- **SECTION 2**

  STRUCTURE OF TRANSFER CASE AND ITS OPERATING PRINCIPLE

  The structure of VG1200 Type transfer box is basically the same as that of VG2000, now VG1200 Type transfer box is taken to brief the structure and operating principle.

- Ⅰ VG1200 Transfer Case With out Interaxle Differential
- As shown in Fig.5-1, the transfer case is composed of housing, 4 shafts and driving gears. The power of transfer box, through short propeller shaft, is delivered to input shaft 2 from drive flange 1. Two driving gears 4 and 8 are installed on the input shaft 2, the two driving gears are sleeved on the shaft freely. A engagement sleeve 6, which is coupled with the shaft and spline, can move leftwards and rightwards, so that the input shaft can be engaged respectively with the driving gears 4 and 8. The intermediate shaft 18 is a double-link gear wheel shaft, its left and right gears are engaged respectively with gears 4 and 8, at the same time, the left gear is also meshed to gear 13 of rear drive shaft. One end of front drive shaft 15 is inserted inside rear drive shaft 13, and another end is supported on the end cover by using bearing.

- During normal running on the road, no compressed air gets into the front drive gear cylinder, under the action of spring force, the gear piston returns to the position as shown in Fig.5-1, the shifting fork drives the engagement sleeve 14 to return to the position as shown in Fig. At this time, the power, through transfer box, is directly delivered to the rear drive axle by rear drive output shaft 13, drive flange 11 and propeller shaft.

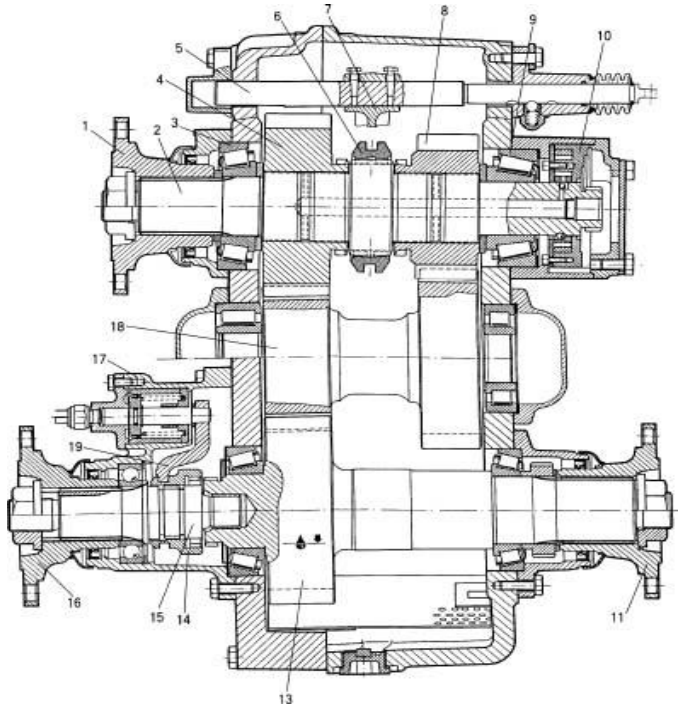
- while the front drive axle is in disconnected state without load. When the vehicle is running on the slosh road surface or in a grade climbing state with high drag (cross-country), driver presses down the "front drive" button, the front drive solenoid valve is energized and to be open, the compressed air goes to the geared cylinder 17 through solenoid valve, the piston is pushed by compressed air to move rightwards, and the engagement sleeve 14 is meshed with drive shaft 13 through shifting fork 13. At this time, the power, through power transfer box, is delivered to the front driving shaft 15 and rear driving shaft 13, and via front driving flange 16 and front propeller shaft, it is delivered to the front driving axle, through rear driving flange 11 and rear propeller shaft, is delivered to (middle) rear driving axle, thus realizing full wheel driving. It is worth to point out that, after the transfer case and front driving shaft are meshed, the front driving shaft and rear driving shaft becomes one. Therefore, there is no speed difference between front driving shaft and rear driving shaft at any moment. At any moment, its torque (power) is distributed equally to the front and rear.

- There are two steps for VG1200 Type transfer case. As shown in Fig.5-1, when the engagement sleeve 6 is pushed rightwards to mesh the low speed driving gear 8, the power will be delivered to the input shaft 2 from driving flange 1, to low speed gear 8 through the engagement sleeve 6, to the intermediate shaft 18 through meshed gears, then to the output shaft gear 13 through the left driving gears of intermediate shaft, thus to the front driving shaft. Because of two-stage speed reduction of the gear 8 with the right gear of intermediate shaft and the left gear of intermediate shaft with the gear 13 of the output shaft, thus the input is delivered to the output with a certain reduction ratio, realizing the low speed gear driving. When the engagement sleeve 6 is operated to move leftwards so that the input shaft 2 meshes with high speed gear 4, the power is delivered to the high speed gear 4 from the flange 1 and input shaft 2 through engagement sleeve 6, after that, directly to the output shaft gear 13 via the left gear of intermediate shaft 18, with transmission ratio 1=1 of direct gear, and finally to the front, rear driving axles, thus realizing the high speed gear.

- Generally speaking, under the highway running condition, the front drive is usually disengaged and the transfer case is engaged to direct gear, thus saving power and reducing the parts wearing. Under the off-highway cross-country running condition, it is necessary to engage the front drive. Only when cross-country drag is relatively big (for example grade-climbing), can the low speed gear be engaged. Fig.5-2 shows the power delivery diagrams in different operation conditions, in which A is the highway running condition, B is the off-highway running condition and C is off-highway low speed gear running condition.

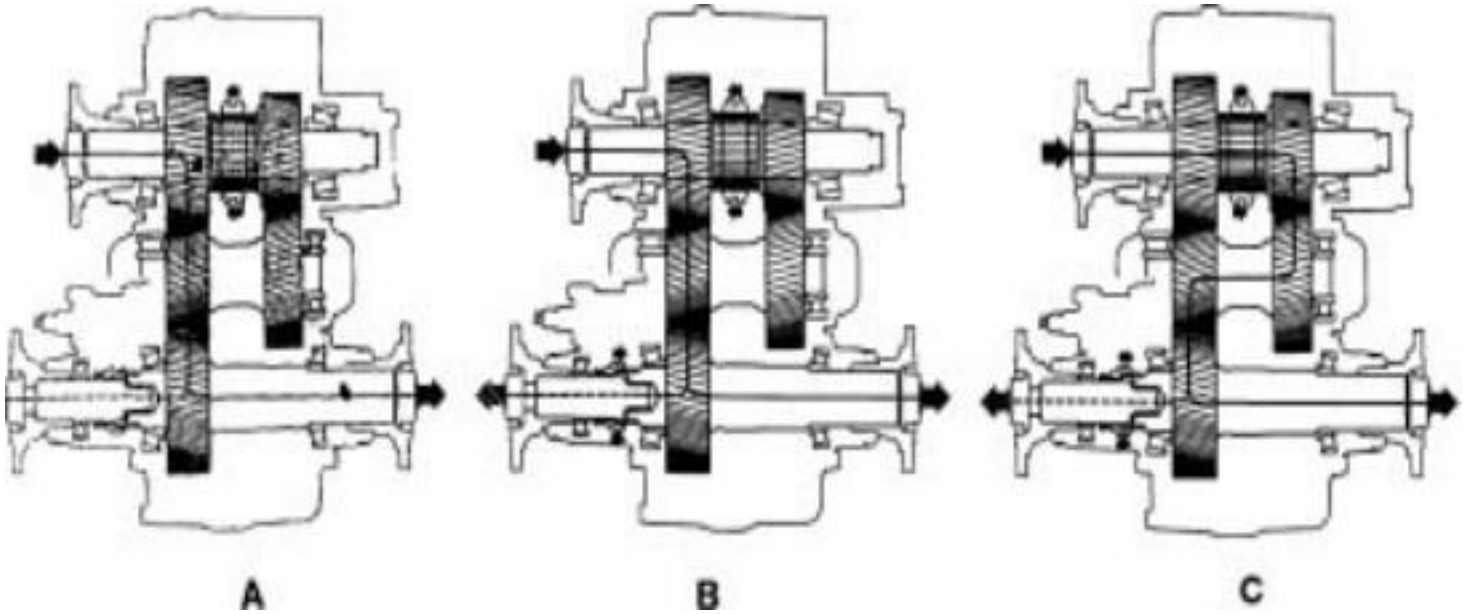
- There are three kings of transmission ratio I=1.22、1.75 and 1.91 for the low speed gear of VG1200 Type transfer case. Refer to Fig. 5-3 for teeth numbers of three transmission ratios. The commonly-used transmission ratio is 1.75, the other two transmission ratios are optional for customers.

- Fig.5-1 VG1200 Type transfer case structure

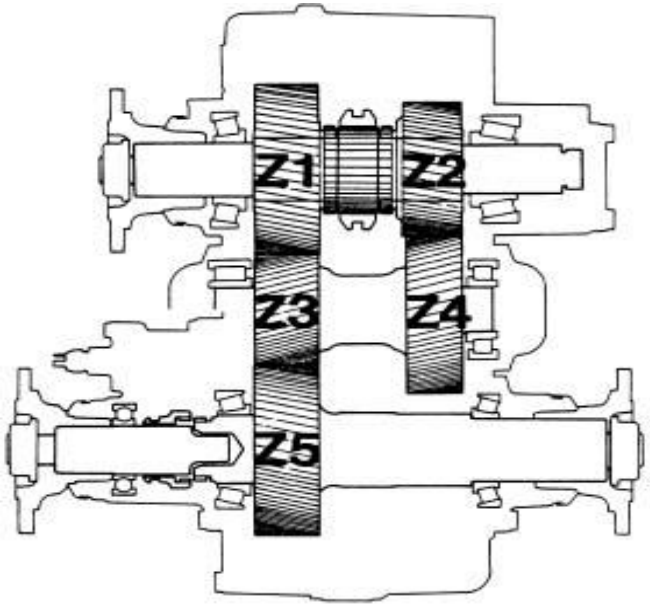


- 1. Flange 2. Input shaft 3. Bearing 4. High speed gear 5. Shifting shaft 6. Engagement sleeve 7. Shifting fork 8. Low speed gear 9. Bearing 10. Oil pump 11. Rear driving flange 13. Output shaft gear 14. Engagement sleeve 15. Front driving shaft 16. Front driving flange 17. Front driving gear cylinder 18. Intermediate shaft

- Fig. 5-2 Power delivery diagram



- Fig.5-3 Teeth number of gear with various transmission ratios



Transmission ratio of low speed gear i	1.22	1.75	1.91
Z1	23	23	23
Z2	21	17	17
Z3	17	23	17
Z4	19	22	24
Z5	23	23	23

- The lubrication mode of combined splash lubrication and pressure lubrication is adopted for VG1200 Type transfer case. An internal gear oil pump 10 is installed on the end of input shaft as shown in Fig. 5-1 and Fig. 5-7. The lubricating oil drawn from the bottom of transfer case mainly lubricate the shaft hole and shaft of two driving gears 4 and 8 throughcentral input oil passage. In winter time, because the temperature is very low and oil viscosity is thick, the oil pump is hard to operate, and the lubrication condition at low temperature is rigour. Therefore, for vehicle installed with such transfer case, at the beginning of running, it is necessary to transfer gradually from low speed running to high speed running, so that the vehicle can run at high speed after the oil temperature rises to normal.

- **Ⅱ. VG1200 Transfer Case with Interaxle Differential**
- There is a big shortcoming for the transfer case with no interaxle differential: that is, before engagement and after driving, the front driving shaft and rear driving shaft have already become one rigid shaft, therefore there is not only no speed difference action between front shaft and rear shaft, but also the power will be distributed equally to the front and rear at any moment. Due to the distribution of vehicle axle load, generally the front driving shaft needs only 1/3 of total power. Therefore, this kind of transfer case causes waste of power, and is unable to bring into full play of engine power performances. At the same time, because there is no speed difference between the front and rear shafts, the wearing and damage of parts will be accelerated when

  running on uneven road surfaces.

- In order to solve this problem, a cylindrical planetary pinion differential can be added between the front and rear driving shafts for VG1200 Type transfer case. It not only plays a function of speed difference between front and rear shafts, but also distributes 1/3 power (torque) to the front shaft and 2/3 power to the rear shaft at any moment when the differential lock is not engaged. In this way the reasonable power distribution is realized, so it is also called a torque distributor.

- Fig. 5-4 shows the structure of VG1200 Type transfer case with cylindrical planetary pinion interaxle differential (torque distributor).
- As shown in Fig. 5-4, the power is delivered to the output shaft gear 3 from the intermediate shaft gear, while the gear 3 is also the planetary gear carrier, there are 5 planetary gears 5 around it. While the sun gear 4 of the planetary gear mechanism is integrated with the front driving shaft 2, and the ring gear 6 is integrated with the driving shaft 7. Thereout it plays a function of speed difference between the front shaft and rear shaft, so as to adapt to the needs of running on road surface

- At the same time, due to reasonable matching of the differential gear teeth numbers, at any moment 1/3 power is distributed to the front shaft and 2/3 power is distributed to the rear shaft, so as to adapt to the driving needs of axle load. The front driving shaft of this transfer case is normally engaged. Therefore it enhances the throughput performance of vehicle while not increasing the mechanical wearing.

- When the vehicle is running on smooth or sloughy road and has slippage (for example, the front wheel slipping or rear wheel slipping). If the interaxle differential lock inside driving axles are engaged, however the vehicle still can not get out from the defective road, then the interaxle differential lock inside VG1200 transfer case needs to be engaged. As shown in Fig. 5-4, at this time the engagement sleeve 1 of differential lock is meshed with the planetary gear carrier 3 into one, that is, the driving shaft 2 and planetary gear carrier 3 becomes rigid one. At this time the whole planetary gear differential becomes an integrated one, it will no longer play a speed difference function, that is to say, the front driving shaft and rear driving shaft are becoming an integral one and the vehicle will be able to get out from defective road.

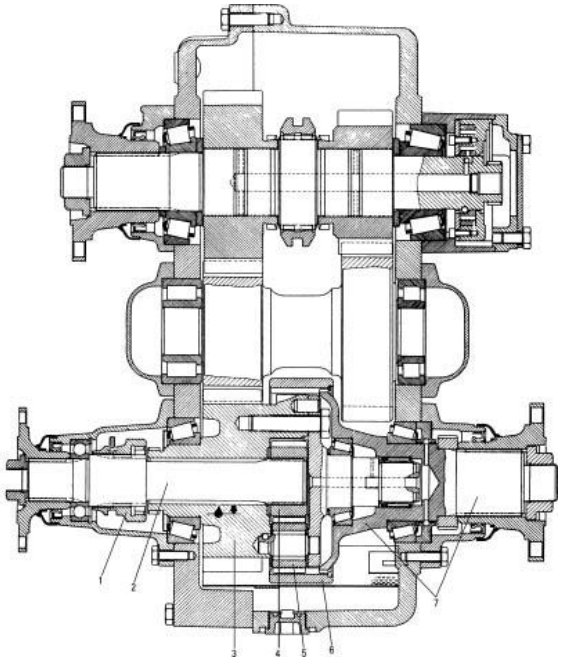
- Fig.5-5 shows the power distribution condition, in which diagram A is the condition that the differential is functioning, the 1/3 power is delivered to the front and 2/3 is delivered to the rear. Diagram B is the condition that the differential lock is engaged, at that time the front and rear driving shafts are becoming an integral one. The power will be distributed equally to the front and rear.

- There are also two steps for this kind of transfer case: direct gear and low speed gear. There are two transmission ratios for low speed gear.

  Refer to Fig. 5-6 for different driving gear teeth numbers:

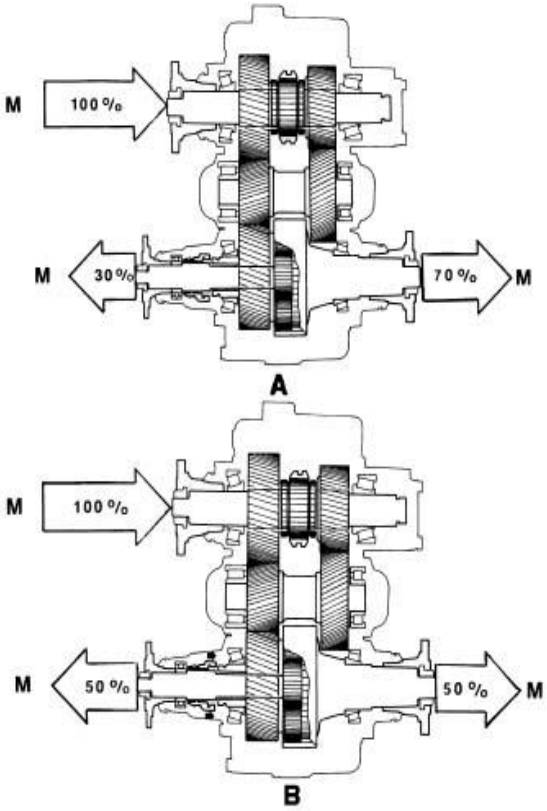
Transmission ratio of low speed gear i	1.75	1.22
Z1	23	23
Z2	17	23
Z3	17	21
Z4	22	19
Z5	23	23
Differential sun gear Z6		28
Planetary gear Z7		18
Ring gear Z8		67
Interaxle differential transmission ratio i=1.239		

- **Fig. 5-4 Transfer case with interaxle differential**

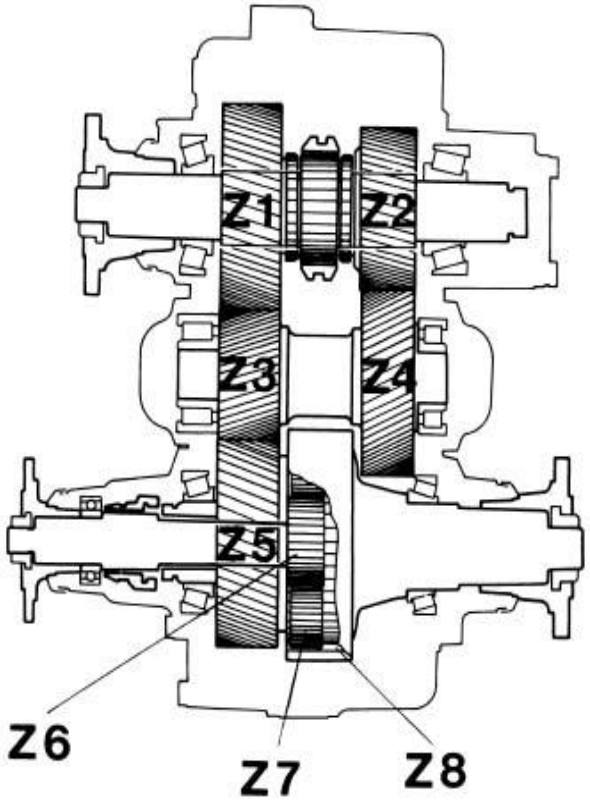


- 1. Engagement sleeve 2. Front driving shaft 3. Plalet carrier 4. Sun gear 5. Planetary gear 6. Ring gear 7. Rear driving shaft

- Fig. 5-5 Power distribution diagram



- Fig. 5-6 Driving gear teeth numbers



- # Ⅲ. Operating Mechanism
- 1. Front Driving Engagement Operation
- Electrical operation is adopted for the front driving engagement mechanism of VG1200 Type transfer case. Refer to Fig. 5-1, depress the front driving switch, turn on the solenoid valve which opens the air inlet port, the compressed air of air reservior enters into the engaged cylinder from solenoid valve and pushes the piston to engage the shifting fork 19, the engagement sleeve 14 moves rightwards, as the result, the engagement sleeve will be meshed with mating teeth on output shaft, the power is delivered to the front driving shaft 15, and then to the front driving axle through propeller shaft. Turn off the front driving switch, the compressed air inside cylinder is deflated from the solenoid valve. Under the action of cylinder return spring, the piston and engagement sleeve move leftwards to return to their original positions, to disengage from the mating teeth of output shaft, and to interrupt the power delivery to the front axle.

- **2. High and low speed gears operations**
- There are two structures of manual and electrical operations for high and low speed gears. Fig. 5-1 shows the manual shifting mechanism, its engagement sleeve and shifting shaft of shifting fork are manually operated by mechanical manner. Fig. 5-7 shows the electrical operation mechanism. The change of high and low speed gears is realized by leftward and rightward movements of the integral shifting cylinder piston of engagement sleeve and shifting fork.

- **3. Operation of differential lock**
- The operation of differential lock is the same as the front driving engagement mechanism.
- Fig. 5-7 Electrically-operated GV1200 Type transfer case