RESTRICTED

WAR DEPARTMENT

TECHNICAL MANUAL

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ORDNANCE MAINTENANCE

ACCESSORIES FOR WRIGHT R975—EC2 ENGINES FOR MEDIUM TANKS M3 AND M4

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Prepared under the direction of the
Chief of Ordnance

CONTENTS

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Chapter 1

INTRODUCTION

1. SCOPE.

This manual is published for the information and guidance of ordnance maintenance personnel. It contains detailed instructions for disassembly, inspection, maintenance, repair, and assembly of the accessories for the Wright Whirlwind R-975-EC2 Tank Engine, supplementary to those in TM 9-750 and in Field Manuals prepared for the using arm. Additional descriptive matter and illustrations are included to aid in providing a complete working knowledge of the materiel. All the components in the fuel system, governor, governor valve, ignition system, engine electrical system, and engine lubricating system are discussed in this manual.

Chapter 2

ENGINE TROUBLE SHOOTING

2. GENERAL.

This section is devoted to a discussion of the most common engine troubles and their causes. Its purpose is to minimize, in so far as possible, the time wasted in ascertaining the source of a given trouble. Difficulty in determining the exact cause of an engine trouble may be encountered at times, due to the number of sources to which a given symptom can be attributed. The best method of trouble shooting is to isolate the troubles as general troubles, local troubles, and unit troubles. A general trouble is one affecting all cylinders alike. This will limit the probable cause to some accessory which affects all cylinders. A local trouble affects only one cylinder or a few cylinders; that is, if the cylinder is missing, the trouble is to be determined in the ignition system, spark plugs, and spark plug leads, and not in the magneto. It is assumed that if the magneto will fire eight cylinders, it will fire the ninth. A unit trouble affects a mechanism which is not a part of the basic engine, such as generator, control box, booster coil, etc.

3. FAILURE OF AN ENGINE TO START.

If the engine fails to start, determine whether the fault is with the fuel system or ignition system. The delivery of a priming charge to the engine is ascertained by the resistance felt to the pressure stroke of the priming pump. If the engine is receiving a priming charge, notice whether there is any firing at all or whether the engine is completely dead. If there is slight firing, as evidenced by coughing or sputtering, the ignition system is operative and the fuel system is unable to supply the fuel requirements after the priming charge has been consumed. If there is no evidence of firing at all, investigate the ignition system first.

a. Fuel System Troubles.

(1) LACK OF FUEL. Examine the fuel supply, the shut-off cocks,

the traps, and the line condition. Check the sump fuel strainer and the carburetor fuel strainer for clogged condition.

(2) THROTTLE OPENING INCORRECT. Keep the throttle almost closed or about one-tenth open until the engine starts to fire.

(3) RAW FUEL IN AIR SCOOP. Remove the air scoop from the bottom of the carburetor. If this is found to be partially filled with gasoline, remove the carburetor to check for sticking of the float needle valve. Besides checking the needle valve, check to insure that the needle valve seat has not been tampered with so as to leave a gap between the lower end of the seat and the seating gasket. If adjustment of the float level is necessary, insert gaskets until proper adjustment is obtained. These gaskets may be obtained in various thicknesses from $\frac{1}{64}$-inch to $\frac{1}{16}$-inch. NOTE: In many installations, the air scoop is provided with a ⅛-inch drain cock in the bottom so that removal of the air scoop will not be necessary.

(4) WATER IN CARBURETOR. Remove the float chamber drain plug and the strainer, and drain off.

(5) UNDERPRIMING AND OVERPRIMING.

(a) Underpriming. If the engine is underprimed, check the functioning of the primer pump and further load the engine by turning it over with the starter, with the ignition off and the throttle closed. Attempt to start the engine again.

(b) Overpriming. If the engine is overprimed, shut off the fuel at the tanks and turn the engine over by the starter with the ignition switch off and throttle open wide to remove the extra fuel produced by overpriming.

b. Ignition System Troubles.

(1) DEFECTIVE BOOSTER COIL. To check the operation of the booster coil, station one man in the engine compartment while another operates the booster coil switch. A buzzing sound will be heard by the man in the engine compartment if the booster coil is operating. If it is not operating, attempt to adjust the booster coil to draw 1¼ to 1½ amperes. In the absence of an ammeter, adjust the booster coil to sustain a spark ⅜-inch long. Test by removing the booster wire from the magneto and holding it ⅜ inch from the engine while operating the booster coil. If a spark fails to jump the gap, the booster and/or booster wire is defective and should be replaced.

(2) FAULTY MAGNETO.

(a) See that the magneto breaker points are clean and free from excessive oil. Remove a spark plug terminal and hold it ¼ inch from a ground while rotating the engine. If a spark is emitted, the magneto

is operative and the trouble is in the spark plug. If there is no spark at the terminal, remove the terminal blocks at the magneto and hold a ground about ⅛ inch from the distributor segments while rotating the engine. If there is a spark, the magneto is functioning and the defect is in the ignition harness.

(b) To prevent faulty operation of the magnetos during conditions of high humidity, treat the dielectric parts against moisture absorption. Pay particular attention to the distributor block, distributor cylinder, booster and coil terminal blocks, booster collector ring, condenser, and coil. If the dielectric parts have previously been treated with lacquer and if the lacquer is in good condition, merely wipe the parts carefully with a clean cloth. When the lacquer is flaked or in otherwise poor condition, magnetos should be removed and overhauled. For dielectric parts that have been treated with oil, wipe the parts with a clean cloth, and then rub them for a few minutes with a cloth moistened with OIL, engine, SAE 30.

(3) SPARK PLUGS. Remove and inspect the spark plugs. Clean and set the gap to 0.012 inch if necessary. After cleaning and setting the gaps, test the spark plugs under a pressure of 120 pounds per square inch to see that they fire correctly. Spark plugs covered (1) with wet oil, indicate the cylinder is not firing; (2) with carbon, indicate the cylinder has been firing but not correctly; (3) with white powder, indicate that they have been operating too hot. Inspect core for tightness, and inspect the ignition wire and terminals for failure.

(4) DEFECTIVE IGNITION WIRING. Test all ignition wires by placing them in a circuit with a lamp and source of power. The lamp will light if the ignition wire is serviceable.

c. Mechanical Troubles.

(1) LOW COMPRESSION. Check the compression of each cylinder by removing all the rear spark plugs and noting the compression of each cylinder as the engine is rotated. The compression pressure reading should be 105-110 pounds per square inch. If a cylinder is found to have no compression, check the valve clearance. Remove all cylinders having more than ten pounds per square inch variation and check the following:

(a) Broken, worn, or weak piston rings.

(b) Broken or weak valve springs.

(c) Gummed, sticking, broken, or burnt valves.

(d) Excessive cylinder wear.

(e) Leaking, or improperly seated spark plugs.

(f) Cracks in the cylinder head, barrel, or piston.

(g) Warped, pitted, or burnt valve seat inserts.

(2) INCORRECT TIMING.

(a) Check the valve timing to see that it is within its limits. If the valve timing cannot be adjusted to within its limits, check the following:

1 Valve clearance for correct setting, which is 0.010 inch.

2 Push rods for correct length and excessive wear.

(b) See that the ignition timing is correct. If not, check the following:

1 Breaker point gap, which should be 0.012 inch.

2 To see that the points are breaking at 1½ degrees after top dead center.

(3) MECHANICAL FAILURE. Mechanical failures are caused by high temperatures or defective parts.

(a) High temperatures are caused by friction, which also causes wear. Friction can be minimized by lubricating the parts, therefore some mechanical failures can be traced to poor lubrication.

(b) Failures due to defective parts can be partially eliminated by an effective inspection at the time of assembly.

(c) If mechanical failures are suspected, make a more comprehensive check after removing the engine from the vehicle.

4. ENGINE STARTS BUT STOPS.

If the engine starts but stops with sputtering and backfiring, the trouble is in the fuel system. Check the fuel system as outlined in paragraph 3 **a**. If, when testing the operation of the engine on each magneto separately, the engine stops abruptly, as is ordinarily the case when there is a defective magneto, then the fault is in the ignition system. Check the ignition system (par. 3 **b**).

5. LOW POWER AND UNEVEN RUNNING.

Low power and uneven running may be attributed to any of the following causes:

a. Incorrect Governor Setting. If the engine appears to operate satisfactorily but cannot attain full power output, check to see that the governor setting is correct. This check can be made by observing the movement of the butterfly valve control arm on the governor throttle box. The butterfly valve should not close until the engine speed reaches 2375 revolutions per minute. Any change in the governor setting should be made under the guidance of an authorized inspector.

b. Rich or Lean Mixture. Too rich a mixture is shown by uneven running and continuous black smoke from the exhaust. Too lean a mixture is shown by uneven running, overheating, backfiring, and detonation. Detonation will cause black smoke to come from the exhaust in intermittent bursts. When rich or lean mixture is evidenced, check the fuel pressure at the carburetor float bowl. The fuel pressure regulator may be at

fault through mechanical defects or misadjustments. The fuel supply pressure should be between 3 and 4 pounds per square inch. A pressure above this will raise the gasoline level in the float bowl, causing a rich mixture, while a pressure below that specified will cause a low fuel level and result in a lean mixture.

c. Fuel Line Restrictions. A restriction in the fuel line, such as a partially clogged strainer, kinked fuel lines, or dirty fuel passage, may result in the engine operating normally up to half or even three-quarter load, but when fully loaded it will miss, cut-out, and backfire (a symptom that can be mistaken for ignition trouble) due to the lack of sufficient fuel when maximum power is demanded.

d. Leaks in Induction System. Examine the intake pipes for cracks and for leaks at the cylinder and crankcase connections. Examine the carburetor and intake manifold flanges for tightness. Examine the cast elbow between the carburetor and rear section for cracks which may develop from vibration and rough usage. A crack in this section would result in an extremely lean mixture.

e. Spark Plugs. To locate a faulty spark plug, determine first whether it is in the front or rear set. Do this by running the engine first on the left magneto, then on the right magneto. An abnormal drop in engine speed while running on one magneto would indicate in which set the faulty plug is located, since that cylinder would stop firing completely. If operation of the engine on eight cylinders is continued the exhaust stack of the missing cylinder will soon cool below the temperature of those in operation and can be located by placing a few drops of water on the exhaust stack and observing the rapidity with which it evaporates. CAUTION: Do not attempt to test the temperature of the exhaust stacks with bare hands as a severe burn will result.

f. Valve and Valve Gear Trouble. Check the valve tappet clearance, springs, washers, rocker arms, and push rods. Make sure the valves are not sticking. Valve clearances are 0.010 inch on all valves and must be checked and set when the engine is at room temperature. Take care to insure that the valve is completely closed and the valve tappet roller is completely off the cam ring lobe.

g. Poor Fuel. Use only the recommended grade of gasoline and see that it flows freely to the carburetor.

h. Magneto Breaker Points. See that the magneto breaker points are clean and check the operation of the magneto.

i. Ignition Wiring Deteriorated or Burned. Check the condition at the terminals. Drill a $\frac{1}{32}$-inch hole $\frac{1}{8}$ inch above the bottom of each blank end of the main ignition manifold to allow any moisture to escape that might collect therein.

j. **Engine Overheating.** This condition may be caused by any reasons indicated in paragraph 5 **a**, **c**, **d**, and **f** and it is easily recognized by the fact that the engine will run at normal speed just after idling and then the speed will slowly fall off. Continued running of an engine exhibiting this symptom is likely to cause considerable damage; investigate the cause immediately. Other causes of engine overheating include improper cowling, excessive air temperatures, thin oil, and insufficient oil cooling.

k. **Carburetor Leakage.** See paragraph 11.

6. ENGINE RUNS BUT WILL NOT STOP.

If this occurs, the trouble is in the system that controls the ignition of the fuel charge in the cylinders. Turn the magneto switch to the "off" position and if the engine continues to run smoothly, the switch did not ground either one or both magnetos. Close the automatic fuel cut-off valve and the engine will stop. Check the magneto switch and grounding to both magnetos. If the engine continues to fire irregularly after the magneto switch has been turned off, the firing is attributable to autoignition; follow the cooling off procedure.

7. LOSS OF OIL PRESSURE.

a. CAUTION: Stop the engine immediately and determine the cause of the pressure drop before restarting. Make sure the engine is not operated for any length of time without oil pressure.

b. Loss of oil pressure is usually an indication of one or more of the following conditions. Perform the inspections and follow the remedies outlined below:

(1) Inspect the oil tank for adequate supply.

(2) Inspect the oil inlet line to the pump for proper connections.

(3) Air leaks in a flexible oil line are difficult to find because of chafing or rupturing of the inner lining, which is not visible from the outside. Often these lines will allow air to enter when a suction is applied to the line but will hold when tested under pressure. The lack of oil around a connection is not always an indication that the connection is tight. A slight air leak may cause low oil pressure and often necessitate the priming of the oil pump after the engine has stood for awhile.

(4) Inspect oil pressure gage line for proper connections.

(5) Remove the oil pressure relief valve and check the following:

(a) Spring tension. The spring compressed to 1¼ inches in height should register 4.95 pounds on the scale. If the spring is not within limits and a new spring is not available, add shims behind it to increase the tension.

(b) Valve seat. Check the seat of the pressure relief valve to insure that no obstruction is interfering with its seating.