The specific fuel consumption of the turboprop powerplant is defined as follows:

specific fuel consumption =

$$\frac{\text{engine fuel flow}}{\text{equivalent shaft horsepower}}$$

$$c=\frac{\text{lbs. per hr.}}{ESHP}$$

Typical values for specific fuel consumption, c, range from 0.5 to 0.8 lbs. per hr. per *ESHP*. The variation of specific fuel consumption with operating conditions is similar to that of the turbojet engine. The minimum specific fuel consumption is obtained at relatively high power setting and high altitudes. The low inlet air temperature reduces the specific fuel consumption and the lowest values of c are obtained near altitudes of 25,000 to 35,000 ft. Thus, the turboprop as well as the turbojet has a preference for high altitude operation.

THE RECIPROCATING ENGINE

The reciprocating engine is one of the most efficient powerplants used for aircraft power. The combination of the reciprocating engine and propeller is one of the most efficient means of converting the chemical energy of fuel into flying time or distance. Because of the inherent high efficiency, the reciprocating engine is an important type of aircraft powerplant.

OPERATING CHARACTERISTICS. The function of the typical reciprocating engine involves four strokes of the piston to complete one operating cycle. This principal operating cycle is illustrated in figure 2.15 by the variation of pressure and volume within the cylinder. The first stroke of the operating cycle is the downstroke of the piston with the intake valve open. This stroke draws in a charge of fuel-air mixture along *AB* of the pressure-volume diagram. The second stroke accomplishes compression of the fuel-air mixture along line *BC*. Combustion is initiated by a spark ignition apparatus and combustion takes place in essentially a constant volume. The combustion of the fuel-air mixture liberates heat and causes the rise of pressure along line *CD*. The power stroke utilizes the increased pressure through the expansion along line *DE*. Then the exhaust begins by the initial rejection along line *EB* and is completed by the upstroke along line *BA*.

The net work produced by the cycle of operation is idealized by the area *BCDE* on the pressure-volume diagram of figure 2.15. During the actual rather than ideal cycle of operation, the intake pressure is lower than the exhaust pressure and the negative work represents a pumping loss. The incomplete expansion during the power stroke represents a basic loss in the operating cycle because of the rejection of combustion products along line *EB*. The area *EFB* represents a basic loss in the operating cycle because of the rejection of combustion products along line *EB*. The area *EFB* represents a certain amount of energy of the exhaust gases, a part of which can be extracted by exhaust turbines as additional shaft power to be coupled to the crankshaft (turbo-compound engine) or to be used in operating a supercharger (turbosupercharger). In addition, the exhaust gas energy may be utilized to augment engine cooling flow (ejector exhaust) and reduce cowl drag.

Since the net work produced during the operating cycle is represented by the enclosed area of pressure-volume diagram, the output of the engine is affected by any factor which influences this area. The weight of fuel-air mixture will determine the energy released by combustion and the weight of charge can be altered by altitude, supercharging, etc. Mixture strength, preignition, spark timing, etc., can affect the energy release of a given airflow and alter the work produced during the operating cycle.

The mechanical work accomplished during the power stroke is the result of the gas pressure sustained on the piston. The linkage of the piston to a crankshaft by the connecting rod applies torque to the output shaft. During this conversion of pressure energy to mechanical energy, certain losses are inevitable because