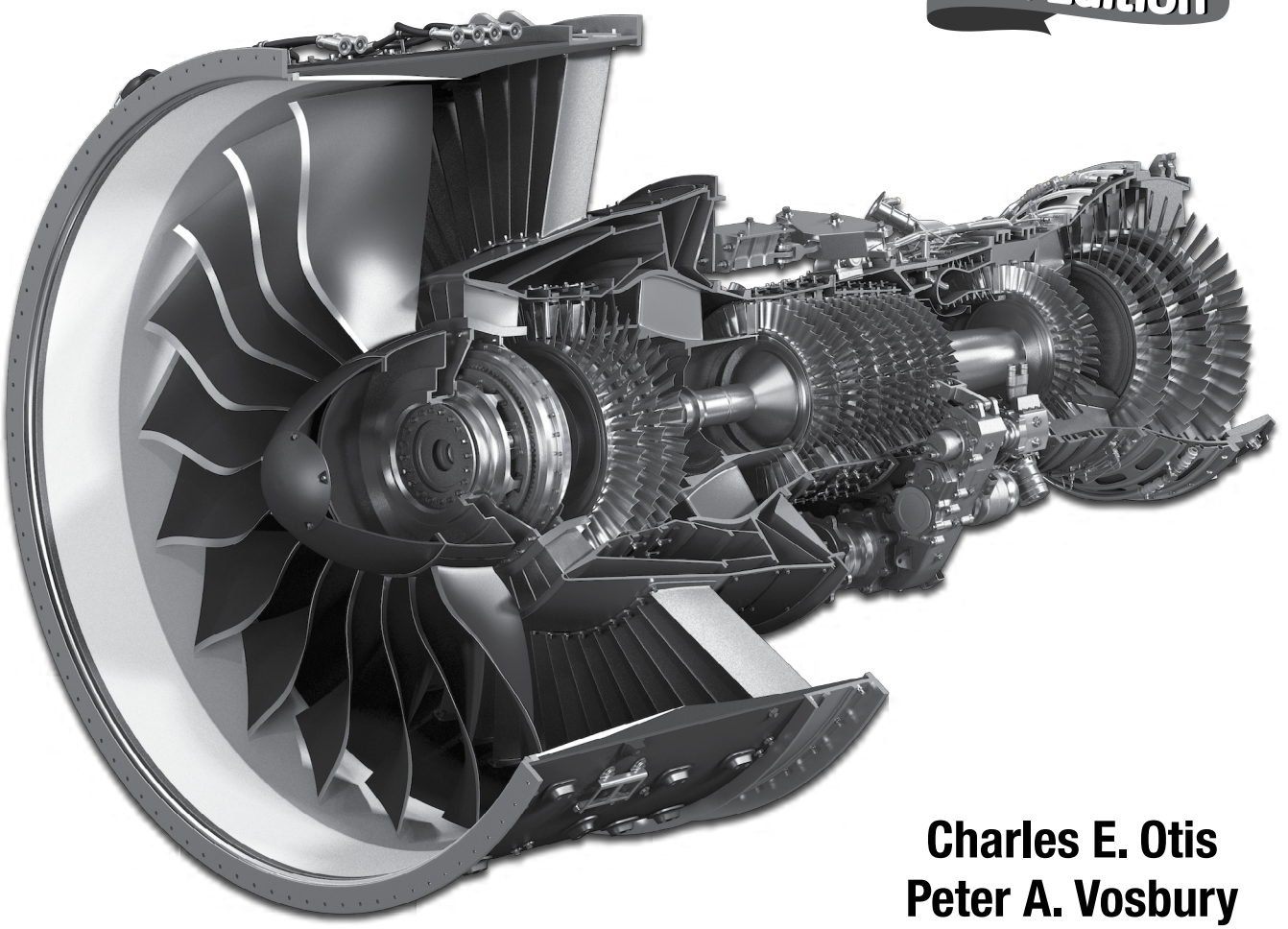
AIRCRAFT GAS TURBINE POWERPLANTS

WORKBOOK

5th Edition



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Introduction

The first historical application of the jet propulsion principle occurred when a steam-driven toy was demonstrated in Egypt before the Common Era. For nearly twenty centuries, the idea of jet propulsion evolved slowly. It wasn't until the early 20th century that Sir Frank Whittle, an English inventor, first described the possibility of using a gas turbine device as a means of jet propulsion for aircraft. From this modest idea, jet aircraft use has grown into the large multinational industry we know today. Whittle, the "father of the modern gas turbine engine," remained active in gas turbine engine design well into his 70s. He died at the age of 89 in 1996.

To meet the growing demands of modern aircraft, gas turbine engine designs have become increasingly complex and powerful, and the technical tasks required to maintain them have become more and more demanding. It is no longer possible for technicians to gain expertise based on hands on experience alone. Today's complex turbine engines and systems require expert technical training. This textbook serves as a starting point for this training process. It is intended both for those just beginning to explore the world of gas turbine engines and for experienced technicians and flight personnel who are exploring new directions and opportunities within the aviation industry.

Whether you proceed through this book in a formal classroom setting or as an independent student, the material in this textbook provides a sound foundation of the principles of gas turbine engine theory, design, maintenance, and troubleshooting.

Every successful technical educational endeavor begins by providing learners with solid entry-level knowledge. The proven way to acquire this knowledge is to read the material carefully, answer the questions at the end of each chapter, review and research the text, and finally reinforce this knowledge by applying it in actual work experience.

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POTENTIAL AND KINETIC ENERGY

Page 2-16

KEY POINTS

1. Refer to Figure 2-26B in the textbook. When the water is flowing from the sprinkler heads, it is referred to as _____ energy.
   A. Potential
   B. Kinetic

RESEARCH QUESTIONS

1. What terms best represent potential and kinetic energies in a turbine engine?
   A. Velocity and acceleration of airflow
   B. Velocity and motion of airflow
   C. Heat and motion of airflow

BERNOULLI'S PRINCIPLE

Page 2-16 to 2-18

KEY POINTS

1. Bernoulli's principle refers to airflow at a constant value (lb/sec) through a frictionless duct and at a _____ flowrate.
   A. Supersonic
   B. Subsonic

2. In a convergent duct, when a constant, subsonic air flowrate exists, velocity is _____.
   A. Increasing
   B. Decreasing

3. In a divergent duct, when a constant, subsonic air flowrate exists, velocity is _____.
   A. Increasing
   B. Decreasing

4. In either a convergent or divergent duct, when a constant subsonic air flowrate exists, total pressure will _____.
   A. Increase
   B. Decrease
   C. Remain the same

RESEARCH QUESTIONS

1. What are the components of total pressure?
   A. Static plus ram
   B. Ram plus venturi
   C. Static minus ram

2. When applying Bernoulli's principle, what gas flow (lbs./hr) performs best?
   A. Accelerating in the direction of flow
   B. Decelerating in the direction of flow
   C. Constant in the direction of flow

THE BRAYTON CYCLE

Page 2-18 to 2-20

KEY POINTS

1. The four events of the constant pressure cycle, also known as the Brayton cycle, are inlet, compression, expansion, and _____.
   A. Thrust
   B. Exhaust

2. The constant pressure cycle occurs because internal engine pressure is fairly constant across the _____ section.
   A. Compressor
   B. Combustor

3. The pressure drop in compressor discharge air as it passes through the remainder of the engine is controlled by the size of the _____ nozzle.
   A. Exhaust
   B. Turbine

RESEARCH QUESTIONS

1. Refer to Figure 2-30A in the textbook. What is the point of highest pressure within a turbine engine?
   A. Compressor
   B. Diffuser
   C. Combustor

2. Look at Figure 2-1 and select the lettered engine location that would properly match the following statements. Write your letter choice on the line next to the statement.
   _____ The point of highest static pressure
   _____ The point of highest axial velocity
   _____ The point of highest temperature

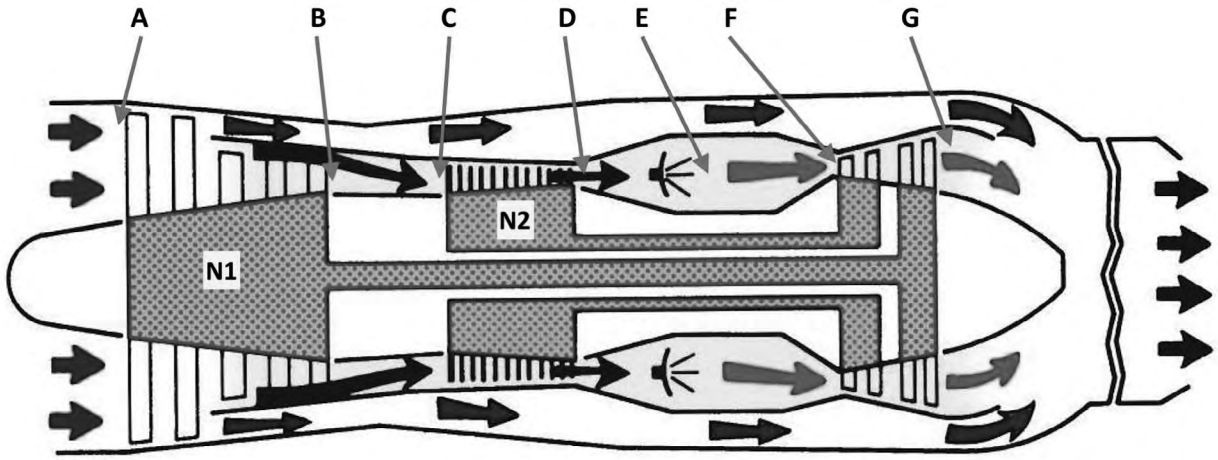

Figure 2-1.

NOTES

NEWTON'S LAWS AND THE GAS TURBINE

Page 2-20 to 2-22

KEY POINTS

1. Newton's _____ law states: A body at rest tends to remain at rest and a body in motion tends to remain in motion.
   A. First
   B. Second
   C. Third

2. Newton's _____ law states: For every acting force there exists an equal and opposite reacting force.
   A. First
   B. Second
   C. Third

3. Newton's _____ law provides the formula ($F = m \times A$) for computing the value of his third law of "action and reaction."
   A. First
   B. Second
   C. Third

RESEARCH QUESTIONS

1. What is the thrust created when 644 pounds of air is accelerated through an engine from 0 to 1,400 ft/sec in one second?

   $F = \frac{(\quad)}{(\quad)} \times \frac{(\quad)}{(\quad)}$

   $F =$ _____ × _____

   $F =$ _____ lbs.

   Where:
   W = _____ lbs.
   V_1 = _____ ft/sec
   V_2 = _____ ft/sec
   g = _____ ft/sec²
   t = _____ sec.

2. It is possible to convert "m" to W/g in the thrust formula; the logic of this conversion is as follows:
   A. If a one-pound object exerts a 1-pound force (weight) on an ordinary scale by the pull of gravity.
   B. Then: F = mA, when A = 32.2 ft./sec.² and F = 1 lb.
   C. Therefore when:

   $F = m \times A$

   1 lb. = _____ m × 32.2

   _____ = lb./32.2

3. If one mass unit of air enters a turbine engine, another unit leaves. How does the unit of air leave?
   A. At higher velocity
   B. At higher mass