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# 4WD DPS Construction and Function

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## ■ Outline

The real-time 4WD dual-pump system places a hydraulic clutch and a differential mechanism in the rear-differential assembly. Under normal conditions, the vehicle is driven by the front wheels; however, the 4WD dual-pump system can, in accordance with the current front-wheel driving force and road conditions, instantly transmit an appropriate driving force to the rear wheels without requiring the driver to switch between front-wheel drive (2WD) and four-wheel drive (4WD). The mechanism for switching between 2WD and 4WD is integrated into the rear-differential assembly in order to make the system light and compact.

When driving in forward gears rear wheel drive activation (4WD) does not occur during braking. This action allows the braking system to work properly on models equipped with an anti-lock brake system (ABS).

## ■ Construction

The rear-differential assembly consists of a torque-control differential-case assembly and a rear-differential carrier assembly. The torque-control differential-case assembly in turn comprises a differential-clutch assembly, a companion flange, and an oil-pump-body assembly. The rear-differential carrier assembly contains the differential mechanism. Note that the differential drive and driven gears are hypoid gears.

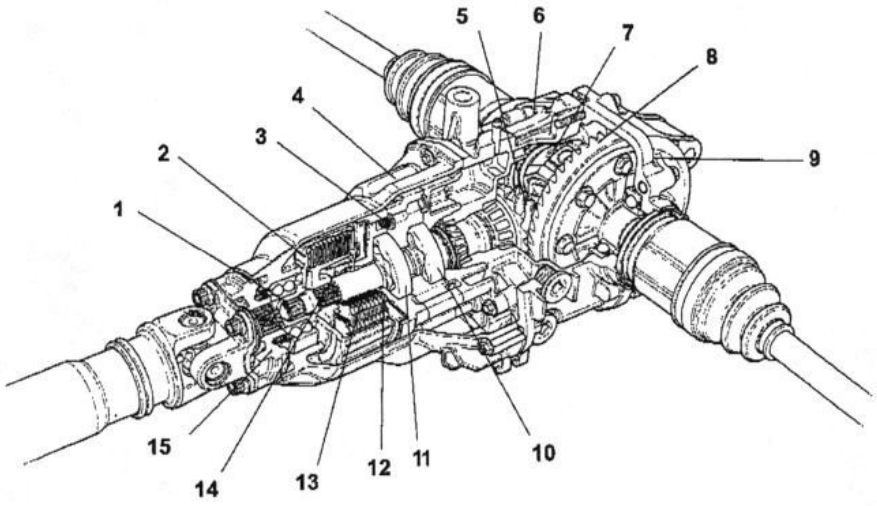
The oil-pump-body assembly consists of a front oil pump, a rear oil pump, a hydraulic-control mechanism, and a clutch piston. The clutch piston contains a disc spring that constantly provides the differential-clutch assembly with a preset torque which prevents unwanted noise.

The differential-clutch assembly contains a clutch guide which is connected to the propeller shaft via the companion flange. This component receives driving force from the transfer case, subsequently rotating the clutch plate and the front oil pump located in the oil-pump body.

The clutch hub located in the differential-clutch assembly contains a clutch disc that is splined with the hypoid-drive pinion gear. The hypoid-drive gear operates to drive the rear oil pump.

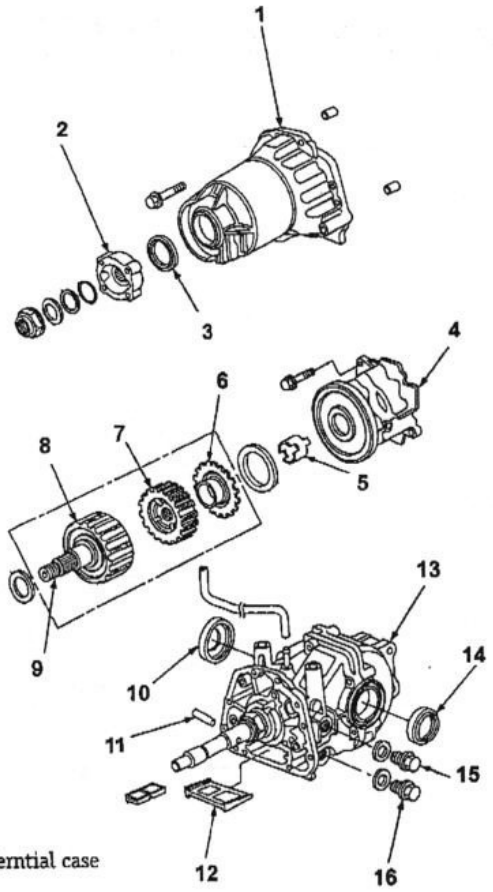
The front and rear oil pumps are both trochoidal pumps. The capacity of the rear-oil pump is 2.5 percent larger than that of the front oil pump. This helps to compensate for the difference in rotation between the front and rear wheels which is caused by tight corner braking and worn front tires. In addition, the oil pumps are designed so that the fluid intake works as a fluid discharge when the oil pumps rotate in reverse. Honda Dual Pump fluid is still being used in this system.

The following drawing shows the components of the rear-differential assembly.




1 Clutch guide
2 Differential-clutch assembly
3 Oil pump body
4 Torque-control differential case
5 Hypoid-drive pinion gear
6 Differential carrier
7 Differential
8 Hypoid-ring gear
9 Differential housing
10 Rear-oil pump
11 Front-oil pump
12 Clutch disc
13 Clutch plate
14 Clutch hub
15 Companion flange

The following drawing shows the components of the rear-differential assembly.




1 Torque-control differntial case
2 Companion flange
3 Oil seal
4 Oil-pump assembly
5 Oil-pump driveshaft
6 Pressure plate
7 Clutch hub/plates/discs
8 Differential-clutch assembly
9 Clutch guide
10 Oil seal
11 Oil-pump pin
12 Oil strainer
13 Differential-carrier assembly
14 Oil seal
15 Oil-filler plug

## ■ Operation

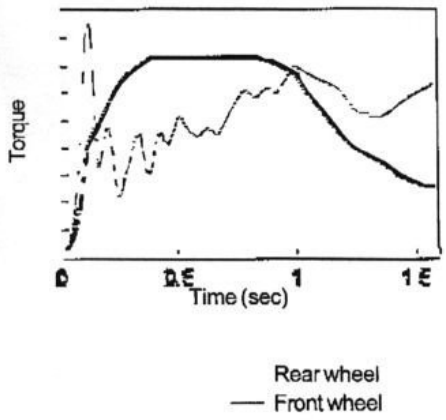
When there is a difference in rotation speeds between the front wheels (i.e. clutch guide) and the rear wheels (i.e. hypoid-driven gear), hydraulic pressure from the front and rear oil pumps causes the differential clutch to be engaged. This enables drive force from the transfer case to be applied to the rear wheels.

The hydraulic-pressure control mechanism from the oil-pump body selects 4WD mode when rotational difference between the front and rear wheels is generated. This is caused from accelerating in a forward or reverse gear, or when braking in a reverse gear (decelerating). This mechanism switches to 2WD mode when there is no rotation difference between the front and rear wheels. This is caused when the vehicle is driven at a constant speed in a forward or reverse gear, or when braking in a forward gear (decelerating).

The differential-clutch assembly is lubricated by hydraulic pressure generated from the oil pumps, and can be generated in either 2WD or 4WD modes. The thermal switch relieves hydraulic pressure on the clutch piston and cancels 4WD mode if the temperature of the differential fluid rises beyond specified operating levels.

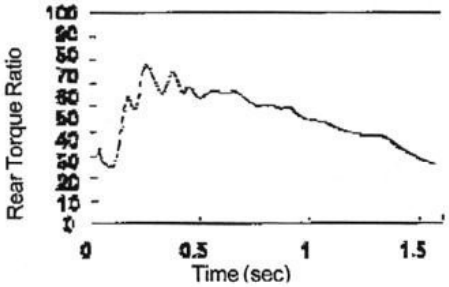
The Dual Pump system operates differently than a full time 4WD system, which controls torque transmission with a center differential. Unlike a conventional 4WD system that can be turned on and off by a switch, the dual pump system is activated mechanically. This system uses wheel speed differences between the front and the rear wheels in order to control rear wheel drive torque. The transmitted torque (4WD) can be engaged anytime while driving to maintain driveability, except when deceleration in a forward gear (braking). This system delivers Front Mounted Engine, Front Wheel Drive (FF) car driving feel on high grip roads (e.g. asphalt pavement), while achieving 4 WD controllability.

**Graph 1:** When accelerating from a stopped position in snowy conditions.



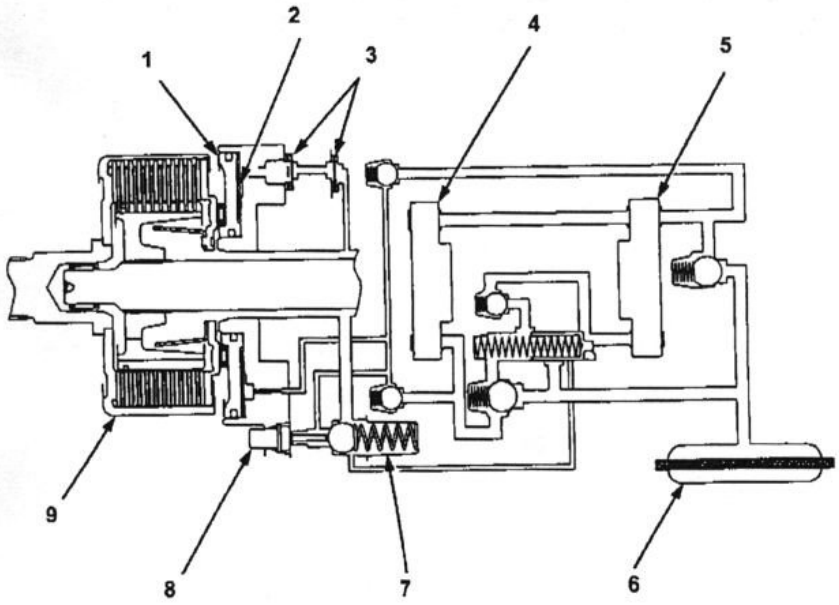

As front wheel torque reduces, the system transmits rear wheel torque in order to maintain starting performance. After traction has been achieved, the system reduces transmitting torque to the rear wheels reducing driving load.

**Graph 2:** Shows above conditions torque transmition ratio.




$$\text{Rear Torque Ratio} = \frac{\text{Rear wheel torque}}{\text{Front \& Rear torque}}$$

The following diagram shows a schematic for the hydraulic control system of the 4WD dual-pump system.



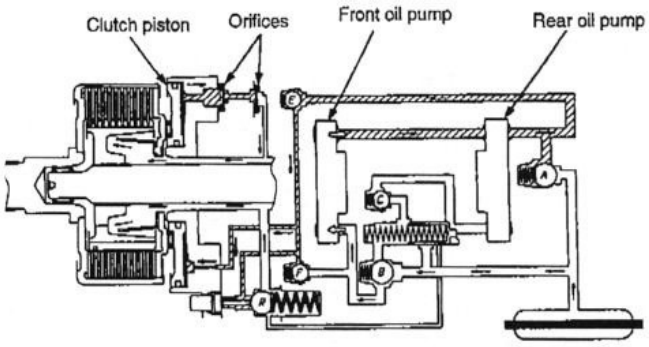

1 Clutch piston
2 Disc spring
3 Orifices
4 Front oil pump
5 Rear oil pump
6 Oil strainer
7 Relief valve
8 Thermal switch
9 Differential-clutch assembly

## ■ Hydraulic Flow in the DPS

### Forward Starting and Acceleration (4WD)

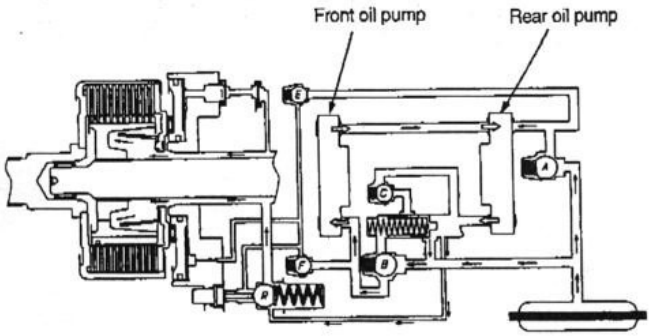
The dual-pump system can engage four wheel drive during a forward start and/or during forward acceleration. If the front wheels begin to spin faster than the rear wheels, the front oil pump will operate faster than the rear oil pump. The front pump draws fluid through check valve B and discharges this fluid, and some of the discharged fluid is drawn in by the rear oil pump. The remaining fluid will pass through check valve E into the clutch piston. There, hydraulic pressure is regulated by the action of two orifices.

The regulated hydraulic pressure acts at the clutch piston to push the plates and discs of the clutch together. The engaged clutch then passes driving force from the transfer case to the rear wheels and enables the vehicle to operate in 4WD mode.



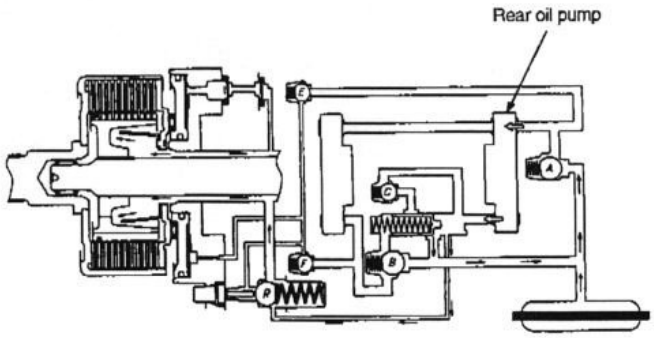

### Forward Driving at Constant Speed (2WD)

When driving forward at a constant speed (i.e., when cruising), the dual-pump system functions in two-wheel drive mode. Since the rotation speed of the front and rear wheels will be identical, the speed of the front and rear pumps will also be the same. The fluid which is discharged by the front oil pump is drawn in by the rear oil pump and is circulated through the system. Because there is no pressure built up at the clutch piston, the clutch does not engage and the vehicle remains in 2WD mode.




**Forward Deceleration (2WD)**

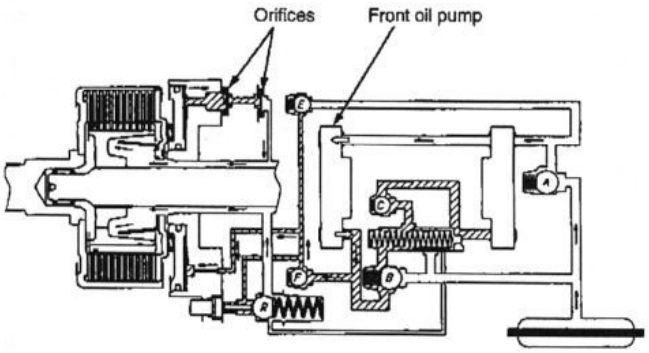
During forward deceleration (braking) the dual-pump system functions in two-wheel drive mode. Rear wheel speed may exceed that of the front wheels during deceleration, causing the rear oil pump to operate faster than the front oil pump. The fluid discharged by the rear oil pump is simply drawn in again and recirculated by that pump. Since there is no build up of pressure at the clutch piston, the clutch piston will not engage and the vehicle will remain in 2WD mode.



**Reverse Start and Acceleration (4WD)**

The dual pump system can engage four wheel drive during reverse start and during reverse acceleration. If the front wheels should begin to spin faster than the rear wheels, the front oil pump will operate faster than the rear oil pump. The front oil pump draws fluid in through check valve A and discharges this fluid. (Note that in reverse, the direction of the pumps is the opposite of that during forward driving.)

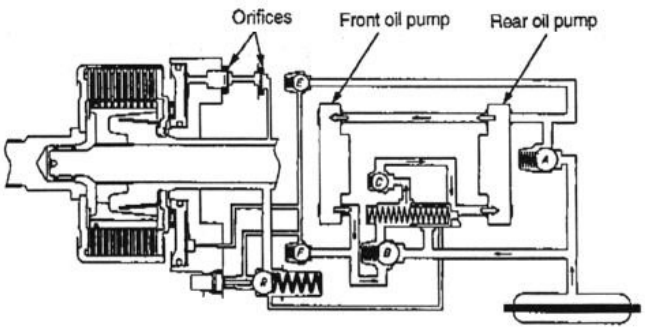
Some of the fluid that is discharged by the front oil pump is drawn in by the rear oil pump. The remaining fluid passes through check valve F into the clutch piston's cylinder, where its pressure is controlled by the action of two orifices. The action of this regulated hydraulic pressure at the clutch piston may force the plates and discs of the clutch into contact and engage a connection. The engaged clutch will pass driving force from the transfer case to the rear wheels and will enable the vehicle to operate in 4WD mode.




**Reverse Driving at Constant Speed (2WD)**

When driving in reverse at a constant speed, the dual-pump system functions in two wheel drive mode. Since the rotation speed of the front and rear wheels will be identical, the speed of the front and rear pumps will also be the same. The fluid which is discharged by the front oil pump is drawn in by the rear oil pump and is circulated through the system. Since there is a difference in the capacities of the two pumps, the fluid will flow through check valve E and then through the orifices. This fluid provides lubrication and cooling to the clutch assembly and bearings.

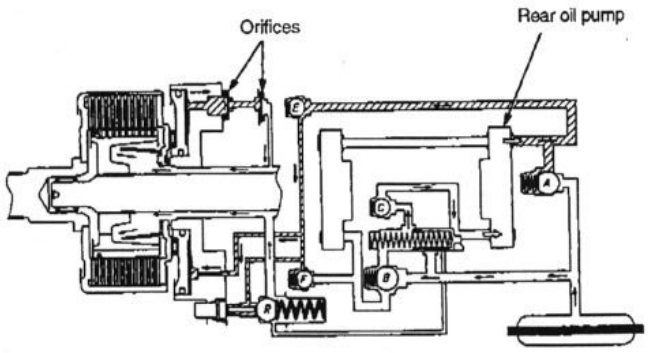
In such a condition, only a low degree of pressure will be built up at the clutch piston. The clutch will not engage and the vehicle will remain in 2WD mode.




**Reverse Deceleration (4WD)**

The dual-pump system can engage four wheel drive during reverse deceleration (braking). When decelerating in the reverse direction, the speed of the rear wheels may exceed that of the front wheels. This causes the rear oil pump to draw fluid through check valves B and C, the rear oil pump discharges some of the fluid which then flows through check valve E to the clutch piston, where the pressure is regulated by the action of two orifices.

The action of the regulated hydraulic pressure at the clutch piston may force the plates and discs of the clutch into contact, forming a connection. If engaged, the clutch will deliver driving force from the transfer case to the rear wheels, thus enabling the vehicle to operate in 4WD mode.



**Thermal Switch Operation (2WD)**

During operation in 4WD mode, pressure-regulated fluid makes contact with the clutch piston and the thermal switch. If the temperature of the fluid in the differential becomes excessively high, the thermal switch will push open the relief valve R. This action causes the pressure in the clutch piston to drop, and 4WD mode will consequently be disengaged.

**Relief Valve Operation**

When the fluid pressure exceeds the relief valve's spring force, check valve R will open, and the pressure applied at the clutch piston will be held constant. This feature adds stability by preventing the rear-wheel drive system from experiencing excessive torque.