-28- Foolishly, the temperature becomes high. As described above, the fuel ignites at this point. Refer to Figure 2-3 (Combustion Stroke State) and (C). The piston (P) is at the state where the valve is closed, and compression ends. (D) Exhaust Stroke: Just before the crank reaches the bottom dead center, the exhaust valve (E) starts to open so that the piston starts rising. (E) Exhaust Valve: As the piston passes bottom dead center, the exhaust valve (E) opens further. When the exhaust stroke is fully reached, the combustion gas is discharged into the atmosphere, ending the exhaust. Refer to Figure 2-3 (1) (Exhaust Stroke). (A little before the crank reaches bottom dead center) (P), the piston is at the combustion stroke. The fuel is injected into the cylinder by the fuel injection device with high pressure and high temperature due to the air. The fuel ignites spontaneously, causing a rapid natural ignition that leads to an explosion in the internal combustion. This is the combustion stroke, also called the power stroke. The expanding force becomes the power that pushes the piston down, which in turn rotates the crankshaft via the connecting rod.

BOS) ATR (A)

-28- **2.4.2 □□□□□**
□□
(1) □□□□□□□□□□
□□2-3□□□□□□□
(2) □□□□□□□□□□
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(3) □□□□
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2.4.3 □□
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(1) □□□□□□□□
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(3) □□□□□
□□□ (A)
□□□ (B)
□□□
-28- **2.4.2 Sealing Mechanism** A sealing mechanism is provided between the pump shaft and the pump casing to prevent liquid inside the pump from leaking to the outside. There are two types of sealing mechanisms: gland packing and mechanical seal. **(1) Gland Packing Type** The gland packing type seals by wrapping packing around the pump shaft and tightening it with a gland follower (see Figure 2-3). Since the packing wears due to friction with the shaft, periodic tightening adjustment is required. Also, a small amount of liquid needs to be leaked to cool the frictional heat with the shaft. **(2) Mechanical Seal Type** The mechanical seal type seals by bringing a rotating ring attached to the pump shaft and a stationary ring attached to the casing

into close contact (see Figure 2-4). Ceramic, carbon, SiC, etc. are used as the material for the rings. Mechanical seals are characterized by higher sealing performance and less leakage than gland packing. However, they also have the disadvantage of being vulnerable to foreign matter contamination and sudden pressure fluctuations. **(3) Seal Fluid** When using a mechanical seal, seal fluid may be used to lubricate and cool the sealing surfaces. Water, oil, or special solvents are used as the seal fluid. The selection of the seal fluid must be made considering the type, temperature, and pressure of the liquid handled by the pump. Using an inappropriate seal fluid can cause premature wear of the seal or contamination of the liquid. **2.4.3 Bearings** Bearings are used to support the pump shaft and ensure smooth rotation. Bearings include ball bearings, roller bearings, and plain bearings. **(1) Ball Bearings, Roller Bearings** Ball bearings and roller bearings are types of rolling bearings with a structure in which balls or rollers are arranged between an inner ring and an outer ring. Because of rolling contact, friction resistance is low, and they are suitable for high-speed rotation. They are widely used as pump bearings. **(2) Plain Bearings** Plain bearings have a structure in which the shaft and bearing metal are in direct contact and rotate. Lubricating oil is supplied between the shaft and the bearing metal to form an oil film and reduce friction. Plain bearings are characterized by less vibration and noise compared to ball bearings and roller bearings. **(3) Bearing Lubrication** Bearing lubrication is very important to prolong the life of the bearing. Lubrication methods include grease lubrication and oil lubrication. (A) Grease lubrication: A method of lubricating by filling the bearing with grease. The grease needs to be replaced regularly. (B) Oil lubrication: A method of lubricating by supplying lubricating oil to the bearing. Oil lubrication includes oil bath lubrication, drip lubrication, forced circulation lubrication, etc.

P

PP2 B

 (1) Exhaust Stroke

Suction Stroke P1 SA

V2 Piston Stroke → V1 Abort

2-4 Four-Stroke Engine Indicator Diagram

As described above, in a 4-stroke (2-reciprocating) engine where (P) is the piston, the crankshaft makes two rotations, and this work stroke occurs only once (Figure 2-4). This figure shows the indicated pressure diagram (PV diagram) of the engine. Gas is introduced into the cylinder, and the piston is sequentially pushed in from position A, compressing it to position B. Conversely, the expansive force of the gas pushes the piston from position B back to position A inside the cylinder. The horizontal axis represents the volume (V) to represent the change in the gas state, and the vertical axis represents the pressure (P). The relationship between pressure and volume represents the state of the gas inside the cylinder. When the piston is at A, the volume is V1 and

the pressure is P1. When the piston is pushed in to B, the volume becomes V2 and the pressure becomes P2. This is represented by the PV diagram, also called the indicated pressure diagram or the pressure-volume diagram. -28-