POWER FOR AIRCRAFT

WORK BOOK

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PREFACE

The exercises and activities prescribed in this workbook will help you attain the purposes of each lesson. These purposes will be brought to your attention by your instructor. No excercise is to be attempted until your reading assignment has been completed. Do not attempt the exercises until you have made preparation after planning with the instructor and paying heed to his presentation at the first lesson session. Do not hesitate to use every method at your command in order to obtain essential information. Observe, read, ask questions of your instructor and the resource people that visit your classroom. You will note that lessons are numbered in accordance with a natural sequence and not with reference to a particular workbook; for example, the first lesson of the workbook: Aircraft in Flight is Lesson VII; that of the workbook: Power for Flight is Lesson XIV. This procedure is also used to identify the lesson plans of the several booklets of the Instructor Guide series.

By means of a key your instructor will help you correct Exercises 1, 2, and 3 of each lesson. Since it has not been possible to key the responses to Exercise 4, the quality of these should be appraised during discussion by students and instructor.

HAROLD E. MEHRENS, Editor

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POWER FOR AIRCRAFT

Lesson XIV

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

Place a *T* in the blank space which precedes a true statement; place an *F* in the blank space which precedes a false statement.

a. T Without a dependable power plant, the airplane could not have been put into practical use.

b. T Before the Wright Brothers made their historic flight at Kitty Hawk in 1903, men had flown in man carrying gliders.

c. F From the outset, aircraft power plants have been reliable machines.

d. TF The aircraft engine is a complete power unit and does not depend on related systems to perform its function.

e. F The principles of the six simple machines have no application to aircraft power plants.

f. T The first task of any engine is to convert potential energy into kinetic energy.

g. F Energy, once created, cannot be changed into another kind of energy.

h. F Practically all aircraft engines are external combustion engines.

i. F Robert Boyle (1627-1691) discovered that the pressure of a confined gas is directly proportional to its temperature.

j. TF All internal combustion engines have pistons that turn a crank shaft by means of a connecting rod.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

Fill in the blank spaces with the word, or words, that properly complete the statement.

a. When the pressure of a gas is doubled, its volume is reduced by one-half.

b. The Screw, one of the six simple machines, may be regarded as an inclined plane wrapped around a shaft.

c. One characteristic of energy is that although it cannot be created nor destroyed, it can be converted.

d. A mixture of fuel, such as gasoline and air, has potential energy.

e. Work is defined as force times distance.

f. The child's teeter totter on the playground is an example of the lever.

g. The wedge is a movable inclined plane.

h. In Paris 1929 the then Major Carl Spaatz and Captain Ira C. Eaker kept the Question Mark aloft for over six days.

i. It is the aircraft power plant that makes sustained flight possible.

j. Energy in action is called ~~mechanical~~ Kinetic energy.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

Draw a circle around the number preceding the phrase that makes the statement most correct.

a. It may be that the greatest accomplishment of the Wright Brothers was to design and build, with the help of Charles Taylor, the first successful

1. Internal compustion engine.
2. Soaring plane.
3. Aircraft power plant.
4. Commercial air field.

b. The crank shaft of an internal combustion engine is an adaptation of

1. The screw.
2. The wheel and axle.
3. The pulley.
4. The piston rod.

c. The first man ever to make a balloon ascension was

1. Jacques Charles
2. Charles Taylor
3. Octave Chanute
4. Orville Wright

d. The internal combustion engine puts to practical use the two principles discovered by

1. Orville and Wilbur Wright
2. Generals Eaker and Spaatz
3. Robert Boyle and Jacques Charles
4. Charles A. Lindbergh

e. The power generated by an aircraft reciprocating engine is productive only when harnessed to an airplane propeller or helicopter rotor by a

1. Control System
2. Carburetor
3. Transmission System
4. Pulley System

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

1. Write a paragraph explaining the principles discovered by Robert Boyle and Jacques Charles. How are these principles put to practical use in the internal combustion engine?

2. Write a paragraph explaining how the potential energy in aircraft fuels is converted into the thrust required for powered flight.

Lesson XV

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

Place a *T* in the blank space which precedes a true statement; place an *F* in the blank space which precedes a false statement.

a. F Reciprocating engines are also known as reaction engines.

b. T The turbo-jet engine is in many respects less complicated than a reciprocating engine.

c. T Most aircraft reciprocating engines are of the "four-stroke-five-event-cycle" type.

d. T Ignition in the combustion chamber takes place some time after the compression stroke is started and before the power stroke is completed.

e. F The diesel engine shows promise as a future aircraft engine.

f. F The valves of a two stroke cycle engine open and close twice as fast as they do on a four-stroke cycle engine.

g. T Normally, in-line engines are liquid-cooled while radial engines are air-cooled.

h. F Radial engines always have an odd number of cylinders in each row.

i. T Jet propulsion is based on Newton's second and third laws of motion.

j. F Rocket engines like the turbo-jet engines have been developed to the point where they can be effectively used in large bomber and transport type aircraft.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

Fill in the blank spaces with the word, or words, that properly complete the statement.

a. The most simple reciprocating engine consists of Cylinder, a Piston, a Connecting rod, and a Crankshaft.

b. Since an aircraft engine must be of comparatively lightweight, little use is made of the diesel as a power plant unit for aircraft.

c. The principle advantage of jet propulsion of aircraft is speed.

d. One type of turbo-jet engine has an afterburner where extra fuel is injected into the escaping gases, giving added thrust to the engine.

e. The first jet propelled aircraft that actually flew was developed by an Italian named Campine.

f. It appears likely that reciprocating engines will be used as the principal element of light plane and helicopter power plants for many years to come.

g. The connecting rod helps convert the straight-line motion of the piston to the rotary motion of the crankshaft.

h. The five events that happen during the four-stroke cycle are intake, Compression, ignition, power, exhaust.

i. A common application of jet propulsion is the rotating water Sprinkler, or similar device.

j. in-line engines are easier to streamline than radial engines.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

Draw a circle around the number preceding the phrase that makes the statement most correct.

a. The first turbo-jet power plant was designed by

1. An Italian named Campine
2. Charles Taylor
3. (3) Air Commodore Frank Whittle
4. Robert Boyle

b. A jet engine that has a device whereby extra fuel can be injected into the escaping gases to give added thrust is said to be equipped with a

1. Hot pipe
2. Afterthought
3. (3) Afterburner
4. Afterglow

c. Most air cooled engines are of the

1. In-line type
2. (2) Radial type
3. Four-stroke-cycle type
4. None of these

d. Both the intake and the exhaust valves in a four-stroke engine are closed on the

1. Intake stroke
2. (2) Power stroke
3. Ignition stroke
4. Exhaust stroke

e. That part of the turbo-jet engine that does the same job as the piston in a reciprocating engine is called a

1. Turbine
2. (2) Compressor
3. Turbo-supercharger
4. None of these

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

1. Show, by means of a drawing, the position of the valves and the direction of travel of the piston during each of the four strokes of an internal combustion engine.

2. Radial engines are usually easier to maintain than in-line engines. Why is this the case?

Lesson XVI

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

Place a *T* in the blank space which precedes a true statement; place an *F* in the blank space which precedes a false statement.

a. F In order to get the proper fuel-air mixture into an engine's combustion chamber, either a diaphragm-carburetor or an injection-carburetor must be used to meter and atomize the fuel and mix the fuel with air.

b. F A float type carburetor is not affected by any unusual change in the altitude of the aircraft as the diaphragm type carburetor is.

c. T When fuel is vaporized in the carburetor it can cause a decrease in air temperature of as much as 30° to 40° F.

d. T The fuel injection system eliminates completely the problem of ice formation, since fuel vaporization takes place at the intake valve where temperatures are normally quite high.

e. F A supercharger is a part of the induction system.

f. F Superchargers are primarily used on aircraft engines designed for low altitude operation.

g. F A jet engine uses a diaphragm type carburetor so that it will function properly regardless of the altitude of the aircraft.

h. T A supercharger is a sort of air compressor.

i. T All superchargers operate on the same principle, i.e. revolving blades press the air into the carburetion system and consequently build up manifold pressure.

j. T The economizer valve in a carburetor works in cooperation with the accelerating pump.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

Fill in the blank spaces with the word, or words, that properly complete the statement.

a. A carburetor is used with reciprocating type engines that do not employ the fuel injection system.

b. The first task of a carburetor is to meter fuel.

c. The second task of a carburetor is to atomize the fuel.

d. The air bleed system helps break the fuel into small particles as it is discharged from the carburetor nozzle.

e. An engine driven internal supercharger located between the carburetor and the intake manifold is called an impeller.

f. The turbosupercharger compresses the air before it reaches the carburetor.

g. detonation is caused by improper combustion.

h. The butterfly valve controls the amount of the fuel-air mixture entering the manifold for distribution to the cylinders.

i. An idling system is incorporated in the aircraft carburetor to allow an aircraft engine to run while the throttle is fully closed.

j. The function of the induction system is to transmit air to the carburetor and feed the resulting mixture to the cylinders in the proper amount and at the proper pressure and temperature.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

Draw a circle around the number preceding the phrase which makes the statement most correct.

a. One of the following is *not* the proper nomenclature for a type of aircraft carburetor.

1. Ram air type
2. Fuel injection type
3. Diaphragm type
4. Float type

b. When compared to sea level pressure, atmospheric pressure at 15,000 feet is

1. About twice as much
2. About half as much
3. About 15 times as much
4. About the same

c. Which of the following is *not* a part of the carburetor

1. Venturi
2. Idle air bleed
3. Impeller
4. Discharge nozzle

d. In a turbo-supercharger the turbine wheel is driven by
   1. An auxiliary motor
   2. The crankshaft
   3. Exhaust gases from the engine
   4. Air induction motor

e. Jet engines use
   1. Ram air type carburetors
   2. Fuel injection systems
   3. Fuel injection type carburetors
   4. Diaphragm type carburetors

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

1. List the similarities and differences between a turbo-supercharger and a turbo jet engine.

2. List the advantages of the fuel injection carburetor over the diaphragm and flow type carburetors. What is the main disadvantage of the injection type carburetor?

3. Draw schematically the induction system of a large aircraft engine. Show the location of such parts of the system as internal supercharger, turbo supercharger, carburetor and intake manifold.

Lesson XVII

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

Place a *T* in the blank space which precedes a true statement; place an *F* in the blank space which precedes a false statement.

a. T If a magnetic field is moved across a conductor, the effect is the same as that which occurs when the conductor is moved through the magnetic field.

b. F Ignition systems are of two types: generator and magneto.

c. F The purpose of a condenser in an ignition system is to reduce the electricity at the distributor.

d. T Direct electric starting is the most widely used of all starting systems.

e. T An electric motor is a generator operating in reverse.

f. F Aircraft using magnetos for ignition usually use the magneto as a source of electricity to operate other aircraft systems.

g. T The ignition system of the jet engine is much less complicated than that of the reciprocating engine.

h. F A booster coil is used to build up the voltage for the "spark-jump" when the engine is turning at take-off RPM.

i. T An induction (secondary) coil is used with each spark plug to obtain voltage needed for the "spark-jump" when low tension magnetos are used.

j. T A condenser does not provide a path for the transmission of an electrical current.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

Fill in the blank spaces with the word, or words, that properly complete the statement.

a. One type of magneto, the low tension magneto, does not "step up" the voltage of the primary circuit.

b. Electric starters use an electric motor whose source of electricity is produced by the generator and stored in an electric battery.

c. When a conductor of electricity is moved through a magnetic field a current will flow through the conductor.

d. The distributor is a revolving contact point which passes over a circle of other stationary contact points.

e. An induction coil of a magneto is really a transformer that steps up the voltage.

f. If a primary coil which has 50 turns of wire produces 24 volts, its secondary coil which has 500 turns will produce 240 volts.

g. The magneto is a special kind of generator.

h. In inertia starting the crank turns a flywheel, which in turn rotates the crankshaft through a clutch arrangement.

i. A current flowing through a conductor sets up a magnetic field around the conductor.

j. In an aircraft magneto, magnets are rotated between "pole shoes" by means of an accessory shaft geared to the engine crankshaft.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

Draw a circle around the number preceding the phrase which makes the statement most correct.

a. The voltage produced by the average aircraft magneto is

1. 20 volts
2. 200 volts
3. 2000 volts
4. 20,000 volts

b. The most widely used starting system for aircraft is the

1. "Spinning the prop by hand" system
2. Electric inertia starting system
3. Direct electric starting system
4. Hand crank inertia starting system

c. One of the following is not considered a part of an aircraft magneto ignition system.

1. Distributor
2. Condenser
3. Battery
4. Spark plug

d. The ignition system found on most modern aircraft is the

1. Dual magneto type
2. Single magneto type
3. Single battery type
4. Dual battery type

e. One of the following is not used to increase the voltage in the ignition system

1. Condenser
2. Magneto
3. Booster coil
4. Distributor

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

1. Draw schematically an aircraft ignition system depicting the essential parts of the system.

2. List the four most commonly used starter systems for modern aircraft.

Lesson XVIII

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

Place a *T* in the blank space which precedes a true statement; place an *F* in the blank space which precedes a false statement.

a. T The principle of operation of the aircraft engine is based upon the fact that heat energy can be changed into mechanical energy.

b. F The first law of thermodynamics states that although energy may change its form, no energy is destroyed except that lost through friction.

c. F In measuring units of work, the British Thermal Unit (BTU) is used.

d. T Mechanical efficiency is the ratio of brake horsepower to indicated horsepower.

e. T In calculating the indicated horsepower of an engine, the horsepower produced varies directly with the length of the stroke.

f. F About 20% of the heat produced in an aircraft combustion chamber is carried away by the exhaust.

g. T If a jet propelled airplane was flown in a vacuum its forward velocity would equal the velocity of the jet its engine produced.

h. T Crude petroleum is the source of modern aviation fuels.

i. F In reciprocating engines, the more rapid the fuel vapor burns, the greater power the engine will produce.

j. F The ability of an engine fuel to turn into vapor is called its fractional distillation index.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

Fill in the blank spaces with the word, or words, that properly complete the statement.

a. The octane rating is an index to the slow-burning quality of the fuel.

b. An English physicist named Joule demonstrated many years ago that it was possible to transform a certain amount of work into the same amount of heat.

c. If all the heat energy in one BTU could be salvaged, it would produce 778 ft./lbs. of work.

d. About 5% of the total heat produced by the reciprocating engine is expended because of friction.

e. One pound of gasoline has a potential heat energy content of 20,000 BTU.

f. Indicated horsepower minus brake horsepower equals friction horsepower.

g. One horsepower is equal to 33,000 ft./lbs. per minute.

h. The letters m.e.p. in thermodynamics stand for mean effective pressure

i. The jet engine's rate of fuel consumption is high when compared to a reciprocating engine.

j. Too rapid burning of fuel vapors in the combustion chamber causes detonation, or a sudden rise followed by a rapid decrease in pressure.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

Draw a circle around the number preceding the phrase which makes the statement most correct.

a. The fuel-air mixture in a reciprocating engine combustion chamber burns at about:

1. 200° Centigrade
2. 200° Fahrenheit
3. 2000° Fahrenheit
4. 2000° Centigrade

b. The thermal efficiency of an aircraft reciprocating engine runs about:

1. 100%
2. 75%
3. 50%
4. 25%

c. One pound of thrust of a jet engine will equal two horsepower when the speed of the jet aircraft is:

1. 250 MPH
2. 375 MPH
3. 500 MPH
4. 750 MPH

d. In calibrating the indicated horsepower of a four-stroke-cycle engine we can arrive at the number of pressure strokes per minute by dividing the RPM of the engine by:

1. 2
2. 3
3. 4
4. 8

e. A British Thermal Unit is:

1. The amount of heat necessary to raise 1 cc of water 1° C.
2. The amount of heat necessary to raise 1 ounce of water 1° F.
3. The amount of heat necessary to raise 1 pound of water 1° C.
4. The amount of heat necessary to raise 1 pound of water 1° F.

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

1. Which engine, the reciprocating or the jet, has the least thermal efficiency. Why?

2. An afterburner on a jet increases the power output of the engine. What effect does the afterburner have on the thermal efficiency of the engine.

Lesson XIX

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

Place a *T* in the blank space which precedes a true statement; place an *F* in the blank space which precedes a false statement.

a. T Friction generates heat.

b. T Petroleum is a member of the hydrocarbon family.

c. F The lower the viscosity of an oil, the greater the weight it can support without breaking.

d. F All crude oils (petroleum) are asphalt base.

e. F Oil gets its lubricating ability from the fact that its molecules are greasier than the molecules of other substances except pure grease.

f. F In air cooled engines cowl flaps are used to scoop up the air that is used to cool the engines.

g. F In liquid cooled engines the oil in the lubrication system acts as the coolant in the cooling system.

h. F Jet engines are liquid cooled.

i. F Wet sump lubricating systems are usually found on large engines.

j. T One way to help keep cylinder head temperatures down is to use a greater ratio of fuel to air in the combustion chamber.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

Fill in the blank spaces with the word, or words, that properly complete the statement.

a. Oil, when placed between moving parts, tends to form a layer only one molecule deep; this is known as a monomolecular layer.

b. An index to an oil's ability to flow at certain temperatures is Viscosity.

c. The flash point test discovers the temperature at which an oil gives off inflammable vapor.

d. The scavenger pump forces the oil of an aircraft engine oil system from the sump through a filter, a radiator and back into the storage tank.

e. The oil pump is used to feed the oil through oil lines to the engine parts.

f. Two systems of engine cooling are used in aircraft engines. They are the liquid cooled system and the air cooled system.

g. Heat has been defined as the motion of the molecules of a substance.

h. As a result of compression and ignition, cylinder head temperatures of an uncooled aircraft engine could reach 4500 degrees F.

i. Radial engines are usually air cooled.

j. Cowl flaps are used to control the amount of air that flows around an air cooled aircraft engine.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

Draw a circle around the number preceding the phrase which makes the statement most correct.

a. The best lubricating oil for aircraft engines is:

1. Animal oil
2. Vegetable oil
3. Mineral oil
4. Wesson oil

b. One of the tests not used to determine the characteristics of lubricating oil is the

1. Viscosity test
2. Octane rating test
3. Flash point
4. Sulphur content test

c. Indicate which of the following statements is false.

1. Friction between two metal parts is less when the parts in contact are of different metals.
2. Petroleum is a member of the great hydrocarbon family.
3. Oil of the oil system carries off a great amount of excess engine heat.
4. In-line engines are more difficult to streamline because they are usually liquid cooled engines and carry radiators and coolant pumps not found on radial engines.

d. The S.A.E. have established viscosity ratings for lubricating oils. S.A.E. stands for

1. Society of Aeronautical Engineers
2. Society of Automotive Engineers
3. Sigma Alpha Epsilon
4. Society of American Engineers

e. The oil system consists of an oil storage tank, an oil pump, oil lines, a sump and scavenger pump, an oil filter and a

1. Coolant
2. Radiator
3. Distributor
4. Manifold

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

1. Discuss the three methods of reducing friction between moving parts. Give an example in the aircraft engine of how the three methods are used in combination.

2. Make a schematic sketch of an aircraft engine oil system showing its various component parts.

Lesson XX

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

Place a *T* in the blank space which precedes a true statement; place an *F* in the blank space which precedes a false statement.

F a. To develop power and to convert it into thrust are the major purposes of the aircraft power plant. The aircraft propeller virtually succeeds in combining these two tasks into one.

T b. The blade of a propeller is a type of airfoil just as the aircraft wing is an airfoil.

T c. The principle of propeller action is based on the fact that a decrease in pressure in any direction will cause the air to produce a force in that direction.

F d. All wood propellers are fixed-pitch and all metal propellers are variable-pitch propellers.

F e. An adjustable propeller can be adjusted by the pilot in flight.

F f. Reversible pitch propellers are used to reverse the direction of rotation of the propeller.

T g. In flight the propeller tip travels faster than the propeller hub.

F h. The electric propeller uses an electric motor to govern propeller speed.

T i. Blade pitch is defined as the angle made by the chord of the blade element and the plane in which the propeller rotates.

T j. The fixed pitch propeller is a compromise, its pitch setting is neither the best possible for take-off nor for cruising.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

Fill in the blank spaces with the word, or words, that properly complete the statement.

a. Like the rotor of a helicopter, the propeller, in a sense, is a rotating wing.

b. In flight the propeller has two motions, forward and rotating, the path of this motion is rotating (shaped like a corkscrew).

c. One classification of propeller is based upon whether the pitch of the propeller blade is fixed or variable.

d. There are two types of variable-pitch propellers; adjustable and controllable.

e. Constant-speed propellers are of two principal types depending upon the system controlling their operation. One type uses a hydraulic system; the other, an electrical system.

f. Both types of constant-speed propellers use a governor as the core of the automatic pitch control.

g. Some propellers are dual rotating, they are called Contra-pump propellers.

h. Propellers that are so constructed that the pilot can change the blade angle to create a backward thrust are called reversible pitch propellers.

i. The governor of a hydraulic propeller activates a control rod that opens and closes a pilot valve and also operates an oil pump which in turn varies the oil pressure on either side of a piston in the dome section of the propeller assembly.

j. The governor of an electric propeller, through the control rod, opens or closes an electric switch to a reversible electric motor in the propeller hub.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

Draw a circle around the number preceding the phrase which makes the statement most correct.

a. Reduction gears are used in propeller systems, particularly on propellers with large diameters to:

1. Reduce wear on the system.
2. Keep propeller tip speed below the speed of sound.
3. Help keep the engine cool.
4. Feather the propeller on "dead" engines.

b. Propellers are feathered to:

1. Help brake the airplane and thereby shorten the landing run.
2. Reduce drag and eliminate windmilling on dead engines.
3. Get more engine power for take-off.
4. Utilize less gas during normal cruise operations.

c. One type of variable pitch propeller is little better than a fixed-pitch one, it is the:

1. Electric propeller
2. Hydraulic propeller
3. Adjustable propeller
4. Controllable propeller

d. Regardless of the length of a propeller blade the speed of the propeller tip, in relation to a section midway between the hub and tip, will travel:

1. At at rate equal to the mid-section
2. At a rate equal to 2 times the rate of the mid-section
3. At a rate one-half times the mid-section
4. At a rate twice that of the mid-section

e. There is a certain similarity between three of the following from the standpoint of function and design. Which one is the dissimilar one?

1. Aircraft propeller
2. Aircraft wing
3. Helicopter rotor
4. Aircraft tail section

EXERCISE NO. 4

(You have 15 minutes to complete this exercise.)

1. Make a simple diagram of the major parts of a hydraulic propeller control system.

2. Explain why a propeller blade is designed in such a way that the camber, chord, and pitch is different for each section.

Lesson XXI

EXERCISE NO. 1

(You have 5 minutes to complete this exercise.)

Place a *T* in the blank space which precedes a true statement; place an *F* in the blank space which precedes a false statement.

a. F Engine designers have been able to reduce the number of engine instruments required for modern aircraft engines under that required by earlier engines.

b. T The pupose of the engine instruments is to keep the pilot informed of the operating conditions of his engine.

c. F Most aircraft engine pressure gauges are of the vapor-pressure, thermometer type.

d. T The tachometer on engines equipped with fixed pitch propellers gives an indication of the engine power output.

e. T The vapor-pressure type, temperature indicator uses a bulb containing a highly volatile liquid.

f. T Electronic mechanisms are electric devices which employ vacuum tubes.

g. F Jet engine controls are much more complicated than reciprocating engine controls.

h. T It is by means of the mixture control that a proper ratio of fuel to air is kept in the induction system.

i. F All engine control systems operate on the "push-pull tube control" system.

j. T Where automatic controls are used, some method of manual control is almost always kept as a safeguard in the event of failure of the automatic system.

EXERCISE NO. 2

(You have 10 minutes to complete this exercise.)

Fill in the blank spaces with the word, or words, that properly complete the statement.

a. Pressure gauges operate either on the bourdon tube principle or the drurdon principle.

b. Temperature indicators may employ the principle of the Wheatstone bridge, the thermocouple, or the vapor-pressure type thermometer and Bourdon tube.

c. On large multi-engine aircraft where considerable distances separate the point where a measurement is to be made, and the instrument panel where the reading is taken remote indicating systems are in common use.

d. The vapor-pressure type temperature indicator uses a adjustable containing a highly volatile liquid such as methyl chloride, a controllable tube and a Bourdon tube.

e. The principles underlying the operation of automatic controls are hydraulic, electric, or electronic.

f. The control pedestal is a frame secured to the floor of the cockpit which supports the control quadrants and control mechanisms.

g. An automatic mixture control lever has four positions. They are idle cut-off, automatic lean, automatic rich, and emergency rich.

h. A manually operated mixture control has any number of positions.

i. In terms of operating method, there are three classifications of engine controls: the manually operated, the semi-automatic, and the automatic.

j. In terms of construction there are two engine control systems. The push-pull tube control and the cable control.

EXERCISE NO. 3

(You have 5 minutes to complete this exercise.)

Draw a circle around the number preceding the phrase which makes the statement most correct.

a. One of the following is not normally used as an aircraft engine instrument.

1. Oil pressure gauge
2. Fuel pressure gauge
3. Manifold pressure gauge
4. Cylinder head pressure gauge

b. Temperature gauges for aircraft instruments are usually one of three types. Which one of the following is not used to measure temperature?

1. Wheatstone bridge
2. Thermocouple
3. Vapor-pressure type thermometer and Bourdon tube
4. Aneroid

c. One of the most important controls, the one that helps the pilot govern the power output of the engine and the speed of the airplane, is the:

1. Mixture control
2. Throttle
3. Propeller control
4. Quadrant

d. Which of the following engine instruments would you expect to find on an in-line engine but not on a radial engine?

1. Cylinder head temperature gauge
2. Manifold pressure gauge
3. Coolant temperature gauge
4. Carburetor air temperature gauge

e. On the control quadrant of airplanes equipped with reciprocating engines are usually found levers marked "P", "T", and "M". These letters stand for

1. Propeller, throttle, and magneto
2. Propeller, turbo-supercharger, and mixture
3. Power, throttle, and magneto
4. Propeller, throttle, and mixture

EXERCISE NO. 4

At this point, if you should have any questions about the material covered in the previous seven classes, bring these to the attention of the instructor. This period should be devoted to discussing all questions which you and other students desire to have answered.