OPERATOR'S MANUAL

LYCOMING

MODEL O-145-B2 AVIATION ENGINE

AN

PRODUCT

LYCOMING

DIVISION AVCO MANUFACTURING CORPORATION

WILLIAMSPORT 38, PENNA., U. S. A.

PRINTED IN U. S. A.
APRIL, 1948

WARRANTY

LYCOMING Division - Avco Manufacturing Corporation, warrants each new engine to be free from defects in material and workmanship, when properly installed and used under normal conditions, for ninety days after the shipment of each engine from the plant. This warranty is limited to replacing or repairing at its shops any part or parts which have been returned to LYCOMING Division - Avco Manufacturing Corporation, with transportation charges prepaid and which in its opinion, are defective. This warranty is expressly in lieu of all other warranties and representations, expressed or implied, and all other obligations or liabilities on the part of LYCOMING Division - Avco Manufacturing Corporation.

This warranty does not cover any labor charges for replacement of parts, adjustments, repairs or any other work done on LYCOMING engines.

This warranty shall not apply to any engine which shall have been repaired or altered outside of our factory in any way so as in our judgment to affect its operation, or which has been subject to misuse, negligence or accident, or which shall have been operated at a speed exceeding the manufacturer's rated speed.

This warranty shall not apply to any engine which shall have been operated with any other than fuel, oil and other lubricants conforming to specifications of LYCOMING Division - Avco Manufacturing Corporation.

LYCOMING Division - Avco Manufacturing Corporation, reserves the right at any time to revise, modify or change the construction of LYCOMING engines without incurring any obligation to incorporate such alterations to engines previously sold.

LYCOMING Division - Avco Manufacturing Corporation, makes no warranty with respect to ignition apparatus, carburetors, instruments or other trade accessories, inasmuch as they are usually warranted specially by their respective manufacturers.

OPERATOR'S MANUAL

LYCOMING Model O-145-B2 Aviation Engine

Please return this book to:

Name

Home Address

Home Telephone

Business Address

Business Telephone Ext.

Home Airport

Pilot License No.

Engine Mfg. Serial No.

Airplane Serial No.

Airplane NC

Social Security No.

Other Pertinent Data

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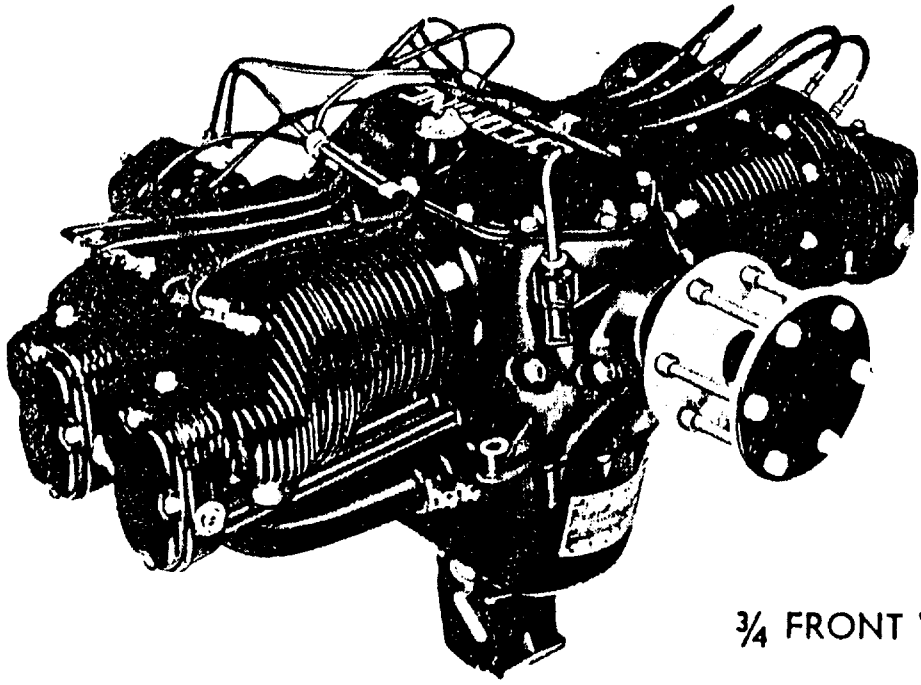


¾ FRONT VIEW

SECTION

1

SPECIFICATIONS

Section I
SPECIFICATIONS
LYCOMING O-145-B2 ENGINE

TYPE—Four Cylinder, Direct Drive, Horizontally Opposed, Air Cooled

Engine Type Certificate	210
Rated Horsepower	65
Rated R.P.M.	2550
Cruising R.P.M. Economy	2200
Performance	2300
Bore	3 5/8 in.
Stroke	3 1/2 in.
Compression Ratio	6.5:1
Piston Displacement—Cubic Inches	144.5
Head Temperature, Max. °F.	525°
Barrel Temperature, Max. °F.	325°
Fuel Octane	80
Oil Grade Summer—Temp. above 40° F.	SAE-40
Winter—Temp. below 40° F.	SAE-30
Oil Sump Capacity—Quarts	4-5
Oil Sump—Safe Minimum Quantity—Quarts	2 1/2
Oil Pressure Minimum Idling—(Lbs. per Sq. In.)	15
Normal Operating—(Lbs. per Sq. In.)	55 to 80
Crankshaft Rotation—Anti-Propeller End	Clockwise
Valve Rocker Clearance (cold)	.015
Spark Occurs—Degrees B.T.C.	25° B.T.C.

SPECIFICATIONS—(Continued)

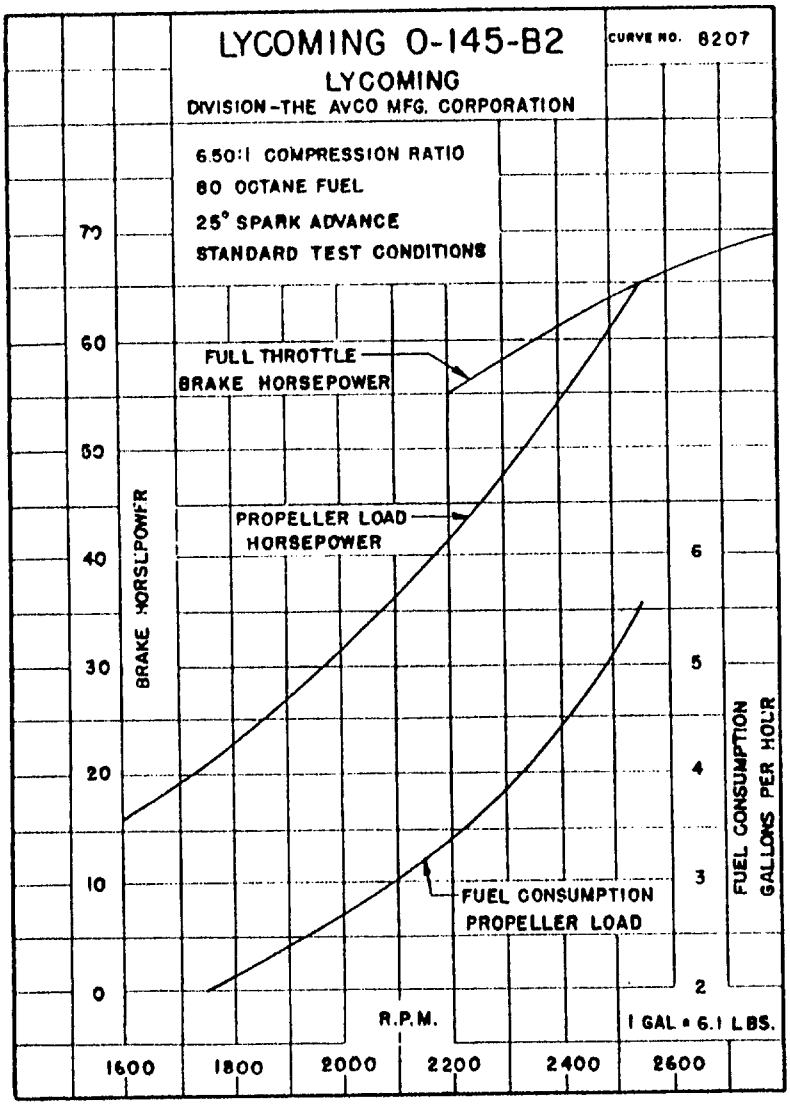
Spark Plug Gap—Shielded	.015 in.
Spark Plug Gap—Unshielded	.025 in.
Firing Order	1-3-2-4

Accessory Drive Ratios	Gear Ratio	*Direction of Rotation
Magnetos	1.00 to 1	Clockwise
Fuel Pump	.5 to 1	(Plunger Operated)
Tachometer	.5 to 1	Counter Clockwise

* Viewed from rear of engine

Standard Engine Dry Weight	165.5 lbs.
Propeller Attaching Parts and Baffles	5.33 lbs.
Engine Total Weight	170.83 lbs.
Engine Height	20.59 in.
Engine Width	29.56 in.
Engine Length	24.62 in.
Valve Timing—"Hot"	Intake Opens 20° B.T.C. Intake Closes 65° A.B.C. Exhaust Opens 65° B.B.C. Exhaust Closes 20° A.T.C.

PERFORMANCE CURVE
LYCOMING MODEL O-145-B2 AVIATION ENGINE



SECTION

2

DESCRITPION

Section II

DESCRIPTION

General—The LYCOMING O-145-B2 aircraft engine is a four cylinder, wet sump, horizontally opposed model. The cylinders are not directly opposite from each other but are staggered, thus permitting a separate throw on the crankshaft for each connecting rod.

Cylinder Crankcase—Is made from a heat-treated high tensile strength, ferrous alloy with the cylinders built integral with it. The crankcase is made in two parts separated on a vertical plane through its longitudinal axis. The parts are fitted on ground, metal to metal faces and fastened by through bolts and studs.

Cylinder Heads—Cylinder head assemblies are machined from heat treated aluminum alloy casting. Each head assembly is secured to cylinder with six studs. The rocker arm assembly is supported by three rocker pin bearings that are cast integral with the head. Adequate valve cooling is assured by means of fins which completely surround the area of the exhaust valve and portions of the intake valve. Both intake and exhaust valve guides and seats are shrunk into the cylinder head.

Crankshaft—The crankshaft is made from an alloy steel forging. All bearing journal surfaces are nitrided, and centrifugal sludge removers are provided in the form of oil tubes at each crankpin and main bearing journal. These tubes can easily be removed during overhaul of the engine and accumulated sludge cleaned out.

Oil Sump—The oil sump incorporates carburetor mounting pad, the intake riser, and the intake pipe connecting tubes. The fuel air mixture, as it passes through the riser, is more completely vaporized than it would otherwise be because it is heated by the oil in the sump that surrounds the riser. This tends to eliminate the hazard of carburetor icing.

Connecting Rods—The connecting rods are made in the form of "H" sections from alloy steel forgings. They have replaceable inserts in the crankshaft ends and split type bronze bushings in the piston ends. The bearing caps on the crankshaft ends of the rods are retained by means of two bolts and nuts.

Pistons—The pistons are made from aluminum alloy and their general construction is of the full skirt type. Two compression rings and an oil regulator ring are located above the piston pin and one oil scraper ring below the piston pin. The piston pin is of the full floating type and an aluminum plug is located in each end to prevent the pin from touching the cylinder wall.

Accessory Housing—The accessory housing is made from an aluminum casting and is fastened to the rear of the crankcase and the top rear of the sump. It forms a housing for the oil pump, tachometer drive, magneto drive.

Gears—The gears are of the conventional spur type and are precision machined. Whenever practical, they are hardened to insure long life and satisfactory operating qualities.

Cooling System—The forward speed of the plane creates pressure in the chamber between the cowling and the top of the cylinders. Thus the cool air is forced between the baffles and the cylinder fins. The air is then exhausted through gills located at the rear of the engine.

Lubricating System—The lubrication system is of the pressure wet sump type. The main bearings, connecting rod bearings, accessory drive bearings, and camshaft bearings, are lubricated by positive pressure. The piston pin, gears, cylinder walls, and other parts are lubricated by spray.

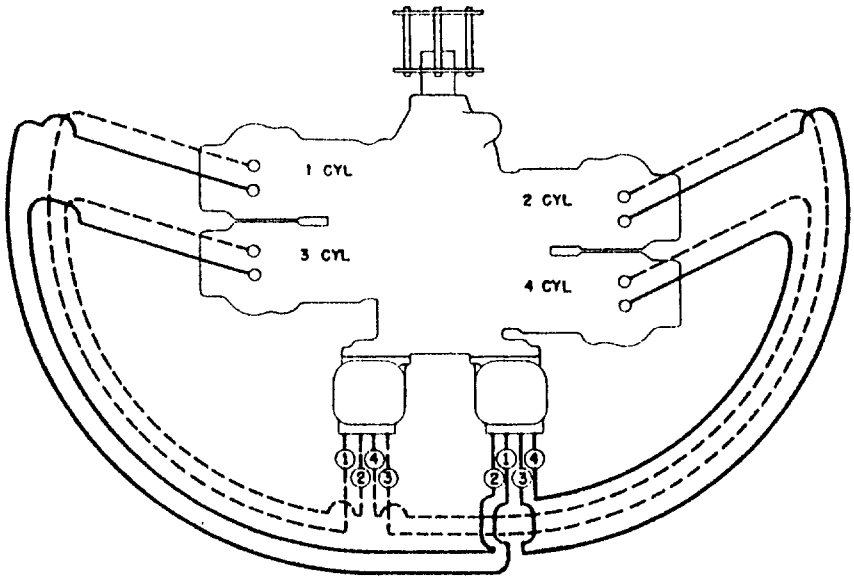
A geared type oil pump is located in the accessory housing and draws oil from the oil sump through a drilled passage and discharges pressure oil past the oil relief valve to the hollow camshaft. The camshaft is the main oil gallery which distributes oil through the three cam bearings to crankshaft main bearings. From here it is forced through drilled passages in the crankshaft to the crankpin journals. The spent oil from the crankpins lubricates the cylinder walls, pistons and gears, then drains back through the oil screen to the sump.

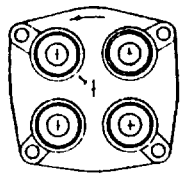
A constant flow of oil is supplied from the crankcase to the rocker arms and valve mechanism by collecting oil in wells at the exhaust valve tappet on inside of crankcase. From here it flows through the exhaust push rod shroud tubes into the rocker boxes where it lubricates intake and exhaust valve mechanism by splash, from the exhaust rocker arm agitating the oil. Oil is returned to the crankcase through the intake shroud tubes.

Induction System—The LYCOMING O-145-B2 engine is equipped with a Marvel-Schebler model MA-2 carburetor. This carburetor is of the single barrel float type. Particularly good distribution of the fuel air mixture to each cylinder is obtained by the center zone induction system which is integral with the oil sump and is submerged in oil insuring a more uniform vaporization of fuel and aids in cooling the oil in the sump. From the riser the fuel air mixture is distributed to each cylinder by separate intake pipes.

Ignition System—Dual ignition is furnished by the magnetos. The ignition wiring is so arranged that the left magneto fires the front plugs and right magneto fires the rear plug.

WIRING DIAGRAM
LYCOMING MODEL O-145-B2 AVIATION ENGINE





REAR VIEW OF CABLE OUTLET PLATE SHOWING POSITION OF NO. 1 CABLE AND ARROW INDICATING DIRECTION OF DISTRIBUTOR ROTATION

FIRING ORDER 1-3-2-4								
	FRONT PLUG				REAR PLUG			
CYLINDER NO.	1	2	3	4	1	2	3	4
MAGNETO NO.	1L	3L	2L	4L	1R	3R	2R	4R

SECTION

3

PACKING AND UNPACKING

Section III
PACKING AND UNPACKING

General—LYCOMING type O-145-B2 aviation engines are securely packed for shipment one to the crate in a horizontal position. The carburetor, rubber and steel mounting washers, propeller hub flange and propeller mounting bolts are packed in a separate carton within the engine crate.

Packing—In packing it is recommended the engine be first prepared for storage, as described later in this section, to prevent unnecessary damage due to corrosion. Also, take particular care in securing engine to shipping crate.

Unpacking—Open shipping crate. Remove inner carton containing carburetor and loose shipping parts. Attach lifting sling around cylinders. With a suitable hoist take up the slack. Remove the bolts and lift engine clear of shipping crate. Invert the engine in the sling with the engine in this position, remove the plugs from each cylinder and rotate crankshaft a few revolutions to drain the oil from the cylinders. Assemble spark plugs and clean exterior of engine thoroughly.

PREPARATION OF ENGINE FOR STORAGE

General—This procedure is for preparing the LYCOMING O-145-B2 aircraft engine to resist corrosion during shipment and 90 day storage under favorable conditions.

Preliminary Operation—The following procedure shall be a continuous series of operations to be accomplished within the shortest practicable time.

Clear Fuel Run—An engine operated on leaded fuel during its final test run shall be subjected to a 15-minute clear fuel run. An engine operated on unleaded fuel during its final test run need not be subjected to an additional clear fuel run.

Oil Drainage—Preferably while the engine is still warm from the final test run, excess oil shall be drained from the engine. Screens or filters shall be removed, cleaned, and replaced. All drain plugs shall be replaced and secured.

PRESERVATION OF ENGINE CYLINDERS

Preservation of Engine Interior—After draining the engine of lubricating oil *Corrosion-Preventive Compound shall be applied to the engine interior other than the cylinder bores by one of the methods listed below. The Corrosion-Preventive Compound may be reused three to four times. Following the completion of any of these operations, the excess oil shall be drained by removing all drain plugs. Replace and secure plugs.

(1) **Test Stand Method**—Concurrent with a 15-minute clear fuel run and while running at idling speed, the engine shall be operated with the Corrosion-Preventive Compound in the lubricating system. The temperature of the Corrosion-Preventive Compound shall not exceed that of the engine lubricating oil at engine idling speed.

(2) **Fill and Drain Method**—Fill all chambers of the engine except the induction system and the cylinder bores with Corrosion-Preventive Compound and rotate the crankshaft slowly through several complete revolutions. Drain excess compound.

(3) **Motoring-in Method**—With spark plugs removed, pump Corrosion-Preventive Compound through the engine oil passages by means of the engine oil pump in sufficient quantity to fill the system. The engine shall be rotated at sufficient speed and for a period of time long enough to assure adequate coverage of the engine interior.

Aspirating Method—This procedure shall be performed immediately after the 15-minute clear fuel run and while the engine is turning over. Inject Corrosion-Preventive Compound into an appropriate opening in the induction system in sufficient quantity to completely cover all cylinder bores. The engine shall be shut down after all cylinders smoke profusely.

Spray Method—Immediately after conclusion of the clear fuel run, Corrosion-Preventive Compound shall be sprayed into each cylinder through the spark plug holes with each piston at the bottom of its stroke in sufficient quantities to insure adequate coverage of all internal surfaces. After all cylinders are sprayed in the above method, respray cylinders through spark plug holes and not turning the crankshaft.

Exhaust Ports—Spray sufficient quantity of Corrosion-Preventive Compound into exhaust ports to coat the exhaust valves completely.

*** Note: A recommended Corrosion-Preventive Compound is a mixture of 25% Standard Oil Compound Rust Ban 606 and 75% SAE 50 lubricating oil.**

Carburetor—The carburetor shall be emptied of all residual gasoline. Fill the carburetor with SAE No. 10 Pennsylvania paraffin base oil. Interior surfaces shall be thoroughly slushed. Care should be exercised not to damage moving parts such as the float or needle valves.

Openings—All openings such as breathers, exhaust and induction ports shall be covered with a closure that will exclude dust and other foreign matter.

Spark Plugs—Spark plugs shall be cleaned and the gaps adjusted. Coat only the threads of the plugs with Corrosion-Preventive Compound and wrap in greaseproof material. The spark plug holes shall be closed with blank plugs.

Accessories—All accessories shall be wrapped in a greaseproof material before being placed in the engine shipping case.

Shipping Case—The engine shall be shipped or stored in an engine shipping case. The date the engine was prepared for storage shall appear on the outside of the case.

Recommended Procedure for Re-preservation—The engines shall be examined every 30 to 90 days depending on weather and locality. If corrosion appears to be starting, the corroded area shall be cleaned free of corrosion and the engine re-preserved.

The above procedure is applicable also to engines installed in aircraft prior to shipment or short time storage.

Note—Inspection and re-preservation will not be the responsibility of the engine manufacturer after engines have been shipped from the engine manufacturer's plant. It shall be the responsibility of the consignee to put engines into service in the order of storage preparation date to reduce the storage period to a minimum.

Engines prepared by the above procedure are not adequately protected for extended periods of storage.

SECTION

4

INSTALLATION OF THE LYCOMING O-145-B2 AIRCRAFT ENGINE

Section IV

INSTALLATION OF THE LYCOMING O-145-B2 AIRCRAFT ENGINE

Preparation of Engine for Installation—Before installing an engine that has been prepared for storage, remove all dehydrator plugs, silica-gel bags, and corrosion preventive mixture from the engine. Corrosion preventive mixture can be removed from cylinder by removing plugs from spark plug holes, inverting engine, then turn crankshaft three or four revolutions by hand. The corrosive preventive mixture will then drain through the spark plug holes. Corrosion preventive mixture which has accumulated in the sump can be drained by removing the oil sump drain plug. After the oil sump has been drained, the plug should be replaced, safety-wired. When installing spark plugs, make sure that they are clean; if not, wash them in clean petroleum solvent. Of course, there will be a small amount of corrosion preventive compound remaining in the engine but not in sufficient quantity to prove harmful. However, after twenty-five hours of operation, the lubricating oil should be drained while the engine is hot. This will remove any residual corrosion preventive mixture that may have been present.

CAUTION

Do not rotate the crankshaft of an engine containing corrosion preventive mixture before removing the spark plugs because if the cylinders contain any appreciable amount of the mixture, the resulting action, known as hydraulicing, will cause the connecting rods to bend. Also, any contact of the corrosion preventive mixture with painted surfaces should be avoided.

General—Should any of the dehydrator plugs, containing crystals of silica-gel or similar material, be broken during their term of storage or upon their removal from the engine, and if any of the contents should fall into the engine, that portion of the engine must be dis-assembled and thoroughly cleaned before using the engine. The oil strainers should be removed and cleaned in gasoline or some other hydrocarbon solvent. The fuel drain screen located in the fuel inlet of the carburetor should also be removed and cleaned in a hydro-

carbon solvent. If any excessive corrosion preventive mixture is contained within the cylinders, it can be determined by rotating the crankshaft. If this condition should exist, it can be removed by draining with a hand pump. The operator should also note if any valves are sticking. If they are, this condition can be eliminated by coating the valve stems generously with a mixture of gasoline and lubricating oil.

Removal of Corrosion Preventive Mixture—Engines that have been removed from storage will have been treated for corrosion prevention. After removing the engine from the shipping box, as previously described, any dehydrator plugs, seals, or enclosures that may be found in any of the openings of the engine should be removed. Such articles will consist of plugs or sacks of silica-gel and normally will be located in spark plug holes, oil sump drains, intake or exhaust chambers of cylinders, and breather locations. Also, corrosion preventive mixture will have been used inside the cylinders, the crankcase, and the sump. This should be thoroughly drained by removal of the oil sump drain plug.

Inspection of Engine Mounting—If the airplane is one from which an engine has been removed, make sure that the engine mount is not bent or damaged by distortion or misalignment because if it is, abnormal stresses can be produced within the engine.

Engine Accessories—Considerable time and work can be saved if all of the trim accessories are assembled on the engine. For example, the carburetor along with the lines connecting them, baffles, oil pressure fittings, exhaust pipes, air intake housing etc.

Attaching Engine to Mount—Hoist engine by means of a sling passed under the cylinder barrels on each side of the crankcase and lower carefully into position in engine mount.

Note:—It may be necessary with some engine mounts to remove the intake pipes from the engine before installing in the mount.

Place mounting rubber washers, sandwiched between steel washers on each side of mounting boss, and a rubber bushing around each mounting bolt. Attach engine to the mount and tighten mounting bolt nuts. These mounting bolt nuts should be tightened until the rubber washers begin to show compression.

Connect ground wire to ground terminal on magneto.

Install oil temperature bulb in oil sump.

Connect primer lines.

Attach tachometer cable.

Connect oil pressure line.

Attach throttle control to throttle lever at carburetor and see that full and positive movement of throttle control is permitted.

Breather Connection—Be sure the breather line is correctly installed. An improperly installed breather can cause oil to be sucked out of the engine or excessive pressure in crankcase will cause oil leaks.

Propeller Installation—Turn crankshaft so number one cylinder is on top center. With crankshaft in this position, assemble propeller over pilot of crankshaft flange in the horizontal position. Place the propeller hub front flange on propeller hub and attach to crankshaft with six 3/8-inch bolts. In attaching the propeller, it is highly important that the mounting bolts be tightened evenly, and after tightening the bolts, the propeller must track within 1/8-inch and any deviation corrected by adjusting the tension on the mounting bolts. After this adjustment is made, the propeller mounting bolts should be securely safety-wired.

SECTION

5

OPERATION

Section V
OPERATION

General—Close adherence to these instructions will greatly contribute to long life, economy, and satisfactory operation of the engine.

Propeller—The propeller should be of such design to permit rated engine speed when engine is operated at full throttle in level flight at sea level.

Fuel—This engine is designed to operate on 80 octane (Aviation Grade) fuel. Under no circumstances should automotive fuel be used.

Lubricating Oil Recommendations

Oil Sump Capacity ..... 4-5 quarts
Recommended Grade of Oil—Summer
(Temp. above 40° F.) ..... SAE 40
Recommended Grade of Oil—Winter
(Temp. below 40° F.) ..... SAE 30

It is recommended that the lubricating oil be changed every 50 flying hours.

Proper Operating Conditions

Minimum Safe Quantity of Lubricating Oil in Entire System ..... 2½ Qts.
Maximum Oil Temperature ..... 220° F.

Minimum Oil Pressure
Idling ..... 15 lbs. per sq. in.
Cruising ..... 55 lbs. per sq. in.
Maximum Oil Pressure ..... 80 lbs. per sq. in.

Fuel Pressure
Minimum ..... ½ lb.
Desired ..... 3 lbs.
Maximum ..... 5 lbs.

Maximum Cylinder Head Temperature
Measured with Spark Plug Gasket Type Thermocouple ..... 525° F.
Take-off and Climb ..... 525° F.
Cruising ..... 475° F.

Minimum Air Speed for Cooling in Climb ..... 65 MPH

Prestarting Inspection—Following installation or a prolonged period of idleness:

Check ground wires on magnetos.

Be sure ignition switch is in the "OFF" position.

Inspect mounting and propeller bolts for proper tightness and safety.

Turn propeller over by hand five or six full revolutions, checking airplane and engine clearance.

Check oil level in sump.

See that fuel tanks are full.

Operate all controls and check travel for full range and freedom from binding.

Clean the fuel strainer and drain sufficient fuel to clear out any foreign matter.

Check baffles and cowling for security.

Care of a New Engine—A new engine has been carefully run-in and has passed a rigid final test at the factory, and no further "Break-In" is necessary, but the operator will benefit by treating it carefully during its first few hours in service. Avoid prolonged operation at full throttle or excessive engine speeds.

Starting Procedure—After completion of prestarting inspection:

Head the airplane into the wind.

Lock the wheels by either wheel brakes or chocks.

Turn fuel valve to "ON" position.

Set throttle to 1/10 open position.

Prime cold cylinders with one to three full strokes of priming pump depending on engine temperature.

Turn ignition switch to left position and pull propeller through, if the engine fails to start, repeat the operation without additional priming. If cylinders should become loaded with excessive amount of raw gasoline, open throttle wide and rotate propeller backwards five or six revolutions and attempt to start again, after engine starts turn switch to "BOTH" position.

When engine fires evenly open throttle to an indicated speed of 800 R. P. M. Check oil pressure gage for an indicated pressure. If oil pressure is not indicated within one-half minute, stop engine and determine trouble.

Cold Weather Starting—During extreme cold weather it may be necessary to preheat the engine or the oil before starting. If engine fails to start at the first attempt, another attempt should be made without priming. If this fails it is possible that the engine is overprimed, turn switch to "OFF" position, open throttle slowly, and turn the engine over approximately ten revolutions. Prime with half the original prime and repeat starting procedure. If this fails, refer to Section VII, Page 31 on Engine Troubles.

Ground Running and Warm-Up—The LYCOMING O-145-B2 engine is an air pressure cooled engine that depends on the forward speed of the airplane to maintain proper cooling. Therefore, particular care is necessary when operating this engine on the ground. To prevent overheating, it is recommended that the following precautions be followed:

Head airplane into the wind.
Avoid prolonged idling at low R. P. M. as this practice may result in fouled spark plugs.
Limit ground running to 4 minutes in cold weather and to 2 minutes at temperatures above 70° F.

Note—Engine is warm enough for take-off when the throttle can be opened without back-firing or skipping of the engine.

Ground Test

Warm up engine 800 to 1200 R. P. M.
With engine running at 1800 R. P. M., switch from both magnetos to only one and check drop-off. Return switch to "BOTH" position and allow spark plugs to clean out. Then switch to the other magneto and again note drop-off. Drop-off should not exceed 100 R. P. M. on either magneto.
Check both oil pressure and oil temperature.
Take off as soon as the test is completed because excessive ground running will cause overheating.

OPERATION IN FLIGHT

Use of Carburetor Heat Control—Under certain moist atmospheric conditions it is possible for ice to form at the carburetor even in summer weather. The integral intake manifold and oil sump on the LYCOMING O-145-B2 engine reduces this icing tendency to a marked degree. However, to be certain of avoiding icing, carburetor air heat should be used under conditions of high humidity. To assure good fuel vaporization as well as to prevent icing, carburetor air heat should be used whenever the outside air temperature is of icing conditions. Formation of ice is indicated by loss of power and R. P. M. that cannot be regained by opening the throttle. On damp days, especially cloudy, foggy, or hazy days, regardless of temperature keep a sharp lookout for loss of power and R. P. M. If the engine begins to lose power or the R. P. M. drops off, apply full heat and open the throttle wide. Fuel vaporization can be helped by using hot air when the outside air temperatures are between 21° F. and 50° F. If ice begins to accumulate, it may be melted out by turning air heat on full. If ice is suspected from a drop in R. P. M. and the air heater is turned on "HOT" to melt the ice, a slight additional drop in R. P. M. will result. This is normal, and if there is ice in the carburetor, this slight drop in R. P. M. will be regained as the ice melts.

In warm dry air the heat control should be left in the full cold position to secure maximum engine power and prevent possible overheating.

Landing—During relatively long glides in making an approach for landing, the throttle should be partially opened at intervals to clear out engine. The carburetor heat control should be kept in the "FULL HEAT" position.

Stopping Engine—After landing allow the engine to idle for a short period before turning off the ignition. If the engine should after-fire when the switch is turned off, the switch should be turned on immediately and the engine allowed to idle for another short period before again turning off the ignition.

Cold Weather Suggestions:

Use lighter oil. See page 19.

In extremely cold weather it may be necessary to preheat the lubricating oil prior to starting.

Avoid excessive running of engine on the ground.

To maintain the desired oil temperature, it may be necessary to block off the oil sump air blast hole or lag sump.

Dusty Operation—When operating from dusty fields or in a dusty location, it will be found a profitable investment to inspect carburetor air intake frequently to make sure that no air enters the carburetor except through the air cleaner.

Notice—Inspect and service air cleaners daily according to manufacturer's instructions.

ENGINE FLIGHT CHART

Fuel and Oil

Fuel Grade 80 Octane

Oil Grade

Engine Model **O-145-B2**

Summer (Temp. Above 40° F.) SAE 40

Winter (Temp. Below 40° F.) SAE 30

	Desired	Maximum	Minimum	Idling
Fuel Pressure (Lbs. per Sq. In.)	3	5.	.5	.....
Oil Pressure (Lbs. per Sq. In.)	70	80	55	15
Oil Temperature (° F.)	180	220	.....	.....

OPERATING CONDITION

Operation	R. P. M.	Fuel Cons. Gals. Per Hour	Oil Cons. Qts. Per Hour	*Max. Cyl. Temp. ° F.
Take-Off	2550	5.5	.37	525
Normal Rated	2550	5.5	.37	525
Performance Cruise	2300	4	.28	475
Economy Cruise	2200	3.5	.24	475

*Measured with spark plug gasket type thermocouple.

SECTION

6

SERVICE INSPECTION AND MAINTENANCE

Section VI

SERVICE INSPECTION AND MAINTENANCE

General—The daily pre-flight inspection is a check of the complete airplane prior to the first flight of the day. This inspection is to determine the general condition of the airplane and engine but is not designed to detect slight wear and minor maladjustments. Such items should be found during the more thorough 50-hour and 100-hour inspections.

The operator should bear in mind that the items listed in the following charts do not constitute a complete inspection, but only so far as the engine is concerned. Consult the aircraft manufacturer's handbook for complete instructions.

At the conclusion of the first 25 hours of operation, the engine should undergo a 50-hour inspection including the draining and renewing of lubricating oil and also the checking of the valve tappet clearance.

INSPECTION AND MAINTENANCE

Daily Pre-Flight

Check fuel and oil level.
Inspect engine for evidence of oil leakage.
Inspect safetying of all drain plugs and covers.
Inspect fuel strainer.
Inspect carburetor and fuel line connections.
Check engine controls for general condition, travel, and free operation.
Check carburetor air cleaner. Clean and re-oil if dry.

50-Hour

Check ignition cables for security.
Drain carburetor bowl.
Check priming system for leaks.
Check oil lines for leaks particularly at connections, security of anchorage, wear due to rubbing or vibration, dents, and cracks.
Drain and refill oil sump with new oil.
Check intake and exhaust systems for leaks and looseness.
Drain and clean fuel strainer.

Note—All the above operations should be performed in addition to those listed under Daily Pre-Flight.

100-Hour

Inspect all electrical wiring for general condition and proper anchorage.
Check baffles for secure anchorage, holes, cracks, bending and close fit around the cylinder.
Check cylinders for cracked or broken fins.
Check air entrances and exits for deformation.
Replace spark plugs.
Remove and clean carburetor fuel strainer.
Check magnetos for synchronization.
Check engine mounting bolts and bushings for general condition and proper torque.

Note—All the above operations should be performed in addition to those listed under Daily Pre-Flight and 50-Hour Inspection.

Carburetor Idling Adjustment—With exception of the idling adjustment, no adjustment of the carburetor is necessary. The mixture is controlled by means of jets and air passages that are not adjustable and are calibrated at the factory.

To adjust the idle mixture and speed: With engine thoroughly warmed up, set throttle stop screw so that engine idles at approximately 550 R. P. M. Turn idle adjusting screw towards "RICH" position until engine "rolls" from richness, then turn screw slowly towards the "LEAN" position (indicated by letter "L") until engine "lags" or runs "irregularly" from leanness. This step will give an idea of the idle adjustment range and of how the engine operates under these extreme idle mixtures. From the "lean" setting, turn screw slowly towards a "richer" setting, leaving the final setting at a mixture just lean enough to prevent a rich "roll" or uneven running from richness. This adjustment will in most cases give a slower idle speed than a slightly leaner adjustment, with the same throttle stop screw setting, but will give smoothest idle operation. A change in idle mixture will change the idle speed, and it may be necessary to readjust the idle speed with the throttle stop screw to the desired point.

Oil Relief Pressure Adjustment—This valve is adjustable. To increase pressure add washers to rea of spring, to decrease pressure remove washers.

Magneto Timing—Remove a spark plug from the No. 1 cylinder. Place the thumb of one hand over the spark plug hole and rotate the crankshaft in direction of normal rotation until the compression stroke is reached. The compression stroke is indicated by a positive pressure inside the cylinder tending to lift the thumb off of the spark plug hole.

CAUTION

The magneto equipped with impulse coupling can only be used on left side of engine, as viewed from the rear of engine.

Magneto Timing—Set the crankshaft at 25 degrees B. T. C. on the compression stroke No. 1 cylinder. This is accomplished by aligning the "ADV 25°" mark on the rear of the propeller flange with upper dividing line of the crankcase. Remove timing inspection plug from magneto. Depress the pawl on the impulse coupling with the finger, turn the magneto until the white tooth on the large gear is in line with the timing pointer. Without allowing the gear to turn from this position, assemble the magneto and gasket in place with washers and nuts. Tighten the nuts only finger tight.

Remove the breaker cover from the rear of the magneto housing. Rotate the magneto assembly clockwise as far as it will go through the range provided by the mounting slots. Insert a strip of .0015" shim stock between the breaker points. Apply a slight tension to the shim stock and at the same time rotate the magneto assembly in mounting slots very slowly in a clockwise direction until the exact breaker point opening is found as indicated by the shim stock being released. Lock the magneto in this position by tightening the mounting nuts.

Repeat the above steps for the other magneto. With both magnetos locked in position, insert shim stock between the breaker points.

Note—When checking timing of magnetos, crankshaft should not be rotated more than ten degrees in direction opposite normal rotation as pawl on the left magneto impulse coupling will engage with stop pin and late timing will be indicated through impulse coupling mechanism. If this should happen, rotate engine in normal direction until sharp click is heard, which will indicate that impulse coupling has passed through firing position; then turn crankshaft in direction opposite normal rotation to approximately 30° before top center and proceed with timing check.

While one person exerts a slight tension on each strip of shim stock, a second person should rotate the crankshaft slowly by bumping in the direction of normal rotation. If the magnetos have been properly timed, both strips of shim stock will be released together. If this condition does not exist, the magneto which is incorrectly timed may be corrected by loosening the mounting nuts and rotating the magneto as required.

After magnetos have been properly timed, clean the breaker points to remove any trace of oil or dirt. Replace breaker cover.

Note—Breaker points on Bendix Scintilla S4 type magnetos are not to be adjusted to a given clearance. For proper S4 magneto adjustments, refer to Scintilla's Instructions.

Removal and Assembly of Cylinder Head Assembly—Remove exhaust manifold. Remove intake pipes, baffles, priming lines, and any clips that interfere with the removal of cylinder heads. Disconnect ignition cable and remove spark plugs. Remove rocker box covers and rotate crankshaft until piston is at approximately top dead center. This may be located by observing top of the piston through the spark plug hole and also watching the valve action. Remove cylinder head attaching nuts and washers and remove cylinder head by lifting cylinder head away from cylinder-crankcase assembly. Be careful to hold the shroud tubes and push rods so as to prevent them from being dropped. Remove valve rocker arms by removing rocker arm pin plugs and sliding valve rocker shaft out of cylinder head.

Removal of Valves and Valve Springs from Cylinder Head—Place the cylinder head over a block of wood so as to hold the valves in a closed position. Compress the valve springs using the valve spring compressor. Remove the tapered split keys from the end of the valve stem. The valve spring and valve spring seats may now be removed from the cyllinder head.

Assembly of Valves in Cylinder Heads—Insert each valve stem in its respective guide being certain that the exhaust and intake valves are not reversed.

Place cylinder heads over a wood block so that the valves are held against the seats and assemble the lower spring seat and valve spring over the valve stem and guide. Place the upper spring seat on top of the springs.

Using valve spring compressor, compress the valve spring and assemble the two valve keys into the groove around the upper end of the valve stem. Slowly release the pressure on the valve spring compressor and allow the upper spring seat to lock itself in place around the valve keys.

Assembly of Cylinder Head and Related Parts—Assemble valve adjusting screws in rocker arms and install hex nuts over screws. Place a valve rocker shaft washer on each side of intake and exhaust rocker arms and install rocker arms with washer in cylinder head. Assemble valve rocker shaft through cylinder head supports, valve rockers and valve rocker washers. Place a valve rocker shaft plug gasket over valve rocker shaft plug and assemble plug with gasket in rocker shaft boss. Safety plug through lockwire hole at side of boss using lockwire.

Place a new shroud tube seal in crankcase opening and in each cylinder head opening.

Assemble a push rod assembly in each push rod shroud tube.

Rotate crankshaft so that the connecting rod of the cylinder being assembled is at the top center position with both tappets on the low side of the cam in a position that corresponds with both valves closed.

Push rods and shroud tubes must be assembled on the engine at the same time as the cylinder heads. Place a cylinder head inner gasket in cylinder counterbore and two cylinder head outer gaskets over cylinder head studs and assemble head with gaskets on cylinder barrel. At the same time enter ends of push rods against valve tappets and valve rocker arm adjusting screws and enter shroud tubes in shroud tube seals. Assemble lock washers and nuts and tighten evenly.

Install an intake pipe hose with clamps on each intake pipe connection at the cylinder head and on straight end of each intake pipe. Assemble intake pipe to engine by sliding cylinder head end of pipe inside hose attached to intake pipe connection then slide hose on straight end of intake pipe over connection at oil sump. Tighten hose clamps at each end of hose.

The firing order of the engine is 1-3-2-4. Adjust the valve clearances to .015" starting with No. 1 cylinder. Turn crankshaft in direction of rotation until piston of No. 1 cylinder is at top center on the firing stroke when both valves will be closed. Using a .015" thickness gauge between the valve rocker and valve tip, turn adjusting screw with screw driver until a drag is felt on the feeler gauge. Hold adjusting crew with screw driver and tighten hex. nut. Recheck valve clearance after tightening. In same manner adjust valve clearances of balance of cylinders. Place rocker box cover gaskets over rocker box cover studs on cylinder heads using sealing compound on both sides of gasket and install covers. Tighten covers, using No. 10 plain washers, and plain nuts.

SECTION

7

ENGINE TROUBLES AND THEIR REMEDIES

Section VII

ENGINE TROUBLES AND THEIR REMEDIES

General—Experience has proven that the best method of "trouble-shooting" is to decide on the various possible causes of a given trouble and then to eliminate these causes one by one beginning with the most probable. The following chart lists some of the more common engine troubles usually found in maintaining aircraft engines.

TROUBLE	CAUSE	REMEDY
Failure of Engine to Start	Lack of fuel	Check fuel systems for leaks. Fill fuel tank. Clean fuel lines, strainers or fuel cocks.
	Underpriming	Prime with 2 or 3 strokes of primer.
	Overpriming	Open throttle and "unload" engine by turning in counterclockwise direction.
	Incorrect throttle setting	Open throttle to one-tenth of its range.
	Defective spark plugs	Clean and adjust or replace spark plug or plugs.
	Defective ignition wire	Check with electric tester, and replace any defective wires.
	Improper operation of magneto breaker points	Clean points. Check internal timing of magnetos.

TROUBLE	CAUSE	REMEDY
Failure of Engine to Start	Water in carburetor	Drain carburetor and fuel lines.
	Internal failure	Check oil sump strainer for metal particles. If found, complete overhaul of the engine may be indicated.
Failure of Engine to Idle Properly	Incorrect carburetor idle adjustment	Adjust throttle stop to obtain correct idle.
	Idle mixture	Adjust mixture.
	Leak in the induction system	Tighten all connections in the induction system. Replace any parts that are defective.
	Low cylinder compression	Check condition of piston rings and valve seats.
	Faulty ignition system	Check entire ignition system.
Low Power and Uneven Running	Mixture too rich; indicated by sluggish engine operation, red exhaust flame at night. Extreme cases indicated by black smoke from exhaust	Readjustment of carburetor by authorized personnel.
		Check primer shut-off valve for leakage.
	Mixture too lean; indicated by overheating or back-firing	Check fuel lines for dirt or other restrictions. Check fuel supply.

TROUBLE	CAUSE	REMEDY
Low Power and Uneven Running	Leaks in induction system	Tighten all connections. Replace defective parts.
	Defective spark plugs	Clean or replace spark plugs.
	Poor fuel	Fill tank with fuel of recommended grade.
	Magneto breaker points not working properly	Clean points. Check internal timing of magnetos.
	Defective ignition wire	Check wire with electric tester. Replace defective wire.
	Improper ignition timing	Check magnetos for timing and synchronization.
	Defective spark plug terminal connectors	Replace connectors on spark plug wire.
	Incorrect valve clearance	Adjust valve clearance.
	Incorrect valve timing	Check valve timing.
Failure of Engine to Develop Full Power	Throttle level out of adjustment	Adjust throttle lever.
	Leak in the induction system	Tighten all connections, and replace defective parts.

TROUBLE	CAUSE	REMEDY
Failure of Engine to Develop Full Power	Restriction in carburetor air scoop	Examine air scoop and remove restrictions.
	Improper fuel	Fill tank with recommended fuel.
	Faulty ignition	Tighten all connections. Check system with tester. Check ignition timing.
Rough Engine	Cracked engine mount	Replace or repair mount.
	Unbalanced propeller	Remove propeller and have it checked for balance.
	Defective mounting bushings	Install new mounting bushings.
	Malfunctioning engine	Check entire engine.
Low Oil Pressure	Insufficient oil	Check oil supply.
	Leak in suction line or pressure line	Check gasket between accessory housing and oil sump.
	Air lock or dirt in relief valve	Remove and clean oil pressure relief valve.
	High oil temperature	See "High Oil Temperature" in "Trouble" column.

TROUBLE	CAUSE	REMEDY
Low Oil Pressure	Defective pressure gage	Replace gage.
	Stoppage in oil pump intake passage	Check line for obstruction.
High Oil Temperature	Insufficient oil cooling	Check air inlet and outlet for deformation or obstruction.
	Insufficient oil supply	Fill oil sump to proper level.
	Low grade of oil	Replace with oil conforming to specification.
	Excessive blow-by	Usually caused by worn or stuck rings. Complete overhaul required.
	Failing or failed bearing	Examine sump for metal particles. If found, overhaul of engine is indicated.
	Improper engine operation	Check entire engine.
	Defective temperature gage	Replace gage.
Excessive Oil Consumption	Low grade of oil	Fill tank with oil conforming to specification.
	Failing or failed bearing	Check sump for metal particles and, if found, overhaul engine.

TROUBLE	CAUSE	REMEDY
Excessive Oil Consumption	Worn piston rings	Install new rings.
	Incorrect installation of piston rings	Install new rings.
Cold Weather Difficulties	Cold oil	Move aircraft into a heated hangar. Heat oil.
	Inaccurate pressure readings	In extreme cold weather oil pressure readings up to approximately 100 lbs. do not necessarily indicate malfunctioning.
	Overpriming	Rotate crankshaft in counterclockwise direction with throttle "FULL OPEN" and ignition switch "OFF."

SECTION

8

TABLES

Section VIII

SERVICE TABLE OF LIMITS

Description	Mfg. Min.	Mfg. Max.	Repl. Max.
Crankshaft Run-out at Flange			.005
Piston Pin in Piston	.0001T	.0004L	.0025L
Piston Ring and Piston—Top Ring—Side Clearance	.0035L	.005L	.008L
Piston Ring and Piston—Second Ring—Side Clearance	.0025L	.004L	.007L
Piston Ring and Piston—Third Ring—Side Clearance	.002L	.0035L	.006L
Piston Ring and Piston—Bottom Ring—Side Clearance	.001L	.0025L	.005L
Piston Skirt and Cylinder—Clearance	.009L	.0115L	.017L
Exhaust Valve Stem and Valve Guide—Clearance	.0025L	.0040L	.0075L
Intake Valve Stem and Valve Guide—Clearance	.0025L	.0040L	.0075L
Valve Rocker Shaft and Valve Rocker Bushing—Clearance	.0015L	.0022L	.005L
Piston Ring Gap	.009	.014	.025

SERVICE TABLE OF LIMITS

	Description	Mfg. Min.	Mfg. Max.	Repl. Max.
Valve Spring	Compressed 1-9/16	18 lbs.	22 lbs.	16 lbs. Min.
	Compressed 1-3/16	60 lbs.	64 lbs.	55 lbs. Min.

TORQUE LIMITS

Tightening Torque Table	Recommended Torque
Spark Plugs	300 to 360 In. Lbs.

GENERAL APPLICATIONS

1/4" Nuts and Capscrews	75 In. Lbs. Torque
5/16" Nuts and Capscrews	150 In. Lbs. Torque
3/8" Nuts and Capscrews	300 In. Lbs. Torque
7/16" Nuts and Capscrews	400 In. Lbs. Torque
1/2" Nuts and Capscrews	550 In. Lbs. Torque

CABLE LENGTH

		Cyl. No. 1	Cyl. No. 2	Cyl. No. 3	Cyl. No. 4	Total Length
Dual Ignition Engines	Front Plugs	31.0"	35.0"	25.5"	29.0"	
	Rear Plugs	32.0"	26.50"	32.0"	27.0"	
						19'-10"

FULL THROTTLE HP AT ALTITUDE

Altitude Ft.	% S.L. HP.	Altitude Ft.	% S.L. HP.	Altitude Ft.	% S.L. HP.
0	100	8,500	74.8	17,000	54.3
500	98.5	9,000	73.5	17,500	53.1
1,000	96.8	9,500	72.5	18,000	52.1
1,500	95.3	10,000	70.8	18,500	51.4
2,000	93.6	10,500	69.5	19,000	50.0
2,500	92.0	11,000	68.3	19,500	49.1
3,000	90.5	11,500	67.2	20,000	48.0
3,500	89.3	12,000	65.8	20,500	47.6
4,000	87.5	12,500	64.7	21,000	46.0
4,500	85.9	13,000	63.4	21,500	45.2
5,000	84.6	13,500	62.3	22,000	44.0
5,500	83.2	14,000	61.0	22,500	43.3
6,000	81.7	14,500	59.8	23,000	42.2
6,500	80.2	15,000	58.7	23,500	41.4
7,000	78.9	15,500	57.6	24,000	40.3
7,500	77.5	16,000	56.5	24,500	39.5
8,000	76.2	16,500	55.4	25,000	38.5

TABLE OF SPEED EQUIVALENTS

Sec./Mi.	M.P.H.	Sec./Mi.	M.P.H.	Sec./Mi.	M.P.H.	Sec./Mi.	M.P.H.
72.0	50	31.3	115	20.0	180	13.8	260
65.5	55	30.0	120	19.4	185	13.3	270
60.0	60	28.8	125	18.9	190	12.8	280
55.4	65	27.7	130	18.4	195	12.4	290
51.4	70	26.6	135	18.0	200	12.0	300
48.0	75	25.7	140	17.6	205	11.6	310
45.0	80	24.8	145	17.1	210	11.2	320
42.3	85	24.0	150	16.7	215	10.9	330
40.0	90	23.2	155	16.4	220	10.6	340
37.9	95	22.5	160	16.0	225	10.3	350
36.0	100	21.8	165	15.6	230	9.6	375
34.3	105	21.2	170	15.0	240	9.0	400
32.7	110	20.6	175	14.4	250		

CENTIGRADE-FAHRENHEIT CONVERSION TABLE

°F = 9/5 °C + 32 = 1.8 (°C + 17.8)

°C = 5/9 (°F — 32)

C	C/F	F	C	C/F	F
—62.2	—80	—112.0	4.44	40	104.0
—56.7	—70	—94.0	7.22	45	113.0
—51.1	—60	—76.0	10.00	50	122.0
—45.6	—50	—58.0	12.78	55	131.0
—40.0	—40	—40.0	15.56	60	140.0
—34.0	—30	—22.0	18.33	65	149.0
—31.7	—25	—13.0	23.89	76	167.0
—28.9	—20	—4.0	21.11	70	158.0
—26.1	—15	5.0	26.67	80	176.0
—23.3	—10	14.0	29.44	85	185.0
—20.6	—5	23.0	32.22	90	194.0
—17.8	0	32.0	35.00	95	203.0
—15.0	5	41.0	37.78	100	212.0
—12.22	10	50.0	40.56	106	221.0
—9.44	15	59.0	43.33	110	230.0
—6.67	20	68.0	46.11	115	239.0
—3.89	25	77.0	48.89	120	248.0
—1.11	30	86.0	51.67	125	257.0
1.67	35	95.0	54.44	130	266.0

CENTIGRADE-FAHRENHEIT CONVERSION TABLE—(Continued)

C	C/F	F	C	C/F	F
57.22	135	275.0	176.67	350	662.0
60.00	140	284.0	182.22	360	680.0
65.56	150	302.0	187.78	370	698.0
71.11	160	320.0	193.33	380	716.0
76.67	170	338.0	198.89	390	734.0
82.22	180	356.0	204.44	400	752.0
87.78	190	374.0	210.00	410	770.0
93.33	200	392.0	215.56	420	788.0
98.89	210	410.0	221.11	430	806.0
104.44	220	428.0	226.67	440	824.0
110.00	230	446.0	232.22	450	842.0
115.56	240	464.0	257.78	460	860.0
121.11	250	482.0	243.33	470	878.0
126.67	260	500.0	248.89	480	896.0
132.22	270	518.0	254.44	490	914.0
137.78	280	536.0	260.00	500	932.0
143.33	290	554.0	265.56	510	950.0
148.89	300	572.0	271.11	520	968.0
154.44	310	590.0	276.67	530	986.0
160.00	320	608.0	282.22	540	1004.0
165.56	330	626.0	287.78	580	1022.0
171.11	340	644.0			

INCH FRACTION CONVERSIONS

Decimals, Area of Circles, and Millimeters

Inch Fraction	Decimal Equiv.	Area Sq. In.	MM. Equiv.	Inch Fraction	Decimal Equiv.	Area Sq. In.	MM. Equiv.
1/64	.0156	.0002	.397	9/32	.2812	.0621	7.144
1/32	.0312	.0008	.794	19/64	.2969	.0692	7.540
3/64	.0469	.0017	1.191	5/16	.3125	.0767	7.937
1/16	.0625	.0031	1.587	21/64	.3281	.0845	8.334
5/64	.0781	.0048	1.984	11/32	.3437	.0928	8.731
3/32	.0937	.0069	2.381	23/64	.3594	.1014	9.128
7/64	.1094	.0094	2.778	3/8	.375	.1105	9.525
1/8	.125	.0123	3.175	25/64	.3906	.1198	9.922
9/64	.1406	.0154	3.572	13/32	.4062	.1296	10.319
5/32	.1562	.0192	3.969	27/64	.4219	.1398	10.716
11/64	.1719	.0232	4.366	7/16	.4375	.1503	11.112
3/16	.1875	.0276	4.762	29/64	.4531	.1612	11.509
13/64	.2031	.0324	5.159	15/32	.4687	.1726	11.906
7/32	.2187	.0376	5.556	31/64	.4844	.1842	12.303
15/64	.2344	.0431	5.953	1/2	.5	.1964	12.700
1/4	.25	.0491	6.350	33/64	.5156	.2088	13.097
17/64	.2656	.0553	6.747	17/32	.5312	.2217	13.494

INCH FRACTION CONVERSIONS

Decimals, Area of Circles, and Millimeters

Inch Fraction	Decimal Equiv.	Area Sq. In.	MM. Equiv.	Inch Fraction	Decimal Equiv.	Area Sq. In.	MM. Equiv.
35/64	.5469	.2349	13.891	25/32	.7812	.4794	19.844
9/16	.5625	.2485	14.288	51/64	.7969	.4987	20.241
37/64	.5781	.2625	14.684	13/16	.8125	.5185	20.637
19/32	.5937	.2769	15.081	53/64	.8281	.5386	21.034
39/64	.6094	.2916	15.478	27/32	.8437	.5591	21.431
5/8	.625	.3068	15.875	55/64	.8594	.5800	21.828
41/64	.6406	.3223	16.272	7/8	.875	.6013	22.225
21/32	.6562	.3382	16.669	57/64	.8906	.6229	22.622
43/64	.6719	.3545	17.065	29/32	.9062	.6450	23.019
11/16	.6875	.3712	17.462	59/64	.9219	.6675	23.416
45/64	.7031	.3883	17.859	15/16	.9375	.6903	23.812
23/32	.7187	.4057	18.256	61/64	.9531	.7134	24.209
47/64	.7344	.4235	18.653	31/32	.9687	.7371	24.606
3/4	.75	.4418	19.050	63/64	.9844	.7610	25.003
49/64	.7656	.4604	19.447	1	1.	.7854	25.400