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VERSION	EFFECTIVE DATE	DESCRIPTION OF REVISION(S)
001	2016.02	Module creation and release.
002	2017.11	Format updates and minor type corrections.
003	2019.04	Fine tuned Submodule content sequence based on Appendix-A. Updated layout and styling.
003.1	2023.04	Inclusion of Measurement Standards for clarification, page iv. Minor appearance and format updates.
004	2024.12	Regulatory update for EASA 2023-989 compliance.
004.1	2026.02	Updates per EASA 2025-111.

Module was updated based upon the EASA 2025-111. Enhancements included in this version 004.1 are:

14.1 Sections renamed per 2025-111.
14.4 Clarified amperage usage during Start Cycle.
Various minor typographical corrections throughout.

PART 66 BASIC KNOWLEDGE REQUIREMENTS

SUBMODULE KNOWLEDGE DESCRIPTIONS		LEVEL
		B2
14.1	**Engines** (a) Turbine engines. (b) Auxiliary Power Units (APUs). (c) Piston engines. (d) Electric and hybrid powerplants and auxillery systems. (e) Engine control.	 1 1 1 2 2
14.2	**Electric/Electronic Engine Indication Systems** — Exhaust gas temperature / interstage turbine temperature systems; — Cylinder head temperature, engine coolant temperature, engine speed; — Engine thrust indication: engine pressure ratio, engine turbine discharge pressure or jet pipe pressure systems; — Vibration measurement systems; — Oil pressure and temperature; — Fuel pressure, temperature, and flow; — Manifold pressure; — Engine torque.	 2
14.3	**Propeller Systems** — Propeller speed indication; — Speed control and pitch change methods – electrical/electronic; — Synchronising and synchrophasing equipment; — Electrical anti-icing/de-icing equipment.	 2
14.4	**Starting and Ignition Systems** — Operation of engine start systems and components; — Ignition systems and components; — Maintenance safety requirements.	 2

Engines

Submodule
1

SUBMODULE KNOWLEDGE DESCRIPTIONS		LEVEL
		B2
14.1	**Engines**	
	(a) Turbine engines.	1
	(b) Auxiliary Power Units (APUs).	1
	(c) Piston engines.	1
	(d) Electric and hybrid powerplants and auxillery systems.	2
	(e) Engine control.	2

14.1 ENGINES

SECTION A

TURBINE ENGINES

FUNDAMENTALS OF OPERATION

Aircraft require thrust to produce enough speed for the wings to provide lift or enough thrust to overcome the weight of the aircraft for vertical take off. For an aircraft to remain in level flight, thrust must be provided that is equal to and in the opposite direction of the aircraft drag. This thrust, or propulsive force, is provided by a suitable type of aircraft heat engine. All heat engines have in common the ability to convert heat energy into mechanical energy by the flow of some fluid mass (generally air) through the engine. In all cases, the heat energy is released at a point in the cycle where the working pressure is high relative to atmospheric pressure.

The propulsive force is obtained by the displacement of a working fluid (again, atmospheric air). This air is not necessarily the same air used within the engine. By displacing air in a direction opposite to that in which the aircraft is propelled, thrust can be developed. This is an application of Newton's third law of motion. It states that for every action there is an equal and opposite reaction. So, as air is being displaced to the rear of the aircraft the aircraft is moved forward by this principle. One misinterpretation of this principle is air is pushing against the air behind the aircraft is making it move forward. This is not true.

Rockets in space have no air to push against, yet, they can produce thrust by using Newton's third law. Atmospheric air is the principal fluid used for propulsion in every type of aircraft powerplant except the rocket, in which the total combustion gases are accelerated and displaced. The rocket must provide all the fuel and oxygen for combustion and does not depend on atmospheric air. A rocket carries its own oxidizer rather than using ambient air for combustion. It discharges the gaseous byproducts of combustion through the exhaust nozzle at an extremely high velocity (action) and it is propelled in the other direction (reaction).

The propellers of aircraft powered by piston or turboprop engines accelerate a large mass of air at a relatively lower velocity by turning a propeller. The same amount of thrust can be generated by accelerating a small mass of air to a very high velocity. The working fluid (air) used for the propulsive force is a different quantity of air than that used within the engine to produce the mechanical energy to turn the propeller.

Turbojets, ramjets, and pulsejets are examples of engines that accelerate a smaller quantity of air through a large velocity change. They use the same working fluid for propulsive force that is used within the engine. One problem with these types of engines is the noise made by the high velocity air exiting the engine. The term turbojet was used to describe any gas turbine engines, but with the differences in gas turbines used in aircraft, this term is used to describe a type of gas turbine that passes all the gases through the core of the engine directly.

Turbojets, ramjets, and pulse jets have very little to no use in modern aircraft due to noise and fuel consumption. Small general aviation aircraft use mostly horizontally opposed piston piston engines. While some aircraft still use radial piston piston engines, their use is very limited. Many aircraft use a form of the gas turbine engine to produce power for thrust. These engines are normally the turboprop, turboshaft, turbofan, and a few turbojet engines. Now that there are so many different types of turbine engines, the term used to describe most turbine engines is "gas turbine engine." All four of the previously mentioned engines belong to the gas turbine family.

Starting and Ignition Systems

SUBMODULE KNOWLEDGE DESCRIPTIONS		LEVEL
		B2
14.4	**Starting and Ignition Systems** — Operation of engine start systems and components; — Ignition systems and components; — Maintenance safety requirements.	2

14.4 STARTING AND IGNITION SYSTEMS

ENGINE START SYSTEMS AND COMPONENTS

PISTON ENGINE STARTERS

A starter is an electromechanical mechanism capable of developing large amounts of mechanical energy that can be applied to an engine, causing it to rotate. Piston engines need only to be turned through at a relatively slow speed until the engine starts and turns on its own. Once the piston engine has fired and started, the starter is disengaged and has no further function until the next start.

DIRECT CRANKING ELECTRIC STARTERS

The most widely used starting system on all types of piston engines utilizes the direct cranking electric starter. This type of starter provides instant and continual cranking when energized. The direct cranking electric starter consists basically of an electric motor, reduction gears, and an automatic engaging and disengaging mechanism that is operated through an adjustable torque overload release clutch. A typical circuit for a direct cranking electric starter is shown in **Figure 4-1**. The engine is cranked directly when the starter solenoid is closed. As shown in **Figure 4-1**, the main cables leading from the starter to the battery are heavy duty to carry the high current flow, which may be in a range from as high as 350 amperes at the beginning of the start cycle, and reducing to 100 amperes to maintin it depending on the starting torque required. The use of solenoids and heavy wiring with a remote control switch reduces overall cable weight and total circuit voltage drop. The typical starter motor is a 12 or 24 volt, series wound motor that develops high starting torque.

On many units, the torque of the motor is transmitted through reduction gears to the overload release clutch. Typically, this action actuates a helically splined shaft moving the starter jaw outward to engage the engine cranking jaw before the starter jaw begins to rotate. Some starters use direct drive without the benefits of gearing. After the engine reaches a predetermined speed, the starter automatically disengages. The schematic in **Figure 4-2** provides a pictorial arrangement of an entire starting system for a light twin engine aircraft.

DIRECT CRANKING FOR LARGE PISTON ENGINES

In a typical high horsepower piston engine starting system, the direct cranking electric starter consists of two basic components: a motor assembly and a gear section. The gear section is bolted to the drive end of the motor to form a complete unit. The motor assembly consists of the armature and motor pinion assembly, the end bell assembly, and the motor housing assembly. The motor housing also acts as the magnetic yoke for the field structure.

The starter motor is a nonreversible, series interpole motor. Its speed varies directly with the applied voltage and inversely with

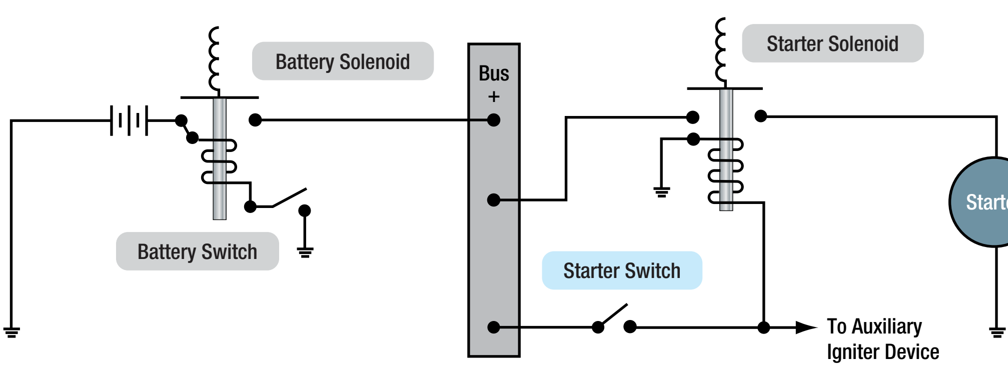

Figure 4-1. Typical starting circuit using a direct cranking electric starter.