CHAPTER I . . DESCRIPTION

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ILLUSTRATIONS

The Automatic Gearbox

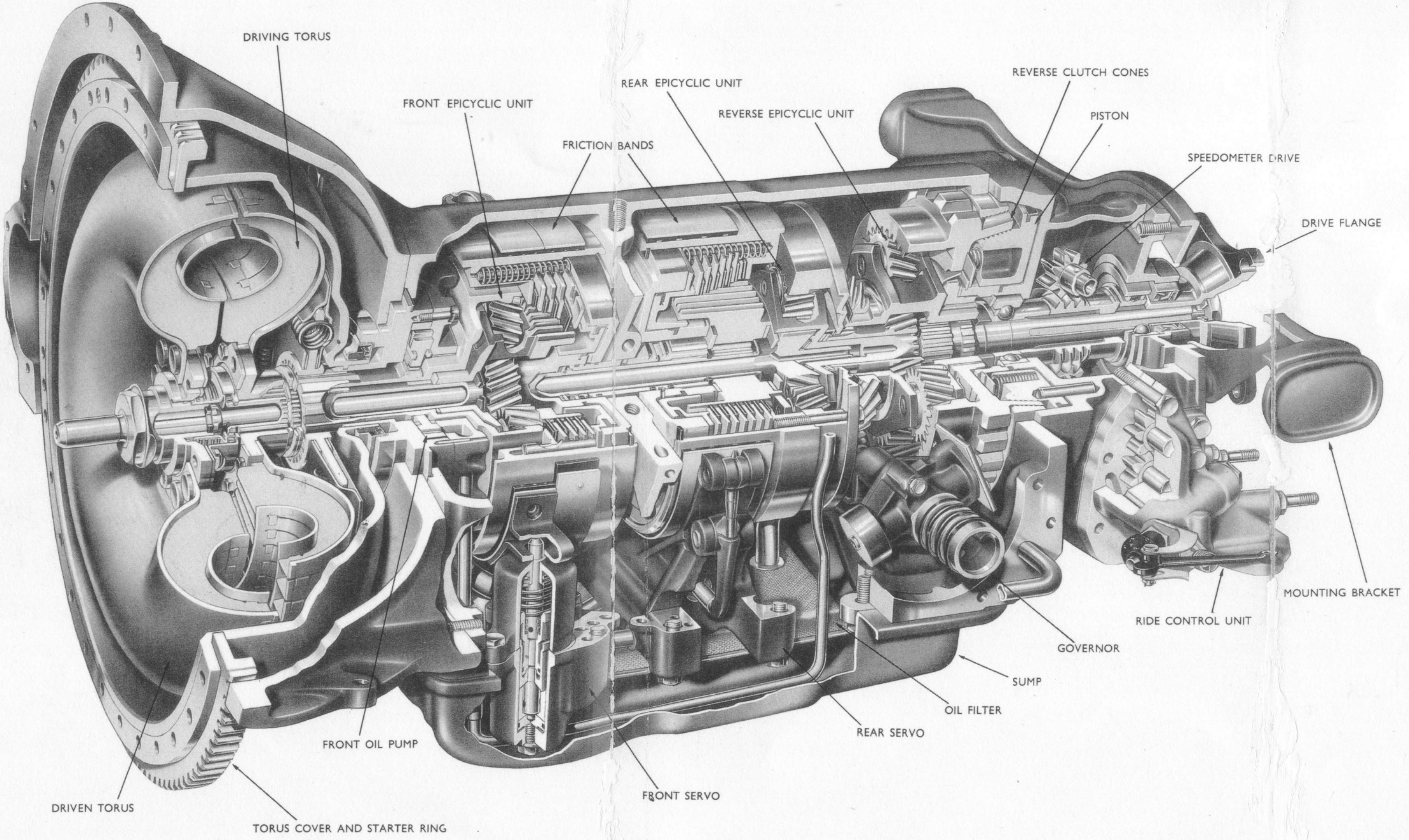
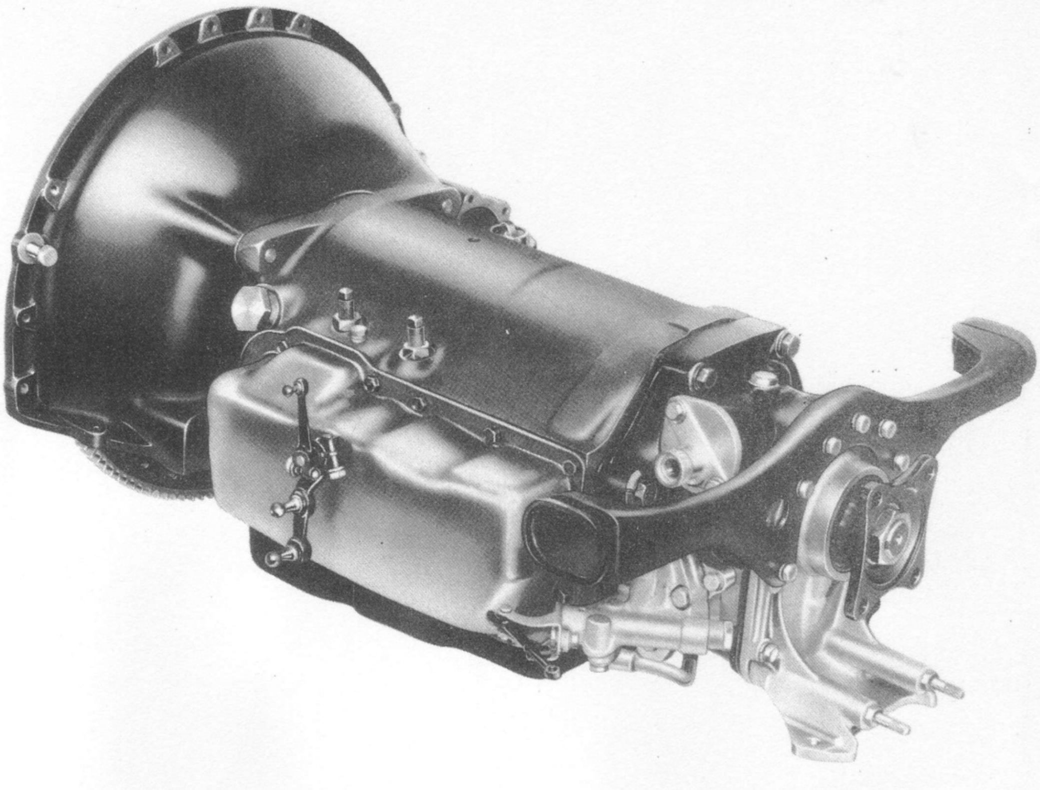
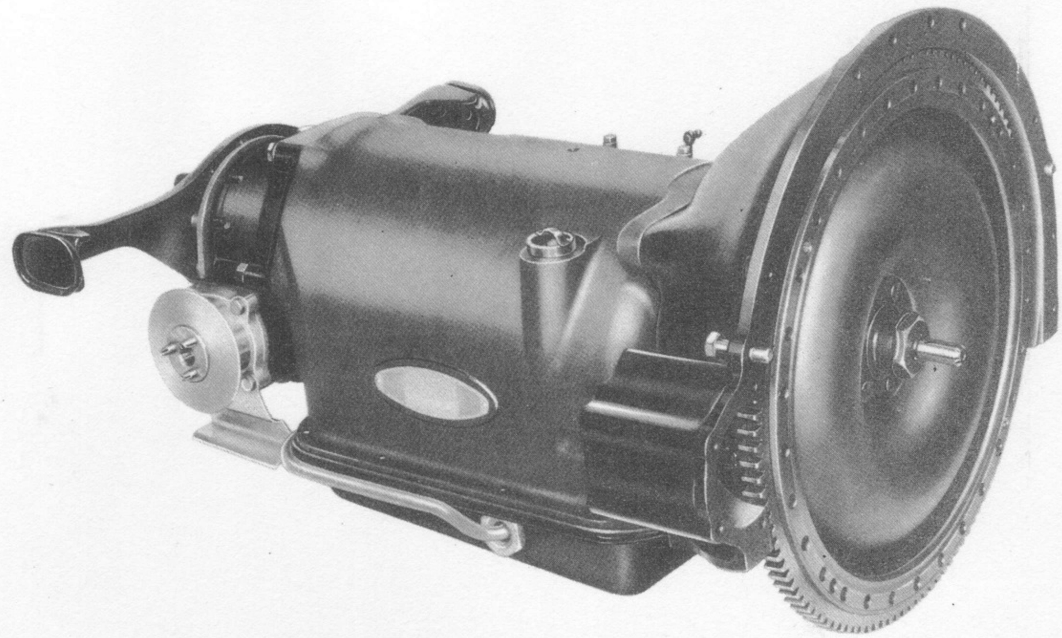


Fig. 1 The automatic gearbox





CHAPTER I . . DESCRIPTION

The automatic gearbox fitted to Rolls-Royce and Bentley cars combines epicyclic gear trains with a fluid coupling and automatic control of gear changes. The epicyclic gear trains provide four forward ratios and a reverse, while the method of gear change in the forward gears is such that driving torque is applied continuously to the road wheels during the change from one ratio to another.

Though gear changes take place automatically, a selector lever is provided giving three forward ranges in addition to neutral and reverse. This permits the driving technique to be altered to meet varying road and traffic conditions.

The selector lever, situated on the steering column, is connected to a selector valve in the gearbox by rods and levers ; the five positions are marked ' N,' ' 4,' ' 3,' ' 2 ' and ' R,' and a gate is provided between positions 2 and 3. The gate, in conjunction with lever stops which prevent engagement of reverse and neutral unless a button is depressed, makes selection of the required position quick and sure.

In ranges ' 4,' ' 3 ' and ' 2 ' the drive is engaged but the car will remain stationary at low throttle openings and with the brake on, due to slip in the fluid coupling. When the brake is released and the engine is accelerated, the car will move forward in first gear and change to the higher ratios automatically, as the road speed increases.

Range ' 4 ' is the normal driving position. When starting from rest with small throttle opening, the control will change from first to second at 5 to 7 m.p.h., second to third at 10 to 13 m.p.h. and top gear will be attained at approximately 19 to 22 m.p.h. Depressing the accelerator causes the up-changes to occur at progressively higher road speeds ; when depressed beyond the full throttle position a full throttle down-change occurs to increase driving torque and give increased acceleration.

Range ' 3 ' is known as the performance range, and gives maximum acceleration by delaying the up-change to fourth gear, which occurs at approximately 65 m.p.h. It can be used to assist braking and reduces the number of automatic gear changes when driving in traffic.

Range ' 2 ' will reduce gear changing in very slow traffic by preventing changes above second gear. It can also be used to assist retardation of the car by using the engine as a brake.

In neutral (N) the drive is disconnected, allowing the planet gears to idle without transmitting torque. The selector lever is also made to interrupt the electrical supply to the starter motor except when in neutral ; this is a safeguard to prevent the engine being started with the car in gear, where it would have a slight tendency to move forward owing to torque transmitted by the fluid coupling.

Reverse can be selected during forward movement of the car up to about 10 m.p.h. This may be of use in awkward situations, but exerts great stress on the transmission and suspension and should be used only when necessary. The reverse position can also be used as a parking lock by selecting reverse. This locks the transmission by engaging two gears simultaneously.

The automatic control answers to engine power through interconnection with the accelerator and to road speed through a governor driven by the gearbox output shaft.

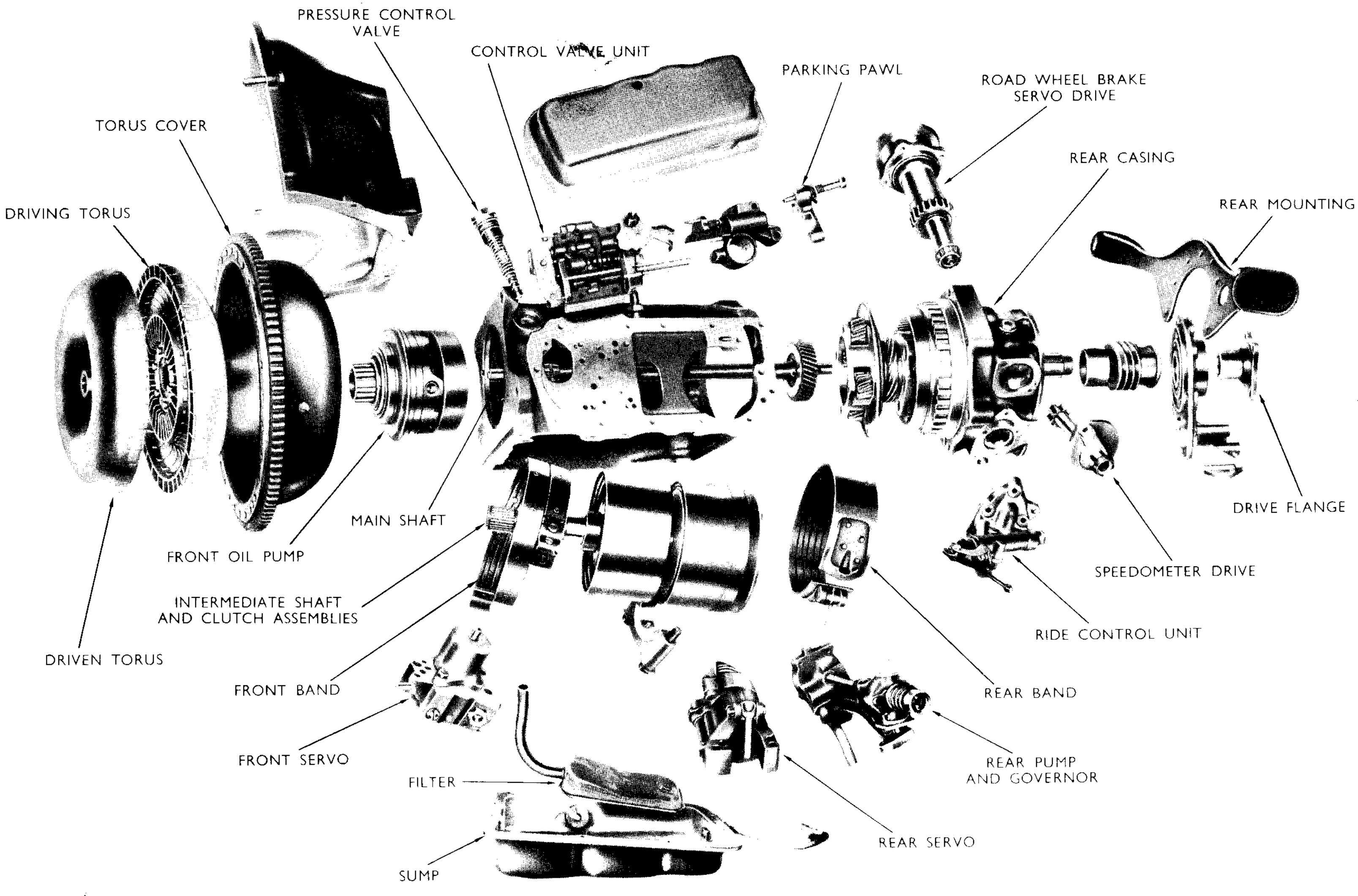


Fig. 2 Gearbox exploded to units

MECHANICAL ARRANGEMENT

The four forward gear ratios are obtained by using two epicyclic gear trains which have dissimilar ratios.

The lowest ratio (first gear) is obtained when the front and rear trains are in reduction.

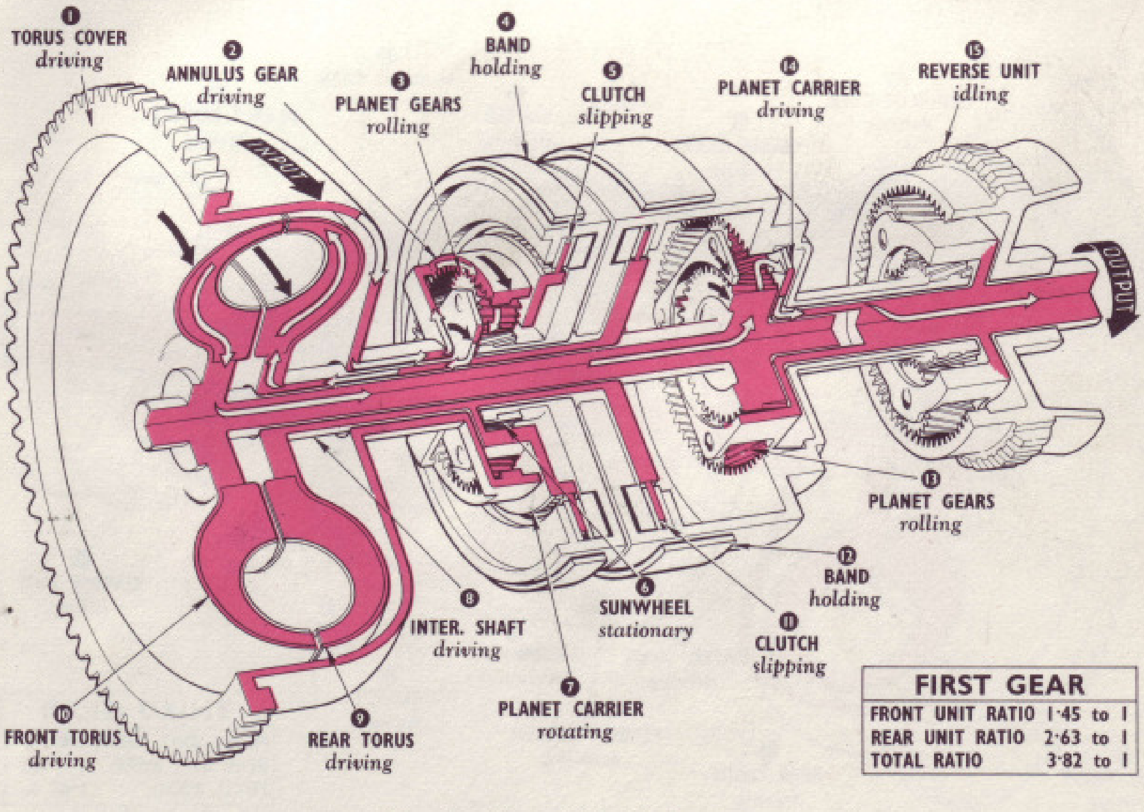
The two intermediate ratios are obtained by a combination of direct drive in one train with reduction in the other; in second gear the front train is locked in direct drive, and in third gear the rear train is locked.

Fourth gear is obtained with the front and rear trains locked and giving a direct drive.

The change of direction for reverse, together with a further slight reduction, is obtained through another epicyclic gear train which operates in conjunction with the rear train when reverse is selected. The reverse epicyclic train idles in all the forward gears.

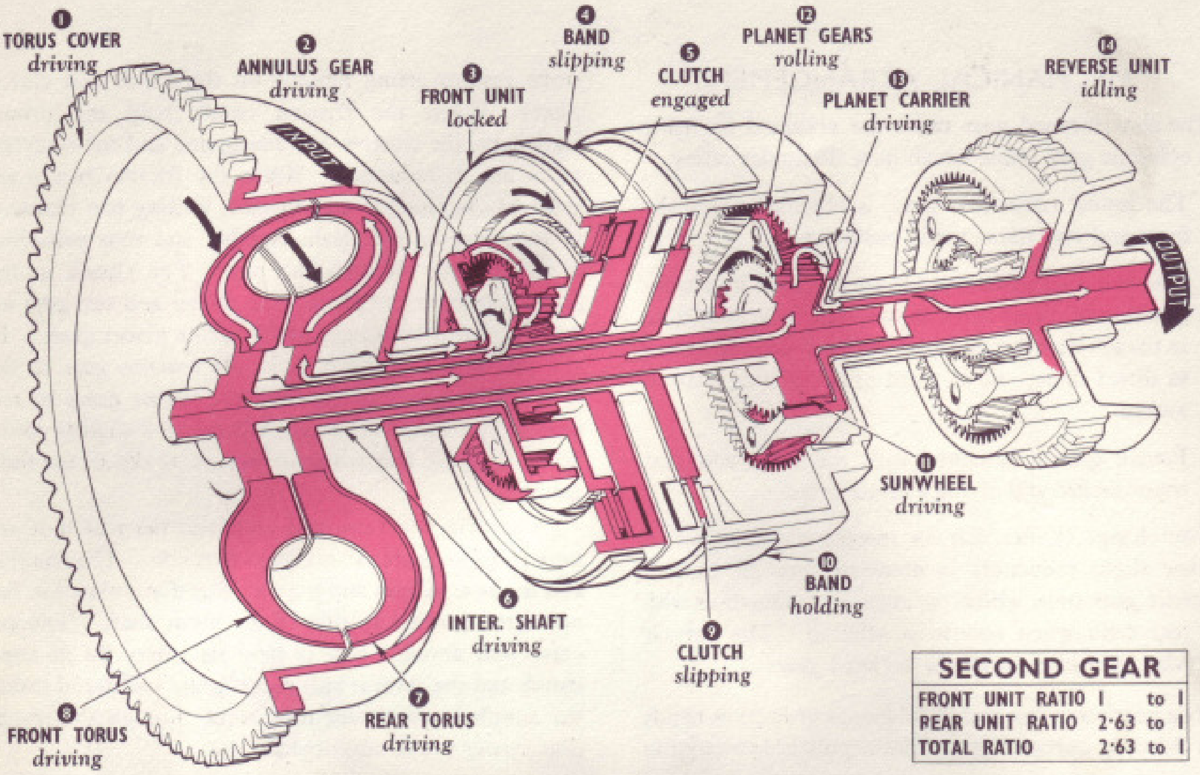
The gear ratios are varied by means of friction bands and clutches, operated by hydraulic pressure directed to servo pistons acting directly on the bands and clutch plates. When the friction bands hold the drums stationary, the clutches are disengaged and the epicyclic gears are in reduction. When the friction bands are released the clutches are engaged, locking two elements of the epicyclic gear train together and thus providing a direct drive through the unit. The clutch in the front unit locks the planet gear carrier and sun gear together, thus preventing rotation of the planet gears. In the rear unit the clutch locks the annulus gear to the intermediate shaft, permitting the planet gears to roll around the sun gear, which rotates at a slightly lower speed than the annulus gear because of slip in the fluid coupling.

In reverse, the band and clutch in the rear unit are both freed to permit all the gears to rotate. The annulus and the reverse unit sun gear are therefore rotated in the opposite direction to that of the input shaft. The reverse unit annulus gear is held stationary by its cone clutch and the reverse unit planet gears roll round inside the annulus to transmit the torque through the planet gear carrier to the output shaft.

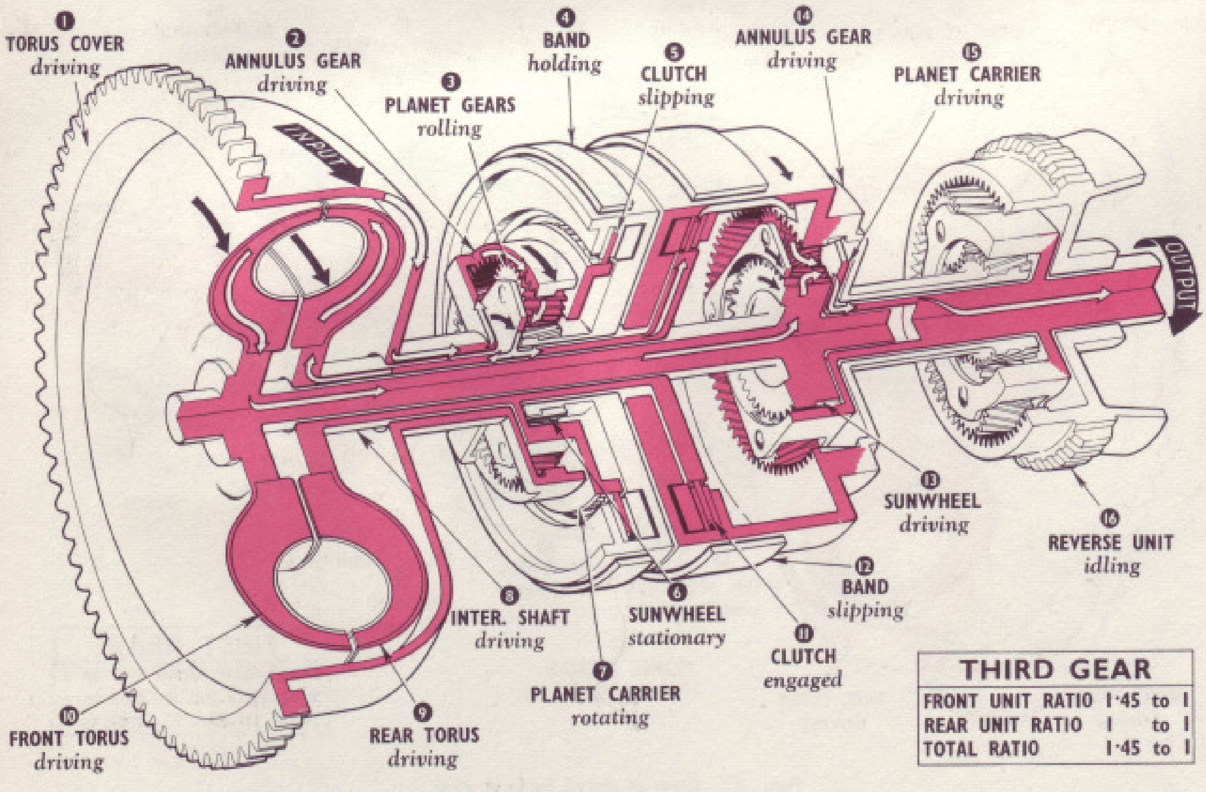


FIRST GEAR	
FRONT UNIT RATIO	1·45 to 1
REAR UNIT RATIO	2·63 to 1
TOTAL RATIO	3·82 to 1

Fig. 3 Line of drive in first gear



SECOND GEAR		
FRONT UNIT RATIO	1	to 1
REAR UNIT RATIO	2·63	to 1
TOTAL RATIO	2·63	to 1



THIRD GEAR		
FRONT UNIT RATIO	1·45	to 1
REAR UNIT RATIO	1	to 1
TOTAL RATIO	1·45	to 1

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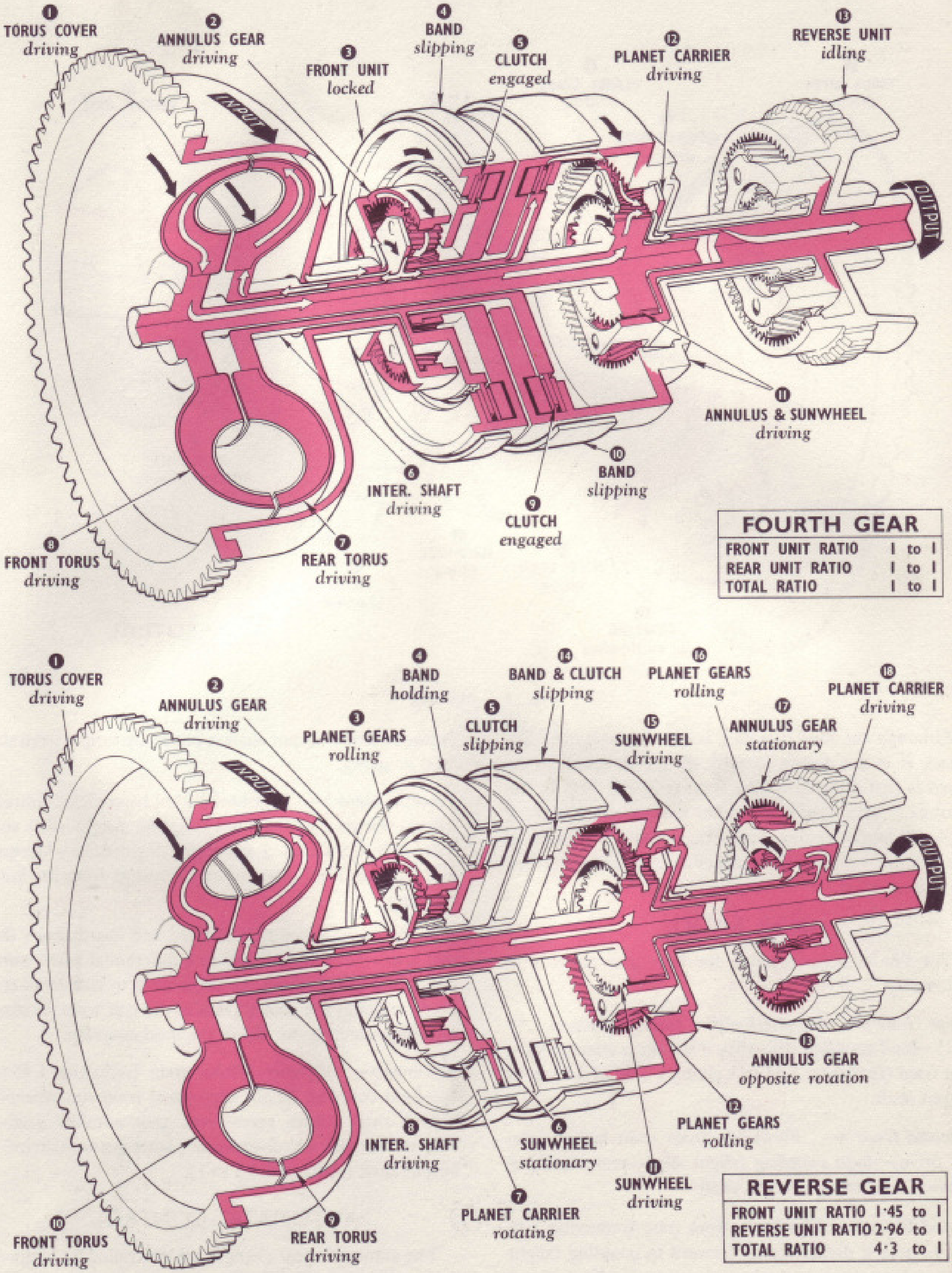
Fig. 4 Line of drive in second and third gears



FOURTH GEAR	
FRONT UNIT RATIO	1 to 1
REAR UNIT RATIO	1 to 1
TOTAL RATIO	1 to 1

REVERSE GEAR	
FRONT UNIT RATIO	1·45 to 1
REVERSE UNIT RATIO	2·96 to 1
TOTAL RATIO	4·3 to 1

Fig. 5 Line of drive in fourth and reverse gears

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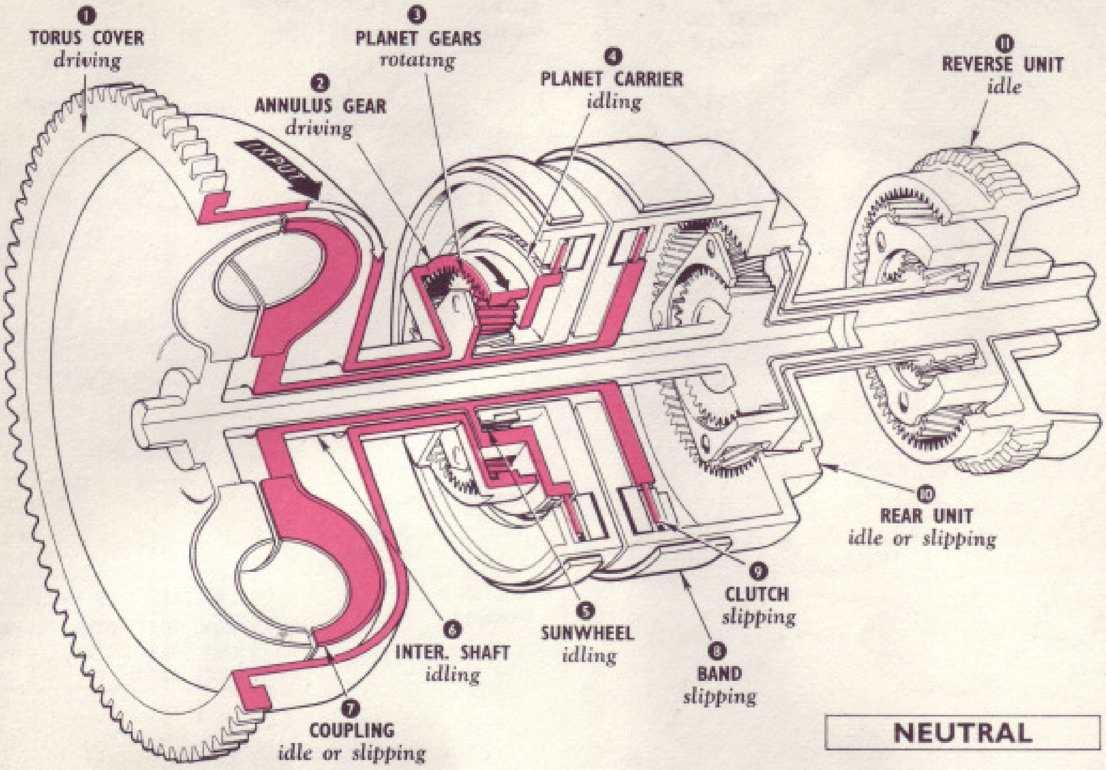


Fig. 6 Neutral

Although the fluid coupling is housed inside the flywheel, it is not driven directly by the flywheel, as its speed is first reduced by the front epicyclic train in the gearbox. This speed reduction permits the coupling to slip at higher engine speeds than would otherwise be possible and reduces the tendency to creep forward when drive is selected.

GEAR RATIOS

The line of drive through the four gear ratios is as follows :—

First Gear :— Flywheel—front train (reduction 1.45 to 1)—fluid coupling (this slips if the car is stationary)—rear train (reduction 2.63 to 1 giving a total of 3.82 to 1) output shaft.

Second Gear :— Flywheel—front train locked (direct drive)—fluid coupling (slight slip)—rear train (reduction 2.63 to 1)—output shaft.

Third Gear :— Flywheel—front train (reduction 1.45 to 1)—here it divides going forward to coupling (slight slip) and rearwards to the locked rear train (direct drive)—torque to the output shaft is joined by torque from the fluid coupling.

Fourth Gear :— Flywheel—front train locked (direct drive)—forward to the fluid coupling (slight slip) and rearwards to the locked rear train (direct drive)—torque to the output shaft is joined by the torque from the fluid coupling.

It should be noted that in third and fourth gears the rear gear train acts similarly to a differential when combining the torque from the front train to that from the fluid coupling, the planet gears in the rear train rotating to compensate for the slip in the fluid coupling.

Reverse :— Flywheel—front train (reduction 1.45 to 1)—fluid coupling (slight slip)—rear train sun wheel—output shaft planet gears—rear unit annulus gear—reverse unit sun wheel—reverse planet gears—carrier—output shaft (reduction 4.3 to 1).

AUTOMATIC CONTROL

The automatic gear changes are controlled by hydraulic pressure, regulated according to road speed and accelerator position, and directed through shift valve ports to the appropriate clutch and servo pistons. A pressure commensurate with engine power is obtained by connecting a hydraulic valve with the engine throttle. An indication of road speed is given by a governor controlling two hydraulic valves. The driver superimposes his requirements on the automatic control by means of a selector valve.

The oil flow to the servo and clutch pistons is controlled by three two-position shift valve assemblies, each one positioned by governor and throttle pressures to control a gear change ; the 1–2 valve assembly controls the gear change between first and second gear, the 2–3 valve controls the change between second and third gear and the 3–4 valve controls the 3–4 or 4–3 change. In first gear all the shift valves shut off servo pressure and open the clutch and band release chambers to exhaust. As each valve moves to change gear, the ports are opened to permit main pressure to act on the appropriate clutch and servo pistons until in fourth gear all the shift valves have moved across (fig. 22 to 26). The process is reversed for the down change.

The pressure is generated by two oil pumps, one driven by the gearbox input shaft and one by the output shaft ; this ensures that servo pressure is available whenever the engine is running or the car is moving.

The two pumps draw oil from the gearbox sump and feed it at approximately 60 to 90 lb. per sq. in., into a common outlet passage leading to a governor and to a manually operated selector valve in the control valve unit. A spring loaded non-return valve is interposed between the two pumps to prevent loss of oil pressure when one pump is not working. Oil is also delivered to the fluid coupling and to lubricate the bearings of the gearbox, as explained later.

The governor, driven by the gearbox output shaft, provides a signal of road speed in terms of oil pressure. It gives two pressures which increase at different rates to give accurate control at low and high road speeds. The oil flow to the governor is prevented from passing to the automatic control valve unit when the car is stationary, but when the car begins to move the centrifugal force of the governor weights opens valve ports and oil is permitted to flow to the control valve unit at pressures increasing progressively with car speed.

In addition to the selector valve and the automatic control valves, the valve unit contains a throttle valve connected by rods and levers to the engine throttle ; this provides a signal of engine power in terms of oil pressure. When the selector valve is in any of the drive positions, oil at pump pressure is directed to the throttle valve ports which are opened and closed with the throttle, thus providing an oil pressure which increases progressively with throttle opening.

This oil pressure passes into the valve unit to oppose the force of governor pressure acting on each of the shift valve assemblies. These valves are therefore positioned to direct servo oil pressure to apply the lowest gear ratio when governor pressure is nil (road wheels not turning) and move to select higher gear ratios as the governor pressure increases and overcomes the opposing throttle pressure to move the shift valve. It will be seen also that lower gear ratios will be selected whenever increasing throttle opening causes throttle pressure to overcome governor pressure and move the valve the other way.

When selecting the gear ratios in the above manner, the shift valves are positioned to direct oil to five two-position pistons and servos which engage or disengage the clutches and apply or release the friction bands in various combinations as shown in the table. In addition the hydraulic holding force of the friction bands is increased by compensator pressure as the torque increases.

	FRONT BAND	FRONT CLUTCH	REAR BAND	REAR CLUTCH	REVERSE CLUTCH
NEUTRAL	OFF	OFF	OFF	OFF	OFF
REVERSE	ON	OFF	OFF	OFF	ON
Ist GEAR	ON	OFF	ON	OFF	OFF
2nd GEAR	OFF	ON	ON	OFF	OFF
3rd GEAR	ON	OFF	OFF	ON	OFF
4th GEAR	OFF	ON	OFF	ON	OFF

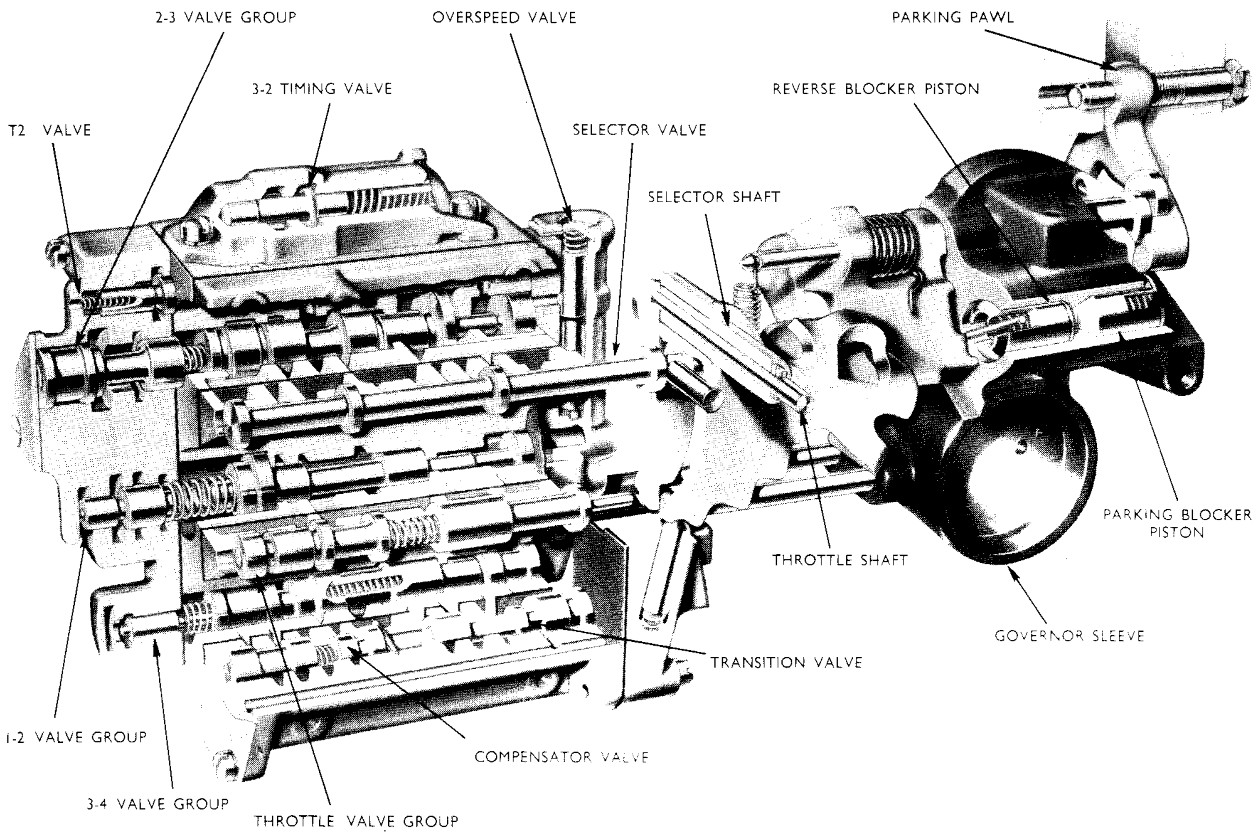


Fig. 7 Control valve assembly

These results are obtained by use of intermediate oil pressures which act on various relay, timing and locking valves and plugs, some of which are positioned solely by oil pressure and others by oil and spring pressures.

The function of the oil pressures may be summarized as follows :—

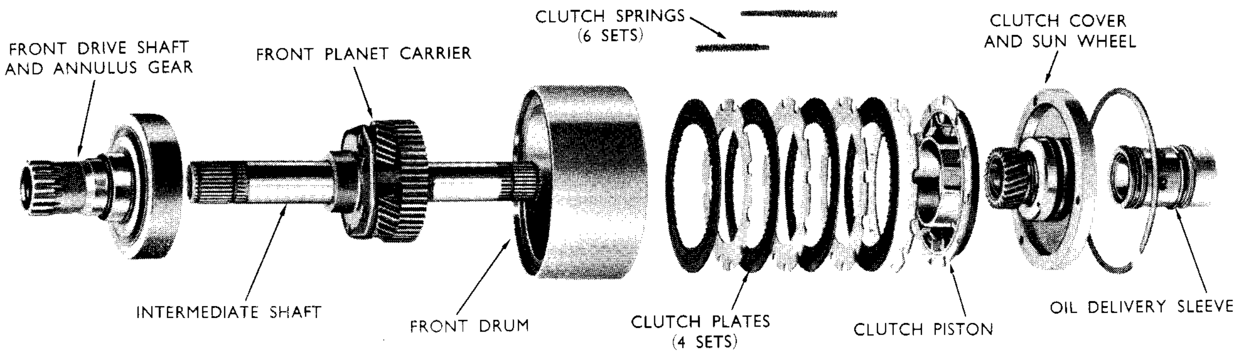
The *main pressure* is applied through the shift valve ports to the clutch pistons and band servos, while the *compensator pressure* is applied direct to the band servos.

Throttle pressures act on the shift valves in opposition to the *governor pressures*, and the shift valves are therefore positioned to permit the *main pressure* to pass to the appropriate servo and clutch pistons.

FLUID COUPLING

The fluid coupling is housed inside a cover connected to and rotating with the flywheel. An oil supply is pumped by the front oil pump into the cover to fill it completely. Two torus members, connected to separate shafts rotate in the oil and are so shaped that the oil flung from the driving member to the driven member causes the two to rotate together, although there is no mechanical connection between the two. At all speeds there is a certain amount of slip but this decreases to negligible proportions as speed increases. A point of interest is that the rear torus member, and not the front is the driver. The shaft attached to the driven torus protrudes from the hollow intermediate shaft and is centralised by a spigot bearing in the flywheel.

Turbulence of the fluid in the coupling is kept to a minimum by the design of the torus members which are fabricated from steel pressings, the vanes being located in slots and retained by tangs. The circular flow path between the vanes is designed to reduce heat generated by fluid friction, and, to reduce the operating temperature still further, a constant flow of oil is maintained through the coupling whenever the engine is running or



* **Fig. 8 Front epicyclic unit exploded**

the car is moving. The out-flow from the coupling passes through a relief valve between the inner and outer shafts and into the gearbox to lubricate the bearings and clutches.

As the oil in the coupling is under pressure from the pumps and centrifugal force, extra care to prevent oil leakage is necessary. Prevention of leakage is dependent on accurate face joints and closely spaced bolts holding the torus cover to the flywheel and flywheel to crankshaft, and oil seals between the torus cover and the front oil pump body.

FRONT EPICYCLIC UNIT

From the torus cover, fitted to the flywheel, the drive is transmitted by the tabular front drive shaft to the front planetary unit. The rear end of the tubular shaft is the annulus gear which drives the four planet gears rotating on hardened pins riveted into the planet carrier. This planet carrier, which is splined to carry the composition faced clutch plates, is integral with the hollow intermediate shaft which transmits the drive rearwards to the second epicyclic gear train and forward through the hollow intermediate shaft to the rear torus member. Splines and spring rings in grooves are used to drive and retain the driven members.

Completing the front gear train assembly is the front drum, driving and driven clutch plates and clutch cover with integral sun wheel. The clutch pack fits into the drum with the composition faced driving plates splined to the planet gear carrier and the steel driven plates linked to the drum by three pins. The assembly is held together by a spring ring fitting in a groove in the brake drum.

The driven plates are perfectly flat, but the driving plates are slightly corrugated to help them to separate when released by the clutch piston. The clutch piston is a light alloy casting operated by oil pressure in an annular space between the piston and clutch cover. Oil leakage is prevented by two synthetic rubber seals, one on the clutch cover spigot and the other on the outer diameter of the clutch piston.

The front friction band passes twice round the drum. A bracket on one end abuts the band adjusting screw and the other end is connected to the hydraulic servo operating rod. The linings are of wear resisting compound riveted to a spring steel band and afterwards ground and burnished to give maximum bedding area on the outer diameter of the drum. Grooves in the face of the lining assist lubrication of the band.

Direct drive through the unit is obtained when the friction band is released and the clutch piston inside the clutch cover is forced by oil pressure to compress the clutch pack and its release springs. Reduction is obtained when the drum is held by its friction band, and the clutch is disengaged by the springs, oil pressure having been released. The drum, clutch cover and sun gear are then held stationary and the disengaged clutch slips to allow the planet gears to rotate.

REAR EPICYCLIC UNIT

The rear drum has seven clutch plates to transmit the torque and is fitted with guide pins inside the clutch springs. In addition to carrying the annulus gear for the rear epicyclic unit, the drum is drilled and tapped for the flange which transmits the drive to the reverse epicyclic gear train.

* Amended illustration December 1955

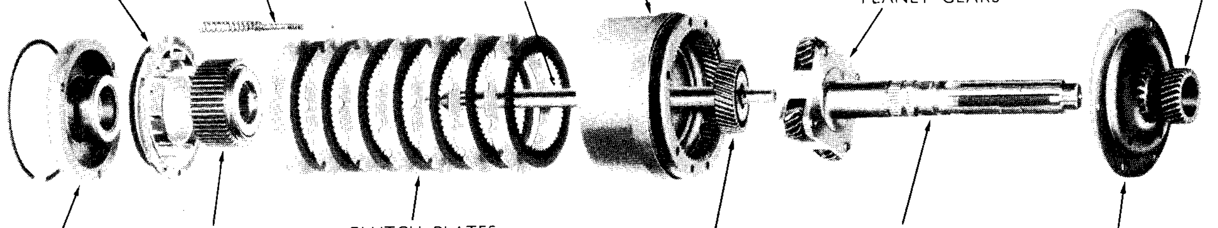


Fig. 9 Rear epicyclic unit exploded

The hollow intermediate shaft carrying the front and rear drums is supported in an oil delivery sleeve clamped in the centre web of the main casing by a cap secured by two bolts. Passing through the centre of this hollow sleeve are the intermediate and main drive shafts. The forward end of the output shaft acts as the planet gear carrier for the rear epicyclic unit in addition to carrying the spigot bearing for the rear end of the main shaft. The planet gears rotate inside an annulus gear secured to the rear drum which carries the driven clutch plates. The clutch hub carrying the driving plates is splined to the hollow intermediate drive shaft, and the clutch is similar in operation to the front one, except that it locks the annulus gear and intermediate shaft together, permitting the planet gears to rotate.

The rear friction band is similar to the front one, except that it passes once round the drum and is of double width to resist the higher torque.

REVERSE EPICYCLIC UNIT

The reverse planet carrier is similar in principle to the other two planet carriers except that it has three large gears instead of four small ones and carries the skew gear for driving the rear oil pump and governor. It is splined on to the output shaft immediately in front of the reverse annulus gear inside which the planet gears rotate. The reverse annulus gear runs free in all forward gears, but is held stationary by a cone clutch when reverse is selected.

The sun wheel of this epicyclic gear train rotates freely on the output shaft journal and is driven by the

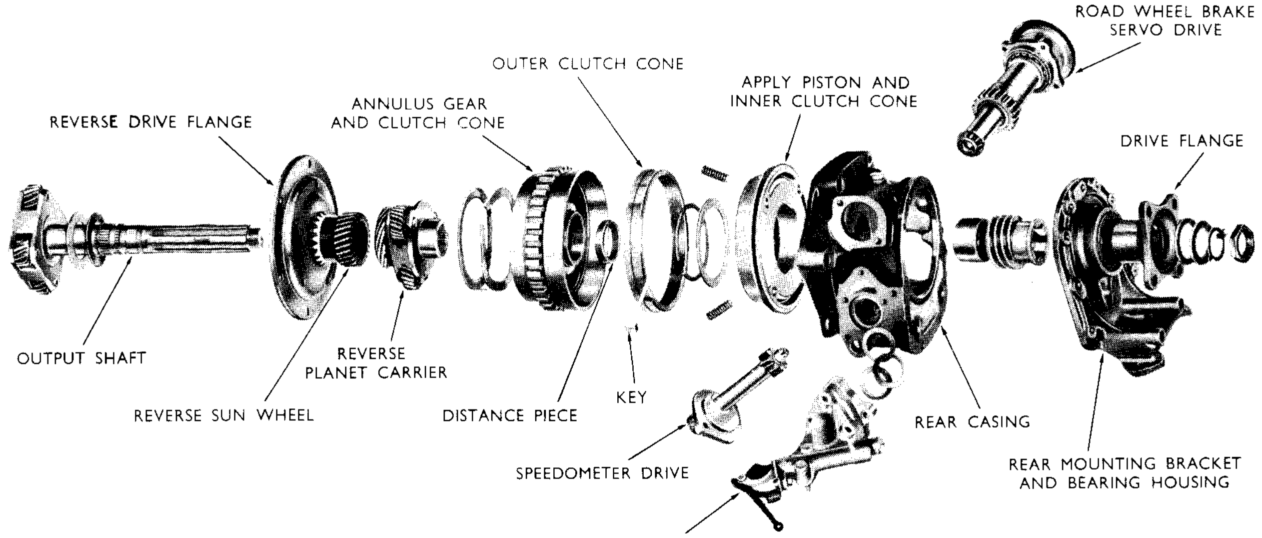


Fig. 10 Reverse epicyclic unit exploded

drive flange attached to the rear drum. The stationary elements of the cone clutch consist of inner and outer friction cones which fit into the gearbox rear casing. The centre of the internal cone forms a hydraulic piston which prevents rotation of the annulus gear when oil pressure moves it axially on four guide pins which also prevent rotation ; the cone is disengaged by six springs and oil leakage is prevented by rubber seals. The external cone is a split ring fitting inside the spigot bore of the gearbox main casing, rotation being prevented by a key. The stationary internal and external cones are of light alloy and are provided with oil grooves. The rotating cone is of steel and is integral with the reverse unit annulus gear.

The output shaft is carried in ball bearings in the gearbox rear casing and in the rear mounting bracket. The final drive splines carry the skew gear for driving the road wheel brake servo, ride control oil pump, speedometer and the drive flange for the transmission shaft universal joint.

BEARINGS AND THRUST WASHERS

The complete rotating assembly is carried in plain bearings at the front and centre, and in ball bearings at the rear. Axial thrust is transmitted by phosphor-bronze thrust washers, backed by steel washers.

The front plain bearings are between the front end of the intermediate shaft, the front annulus gear shaft and the front pump casing.

The centre plain bearing is also an oil delivery sleeve which supports the intermediate shaft between the front and rear drums. It also provides a bearing surface for the rear drum when in reduction. The front drum rotates on the intermediate shaft when in reduction. A spigot bearing in the front end of the output shaft supports the rear end of the main shaft, and the output shaft also carries the reverse unit sun wheel on a plain bearing.

The two ball bearings are housed one in the front wall of the rear casing and one in the rear mounting bracket.

Thrust washers are situated as follows :—

A pair of steel and phosphor-bronze washers between the rear torus hub and the end face of the front annulus gear shaft.

One phosphor-bronze washer between the hub of the planet gear carrier and the front annulus gear.

A pair of steel and phosphor-bronze washers between the front sun wheel and planet gear carrier.

A pair of steel and phosphor-bronze washers behind the front unit sun wheel bearing and retained on the intermediate front shaft by a spring ring.

A phosphor-bronze washer on each side of the rear unit clutch hub.

A pair of steel and phosphor-bronze washers between the rear unit planet carrier and the reverse drive flange.

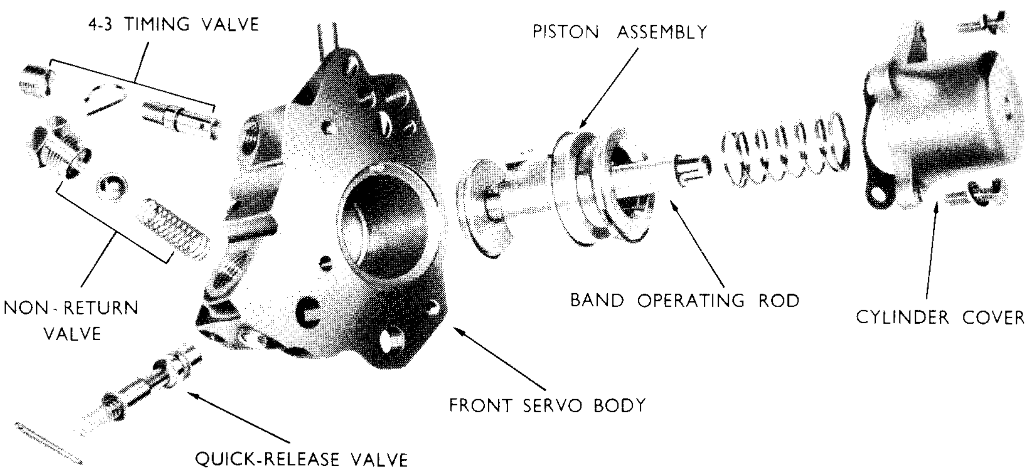


Fig. 11 Front servo exploded

End float is controlled by a selective adjusting washer between the rear unit sun wheel and the rear planet gear carrier on the front end of the output shaft.

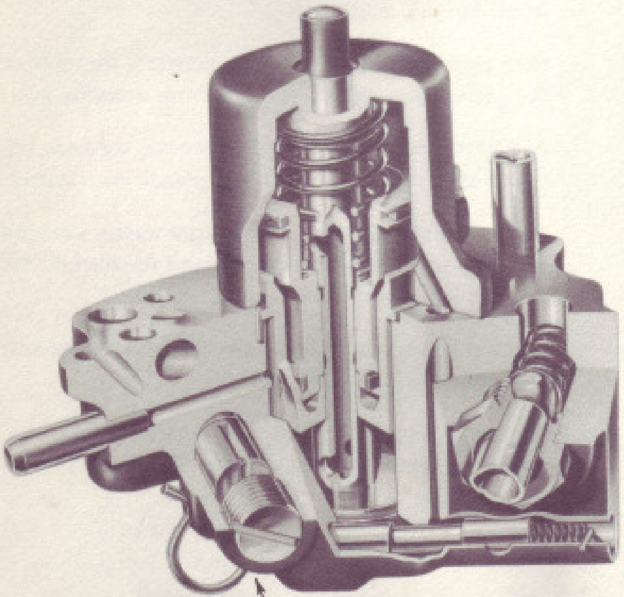
BAND SERVO UNITS

The band servo units are hydraulically-operated pistons which extend to close the band on to the drum and hold it stationary. The front servo band is applied and released by oil pressure, but the rear unit is spring-applied and oil pressure released. Both units incorporate valves which synchronize band application with clutch release under certain conditions of road wheel torque.

FRONT SERVO

The front servo unit consists of two casings, housing a double piston assembly. The main body houses three valves, a 4–3 timing valve, a quick-release valve and a non-return valve which prevents the front pump from feeding into the rear pump delivery line. The piston assembly is integral with the operating push rod and carries three piston ring seals dividing the oil cylinders into five chambers. Two chambers receive band-apply oil pressure ; one chamber receives compensating oil pressure, augmenting apply-pressure ; and two receive band release oil pressure (fig. 12). The compensator and front band-apply oil pressures are fed to the unit in all drive ranges, but release pressure, which overcomes both compensator and band-apply pressure owing to the larger piston areas, is applied only when band release is required (in second and fourth gear).

The oil feed passage between the band-apply chambers contains the quick-release valve, which passes the oil acting on the large apply-piston to exhaust when release oil is fed to the unit. The oil feed passage between the band-release chambers is a hole down the centre of the operating push rod. A spring acts on the piston assembly to release the band when in neutral. A point to be noted is that the band-release and band-apply pressure act together on the front servo when the band is released, the release piston area being greater than that of the apply-piston. The difference in effective piston area is increased by the action of the quick-release valve.



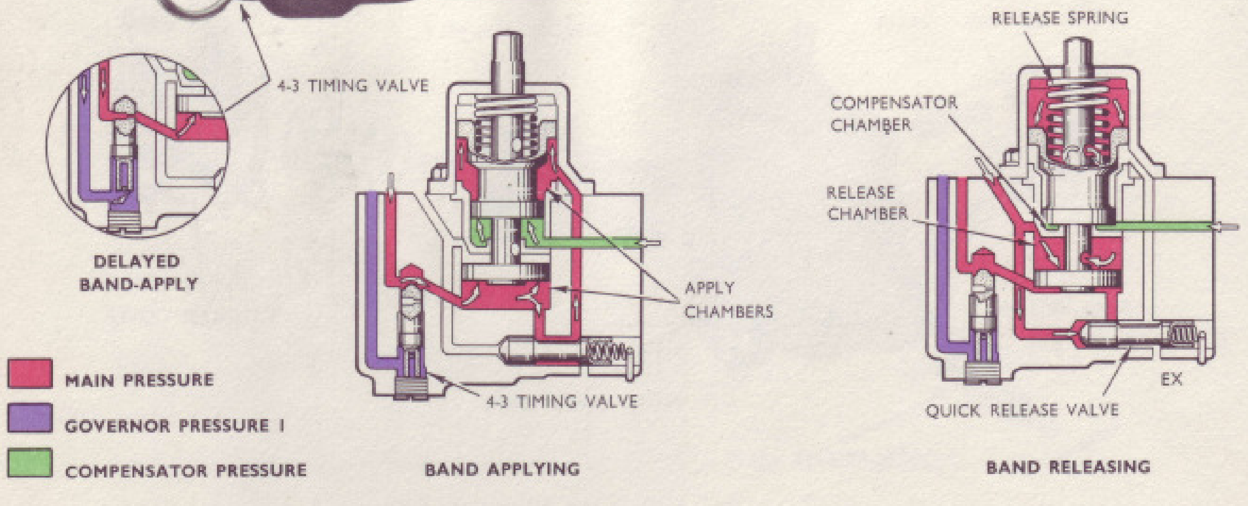


Fig. 12 Front servo

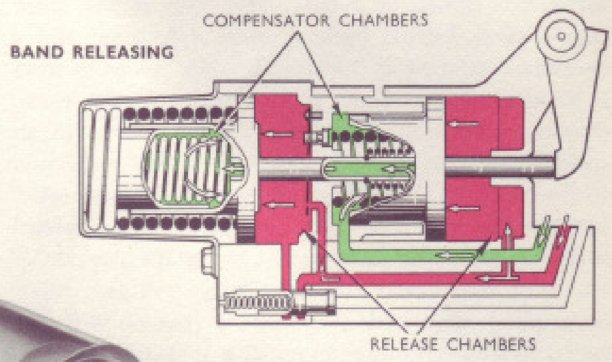
The 4–3 timing valve is a plunger, acted on by G1 pressure to restrict the oil flow to the small diameter apply-piston during a 4–3 forced down-change. This delays band application until the front clutch is released and occurs when G1 pressure overcomes the band-apply pressure acting on the valve, forcing it into the apply passage to restrict the flow from the cylinder.

REAR SERVO

The rear servo is larger than the front one to give a greater holding force on the band because of the higher torque transmitted through the second gear train. Construction is similar to that of the front servo except for the differences described in the following paragraphs.

Three piston ring seals divide the oil compartments into four chambers, two of which are band-release chambers and two compensator oil pressure chambers connected by a hole down the centre of the operating push rod. Compensator pressure augments the band application by the spring. The main apply-springs are retained by a U shaped strap, the inner one being contained in the compensator cylinder.

The two valves incorporated in the rear servo unit are interposed in the feed line to one of the band-release chambers. One of these valves is operated by compensator pressure to give unrestricted flow to servo-release oil and to restrict the exhaust of release oil from the chamber, thus delaying band application. The other valve is operated by main pressure and functions only when range 2 is selected ; it serves merely to cancel the effect of the restrictor valve and gives rapid band application. This is a device to enable a quick change from reverse to forward speed.



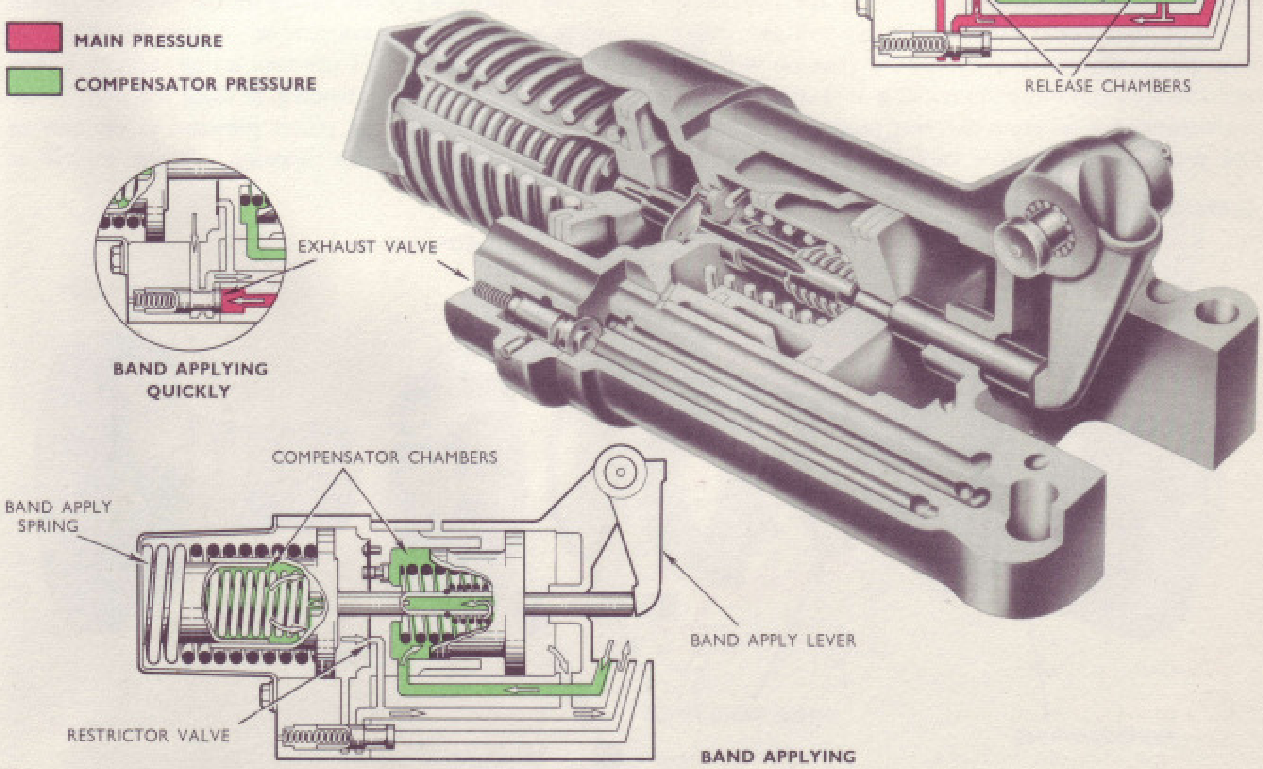


Fig. 13 Rear servo

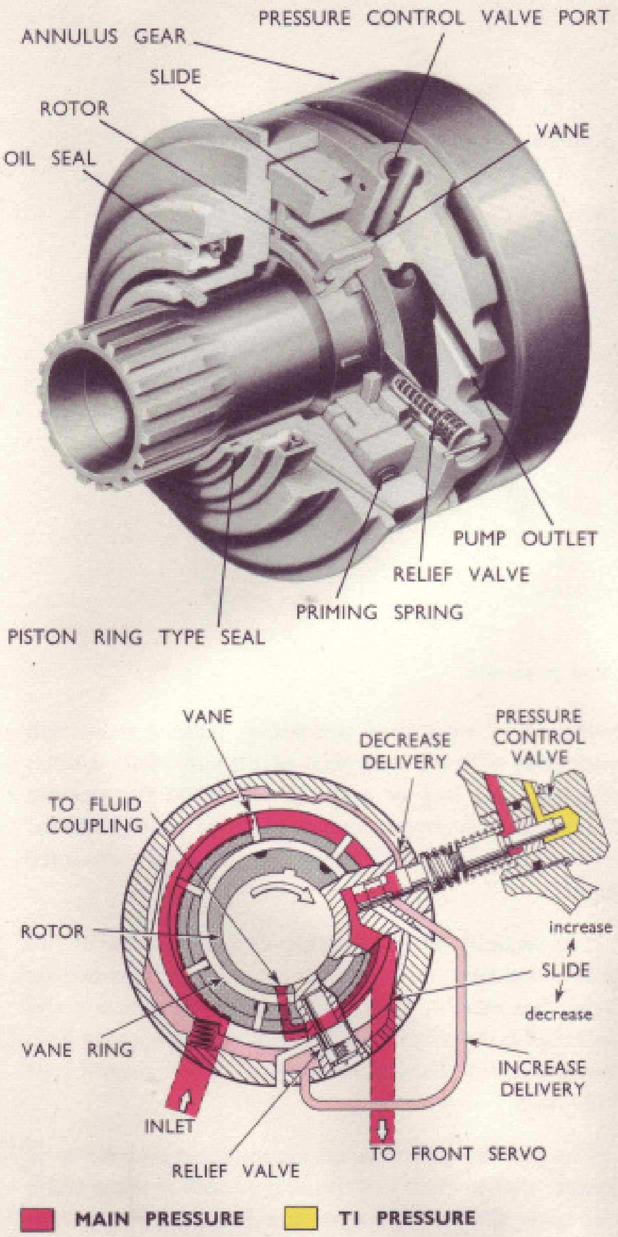


Fig. 16 Front pump

selected additional pressure acts on the reverse plug to close the port still further thus increasing pump delivery pressure for reverse clutch engagement.

Although the front pump can act as a relief valve for excessive delivery from the rear pump, a safety valve is fitted to limit the maximum pressure in the system.

The pump draws oil from the sump oil filter and delivers to the front servo unit where it is joined by the delivery from the rear pump, after passing through a non-return ball valve. The purpose of this non-return valve is to prevent the front pump from discharging into the rear pump. A small bleed by-passes the non-return valve, its purpose being to allow the front pump to maintain oil in the pipe and rear pump when the car is stationary or moving in reverse gear.

REAR OIL PUMP AND GOVERNOR

The rear pump and governor are mounted on a common shaft driven by a bronze skew gear on the reverse planet gear carrier.

The pump consists of a small gear meshing with a larger annulus gear which itself rotates in the pump casing. The inlet and outlet ports are separated by a crescent shaped projection of the pump casing. This forms a seal between the periphery of both gears and oil is carried in sealed pockets between the gear teeth from the inlet port to the discharge port.

A flat plate secured by four screws seals the pump chamber. The oil is drawn through an inlet pipe which projects into the sump filter and is delivered through a pipe to the front servo unit.

The governor consists of a small casting bolted to a flange pinned to the oil pump drive shaft. Oil is fed to

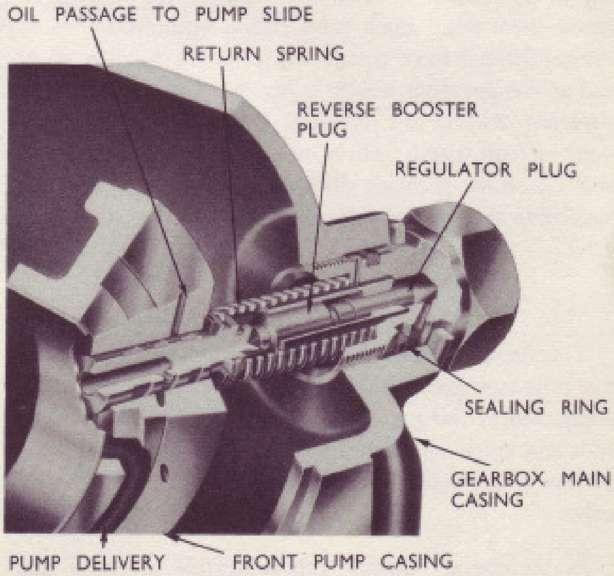


Fig. 17 Pressure control valve

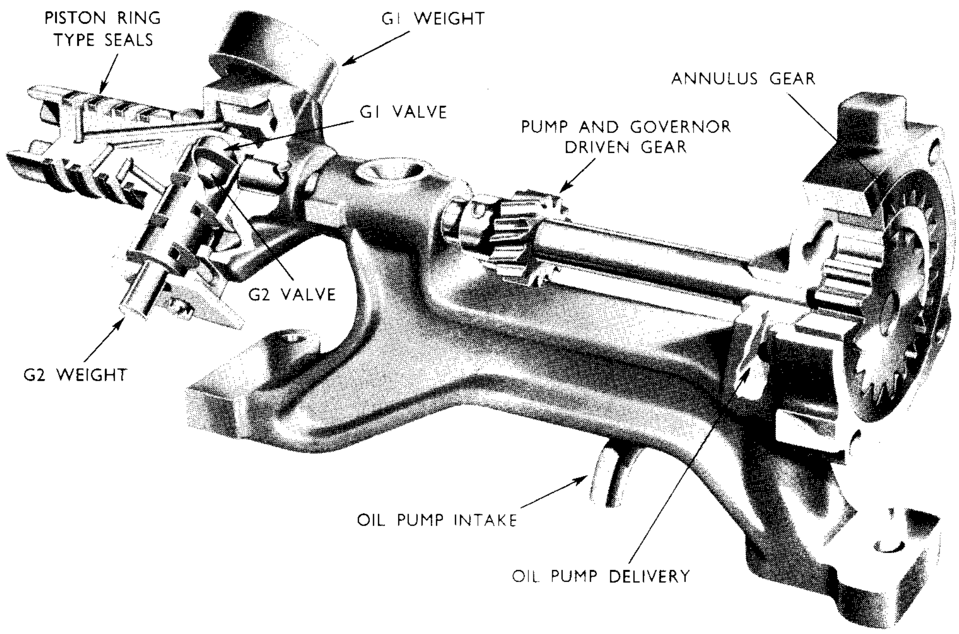


Fig. 18 Rear pump and governor

it through a stationary sleeve, which is a close fit around three annular grooves, sealed from each other by four piston ring type seals. From the annular grooves the oil flows through drillings to ports controlled by two valves operated by governor weights.

The valves are balanced by metered oil pressure tending to hold them in, and centrifugal force tending to throw them out. Each valve attains equilibrium when the centrifugal force equals the pressure holding it in, and as one governor weight is heavier than the other the governor delivers two pressures both of which are functions of road speed. Oil at these pressures, termed G1 and G2, flows through drillings in the sleeve to pipes leading to the control valve unit.

CONTROL LINKAGE

The drive selector lever on the steering column has five positions marked ' N,' ' 4,' ' 3,' ' 2,' and ' R.' It is connected to the gearbox selector lever by a system of rods and levers connected by ball joints and clevis pins, as also is the accelerator pedal to the gearbox throttle valve.

As the engine-gearbox unit is flexibly mounted and the counter shaft for the controls is mounted on the bulkhead, a method of preventing relative movement interfering with the controls is necessary. This consists of a swinging link or trapeze, secured to the steering column and carrying a counter shaft on which both the selector and throttle intermediate levers are mounted fig. 20).

The swinging link is so positioned, by the use of two rods connecting the selector lever with its intermediate lever, that relative movement between the gearbox and bulkhead is absorbed by movement of the swinging link, thus preventing incorrect movement of the control rods and levers.

The gearbox control levers are mounted on concentric counter shafts which pass through oil seals in the gearbox side cover and through a bearing integral with the control valve unit. The levers are splined to their shafts and can be fitted in one position only.

The outer shaft operates the selector valve by means of a pin engaging in a groove in the end of the valve. The five selector positions are determined by a spring-loaded plunger engaging with notches in a plate attached to the lever shaft. Projections on the plate contact a blade which moves a cam to engage or disengage the parking pawl when the selector lever is moved into or out of reverse. The blade is spring-loaded to permit

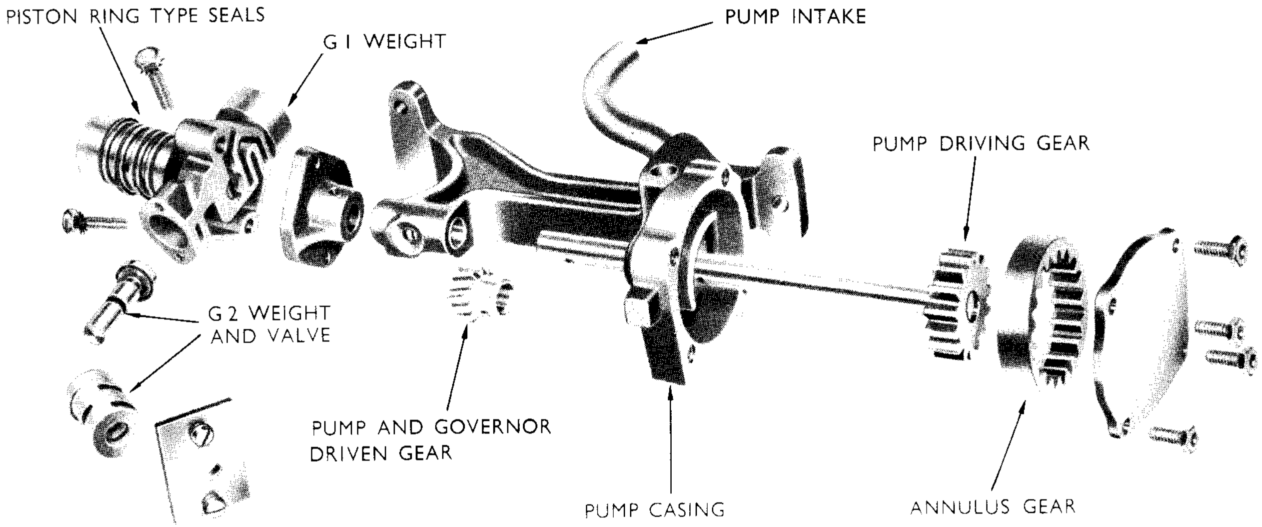


Fig. 19 Rear pump and governor exploded

the pawl to be held out of engagement by the parking blocker piston.

The lever on the inner shaft varies the throttle valve pressure by acting on the stem of the valve, compressing the throttle valve spring in the control valve unit.

OIL CIRCULATION

The oil for the fluid coupling, the hydraulic servo system and gearbox lubrication is pumped from the sump which is filled through a filler neck on the right hand side of the gearbox. The oil is drawn through a gauze filter in the sump by the two pumps previously described.

The flow to the fluid coupling passes forward through the annular space between the front drive shaft and the pump body, into the fluid coupling. When this has filled with oil, a relief valve opens to permit a flow between the main drive and the intermediate drive shaft to lubricate the bearings, and through holes drilled in the shafts to lubricate the clutches, gears, splines and thrust washers of the rotating assemblies.

Pipes carry the oil from both pumps to the casing of the front servo unit from which it passes through drillings in the main casing to the control valve assembly and back to operate the servo pistons. The oil feed to the governor is through drillings in the casing, and the governor pressures pass from the governor sleeve to the control valve assembly through two straight oil pipes. The annular spaces in the governor sleeve are sealed from each other by piston ring type oil seals.

The oil flow from the control valve assembly passes through drillings in the main casing to the front and rear servo units and to an oil delivery sleeve on the intermediate shaft between the front and rear drums. This sleeve forms the centre plain bearing and is located in the centre web of the main casing by a dowel in the bearing cap. Oil passes through the delivery sleeve to the front and rear clutches, oil leakage being prevented by piston ring type oil seals. The oil to the reverse clutch passes through a pipe and drillings in the rear casings.

A main oil exhaust valve, located in the main feed passage in the main casing, opens under light spring pressure to reduce the control pressures quickly by allowing the oil in the servos and control valves to exhaust when delivery from the pumps ceases.

CONTROL PRESSURES

Main pressure, obtained direct from the two oil pumps, is used to operate all the servo pistons and to supply the oil for conversion to lower controlling pressures by the governor and control valves. In addition main pressure is applied to the transition and timing valves.

Compensator pressure is obtained by metering main pressure through ports controlled by a compensator valve, spring and auxiliary valve. This pressure is lower than pump pressure and is directed to the front and rear band servos to increase the holding force as driving torque increases.

Throttle pressure (T1), obtained as already described, acts on the compensator valve to regulate the compensator pressure in accordance with throttle opening. It is also applied to the regulator plug in the pressure control valve and so varies pump pressure with throttle opening.

Throttle pressure No. 2 (T2) is obtained by metering T1 pressure past the spring-loaded T2 valve. In addition to acting on the 2–3 shift valve in first and second gear, it is applied to the lock valves, which control the ports permitting pressure to act on the 1–2 and 3–4 shift valves ; this locks the shift valves in gear after an up or down change and prevents hunting.

Throttle pressure No. 3 (T3), obtained when T2 pressure is metered past the 1–2 lock valve, acts on the shift valve to make the down change and, by resisting governor pressure, times the up changes.

Governor pressure No. 1 (G1), obtained by metering oil past the valve controlled by the large governor weight, is directed to the 3–4 shift valve, G1 plug, 3–4 over-speed valve, 1–2 shift valve, 2–3 G1 plug, reverse blocker

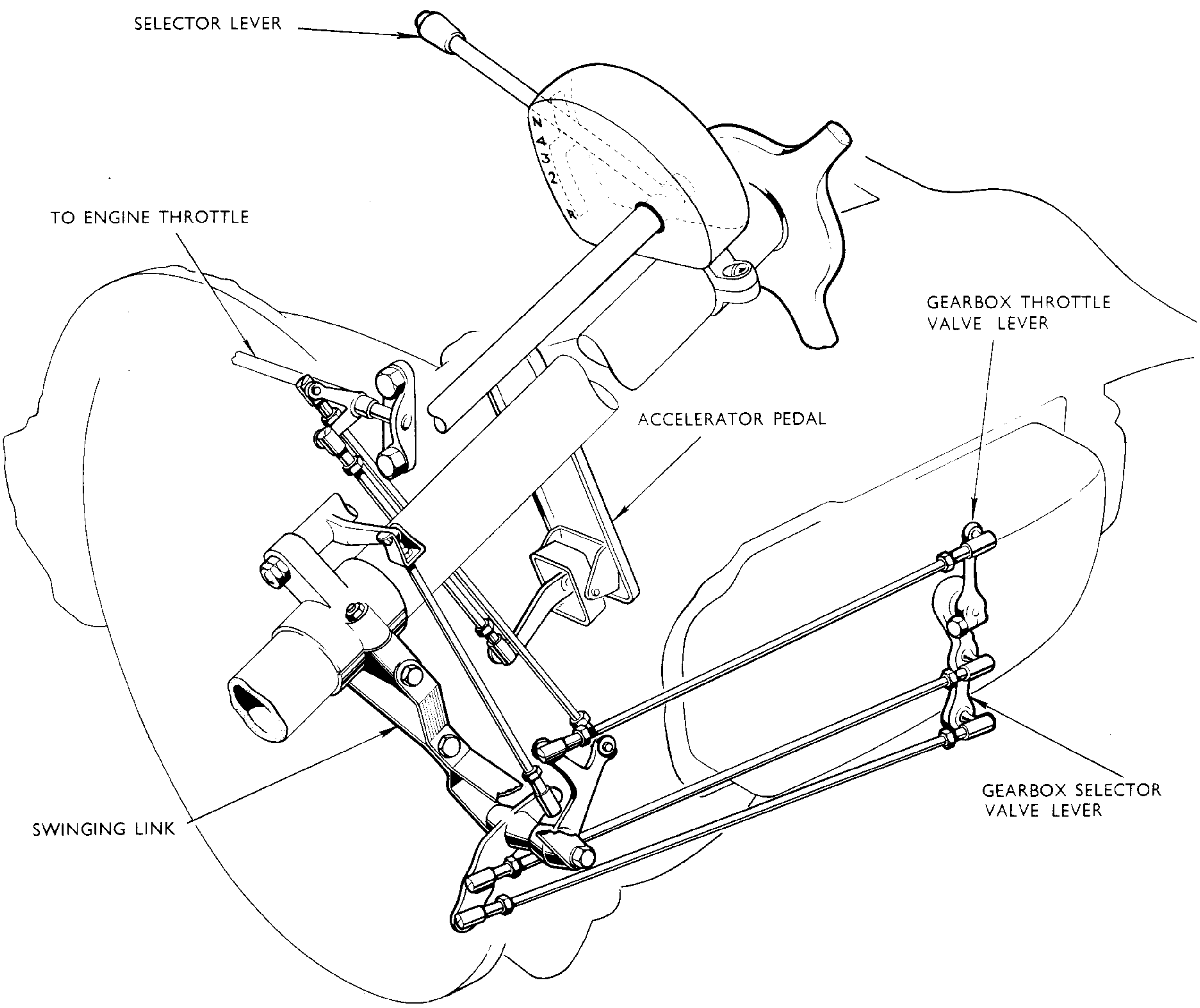


Fig. 20 Control linkage

piston and to the 4–3 timing valve in the front servo. The high rate of pressure increase caused by the large governor weight gives accurate control at low road speeds.

Governor pressure No. 2 (G2), obtained by metering oil past the valve controlled by the small governor weight, is directed to the 2–3 G2 plug, the 3–4 over-speed valve and the 3–4 G2 plug. The rate of pressure increase is greatest at high road speed, where G1 pressure is insufficiently sensitive.

VALVE OPERATION

The detailed operation of the valves in selecting the appropriate gear ratio is illustrated in fig. 22 to 26 and described in the following paragraphs.

First gear

Oil pressure is as shown in fig. 23 ; as the accelerator is depressed, the throttle valve compresses the spring acting on the T1 valve. This increases T1 pressure progressively as the throttle is opened.

T1 pressure acting on the compensator valve moves it against auxiliary valve spring pressure to permit main pressure to meter through compensator valve ports and become compensator pressure ; compensator pressure augments the spring force of the auxiliary valve, and this pressure will also increase progressively with throttle opening.

T1 pressure acting on the regulator plug assists the pressure control valve to regulate the front pump capacity to maintain the pump pressure at a controlled

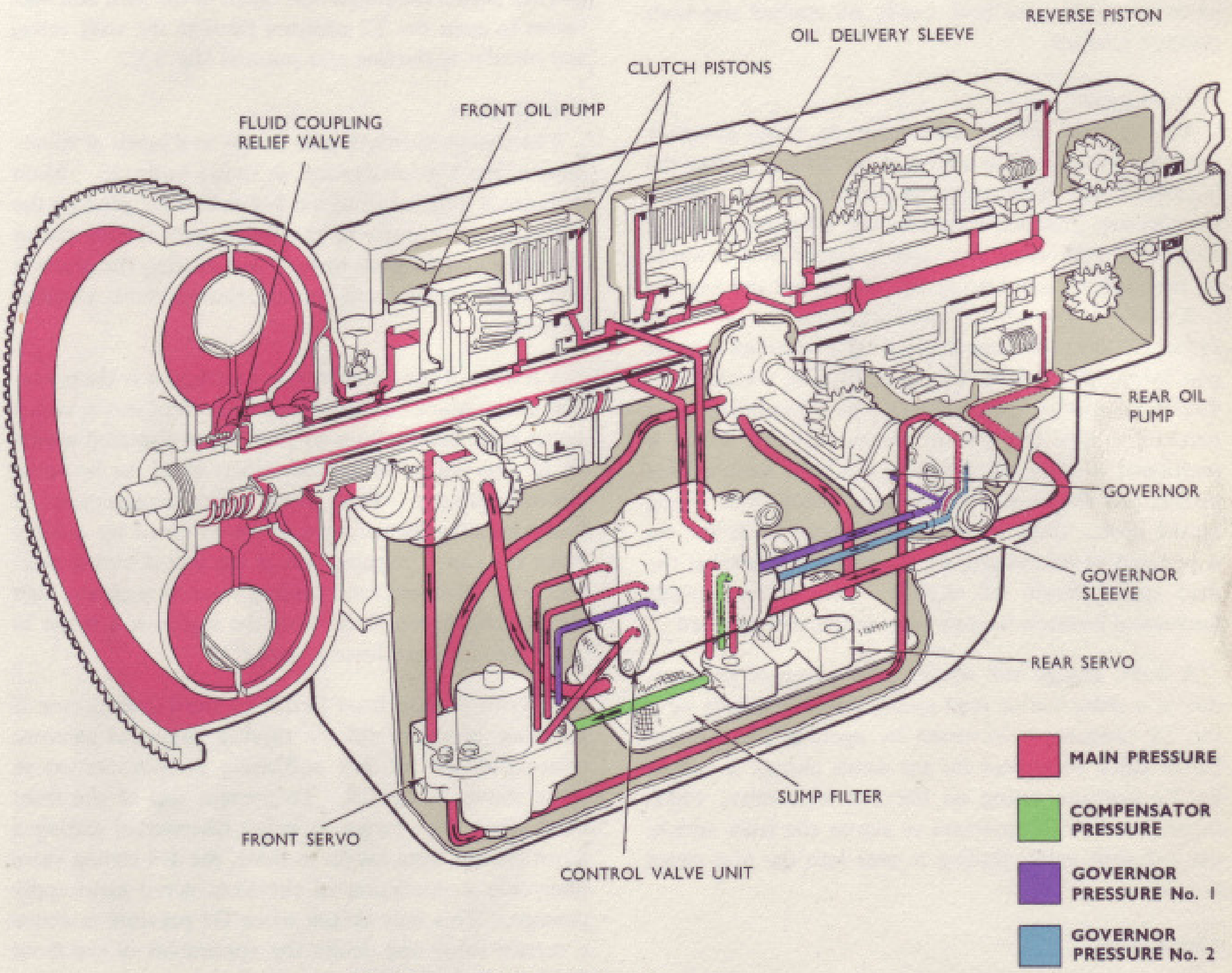


Fig. 21 **Oil circulation diagram**

amount above T1 pressure.

T1 pressure applied to the T2 valve moves it against spring pressure to open a port allowing oil to meter past and become T2 pressure.

T2 pressure assists spring pressure in holding all the shift valves in their low gear positions ; it forces the 1–2 lock valve against the spring pressure towards the 1–2 shift valve and permits oil at T3 pressure to act on the 1–2 shift valve. The same occurs with the 3–4 lock valve and shift valve while T2 pressure acts directly on the 2–3 shift valve. As there is no oil pressure acting on the clutch pistons and the bands are tightened on to the drum (the rear band by servo spring pressure augmented by compensator pressure and the front band by main pressure acting on the band-apply pistons and compensator pressure on the compensator piston) the car will be in first gear since both bands are applied and both clutches released.

Second gear

As the road wheels commence to turn, governor pressures are applied as shown in fig. 23 and oppose the T2 and T3 pressures acting on the shift valves. When the governor pressure overcomes the T3 pressure acting on the 1–2 shift valve, the valve is forced over towards its lock valve, compressing the spring and moving the lock valve to cut off T3 pressure from the 1–2 shift valve. At the same time the lock valve opens an exhaust port for the oil displaced by the shift valve, which therefore moves quickly over, opening a port permitting main pressure to flow through the transition valve, which is positioned to allow oil to flow to the front servo release pistons and the front clutch engage piston, thus giving second gear. Once the change has been made the car is retained in second gear by the lock valve, even if the road speed should fall slightly. This feature avoids fluctuation between the two gears at the critical speed.

A down change will occur if the governor pressure, due to a reduction in road speed, falls sufficiently or if the T2 pressure is increased by opening the throttle. Initial valve movement for the down change is caused by T2 pressure acting on the 1–2 lock valve, which moves to allow T3 pressure to act on the large area of the 1–2 shift valve, forcing it over into the first speed position.

Third gear

Increasing road speed causes the governor pressures to increase ; G1 pressure acting on the 2–3 G1 plug and G2 pressure acting on the 2–3 G2 plug, will overcome T2 pressure acting on the 3–2 shift valve. The whole group of 2–3 valves moves against spring pressure to cut off T2 pressure and permit displaced oil to exhaust. In this position the shift valve directs pump pressure into the 3–2 timing valve and from there by its unrestricted passage to the rear clutch piston and also to the transition valve by way of the selector valve ; this forces the transition valve towards the auxiliary valve, thus cutting off the oil supply to the front clutch and the front servo release piston, and putting the car into third gear. (Front clutch and rear band released, rear clutch and front band applied).

A down change from third to second will occur if the road speed and, therefore, governor pressures fall sufficiently to permit the initial movement of the shift and lock valves to open the T2 pressure ports to the shift valve, and move it to the low gear position (fig. 23).

Fourth gear

The change to fourth gear occurs as a result of movement of the 3–4 valve group, as shown in fig. 23. Main pressure is directed from the 3–4 shift valve through the transition valve ports to the front servo release piston and front clutch apply-piston, thus putting the gearbox into direct drive (both bands released, both clutches applied).

A feature of the up-change to fourth gear is the operation of the quick-release valve in the front servo, which assists front band release by permitting displaced apply-oil to pass direct to exhaust when acted on by servo release pressure. This gives quick engagement of fourth gear by allowing the drum to speed up quickly when the clutch engages, and in the non-releasing position gives increased band holding force to resist the high torque transmitted when using the engine as a brake in third gear (selector lever in range 3).

A down change from fourth to third gear occurs if governor pressures fall or throttle pressures increase whereupon the oil flow and valve positions revert to those shown in fig. 23. To prevent slip of the front band when high torque is being transmitted during a down change from fourth to third, the 4–3 timing valve interposes a restriction in the front servo band-apply passage. This only occurs when G1 pressure is above a certain value and delays the application of the front band until the front clutch is released.

Automatic Control Diagrams

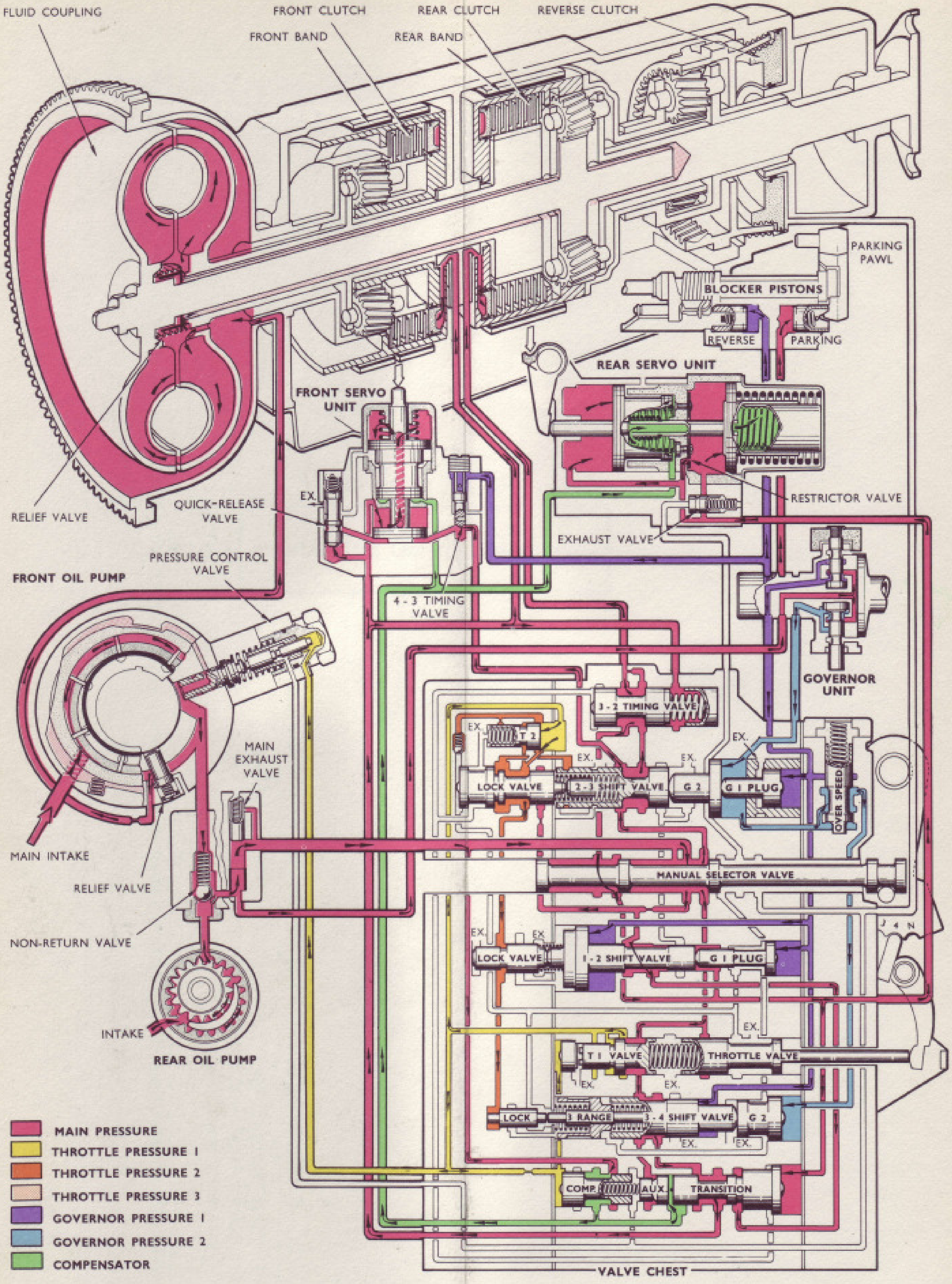


Fig. 22 Diagram of Automatic Control

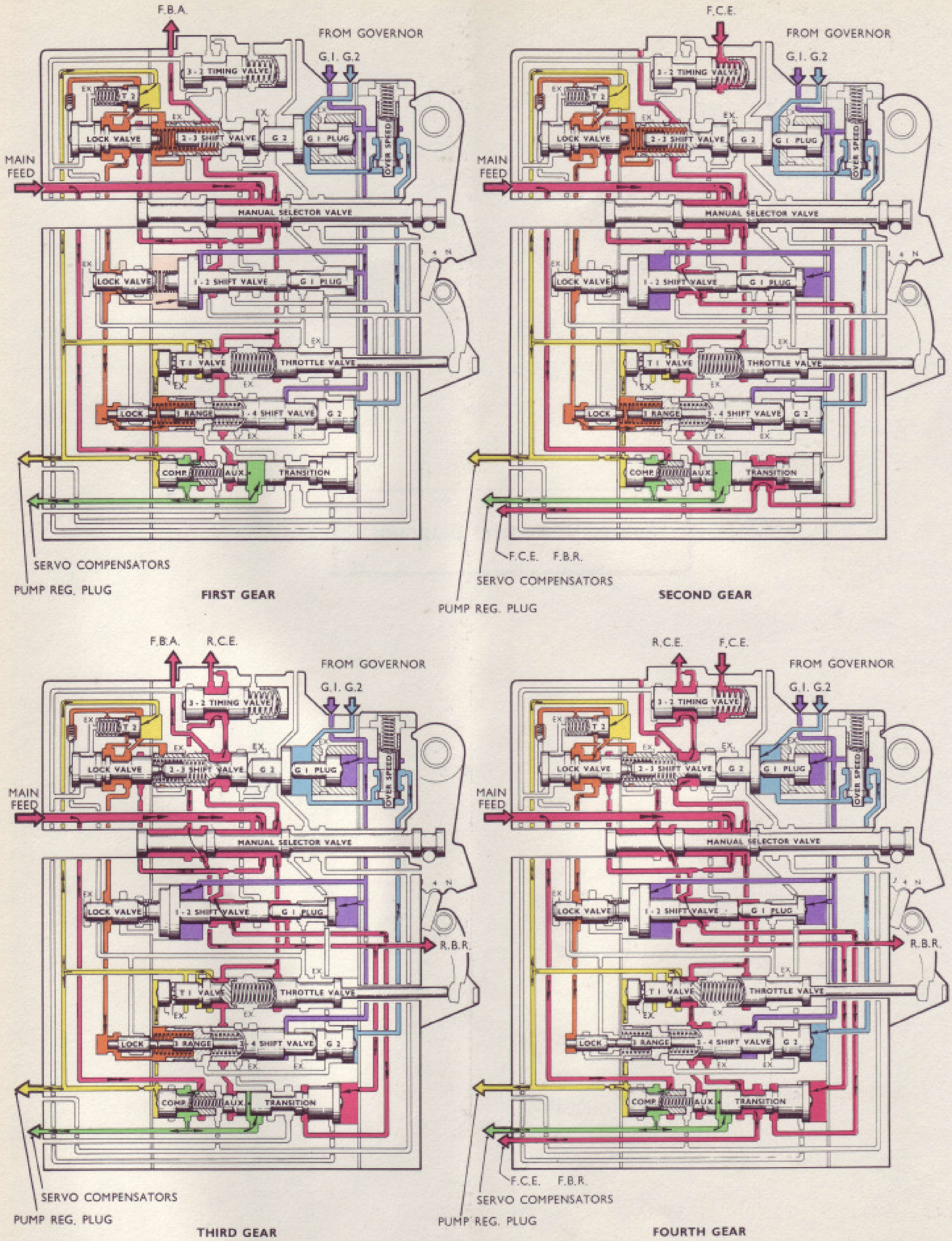


Fig. 23 Valve operation (Range 4, part throttle)

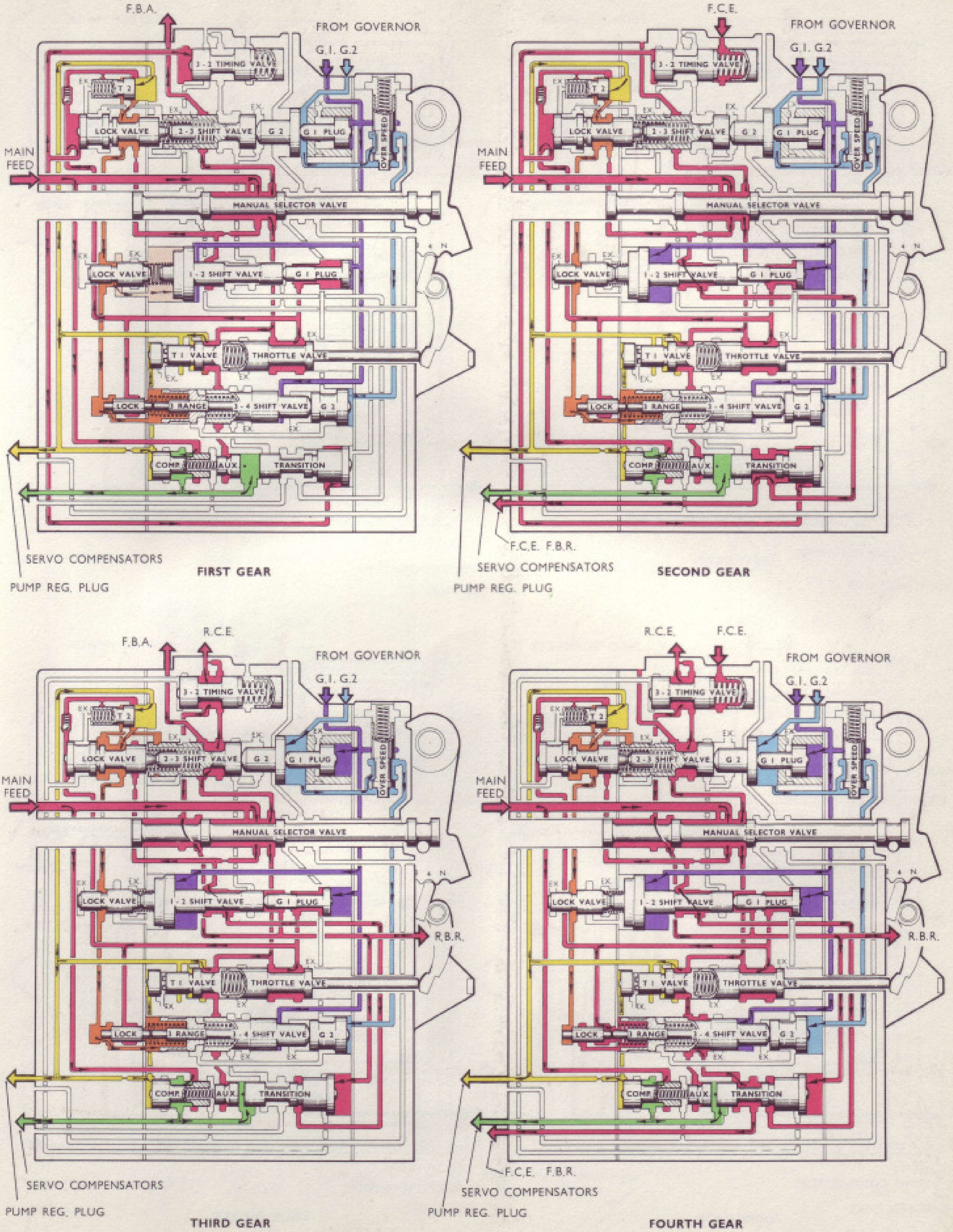


Fig. 24 Valve operation (Range 4, full throttle)

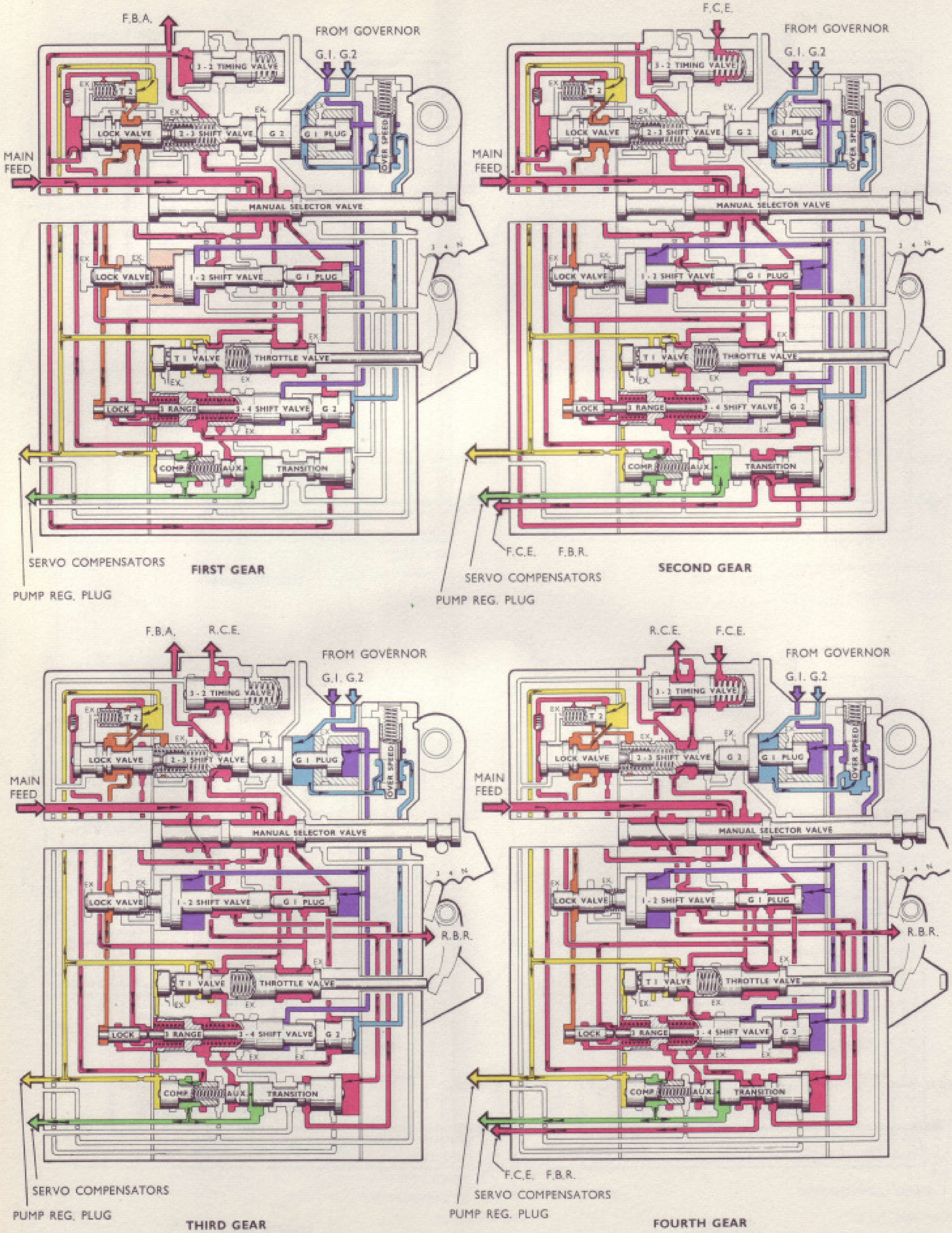


Fig. 25 Valve operation (Range 3, full throttle)

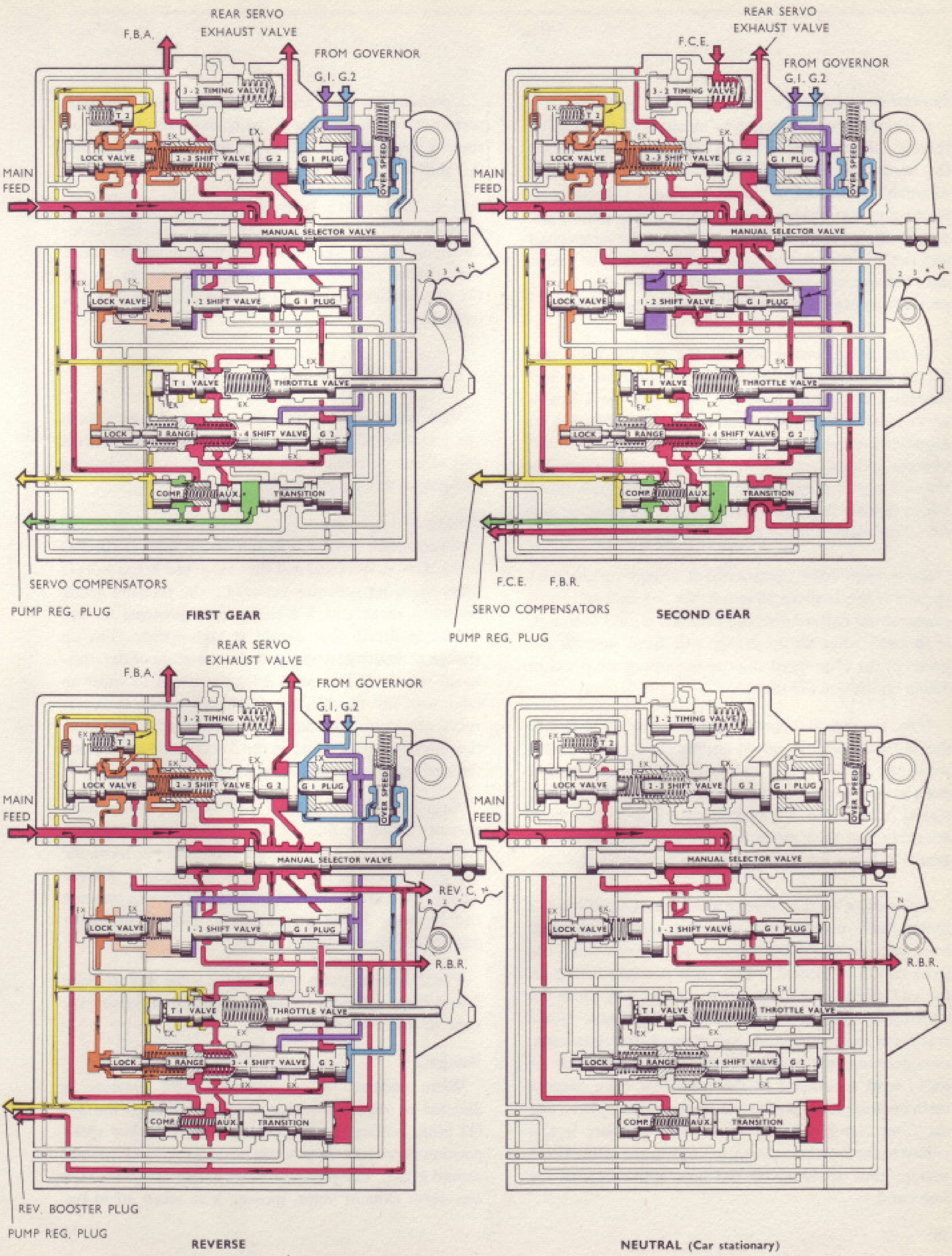


Fig. 26 Valve operation (Range 2, Reverse and Neutral)

Forced down-change

A forced down-change can be obtained by opening the throttle fully and then exerting slightly greater force on the accelerator pedal. This forces the throttle valve assembly to the end of travel, causing T1 pressure to increase to approximately the same value as main pressure, because the throttle valve spring is fully compressed and the T1 valve is wide open. The cushion of resistance felt on the accelerator pedal is provided by T1 pressure acting on the end of the valve assembly.

In the fully opened position the throttle valve uncovers a port permitting oil at main pressure to flow through a non-return valve and bleed past the T2 valve to increase T2 pressure and to act in opposition to governor pressures on the 3–2 and 2–1 lock valves. Oil at main pressure acts on the 3–2 lock valve and passes through a port partially covered by the 3–4 lock valve, which thereby is forced over to cut off T2 pressure and substitute main pressure on the 3 range valve.

Subsequent valve operation will depend on the road speed ; if this is above 18 m.p.h. the 3–4 shift valve will change down to third gear and maintain it until 65 m.p.h. is attained, when an up change will occur through the action of the over-speed valve in increasing the pressure acting on the 3–4 G2 plug.

If the road speed is above 8 m.p.h. but below 18 m.p.h. the 3–2 lock valve is moved against spring pressure towards the 2–3 shift valve and uncovers a port permitting main pressure to act on the transition valve and the 3–2 timing valve ; the 3–2 lock valve and 2–3 shift valve assembly will then move to change down into second gear. If below 8 m.p.h. a change to first gear will occur.

A feature of the 3–2 change is the operation of the 3–2 timing valve which delays the application of the rear band and disengagement of the rear clutch until the front clutch is applied. The main pressure acting on the end of the 3–2 timing valve moves it to close the unrestricted passage ; the discharge to exhaust of the rear servo must, therefore, pass through the restriction, thus delaying rear band application and rear clutch release, until movement of the transition valve permits main pressure to act on the front servo-release piston and the front clutch engage-piston. This pressure is also passed to the 3–2 timing valve to uncover the unrestricted passage thus speeding up the final application of the rear band.

Up-change to third gear will not occur until approximately 35 m.p.h. because of the main pressure acting on the 3–2 lock valve instead of T2 pressure acting on the 2–3 shift valve.

If the road speed is below 8 m.p.h. the 1–2 shift valve assembly will operate to change down, and the subsequent up-change will occur at a slightly higher speed than normal due to the pump pressure acting on the G1 plug and the higher T2 pressure acting on the 1–2 lock valve.

SELECTOR POSITIONS

Valve movement in the other drive positions follows the principle of operation previously described and the role of each selected range is described in the following paragraphs and fig. 25 and 26.

Range 3

When range ' 3 ' is selected, main pressure is directed to the 3 range valve and 3–4 shift valve and to the 1–2 G1 plug, opposing governor pressure ; the pressure acting on the 3 range and 3–4 shift valves prevents an up-change to fourth gear except at high speed. The up change to fourth gear requires the operation of the over-speed valve. If the car is driven to about 65 miles an hour with full throttle, the G2 pressure lifts the over-speed valve and substitutes G1 pressure for G2 pressure, thus increasing the thrust on the 3–4 G1 plug and forcing the shift valve to change into fourth gear.

An up-change to second gear is delayed by main pressure acting on the 1–2 G1 plug, requiring a greater governor pressure and therefore road speed to move the G1 plug and shift valve for the up-change. Alternatively, for a given road speed a higher throttle pressure and therefore higher power can be used in the lower gear before an up-change occurs.

The 2–3 valve group works in the same way in range 3 as in range 4, the up and down change points being the same in either selector position.

Range 2

When position ' 2 ' is selected, main pressure is directed to oppose governor pressure acting on the 2–3 G2 plug, locking the 2–3 valve group in the low speed position to prevent the gearbox from changing up beyond second gear. The pump pressure is also directed to the rear servo exhaust valve, moving it to allow oil to by-pass the restrictor and give quick application of the rear band.

Reverse

When the selector lever is moved into the reverse position, main pressure is directed to the rear band release piston, the compensator valve and the reverse cone clutch. It also acts on the reverse plug in the pump pressure control valve and raises main pressure to about 180 lb. per sq. in. which ensures that the rear clutch is engaged quickly and securely. The main pressure acting on the compensator valve shuts off compensator pressure and this, together with use of a clutch to engage reverse, permits instant change from forward to reverse drive and back again when necessary, but a safety blocker piston, operated by governor pressure, prevents reverse from being selected at more than about 10 miles per hour.

Parking

When parking the car, the transmission can be locked by engaging reverse. This locks the gearbox by a spring-loaded pawl which engages with teeth around the outer diameter of the reverse annulus gear. The parking pawl is disengaged when neutral is selected for the engine to be started. It cannot then be re-engaged while the engine is running or the car is moving because oil from either of the pumps will cause a parking blocker piston to emerge and hold the pawl out of engagement. When the pumps stop, the main exhaust valve lets the pressure drop immediately, so retracting the blocker piston and allowing the parking pawl to engage when reverse is selected.

Neutral

When the selector lever is moved into the neutral position it disengages the parking pawl ; starting the engine causes the front pump to build up oil pressures which are applied as shown in fig. 26. The rear band is released by oil pressure acting against the servo spring ; the front servo and front clutch remain released (no oil pressure) therefore the drive is disconnected in both front and rear epicyclic units.

Slight drag of the bands and clutches may transmit a small amount of torque through the fluid coupling to the road wheels, but this is negligible when the bands are thoroughly bedded in.