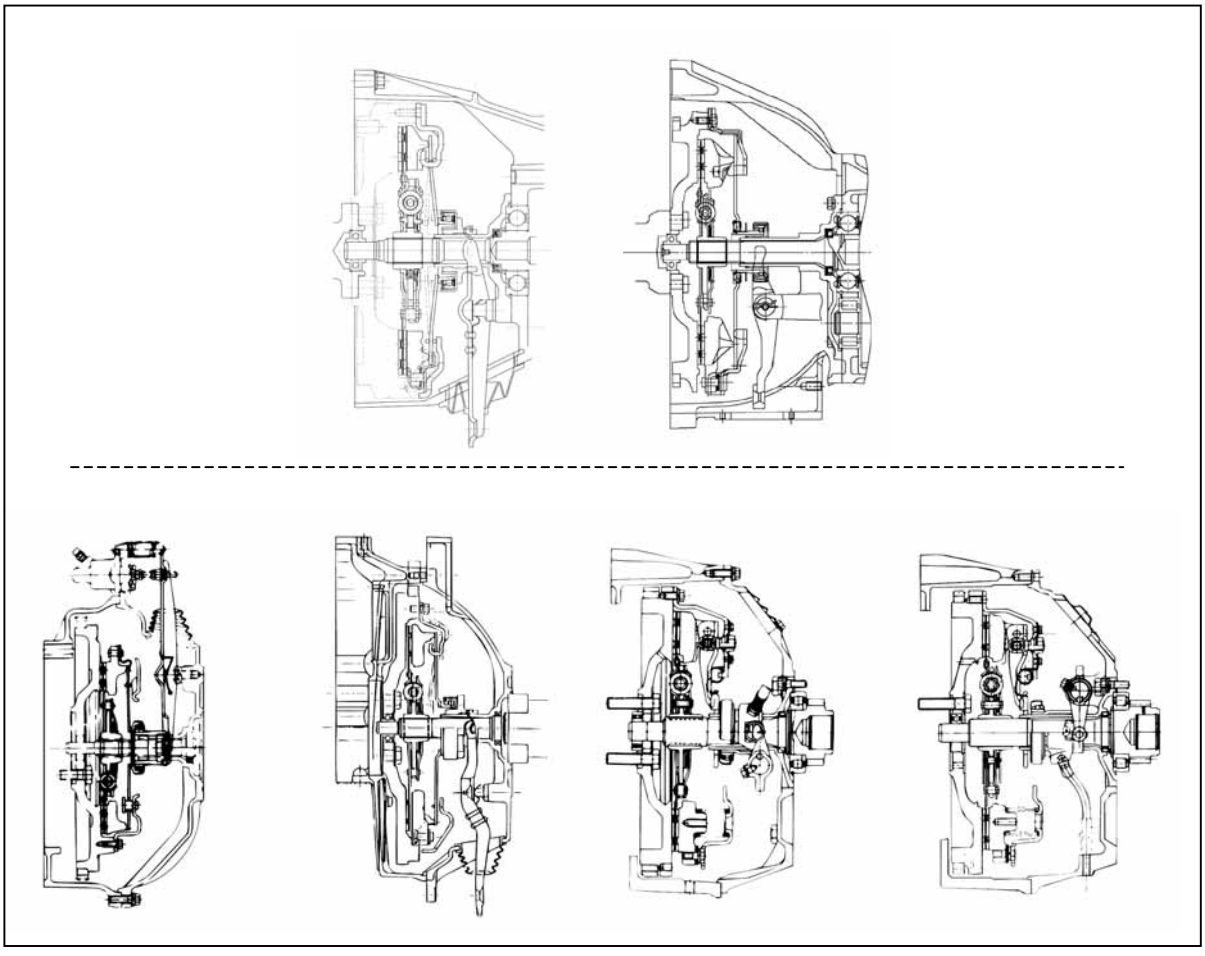
CLUTCH



ISUZU

ISUZU MOTORS LIMITED

CONTENTS

SECTION 1

GENERAL DESCRIPTION OF A CLUTCH

The clutch in general permits the gradual transmission of engine power to the driven wheels, when starting the automobile from a stand still, without lowering the rotative speed of the engine. It also serves to connect and disconnect the transmission to and from the engine, so that gearshifting can be carried out while the transmission is in the no-load condition.

PURPOSE OF INSTALLING A CLUTCH

To facilitate engine starting.
To set the vehicle in motion without grab or chatter.
To ease gearshifting.
To reduce the impact of the rotating power on the power train when the vehicle is in motion.
To maintain the idling speed of the engine.

REQUIRED FUNCTIONS

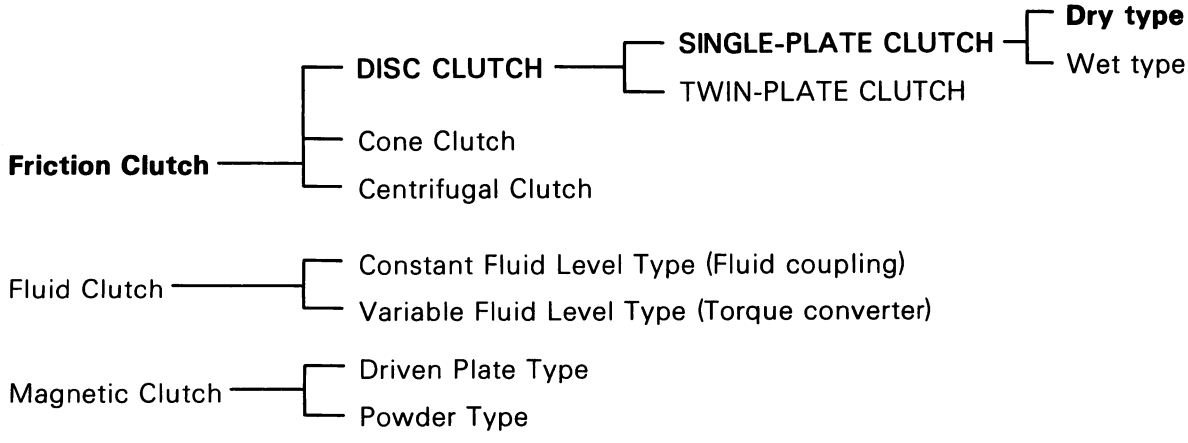
To engage and disengage the engine power.
To synchronize the rotative speed of the engine with vehicle movement.

THE FOLLOWING CHARACTERISTICS ARE REQUIRED BY CLUTCHES FOR VEHICLES

To allow positive, smooth and easy engagement and disengagement.
Excellent heat conductivity qualities.
Moment of inertia of the clutch should be reasonably small.
The clutch should have sufficient capacity to transmit engine torque.
The clutch should be simple in construction, positive in function with high resistance to wear, as well as being easy to service.

TYPES OF CLUTCHES

This manual is explained about the construction and function of the single-plate clutch (dry type) from section 2.



The types of clutches, generally employed for vehicles are the friction disc type, and the single-plate type. This is because they are simple in construction and easy to service.

FRICTION CLUTCH

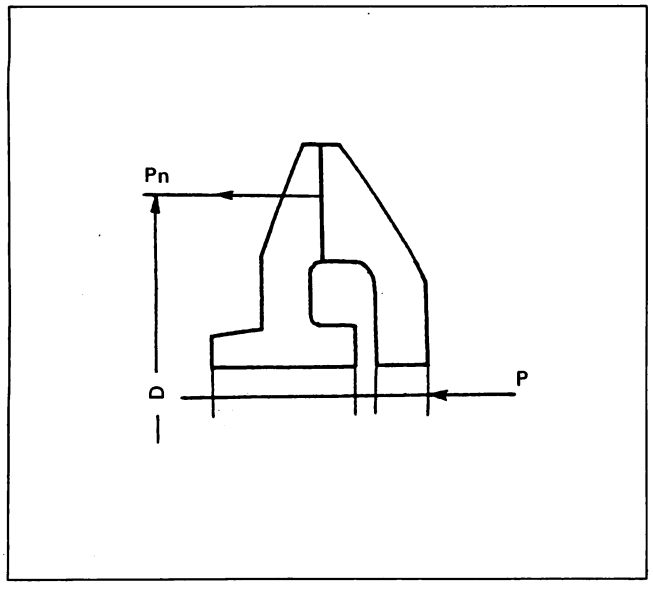
The friction clutch utilizes the friction of the facing to transmit the power from the engine to the transmission. It is available in two types, the dry type and the wet type.

The wet type friction clutch is, as the name implies, designed to operate under lubricated conditions and, therefore, is smoother in engagement and less prone to wear, compared to the dry type clutch.
However, its capacity to transmit engine torque is relatively low, as wet type clutches are generally low in frictional coefficient.
The friction clutch can be classified into the disc type and the cone type according to the shape of the friction face.

In the case of the cone type clutch, a higher capacity can be obtained from a friction face of the same dimensions if the conical angle is decreased. However, engagement of the cone type clutch is less smooth than the disc type.

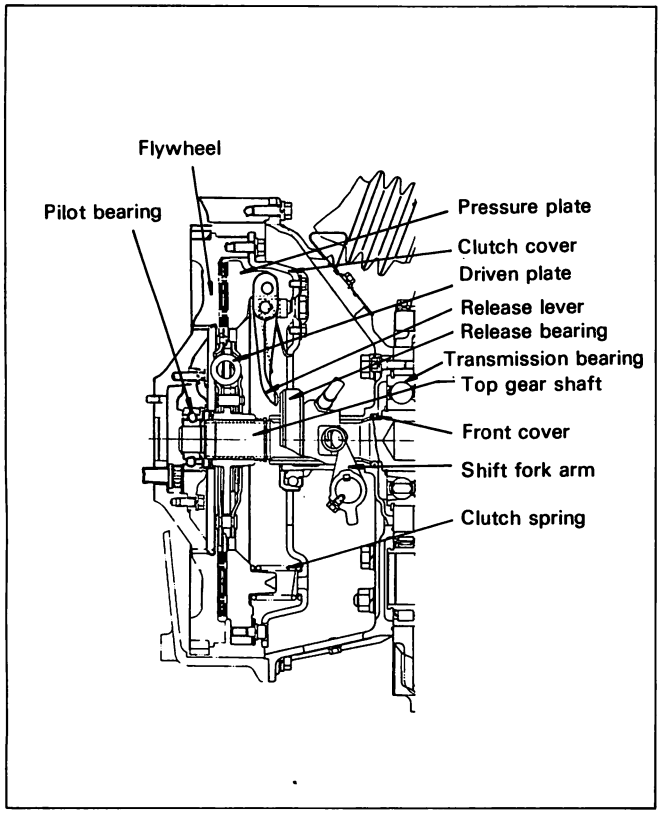
In automobiles of conventional design, the dry single-plate clutch is the type most generally used. However in heavy duty vehicles which require a large-capacity clutch, for example racing cars which require a high-speed engine and a machanism which permits quick gearshifting, the multi-disc clutch is often employed to minimize moment of inertia of the clutch.

The clutch generally used in Isuzu vehicles is of a dry single-plate type.
(A dry twin-plate type is used for a part of heavy-duty vehicles).



DISC CLUTCH

In a disc clutch of the basic design illustrated on the left, the disc type friction clutch utilizes the friction plate to perform engagement and disengagement.
The normal force "Pn" of the friction face is equal to the thrust force "P" and hence the transmitting torque "T" can be calculated from the following formula: $T = \frac{\mu PD}{2}$, This holds true provided the friction coefficient and mean diameter of the friction plate in which the normal force "Pn" is imposed, are represented by the symbols "μ" and "D" respecitvely. The disc clutches which rely upon the above principle can be divided into the following types: single-plate, multi-plate, dry-type, and wet-type.

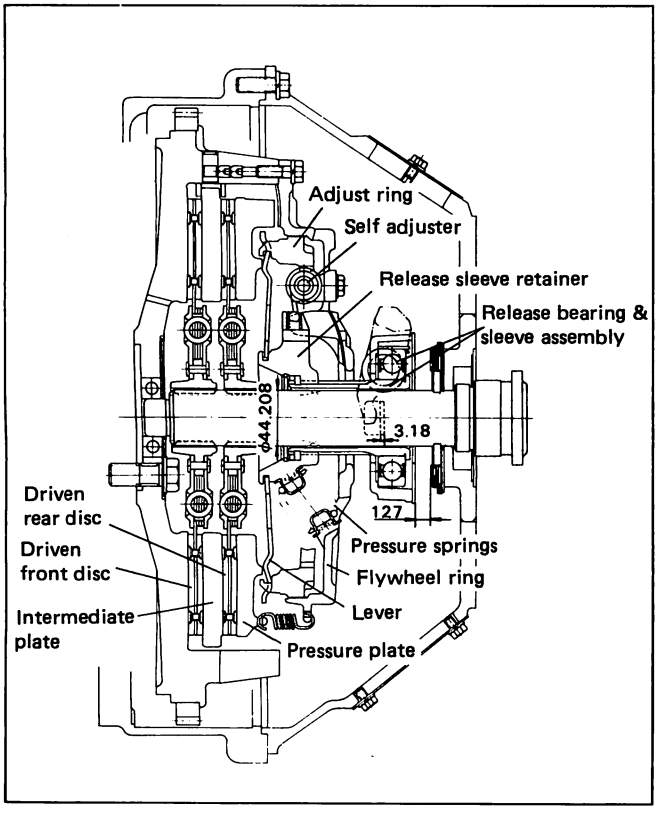


Single-plate clutch (Coil type clutch spring)

This type of clutch is used most widely in four-wheeled automobiles.

As shown in the drawing, the driven plate is positioned between the flywheel and pressure plate of the clutch cover and is forced by the clutch springs against the flywheel. The friction of both faces of the driven plate is utilized to transmit the power from the engine to the transmission.

The linkages are designed to ensure that the movement of the clutch pedal is transmitted to the release lever which, in turn, forces the pressure plate away from the flywheel against the clutch spring tension, thereby disengaging the clutch.



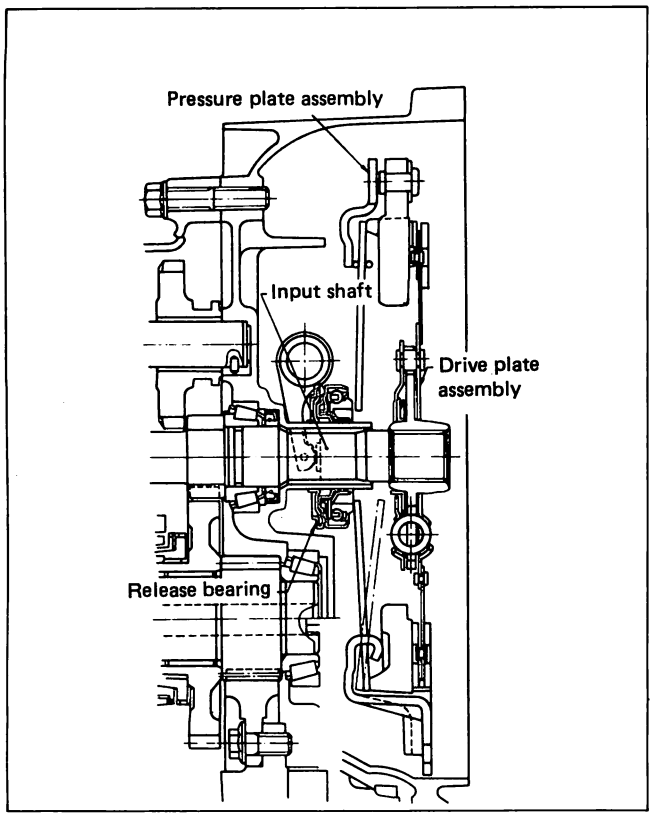
Twin-plate clutch

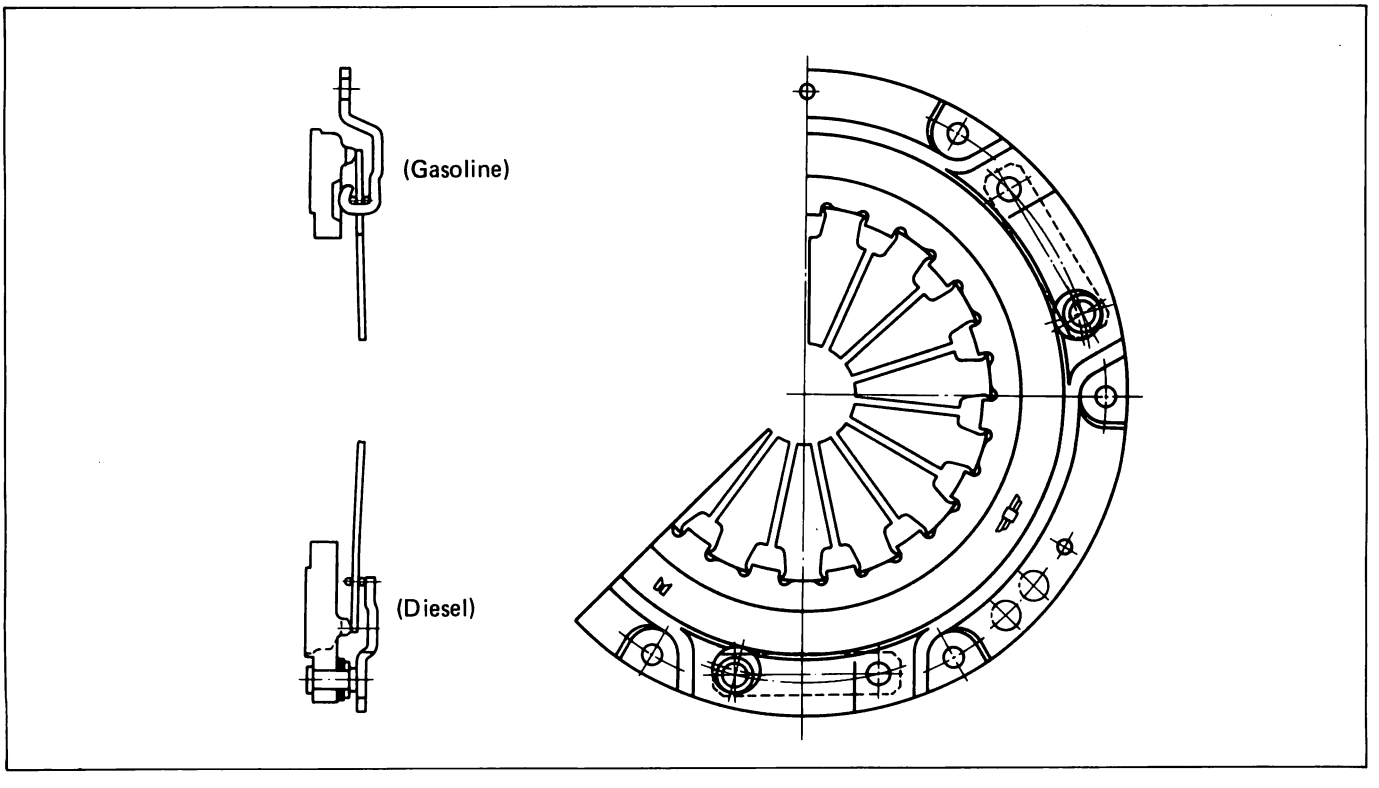
The multi-plate clutch consisting of a plurality of drive plates and driven plates that are arranged alternately. Then can be made small in diameter to transmit a relatively high engine torque, as the total friction face is increased.

The Spicer Clutch (twin-plate) which belongs to this type, is employed for certain Isuzu heavy-duty vehicles. The Spicer Clutch, a pull type clutch, is one in which the release bearing is pulled away from the flywheel to effect disengagement.

(See Twin plate type training manual.)

Single plate clutch (Diaphragm type clutch spring)





SECTION 2

MAIN DATA AND SPECIFICATIONS OF SINGLE-PLATE CLUTCH

Vehicle Model	Clutch Size (inch)	Pressure Plate		Driven Plate		Shift Fork	Control System
		Drive Method	Clutch Spring	Number of Damper spring	Facing Material		
JT	184 (7.25")	Strap Drive	Diaphragm Spring	4	Semi Mold	Withdraw Lever	Cable
JT JJ KB TF	200 (8")	Strap Drive	Diaphram Spring	4	Special Woven	Withdraw Lever	Cable
				4(rubber) + 2(coil)	Semi Mold		
JR, JJ KB, UBS TF,WFR	215 (8.5")	Strap Drive	Diaphragm Spring	6	Semi Mold	Withdraw Lever	Cable or Hydraulic
JR, TF KB, UBS	225 (8.9")	Strap Drive	Diaphragm Spring	6	Semi Mold	Withdraw Lever	Hydraulic
UBS NHR, NKR WHR,BL	240 (9.5")	Strap Drive	Diaphragm Spring	6	Semi Mold	Withdraw Lever	Hydraulic
NKR NPR	260 (10.2")	Strap Drive	Diaphragm Spring	6	Semi Mold	Withdraw Lever	Hydraulic (OPT) with vacuum servo
NKR NPR BE	275 (11")	Strap Drive	Diaphragm Spring	6	Semi Mold	Withdraw Lever	Hydraulic (OPT) with vacuum servo
NPR FSR	300 (12")	Strap Drive	16 Coil Springs	12	Semi Mold	Withdraw Lever	Hydraulic
FSR MR	325 (13")	Lug Drive	9 Coil Springs	6	Semi Mold	Shift Lever Shaft	Hydraulic
		Strap Drive	12 Coil Springs	6 x 2		Withdraw Lever	
FTR, FVR H Series LR MT, LT	350 (14")	Lug Drive Strap Drive	12 Coil Springs	6	Semi Mold	Shift Lever Shaft	Hydraulic or Hydraulic with Mini Pack
FVR FVM/Z	380 (15")	Strap Drive	Coil springs	6	Semi Mold	Shift Lever Shaft	Hydraulic with Mini Pack
C Series E Series D Series	410 (16")	Lug Drive	10 Coil Springs	12	Semi Mold	Shift Lever Shaft	Hydraulic with Mini Pack
			10 x 2 Coil Springs				
CJR, CHR		Strap Drive	16 Coil Springs	6			
C&E Series D Series MV, CQR	430 (17")	Strap Drive	12 Coil Springs	6 x 2	Semi Mold	Shift Lever Shaft	Hydraulic with Mini Pack

Remark ; (OPT) ... OPTION

SECTION 3

CONSTRUCTION AND OPERATION OF SINGLE-PLATE CLUTCH

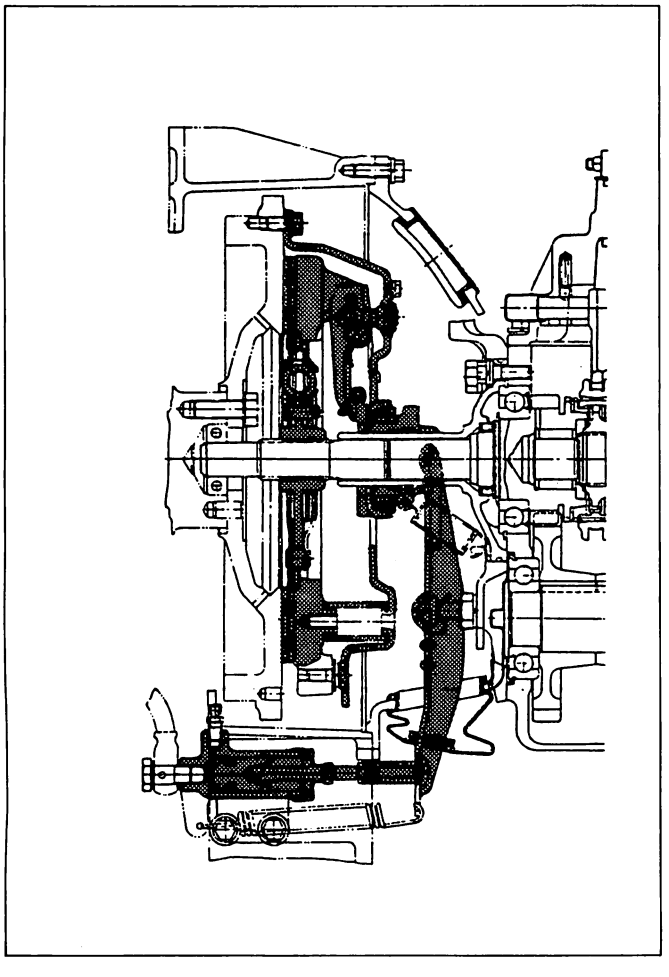
OUTLINE OF CONSTRUCTION

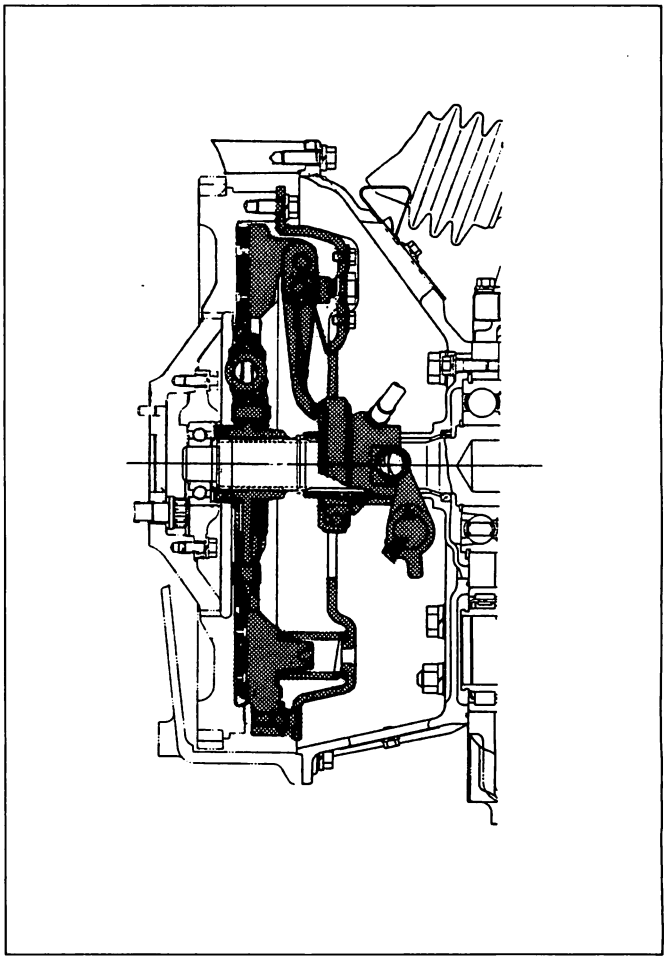
Clutches for vehicles are classified as follows according to construction:

COIL SPRING TYPE

	Driven plate	Clutch spring	Drive method	Shift fork	Clutch control
Medium & Heavy duty vehicle	Dry single-plate	Coil spring	Strap drive or Lug drive	Withdraw lever or Shift lever Shaft	① Cable ② Hydraulic ③ Hydraulic with Mini-Pack

This type employs the coil spring for clutch spring and usually has the withdraw lever or shift lever shaft. The clutch control is cable type, the hydraulic or hydraulic with Mini-Pack (power booster).

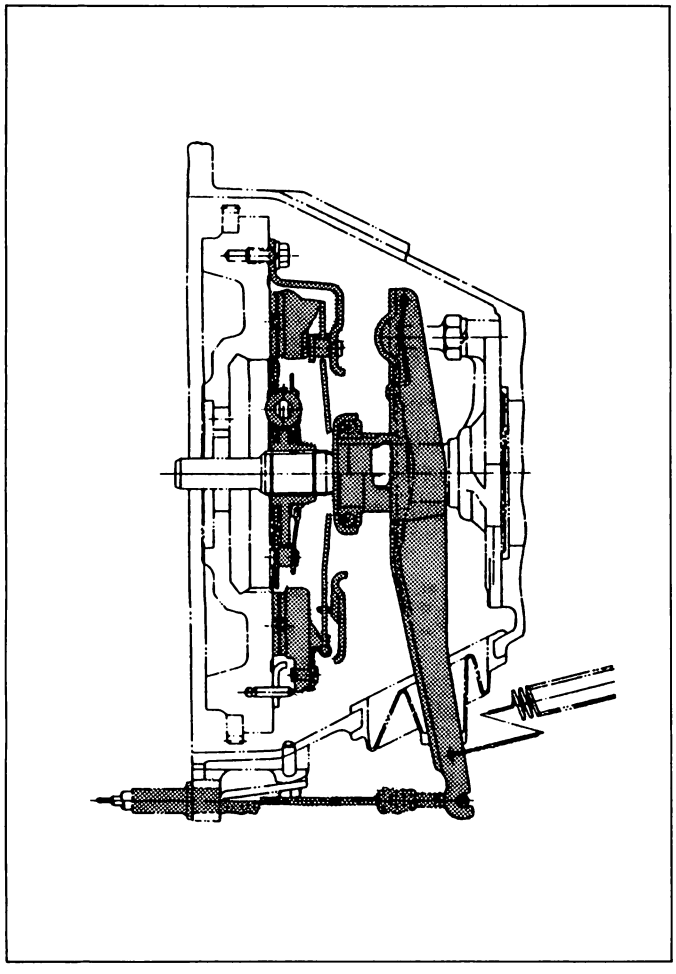




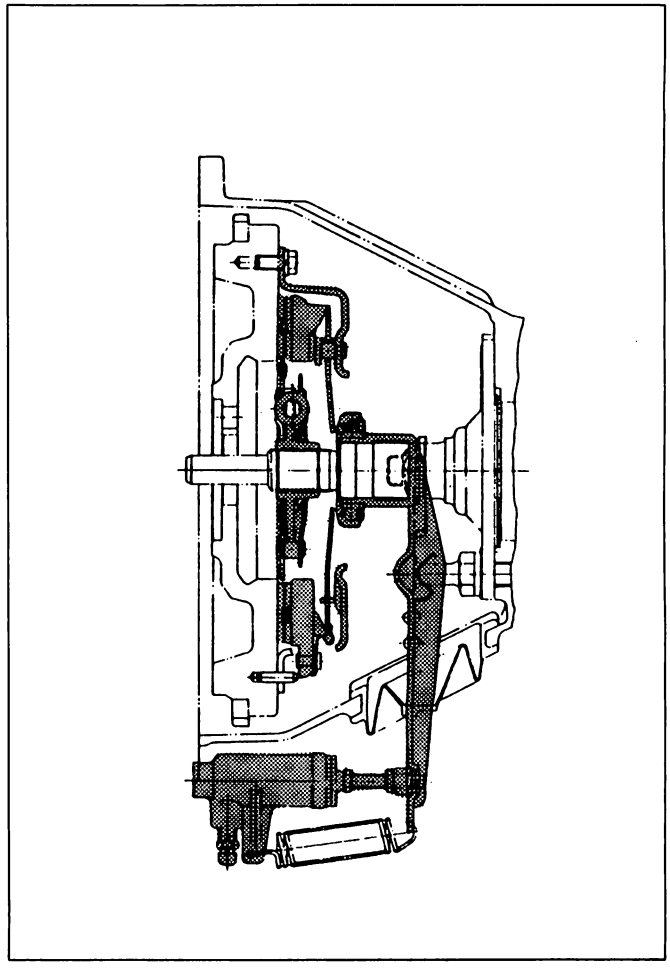
DIAPHRAGM SPRING TYPE

	Driven plate	Clutch spring	Drive method	Shift fork	Clutch control
Passenger car Pick-up and Light duty vehicle	Dry single-plate	Diaphragm spring	Strap drive	Withdraw lever	① Cable ② Hydraulic ③ Hrdraulic With vacuum booster

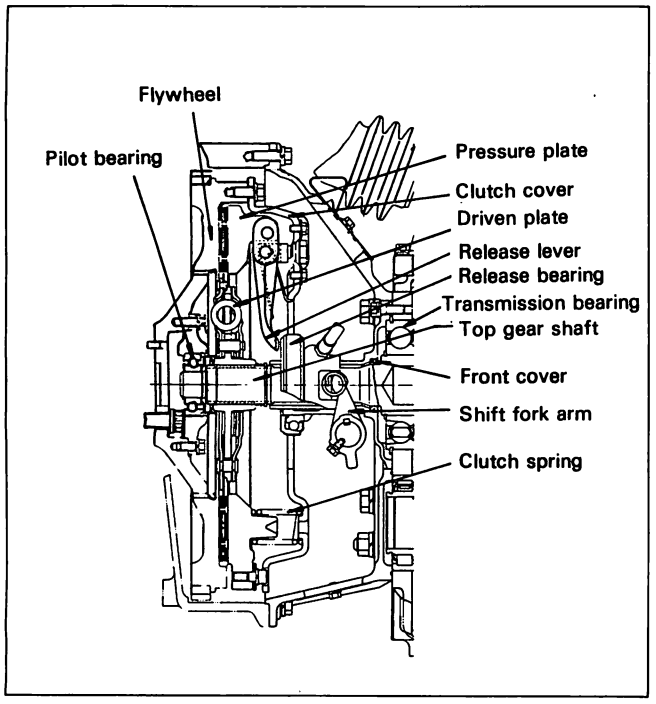
This type employs the diaphragm spring for clutch spring and usually has the withdraw lever. The clutch control is cable control type, hydraulic control or hydraulic control with vacuum booster.

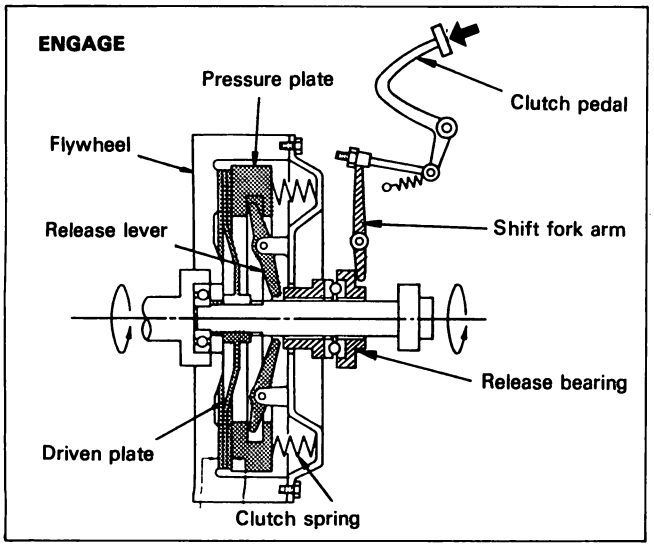


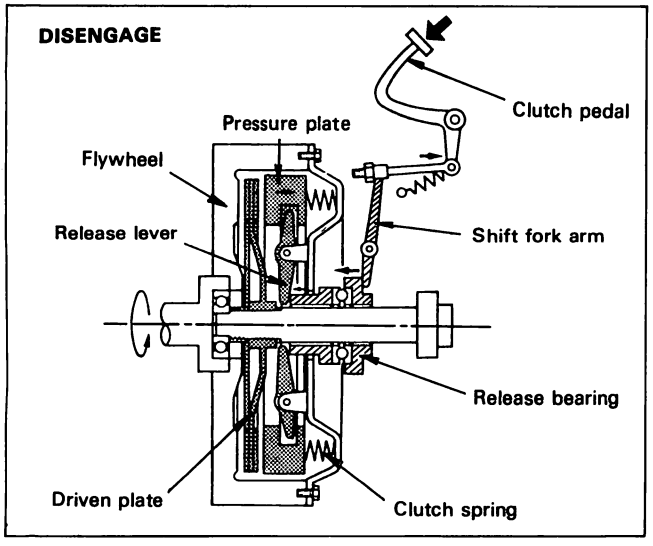
Cable control type



Hydraulic control type







OPERATION

COIL SPRING TYPE

Construction

The pressure plate assembly is composed of a clutch cover and a pressure plate, with the clutch springs mounted inside. The whole assembly is fixed to the engine flywheel.

The front end of the top gear shaft assembly is supported by the pilot bearing of the crank shaft and the rear end is supported by the transmission bearing.

The driven plate assembly is splined to the top gear shaft and can slide freely on it. The driven plate is installed between the flywheel and the pressure plate and is held by the pressure plate, under the pressure of the clutch spring.

The release bearing assembly is located on the front cover and can slide freely when operated by the shift fork arm.

Operation

Engage

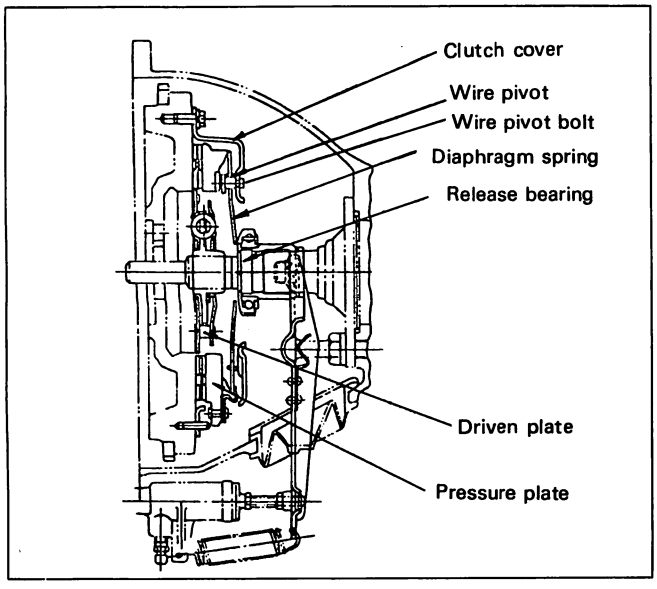
When the clutch pedal is released, the driven plate is forced to the flywheel by the pressure of the clutch springs. This transmits the power of the engine, via the friction of the facing of the driven plate, the pressure plate and the flywheel.

Disengage

When foot pressure on the clutch pedal is applied to the clutch by the shift fork arm, the release bearing is pressed to the face of the flywheel. This moves the pressure plate by leverage toward the transmission, overcoming the resistance of the clutch springs, and freeing the driven plate allowing disengagement of the clutch.

DIAPHRAGM SPRING TYPE

Construction

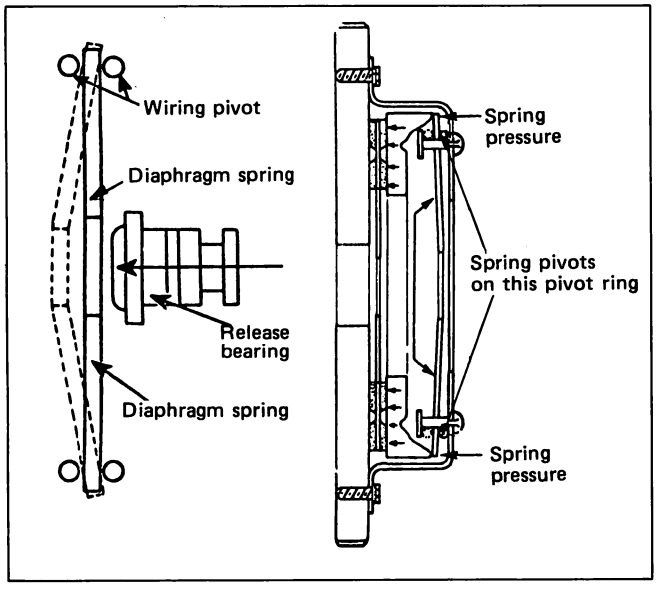


The diaphragm spring serves not only as clutch springs but also as release levers.

The diaphragm spring has wire pivots on both sides and is fixed to the clutch cover by a wire pivot bolt. The outer periphery of the spring is secured to the pressure plate.

The other parts are not mentioned, because they are the same as the previously described release lever type.

Operation



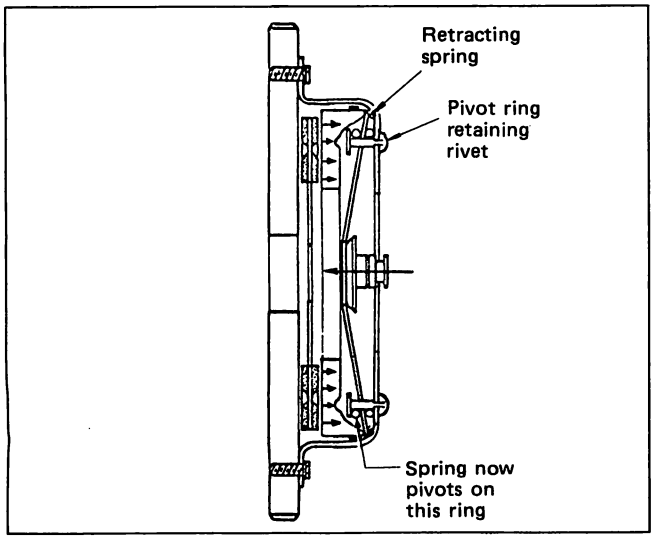
Engage

When the release bearing applies pressure to the diaphragm fingers, the entire diaphragm is bent inward. The action can be compared with the action of squeezing the bottom of an oil can. The inner wire pivot prevents the outer edge of the diaphragm from moving inward, so when the center of the diaphragm is pressed inward, the outer edges pivot outward. When the fingers are released, the diaphragm resumes its original position.

The illustration on the left demonstrates this diaphragm action.

The dotted line shows the diaphragm in the disengaged position.

Notice how outer edge moves back and forth, depending on the position of the fingers.



Disengage

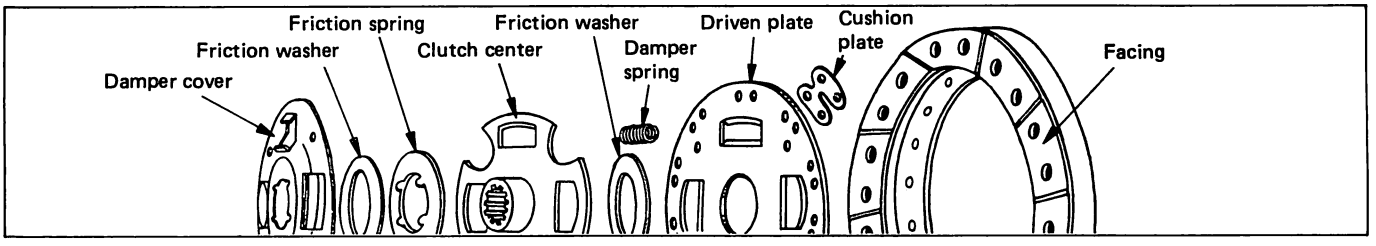
First the release bearing presses the fingers in. The diaphragm then pivots on the inner pivot ring, and the outer edges lift the pressure plate away from the clutch driven plate. The clutch driven plate is freed and the clutch is disengaged.

The release bearing bents the clutch diaphragm fingers inward. This pulls the outer edge back, retracting the pressure plate and leaving the driven plate free.

MAIN PARTS

(1) Driven plate

The driven plate assembly consists of the parts illustrated in the drawing.
The clutch center and damper springs are positioned between the driven plate and damper cover and are riveted together. The clutch center transmits the engine torque to the damper cover through the damper springs.
The friction washer and friction spring are assembled to the clutch center.



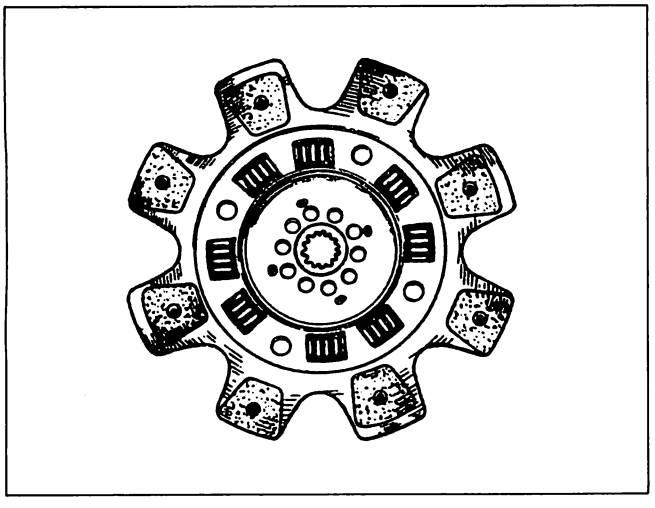
Facing

The facing is riveted to both sides of the cushion plate, and this influences the life of the clutch disc, due to wear and vibration at contact surface of the clutch as well as wear in the corresponding materials. The characteristics required of the facing are as follows:

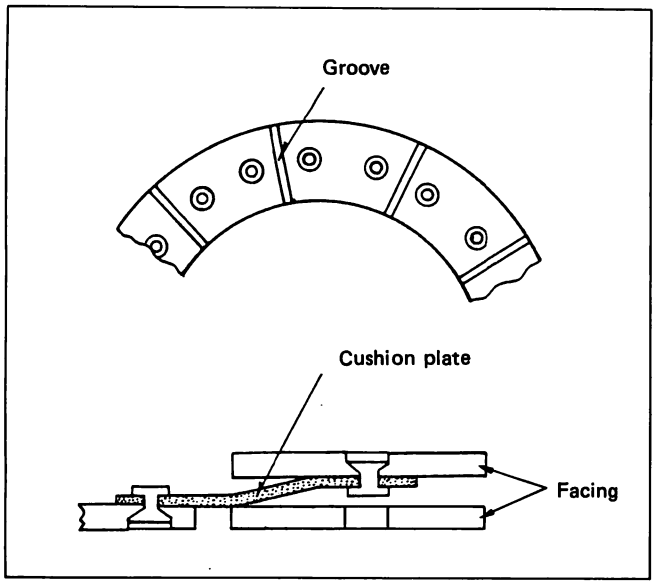
1) Transmit engine torque without excess slippage.
2) High resistance to wear.
3) High mechanical strength.
4) High friction coefficient.
5) High resistance to heat.
6) Excellent tolerance to water and oil.

Characteristics of facing materials.

Classification of material	Composition of material	Material compound	Load applicable	Resistance to wear	Resistance to heat	Engagement shock
Asbestos	Woven or Semi Mold	Thermosetting resin	Medium Heavy	High	High	○
Cerametallic	Copper	Ceramics	Heavy	Excellent	Excellent	△



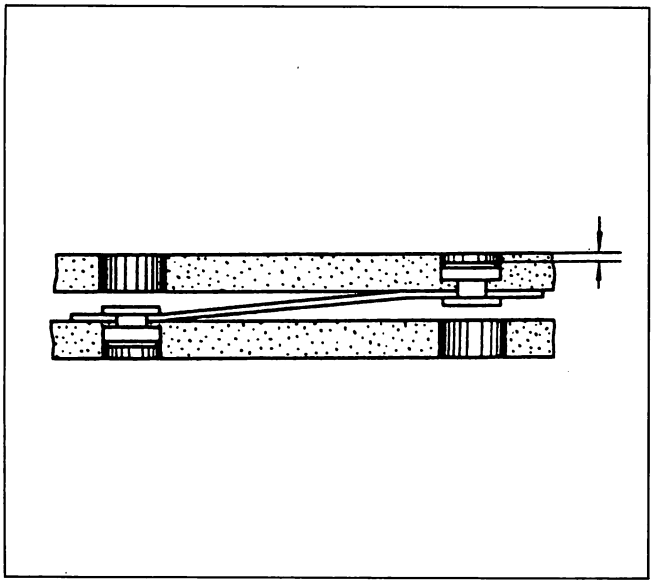
Cerametallic is composed of copper and ceramics. The different types available are compound, pressure-molded and sintered. Therefore, this material is stable against temperature in the same way as the other sintered materials. This material is composed mainly of metal. As the rotative inertia of the clutch increases its influence on the performance and the life of the synchromesh rings in the transmission increases. However this material is high in mechanical strength and can be used by divided it into several segments on the periphery of the facing. This type is rarely employed for buses and heavy duty trucks.



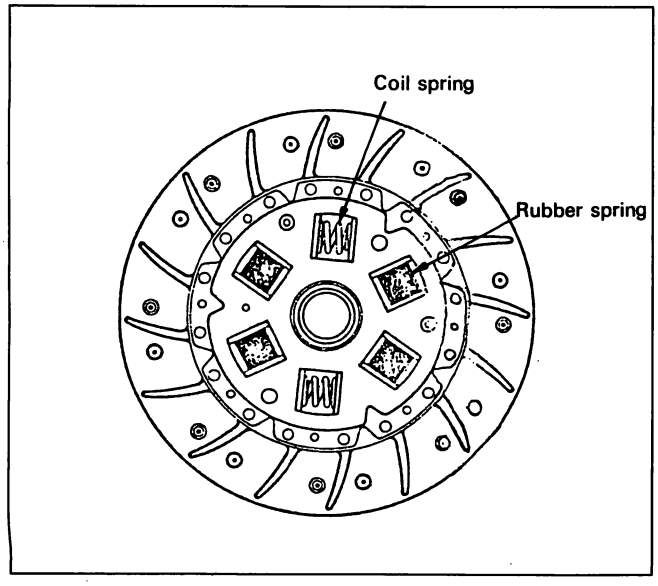
Cushion Plate

To bring the friction face of the driven plate into equal contact with the mating face when the clutch is engaged, the facing is divided into several segments by grooves cut radially into the facing.

For greater assurance of equal contact, and to make the engagement smooth, cushion plates are used.



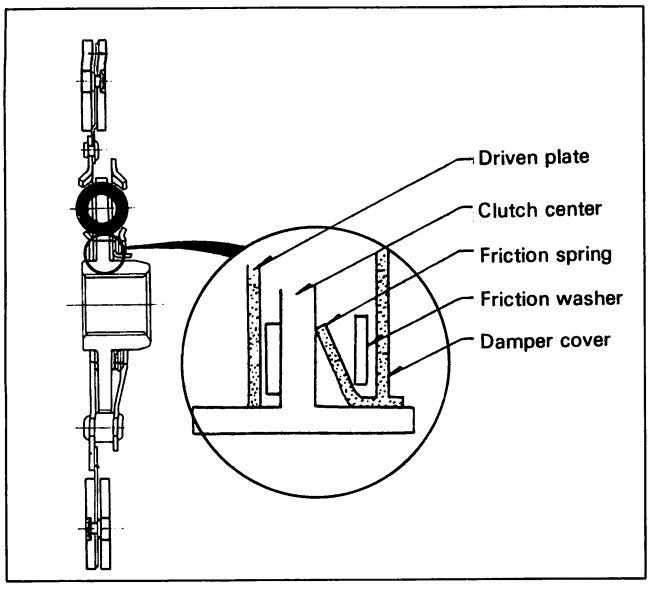
Replace the driven plate assembly if the facing wear is excessive and depression of the rivet heads is beyond the allowable limit. Also if the rivets are loose and rivet holes have been enlarged excessively, the driven plate must be replaced. These symptoms are the cause of clutch vibration or noise.



Damper spring

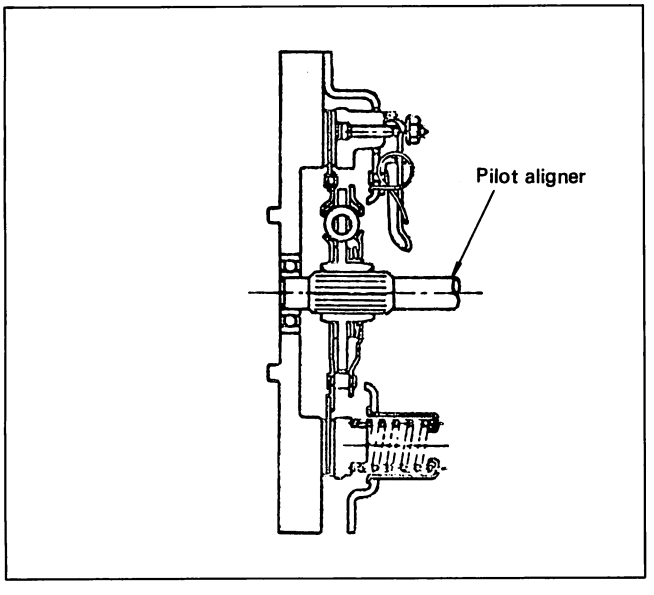
The damper springs are adapted to deaden the shock load produced by the rotative force of the clutch when the clutch is brought into engagement. They also are intended to soak up road shocks carried up to the clutch when the road wheels encounter a bump in the road.

Regarding model PFD (passenger car) a damper spring assembly consisting of two coil springs and four heat resisting synthetic rubbers, is employed to reduce noise caused by variations in speed.



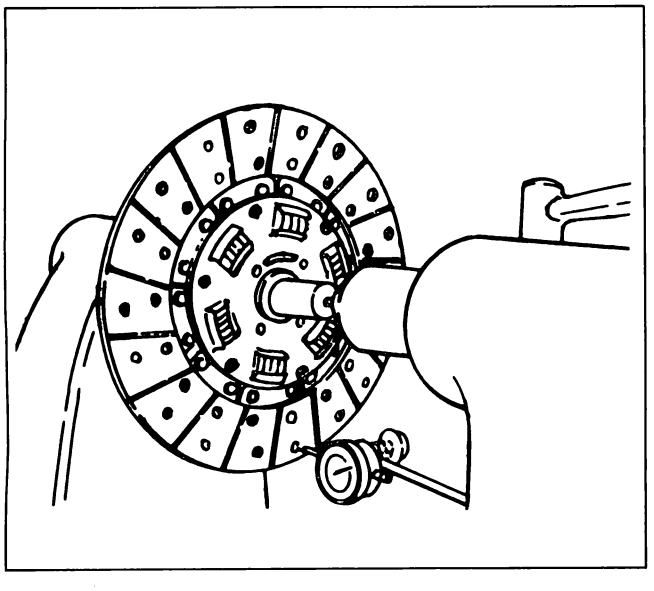
Friction washer

In generall, the springs invite self-oscillation when a load imposed on them is removed. Self-oscillation of the damper spring may result in cracked cushion plates, loosened rivets, sagged or broken damper springs, which can lead to clutch failure. To minimize this self-oscillation through the effect of mutual friction resistance, friction washer and friction springs are placed between the clutch center and damper cover.



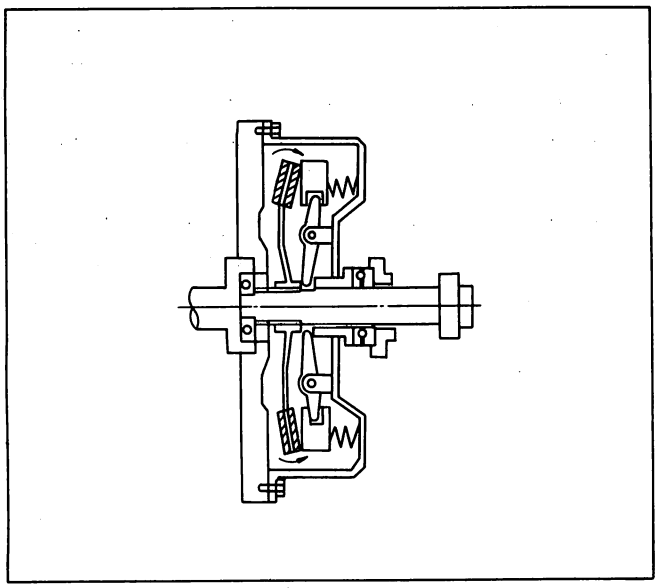
Importance of inspection

When installing the driven plate, make sure to use the special tool available (Clutch pilot aligner).



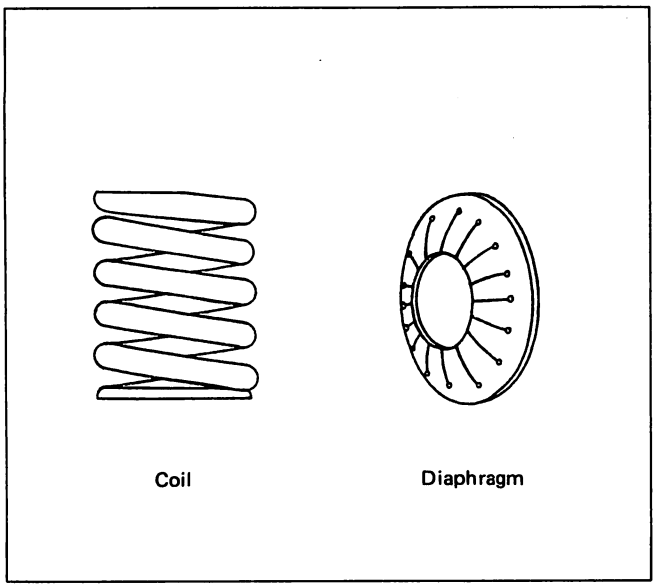
When using this tool, examine the clutch facing for distortion in the following manner. (This will be the cause of the clutch being not releasing properly.)

Put the test bar through the splines and turn the facing on a lathe or other suitable machine by hand. Rectify minor distortions if possible. Replace the parts if the distortion is beyond repair. Measure the play in the spline in the rotative direction at the periphery of the plate and replace the top gear shaft or the driven plate if the play is beyond the allowable limit.



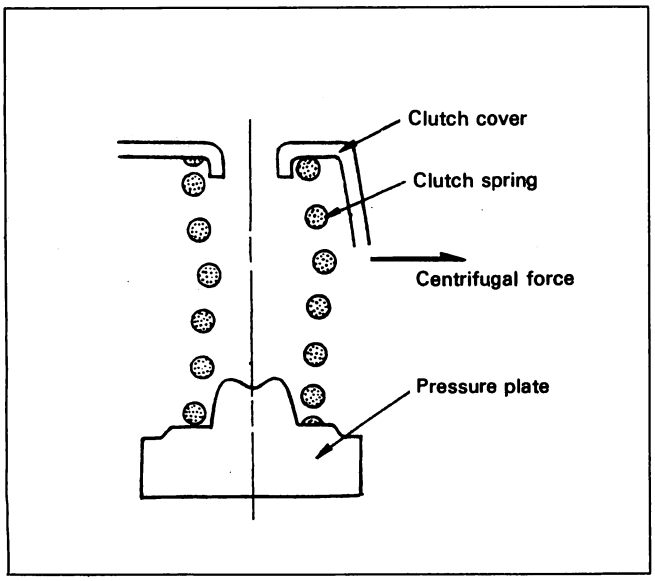
Conical type driven plate

The conical type is the driven plate which has also a facility of conical spring and prevents its facing from sticking to the flywheel. It is employed in the current model and this means that the clutch assister is no longer required.
This type is employed for almost of the 12" to 17" clutches.



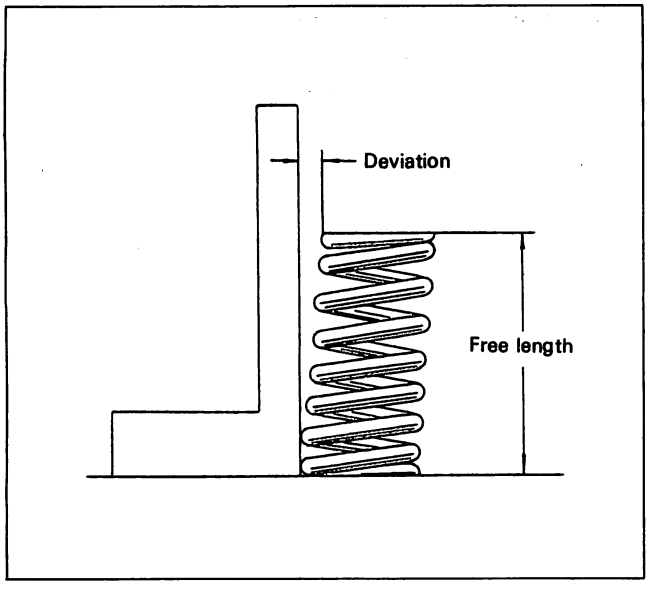
(2) Clutch spring

The clutch springs are assembled under compression between the clutch cover and the pressure plate. They press the driven plate equally, and the force of the clutch spring has a great influence on the performance of the power train.
Generally coil springs or a diaphragm spring is employed for the clutch spring.
Some clutches have two kinds of coil springs, putting one upon another to get the required force.



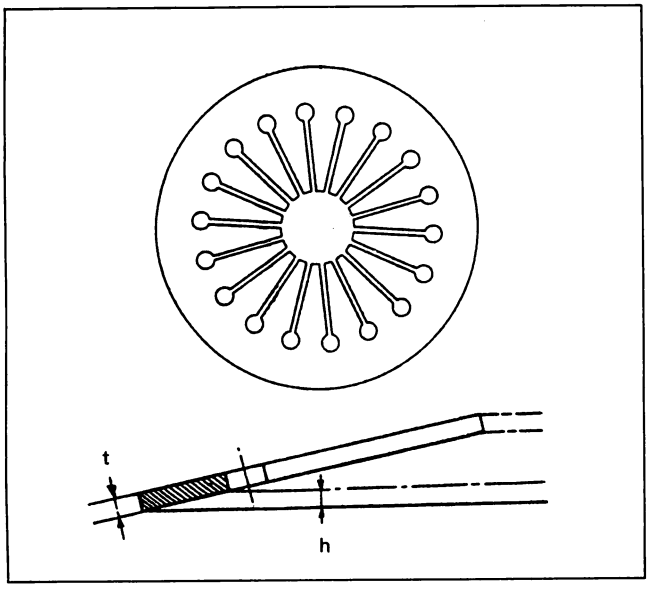
Coil spring

The compression coil spring is normally used as a clutch spring. As the clutch uses several coil springs, the free length, (the lengths at fitting) and the spring forces must be equal.
The spring constant remains unchanged. Therefore a strong force is required for releasing. As the friction surface of the facing, the pressure plate and the flywheel wear, the strength of the spring force changes. However, the coil spring is not suitable for use in a clutch which is subject to high-speed operation, as, if the rotative speed of the clutch is increased, it causes the coil spring to deflect outward, thus allowing the spring load to decrease.



Check the springs for distortional sagging and damage and replace, if any of the following conditions exist: The free length, the fitting load required or the deviation from the vertical are outside the allowable limits.

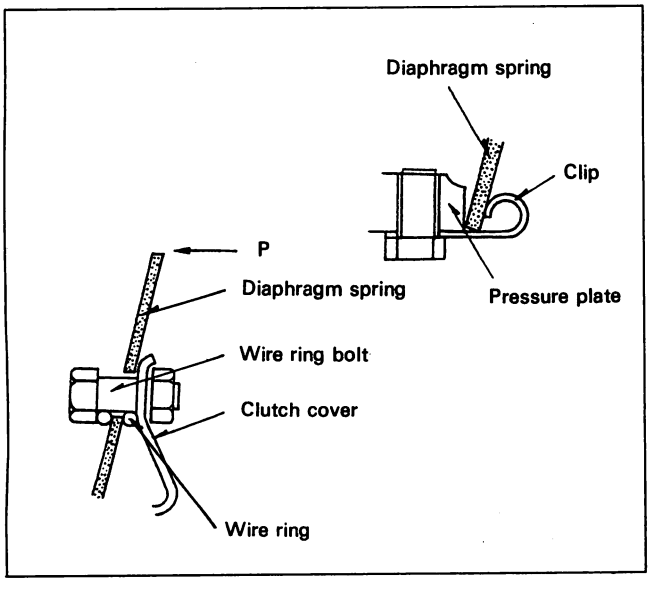
When changing the clutch springs, all springs should be replaced to ensure that an even pressure is applied.



Diaphragm spring

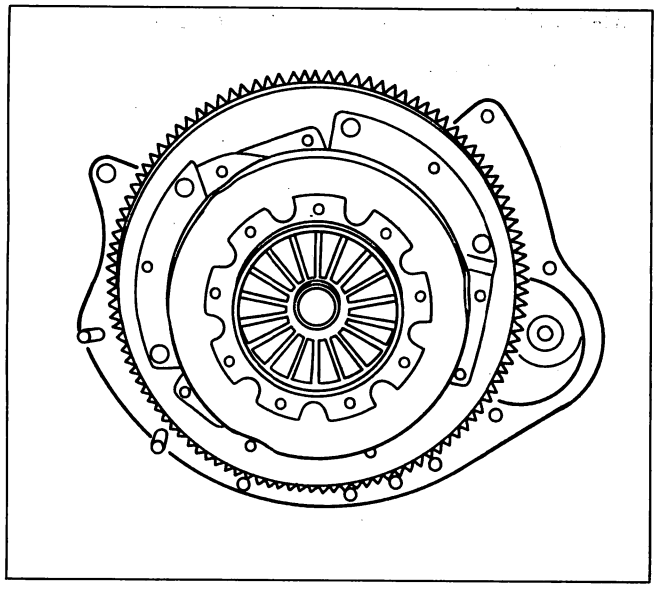
The diaphragm spring is increasingly used in high-speed automobiles as the clutch spring.

A desirable spring constant range can be obtained by carefully determining the thickness and height of the diaphragm. From the construction aspect, it should be noted that the diaphragm spring serves not only as a clutch spring but also as release levers.



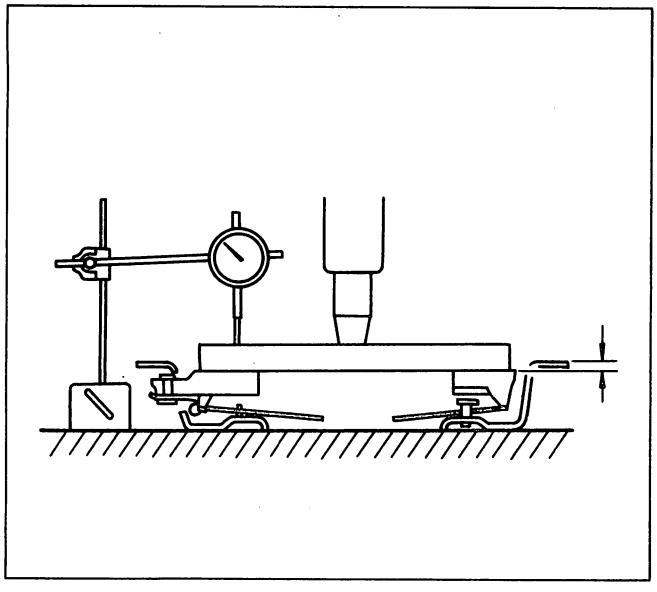
The intermediate part of the diaphragm spring is bolted to the clutch cover through wire rings attached to both sides of the spring, while the outer periphery of the spring is secured to the pressure plate.

When pressure is exerted inwardly on the inner periphery of the diaphragm spring, it forces the entire spring against the wire rings, causing the outer periphery of the diaphragm to flex outward, thereby moving the pressure plate away from the flywheel.

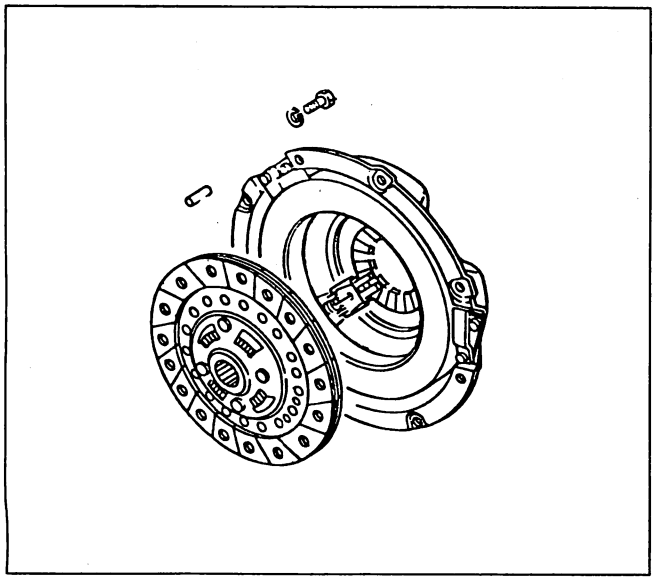


- **Features of diaphragm spring**

1) Stable against variation in spring load even when subjected to high speed operation.
   Unlike the coil spring, the diaphragm spring is not affected by centrifugal forces created through high-speed rotation, and hence the spring load remains unchanged.
2) Release lever floating is eliminated.
   Release levers are not required as the diaphragm spring itself serves as the release levers.
3) Force required to disengage the clutch is small.
4) Spring load imposed on clutch components remains unchanged even when the facing is worn.



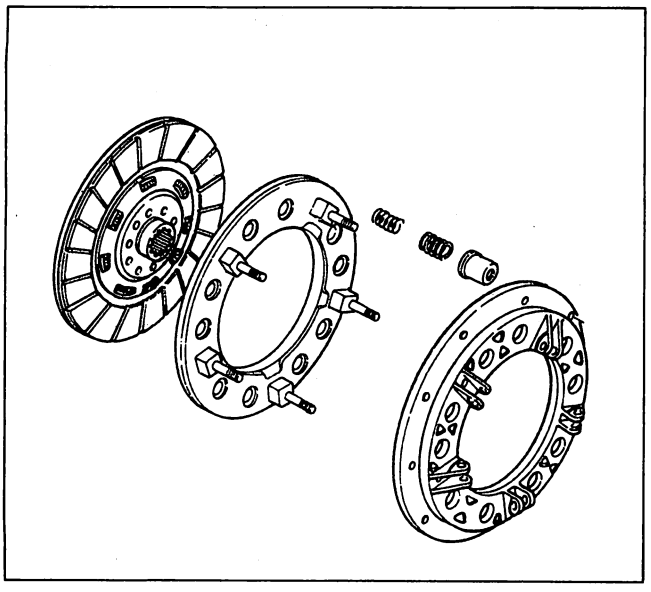
If the fingers of the diaphragm spring are checked for alignment and the amount of misalignment is found to be considerable, replace the entire assembly, as a worn out pressure plate will cause clutch noise.



(3) Pressure plate

The pressure plate which is normally made of pearlite cast iron should have sufficient thickness to maintain pressure on the contacting face at a constant level through a reduction in heat deformation.

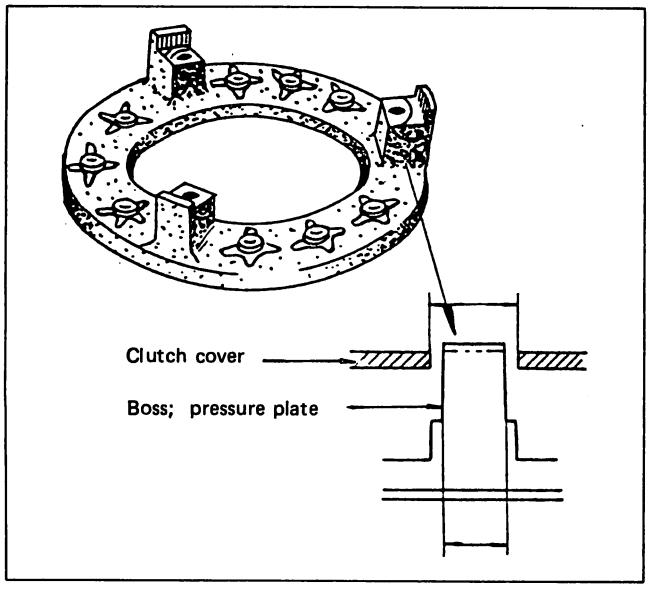
The pressure plate should be dynamically balanced, as it normally rotates with the flywheel.



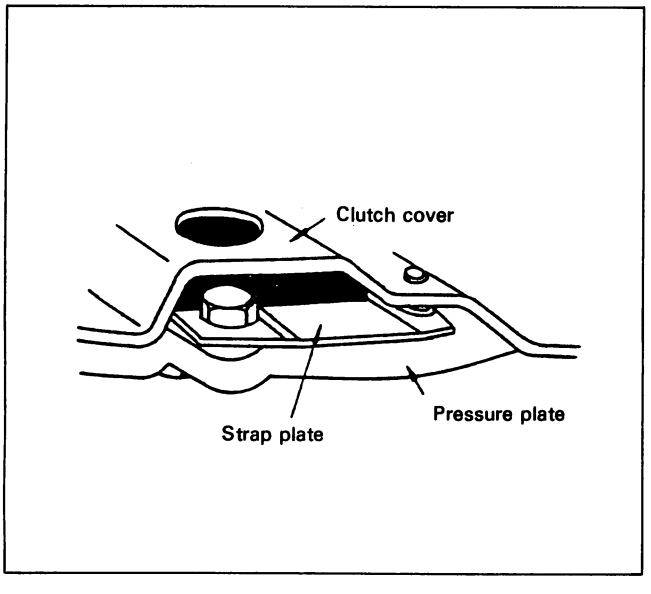
Method of engine power transmission

- **Lug drive type**

According to the method generally applied, the projection on the pressure plate is fitted into a hole in the clutch cover to permit a sliding motion of the pressure plate in the axial direction. As this type of the clutch relies upon the friction of the facing material for transmitting the engine torque, the friction material is liable to wear, causing the disengagement operation to become uneven if engine torque increases excessively.

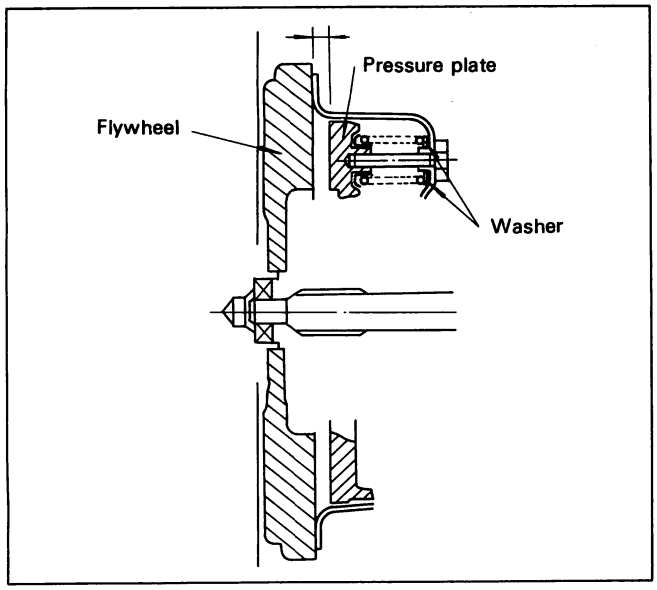


If the clearance between the bosses on the pressure plate and the square holes in the clutch cover is beyond the allowable limit, check for wear in the parts, and replace either the pressure plate or the clutch cover which ever has the higher rate of wear, as this will cause clutch noise.



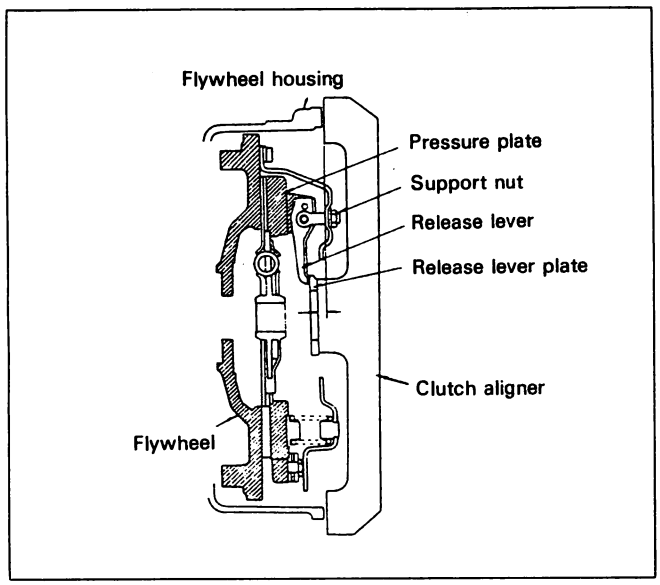
- **Strap drive type**

In a certain type of clutch, the clutch cover is connected with the pressure plate by means of strap plates, the deflection of which is utilized to move the pressure plate in an axial direction, thereby allowing the clutch to engage and disengage. The mechanical arrangement of the clutch ensures positive transmission of engine torque as the pressure plate is prevented from slipping on the clutch cover when the pressure plate is brought into engagement with the mating surface.



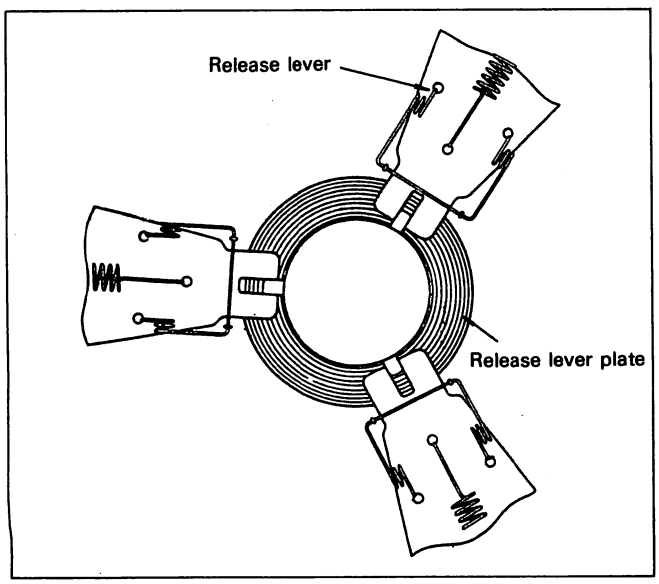
Excessive wear on the friction face of the pressure plate and the flywheel causes clutch releasing difficulties. This can be corrected either by grinding or by replacement.

Machining the friction face of the pressure plate, or the flywheel will lower the tensile force exerted by the clutch springs. If more than 1mm of the material is removed from either the pressure plate or the flywheel through machining, a spacer washer should be installed behind each clutch spring to compensate for the reduction in tensile force of the clutch springs.

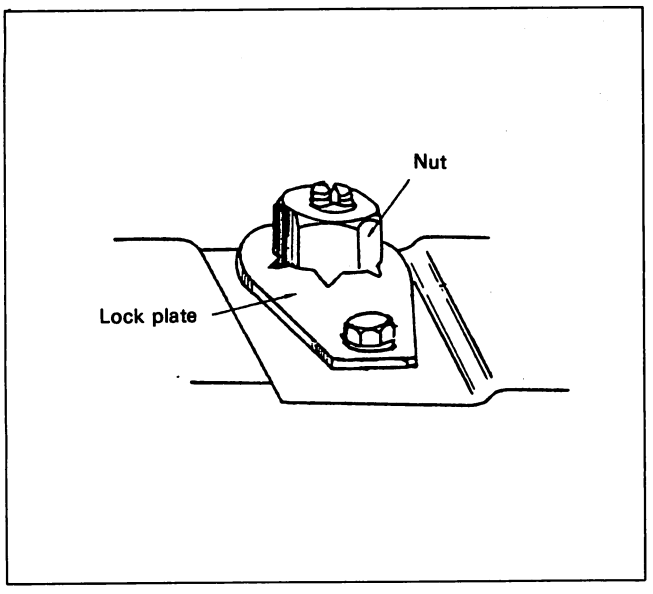


(4) Release lever

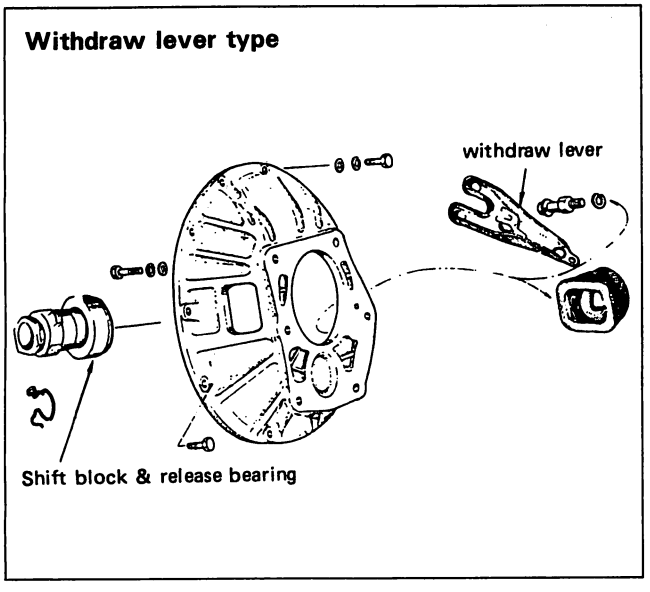
When adjusting the height of the release lever, apply a clutch aligner to the end face of the flywheel housing and adjust the support nuts so that clearance between the release plate and projected center of the aligner is zero for all release lever. If the heights of release levers are unequal, it will cause clutch slippage or improper clutch release.



For some clutches in the 9 to 10-inch range old type, a release lever plate is employed. The material used for this type of release lever is simply steel plate, and therefore liable to wear.



A lock plate is used to hold the release lever support nut.

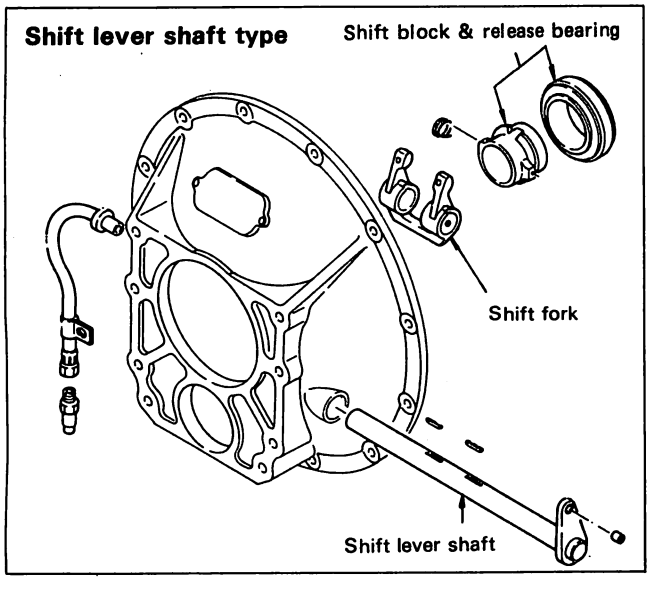


(5) Shift fork and shift block

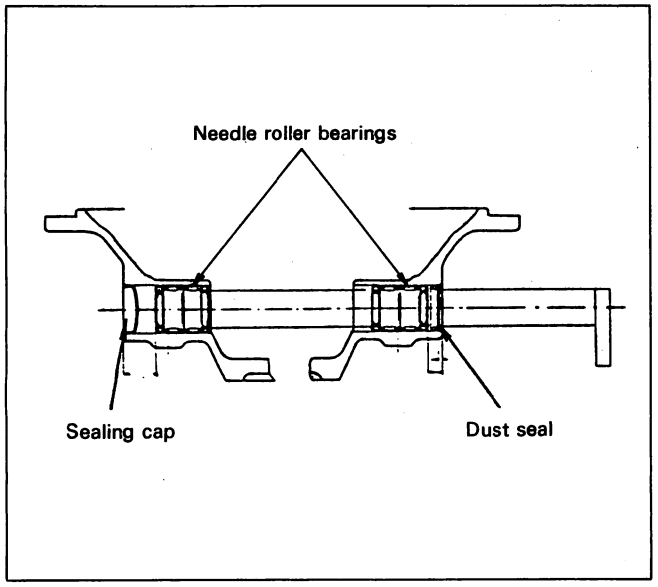
There are two types; the withdraw lever type, the shift lever shaft type.

The shift block and the release bearing, which employs a greased ball bearing are both are installed on the front cover of the transmission.

The shift fork, which is operated by foot pressure through linkages, moves the shift block and the release bearing, and this moves the release lever or the diaphragm spring in the axial direction.

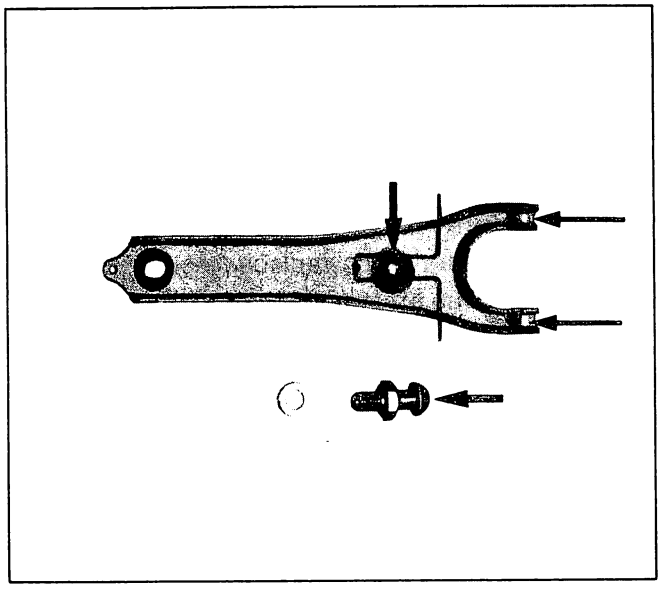


The shift lever shaft is supported on both sides by needle roller bearings, and one is fitted with an oil seal on the shift lever side (clutch Mini-Pack side). This is operated by a force from the Mini-Pack through the shift fork attached to the shift lever shaft, which moves the shift block and the release bearing.

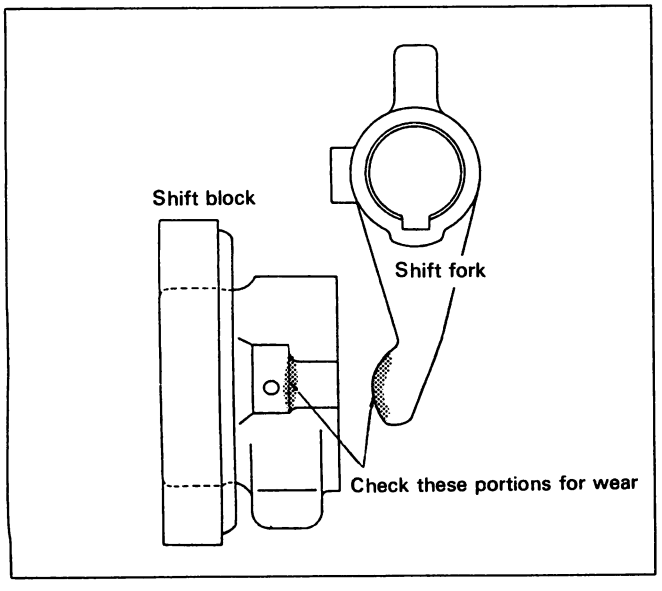


Inspection for wear

If uneven wear or step wear is noticeable, replace the shift fork, together with the needle roller bearing. During the installation of new bearings, be careful not to scratch the oil seal.



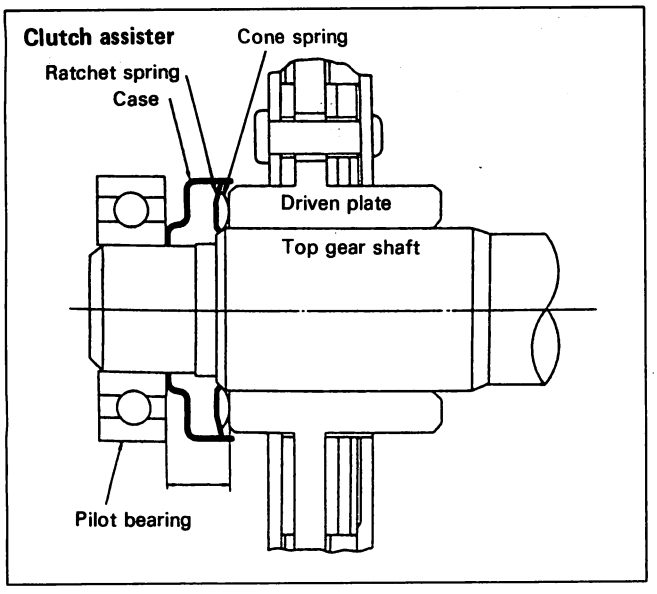
Check the faces of the shift fork in contact with the support and shift block for wear, and replace if wear is considerable.



Check the contact face of the shift fork and shift block for wear. Replace the parts if the amount of wear is in excess of 1 mm.

If a slight amount of wear is noticeable, correct this using an oil stone.

Wipe clean the release bearing but do not wash it in detergent oil as it is a special grease-sealed type.



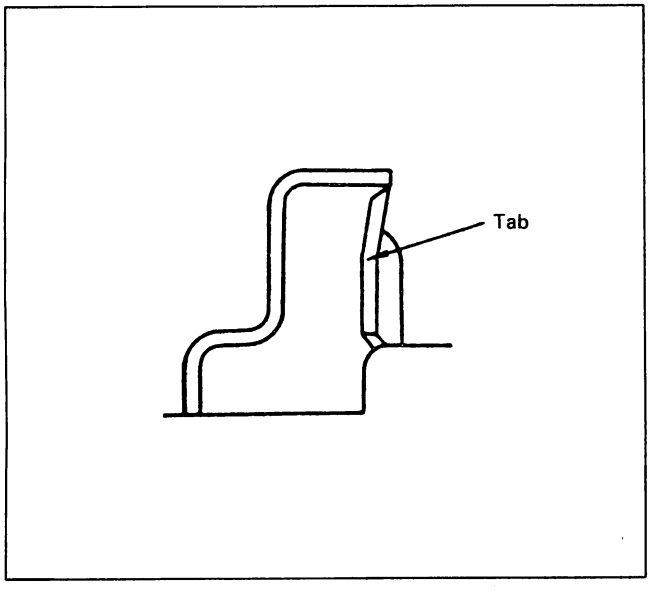
(6) Clutch assister

When the engine is running, the clutch transmits the engine power to the transmission, the pressure plate pressing the driven plate to the flywheel.

When foot pressure is applied to the clutch pedal, the pressure plate is withdrawn by the release lever. The pressure holding the driven plate is removed, allowing the clutch to disengage.

Even after the pressing force on the driven plate is removed, occasionally the driven plate sticks to the flywheel causing a disengagement malfunction. In order to prevent this trouble, a clutch assister is installed and this keeps the driven plate in the midway position when foot pressure is applied to the clutch pedal.

As the illustration, left, shows, the clutch assister is fixed between the pilot bearing of the flywheel and the clutch center of the driven plate, and removes the driven plate mechanically from the flywheel by the cone spring incorporated in it.



When the driven plate is changed the clutch assister should also be replaced and not reused by changing the attaching location of the ratchet springs.

Make sure that the ratchet springs are properly seated on the case during assembly.

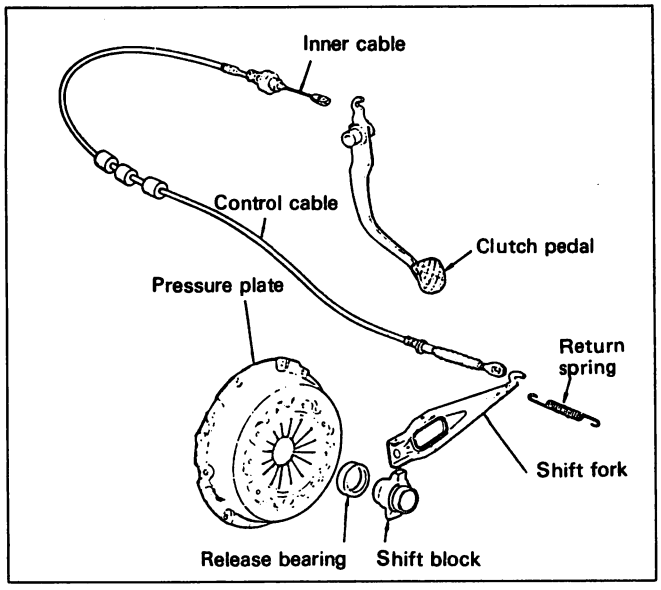
When the ratchets spring are assembled to the case, be careful that the face with chamfering on the tabs is turned inward.

The clutch assister is used for a part of 17" clutches.

CLUTCH CONTROL

Types:

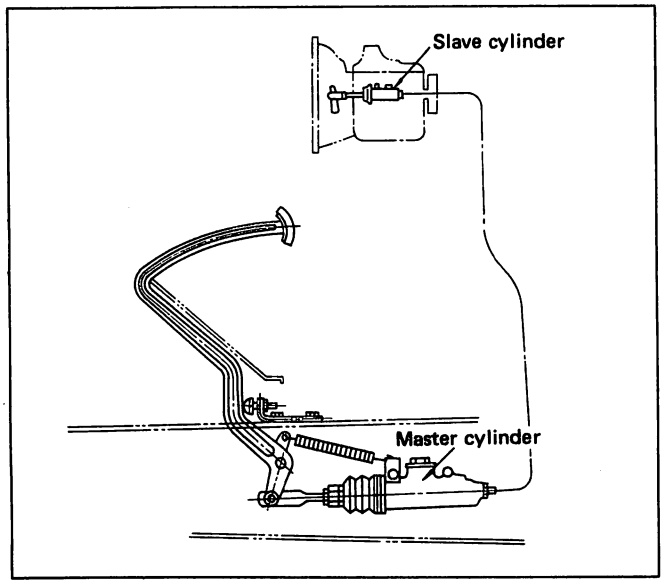
- Mechancal type
  - ① Cable type
  - Link rod type
- Hydraulic type
  - ② Hydraulic type
  - Hydraulic with power assist type
    - ③ Air pressure assist type
    - ④ Vacuum servo



① Cable type

When foot pressure applied to the clutch pedal, the center of the diaphragm spring is pressed via the cable, shift fork, shift block and release bearing thus disengeging the clutch.

When the clutch pedal is released, by the return spring and clutch spring, the shift fork and the clutch pedal return to their original position, engine power is supplied to the transmission.



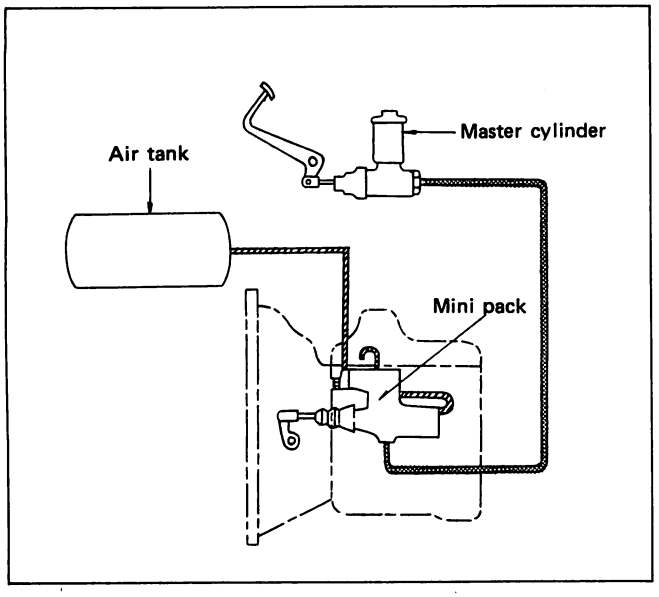
② Hydraulic type

The hydraulic system consists of the clutch pedal, master cylinder, flexible pipe, slave cylinder, shift fork, etc. It is so designed that when foot pressure applied, the clutch pedal pressure is converted into hydraulic pressure, which operates the clutch.

Master cylinder + Slave cylinder

Features:

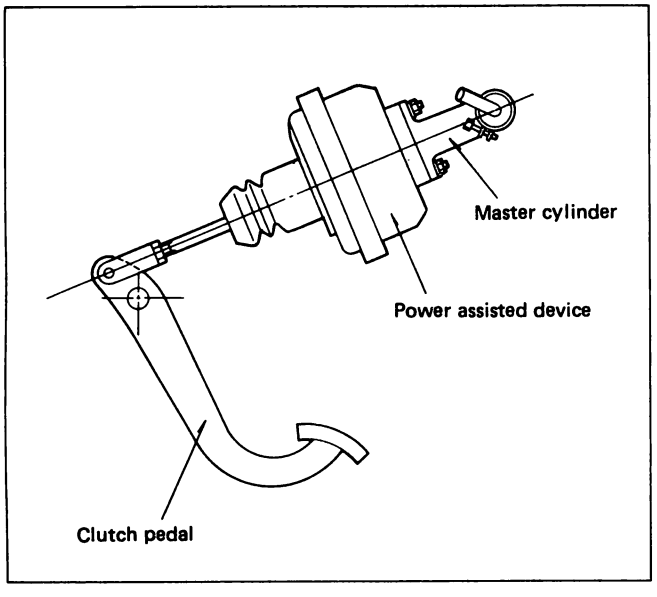
1) The foot pressure required to operate the clutch pedal can be freely controlled by carefully determining the diameters of the master and slave cylinders.
2) The vehicle cabin can be isolated from vibration originating in the clutch mechanism.
3) Location of the linkage can be selected freely.



③Hydraulic with power assist type

This is an auxiliary device attached to the hydraulic system to minimize the effort required to operate the clutch. It utilizes the difference between the compressed air pressure, and the atmospheric pressure to increase hydraulic pressure, thereby facilitating clutch operation.

Master cylinder + Mini pack



④Hydraulic with vacuum servo

The vacuum servo type clutch booster is adopted in light duty vehicle, to reduce the pedal force required to operate the clutch pedal.

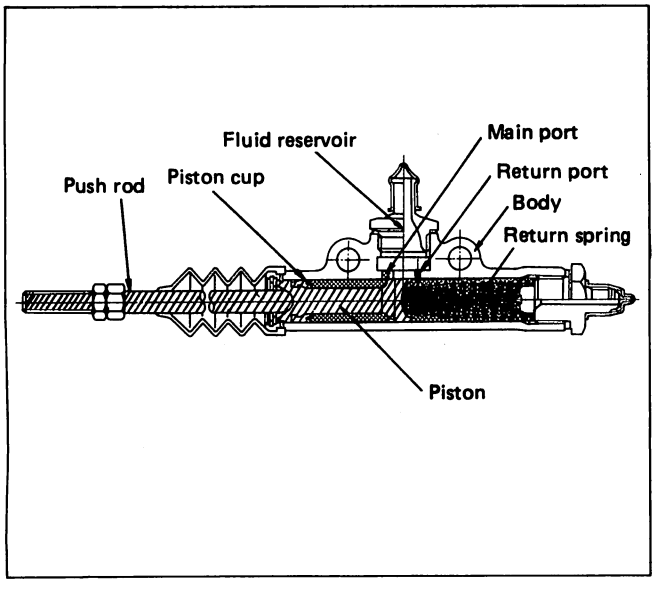
Vacuum servo with master cylinder + Slave cylinder

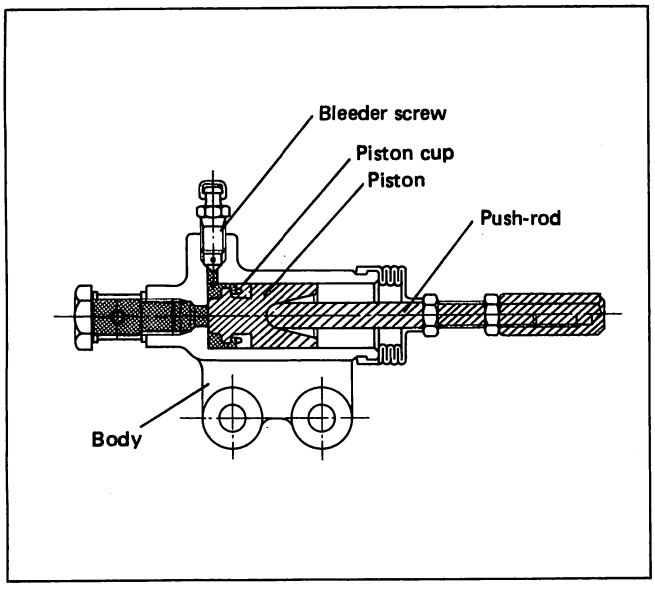
(a) Master cylinder

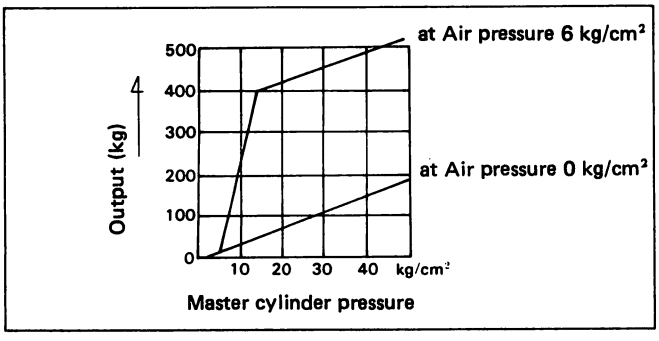
The master cylinder is a device adapted to change mechanical energy into oil pressure.

When the clutch pedal is pushed down, this causes the push-rod to move the piston fitted with a piston cup which, in turn, closes the return port, thereby forcing the fluid out of the cylinder. On release of the clutch pedal, the piston with the piston cup is forced back into the home position by the return spring, thereby opening the return port, and allowing the fluid to flow back into the fluid reservoir.

A means is provided to prevent the entry of air into the system. This ensures that when the clutch pedal is released quickly and the piston is forced back into the normal position by the return spring, the pressure of the fluid on the return spring side becomes lower than that on the push-rod side. This allows the fluid to flow into the return spring side through a port in the piston head.







(b) Actuator

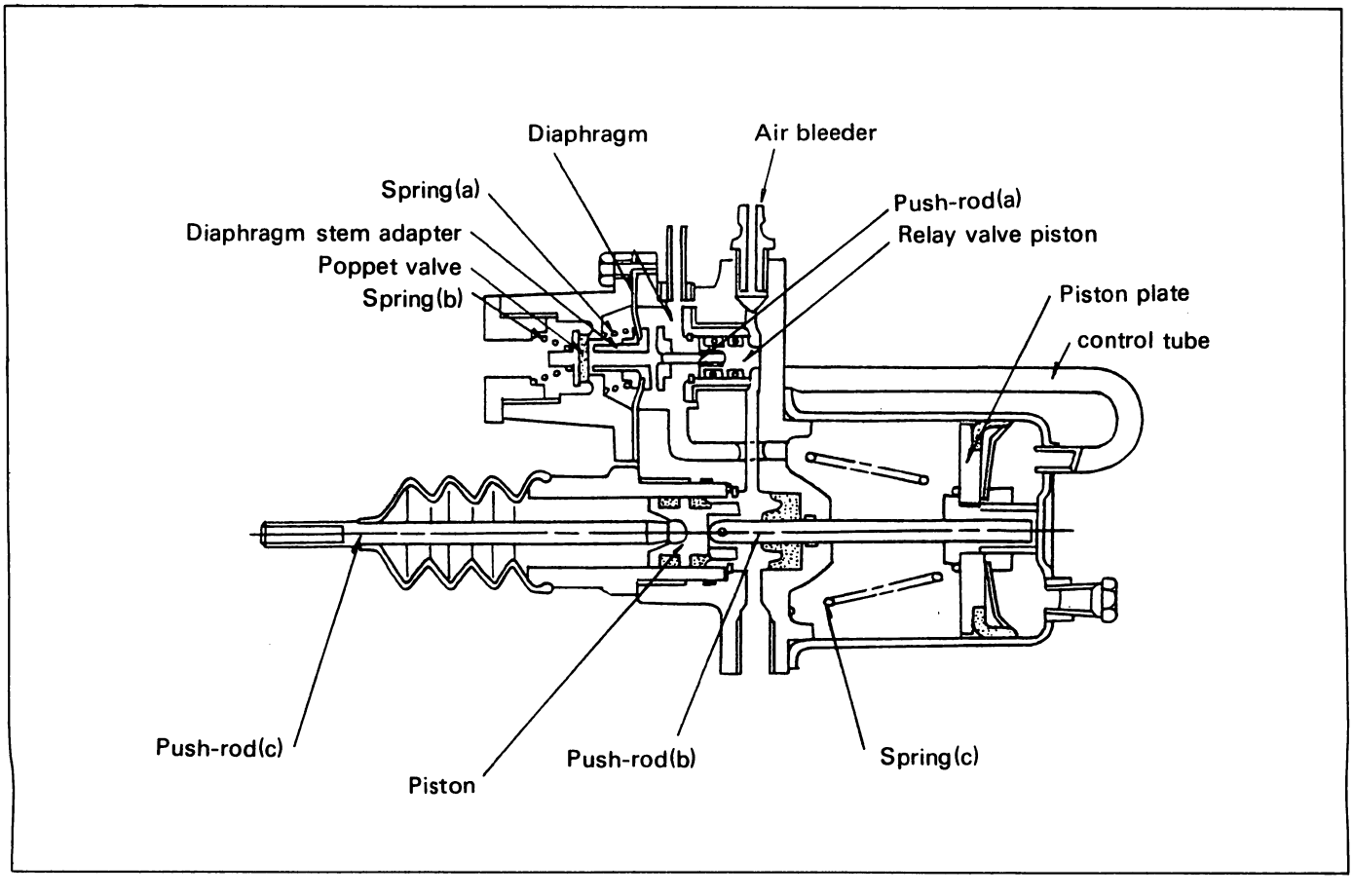
- **Slave cylinder**

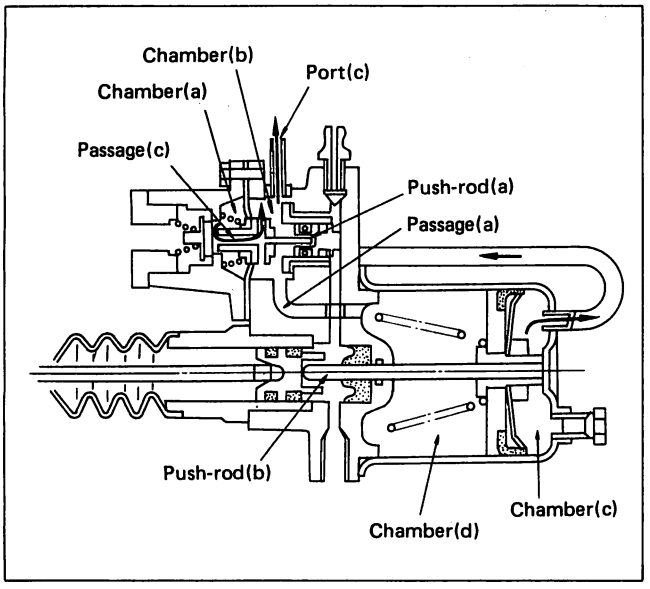
The slave cylinder is a device adapted to change oil pressure into mechanical energy.
The pressurized fluid supplied by the master cylinder moves the piston which, in turn, actuates the shift fork. To facilitate bleeding of the oil pipe, a bleeder screw is provided.

The mechanical energy that the slave cylinder produces is greatly influenced by the diameters of the master cylinder and slave cylinder.
This means that the mechanical energy delivered by the slave cylinder increases in proportion to an increase in the inside diameter of the slave cylinder.

- **Mini-pack (Air assisted power booster)**

This is a power device designed to be used in place of the clutch slave cylinder. It utilizes the hydraulic pressure produced in the clutch master cylinder to actuate the air valve. The compressed air supplied through the valve is converted into mechanical energy to operate the clutch.

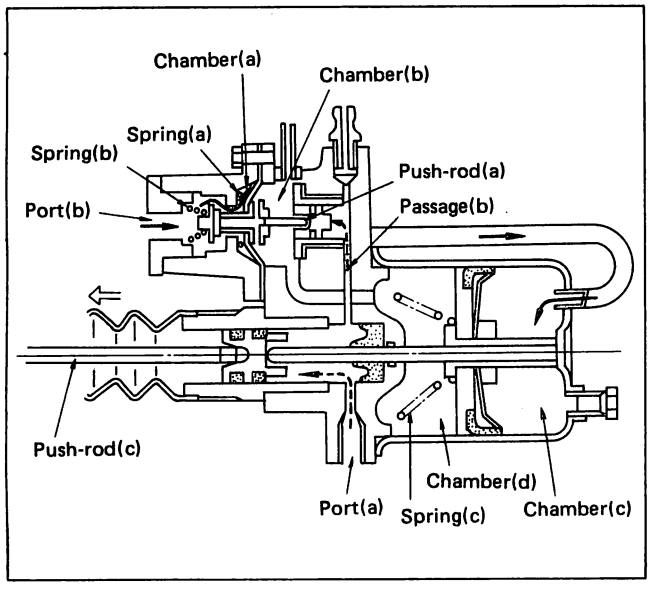




Construction and operation

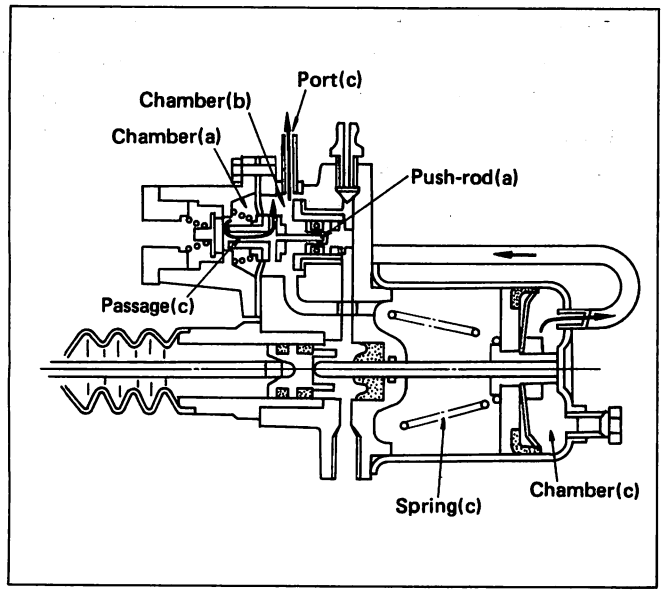
State of the hydraulic system when the automobile is in normal operating condition.

The chamber (d) freely communicates with the atmosphere through the port (c), a chamber (b) and a passage (a). The chamber (b) is connected with the chamber (c) through the passage (c), a chamber (a) and a control tube. With the hydraulic system in this state, the piston plate remains in position, as it is provided with equal pressure on both sides. The piston plate, push-rods (b) and (c) are moved all way toward the right-hand side by the spring (c), thereby holding the clutch in the engaged position.

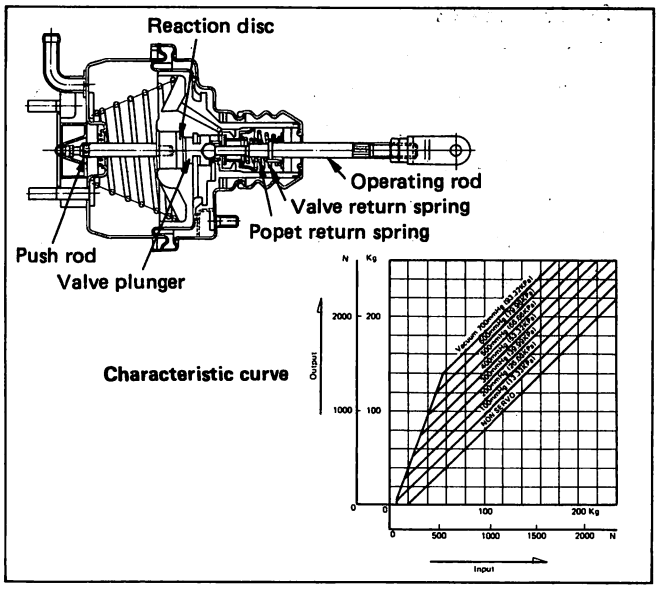


When the clutch is disengaged the pressurized fluid supplied from the master cylinder is applied to the relay valve piston through the port (a), the rear face of the hydraulic piston and the passage (b). When the pressurized fluid conveyed through the push-rod (a) and diaphragm stem adapter, overcomes the spring resistance (a) causes the relay valve piston to move leftward, the diaphragm is also made to move leftward, bringing the tip of the diaphragm stem adapter into close contact with the poppet valve. This, in turn, separates the chamber (b) from the chamber (a).

When the hydraulic pressure is further increased and overcomes the tension of the spring (b), it causes the poppet valve to move leftward, allowing compressed air into the chamber (c) through the port (b), the chamber (a) and the control tube. Since the chamber (d) is at atmospheric pressure, the difference in pressure causes it to move leftward against the spring (c), and the piston plate. This movement is transmitted through the push rod (b), the hydraulic piston and the push rod (c) to disengage the clutch.

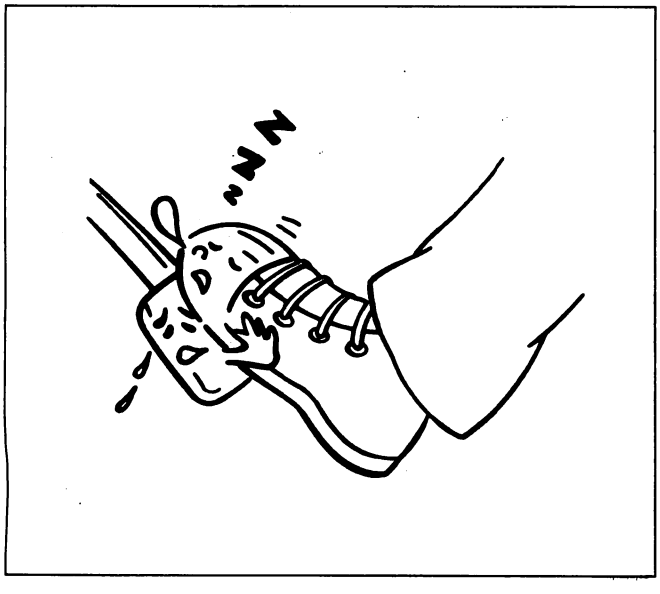


When the clutch pedal is released, the force acting on the relay valve piston is completely removed so that the difference in pressure between the chamber (a) and the chamber (b) forces the diaphragm, the diaphragm stem adapter, the push rod (a) and the relay valve piston to move toward the right-hand side.
When the poppet valve is closed and the flow of compressed air is interrupted, the compressed air held in the chamber (c) is discharged into the atmosphere through the control tube, the chamber (a), the passage (c), the chamber (b) and the port (c), causing the spring (c) to move the piston plate toward the right-hand side.



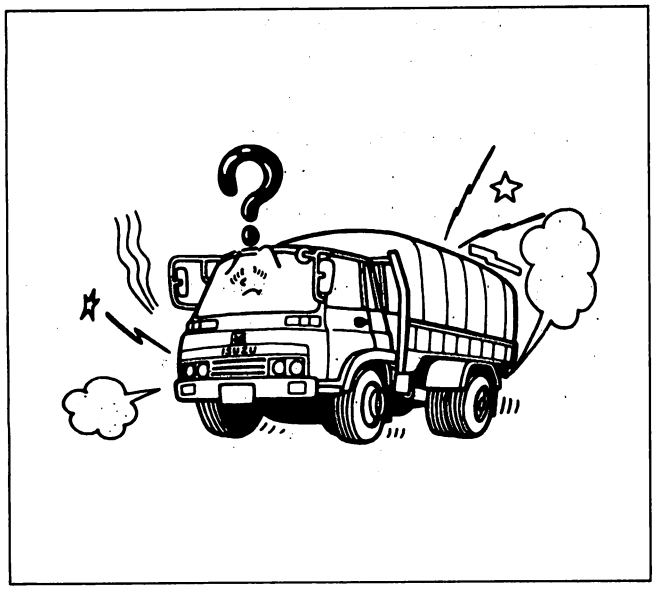
- **Vacuum servo**

CLUTCH TROUBLES

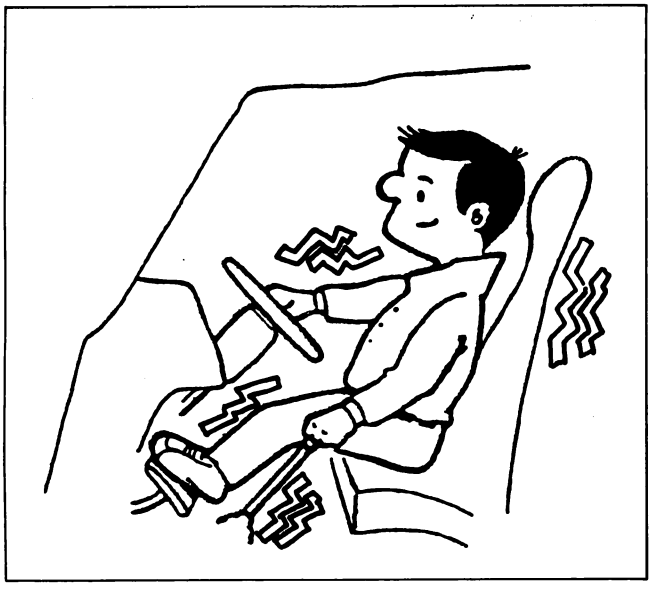


Clutch slippage

The main cause of clutch slippage is a decrease in the coefficient of friction, which can be caused by the facing becoming contaminated with oil. It can also be the result in a decrease in total spring pressure caused by excessive wear of the springs.
If the capacity of the clutch is excessive for the torque developed by the engine, it tends to invite engine stalling when the clutch is brought into engagement, while too small a capacity of the clutch gives a rise to wear of the facing as the clutch is liable to slip. It is, therefore, important that the capacity of the clutch be carefully determined according to the engine output.



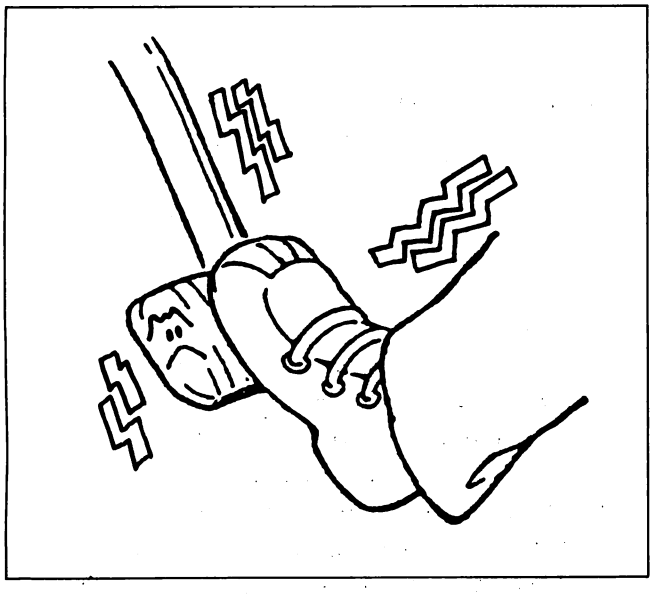
Abrupt engagement and disengagement, excess use of a half-engaged clutch, and overloading will increase clutch slippage and will cause accelerated wear of the facing. Therefore an adequate clutch capacity and a sympathetic driving technique are important.



Clutch judder

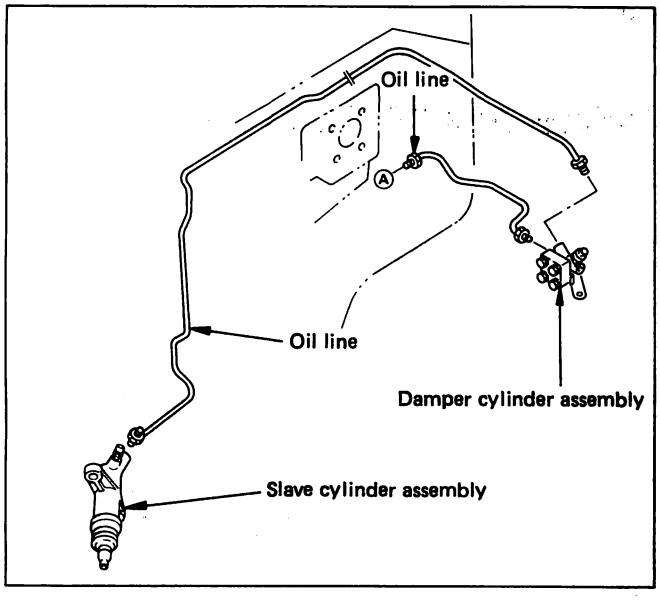
Occasionally when starting the automobile, it is hard to engage the clutch, on account of severe vibration at a relative low frequency. This originates from the power train which includes the engine and chassis springs.

Such abnormal vibration, generated during clutch operation is termed "Judder".



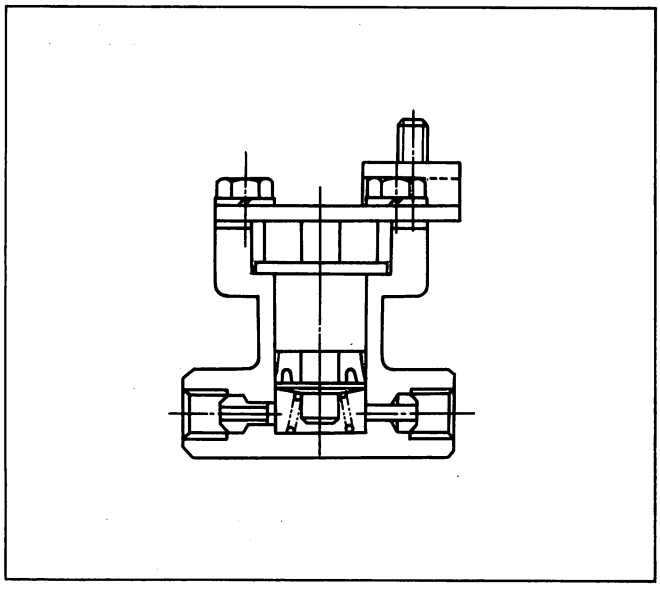
The main causes are as follows:

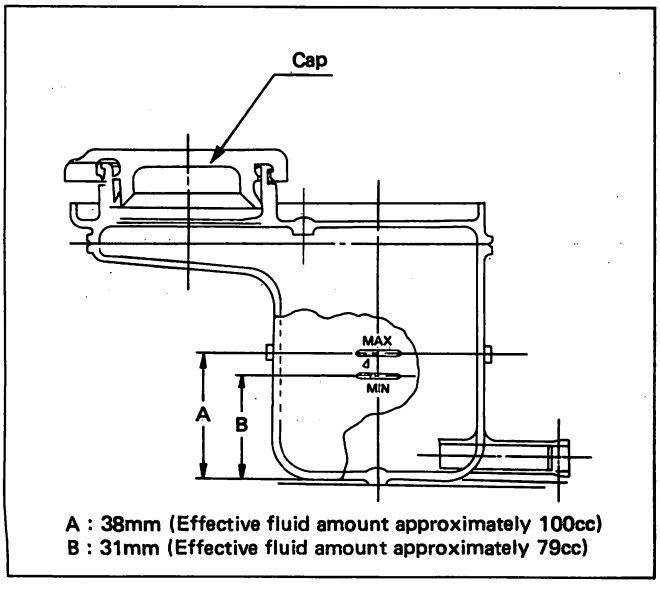
1)	Driven Plate	* Wear or broken damper springs
		* Hardening or oil adhering to facing
2)	Clutch Spring ...	* Unequal spring forces
3)	Linkage & Mounting	* Looseness in connections
		* Looseness in mountings or wear in mounting rubbers.



Damper cylinder

In order to reduce the clutch squeaking noise, damper cylinder is employed in clutch hydraulic line between master cylinder and slave cylinder.





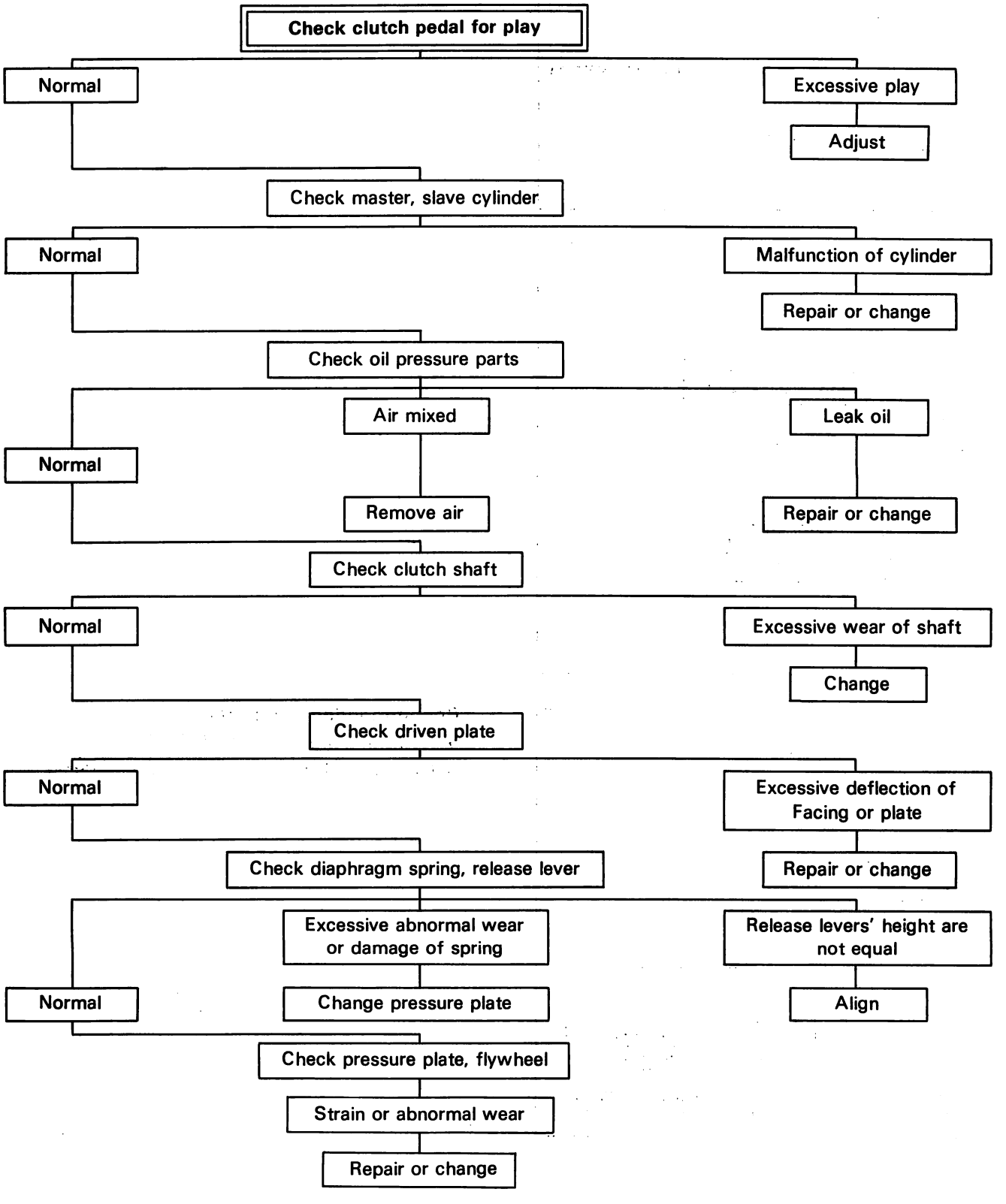
A : 38mm (Effective fluid amount approximately 100cc)
B : 31mm (Effective fluid amount approximately 79cc)

Recommended clutch fluid

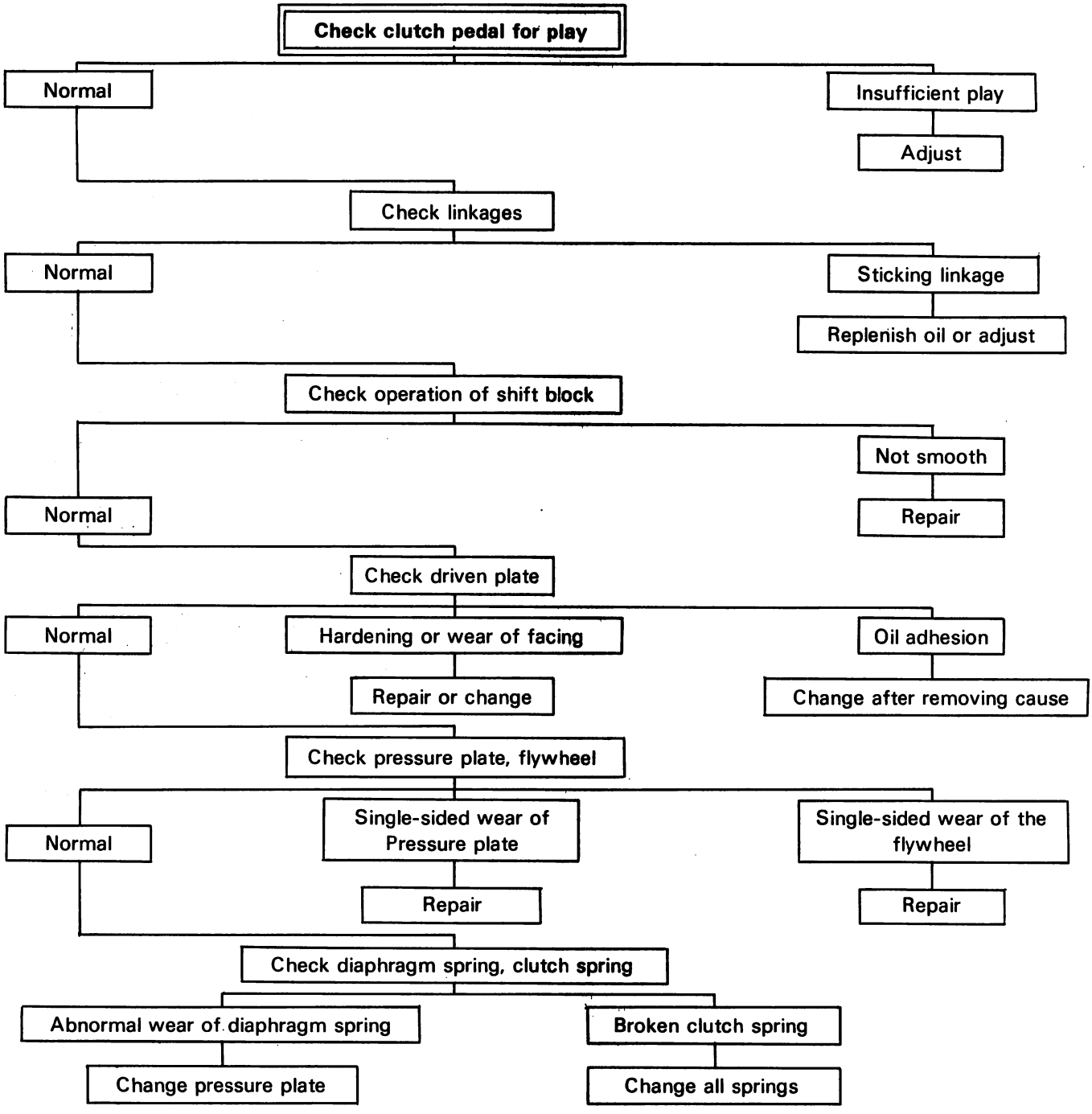
- Hydraulic brake fluid SAE J1703
- FMVSS 116 DOT. 3 grade clutch fluid reservoir

TROUBLE-SHOOTING OF SINGLE-PLATE CLUTCH

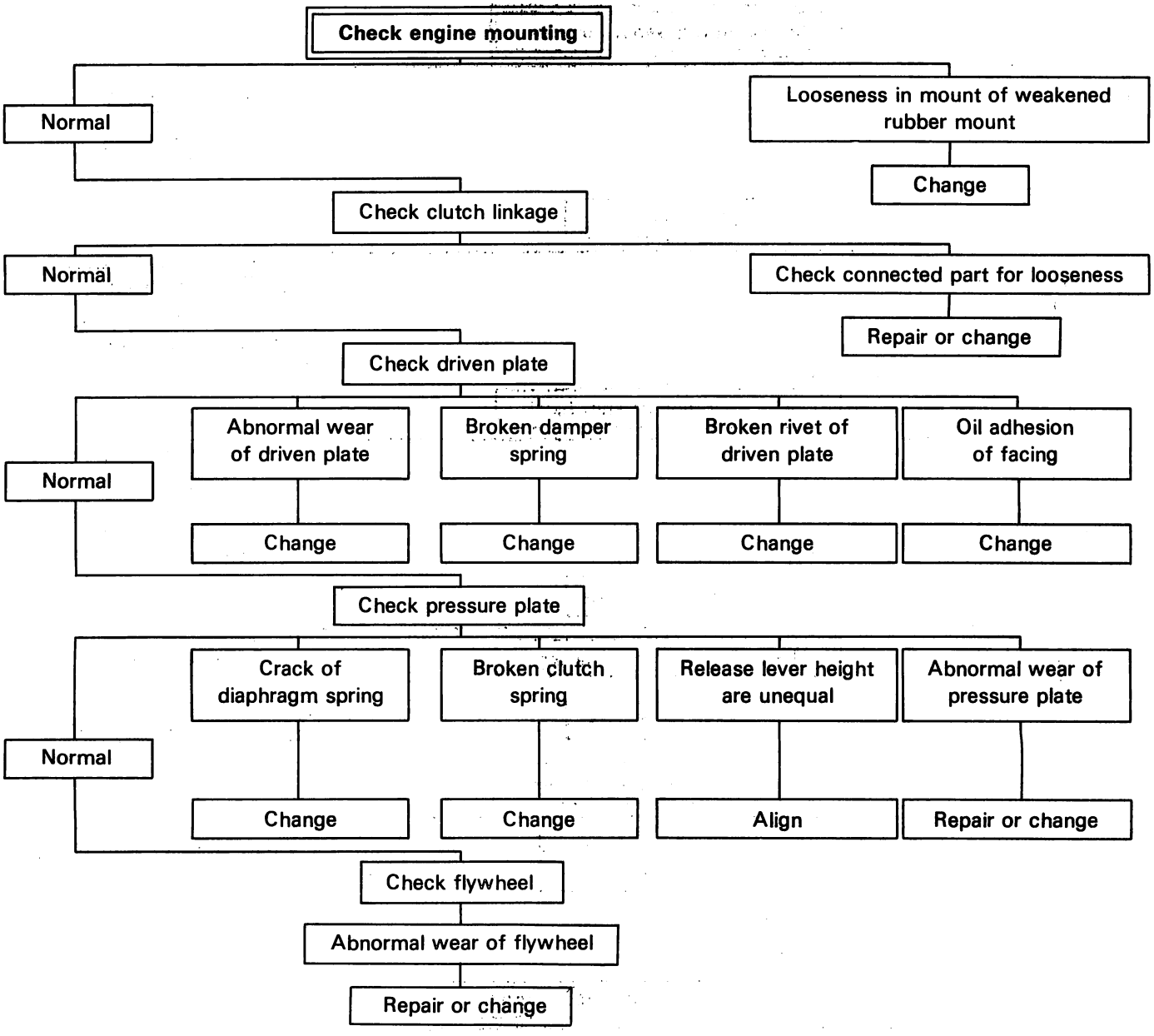
1. CLUTCH WILL NOT RELEASE PROPERLY



2. CLUTCH SLIPS



3. VIBRATION IN ENGAGEMENT OR DISENGAGEMENT



4. CLUTCH NOISY