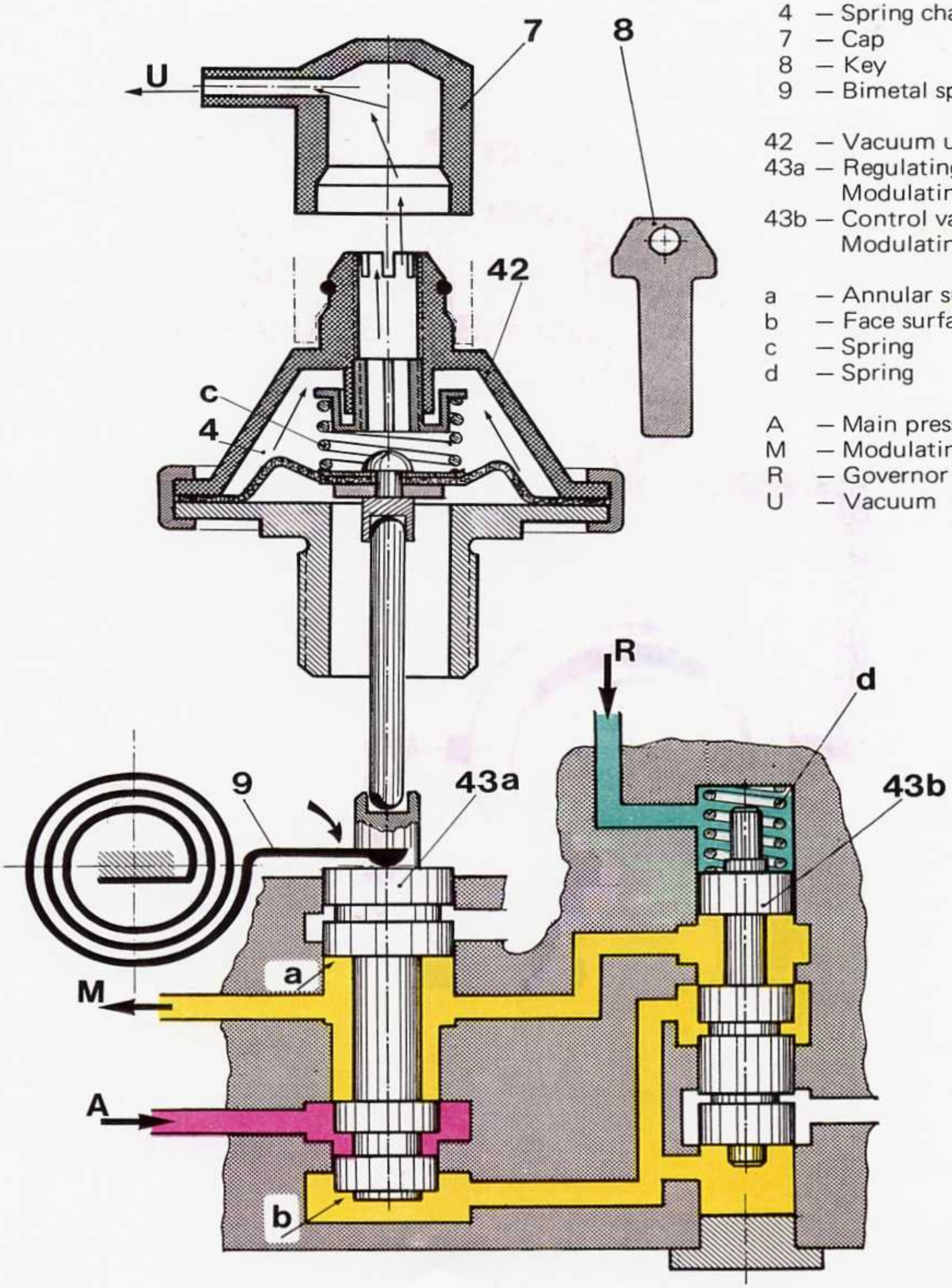
2. Lubricating Pressure

The ATF returning via "c" passes through the ATF cooler located in the front of the car to the torque converter and through the input shaft for the lubrication of mechanical parts in the transmission.

The pressure produced is known as **lubricating pressure**.



21 – Control valve main pressure
L – Control valve left piston main pressure
O – Return flow without pressure
A – Main pressure
M – Modulating pressure
SR – Lubricating pressure
a – Face surface
b – Annular surface
c – Lubricating pressure return flow edge
d – Return flow edge
e – Basic spring



4 — Spring chamber
7 — Cap
8 — Key
9 — Bimetal spring

42 — Vacuum unit
43a — Regulating valve Modulating pressure
43b — Control valve Modulating pressure

a — Annular surface
b — Face surface
c — Spring
d — Spring

A — Main pressure
M — Modulating pressure
R — Governor pressure
U — Vacuum

3. Modulating Pressure

Modulating pressure must **control** the **main pressure** from partial to full throttle.

Modulating pressure is derived from the main pressure and controlled by modulating pressure control valve (43a).
A changing pressure is produced in conjunction with vacuum unit (42) in accordance with engine vacuum (U). The force of spring (c) presses the control valve down in direction of "open".
With the engine running, vacuum (U) enters the spring chamber (4) of the modulator, which together with force of modulating pressure on the annular surface (a) and face surface of piston (b) acts against the force of spring (3).

The modulator pressure regulating valve (43b) reduces the pressure which reaches the face surface (b) at low speeds. This pressure will be determined by the **force of spring** (6) acting against modulator pressure regulating valve (43b) as well as the **governor pressure** (R). For low pressure on face surface (b), there must be high modulating pressure on annular surface (a).

The road speed dependent governor pressure (R) will be so great at approx. 45 km/h (28 mph) that the modulator pressure regulating valve will be pressed against the lower stop.
The modulating pressure will have the same value at surfaces (a) and (b).

The ATF temperature is another factor influencing the modulating pressure. As the temperature increases the force from bimetal spring (9) on modulating pressure control valve (43a) will increase continuously.

Modulating Pressure Test

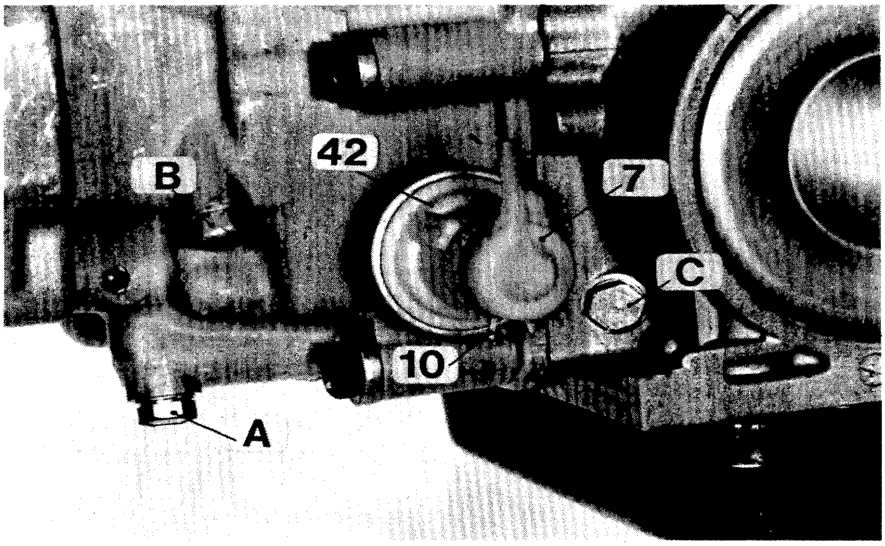
The modulating pressure is tested with car on a dynamometer or during a test drive. For this purpose a pressure gauge line is routed from the test connection on the transmission case to a test gauge.

Test specifications:

Conditions	**Pressure (bar)**
In "D"; approx. 100 km/h; full throttle; ATF temperature below 90°C; vacuum line to engine connected	**3.1 ... 3.15**
In "D"; atstall speed vacuum line to engine disconnected	**4.6 ... 4.9**

Modulating Pressure Adjustments

The modulating pressure shares the responsibility for smooth shifts, service life of friction parts and the speed at which the upshifts and downshifts take place. Correct adjustments are easy to make.

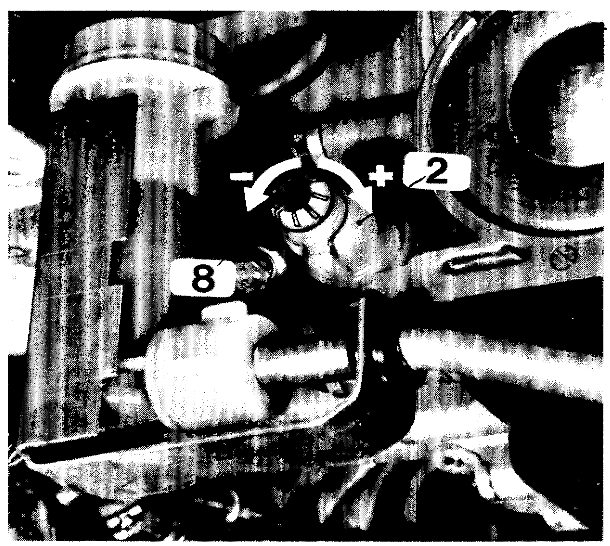


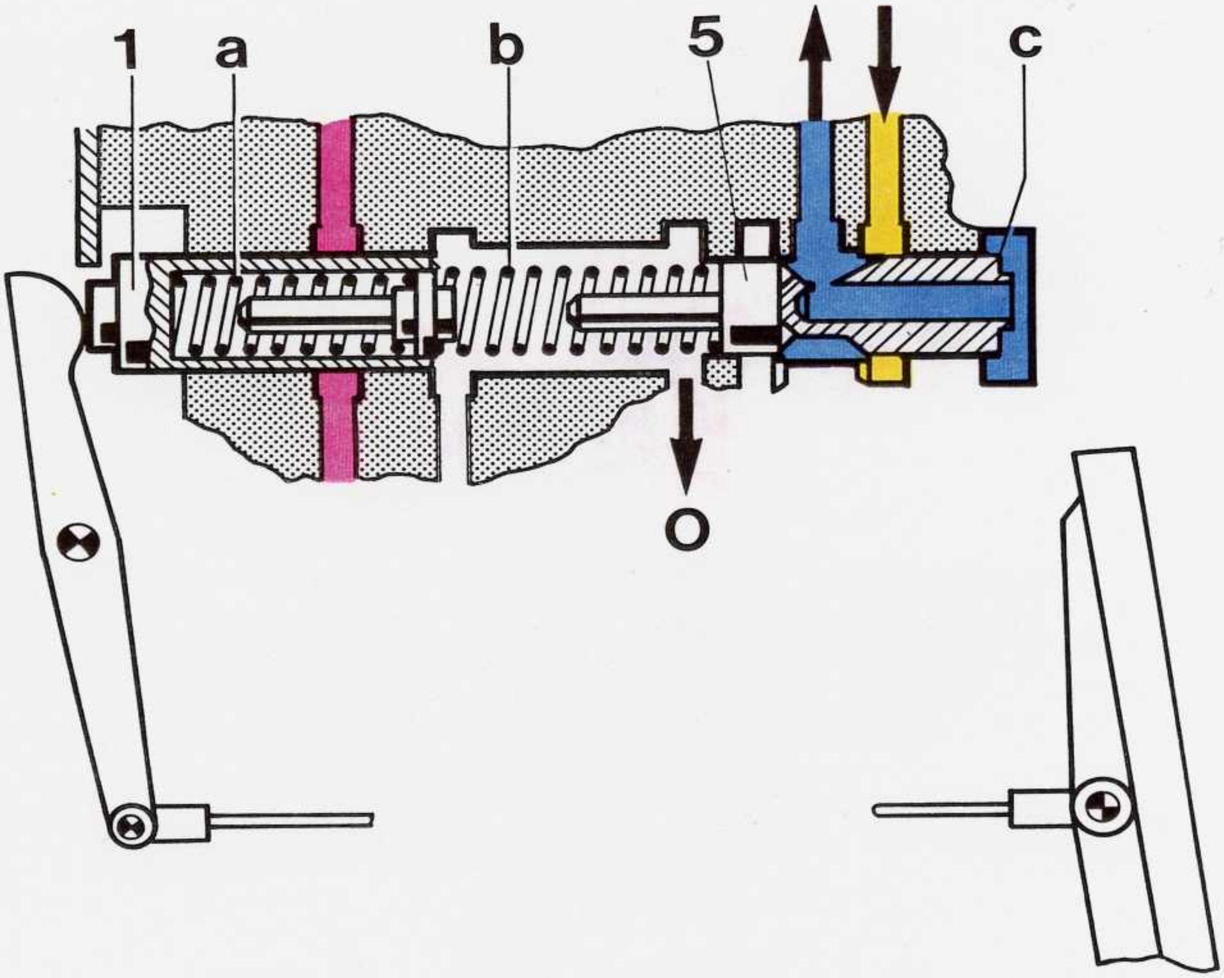
Pressure Testing Connections

A — Main pressure
B — Governor pressure
C — Modulating pressure

- Compress snap ring (10).
- Take off cap (7) from vacuum unit. Locked key (8) can now be seen.
- Pull key (8) out a little and turn to adjust modulator.
- After completion of adjustments, press key (8) back into nearest locking slot.
- Install cap (7) again.

One turn of adjusting screw will change pressure by about 0.2 bar. Turn clockwise to increase (+) pressure and counter-clockwise to reduce (—) the pressure.





1 – Throttle pressure piston
5 – Throttle pressure control valve

0 – Return flow
a – Spring
b – Spring
c – Face surface

4. Throttle Pressure

The throttle pressure can be used to influence the downshift points.

Throttle pressure is derived from the modulating pressure and is controlled by the throttle pressure control valve (5).
It acts against the governor pressure at the command valves.

The throttle pressure control valve (5) is pressed to the right by the force from both springs (a) and (b). As a result, there is a connection between the modulating pressure and throttle pressure systems.

Throttle pressure also reaches the piston face surface (c) through bores in the control valve. The increasing throttle pressure will press the control valve (5) into control position against the spring force. Depending on operating conditions, this will restrict the fluid flow or open the return flow (0) when control pressure is dropping.

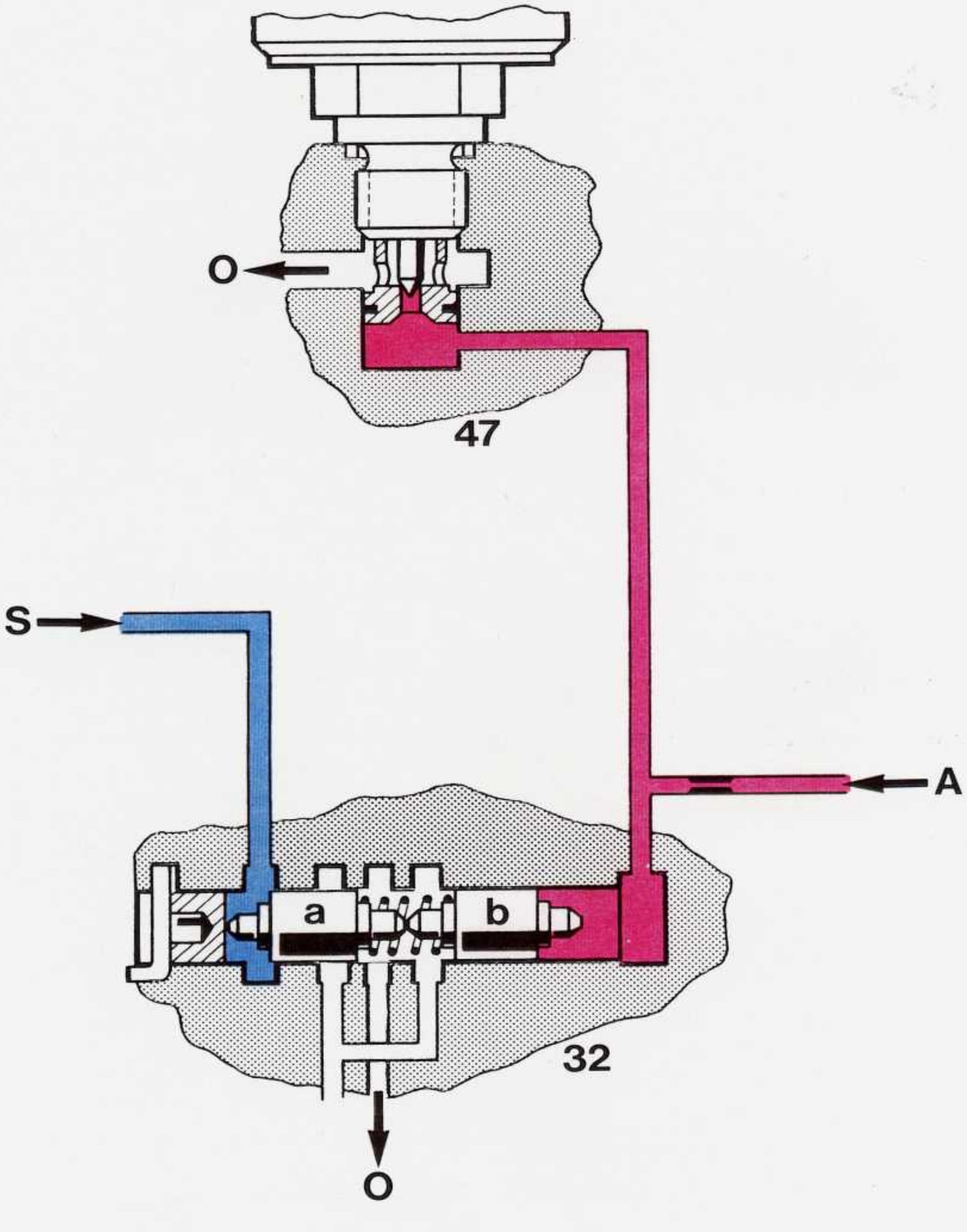
The spring force will be influenced by the accelerator pedal position via the throttle pressure cable.

This means:

no pressure on accelerator pedal — low spring force — low throttle pressure

full throttle — high spring force — high throttle pressure

The full throttle pressure equals the full throttle modulating pressure.



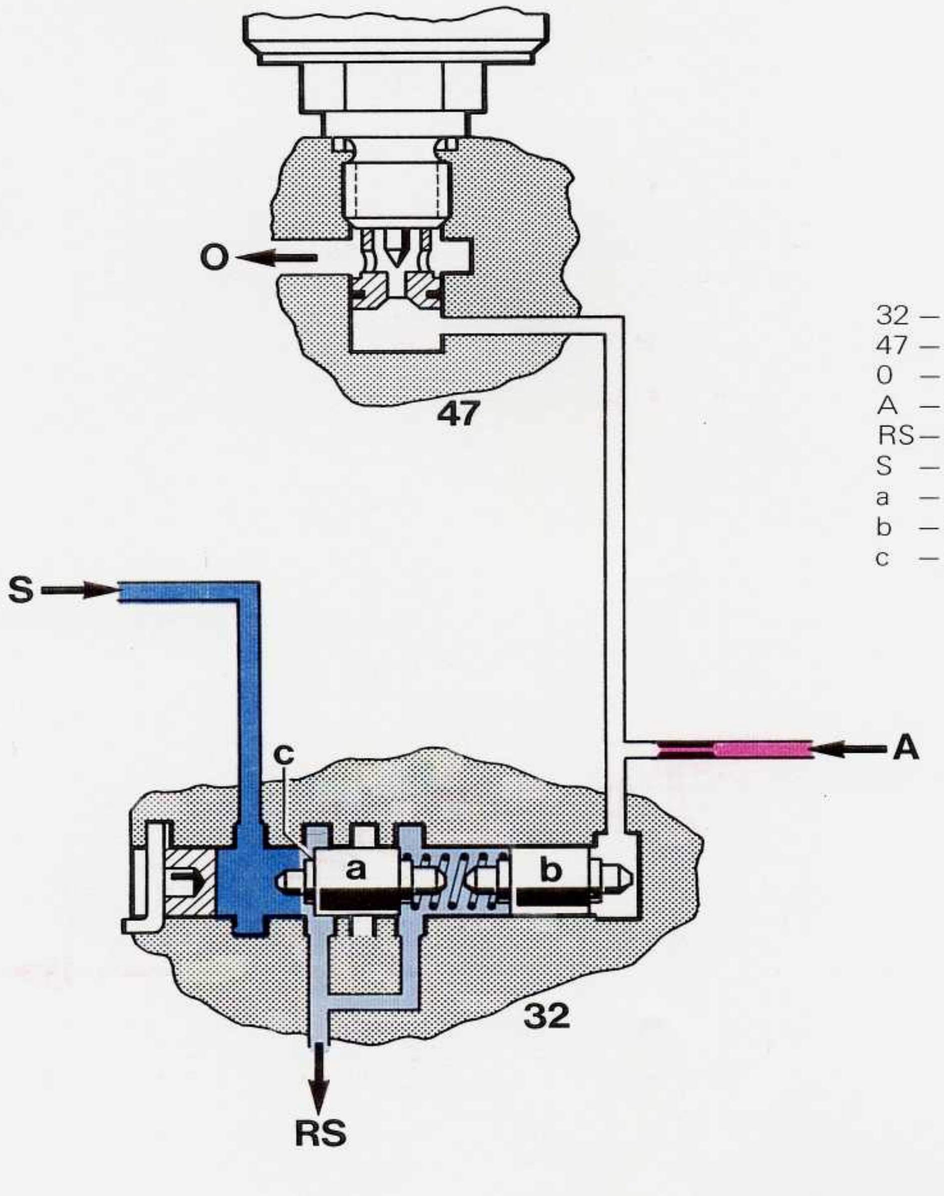
32 – Kickdown control valve
47 – Kickdown solenoid
0 – Return flow
A – Main pressure
S – Throttle pressure
a – Valve
b – Valve

5. Reduced Throttle Pressure

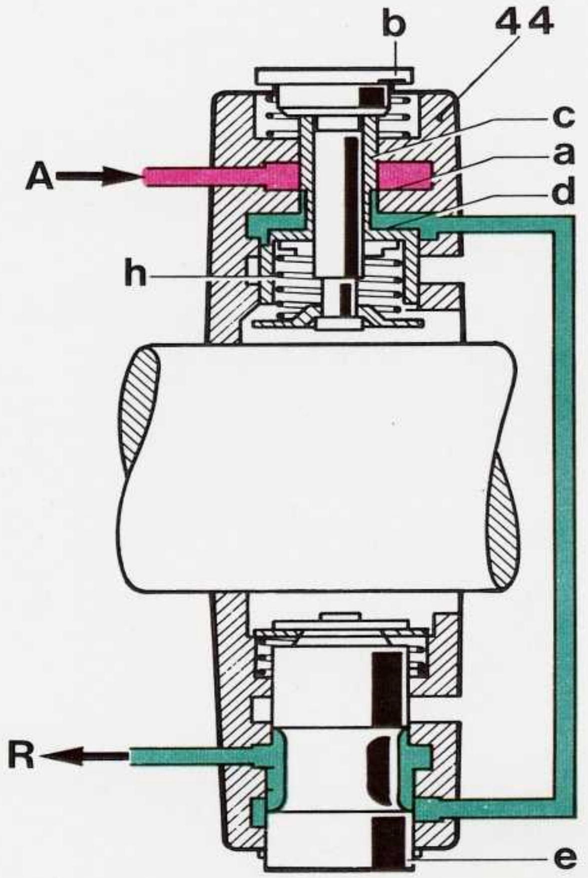
Kickdown downshifts and downshifts at partial or full throttle are introduced by reduced throttle pressure (RS).

When depressing the accelerator pedal past full throttle, an electric switch makes contact to supply power to solenoid (47). This will open the solenoid and allows main pressure (A) to flow from kickdown control valve (32) to ATF sump (10) (left side of figure).

The throttle pressure (S) presses valves "a" and "b" into control position, so that throttle pressure can go to the command valves and via a branch into the spring chamber of control valve (32). A throttle pressure reduced by the force of the spring will be available at control surface "c" (bottom of figure).

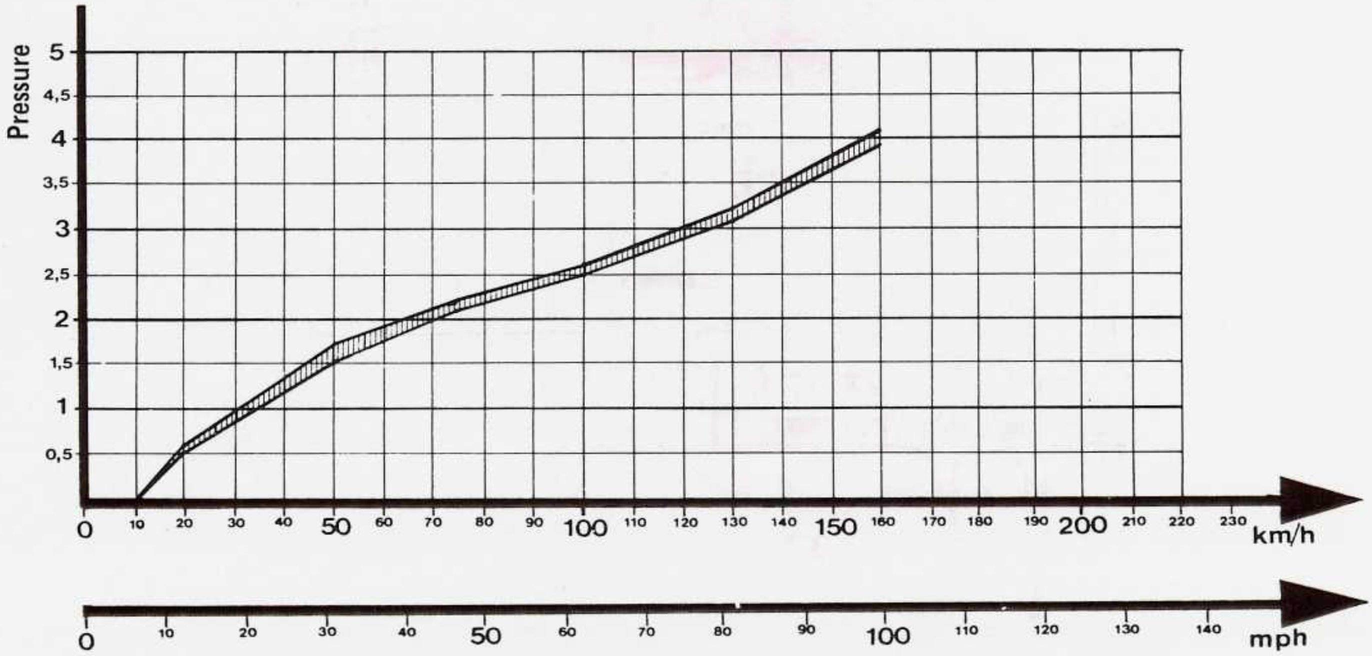


32 — Kickdown control valve
47 — Kickdown solenoid
0 — Return flow
A — Main pressure
RS — Reduced throttle pressure
S — Throttle pressure
a — Valve
b — Valve
c — Control surface



44 — Centrifugal governor
A — Main pressure
R — Governor pressure
a — Control edge
b — Centrifugal weight
c — Control sleeve
d — Annular surface
e — Shut-off piston
h — Control spring

Governor Pressure



6. Governor Pressure

The centrifugal governor controls the governor pressure in accordance with the road speed. Governor pressure is derived from the main pressure and is used to cause upshifts.

The control of the governor pressure takes place at control edge "a" depending on the centrifugal force, which acts on the governor sleeve "c", governor spring "h" and centrifugal weight "b".

The governor pressure on the annular surface "d" acts against the centrifugal force and holds sleeve "c" in control position.

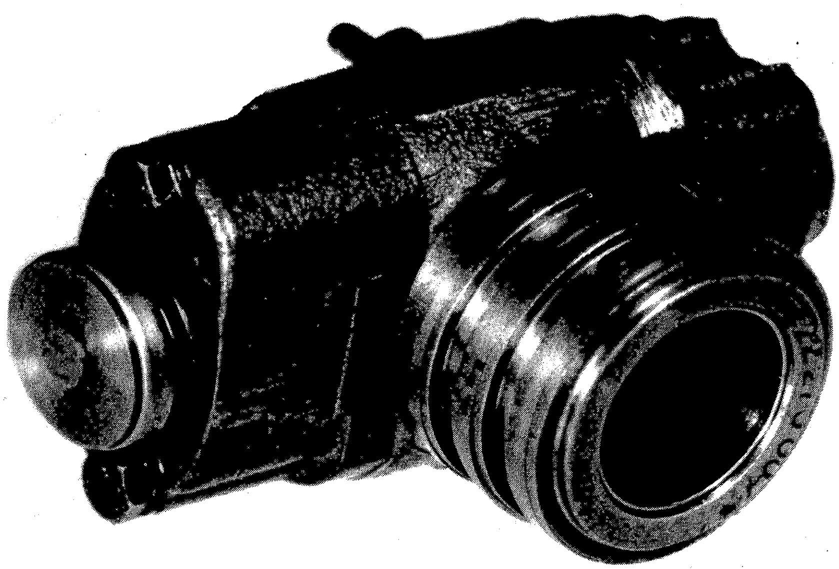
This means:

low road speed — low governor pressure

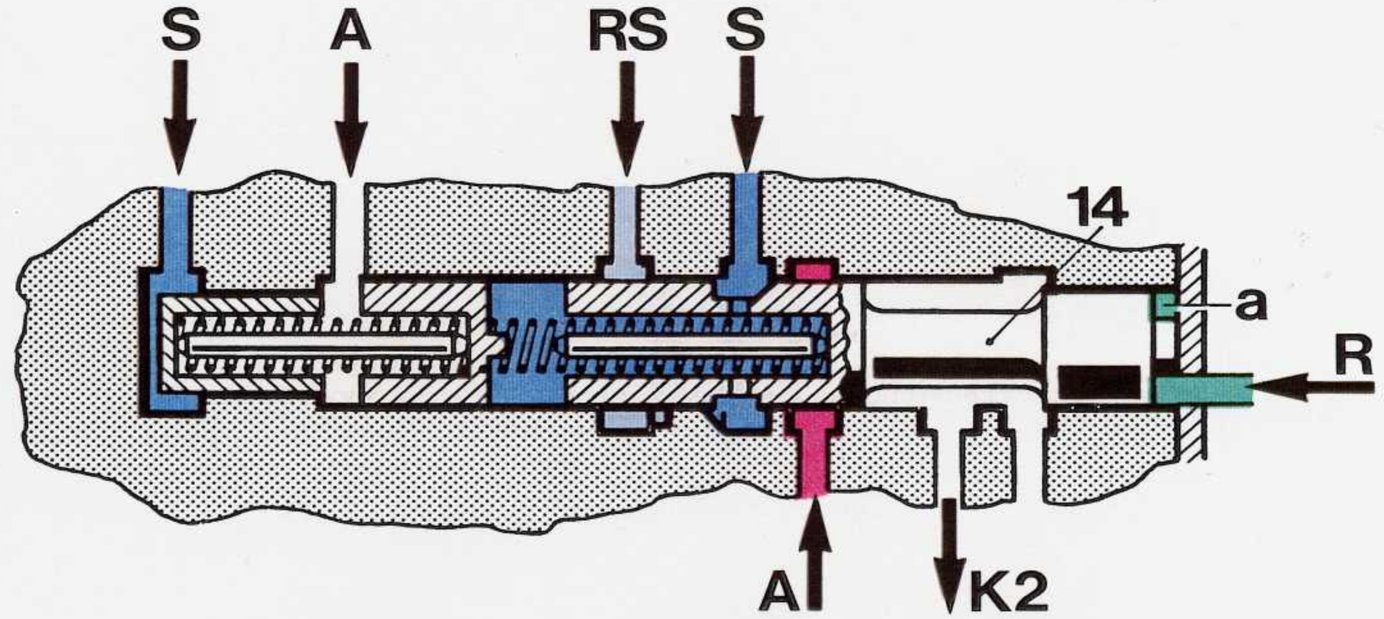
high road speed — high governor pressure

Piston "e" must open the connection to the governor pressure system at approx. 10 km/h (6 mph) and close it again at 5 km/h (3 mph).

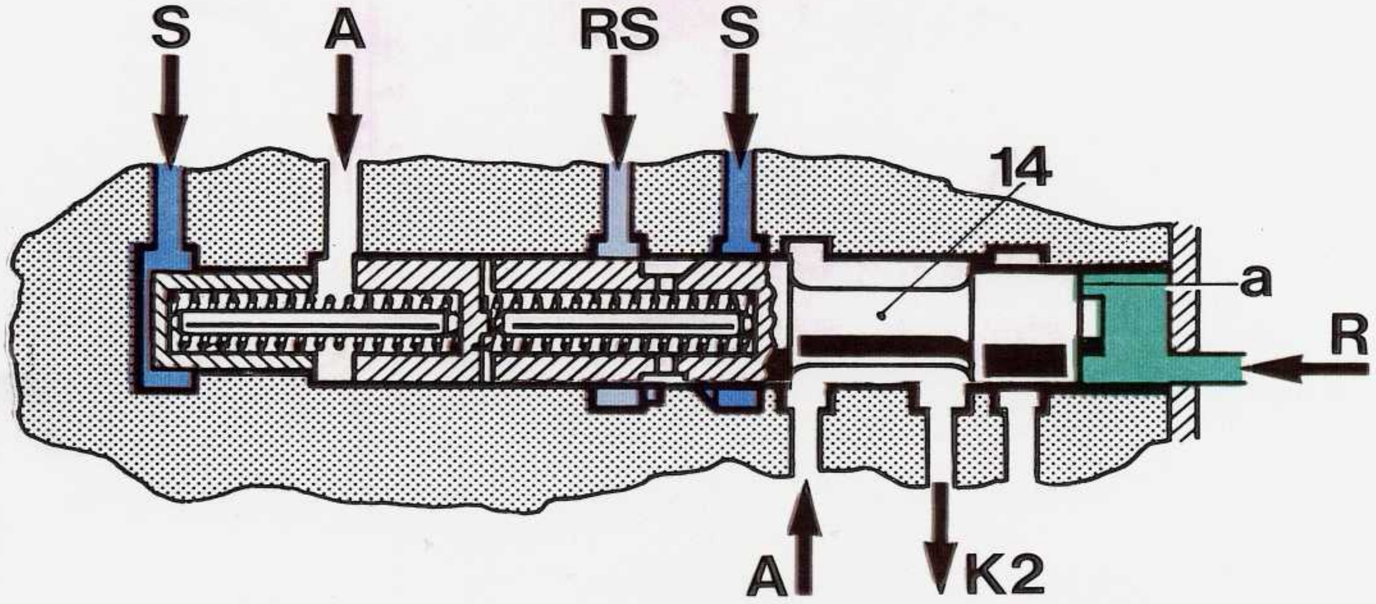
Centrifugal Governor



Lower Gear



Higher Gear



Command valves control shifts. This transmission has two command valves.

Command valve (7) for shifts 1 — 2 — 1

Command valve (14) for shifts 2 — 3 — 2

Basically both command valves operate identically and the following text uses command valve (14) for descriptions.

In its initial position the command valve is held in the position of the lower gear by the spring on the right side and throttle pressure from right.

As the road speed increases, the governor pressure on face surface "a" rises and at first pushes the command valve toward the left slowly. As soon as the cut in the command valve has opened the connection to the return bore "RS", throttle pressure is removed quickly from the spring chamber through a radial bore. There is greater force from the governor pressure side. The command valve snaps into the position for the higher gear.

The snapping effect for a downshift occurs when throttle pressure enters into the right spring chamber. The initial motion of the command valve against the governor pressure can occur under any of the following conditions;

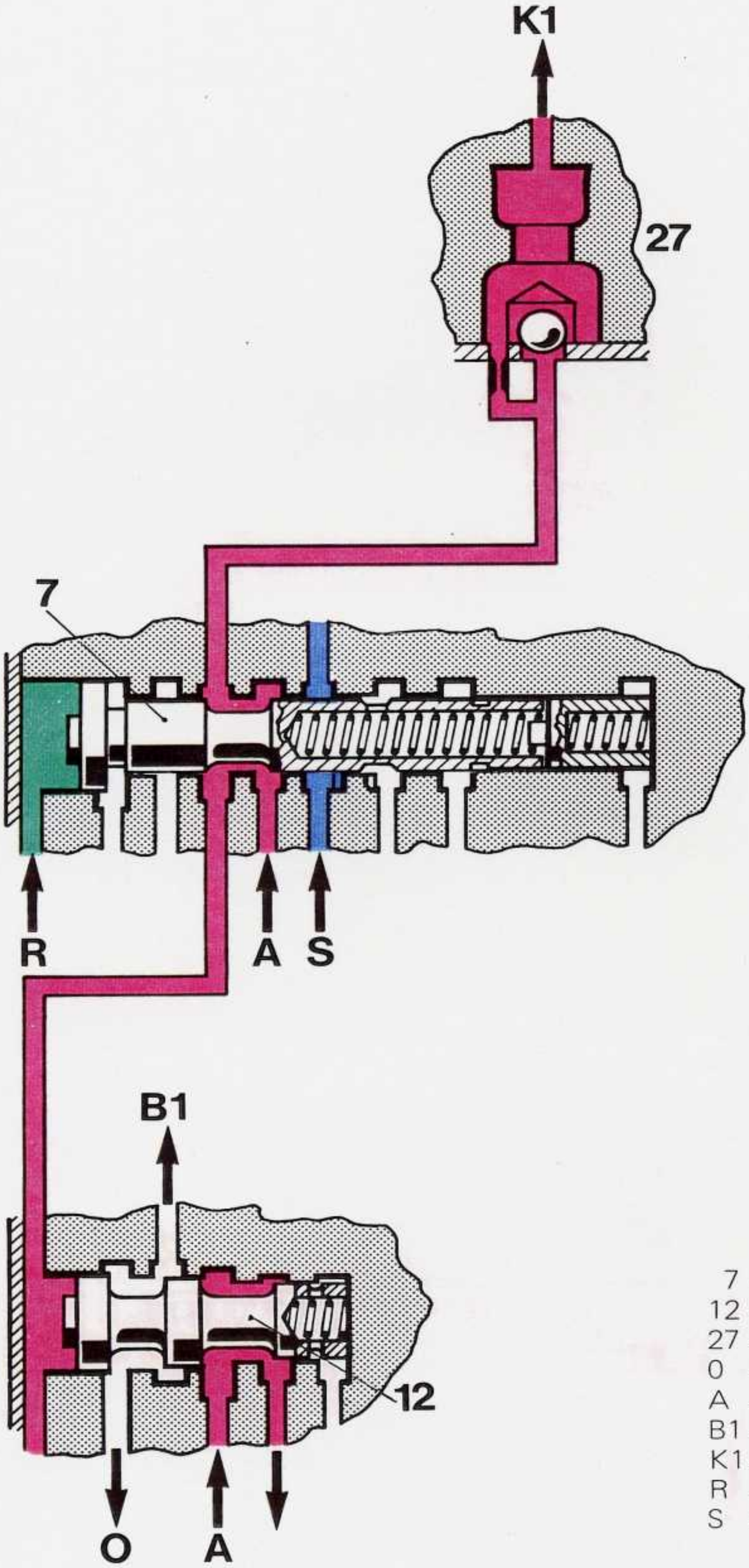
— at partial throttle by force from the right spring,

— at kickdown by force from the right spring and by reduced throttle pressure, and

— at full throttle by force from the throttle pressure on the left piston.

The command valves control shifting and releasing valves, which in turn are controlled by clutch pack apply pressures and operate the brake bands.

14 — Command valve
A — Main pressure
K2— Apply pressure to clutch K2
R — Governor pressure
RS— Reduced throttle pressure
S — Throttle pressure
a — Face surface



7 — Command valve
12 — Brake band B1 shift valve
27 — Clutch K1 one-way valve
0 — Return flow
A — Main pressure
B1 — Apply pressure to brake B1
K1 — Apply pressure to clutch K1
R — Governor pressure
S — Throttle pressure

Upshifts and Downshifts with Command Valve (7).

Upshift:

Clutch K1 must be applied and brake B1 released.

Governor pressure will press command valve (7) to the position of the higher gear. Main pressure will go through one-way valve (27) to K1 and left side of shift valve B1 (12) (left figure).

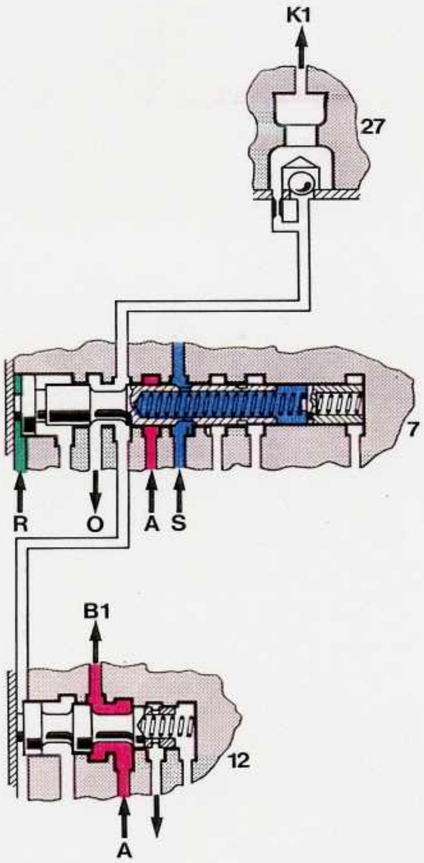
As soon as clutch K1 is engaged shift valve B1 (12) switches and connects the brake B1 apply passage to the large return passage. In order for this to happen, the clutch apply pressure must overcome the spring force and force of main pressure, which acts on the other side of shift valve B1 (12) (left figure).

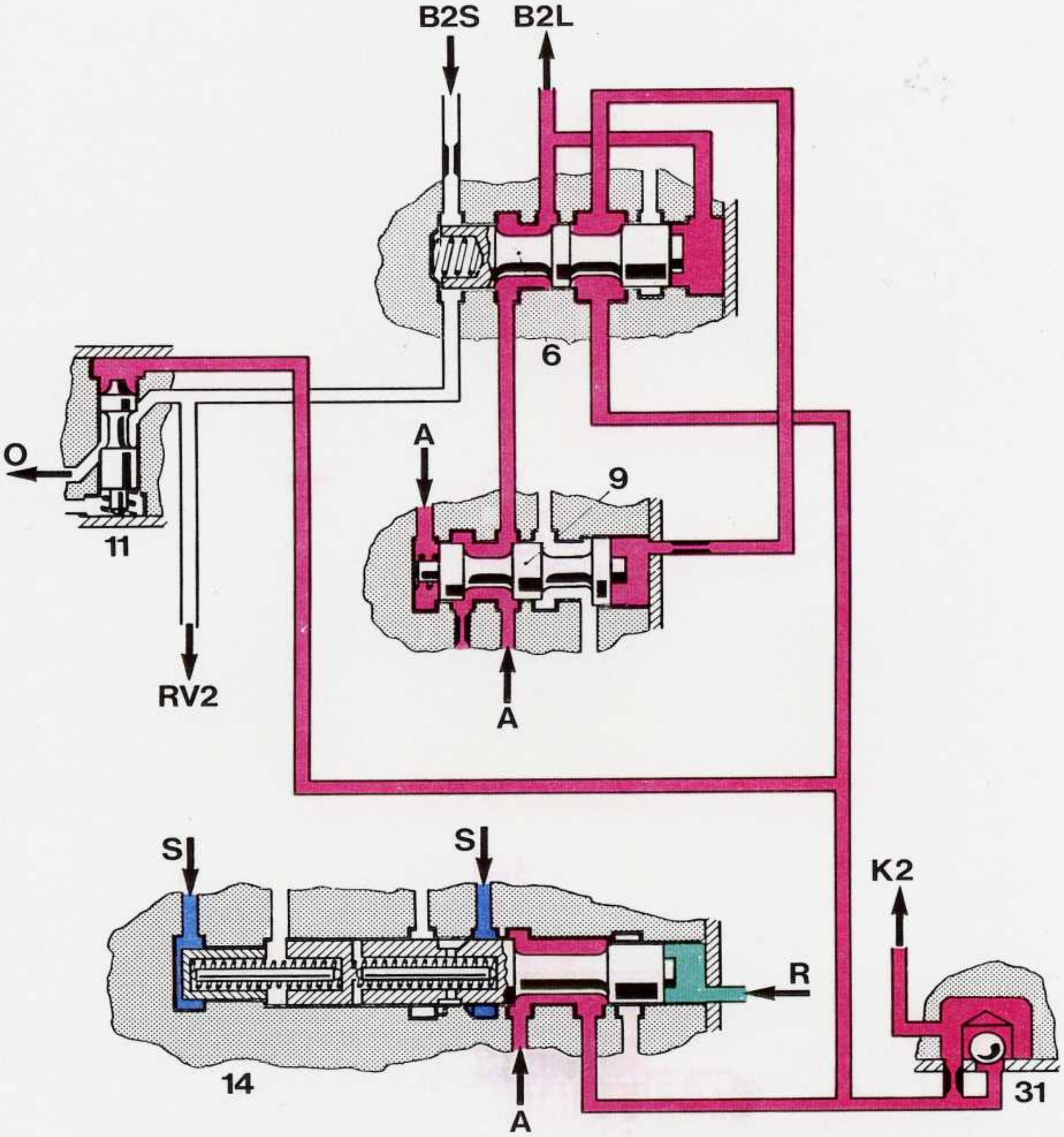
Downshift:

Brake band B1 must be applied and clutch K1 released.

Command valve (7) goes to the left in position of lower gear (right figure).

Clutch K1 and left side of shift valve B1 (12) are moved to "0". Clutch K1 discharges itself slowly via a restrictor bore in one-way valve (27). The shift valve B1 (12) is pressed to the left by spring force and main pressure (right figure). The apply side of brake B1 receives main pressure.





6 — Release valve for brake B2
11 — Shift valve
14 — Command valve
31 — One-way valve, clutch K2
0 — Return flow
A — Main pressure
B2S — Brake B2 apply side
B2L — Brake B2 release side
RV2 — To reaction valve 2
K2 — Apply pressure to K2
R — Governor pressure
S — Throttle pressure

Upshift with Command Valve (14).

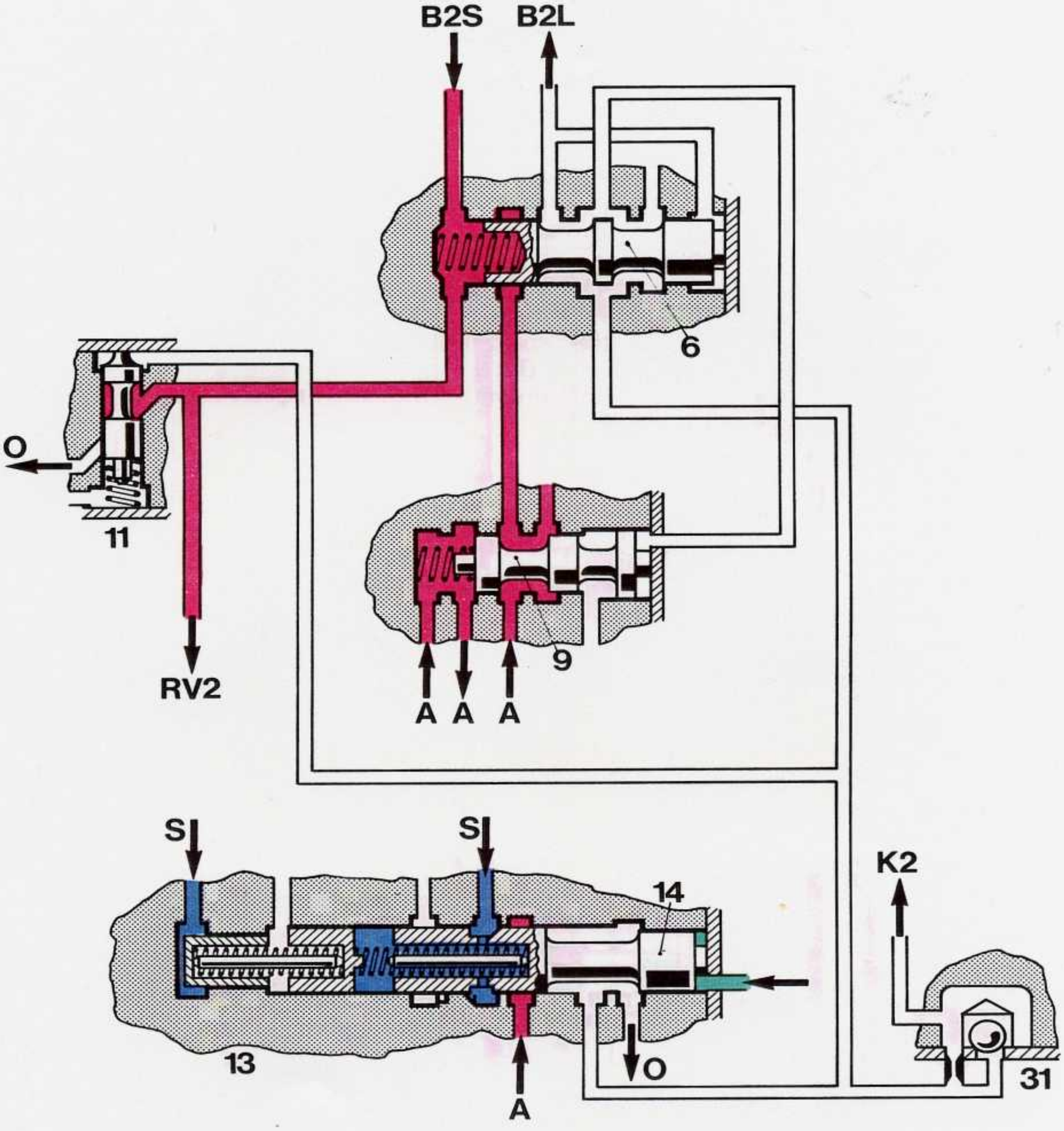
This shift requires clutch K2 to be applied and brake B2 to be released.

Governor pressure presses the command valve into the position of the higher gear.

Apply pressure passes through the one-way valve (31) to clutch K2 and through a branch to releasing side of brake B2 as well as to face surfaces of shift valves (6, 9 and 11).

At first the clutch apply pressure will press release side of shift valve (11) down and vents the bore to reaction valve 2. The releasing valve for brake B2 (6) goes to the left and applies full pressure to release side of brake B2. As soon as clutch K2 is fully applied apply valve for brake B2 (9) will shift and vent the apply side of brake B2 to the large return line (0).

In order to accomplish this the clutch apply pressure must overcome the left side spring force and main pressure against apply valve for brake B2 (9).



6 — Release valve for brake B2
9 — Apply valve for brake B2
11 — Shift valve
14 — Command valve
31 — One-way valve for clutch K2
0 — Return flow
A — Main pressure
B2S — Brake B2 apply side
B2L — Brake B2 release side
RV2 — To reaction valve
K2 — Apply pressure to clutch K2
R — Governor pressure
S — Throttle pressure

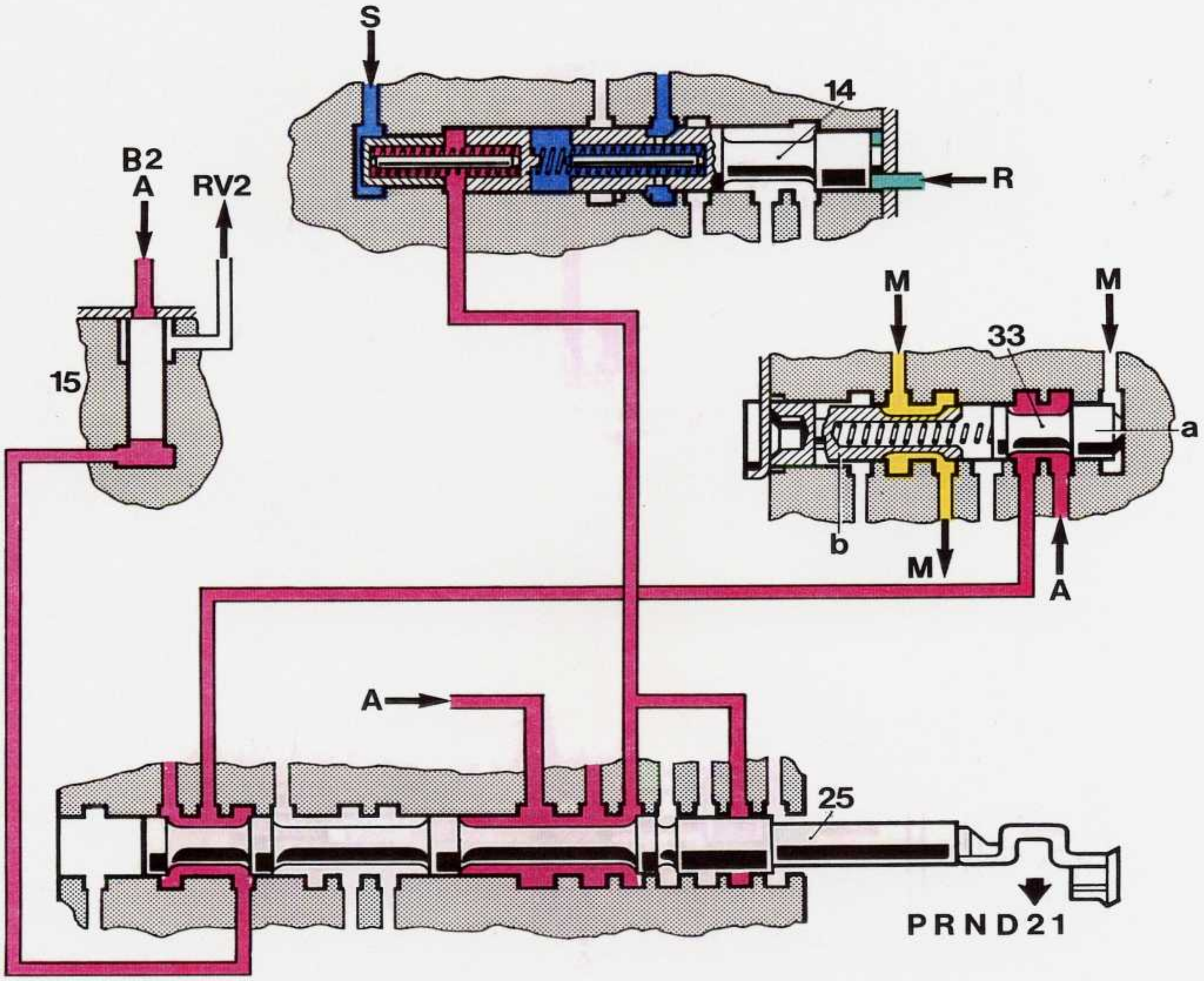
Downshift with Command Valve (14).

For this downshift, brake B2 must be applied and clutch K2 released.

Command valve (14) is pressed to its initial position and opens the large return flow channel.

Pressure is vented from the face surfaces of the release valve for brake B2 (11) and apply valve for brake B2 (9). The spring force presses. The release valve for brake B2 (11) to other end position and closes the return line (0). The apply valve for brake B2 (9) moves to the right and main pressure can go to the apply side of the brake band B2 piston. Clutch K2 discharges itself slowly through one-way valve of clutch K2 (31).

After closing of the reaction valve, the release valve of brake B2 (6) is pressed to the right and the release side of brake B2 is vented to the return line. The brake band is fully applied.



14 — Command valve
15 — Brake apply piston
25 — Selector valve
33 — Neutral shift valve
A — Main pressure
B2 — Apply pressure to brake B2
RV2 — Apply pressure to reaction valve 2
M — Modulating pressure
R — Governor pressure
S — Throttle pressure

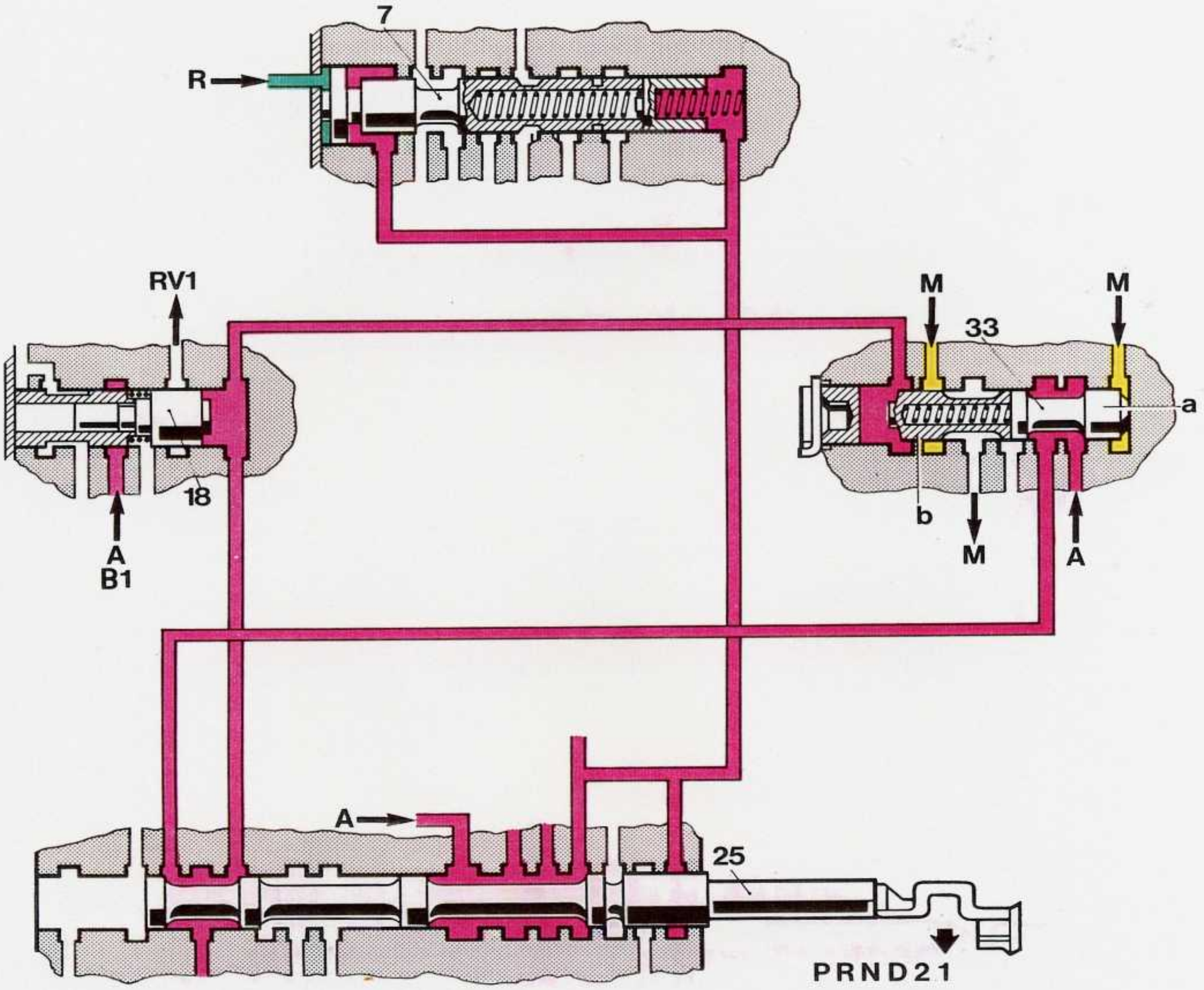
Selector Lever Downshifts

Downshift by Moving Selector Lever from "D" to "2".

With selector lever at 2 main pressure goes from selector valve (25) into left side spring chamber of command valve (14). The command valve will be moved to the lower gear position regardless of road speed or amount of governor pressure.

If downshift is made while accelerating, reaction valve RV2 will apply the brake band.

If downshift is made while coasting, the main pressure is connected from neutral shift valve (33) to brake piston (15) via selector valve (25). Brake piston (15) closes the connection to reaction valve RV2 and simulates a closed reaction valve.



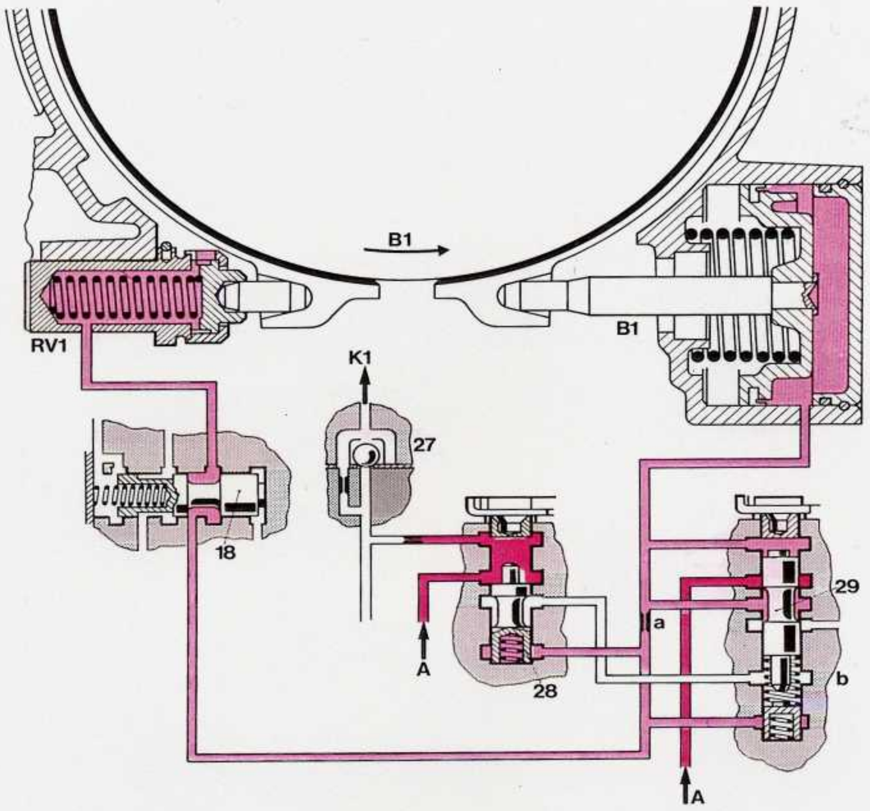
7 — Command valve
18 — Brake shift valve
25 — Selector valve
33 — Neutral shift valve
A — Main pressure
B1 — Apply pressure
M — Modulating pressure
R — Governor pressure
RV1 — Apply pressure to reaction valve 1

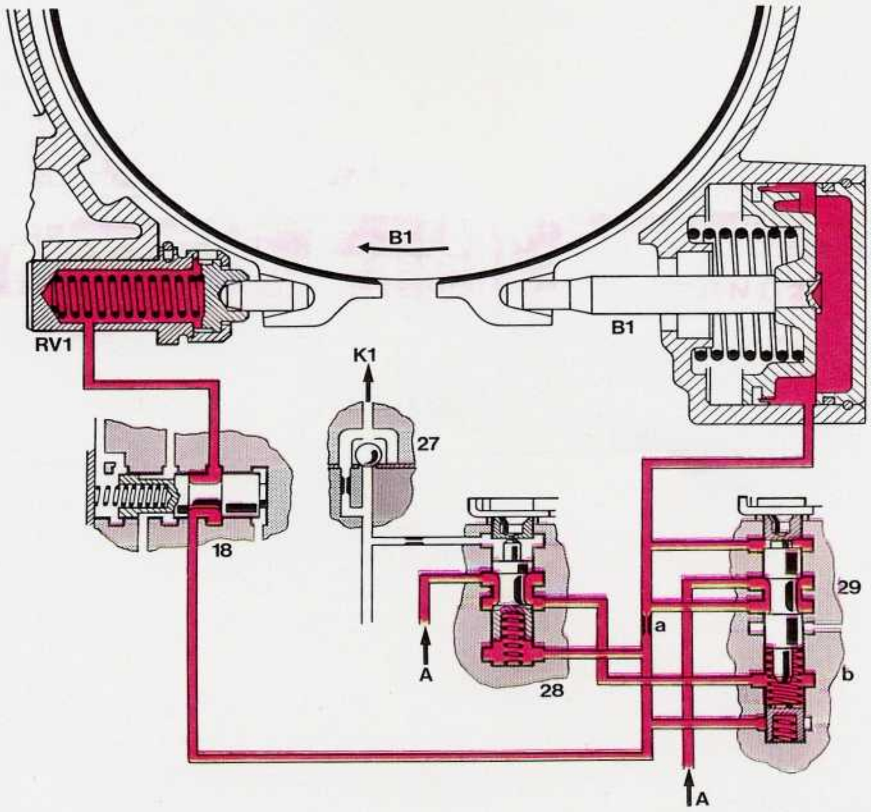
Downshift by Moving Selector Lever from 2 to 1.

With selector lever at 1 main pressure goes from selector valve (25) to annular surface on command valve (7) and to piston on right side. Command valve (7) will be held in the lower gear position regardless of road speed and amount of governor pressure.

If downshift is made while accelerating, reaction valve RV1 will apply the brake band.

If downshift is made while coasting reaction valve RV1 will not close, since the brake band drum does not change its direction of rotation. Main pressure comes through a connection from the neutral shift valve (33) via selector valve (25) to the brake shift valve (18). Brake shift valve (18) moves to the left and closes the connection to the reaction valve. Brake B1 is applied.


B1
RV1
B1
K1
27
18
29
a
A
28
b
A


B1
RV1
B1
K1
27
18
29
a
A
28
b
A

During a downshift while accelerating, the clutch pack of the higher gear must release slowly so that engine speed can increase to match the ratio of the lower gear. At the instant the engine has reached this "synchronized" speed, the clutch drum for the brake band of the lower gear will momentarily stop and the brake band must be applied firmly to insure a smooth shift with no sensation of transmission slippage.

The brake band for the lower gear is applied in two stages; the first stage is a light application to "sense" the direction of rotation of the clutch drum, the second stage is the firm application of the brake band to "lock" the clutch drum.

When coasting and while the engine speed is increasing, the brake band drum will turn against the brake band apply piston, the reaction valve remains open and pressure cannot be built up behind restrictor "a" (upper figure).

When car is accelerating or with opposite direction of rotation, the drum will turn against the reaction valve. Reaction valve closes and pressure is built up behind restrictor "a" (lower figure).

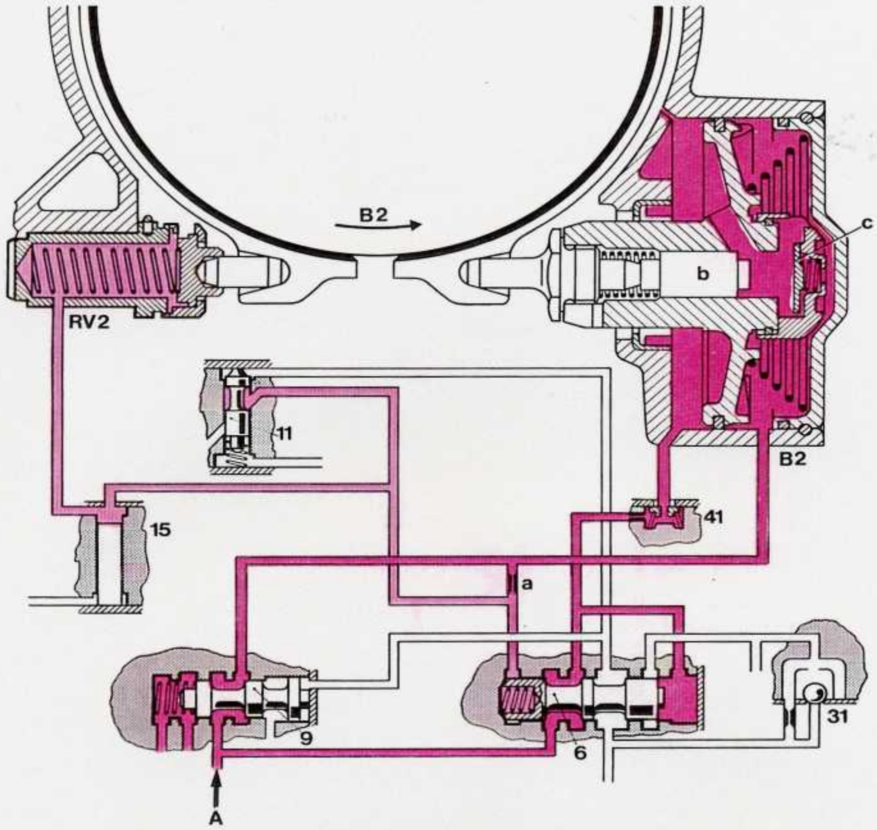
Downshift with Car Accelerating, Introduced by Command Valve (7).

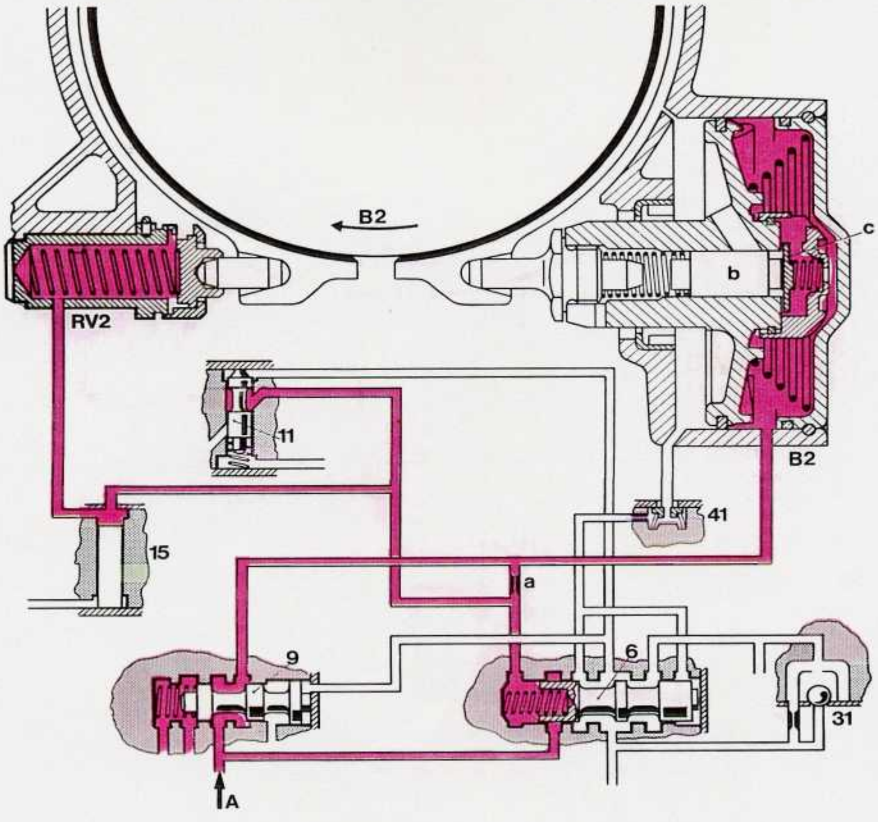
After introduction of a downshift, operating pressure goes through brake B1 control valve (29) to brake band apply piston B1 and through a restriction to the open reaction valve RV1. As soon as a "sensing" pressure of approx. 2.0 bar is reached on the brake band apply piston B1 or face surface of brake B1 control valve (29), brake B1 control valve will move down against force of spring (b). This will restrict the pressure supply to such an extent, that a high oil pressure cannot build up on brake band piston B1 (upper figure).

As soon as reaction valve RV1 closes, the ATF pressure can build up behind restrictor (a) and press up the brake B1 control valve (29) and shift valve for reaction valve RV1 (28). The brake band apply piston receives full pressure and the brake band is locked.

During forced downshifts while coasting, main pressure goes through the shift valve for reaction valve (28) to the bottom of the brake B1 control valve (29) to insure positive engagment at the brake band.

18 – Brake shift valve
27 – Clutch K1 one-way valve
28 – Reaction valve for shift valve 1
29 – Brake B1 control valve
B1 – Brake band and piston
K1 – Apply pressure to clutch K1
RV1 – Reaction valve 1
a – Restrictor
b – Spring


B2
c
b
RV2
11
B2
41
15
a
9
6
31
A


B2
c
b
RV2
11
B2
41
15
a
9
6
31
A

Downshift While Accelerating, Introduced by Command Valve (14).

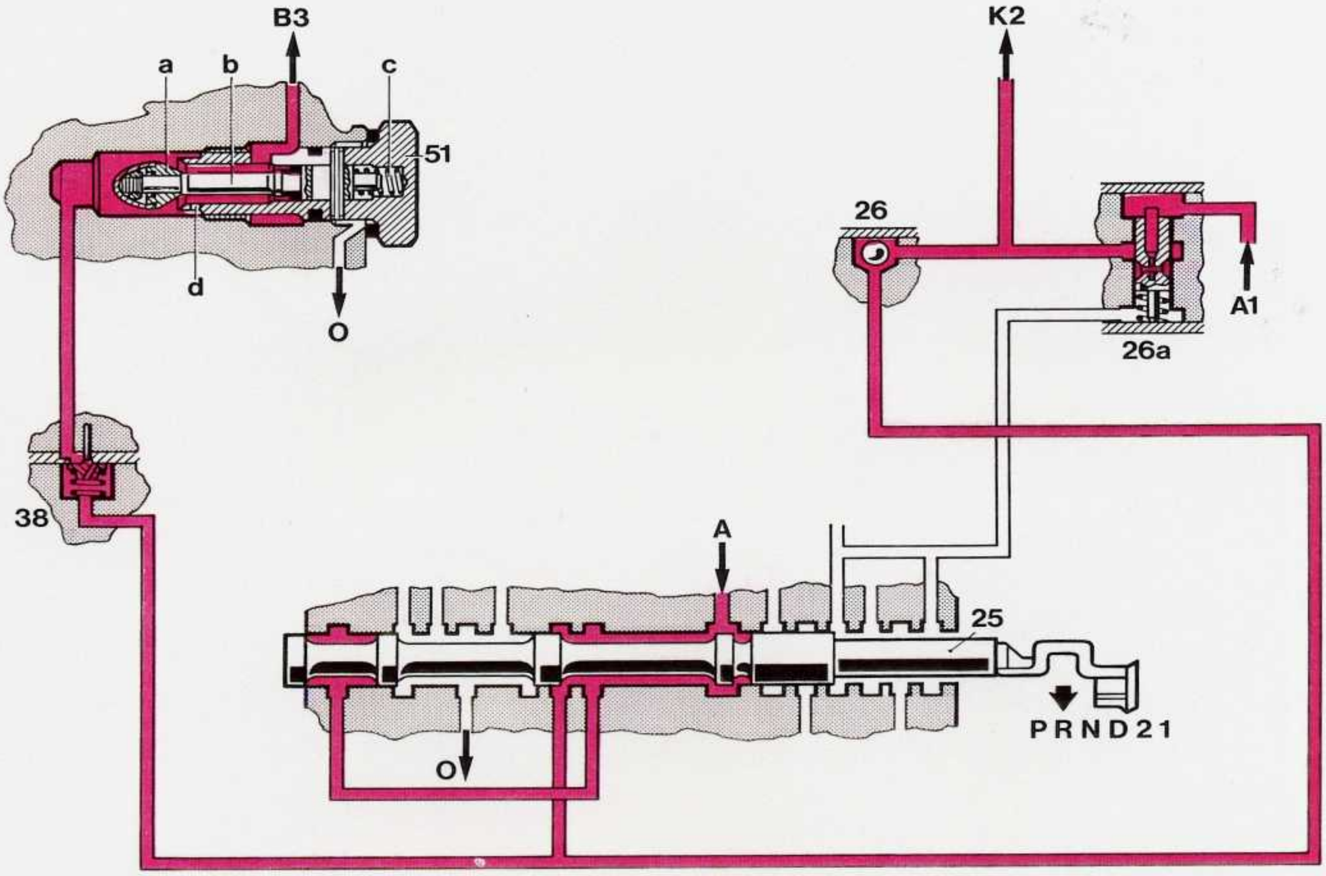
After introduction of the downshift, apply pressure goes to the apply side of brake band piston B2 and through a restriction to the opened reaction valve RV2. The force of ATF pressure from the apply side opens bypass valve (b) and ATF flows from the release side to the apply side. Brake band B2 can be moved to "sensing" position in approx. 5/100 seconds by this direct exchange of ATF.

The "sensing" force results from the difference in surface area of the brake band pistons.

If there is equal pressure between the apply and release sides, spring force will press valve disc (c) against its seat and break the connection. After removal of ATF pressure on the releasing side, bypass valve (b) is pressed back to the initial position.

As soon as reaction valve RV2 closes, the force of ATF pressure, which was built up behind restrictor (a), will press brake B2 releasing valve (6) to the right and move the releasing side of brake band B2 as well as the residual pressure of clutch K2 to zero. Brake band B2 will be locked.

6 — Brake B2 releasing valve
9 — Brake B2 apply valve
11 — Brake B2 shift valve on release side
15 — Brake shift piston
31 — Clutch K2 one-way valve
41 — Brake B2 one-way valve on releasing side
B2 — Brake band and piston B2
RV2 — Reaction valve 2
a — Restrictor
b — Bypass valve
c — Valve disc



25 — Selector valve
26 — Check valve
26a — Locking valve clutch K2
38 — One-way valve
51 — Quick filling valve
0 — Retürn line
A — Main pressure
A1 — Apply pressure for 1st gear only
a — Seal
b — Shift valve
c — Spring
d — Restrictor bore

With the selector lever at "R" main pressure goes from selector valve (25) through brake B3 one-way valve (38) and quick filling valve (51) to brake band piston B3.

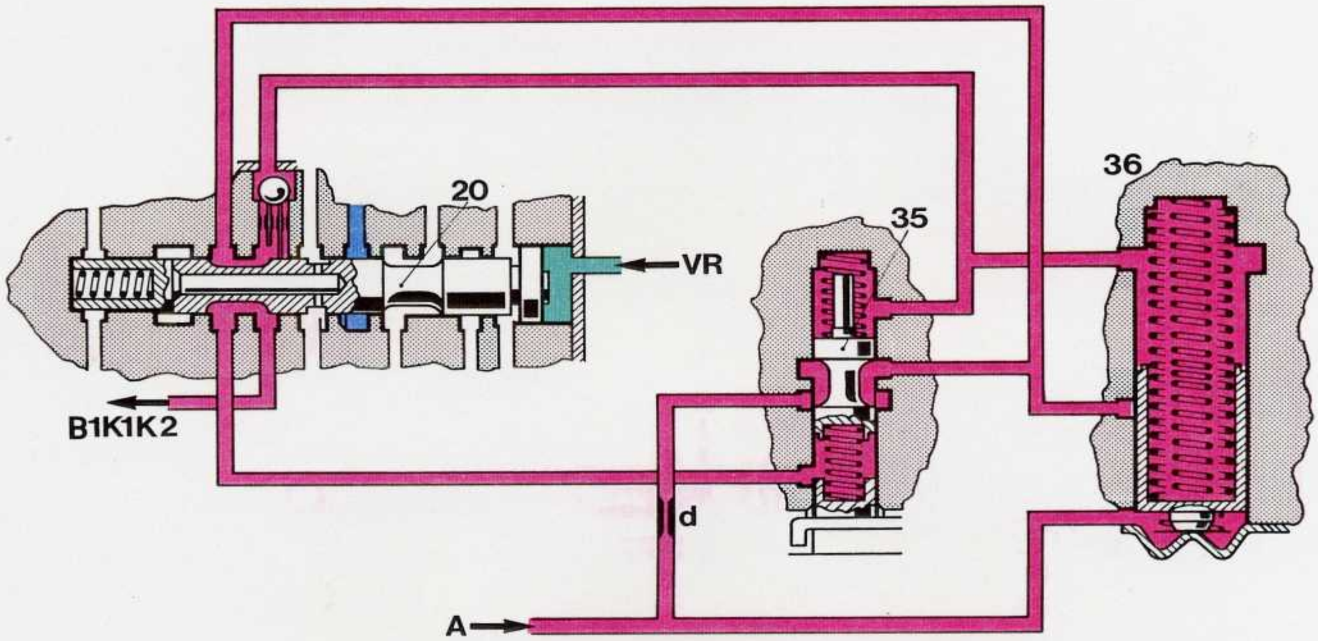
This requires stopping the free-rotating gears from selector lever position "P" or "N".

The apply pressure first flows unrestricted through the opened seal (a). As soon as the brake band is moved against the brake band drum, shift valve (b) will be pressed against spring (c) as pressure on the brake band piston starts to rise, so that seal (a) closes the feed bore.

The remaining A.T.F. needed to fully engage B3 must flow through restrictor (d).

When disengaging reverse gear, the filling bore in the selector valve (25) will be discharged. The backflowing fluid will lift seal (a) from its seat. This relieves the pressure from brake band piston B3 quickly.

Operation of Accumulator for B1, K1 and K2



20 — Command valve
35 — Accumulator control valve
36 — Accumulator for brake B1 and clutches K1/K2
B1 — K1/K2 apply pressure to brake B2
and clutches K1 and K2
VR — Amplified governor pressure
d — Restrictor

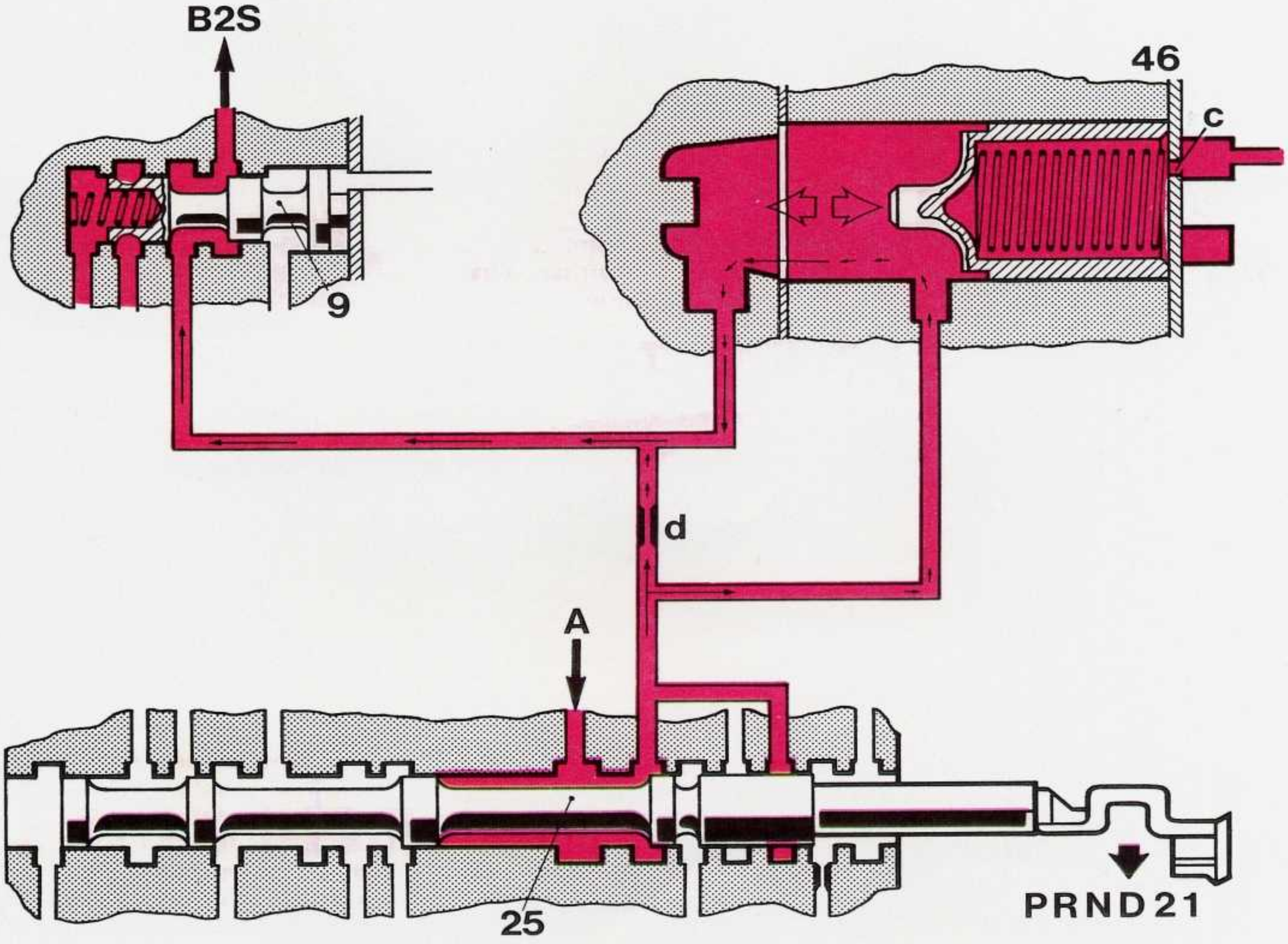
Operation of accumulator for B1, K1 and K2

The accumulator (36) must let the apply pressure increase progressively when operating the servo parts of brake B1, clutch K1 and clutch K2, to improve shifts.

The fluid required for operation of servo parts for brake B-1, clutch K1 and clutch K2 goes from accumulator control valve (35) or accumulator (36) through an annular port to command valve (20).

Restrictor (d) in ATF bore leading to accumulator control valve (35) provides a drop in pressure according to the cross section size when a servo part is operated or large amounts of fluid are required. The spring chamber of accumulator (36), through which the 3-way restrictor valve is connected with the annular port on command valve (20), is also relieved of pressure so that the piston is moved toward final stop. The open connection made in this manner lets the missing amount of fluid flow without restriction. The force of the filling pressure acts on the servo part, so that the pressure in spring chamber of sensor (36) increases through the 3-way restrictor valve and the piston is pressed to its initial position. The full force of the apply pressure can finally be built up on the servo part.

During the running time of the accumulator (36), accumulator control valve (35) closes the feed port, in that the center position is cancelled. In opposition to motion of the accumulator, the pressure controlled accumulator control valve (35) will rest briefly against the upper and/or lower stop.



9 — Brake B2 apply valve
25 — Selector valve
46 — Engagement accumulator
A — Main pressure
B2S — Apply side of brake B2
c — Restrictor bore
d — Restrictor bore

Operation of Engagement Accumulator

The engagement accumulator (46) must let brake band B2 be applied when selector lever is moved to a forward drive position. The free rotating gears from selector lever position "P" or "N" are braked slowly to reduce the engagement jolt.

When moving selector lever to "D", "2" or "1", main pressure goes from selector valve (25) through a restricted feed bore and brake B2 apply valve (9) to the apply side of brake band piston B2 and face surface of accumulator piston (46).

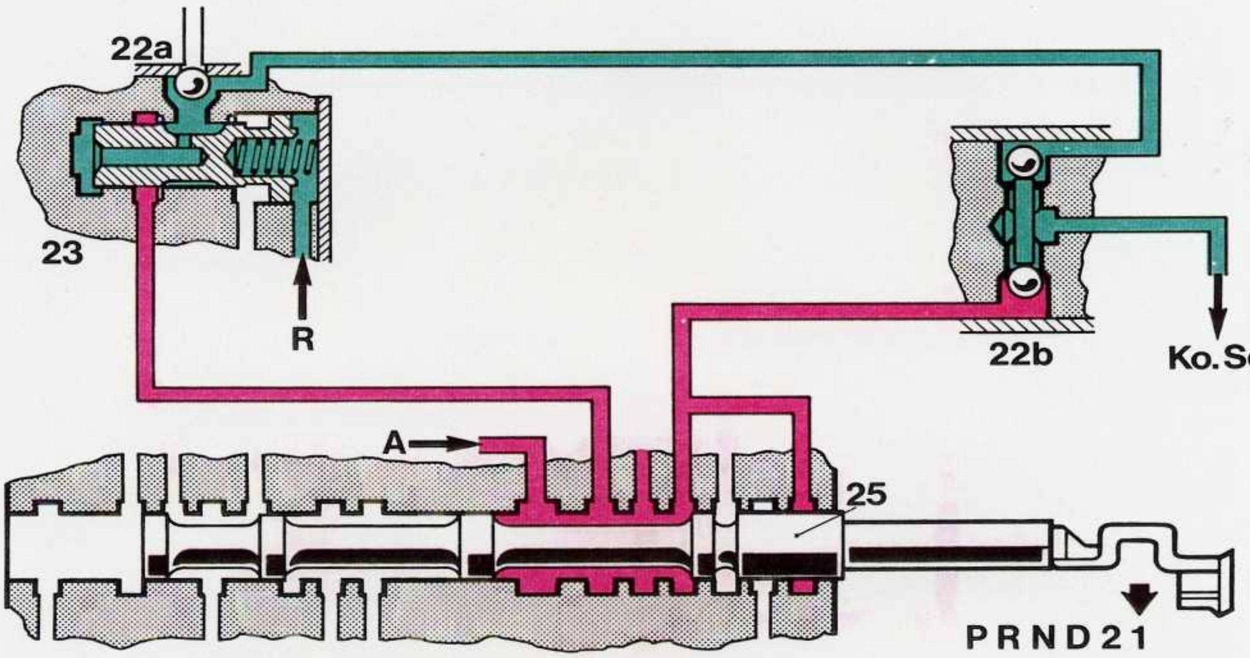
As pressure increases at brake band piston B2 or accumulator (46) the accumulator piston will move to the right, whereby the fluid volume of the spring chamber will be pushed out through restrictor bore (c) of the housing.

This action of the accumulator piston provides a slow build up of pressure on the apply side of brake band B2.

Note!
The cross section opening of the restrictor bore determines the operating time of the accumulator and pressure build-up on the apply side of brake band B2.

Shortly before reaching its final stop, the spring-loaded piston will open the pressure port and allow full pressure to be applied.

With the selector lever at "P", "R" or "N", the pressure on the accumulator is removed and the ATF for filling the spring chamber is drawn in from ATF sump through a restrictor bore.



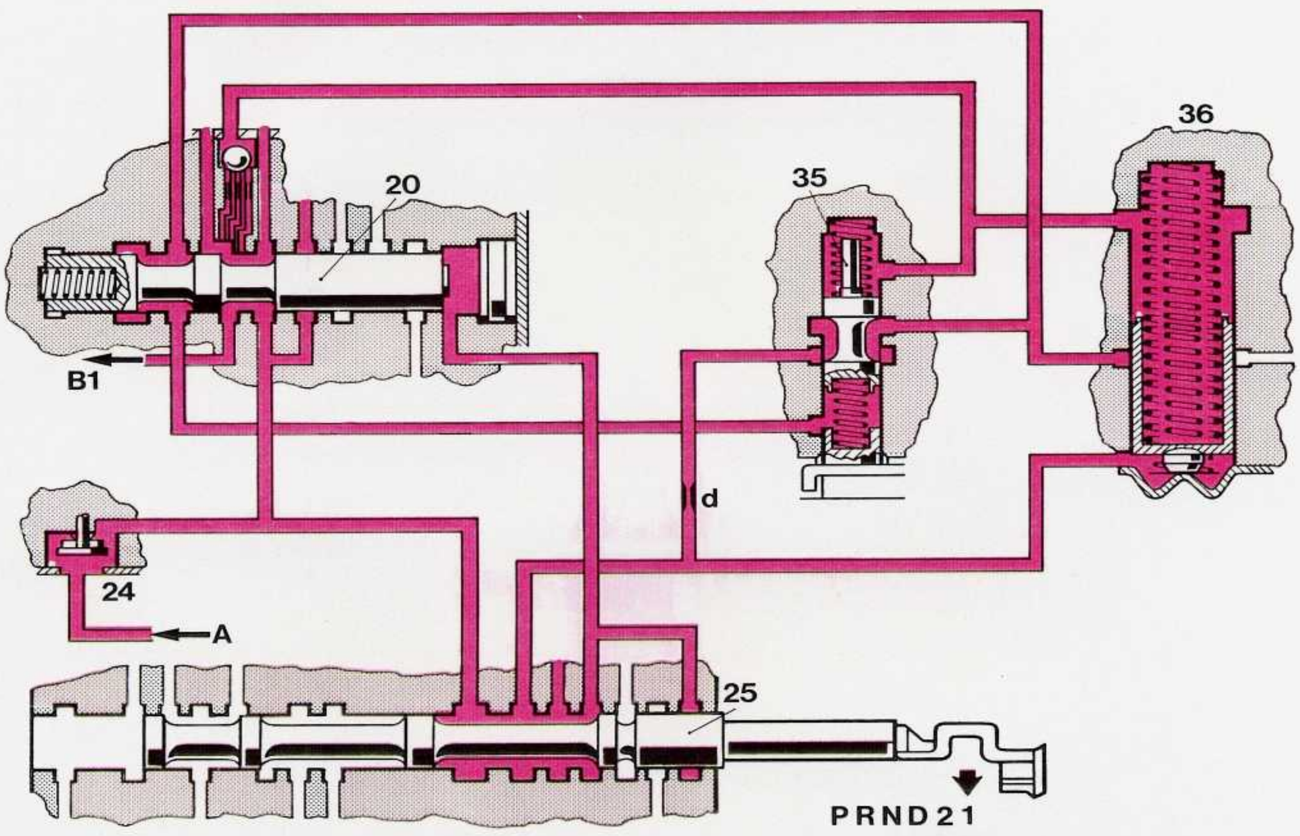
22a — Two way ball valve
22b — Double ball valve
23 — Governor pressure amplifying valve
25 — Selector valve
A — Main pressure
Ko. Sch. — Governor pressure to command valves
R — Governor pressure

Operation of Double Ball Valve

The valve body lower section incorporates a double ball valve (22b), to reduce leak losses in the valve body.

With the selector lever at "1", main pressure goes from selector valve (25) to bottom of double ball valve (22b). The lower ball will be pressed against its seat and the upper ball will be lifted by way of a plastic pin. Amplified governor pressure, which is lower than the main pressure, goes through the opened upper ball valve to command valves 1 — 2 (7).

Internal leak losses are reduced considerably in this manner.

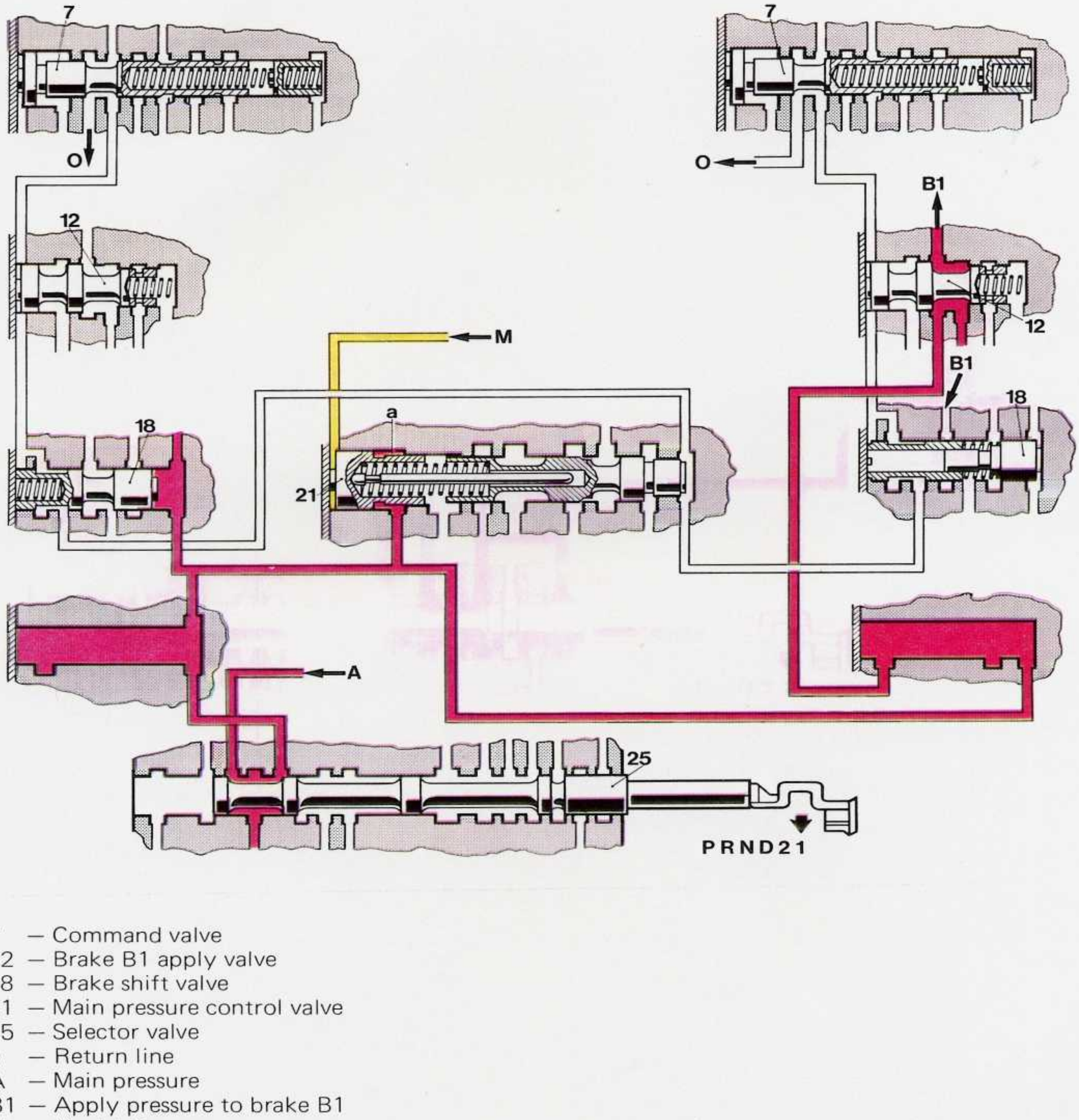


20 – Selector lever **1** range shift valve
24 – Pump check valve
25 – Selector valve
35 – Accumulator control valve for brake B1 and clutches K1/K2
36 – Accumulator for brake B1 and clutches K1/K2
A – Main pressure
B1 – Apply pressure to brake B1
d – Restrictor bore

When downshifting from "2" to "1" by braking car or moving selector lever, the accumulator (36) for brake B1, clutch K1 and clutch K2 will be switched off to reduce the shift time from 2nd to 1st gear.

With the selector lever at "1", main pressure goes from selector valve (25) to right face surface of range "1" shift valve (20). The force of the ATF pressure presses the range "1" shift valve (20) to the left. In this manner main pressure can be taken direct from a branch behind pump check valve (24) and supplied to brake B1.

The accumulator (36) for brake B1, clutch K1 and clutch K2 retains pressure on both sides and thus remains on its lower stop.



7 — Command valve
12 — Brake B1 apply valve
18 — Brake shift valve
21 — Main pressure control valve
25 — Selector valve
0 — Return line
A — Main pressure
B1 — Apply pressure to brake B1
M — Modulating pressure
a — Annular surface

Control of Main Pressure in Selector Lever Pos. "1"

The face surface of main pressure control valve (21) is positioned at the return line by way of brake shift valve (18) and command valve 1 – 2 (7). Apply pressure goes from brake B1 to annular surface (a) on main pressure control valve and reduces the main pressure in partial and full throttle range.

Dr.-Ing. h. c. F. Porsche
Aktiengesellschaft

Postfach 400 640
7000 Stuttgart 40

Service department
Service Technology Section (VKT)
Edited by Service School
Walter Muschweck
Jörg Austen

Printed by Beck & Co., 7000 Stuttgart 40