Aviation Maintenance Technician Series

Dale Crane

Airframe

Volume 2: Systems

Third Edition

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by Dale Crane

Aviation Supplies & Academics, Inc.
7005 132nd Place SE
Newcastle, Washington 98059-3153
Email: asa@asa2fly.com
Website: www.asa2fly.com

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AIRCRAFT ELECTRICAL SYSTEMS

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An Introduction to Aircraft Electrical Systems

An aviation maintenance technician must have a solid foundation in basic electrical principles and a good working knowledge of the way these principles apply to complex systems. Electrical systems provide the muscle for retracting landing gears and starting engines and serve as the brains for electronic flight control and monitoring systems.

Basic electrical principles are covered in the *General* textbook of the *Aviation Maintenance Technician Series (AMTS)*. In the *General* text, electricity is discussed from a theoretical point of view, with emphasis on its laws. Circuit analysis considers the variables in both AC and DC circuits.

The *Airframe* textbook of the *AMTS* takes up where the *General* text leaves off, including a brief review of electrical terms and facts, followed by the practical application of basic electrical principles to aircraft electrical systems.

The *Powerplant* textbook of the *AMTS* covers practical aspects of the generation of electricity and some of the heavy-duty applications, such as engine starting systems.

Aircraft electrical systems covered here range from the simplest component schematics to logic flow charts used for systematic troubleshooting. The intent of this section is to present aircraft electrical systems in their most practical form.

No specific aircraft electrical schematics are used in this text, but the systems used have been adapted from actual aircraft. The procedures discussed are general in their nature, and this text must be considered as a reference document, not a service manual. Information issued by the aircraft manufacturer takes precedence over any procedure mentioned in this text.

One of the fundamental rules of aviation maintenance is that you must use the latest approved information, such as that furnished by the aircraft manufacturer when servicing any part of an aircraft. This is particularly true of electrical systems, as these systems and their components are far too expensive to risk damage as the result of improper servicing procedures. There are limits as to what an aircraft mechanic or technician can do in the repair of certain electrical or electronic components. Some of these can be repaired only by the manufacturer or by a repair station specifically authorized for this work.

To begin this study, we will examine the requirements for an aircraft electrical system and then review some terms and facts.

Electrical System Requirements

Title 14 of the Code of Federal Regulations, Part 23—*Airworthiness Standards: Normal, Utility, Acrobatic, and Commuter Category Airplane*—delineates the requirements for electrical systems in civilian nontransport category aircraft. Basic requirements for these systems include the following:

- Each electrical system must be able to furnish the required power at the proper voltage to each load circuit essential for safe operation.
- Each electrical system must be free from hazards in itself, in its method of operation, and in its effects on other parts of the aircraft. It must be protected from damage and be so designed that it produces minimal possibility for electrical shock to crewmembers, passengers, or persons on the ground.
- Electrical power sources must function properly when connected in combination or independently, and no failure or malfunction of any electrical power source may impair the ability of the remaining source to supply load circuits essential to safe operation.
- Each system must be designed so that essential load circuits can be supplied in the event of reasonably probable faults or open circuits.
- There must be at least one generator/alternator if the electrical system supplies power to load circuits essential for safe operation. There must also be a means of giving immediate warning to the flight crew of a failure of the generator/alternator.
- There must be a master switch installed in the electrical system that allows the electrical power source to be disconnected from the main bus. The point of disconnection must be adjacent to the source controlled by the switch.

Review of Terms

Though by now you have a working knowledge of basic electricity, a brief review of some of the terms most commonly used in aircraft electrical systems should prove useful.

bus—A point in an aircraft electrical system supplied with power from the battery or the generator/alternator and from which the various circuits get their power.

conductor—A material that allows electrons to move freely from one atom to another within the material.

current—The assumed flow of electricity that is considered to move through an electrical circuit from the positive side of a battery to its negative side. This is opposite to the flow, or movement, of electrons. Current is measured in amperes (amps) and its symbol is the letter I. Current follows the arrowheads in the diode and transistor symbols.

When current flows through a conductor, three things happen: heat is produced in the conductor, a magnetic field surrounds the conductor, and voltage is dropped across the conductor.

diode—A solid-state device that acts as an electron check valve. Electrons can flow through a diode in one direction, but cannot flow through it in the opposite direction.

electrons—Invisible negative electrical charges that actually move in an electrical circuit.

resistance—Opposition to the flow of current. The unit of resistance is the ohm, and its symbol is R.

voltage—Electrical pressure. The unit of voltage is the volt, and its symbol is either V (used in this text) or E (electromotive force).

voltage drop—The decrease in electrical pressure that occurs when current flows through a resistance.

electron current. The actual flow of electrons in a circuit. Electrons flow from the negative terminal of a power source through the external circuit to its positive terminal. The arrowheads in semiconductor symbols point in the direction opposite to the flow of electron current.

Direction of Current Flow

One of the things that adds confusion to the study of electricity is the way electricity flows in a circuit.

Before much was known about electricity, its flow was compared to the flow of water in a river and was therefore called "current." As water currents flow from high to low, electrical current was considered to flow from positive (+) to negative (–). This was a reasonable conclusion, but was later determined to be wrong. Negatively charged electrons actually flow from negative to positive. This discovery was made only after countless textbooks about electricity had been written and symbols had been decided upon. Because of this, electrons in a circuit actually flow in the *opposite* direction to the way the arrowheads in the diode symbols point. This can be quite confusing.

In the *General* textbook, the term "electron flow" or "electrical current" was used to explain the basic principles of electricity. This *Airframe* textbook (and many other modern texts on practical electricity) uses "conventional current," or simply "current." This is an assumed flow rather than an actual flow, and it travels from positive to negative, which allows us to visualize the flow in the direction of the arrowheads in the diode and transistor symbols. Considering the flow in this direction makes aircraft electrical systems much easier to understand. *See* Figure 7-1.

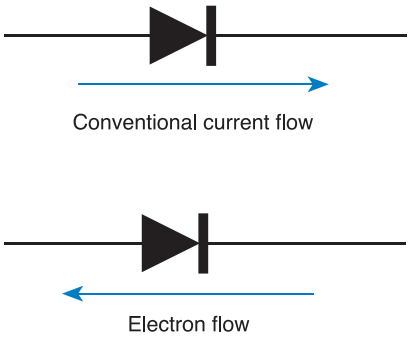


Figure 7-1. *Conventional current flows in the direction of the arrowheads of semiconductor diodes. Electron flow is in the opposite direction.*

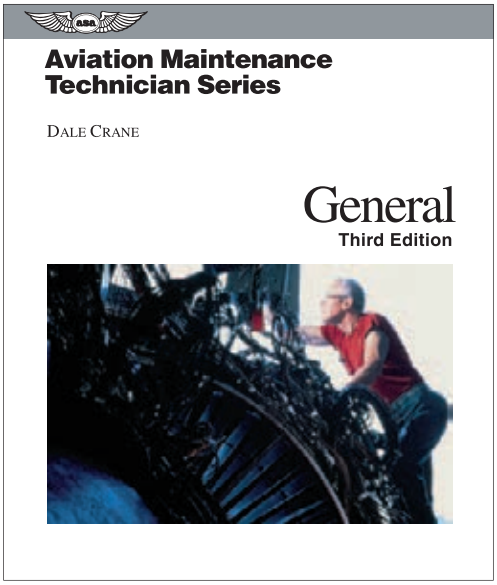
conventional current. An imaginary flow of electricity that is said to flow from the positive terminal of a power source, through the external circuit to its negative terminal. The arrowheads in semiconductor symbols point in the direction of conventional current flow.

Electrical System Components

The most important tool for understanding an aircraft electrical system is the schematic diagram. This road map of the electrical system uses standardized symbols to represent the various components, arranged in a logical sequence with regard to the circuit operation. However, their placement in the schematic tells nothing about their physical location in the aircraft.

This text uses standard symbols to show the way aircraft electrical circuits are built. Chapter 7's Appendix A, beginning on Page 580, show the most common symbols used in schematic diagrams of aircraft electrical systems.

schematic diagram. A diagram of an electrical system in which the system components are represented by symbols rather than drawings or pictures of the actual devices.



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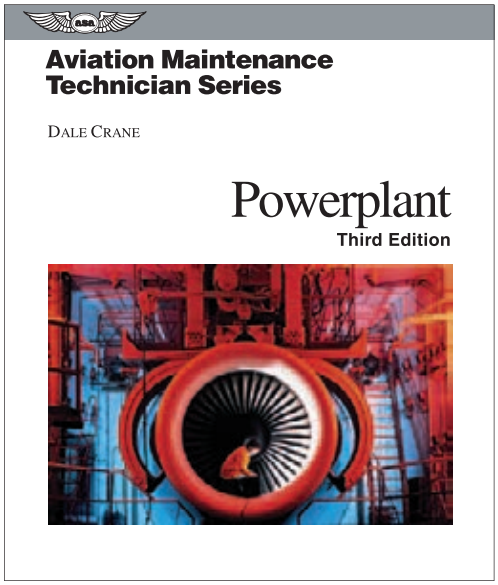

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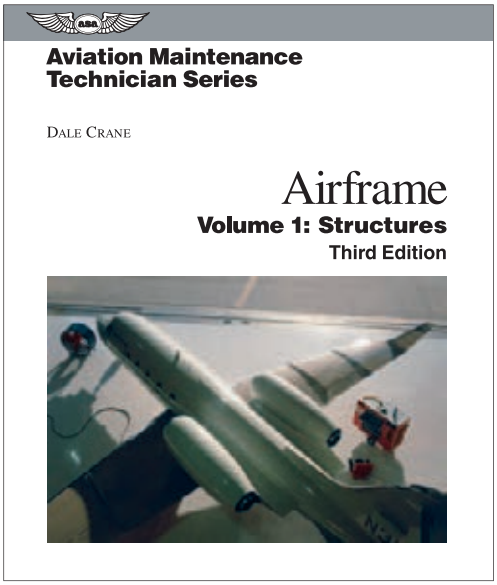

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