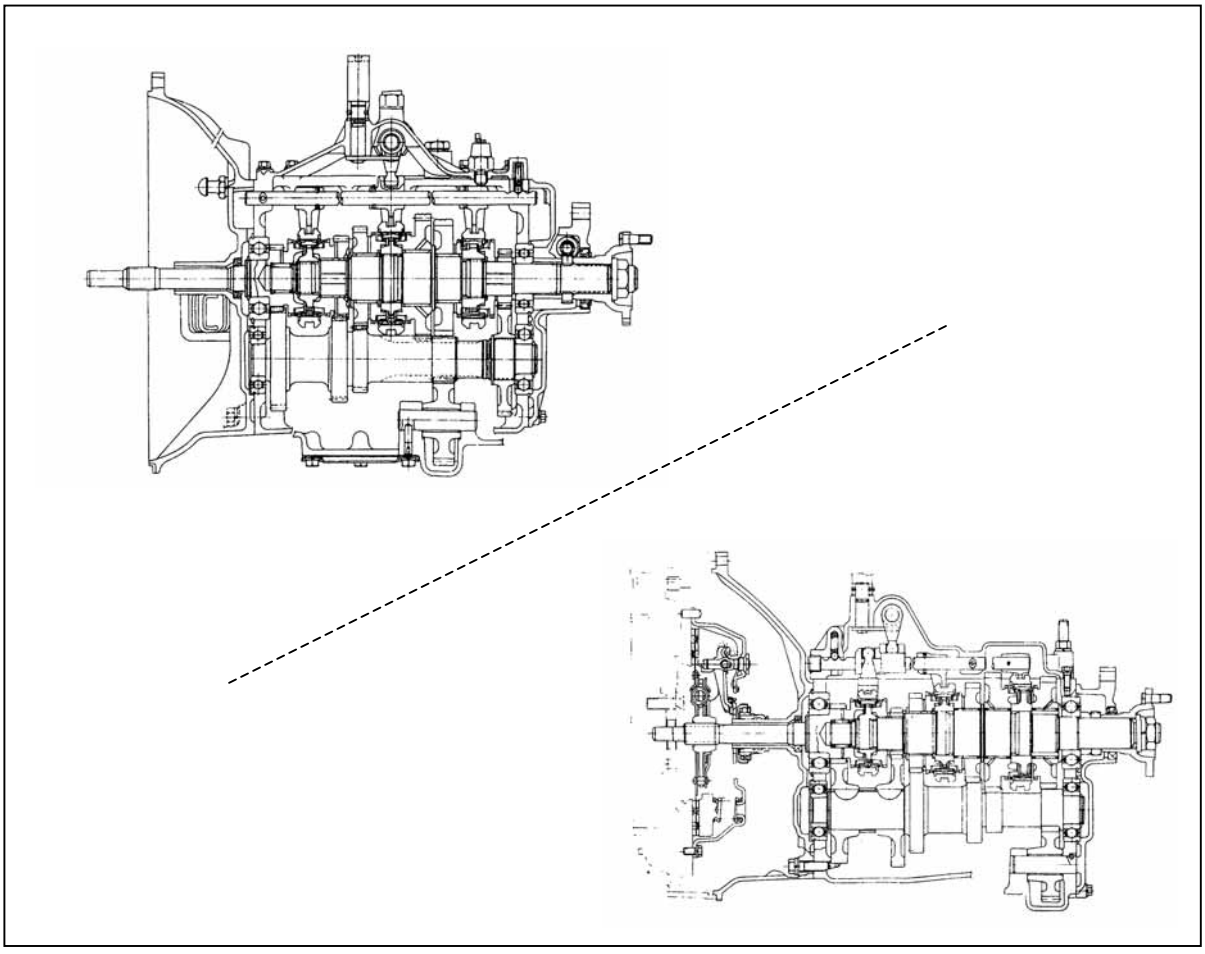
MSA & MSB TRANSMISSION



ISUZU

ISUZU MOTORS LIMITED

CONTENTS

SECTION 1

GENERAL DESCRIPTION

Running resistance of a vehicle varies toward an extremely large range depending upon starting condition, road surface condition, grade, driving speed, weight of load and many other factors.
On the other hand, the torque generated by an engine is approximately constant regardless of engine speed. To generate a driving force with an engine like this in response to running resistance, a transmission which changes torque must be installed between the engine and wheels.

Purposes of installing transmission

- **To generate driving force in response to running resistance.**
- **To ease starting and accelerating**
- **To ease driving with a small size engine**
- **To provide reversing performance**

Required functions

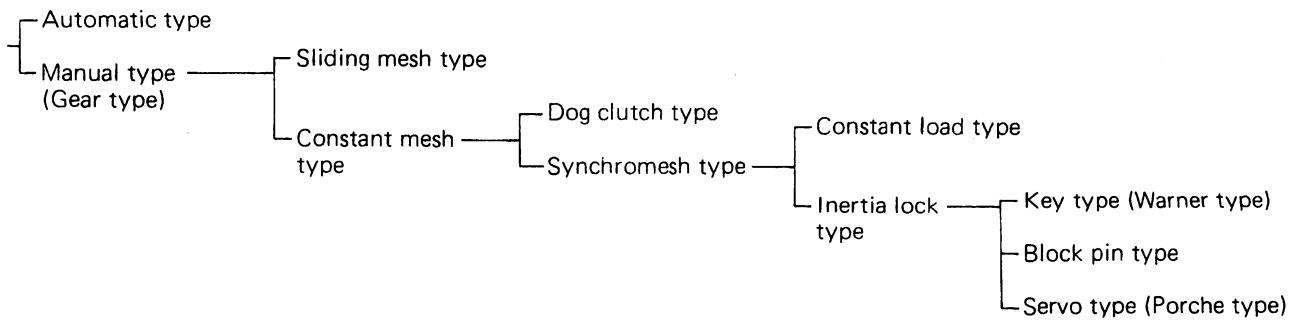
- **Transmission gear ratio can be changed.**
- **Rotating direction can be reversed.**
- **Neutral position can be attained.**

This transmission is installed behind the clutch. The rear side of the transmission is connected to the propeller shaft through the flange of the parking brake which is joined with the mainshaft by means of a spline. With this construction, the transmission transfers power from the engine to the wheels via the differential gears.

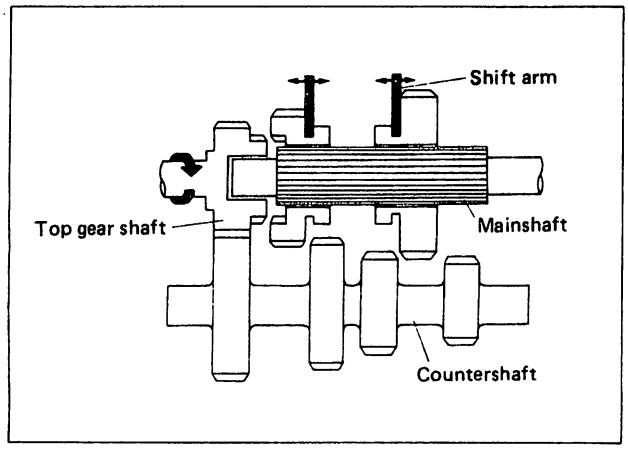
The following characteristics are required by transmissions for vehicles.

- **Can be controlled easily.**
- **Operates quietly and the efficiency is high.**
- **Maintenance service is easy.**
- **Gear ratios are evenly spaced.**
- **Small in dimensions and light in weight**
- **Low manufacturing cost, etc.**

Types of transmission

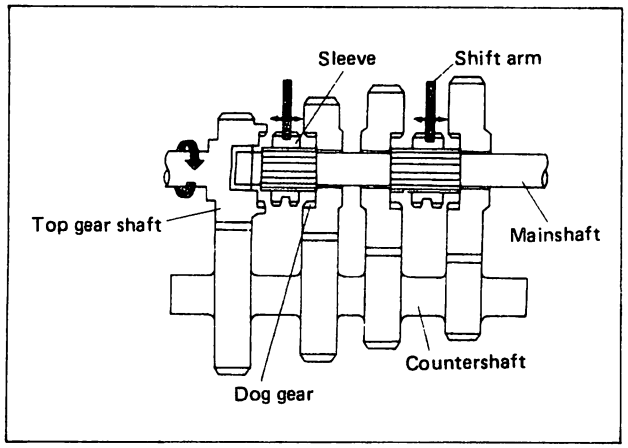


Sliding mesh type



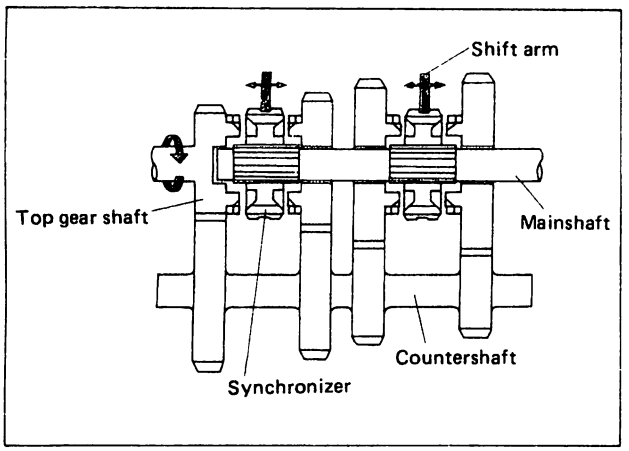
A transmission of this type moves the gears with a shift arm along the spline of the mainshaft to engage and disengage the gears on the mainshaft with the gears on the countershaft which is aligned in parallel with the mainshaft. At present, this type is not so popular.

Constant mesh type



Dog clutch type

In a transmission of this type, the mainshaft gear which is constantly engaged with the countershaft gear is so arranged that it idles. This gear is provided with a dog gear to engage with a sleeve. To the splined portion of the mainshaft, the sleeve is fitted. The mainshaft gear is coupled with the mainshaft by sliding this sleeve with the shift arm. Thus, power is transmitted to the propeller shaft side. At present, this type is employed for the low gear of a large size transmission and for reverse gears of various types of transmission.



Synchromesh type

In this type, a synchromesh system is installed in the dog clutch portion. A disadvantage of the above mentioned dog clutch type is that the engagement is hard when there is a difference of speed between the mainshaft and countershaft. The synchromesh system eliminates this hardness. In this system, gears engage each other when turning speeds at their tooth portions are balanced. Therefore, gear shift control can be done smoothly, easily and quickly.

At present, this system is used for all forward gears of light duty vehicles and passenger cars, or all forward gears except 1st gear of heavy duty vehicles.

SECTION 2

MAIN DATA AND SPECIFICATIONS

Type	5 Speed Over Drive			
Gear mesh type	1st to 5th Synchromesh			
Lubricating oil	Engine oil SC-CC	Grade SAE 30		
oil capacity	MSB	Approx. 3.2 liters	MSA	Approx. 2.7 liters
Dry weight	MSB 5P	Approx. 55kg	MSA	Approx. 68kg
	5M. 5S	Approx. 56kg		

TRANSMISSION GEAR RATIO

Gear ratio (No. of gear teeth)

Type \ Gear position	1st	2nd	3rd	4th	5th	Reverse
MSB 5M	5.608 (42/23x43/14)	2.822 (42/23x34/22)	1.664 (42/23x31/34)	1.000 Direct	0.793 (42/23x20/46)	5.347 (42/23x29/14x41/29)
5P	5.875 (44/23x43/14)	2.956 (44/23x34/22)	1.694 (44/23x31/35)	1.000 Direct	0.790 (44/23x19/46)	5.602 (44/23x29/14x41/29)
5S	5.037 (41/25x43/14)	2.683 (41/25x36/22)	1.591 (41/25x33/34)	1.000 Direct	0.782 (41/25x21/44)	4.802 (41/25x29/14x41/29)
MSA 5	5.774 (47/25x43/14)	2.990 (47/25x35/22)	1.731 (47/25x35/38)	1.000 Direct	0.760 (47/25x19/47)	5.784 (47/25x40/13)

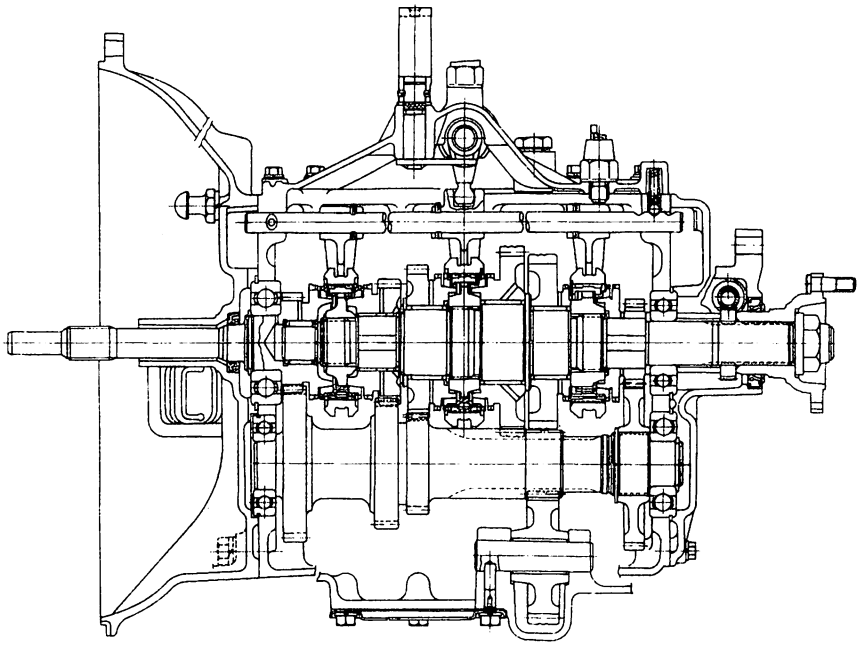
SECTION 3

CONSTRUCTION AND OPERATION

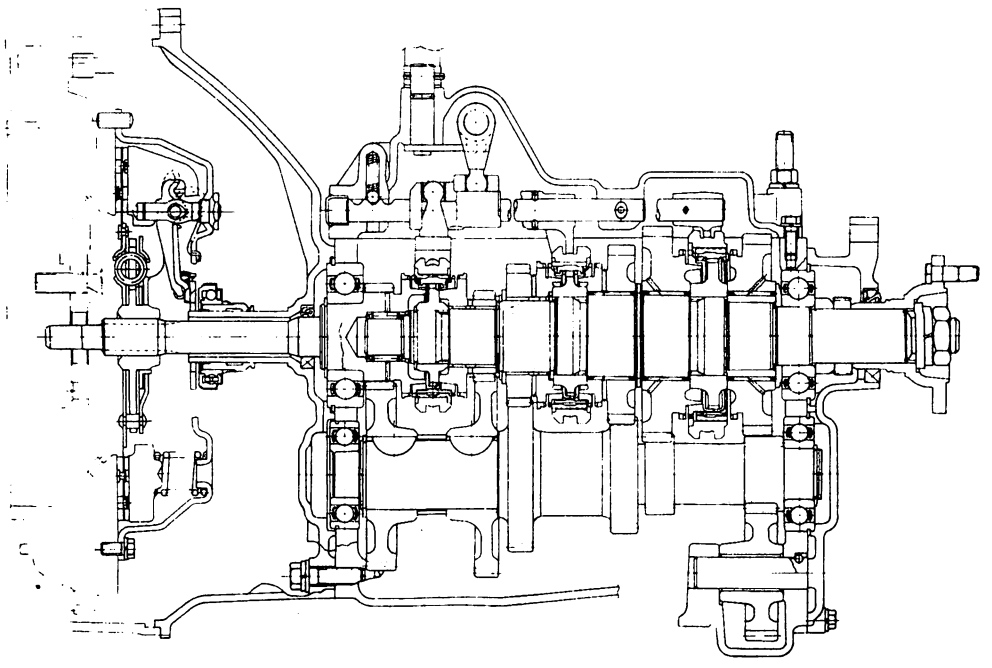
Outline Of Construction

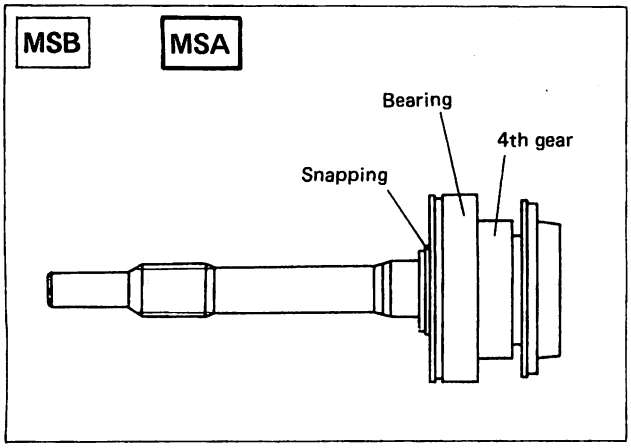
The MSA and MSB transmissions, inertia lock synchromesh type (Key type), are fully synchronized in all five forward speeds (Over drive in fifth gear) and constantly meshed in a reverse speed.
The MSA transmission is available only in a standard type and MSB in standard type, high-speed type, or high-torque type.

MSB



MSA

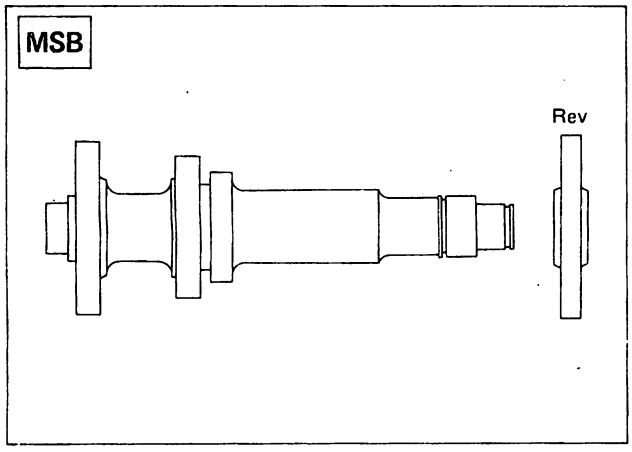




Top gear shaft

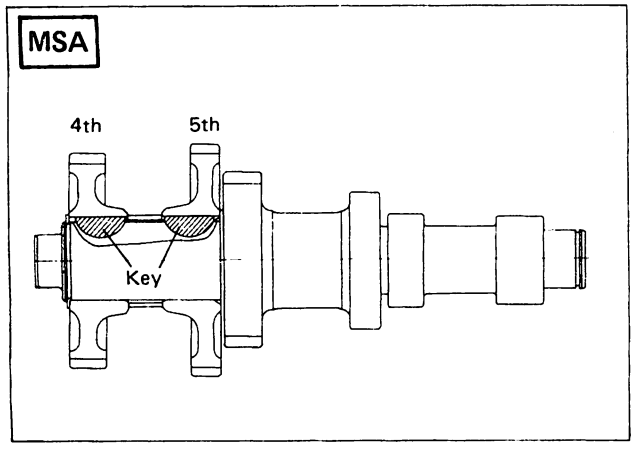
The top gear shaft consists of a spline shaft that slides into the female spline of clutch disc hub, a fourth gear and a dog gear, all integral to each other. The top gear shaft is supported in the case by a ball bearing which is press-fitted over the shaft in front of the fourth gear and retained by a snap ring. It is also supported at its front end by a pilot bearing in the engine crankshaft. The top gear (fourth gear) is in constant mesh with the countershaft drive gear.

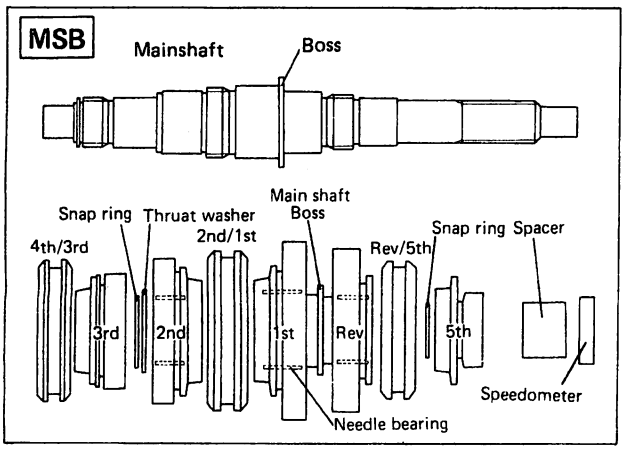
The power flow passes from the engine via the top gear shaft and constant-mesh driving gears to the counter shaft and on to the mainshaft via the engaged gear pair.

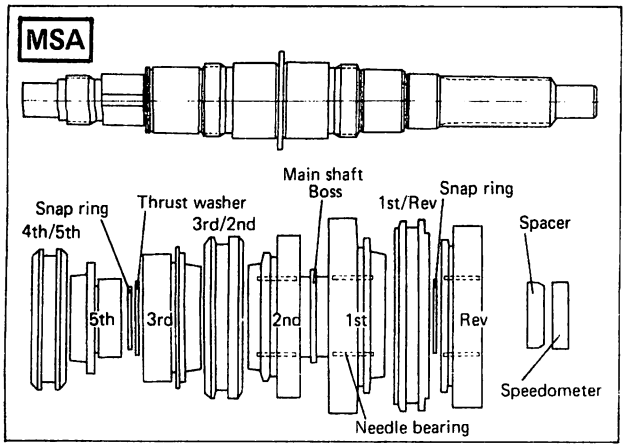


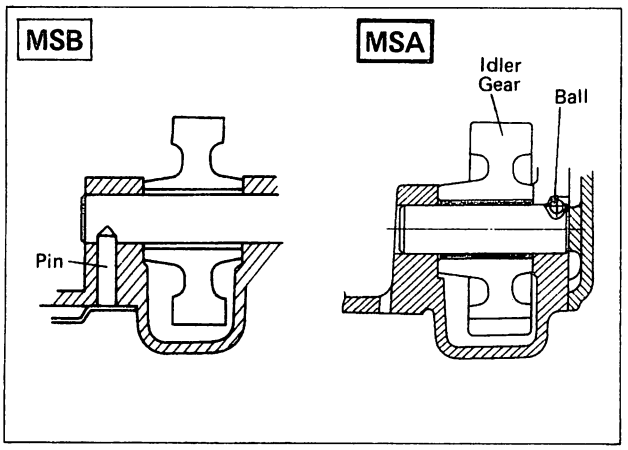
Counter shaft

The counter shaft is supported in the transmission case by ball bearings at both ends. All the forward gears and reverse gear in the counter shaft cluster other than the fifth gear, are integral to the shaft, and the fifth gear is splined to the shaft. (In the MSA transmission, the fourth and fifth gears are press-fitted on to the shaft and secured in the position by keys). The engine torque flow passes from the top gear shaft via the counter shaft, and on to the mainshaft via the engaged gear pair.









Main shaft

The mainshaft is held in line with the top gear shaft by a pilot bearing as its front end and supported in the case by a ball bearing at the rear part. On the middle part of the shaft is an thrust boss flanked by 1st, 2nd, and 3rd gears (2nd, 3rd, and 5th gears in the case of MSA) on the front and reverse and 5th (1st and reverse gears in the case of MSA) on the rear part of the shaft. All the gears on the mainshaft are free to rotate independently on the mainshaft and are in constantmesh with the countershaft gears. Also on the mainshaft are 1st/2nd, 3rd/4th synchronizer assemblies (2nd/3rd, and 4th/5th in the case of MSA) with their sychronizer hubs splined to the mainshaft and retained by snap rings.

In the MSB transmission, 1st and reverse gears (2nd, 1st, and reverse gears in the case of MSA) are supported on the mainshaft by needle bearings.

Speedometer drive gear is installed on the mainshaft within rear cover and, together with the flange, secured by the coupling mounting nut.

The mainshaft also has splines on the rear end for connection to the coupling.

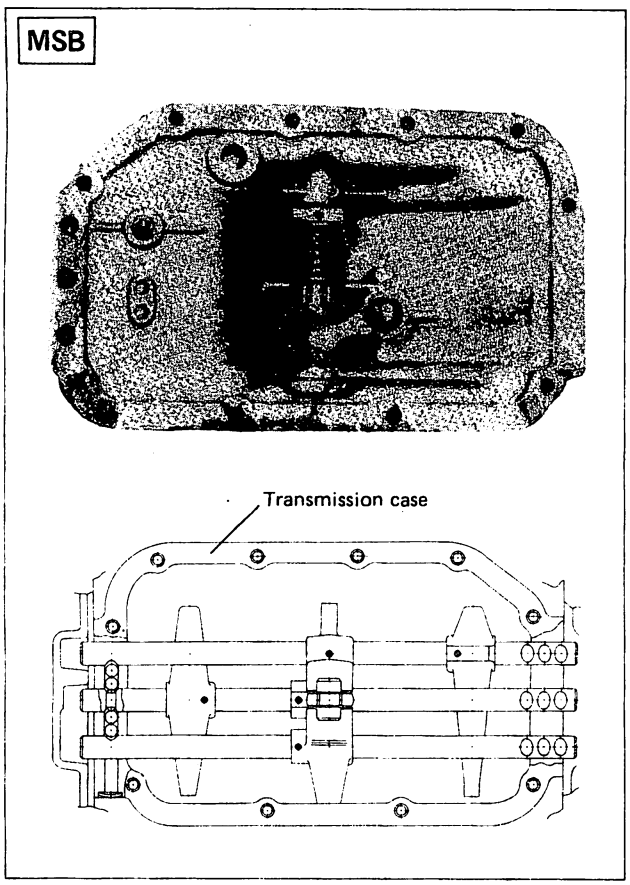
Reverse idler shaft

The reverse idler gear is carried on a reverse idler shaft which is supported in the case and retained in the position by a pin (by a ball in the case of MSA).

Quadrant box

The quadrant box is a control system required for shifting and selection of the desired gear range by sliding a sychronizer sleeve on the mainshift.

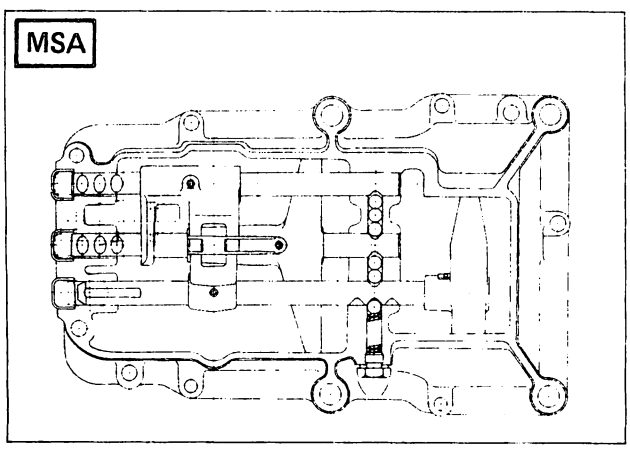
The quadrant box comprises; select levers, detent



- **MSB**

The quadrant box comprises select levers, detent spring, a back-up lamp switch, a neutral switch, etc.

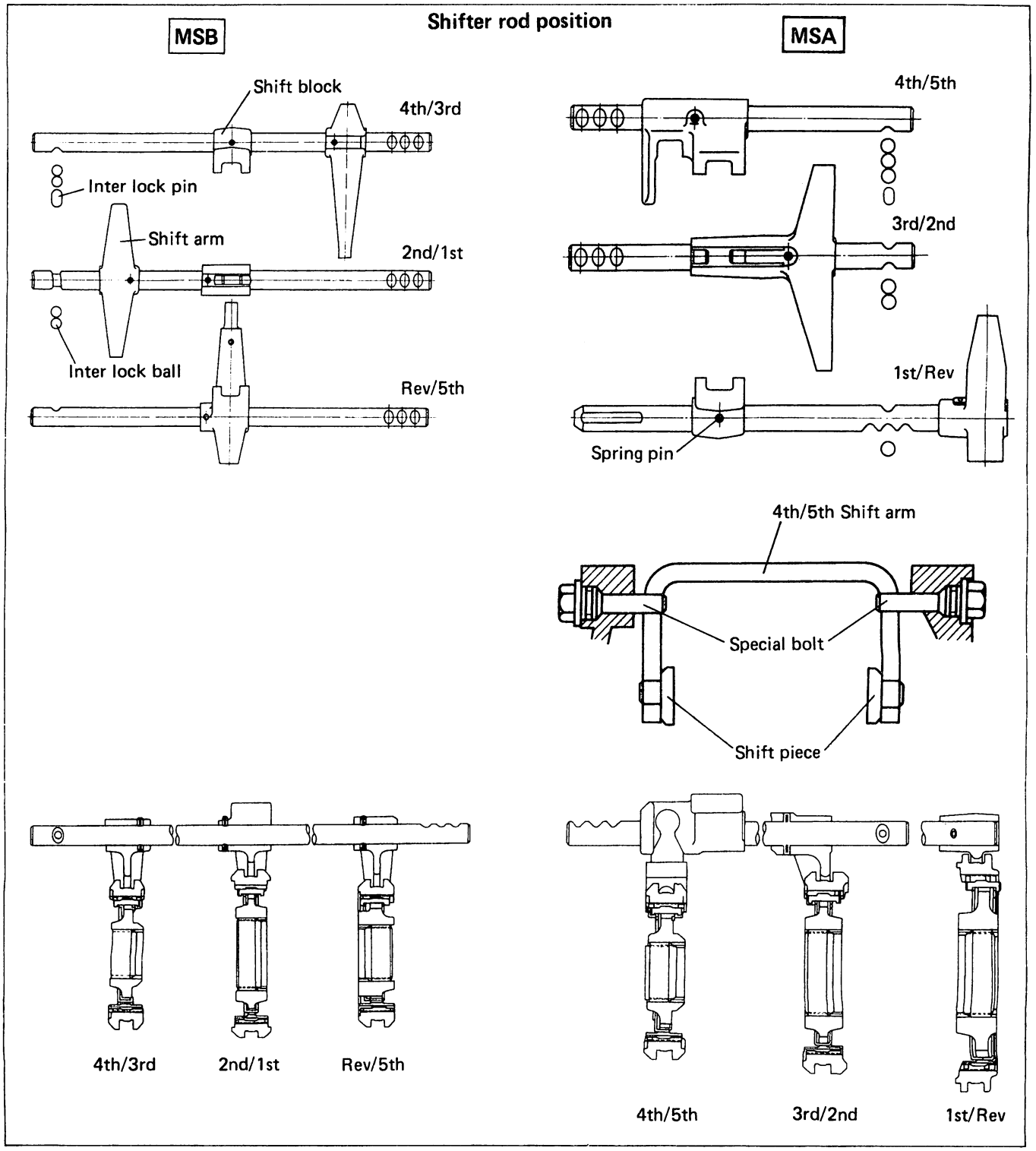
The three shifter rods are carried on the part of the transmission case.



- **MSA**

The quadrant box comprises shifter rods, shift blocks, shift arms, detent balls, springs (for optimzing the operation of the shifter arm and rod), interlock balls (for protection sgainst double engagement), a backup lamp switch, a neutral switch etc.

Each shift arm is mounted over the its respective shifter rod and retained by a spring pin. In the MSA transmission, the 4th/5th shift arm is arranged in such a way that the arm rests on a special bolt acting as a fulcrum, and is moved in a reversed direction by a leverage. Thus the arm differs in shape from other arms. The neutral switch is used to allow the engine to be started by a starter subswitch with the transmission in the neutral while the cabin is in tilted position.

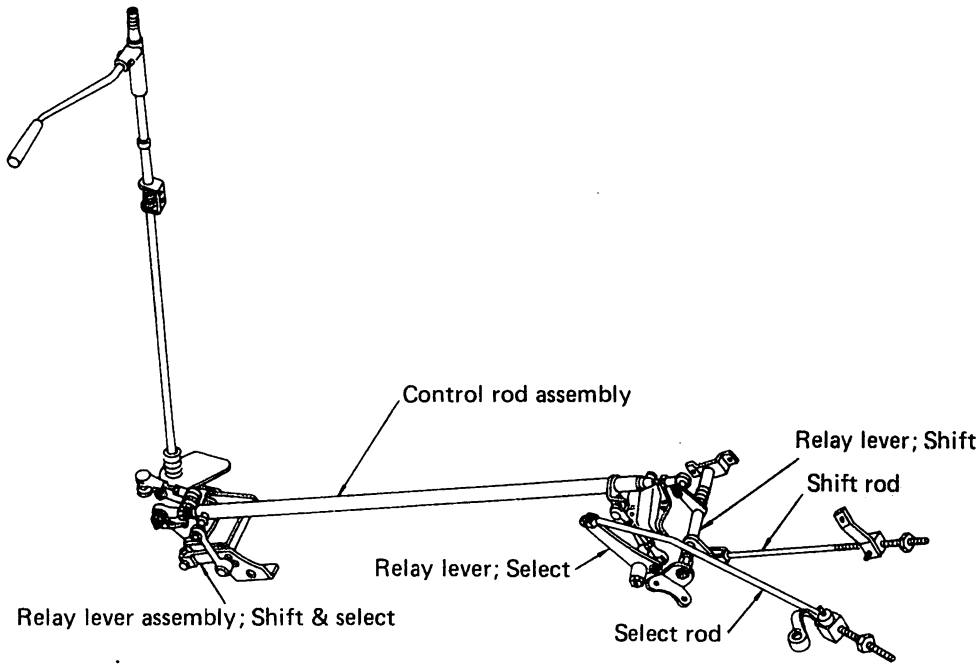


Gearshift control

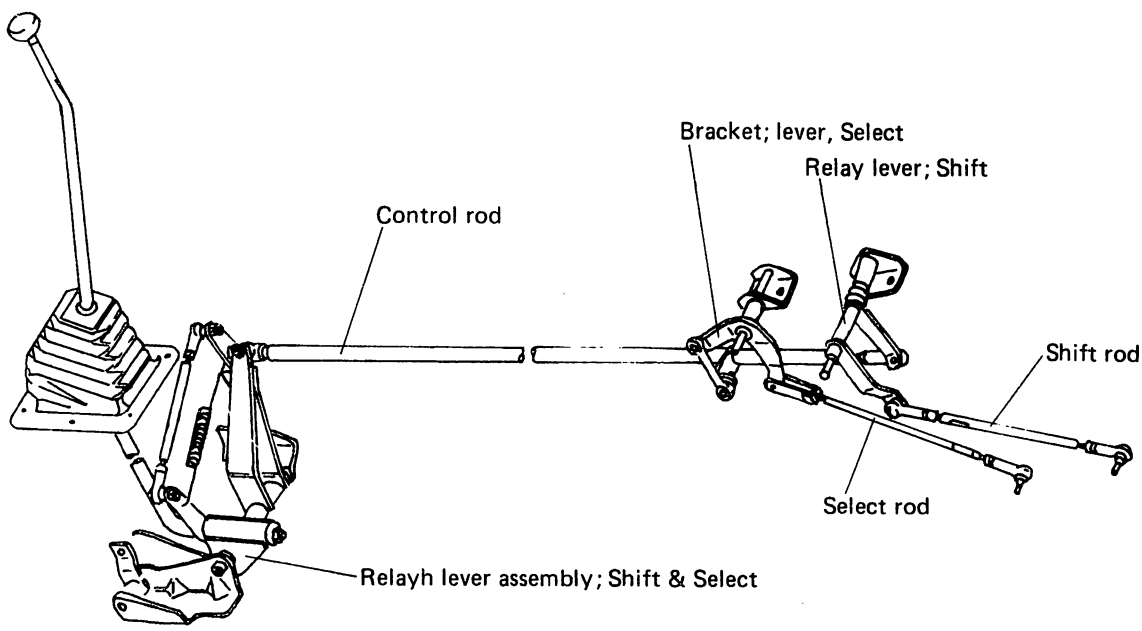
Types MSA and MSB employ two types of remote control system; The column shift type and the floor shift type.

When an gear shift lever is operated in the driver's cab, the movement is transmited through the relay levers and rods to both the shift lever and the selector lever on the quardrand box, thereby shifting to the suitable gear engagement.

Column shift Type

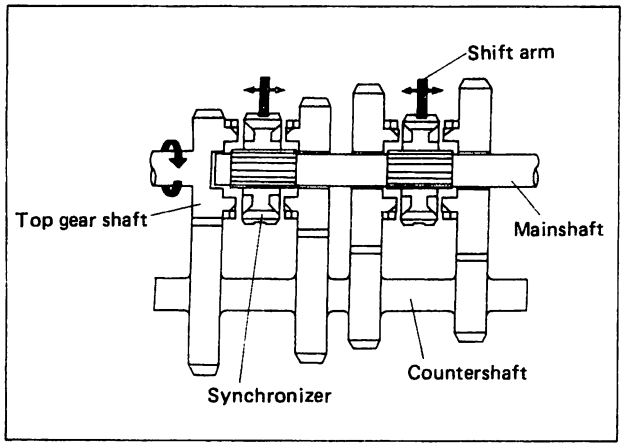


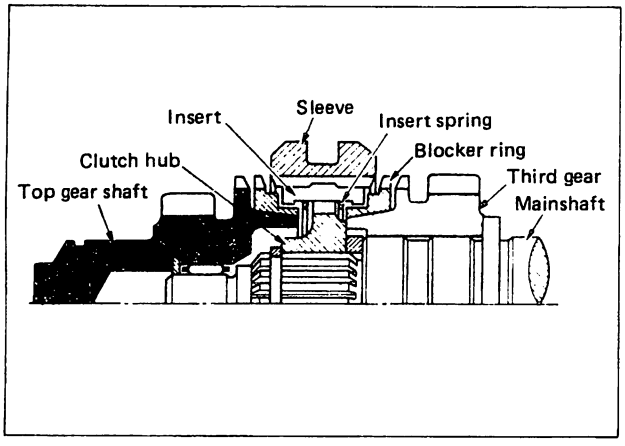
Floor shift Type

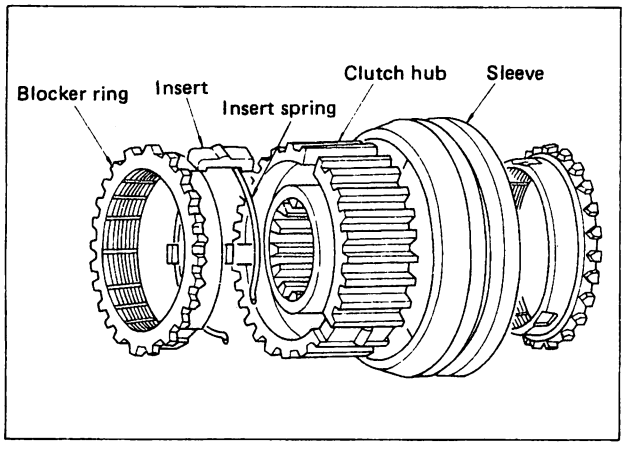


Synchromesh device

Gearshift control can be done smoothly, easily and quickly with the synchromesh device. It is very advantageous especially when decelerating and accelerating. Further, service life of the transmission can be extended and damaging is minimized because no unreasonable force is applied to the gears and other parts.







Key type (Warner type)

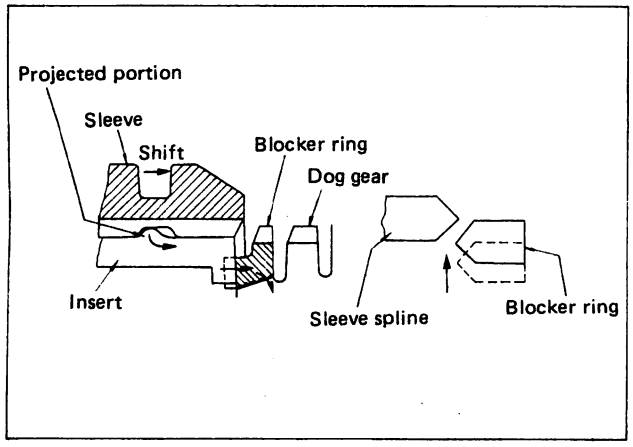
1) Construction

A key type synchromesh mechanism consists of a clutch hub, inserts, springs, sleeve, blocker rings and dog gears of the third gear.

- The clutch hub is fitted to the spline on the mainshaft. There are three key grooves in the spline portion on the periphery of the hub. The inserts are inserted into these key grooves, and sleeves are installed on them.

- The sleeves are fitted to the hub by means of a spline. There is a groove into which shift arm is inserted on the periphery, and they are moved toward the axial direction by the shift arm. There are grooves in the center portion of the sleeve inner circumference, and into these grooves, projected portions of the inserts enter.
- The three inserts are fitted into the individual grooves on the hub, and the center projections are fitted into the grooves on the sleeves. The inserts are pushed outward by the springs against the sleeves. The both ends of the inserts enter the notched portions of the blocker ring, transmitting movement of the sleeves to the blocker ring.
- The periphery of the blocker ring is provided with a spline, and the face which opposes the sleeves is chamfered so that it easily engages with the spline on the sleeve. The interior is in a cone shape and threaded. When shifting gears, the interior comes into contact with the cones of the gears,

thereby cutting oil film and eases the clutch operation.

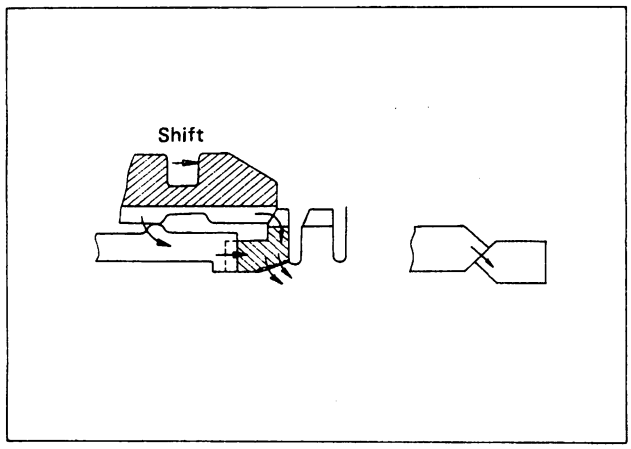


2) Operation

o Step 1

Step 1 covers the operations from the movement of the sleeve by the shift arm to the start of synchronizing process.

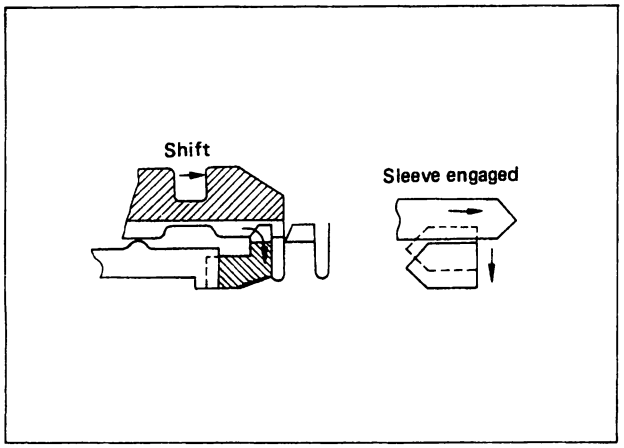
a. Together with the inserts, the sleeve move on the clutch hub.
b. Ends of the inserts push the blocker ring toward the axial direction.
c. The blocker ring is pushed to tapered cone portion of the gear, and the blocker ring is turned by a friction force generated as the blocker ring is pushed against the tapered cone portion of the gear. Relative positions of the spline teeth of the blocker ring and sleeve are shown in the left hand figure.



o Step 2

Step 2 covers the operations from the start of the synchronizing process to the end of the synchronizing process.

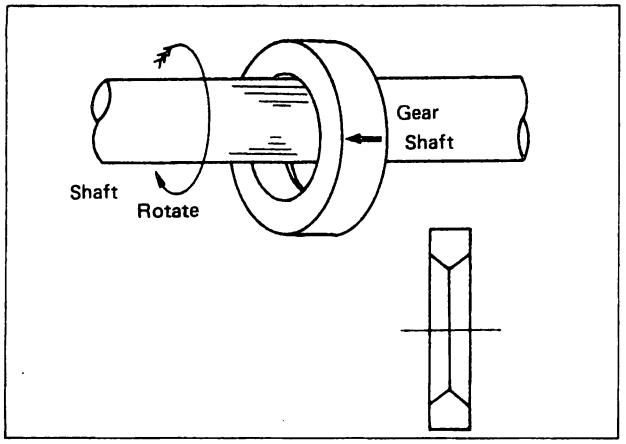
a. When the sleeve is moved further with the shift arm, the three inserts push the springs and sink, and tooth edges of the blocker ring and sleeve come into contact with each other.
b. The sleeve intend to move further by pushing the blocker ring. However, as difference of speed between the gear and synchronizer is big, such a force as to push back the sleeve is applied to the blocker ring, not allowing the sleeve to move further. Consequently, the force of the shift arm which intends to move the sleeve pushes the blocker ring against the tapered cone more strongly, causing friction force to increase.
c. As the result, the synchronizer is accelerated or decelerated until its speed is balanced with that of the gear.



o Step 3

Step 3 covers the operations from the end of the synchronizing process to the end of engagement.

a. When speed of the blocker ring is synchronized with that of the gear, the force which intends to turn the blocker ring fades out, causing the sleeve to push the blocker ring away and move further.
b. The sleeve engages with the dog gear of the mainshaft gear easily because their speeds are balanced.



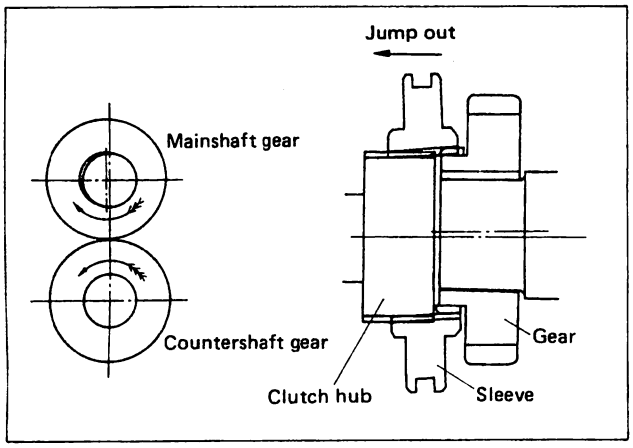
Gear Jump out preventing device

Term "Jump out"

When a vehicle accelerates or decelerates, engaged gears may move naturally and disengage. This occurrence is called "Jump out". The following causes may apply.

- **Insufficient sleeve fixing force**
- **Incorrect parallelism between the mainshaft and countershaft.**
- **Eccentric motion of the mainshaft**
- **Insufficient mesh of teeth**
- **Worn teeth**
- **Influence of vibration, etc.**

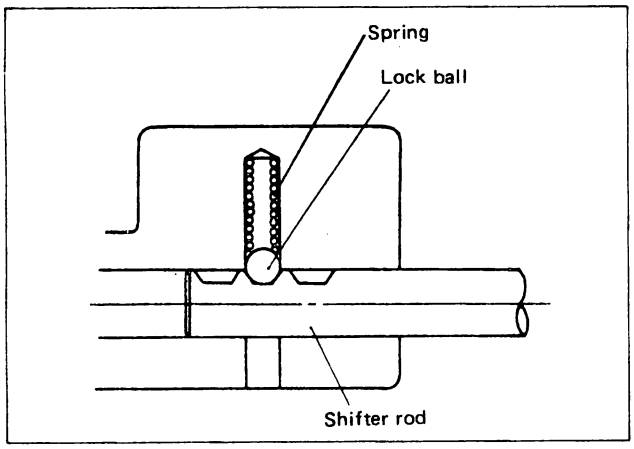
Most of these causes make jump out to occur under some conditions, however, under other conditions, they may not make jump out to occur. In the most presently used transmissions, dog gear and sleeve or clutch hub function as a medium of engagement, and except for those jump out occurred by an influence from the outside, it is generally said that the intermeshed gear, sleeve or clutch hub are caused to incline by some reasons, the inclining causes the sleeve or clutch to move, and gears jump out.



Jump out preventing mechanism

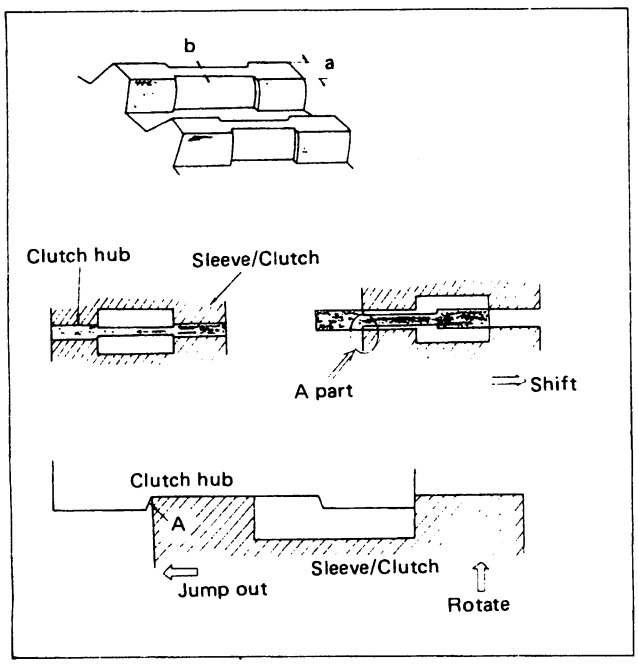
Except for a press-fitted portion, a clearance is remained in the fitted portion of each shaft. However, it is not so advantageous to reduce the clearance by means of machining because such a clearance is increased by wear.

For this reason, generally, such a method as that jump out does not occur even if a gear or sleeve inclined is used. The following methods are generally used.



1) Method in which detent spring is strengthened

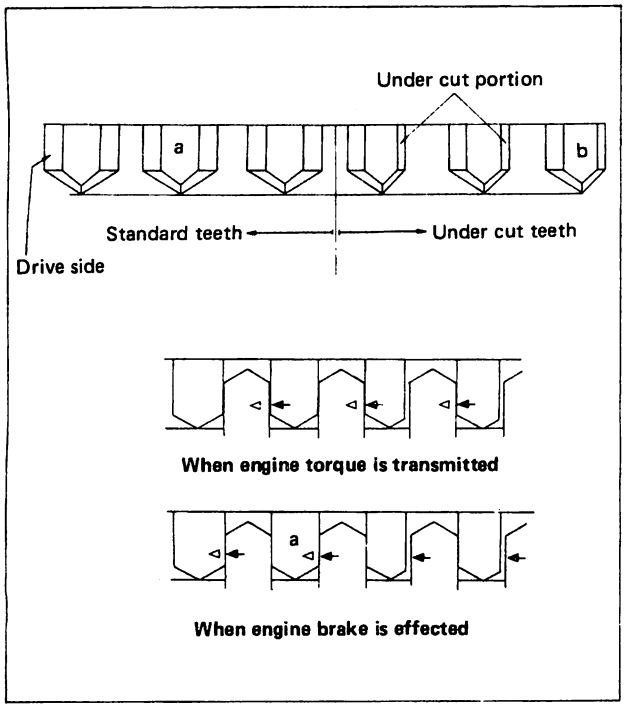
The shifter rod is pushed with a large force by increasing spring constant of the spring so that the rod does not move easily. However, spring constant cannot be increased beyond a certain level because a large force is required in shifting gears.

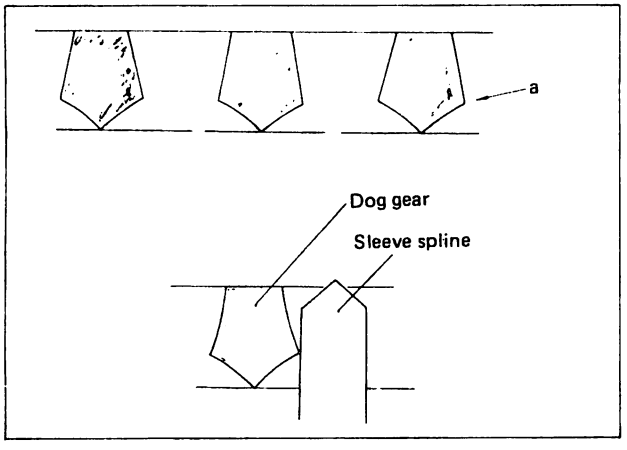


2) Method in which sliding portion is provided with a step

Since gear is shifted by moving the sleeve on the mainshaft, spline of the clutch hub or sleeve is provided with a step and the clutch hub or sleeve is hooked on this step during shifting gear so that slip out does not occur easily.

The left hand figure shows a part of the clutch hub spline. In this figure, "a" is the normal tooth thickness, and "b" is a tooth thickness thinned by the step. The sleeve spline is dropped into this step, preventing jump out.





3) Method in which unit pressure of intermeshing portion is increased.

When it is assumed that a constant force is applied to an intermeshing portion, unit pressure can be increased by reducing intermeshing area, and thus, friction force can be increased.

When this force is larger than the force which intends to disengage gears, the gears do not come off. This is an advantageous method.

a. Method in which number of intermeshing teeth is reduced.

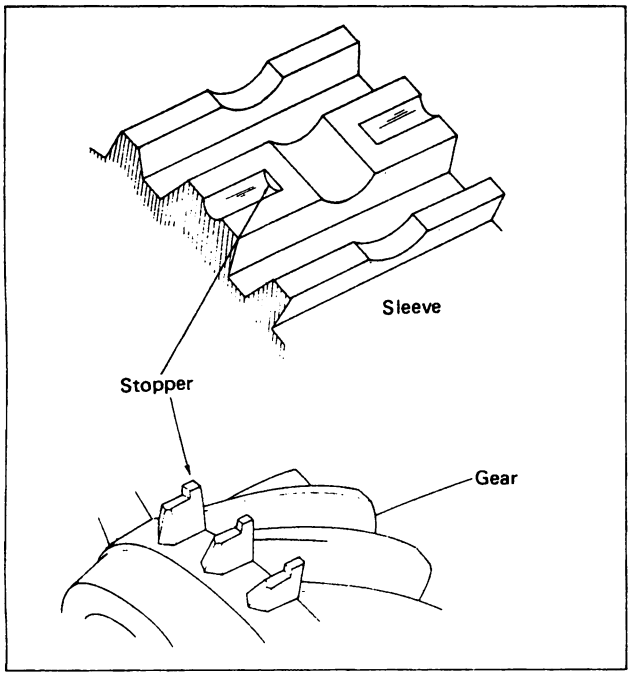
The face of 70 to 80% of the total number of teeth which comes into contact with the mate tooth when engine brake is effected is under-cut so that the teeth do not come into contact with the mate teeth.

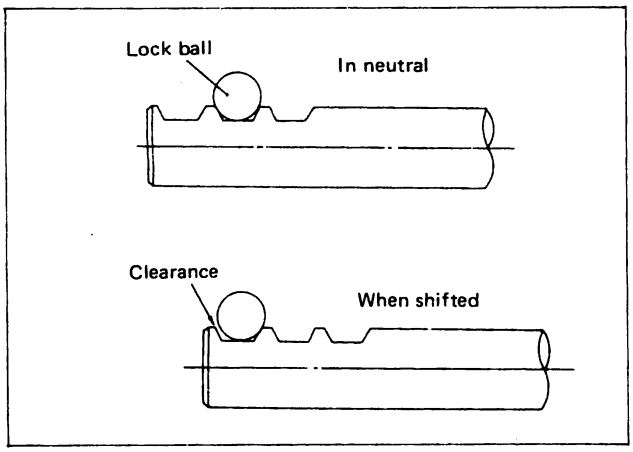
In the left hand figure, "a" indicates the normal tooth, and "b" indicates an under-cut tooth. When driving, power is transmitted by both teeth "a" and "b", and when engine brake is effected, power is transmitted by tooth "a" only.

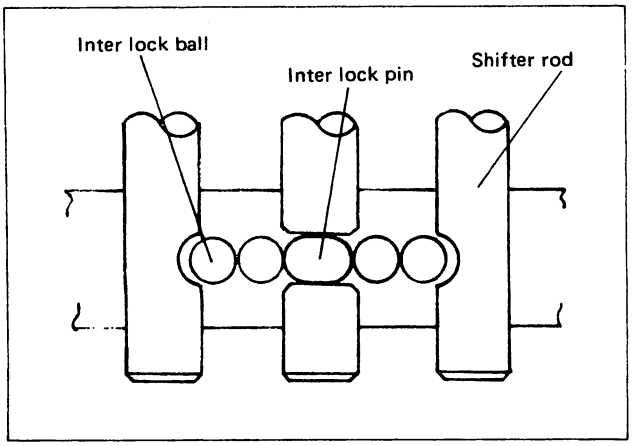
b. Method in which contact area of either one of intermeshing gear teeth is reduced.

In this method, the teeth of either one side are shaped as shown as "a" in the left hand figure, causing them to come into contact with the mate teeth. Then, a large friction force can be obtained and jump out is prevented.

Generally, both faces for engine drive and engine brake are shaped like this so that a high unit pressure can be given to the contact surfaces. Then, a step is formed also on the mate gear teeth, further increasing force of engagement.







4) Method in which reduction of intermeshing depth is prevented.

When intermeshing depth of a gear is shallow, unit pressure of gear teeth increases, wear increases, and the gear jumps out easily. There are various reasons why intermeshing depth reduces. One of them is insufficient intermeshing depth at the time of a gear shifting caused by worn grooves of the sleeve and shift arm. When intermeshing depth is insufficient, the intermeshed gear or sleeve inclines against the mainshaft, and the sleeve tends to move. When direction of this movement is reversed to the shifting direction, gear jump out occurs. However, the direction is the same as gear shifting, an over-shift occurs, a large friction force is applied to the contact portion of sleeve groove and the shift arm, and wear increases.

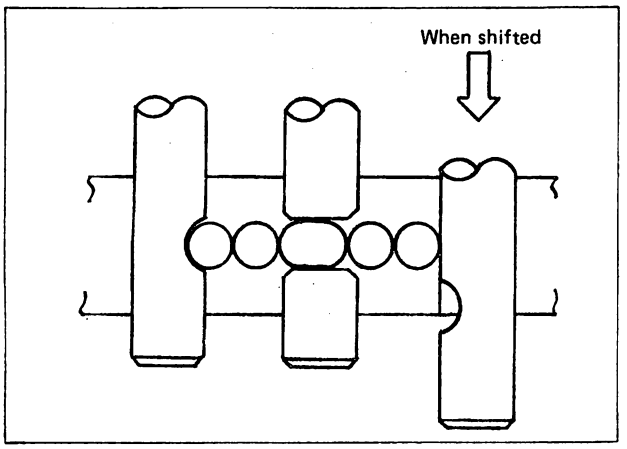
To prevent undesireable occurrences as mentioned above, dog teeth of a gear are provided with a stopper, or shifter rod is provided with an allowance during gear shifting so that a large friction force is not applied to the contact portions.

Double engagement preventing device

When controlling a transmission, normally, it is slightly hard to shift the gears to over-drive or reverse and it is easy to others. For this reason, two sets of gear may possibly engage due to an erroneous shifting. Actually, however, a preventing device is installed so that double engagement will not occur.

This device consists of lock balls located between shifter rods and pins inserted into the rods, and the rods are provided with grooves into which the balls enter.

- When positioned to neutral
  There is a gap between all the lock balls, lock pins and rods. This gap is equivalent to the depth of the groove on a rod and any rod can be moved.



o When a rod is shifted, the inter lock pin(s) is(are) being pushed by the rod, it enters the groove of the neighboringrod, and thus, the inter lock pin locks the rod. Through these operations, the rods other than the shifted rod are locked, preventing double engagement.

SECTION 4

LUBRICATION

Be sure to use engine oil, not gear oil, as lubricating oil for the (MSA, MSB) type transmission.

Basic roles of Transmission oil (Engine oil)

- **Prevents wear and seizure of gear teeth and bearings.**
- **Reduces friction and prevents power loss.**
- **Provides a cooling effect. (Prevents temperature rise casused by motion).**
- **Prevents noise, vibration and shock.**
- **Washes away foreign matter from lubricating surfaces.**

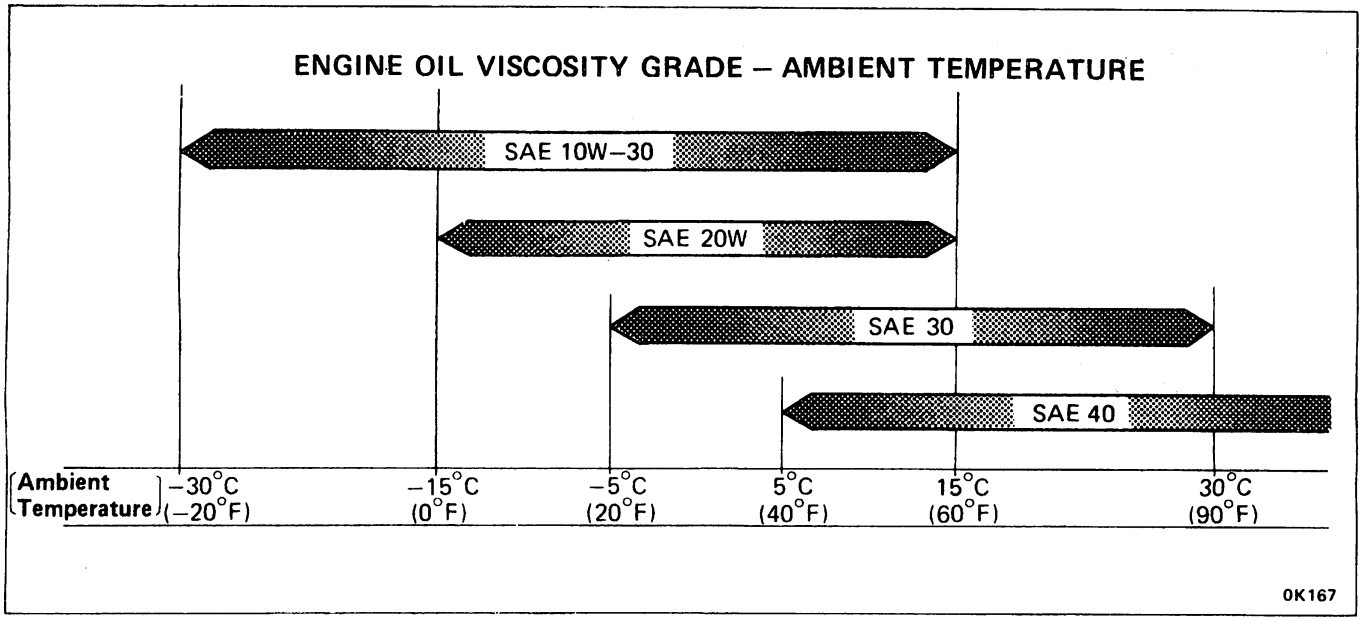
Lubricating oil of excellent quality has come to be required to efficiently operate the mechanisms and protect them from trouble as conditions of use added severity with the progress of vehicles (higher speed, greater horsepower, and more load).
The following performance requirements must be satisfied in order to play the above-mentioned basic roles.

- **Oil must have adequate viscosity characteristics**
- **High fluidity at low temperature**
- **High oxidation stability**
- **High rust and corrosion preventing performance**
- **High foam-eliminating performance**
- **Minimum rubber expanding characteristics**

Classification of Engine oil

There are two types of classification: The SAE viscosity classification, and the API service classification.

Relationship between recommended SAE viscosity and operating temperature.



API service classification

Engine oils are classified by both applications and severity under which the oils, are used. Classification in this manner is called "Service Classification". To allow vehicles to give the optimum performance and operating safely, it is important to select the most suitable oil.

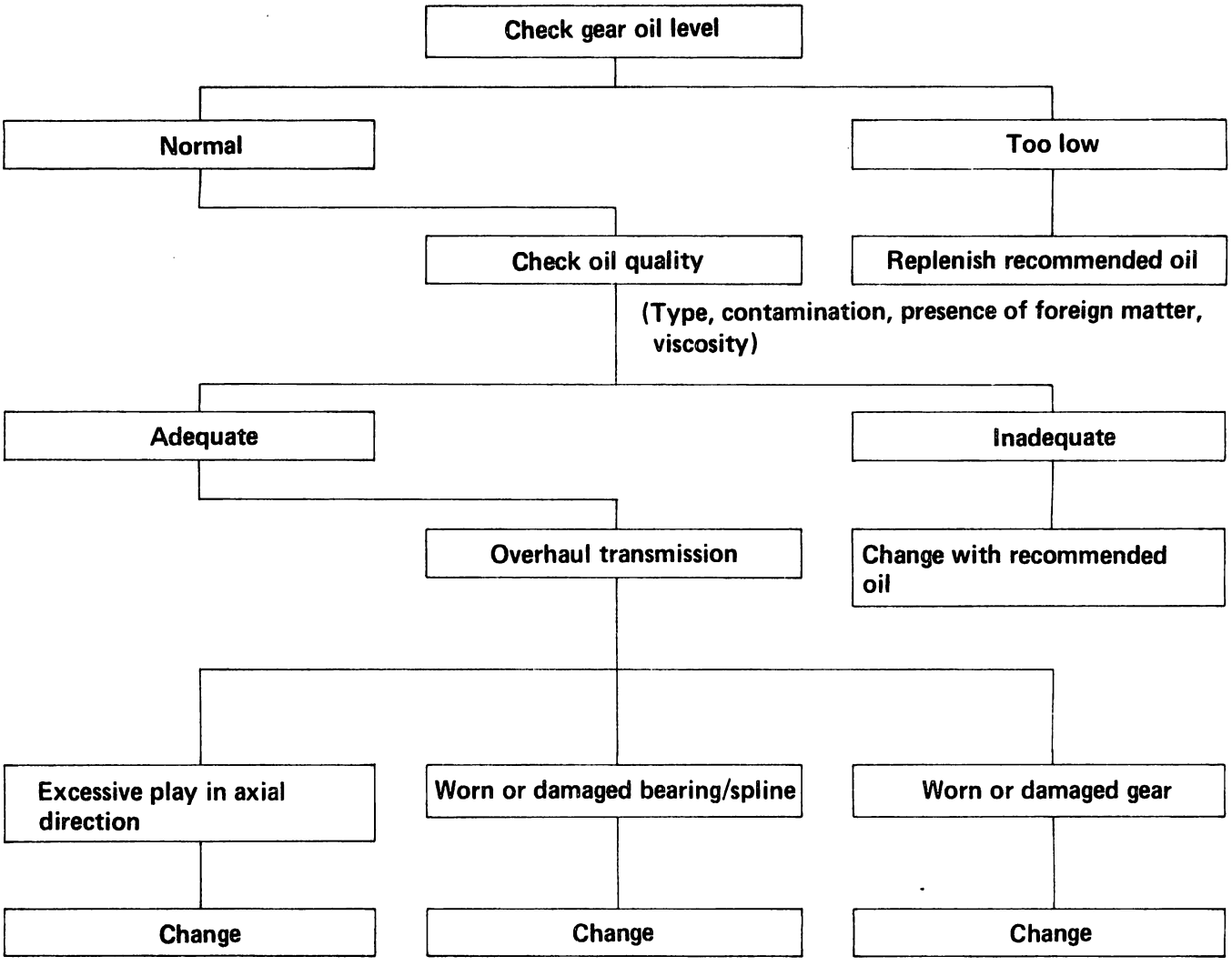
API CLASSIFICATION		REMARKS
For GASOLINE ENGINE	For DIESEL ENGINE	
SC	CC	RECOMMENDED
SD	CD	
SE	———	

SECTION 5

TROUBLE-SHOOTING

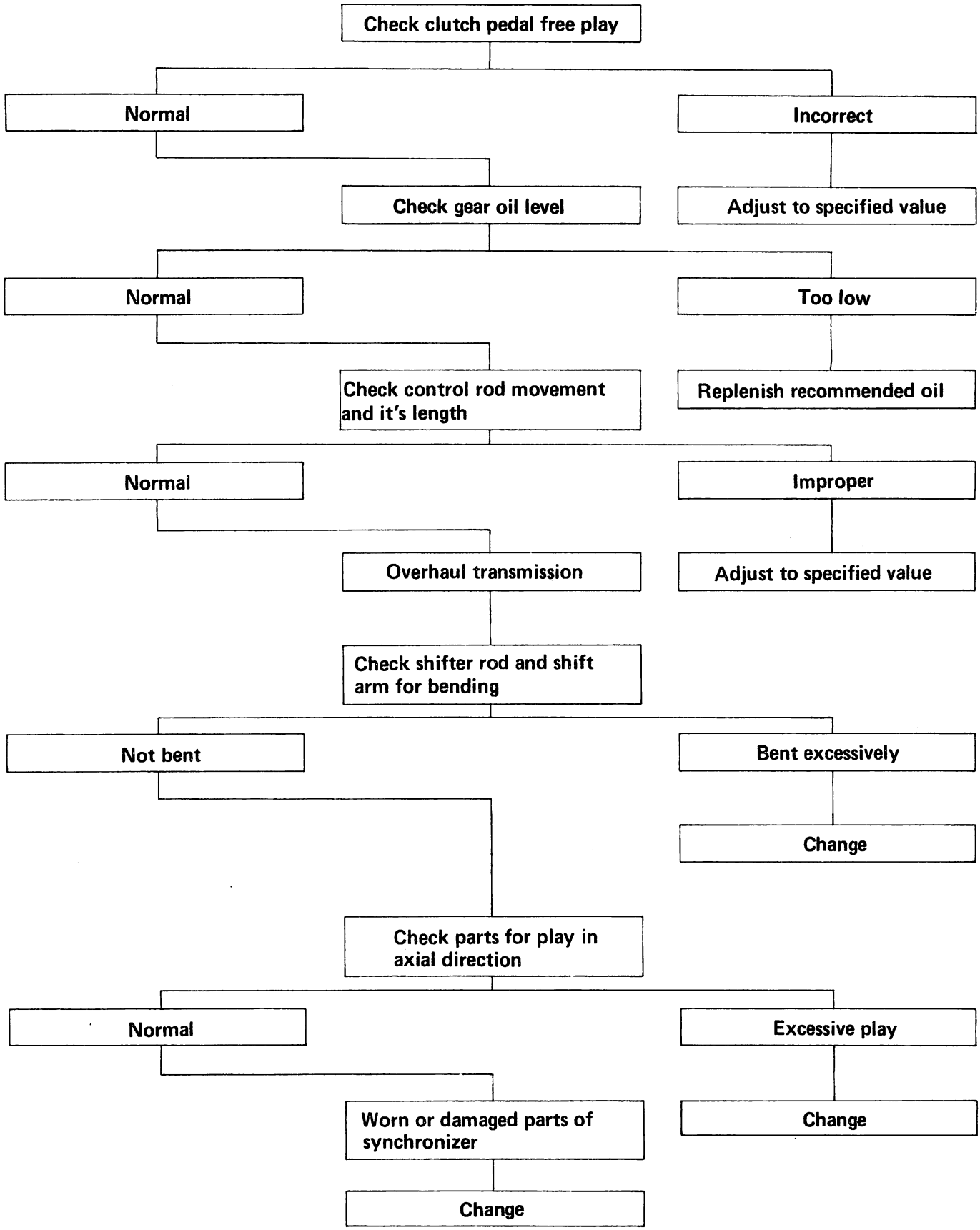
Noise is generated from the transmission

When a noise is generated from the vicinity of the transmission during idling, first, disengage the clutch. If the noise stops, the noise is generated from the transmission.



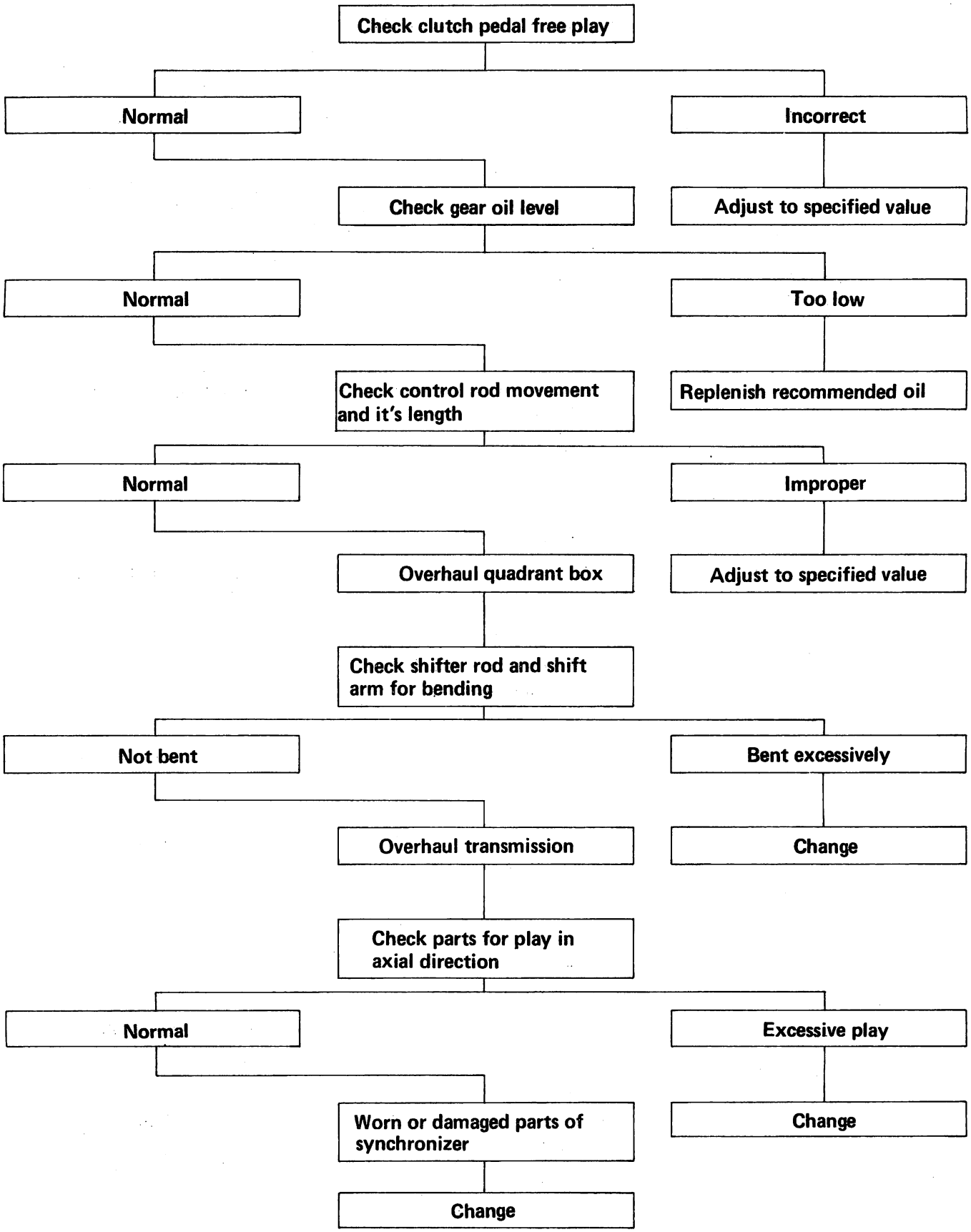
Gears cannot be shifted smoothly. (A sound is generated during shifting)

Only MSB Type



Gears cannot be shifted smoothly. (A sound is generated during shifting)

Only MSA Type



Gear jump out