MODULE 16

FOR A CERTIFICATION

PISTON ENGINE

Aviation Maintenance Technician Certification Series

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REVISION LOG

VERSION	EFFECTIVE DATE	DESCRIPTION OF CHANGE
001	2019 04	Module Creation and Release

PISTON ENGINE

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SUB-MODULE 02

ENGINE PERFORMANCE

SUB-MODULE 03

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PART-66 SYLLABUS **LEVELS**

CERTIFICATION CATEGORY →	A1

Sub-Module 01

FUNDAMENTALS

Knowledge Requirements

16.1 - Fundamentals	
Mechanical, thermal and volumetric efficiencies; Operating principles — 2 stroke, 4 stroke, Otto and Diesel; Piston displacement and compression ratio; Engine configuration and firing order.	1

OPERATING PRINCIPLES

FUNDAMENTAL RECIPROCATING ENGINE OPERATING PRINCIPLES

The relationships between pressure, volume, and temperature of gases are the basic principles of engine operation. An internal combustion engine is a device for converting heat energy into mechanical energy. Gasoline is vaporized and mixed with air, forced or drawn into a cylinder, compressed by a piston, and then ignited by an electric spark. The conversion of the resultant heat energy into mechanical energy and then into work is accomplished in the cylinder. ***Figure 1-1*** illustrates the various engine components necessary to accomplish this conversion and also presents the principal terms used to indicate engine operation.

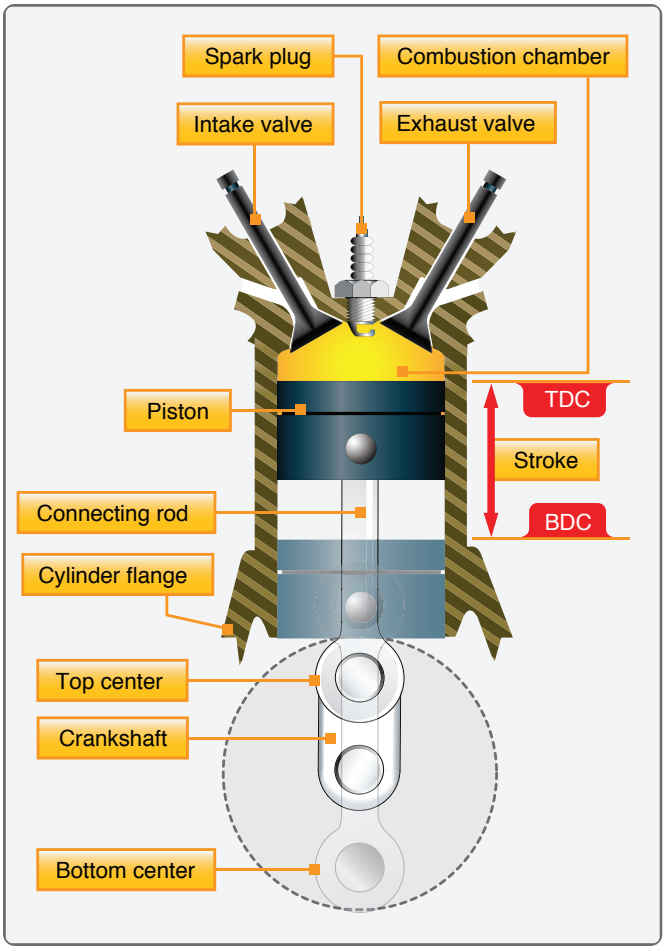

Figure 1-1. Piston engine design and components.

On a typical four-stroke aircraft engine, the operating cycle of an internal combustion reciprocating engine includes the series of events required to induct, compress, ignite, and burn, causing expansion of the fuel/air charge in the cylinder and to scavenge or exhaust the byproducts of the combustion process. When the compressed mixture is ignited, the resultant gases of combustion expand very rapidly and force the piston to move away from the cylinder head. This downward motion of the piston, acting on the crankshaft through the connecting rod, is converted to a circular or rotary motion by the crankshaft. A valve in the top or head of the cylinder opens to allow the burned gases to escape, and the momentum of the crankshaft and the propeller forces the piston back up in the cylinder where it is ready for the next event in the cycle. Another valve in the cylinder head then opens to let in a fresh charge of the fuel/air mixture. The valve allowing for the escape of the burning exhaust gases is called the exhaust valve, and the valve that lets in the fresh charge of the fuel/air mixture is called the intake valve. These valves are opened and closed mechanically at the proper times by the valve-operating mechanism.

The bore of a cylinder is its inside diameter. The stroke is the distance the piston moves from one end of the cylinder to the other, specifically from top dead center (TDC) to bottom dead center (BDC), or vice versa. (***Figure 1-1***)

OPERATING CYCLES

There are several engine operating cycles in use:

1. Four-stroke
2. Two-stroke
3. Rotary
4. Diesel

FOUR-STROKE CYCLE

The vast majority of certified aircraft reciprocating engines operate on the four-stroke cycle, sometimes called the Otto cycle after its originator, a German physicist. The four-stroke cycle engine has many advantages for use in aircraft. One advantage is that it lends itself readily to high performance through supercharging.

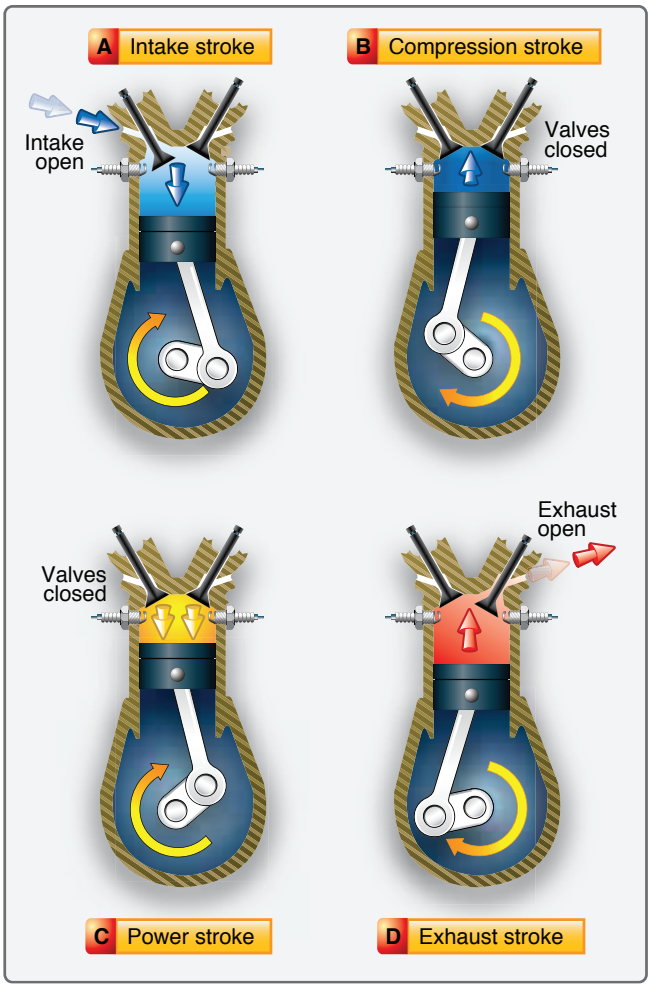

Figure 1-2. Four-stroke cycle.

In this type of engine, four strokes are required to complete the required series of events or operating cycle of each cylinder. Refer to ***Figure 1-2***. Two complete revolutions of the crankshaft (720°) are required for the four strokes; thus, each cylinder in an engine of this type fires once in every two revolutions of the crankshaft. In the following discussion of the four-stroke cycle engine operation, note that the timing of the ignition and the valve events vary considerably in different engines. Many factors influence the timing of a specific engine, and it is most important that the engine manufacturer's recommendations in this respect be followed in maintenance and overhaul. The timing of the valve and ignition events is always specified in degrees of crankshaft travel. It should be remembered that a certain amount of crankshaft travel is required to open a valve fully; therefore, the specified timing represents the start of opening rather than the full-open position of the valve. An example valve timing chart can be seen in ***Figure 1-3***.

INTAKE STROKE

During the intake stroke, the piston is pulled downward in the cylinder by the rotation of the crankshaft. This reduces the pressure in the cylinder and causes air under atmospheric pressure to fl w through the fuel metering device, which meters the correct amount of fuel in proportion to the air ingested by the cylinders. The fuel/air mixture passes through the intake pipes and intake valves into the cylinders. The quantity or weight of the fuel/air charge depends upon the degree of throttle opening.

The intake valve is opened considerably before the piston reaches TDC on the exhaust stroke, in order to induce a greater quantity of the fuel/air charge into the cylinder and thus increase the horsepower (***Figure 1-3***). The distance the valve may be opened before TDC, however, is limited by several factors, such as the possibility that hot exhaust gases remaining in the cylinder from the previous cycle may flash back into the intake pipe and induction system.

In all high-power aircraft engines, both the intake and the exhaust valves are off their valve seats at TDC at the start of the intake stroke. As mentioned above, the intake valve opens before TDC on the exhaust stroke (valve lead), and the closing of the exhaust valve is delayed considerably after the piston has passed TDC and has

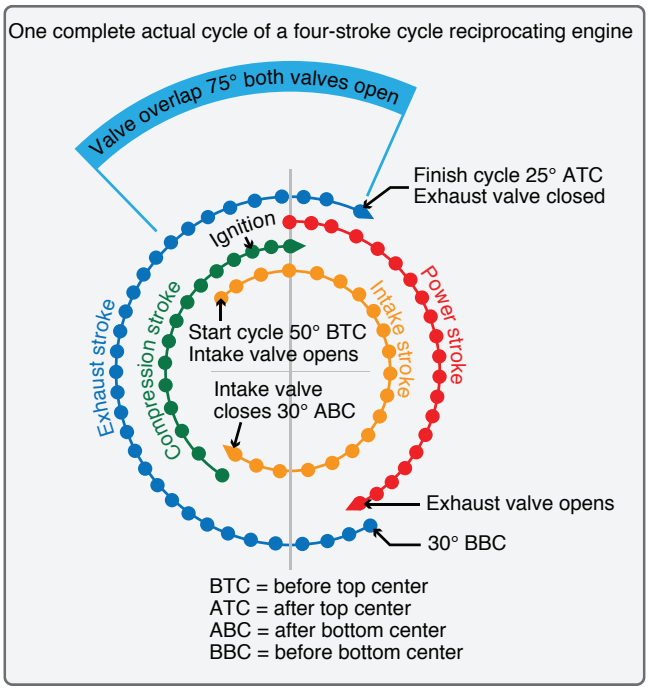

Figure 1-3. Four-stroke valve timing.