DENSO

Basic Technology Series

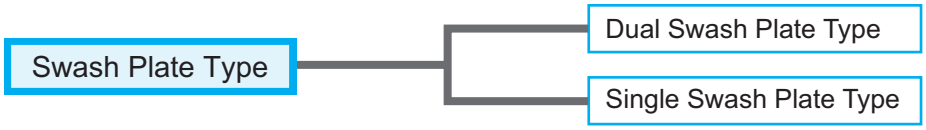
Compressor Fundamentals

2008
Compressor
#002

Swash Plate Type Compressor

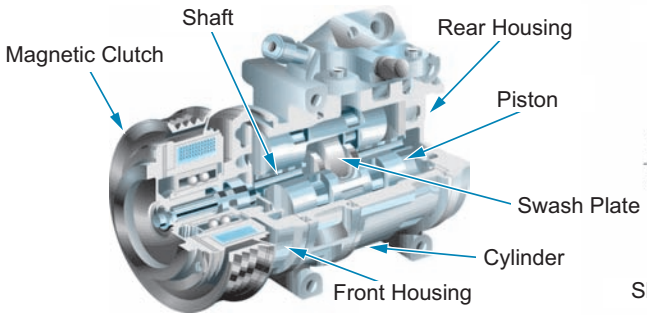
■ Characteristics

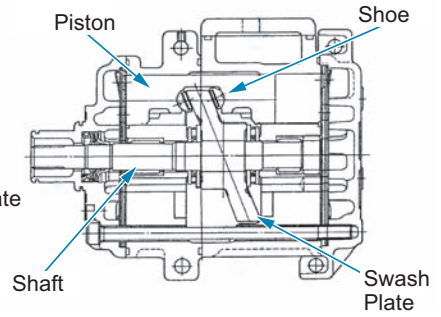
This compressor achieves an all around balance between performance and reliability. The dual swash plate type has pistons on both sides, while the single swash plate type has pistons on one side only. The single swash plate type can continuously modify the discharge capacity in accordance with the thermal load, leading to its widespread recent adoption.



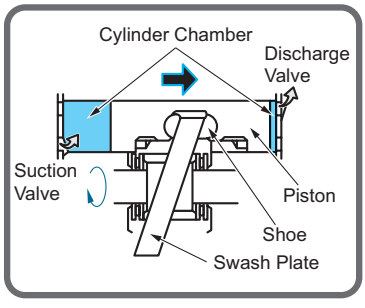
Dual Swash Plate Type

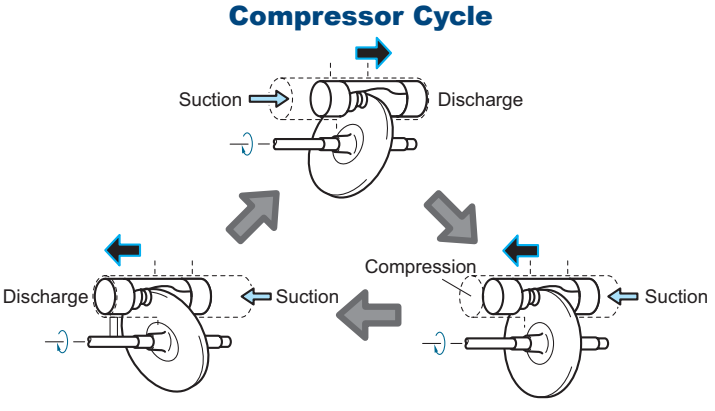
■ Construction





The swash plate is mounted diagonally on the shaft. There are either 3 pistons (with 6 cylinders) or 5 pistons (with 10 cylinders) set with this swash plate. When the shaft rotates, the swash plate forces a reciprocal movement from the pistons in the same direction as the shaft. There are cylinders on both sides of the piston, so when one side is compressing, the other is drawing in refrigerant gas. Thus, each cylinder performs a “compression cycle” for each rotation of the shaft.





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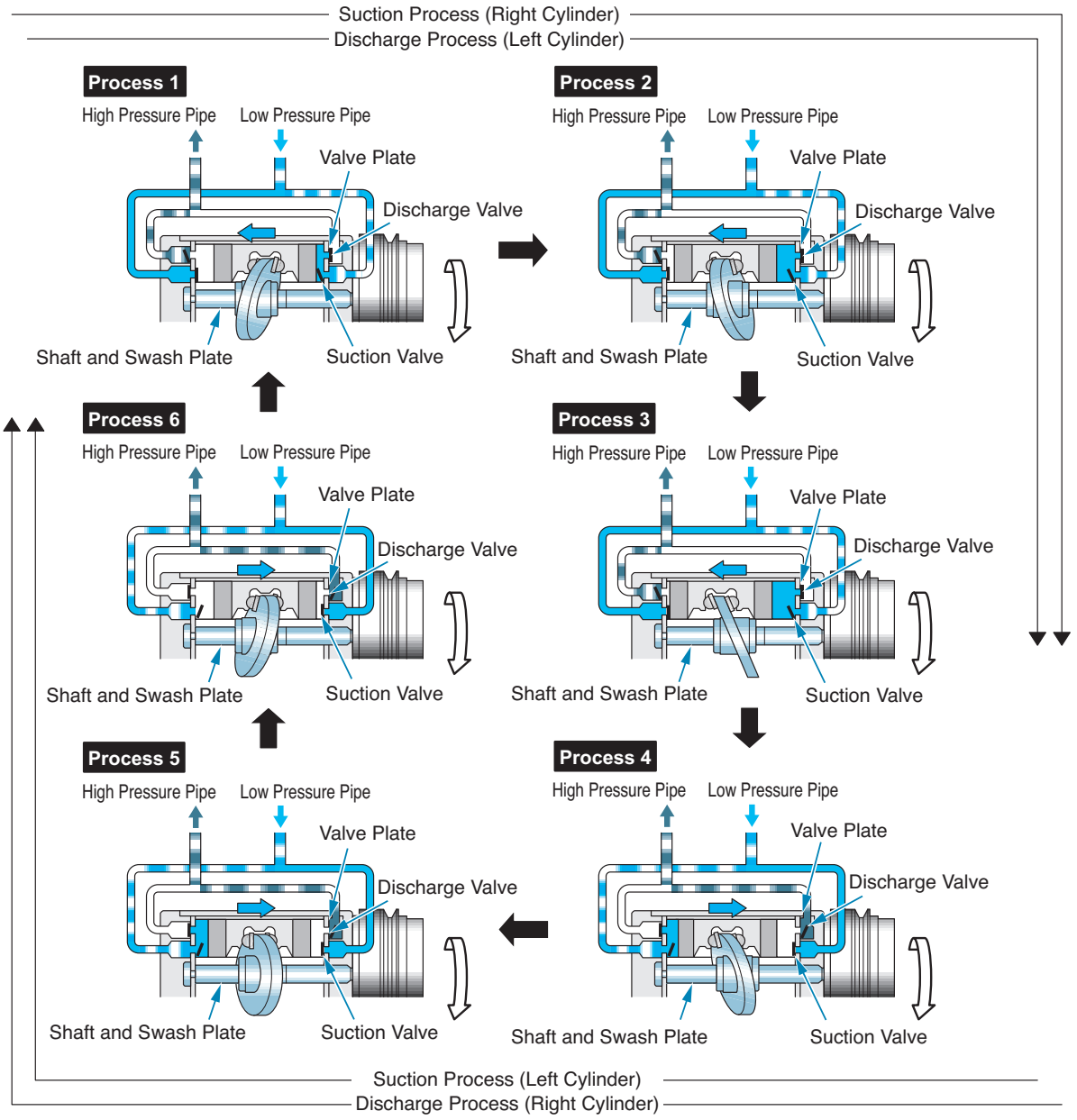
Dual Swash Plate Type – continued

■ Operation

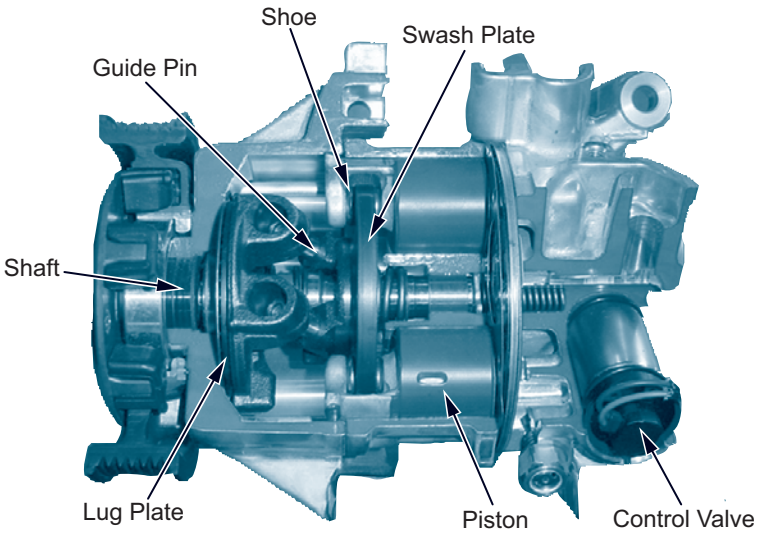
1. Suction process in the right cylinder and compression and discharge process in the left cylinder. **(Processes 1, 2)** The rotation of the swash plate moves the piston to the left side. This increases the capacity of the right side cylinder, causing the suction valve to open. The resultant low pressure draws in refrigerant gas, the force of which keeps the discharge valve closed. Conversely, in the left side cylinder the refrigerant gas is compressed, the pressure of which causes the discharge valve to open, discharging the gas to the high pressure pipe. The high pressure of the refrigerant gas keeps the suction valve closed.
2. Completion of the suction process in the right cylinder and the discharge process in the left cylinder. **(Process 3)** The swash plate continues rotating, moving the piston further to the left side. This completes the suction process in the right cylinder and the discharge process in the left cylinder.
3. Compression and discharge process in the right cylinder and suction process in the left cylinder. **(Processes 4, 5, 6)** Next, the piston starts moving to the right side. This reverses the processes, starting a compression and discharge process in the right cylinder and a suction process in the left cylinder.



Single Swash Plate Type

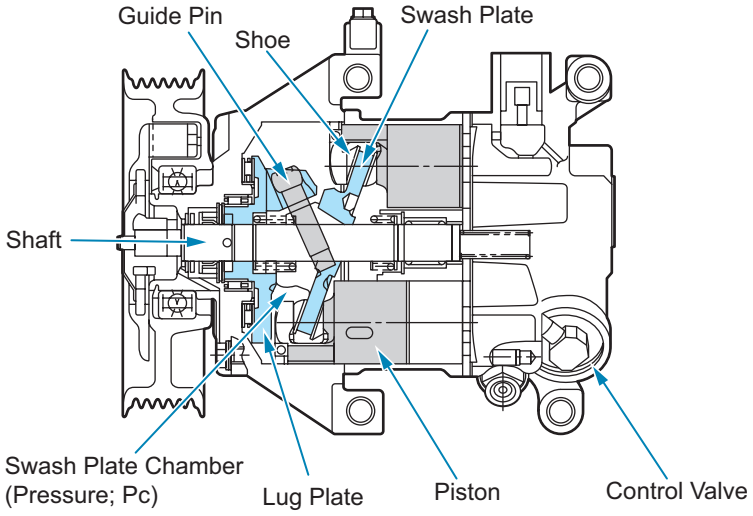
■ Construction and Characteristics

The single swash plate is suitable for variable capacity applications which have their capacity modified by the thermal load. Thus, single swash plates are mostly used in variable compressors.



■ Operation

The lug plate is directly attached to the shaft and rotates with it, causing the guide pin to rotate the swash plate. The shoe converts the rotation of the swash plate into a reciprocal movement inside the cylinder. This starts a suction process in which the piston in the top half of the diagram moves from top dead center (the position furthest to the right) towards the left of the cylinder, and draws in refrigerant gas. At the same time, the piston in the bottom half starts a compression and discharge process, when it moves from bottom dead center (the position furthest to the left) towards the right of the cylinder. This discharges refrigerant gas.

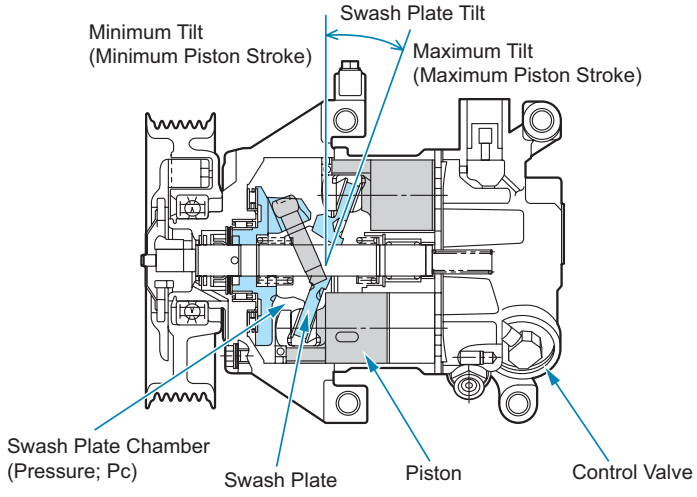


Single Swash Plate Type – continued

■ Variable Capacity

The variable capacity compressor has been developed to decrease energy consumption and increase driving comfort. The single swash plate changes the piston stroke to continuously modify the discharge capacity.

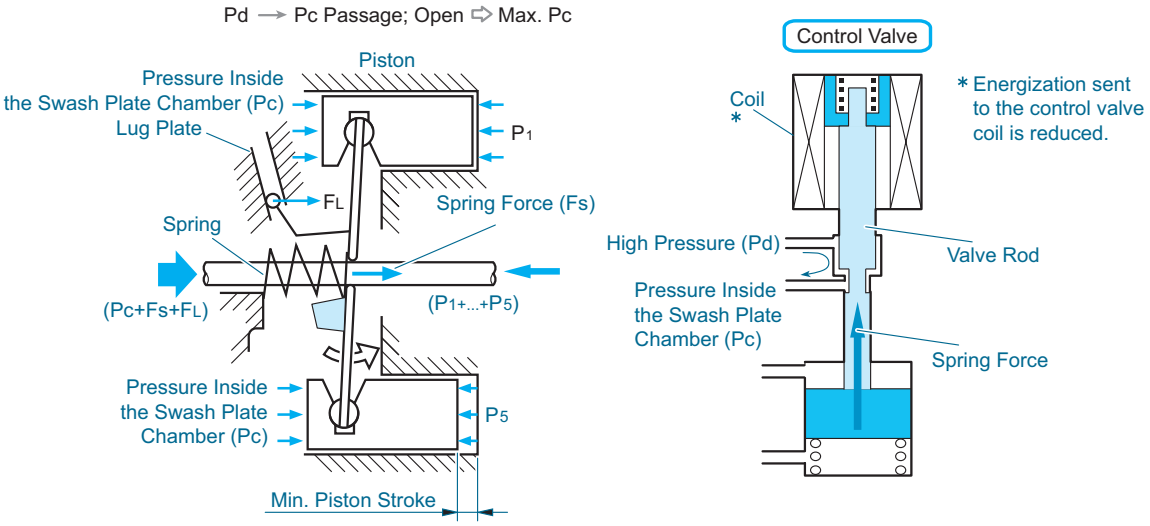
The control valve modifies the pressure within the swash plate chamber. This changes the balance of forces applied to the front and back of the piston, to continuously modify the tilt of the swash plate. The capacity is at its maximum when the lower piston is moved to the left, making the swash plate tilt to its maximum and also producing the maximum piston stroke. When the thermal load reduces, the lower piston is moved to the right and the swash plate tilt is reduced, which reduces the piston stroke and causes partial capacity operation.



■ Operation when there is a small thermal load (low chamber temperature)

Sometimes it is necessary to lower the capacity, such as when the thermal load is small, or during acceleration or high speed driving. In this case, the energization sent to the control valve coil is reduced. As a result, the force of the spring from the bottom moves the control valve to the coil side, opening a passage Pd→Pc. High pressure (Pd) is introduced into the swash plate chamber, gradually increasing the pressure inside. Thus, the pressure on the left side of the piston: (Pc) + the spring force (Fs) + the reactive force from the lug plate (F_L) becomes greater than the pressure on the right side of the piston: (P_1 +...+ P_5). This moves the lower piston to the right and reduces the tilt of the swash plate.

The resultant discharge capacity is reduced, as shown below.



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