

TM 55-1030

WAR DEPARTMENT TECHNICAL MANUAL

ENGINE, GASOLINE, MARINE,
OUTBOARD, EVINRUDE

ZEPHYR MODELS 4359, 4361, 4362, 4363

LIGHTFOUR MODELS 4375, 4376, 4377



WAR DEPARTMENT

JUNE 1945

Digitized by Google

Original from
UNIVERSITY OF CALIFORNIA

ENGINE, GASOLINE, MARINE,
OUTBOARD, EVINRUDE

ZEPHYR MODELS 4359, 4361, 4362, 4363

LIGHTFOUR MODELS 4375, 4376, 4377



WAR DEPARTMENT

JUNE 1945

United States Government Printing Office

Washington: 1945

WAR DEPARTMENT

Washington 25, D. C., 28 June 1945

TM 55-1030, Engine, Gasoline, Marine, Outboard, Evinrude, Zephyr Models 4359, 4361, 4362, 4363; Lightfour Models 4375, 4376, 4377, is published for the information and guidance of all concerned.

[AG 300.7 (17 Oct 44)]

BY ORDER OF THE SECRETARY OF WAR:

OFFICIAL:

J. A. ULIO
Major General
The Adjutant General

G. C. MARSHALL
Chief of Staff

DISTRIBUTION:

AGF (2); AAF (2); ASF (2); T of Opn (2); S Div ASF (1); PE (2); T/O & E 55-47 (5);
55-110-1 (5); 55-500 EA (10).

Refer to FM 21-6 for explanation of distribution formula.

CONTENTS

TM 55:1636
★ ★ 1945 Paragraph

	Paragraph	Page	
PART ONE. INTRODUCTION.			
<i>Section I.</i> General	1- 2	1	
<i>II.</i> Description and Data	3- 4	1	
<i>III.</i> Tools, Parts, and Accessories	5	4	
PART TWO. OPERATING INSTRUCTIONS.			
<i>Section IV.</i> Functioning of Engine	6- 9	7	
<i>V.</i> Preparation of Engine for Service.....	10	9	
<i>VI.</i> Operation Under Usual Conditions	11-14	9	
<i>VII.</i> Operation Under Unusual Conditions	15-17	11	
<i>VIII.</i> Demolition to Prevent Enemy Use	18	12	
PART THREE. MAINTENANCE INSTRUCTIONS.			
<i>Section IX.</i> General	19-20	13	
<i>X.</i> Lubrication	21-24	13	
<i>XI.</i> Preventive Maintenance Services	25-31	14	
<i>XII.</i> Trouble Shooting	32-41	17	
<i>XIII.</i> Maintenance Operations	42-49	19	
APPENDIX I. SHIPMENT AND STORAGE			26
II. REFERENCES			27
INDEX			28

609680

PART ONE

INTRODUCTION

Section I. GENERAL

1. Scope

These instructions are published for the information and guidance of the personnel to whom this equipment is assigned. They contain information on the operation and maintenance of the equipment as well as descriptions of major units and their functions in relation to other components of the equipment. They apply only to the Evinrude Engines, Lightfour Models 4375, 4376, and 4377, and Zephyr Models 4359, 4361, 4362, and 4363 (figs. 1 and 2). These instructions are arranged in three parts: Part One, Introduction; Part Two, Operating Instructions; Part Three, Maintenance Instructions. Other publications applicable to the material covered by this manual are listed in the appendix.

2. Records

Preventive maintenance service on these engines is based on WD AGO Form 55-124 (Marine Craft Operator's Daily Trip Ticket and P.M. Service Record); and on WD AGO Form 55-125 (Preventive Maintenance Service and Technical Inspection Work Sheet for Marine

Craft). WD AGO Form 468 (Unsatisfactory Equipment Report) will be used to report unsatisfactory engines.

Section II. DESCRIPTION AND DATA

3. Description

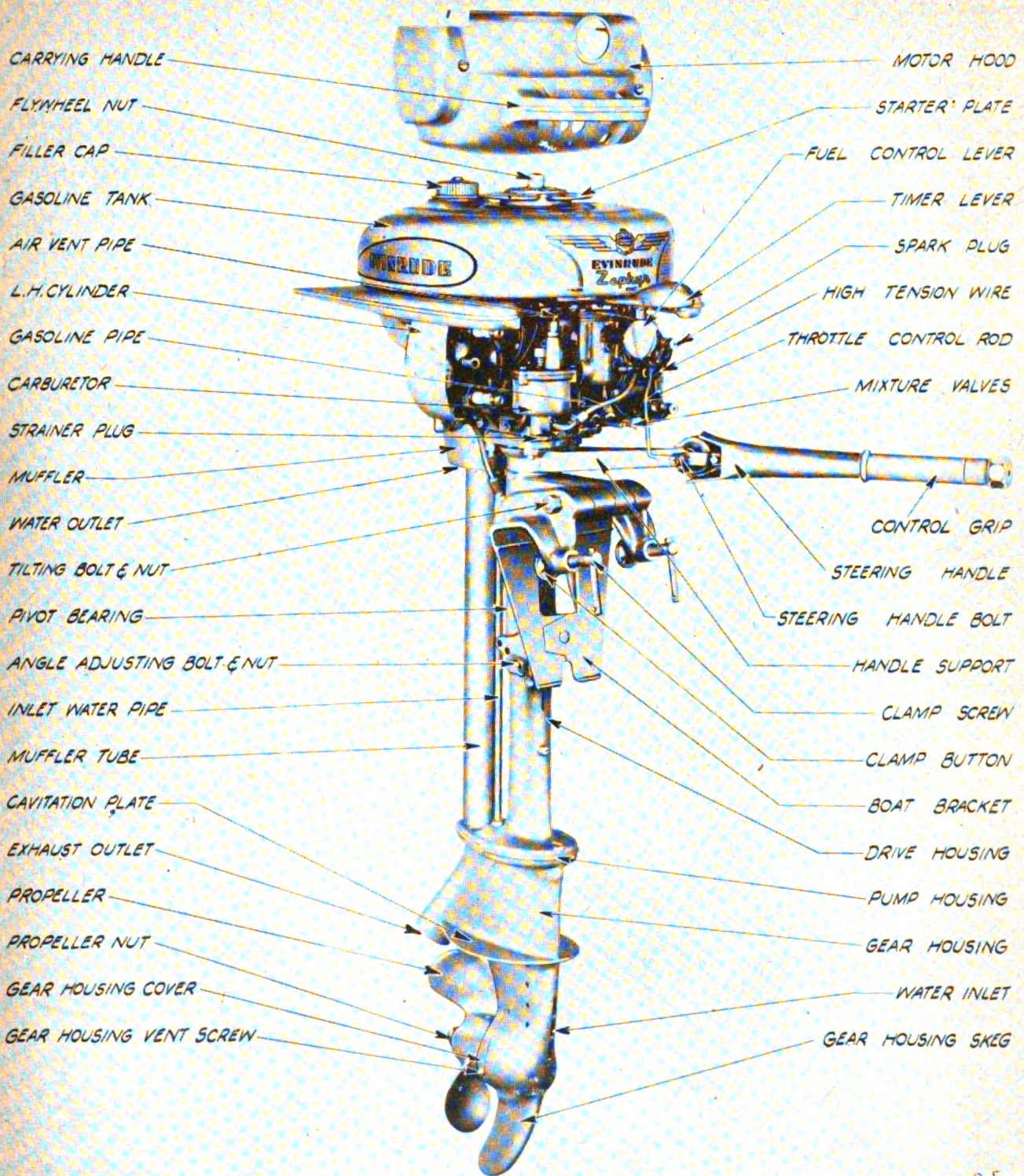
a. GENERAL. The Lightfour and Zephyr models of the Evinrude engine are outboard gasoline engines of the two-cycle, four-cylinder, crankcase-compression type. They have two decks of opposed cylinders firing alternately in pairs. The chief differences between the two models are in brake horsepower, weight, and piston displacement. (See tabulated data, par. 4.)

b. IGNITION. Both models have waterproof, built-in-flywheel magneto ignition.

c. LUBRICATION. See paragraph 21.

d. TILT-UP. Both models tilt automatically when encountering submerged obstructions or when beaching. They have a tilt-up stop to limit upswing.

e. MISCELLANEOUS. Both models have motor rests and provisions for attachment of steering fittings.



84025

Figure 1. Zephyr engine.

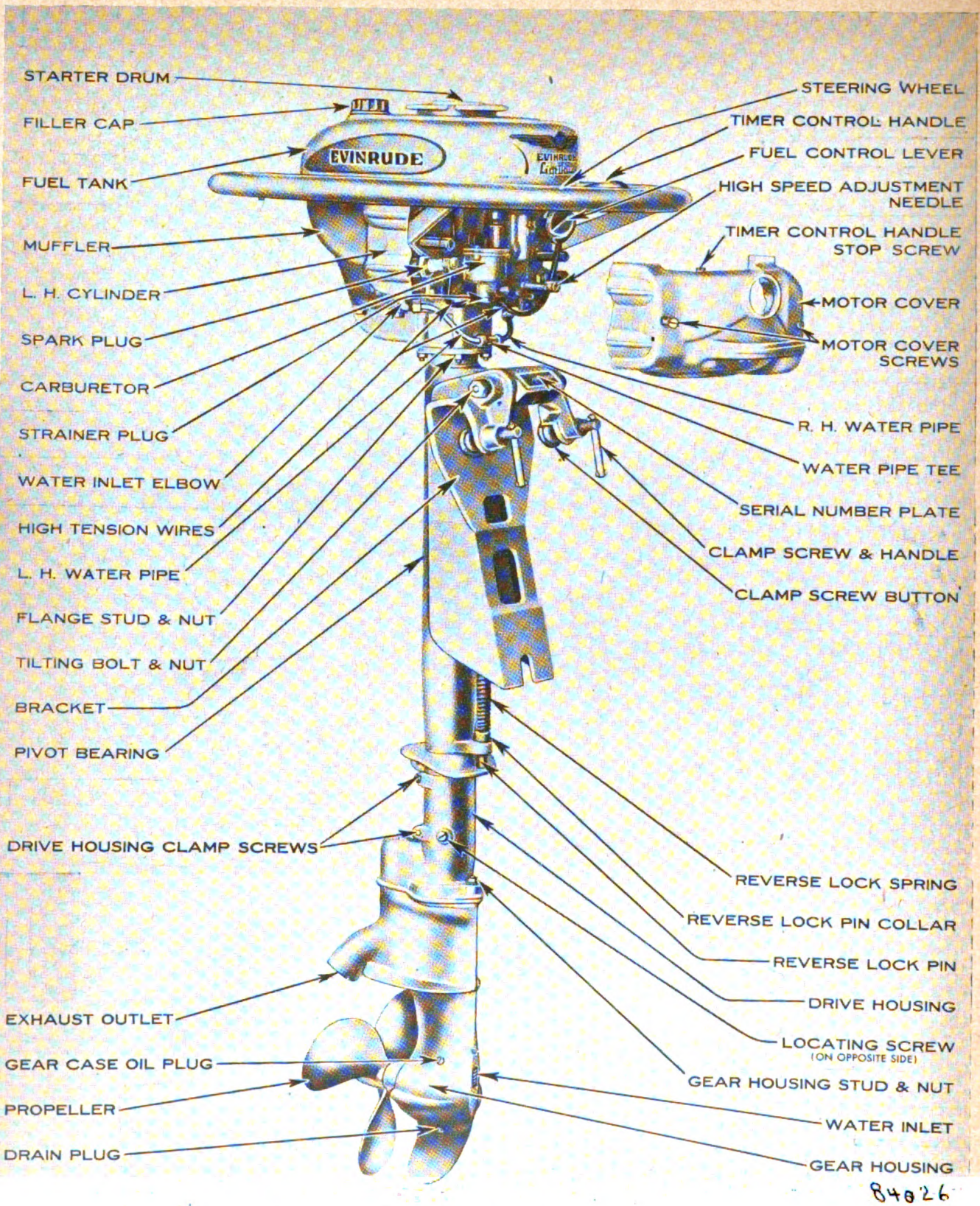


Figure 2. Lightfour engine.

4. Tabulated Data

N.O.A. Certified Brake Horsepower	<i>Zephyr</i> 5.4 N.O.A. certified brake horsepower at 4,000 rpm	<i>Lightfour</i> 9.7 N.O.A. certified brake horsepower at 4,000 rpm
Weight ¹	43 lbs.	63 lbs.
Piston displacement	9.7 cu. in.	15 cu in.
Bore and stroke	1½" x 1¾"	1¾" x 1 ³⁵ / ₆₄ "
Number of cylinders	4	4
Piston rings	2	3
Gasoline tank capacity	Holds 6¾ pts.	Holds 1¼ gals.
Average running time at full speed	1 to 1¼ hrs.	¾ to ¾ hrs.
Gears and gear ratio-engine to propeller	Straight bevel 13:20	Spiral bevel 11:17
Propeller as supplied with engine ²		
Number of blades	2 Weedless	2 Weedless
Diameter X pitch	7½" dia. x 7½" pitch	8¾" dia. x 9" pitch
Extra length shaft	5"	5", 15"
Estimated speeds in mph on: Average row boats, service dinghies, etc.	2 to 10 mph	3 to 11 mph
Speed control	Twist grip	Twist grip
Starting method	Cord	Cord
Propeller protection	Propeller protection Clutch and skeg	Rubber cushioned Drive and skeg
Mounting of motor	Floating in rubber	Floating in rubber
Type of pump giving positive cooling	Two-stage centrifugal	Two-stage centrifugal
Type of carburetor	Float-feed auto type with silencer and indicator dial	Float-feed auto type with si- lencer and indicator dial
Type of carburetor priming device	Integral priming lever	Integral priming lever
Boxed weight (approx.)	80 lbs.	102 lbs.
Over-all dimensions, omitting steering handle		
Standard models	11" x 17¾" x 40"	11¾" x 18" x 41"
Starter models	11" x 17¾" x 41¾"	11¾" x 18" x 42¾"

¹ Weights vary according to material substitutions.

² Standard propeller supplied on engine is suitable for use on most boats. If used on extremely light boat with light load, resulting in rpm beyond 4,000, special high speed propeller should be used.

Section III. TOOLS, PARTS, AND ACCESSORIES

5. Items Furnished

Listed below are tools, parts, and accessories supplied in a kit with the equipment when the equipment is issued to using organizations. These are illustrated in figures 3(1) and (2). After using tools and equipment, clean and dry them thoroughly before storing.

Item No.	Nomenclature	Mfr. Part No.
7	Bag, tool, canvas	201363
8	Pliers, 8 in.	275776
9	Punch, ³ / ₁₆ in.	201111
10	Rope, starter	190256
11	Feeler, breaker, and spark plug	121020
12	Pins, propeller	130321
13	Pins, cotter, propeller nut	120223
14	Plugs, spark	275908

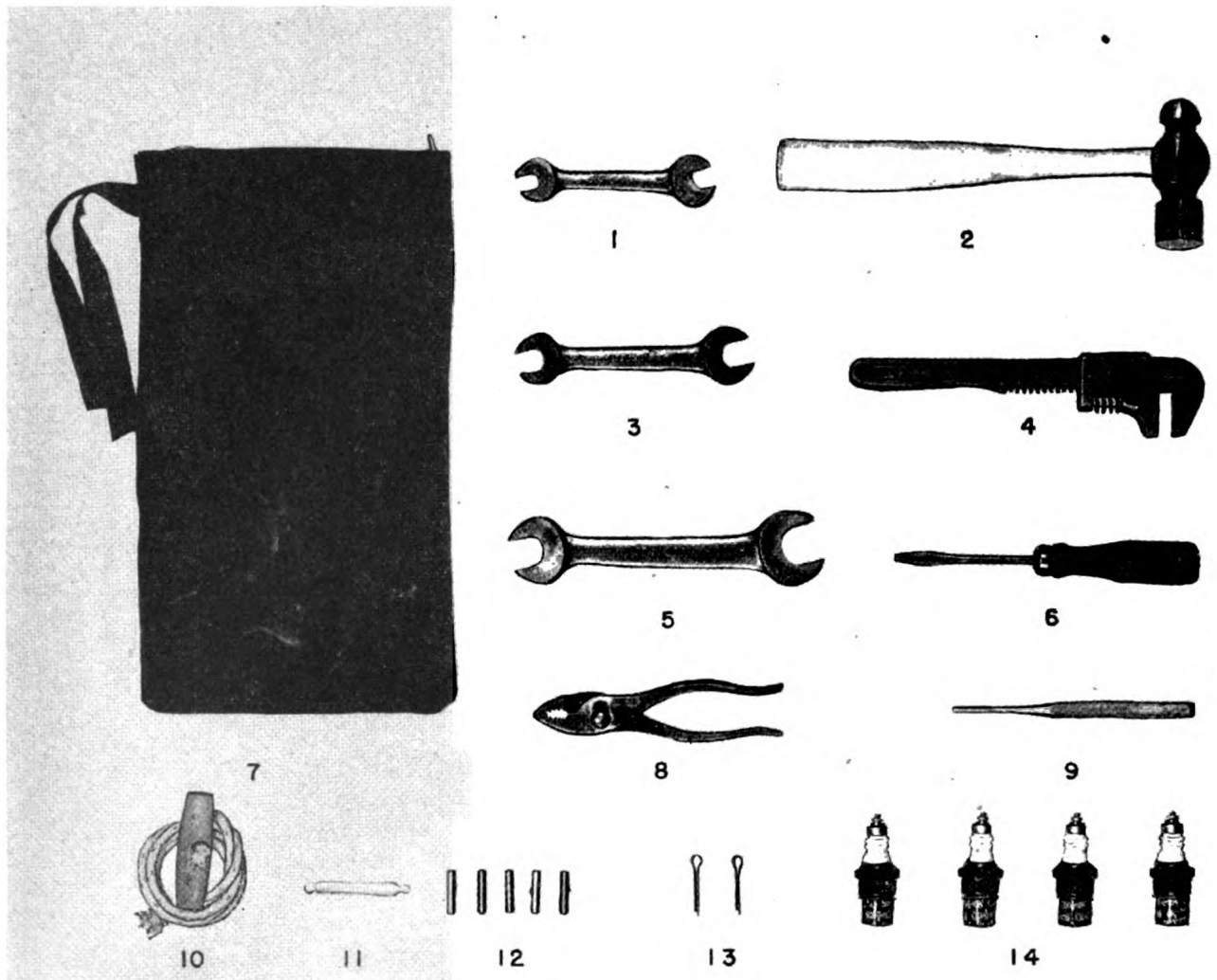
ZEPHYR MODELS

Item No.	Nomenclature	Mfr. Part No.
1	Wrench, open-end ⁷ / ₁₆ x ½ in.	160151
2	Hammer, ball peen, ³ / ₄ lb.	275888
3	Wrench, open-end, ⁹ / ₁₆ x ⁵ / ₈ in.	160152
4	Wrench, adjustable end (9 in.)	190154
5	Wrench, open-end, ³ / ₄ x 1 in.	160153
6	Screw driver, 3½ in.	194046

LIGHTFOUR MODELS

Item No.	Nomenclature	Mfr. Part No.
1	Pliers, 8 in.	275776
2	Hammer, ball-peen, 16 oz.	275778
3	Punch, ³ / ₁₆ in.	201111
4	Screwdriver, 10 in.	275777
5	Bag, tool, canvas	201363
6	Screwdriver, 3½ in.	194046

Item No.	Nomenclature	Mfr. Part No.	Item No.	Nomenclature	Mfr. Part No.
7	Wrench, adjustable end (9 in.)	190154	17	Pins, cotter, propeller nut	121113
8	Cap, filler	275476	18	Nut, propeller	200670
9	Screw, clamp	195350	19	Feelers, breaker, and spark plug	121020
10	Screen, strainer	121179	20	Plugs, spark	200322
11	Plug, strainer	133487	21	Propeller	200175
12	Gasket, plug, strainer	171318	22	Rope, starter	190256
13	Button, screw, clamp	120999		[Note: There is no 23.]	
14	Spring, arm, breaker	275023	24	Can, fuel, 5 gals.	194131
15	Assembly, breaker	194509	25	Funnel, filtering	275851
16	Pins, propeller	130053	26	Cover, canvas, engine	190838



(1) Zephyr models.
Figure 3. Tools, parts, and accessories.



(2) Lightfour models.

Figure 3. Tools, parts, and accessories (cont.)

Original from

UNIVERSITY OF CALIFORNIA

PART TWO

OPERATING INSTRUCTIONS

Section IV. FUNCTIONING OF ENGINE

6. Cycle of Events

Zephyr and Lightfour engines are of the two-cycle, four-cylinder type. The following is a brief description of the cycle of events that transfers fuel into power in each cylinder (fig. 4):

a. ADMISSION AND COMPRESSION STROKE. As the piston, at bottom dead center of travel, moves upward, valves or ports located in the side of the cylinder allow the entry of the fuel charge to be compressed. As the piston continues upward, the intake port in the side of the cylinder is closed by the piston. While the piston is compressing the fuel charge, it is also

drawing a fresh charge of fuel from the carburetor through a check valve into the crankcase. Further travel of the piston compresses the fuel charge and prepares it for ignition by the spark plug. Thus the piston compresses a fuel charge on top and draws a fresh fuel charge in at the bottom.

b. POWER AND EXHAUST STROKE. An electric spark leaps across the electrodes of the plug causing the fuel charge to burn and expand, forcing the piston down. As the piston travels downward, the check valve closes. Thus the fresh fuel charge in the crankcase is compressed. On the piston's downward travel, the exhaust port is uncovered and the exhaust gases are permitted to escape. Further travel of the

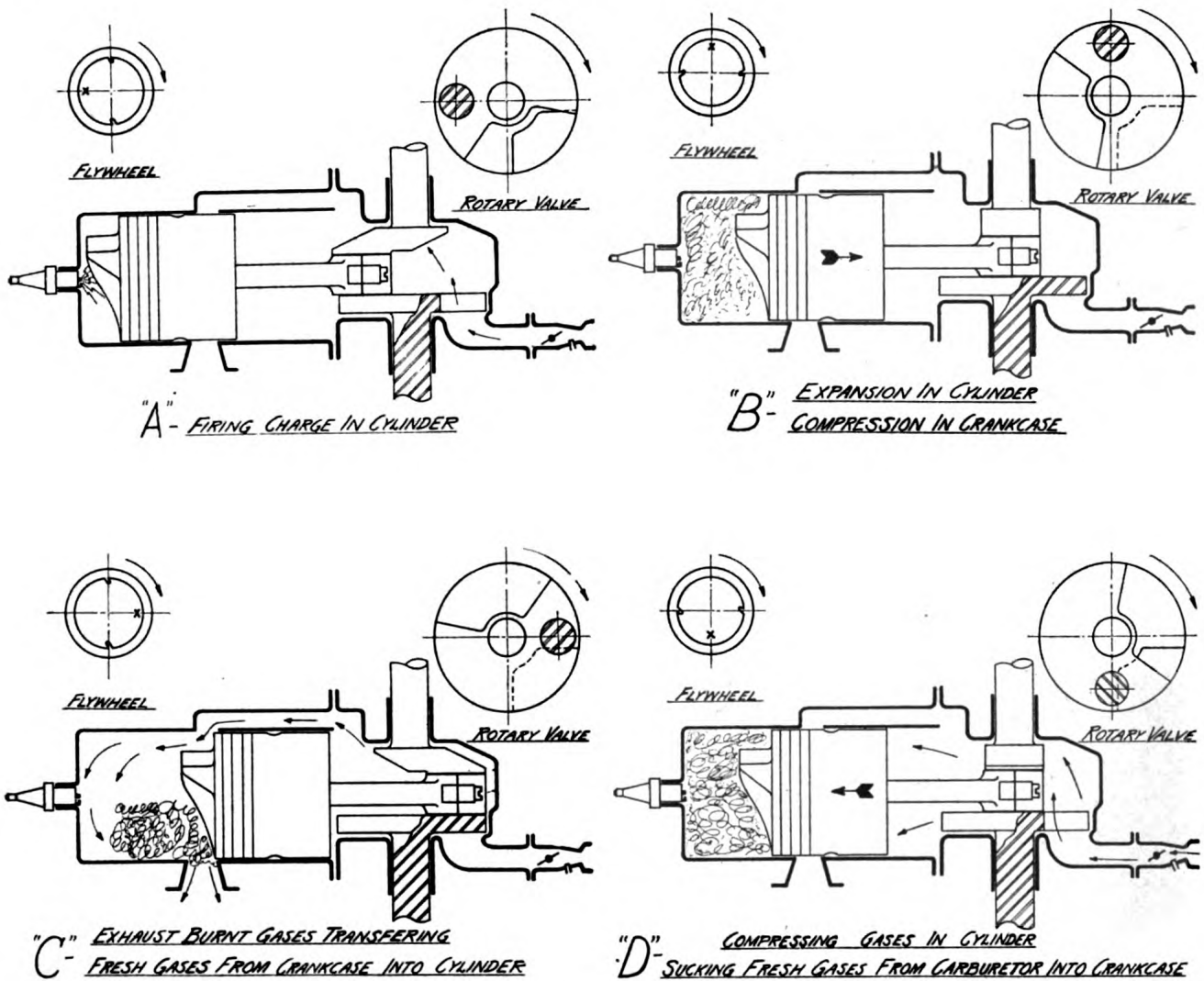


Figure 4. Cycle of events in engine.

piston uncovers the intake port. The compressed fuel charge in the crankcase is allowed to enter the cylinder. Due to the construction of the piston, the fuel mixture is deflected to the top of the cylinder giving a scavenging air effect in helping to remove the burnt gases. As the piston moves upward again, it closes the intake and exhaust ports and begins the compression stroke.

7. Water Pump

A centrifugal pump with two impellers keyed to the drive shaft provides cooling water. With the revolving of the impeller, the water is pumped up through the water intake pipe to the bottom of the cylinders, then exits from the top of the cylinders through the muffler and out of the outlet pipe at the bottom of the muffler (fig. 5).

8. Automatic Exhaust Relief

While the engine is being started, the exhaust relief automatically provides a bypass from which exhaust pressure instantly escapes into the air, unchecked by the water seal. As quickly as the engine attains normal revolutions, the relief is automatically closed by a flow of circulating water, and the noise and fumes are diverted to the water-sealed exhaust outlet. At low speed, therefore, the water will emit in a spray forced out by exhaust gases. At higher speeds water flows in a solid stream (fig. 6).

9. Magneto and Flywheel

Current for ignition is generated by a magneto built into the flywheel and operated by the engine once it has started (fig. 7).

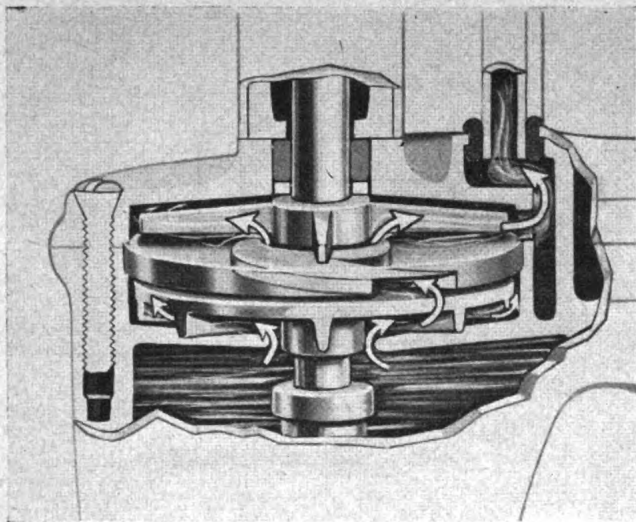


Figure 5. Water pump.

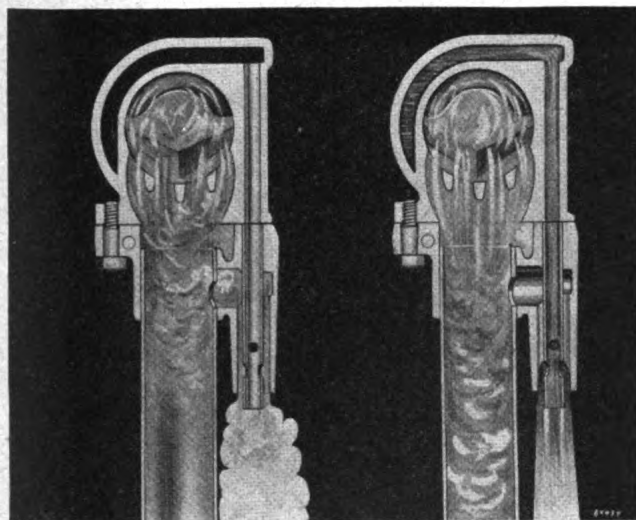


Figure 6. Automatic exhaust relief.

Section V. PREPARATION OF ENGINE FOR SERVICE

10. New or Rebuilt Equipment

a. **ASSEMBLY.** The engine, taken apart at the gear housing flange, is shipped in two sections. After removing the engine from its box, fasten the lower section of the gear housing to the drive housing by means of the two nuts, making sure the square end of the lower drive shaft enters the coupling on the upper drive shaft. Be sure also that the flange nuts are tight.

b. **REMOVAL OF RUST PREVENTIVE.** Before the engine is packed for shipment, a small quantity of oil inserted in the cylinders of the engine through the spark plug holes, acts as a rust preventive. This oil is removed from the cylinders before the engine is operated. To remove the oil,

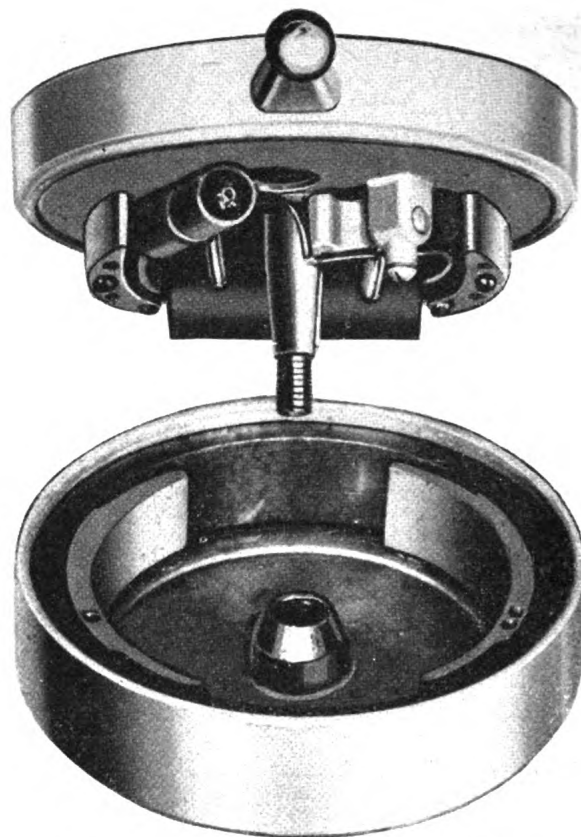


Figure 7. Flywheel with built-in magneto.

take out the corks from the spark plug holes in the cylinders and, before inserting the spark plugs, coil the starter rope around the starter disc on top of the flywheel and spin the engine several times. When this is being done, the spark plug wires from the magneto are grounded to some metal part of the engine.

c. **INSTALLATION AND WIRING OF SPARK PLUGS.** Insert the spark plugs in the cylinders and draw them up tightly. Fasten the wires to the spark plugs so that the wires lead directly away from the engine hood. Tighten the spark plug wire nuts with pliers so that the wires will remain in proper position.

Section VI. OPERATION UNDER USUAL CONDITIONS

11. Attaching Engine to Boat

To attach the engine to the boat, proceed in accordance with the following instructions (see fig. 8) :

a. Hang the engine over the stern of the boat, preferably in the center. Before clamping it into position, see that the propeller is submerged while the boat is floating without load. If the propeller is not fully submerged, the stern of the

boat must be cut down until the propeller is submerged with the boat floating empty. (For best results, this engine should be used on a boat with a stern not more than 15 inches high.) Tighten the clamp screws by hand. Use no tools for this purpose. Hand tightening is sufficient. Then fasten one end of a stout rope to the boat and tie the other end to the engine bracket. An engine so fastened can be recovered if accidentally dropped overboard.

b. With the engine on an empty boat, the drive housing (engine shaft) should be vertical. A 12° boat transom angle is preferable. The transom thickness should not exceed the SAE standard of 1¾ inches. If the engine angle adjustment does not permit an absolutely vertical engine position, remove the wing nut on the angle adjustment bolt which passes through holes in the boat bracket. Remove this bolt and replace it in the next adjusting hole that brings the drive housing into a vertical position, or

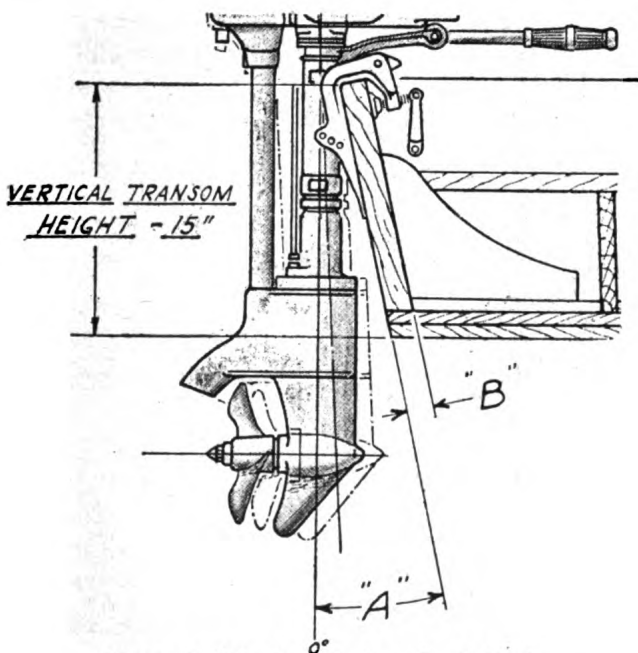


Figure 8. Attachment of engine to boat.

slightly toward the stern of the boat. If the stern of the boat is too vertical to permit the drive housing to reach a vertical position, remove the angle adjusting bolt entirely.

12. Starting and Stopping

To start and stop the engine, proceed in accordance with the following instructions:

a. Move the timer (spark control) lever, located beneath the gas tank, to the START position, as indicated on the tank transfer.

b. Coil the starter rope clockwise around the starter disk. (Engines equipped with a Simplex Starter require no rope.)

c. Turn the control grip on the steering handle until the word "START" is in line with the arrow on the edge of the steering handle.

d. When starting a cold engine, turn the fuel control lever at the front of the engine to the left, in line with the word "PRIME." Hold it in this position about 5 seconds, then turn to the START COLD position. When starting a warm engine, do not prime; turn fuel control lever to RUN position. (If engine fails to start after the next step, turn fuel control lever to START COLD position.)

e. Pull the starter rope forcibly with the right hand. Repeat until the engine starts. (It sometimes happens that too much gasoline is drawn into the crankcase and cylinders when starting the engine, especially when it is warm. When this occurs, the charge cannot be fired, as the mixture is too rich to be explosive. The excess gasoline must be eliminated. To do this, first note the setting of the needle valve(s) on the carburetor so this can be returned to readily; then gently close the needle valve(s) and pull the starter rope until the engine starts, allowing the engine to run until it stops. Now reset the needle valve(s) and follow instructions relative to starting a warm engine.)

f. After the engine starts, turn the fuel control lever gradually toward the RUN position and move the timer lever to the right toward the FAST position.

g. Turn the control grip to the SLOW position and retard the spark by moving the timer lever toward SLOW. Now with a screw driver, turn the low speed mixture valve, located to the left, slowly in or out until the engine runs smoothly. After the best slow-running setting has been obtained, move the timer lever to the FAST position and turn the control grip toward FAST. Now adjust the high speed mixture valve, located to the right, by slowly turning in or out until the best operating setting has been obtained. (The approximate setting of the low speed mixture valve is one turn from the closed position; of the high speed mixture valve, one-half turn from the closed position.) Always adjust the low speed mixture valve first and do not change this setting when adjusting the high speed valve. (It is advisable to run the engine 100 yards or more before making a final adjustment on the carburetor. It takes this

distance to clear the crankcase to the point where a correct adjustment can be obtained, because of the tendency of this type of two-cycle engine to overfill the crankcase when starting off. To eliminate the necessity of re-adjusting the valve(s) every time the engine is used, measure the quantity of lubricating oil mixed with the gasoline very accurately and take care that the same grade and type of both oil and gasoline are always used.)

h. To increase speed, open the throttle by turning the grip toward FAST. To decrease speed, turn the grip toward SLOW. Also use the timer lever to retard the spark for extremely slow speed. RIGHT is advanced; LEFT is retard. (For the first hours of operation, do not run faster than two-thirds the maximum speed.)

i. To stop the engine, press the cut-out spring on bottom of the timer lever. When the engine is not in operation, turn the fuel control lever to the extreme right to the SHUT-OFF position.

13. Steering

Steering is accomplished as follows:

a. The steering handle, mounted on the engine bracket, is used to turn the engine as if it were a rudder.

b. The mechanical "co-pilot" is a relief steering mechanism. It provides a cushioned yielding grip which holds the engine in the selected position when the operator lets go of the tiller. The tension is set at the factory, but may be re-adjusted, if necessary, by tightening or loosening the spring tension screw on upper end of pivot bearing.

c. Full reverse is accomplished by turning the engine 180° from ahead to astern in clockwise direction. Propeller torque makes it easier to turn in this direction.

d. For mounting heavy duty Lightfour engines on rubber boats, a steel bracket is provided (fig. 9). An adjustable hook at the bottom of the bracket engages a hole in an extension of the rubber bottom of the pontoon, and the bracket is then securely lashed to the top of the pontoon. Sliding extension arms distribute the thrust load from the engine to a large area of the pontoon. When the motor is placed in position on the steel bracket, the notched lower end of the aluminum bracket engages the stud on the midsection of the steel boat bracket. The two thumbscrews should then be tightened securely.

14. Precautions When Engine Is Not In Use

The following procedures are essential to effective resumption of operation:

a. When engine is to be left on the boat, see that it is tilted out of the water so underwater exhaust outlet is above water line. Engine should be tilted to an angle that allows the water to drain from exhaust tube. The engine should then be secured with a lashing so it will not drop back into the water from any movement of the boat. Otherwise, water may enter cylinders through exhaust ports.

b. To remove engine from boat, loosen clamps and pull engine straight up and hold in vertical position until all water has drained from the underwater exhaust tube and water system. Never set engine on magneto or carry engine with magneto down, as this may allow water to enter the powerhead from the muffler. When laying down engine, see that carburetor is up; also that storage place is free from sand and grit.

c. If engine is to be laid up after operation in salt water, flush water system (including cylinder jackets, water pipes, and muffler jacket) with fresh water. Also drain water from gear housing.

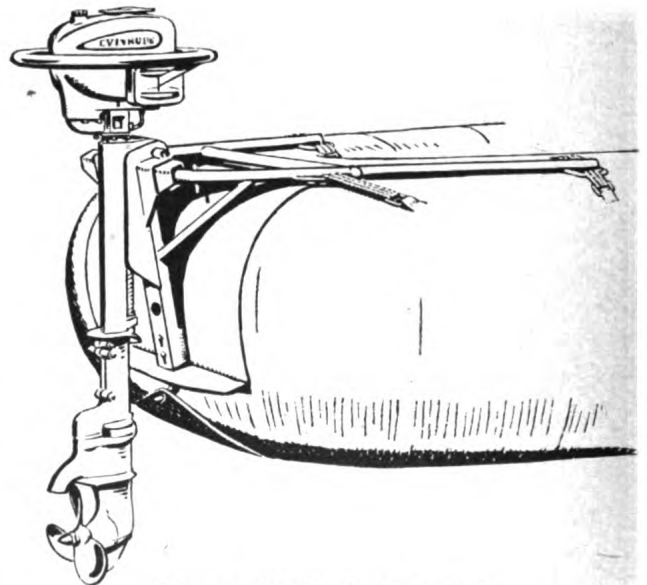


Figure 9. Rubber boat bracket.

Section VII. OPERATION UNDER UNUSUAL CONDITIONS

15. Operation in Shallow or Obstructed Waters

For such operation, consideration must be given to the following:

a. The engines are designed to permit tilting so that the lower unit will not be seriously damaged through striking any submerged object. However, when operating in shallow or obstructed waters, the engine is run at low speed. When tilting the engine, never press down on the steering handle, but grasp the back of the gas tank and pull inward. To tighten the tilting friction, draw up on the tilting bolt nut.

b. The propeller protection clutch on the Zephyr consists of a cone fastened to the propeller shaft by a shear pin and a conical hub integral with the propeller wheel (fig. 10). When an underwater obstruction is struck, the propeller slips on the cone and reengages after passing over the obstruction. Spring pressure holds the propeller in engagement on the cone. (If the engine has not been used for some time, the propeller may have become stuck to the cone through oxidation. If so, set the engine on a rack, hold the flywheel rigid, and turn the propeller, jarring the blades loose from the cone.)

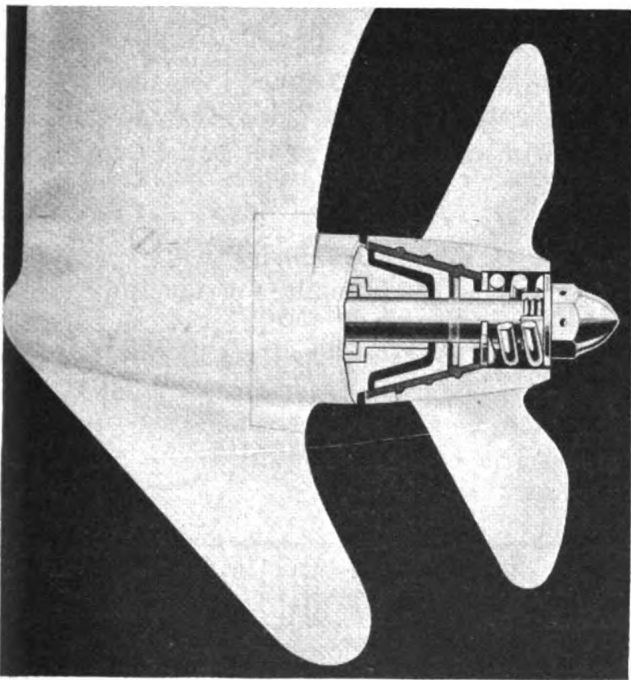


Figure 10. Propeller protection clutch.

c. A propeller shear-off pin prevents damage to the Lightfour engine if it strikes a submerged rock or other obstruction in the water. This is a soft metal "safety" pin which passes through the propeller shaft. If the engine strikes a solid obstruction while running at full speed, the shear-off pin shears off—disengaging the propeller from the driving mechanism and preventing damage. When this happens, the engine runs free of the propeller. In such a case,

stop the engine immediately, and insert another shear-off pin.

16. Care of Engine in Cold Weather

In cold weather, if the engine is to remain idle temporarily, it should be drained. This is accomplished by setting it in an upright position and revolving the flywheel. The water will drain out of the cylinder jackets and pipes, preventing freezing and bursting of parts. In addition, water should be removed from the gear housing.

17. Care of Engine That Has Been Submerged

An engine that has been submerged must be cleaned and dried out thoroughly before it can be operated again. Proceed as follows:

a. Drain and clean the gasoline tank, flushing it thoroughly with clean gasoline.

b. Remove and clean the carburetor, gasoline line, and spark plugs. Make sure all water has been removed from these parts.

c. Hold the engine in position with the carburetor opening in the crankcase down, and revolve the flywheel slowly to remove water from the cylinders and crankcase.

d. Test spark plug wires for satisfactory spark. If not satisfactory, proceed as directed in paragraph 43.

e. Reassemble the carburetor and gasoline line.

f. Put 2 to 3 tablespoonfuls of proper lubricating oil (par. 21) in each cylinder through each spark plug hole, and with the spark plugs removed pull the flywheel over rapidly with starter rope. Repeat this process several times, then put the spark plugs in the cylinders, fill the gasoline tank with a fresh gasoline-oil mixture and proceed to start the engine.

g. Due to the excess oil in the cylinders, as well as the possibility of some water still remaining in the cylinders, it may be necessary to remove and clean the spark plugs once or twice during the process of starting.

Section VIII.

DEMOLITION TO PREVENT ENEMY USE

18. Methods

In combat areas, several steps may be taken to keep the engine from use by the enemy.

a. Start the engine and run it at full speed on straight fuel without any oil. Seizure of parts will result from lack of lubrication.

b. Smash the carburetor, crankcase, and cylinder head with an ax, hammer, or metal bar.

c. Drop the engine into deep water. Recovery of it may be possible when the combat area is retaken.

PART THREE

MAINTENANCE INSTRUCTIONS

Section IX. GENERAL

19. Scope

Part Three contains information for the guidance of the personnel of the using organizations responsible for the maintenance (first and second echelons) of this equipment. It contains information needed for the performance of the scheduled lubrication and preventive maintenance services.

20. Maintenance Responsibilities

a. **FIRST ECHELON MAINTENANCE.** First echelon maintenance is preventive maintenance and includes not only the proper care, use, operation, cleaning, preservation, and lubrication of the equipment, but also inspection, adjustments, and authorized minor repairs and parts replacements that may be accomplished by the boat crew with the on-board tools.

b. **SECOND ECHELON MAINTENANCE.** Second echelon maintenance is the additional maintenance performed by the using organization which includes the boat crew, and by personnel of a shore base. The scope of such maintenance includes replacement of minor assemblies and emergency repairs and adjustments.

Section X. LUBRICATION

21. General

There is no independent oiling system in the Zephyr and Lightfour engines. Lubrication is

effected by the oil that is mixed in the gasoline prior to being placed in the gasoline tank. When this fuel mixture is drawn into the crankcase by the action of the piston (see par. 6), the oil, being less volatile and heavier than the gasoline, deposits itself on the crankshaft, rods, wrist pins, and cylinder walls, creating an oil film on these parts. Zephyr and Lightfour engines will be lubricated in accordance with the provisions of War Department Lubrication Order LO 55-1030 (fig. 11).

22. Fuel and Oil Mixture

Follow instructions given in the Lubrication Order. Thoroughly mix the oil and gasoline in a separate container before pouring the mixture into the gasoline tank. Do *not* use tank to mix gasoline and oil.

23. Propeller Gear Case

The propeller gear case is lubricated in accordance with instructions given in the Lubrication Order.

24. Idle or Stored Equipment

If the engine has been idle for some time or has been stored away before it is operated, pack the gear case with fresh lubricant of the type prescribed in the Lubrication Order. When the engine is to be stored away, make sure the gear case is free of water and filled with prescribed lubricant.

WAR DEPARTMENT LUBRICATION ORDER		LO 55-1030
ENGINE, GASOLINE, MARINE, OUTBOARD (Evinrude "Zephyr" & "Light four")		22 DECEMBER 1944
References: TM 55-1030		<i>Copy of this Lubrication Order will remain with the equipment at all times; instructions contained therein are mandatory and supersede all conflicting lubrication instructions dated prior to 22 December 1944.</i> [A.G. 300.8 (22 Dec. 1944.)] By Order of the Secretary of War: G. C. MARSHALL, Chief of Staff. Official: J. A. ULIO, Major General, The Adjutant General.
FUEL TANK—Use NS 3100 (OIL, lubricating, two cycle engines) and Gasoline, thoroughly mixed in the following proportions. ZEPHYR: ½ pint NS 3100 to 1 gallon of Gasoline. LIGHT FOUR: ¾ pint NS 3100 to 1 gallon of Gasoline.		
PROPELLOR GEAR CASE—Every 64 hours, remove plugs and fill to level of upper plug with GD (GREASE, gear, outboard motor).		
Requisition necessary additional Lubrication Orders in conformance with instructions and Lists in FM 21-6.		

Figure 11. War Department Lubrication Order LO 55-1030.

Section XI. PREVENTIVE MAINTENANCE SERVICES

25. General

Regularly scheduled preventive maintenance services are essential to insure efficient performance of the Zephyr and Lightfour engines, and consequently to avoid serious difficulties in marine operations. These services are divided into two groups:

a. Those performed by engine operators before, during, and after operation, and weekly (first echelon services). WD AGO Form 55-124 will be used by the operator daily to record trips, engine defects and accidents.

b. Those performed by maintenance personnel monthly and semiannually (second echelon services). These are based on WD AGO Form 55-125. Defects noted that cannot be corrected by the first or second echelons will be reported to a higher echelon.

26. Inspection Standards

Inspection of the equipment or any part of it should show whether the equipment or part is in good condition, correctly assembled, secure or excessively worn.

a. Inspection for "good condition" usually is external: visual inspection to determine if the unit is damaged beyond safe or serviceable limits, or if it is in such a condition that damage will result when it is operated. "Good condition" means not rusted, corroded, bent, twisted, chafed, burned, broken, cracked, bare, frayed, dented, collapsed, torn, cut, or inadequately lubricated.

b. Inspection of a unit to see that it is "correctly assembled" is usually an external, visual inspection to determine if it is in its normal position in relation to other units.

c. Inspection of a unit to determine if it is "secure" is usually an external inspection, a hand-feel, or a wrench-check for looseness. The inspection should include any brackets, lock washers, lock nuts, locking wires, or cotter pins used in an assembly.

d. "Excessively worn" means worn close to or beyond serviceable limits and likely to result in a failure if not replaced before the next scheduled inspection.

27. Before-operation Services

This service is designed primarily as a check to see that the equipment has not been tampered

with or damaged since it was last used. Other circumstances may also have rendered the equipment unsatisfactory or even unsafe to operate. The before-operation service consists of inspecting the items in the following schedule according to the procedures prescribed, and correcting or reporting any defects or deficiencies. Upon completion of this service, results should be reported promptly to the designated authority.

a. ITEM 1, TAMPERING AND DAMAGE. Check for any damage that may have occurred from falling debris, fire, sabotage, or collision. Dry the spark plugs and wiring if wet. Check entire engine assembly for loose connections and mountings.

b. ITEM 1A, MOUNTING OF MOTOR. Check the mounting of the motor to see that it is securely and properly mounted.

c. ITEM 3, FUEL AND OIL. Check supply of fuel-and-oil mixture in tank and spare cans. Add as needed. The engine tank contains enough fuel-oil mixture for 1 hour of operation with the engine running at full speed.

d. ITEM 8, LEAKS. Check for any indications of fuel-oil mixture leaks. Trace all leaks to their source and correct or report.

e. ITEM 13, TOOLS, SPARE PARTS, AND EQUIPMENT. See that all engine tools and equipment are present, serviceable, and properly stowed. Extra shear-off pins, spark plug and starter rope (if Simplex starter is not attached) must be included.

28. During-operation Services

The during-operation service consists of detecting improper performance according to the schedule given below. It is important to be on the alert for unusual noises, smoke, odors, or leaks, to detect unsatisfactory performance, and to take corrective steps *before* the defects develop to the point of actual breakdown, fire, or accident. Conditions beyond the scope of the operator should be reported at the earliest opportunity. During operation of the engine, the operation will do the following:

a. ITEM 15, ENGINE OPERATION. Note any unusual noise or unsatisfactory operating characteristics such as lack of power, misfiring or overheating, that may indicate trouble. Check the circulation of the cooling water. Water circulation may be stopped by a clogged intake screen. If the engine vibrates more than usual, inspect the propeller for damage.

b. **ITEM 16, CONTROLS AND DRIVE.** Observe if engine responds to the controls satisfactorily. See that the mixture and speed control levers remain in set positions.

29. After-operation and Weekly Services

The after-operation services listed below are to be performed immediately after each period of operation of the equipment. These services are particularly important because, if they are performed thoroughly, the equipment will be ready to operate again at a moment's notice. When performing after-operation services, operating personnel should take into consideration any irregularities in performance noticed during operation. The after-operation services should never be omitted entirely, even in extreme tactical situations. Those items marked with an asterisk (*) require additional services weekly, the procedures for which are given in the second part of each item so marked. These special services, together with the after-operation schedule, comprise the regular weekly check which serves to reinforce daily maintenance and should be performed by operating personnel under careful supervision.

a. **ITEM 29, ENGINE-GENERAL.** Investigate or report all characteristics of unsatisfactory performance noted during operation. Tighten any loose connections or mountings. Remove excessive dirt or grease from the exterior of the engine.

b. **ITEM 41, LEAKS.** Check for any indications of fuel-oil mixture leaks or water leaks. Trace all leaks to their source and correct or report.

c. **ITEM 36, *STRAINERS (FUEL, WATER).** Remove strainer plug and screen at bottom of carburetor and clean thoroughly with dry cleaning solvent. Check intake holes at front of gear housing and clean if clogged by weeds or other foreign matter. Also see that water pipe connections are tight.

d. **ITEM 30, FUEL, OIL, WATER.** (1) Fill fuel tank with fuel-oil mixture and refill spare cans.

Caution: Fuel and oil should be mixed in a container BEFORE being put in tank.

(2) Drain the entire cooling system. If unit is used in salt water, the system should be flushed with fresh water and the entire engine wiped with an oil-dampened cloth. The gear housing should be drained of any water.

e. **ITEM 34, *ELECTRICAL WIRING.** (1) Check all ignition wiring to see that it is securely connected, clean, and not damaged.

(2) *Weekly.* Check all accessible wiring to see that it is securely connected and supported; that the insulation is not cracked or chafed; and that its conduits and shielding are secure and in good condition. Report any unserviceable wiring.

f. **ITEM 47, TOOLS, SPARE PARTS, AND EQUIPMENT.** See that engine tools and equipment are present, serviceable, and properly stored.

30. Monthly and Semiannual Services

a. The schedule presented in this section outlines procedures to be performed monthly and/or semiannually, as indicated, by maintenance personnel of the second echelon. Each page of the schedule has two columns at its left edge corresponding to the semiannual and monthly maintenance intervals, respectively. Some procedures are not required at both intervals. At the monthly interval, perform the operations indicated opposite each check mark appearing in the monthly column. At the semiannual interval, perform the operations indicated opposite each check mark appearing in the semiannual column.

b. General terms used to designate actions to be taken in the services listed are defined in paragraph 26. Also important are the following:

(1) *Clean.* Remove lubricant or dirt, using dry-cleaning solvent. After parts are cleaned, rinse them in clean solvent and dry them well. Be careful to keep the parts clean until reassembled. Keep cleaning fluid away from rubber or other material that it will damage. Clean the protective grease coating from new parts. (This material usually is not a lubricant.)

(2) *Tighten.* All tightening operations should be performed with sufficient wrench torque (force on the wrench handle) to tighten the units properly. Use the correct tool without any additional extension handle. A torque-indicating wrench should be used where specified. Do not overtighten, since this may strip threads or cause distortion. Tightening should be understood to include the correct installation of lock washers, lock nuts, and cotter pins or locking wires where provided to secure the tightening.

Semiannually	Monthly	SERVICE
✓	✓	10. <i>Engine. a.</i> Start engine and observe any unusual noises, warm-up, power, and temperature. Check the setting of the carburetor needle valve(s) (par. 12). Stop engine.
✓	✓	b. Check to see that the speed control lever remains in a set position. If loose, tighten by drawing up clamp screw on armature base.
✓	✓	c. Check to see if mixture lever remains in a set position. If loose, tighten (par. 48).
✓	✓	13. <i>Cylinder head and gaskets.</i> Look for cracks or indications of compression leaks around studs and gaskets. Tighten <i>only</i> if there is a definite indication of looseness or leaks.
✓	✓	16. <i>Spark plugs. a.</i> Remove the spark plugs and examine for poor condition, paying particular attention to broken insulators, excessive carbon deposits, and to electrodes which are burned thin. Excessive deposits or damaged insulators may indicate incorrect heat range.
✓	✓	b. Clean deposits from the electrodes and insulators, and check again for cracks, replacing plugs if needed.
✓	✓	c. Adjust gaps; correct adjustment on Zephyr and Lightfour engines is .025 inch between points. After completing item 17, reinstall the plugs, using new gaskets and taking care not to overtighten them as this may cause distortion and damage.
✓		17. <i>Compression test.</i> Test each cylinder for compression (par. 47).
✓	✓	37. <i>Magneto. a.</i> Determine whether it is in good condition and securely mounted. Test for spark (par. 43).
✓	✓	b. Adjust contact points so that they open .020 inch.
	✓	c. Simultaneously clean the contact points and replace unserviceable ones.
✓	✓	36. <i>Coil and wiring. a.</i> See that these items are in good condition, clean, correctly assembled and connected, securely mounted, and not chafing against other engine parts.
		b. Clean all exposed ignition wiring with a dry cloth. <i>Note.</i> Do not disturb connections unless they are actually loose. Overtightening may result in damage to the terminals.
✓	✓	35. <i>Carburetor (choke, throttle, linkage, strainer).</i>
		a. See that these items are in good condition, correctly assembled, and securely installed; that the carburetor does not leak; that the choke and throttle assemblies are not excessively worn; that the throttle valve is readily adjustable.
✓	✓	b. Remove the strainer plug and screen, and clean thoroughly in dry-cleaning solvent. If screen is damaged or clogged too much for cleaning, replace it.
✓	✓	21. <i>Fuel (tank, lines).</i> See that they are in good condition, secure, and not leaking.
✓	✓	12. <i>Leaks (fuel-oil).</i> Check for any indication of fuel-oil mixture leaks. Examine the cooling system for possibilities of leakage. Trace all leaks to their source and correct or report them.
✓	✓	20. <i>Exhaust pipe and muffler.</i> Examine the muffler assembly to see that it is secure and shows no evidence of leakage. Check joint where muffler attaches to cylinder and see that it is tight. Be sure that hole in muffler gasket lines up with outlet holes in cylinder and muffler.
✓	✓	45. <i>Propeller (housing gasket, housing nuts and screws, seals, bearings, coupling, shear pin).</i> Observe whether these items are in good condition, correctly assembled and secure. Check alignment of drive shaft. Pay particular attention to the bearing mountings, the bearings and the seals for evidence of excessive wear. See that shear pin is in place.
✓	✓	29. <i>Water pump. a.</i> Check intake holes at front of gear housing to see that they are not clogged by weeds or other foreign matter; also check water pipe for obstructions and see that pipe connections are tight.
✓	✓	b. Check the impellers for wear, and check for leakage or opening in joint where pump housing halves fit. (If not fitted tight, remove the screws and seal with Compound, Sealing, Ordnance Stock No. 52-C-675.)

31. Technical Inspections

a. **PURPOSE.** At least once a year, technical inspections should be made by qualified maintenance personnel to determine whether an engine should be continued in service or withdrawn for overhaul or reclamation of component parts. Frequency of such inspection should be determined by the degree of service of an engine.

b. **SCOPE.** The technical inspection should include the following items in the monthly and semiannual inspection schedule: 10, 13, 16a, 17,

33. Engine Won't Start

Possible cause

- a. **GASOLINE TROUBLE.**
 Tank empty.
 Carburetor flooded.
 Water in carburetor, tank or strainer.
 Improper mixture of oil and gasoline.
 Pipe clogged.
 Spray nozzle or feedhole in carburetor clogged.
- b. **NO SPARK.**
 Spark plug cracked, dirty, or out of adjustment.
 Wire to contact screw disconnected.
 Wire to spark plug disconnected.
 Contact points dirty or out of adjustment.
- c. **WEAK SPARK.**
 Faulty spark plug.
 Contact points dirty or out of adjustment.
 Faulty condenser.
 Weak coil.

Possible remedy

- Replenish fuel supply.
 Adjust choke control; if float valve is not seating, replace carburetor.
 Remove, clean, and dry.
 Paragraph 22.
 Clean.
 Clean.
- Replace, clean or adjust (par. 30, item 16).
 Connect.
 Connect.
 Clean or adjust (par. 46).
- Replace.
 Clean or adjust (par. 46).
 Tighten condenser lead wire or replace condenser.
 Test coil; if faulty, replace.

34. Engine Overheats

Possible cause

- Lack of oil.
 Obstruction in water intake.
 Leak at water pipe connections.
 Broken water pipe.
 Engine not setting deep enough in water.
 Defect in water pump.

Possible remedy

- Paragraph 22.
 Clean.
 Tighten connections or replace faulty part.
 Replace.
 Paragraph 11.
 Locate and adjust or replace.

35. Engine Knocks

Possible cause

- Spark too far advanced.
 Carbon in cylinders.

Possible remedy

- Adjust.
 Remove cylinder head and clean carbon; check for excessive oil in fuel mixture.

Engine too hot, causing pre-ignition.
 Bearings loose or worn.
 Piston or cylinder worn.
 Flywheel nut loose.

Inspect cooling system.
 Adjust or report.
 Report.
 Tighten.

36. Engine Misses

Possible cause

Possible remedy

a. WIRING.

Spark plug wire shorting on engine hood.
 Broken or loose wiring.
 Poor insulation.
 Wires short circuited with moisture, oil or foreign material.

Eliminate shorting.
 Replace or tighten.
 Replace wiring.
 Clean and dry, or replace.

b. TIMER.

Contact points corroded.
 Contact points improperly spaced.
 Weak coil.
 Weak condenser.
 Weak magneto.

Replace.
 Adjust.
 Test coil; if faulty, replace.
 Replace.
 Test (par. 30, item 37) and adjust or replace.
 Clean and dry.

Foreign matter or oil on contact points.

c. CARBURETOR.

Foreign matter in spray nozzle or needle valve or feed hole.
 Supply impeded.

Clean.
 Check lines and strainer.

37. Engine Loses Power

Possible cause

Possible remedy

a. IMPROPER MIXTURE.

Check fuel-oil mixture; clean strainer; replace carburetor if needed.

b. LACK OF COMPRESSION.

Lack of oil.
 Scored cylinder.
 Worn rings.

Check fuel-oil mixture.
 Report.
 Report.

38. Engine Runs but Propeller does not Revolve

Possible cause

Possible remedy

Propeller pin sheared off.
 Plain gear key sheared off.

Replace.
 Replace.

39. Engine Cranks Hard

Possible cause

Possible remedy

Rust in cylinder.
 Bearings out of line.
 Crankshaft bent.
 Coupler broken.
 Gear shaft bent.
 No oil on bearings.

Report.
 Report.
 Report.
 Replace.
 Report.
 Check fuel-oil mixture (par. 22).

40. Engine Vibrates

<i>Possible cause</i>	<i>Possible remedy</i>
No spark in one cylinder.	Test sparking (par. 43).
Loose pivot bearing.	Tighten.
Bent propeller wheel.	Report.
Engine loose on boat.	Tighten (par. 11).
Too lean a mixture of gas.	Paragraph 33a.

41. Engine Runs but Boat Makes Little or No Progress

<i>Possible cause</i>	<i>Possible remedy</i>
Propeller blades bent.	Report.
Rope or other obstruction dragging in water.	Remove.
Weeds on propeller.	Clean.

Section XIII. MAINTENANCE OPERATIONS

42. Purpose

It is the purpose of this section to describe the methods of performing those basic maintenance operations that are the responsibility of the troops using this engine and within the scope of their tools and equipment (par. 5). As such, this section supplements section XI, which is confined to a listing of required maintenance services.

43. Spark Testing

The spark must be of sufficient strength to jump the spark plug gap under compression in the cylinder. To test sparking, proceed as follows:

- a. Detach spark plug wires from spark plugs.
- b. Remove spark plugs.
- c. Ground all spark plug wires except the one being tested.
- d. Hold the end of the latter about $\frac{1}{8}$ inch from the cylinder head.
- e. Rotate the flywheel in the direction in which the engine runs.
- f. Observe the spark produced. If magneto is in good condition, spark will jump gap between end of wire and cylinder head. In bright daylight, spark may not be visible, but a distinctly audible snap should result.

Follow the same procedure with all other spark plug wires, remembering to ground all except the one being tested. Each wire should produce an equal spark. If no spark or a very faint spark is produced, the magneto may be faulty or there may be water on the armature base or contact points. Remove the magneto (par. 45), thoroughly dry the armature base and contact points, and clean and check the

points (par. 46). After necessary adjustments or parts replacement, reinstall the magneto and again check for spark as above. If a spark is still not apparent, the complete magneto should be sent to a repair organization.

44. Testing, Adjustment, and Installation of Spark Plugs

a. To check spark plugs, lay plugs on cylinder head (with wires attached) and proceed in the same manner followed for spark testing. If a spark is not apparent, make sure that the plug is clean, that the porcelain is not cracked, and that the points are not burned off or out of adjustment. The correct adjustment of spark plug points is .025 inch apart. On the feeler gauge provided with the engine, the thickness of the finger marked "Sp. Plug" represents the correct adjustment of the points.

b. To install new plugs, insert them in the cylinder and draw up tight. Fasten the wires to the spark plugs so that the wires lead directly away from the engine hood. Tighten the spark plug nuts with pliers so that the wires will remain in proper position.

45. Removal and Replacement of Flywheel

a. The flywheel should not be removed from the engine except to check the ignition points and coil or to replace high-tension wires. Removal should be carried out as follows: since the flywheel on the engine is inclosed, remove the gas tank first before removing the flywheel. Then, holding the flywheel rigid, unscrew the flywheel nut until it rests against the starter plate, with enough tension to put an upward strain on the flywheel. The starter plate will not act as a wheel puller and care should be taken

so that not too much strain is put on it when loosening the flywheel nut. Pull up on the flywheel and tap the flywheel nut a sharp blow with a hammer. If the flywheel does not come off, put a little more strain on the starter plate by loosening the nut a trifle more. When the flywheel comes off, use care not to lose the key by which the flywheel is held in engagement with the shaft.

b. To install flywheel after inspection of magneto, proceed in reverse order to that described above. Draw up the nut as tightly as possible to prevent flywheel from loosening in operation. Start and run engine 10 to 15 minutes. Then retighten nut as described above. (Newly installed flywheel will settle slightly on taper of crankshaft after a few minutes of operation. Unless tightened again, it is apt to cause serious damage to both flywheel hub and crankshaft taper.)

46. Cleaning and Adjustment of Breaker Points

The left hand contact points fire the upper set of cylinders through the rear coil, and the right hand contact points fire the lower set of cylinders through the front coil. (Right and left hand refer to positions when one is facing the engine on the carburetor side.) To adjust the magneto points, proceed as follows:

a. Remove the flywheel (par. 45).

b. Place speed control lever in center position, directly above carburetor, and turn crankshaft so that fibre plunger of contact finger is riding on high point of crankshaft.

c. Loosen clamp screw directly above breaker and move breaker in toward crankshaft to open points, and outward away from crankshaft to close points. The contact points should open .020 inch. The thickness of the feeler gauge finger marked "Breaker" represents the correct adjustment.

d. When adjusting points, be sure to hold breaker arm in position with finger until point gauge has been removed and clamp screw tightened; otherwise, because of the spring tension against the cam, the breaker arm slips back and correct setting cannot be made. If points are observed to be pitted or corroded, place between the points a narrow strip of #00 sandpaper folded in such a way that both points can be

dressed down simultaneously by drawing the sandpaper back and forth. This should be done before adjusting the points. (Do not use emery cloth.)

47. Compression Test

a. If a compression gauge is available, remove each spark plug and insert gauge in spark plug hole. With the throttle wide open, rotate the engine until the maximum compression is indicated. Repeat this process for each cylinder. If pressure in a cylinder is appreciably below normal, squirt sufficient engine oil on the piston head to prevent loss of compression temporarily, and recheck.

b. Compression can be crudely checked by turning the flywheel by hand (with spark plugs installed). If compression is present, it can be felt when attempting to complete one revolution of the flywheel. If little or no compression exists, no particular effort will be required to turn flywheel one complete revolution.

c. Low compression, brought up to normal by oil sealing, indicates piston, ring, or cylinder wear or damage. Low compression, not brought up to normal by this method, indicates valve or gasket leakage.

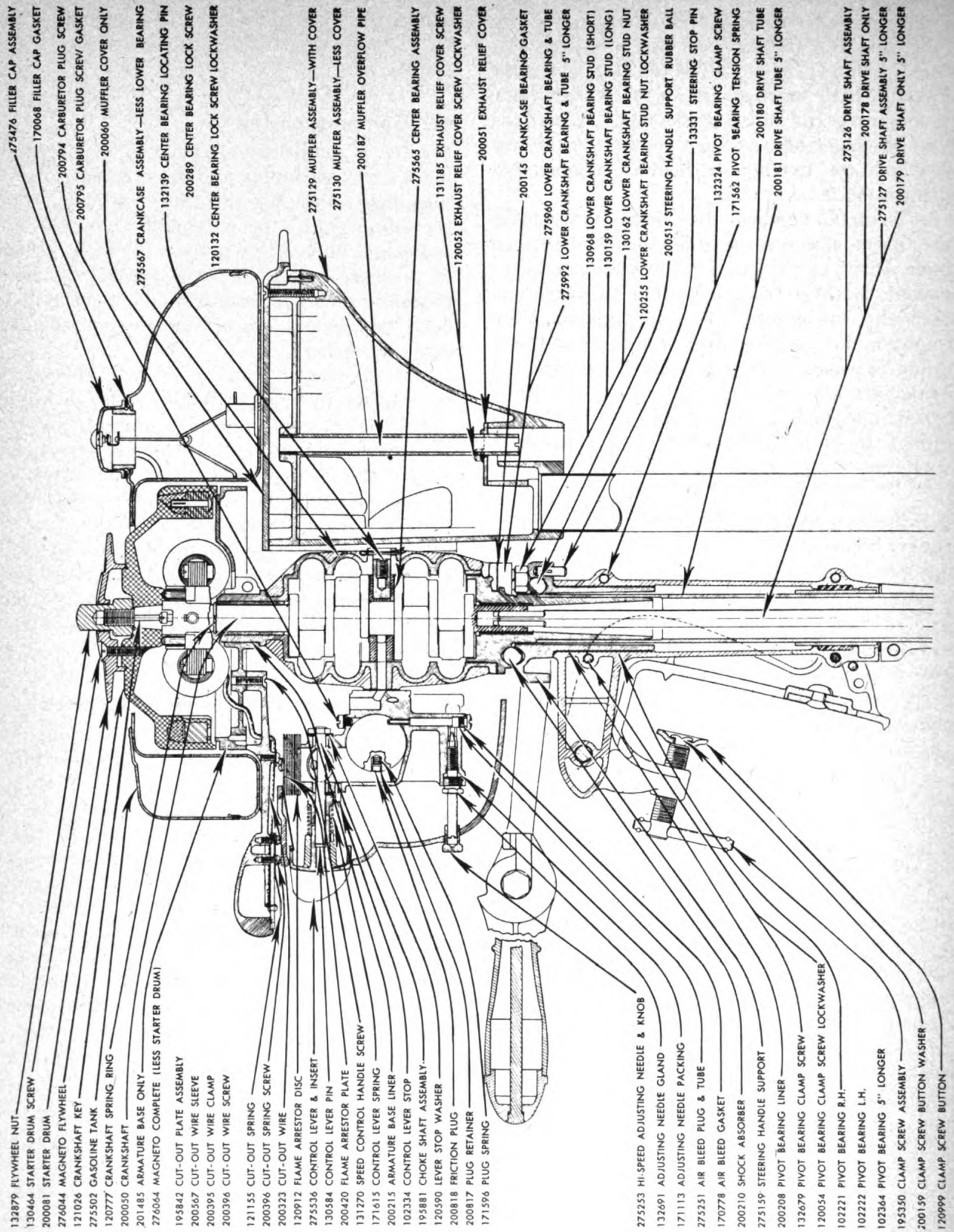
48. Adjustment of Fuel Mixture Controls

a. Operating adjustments of various fuel mixture controls have been covered in detail in paragraph 12.

b. If the mixture lever becomes loose and does not remain in a set position, it can be tightened by drawing down on the packing nut through which the lever passes. If this procedure is not effective, it may be necessary to replace the packing. This is accomplished by removing the lever from the carburetor, removing the packing nut and the old packing, and replacing the latter with new packing. Reassembly is accomplished in the reverse order.

49. Installation of Shear-Off Pins

If shear-off pin has sheared off, immediate replacement is necessary. Remove the propeller nut and slip off the propeller. Then insert another shear-off pin. Repeated shearing of pins for no apparent reason is the result of a loose flywheel (par. 45).

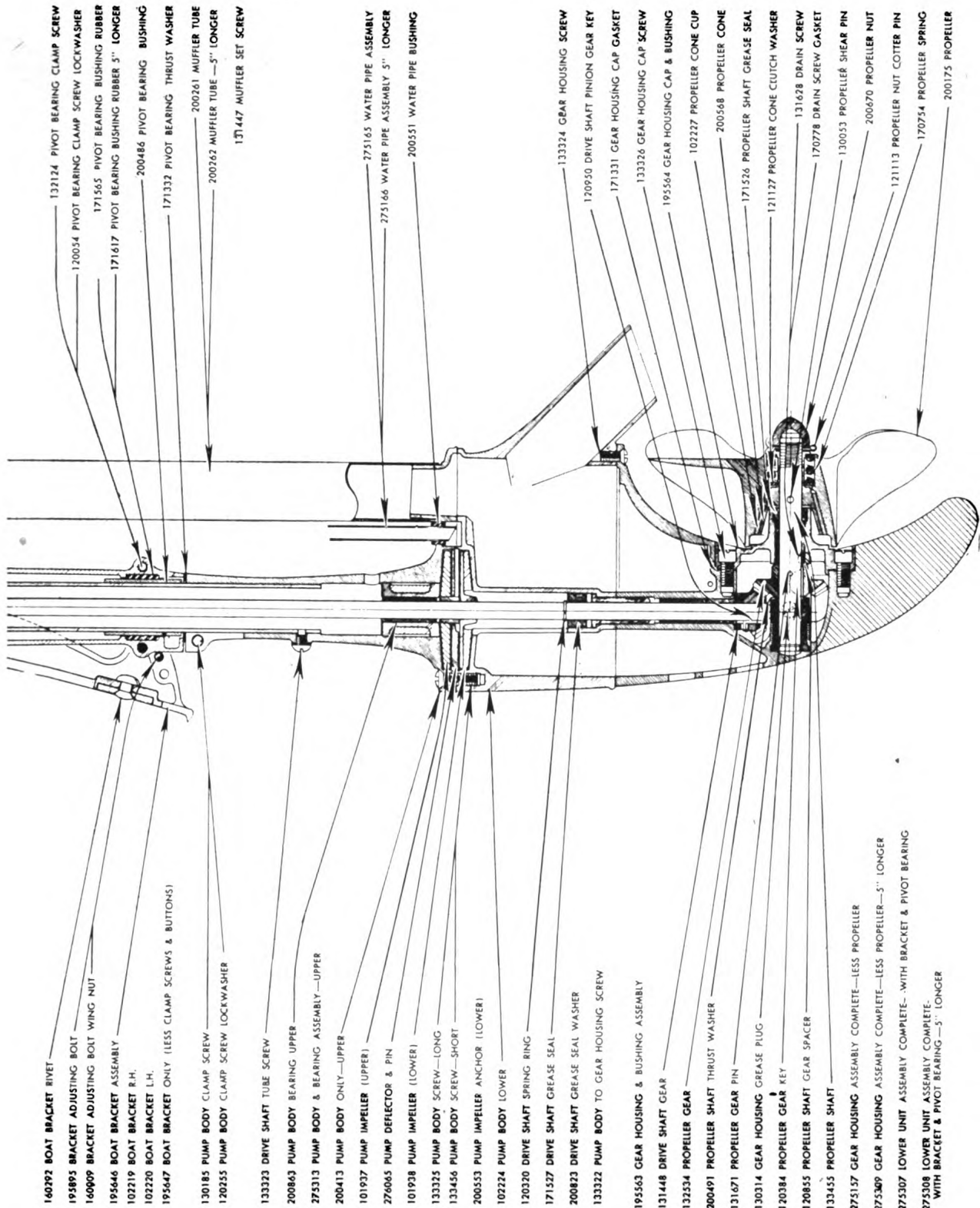


132879 FLYWHEEL NUT
 130464 STARTER DRUM SCREW
 200081 STARTER DRUM
 276044 MAGNETO FLYWHEEL
 121026 CRANKSHAFT KEY
 275502 GASOLINE TANK
 120777 CRANKSHAFT SPRING RING
 200050 CRANKSHAFT
 201485 ARMATURE BASE ONLY
 276064 MAGNETO COMPLETE (LESS STARTER DRUM)
 195842 CUT-OUT PLATE ASSEMBLY
 200567 CUT-OUT WIRE SLEEVE
 200395 CUT-OUT WIRE CLAMP
 200396 CUT-OUT WIRE SCREW
 121155 CUT-OUT SPRING
 200396 CUT-OUT SPRING SCREW
 200323 CUT-OUT WIRE
 120912 FLAME ARRESTOR DISC
 275536 CONTROL LEVER & INSERT
 130384 CONTROL LEVER PIN
 200420 FLAME ARRESTOR PLATE
 131270 SPEED CONTROL HANDLE SCREW
 171613 CONTROL LEVER SPRING
 200215 ARMATURE BASE LINER
 102334 CONTROL LEVER STOP
 195881 CHOKE SHAFT ASSEMBLY
 170590 LEVER STOP WASHER
 200818 FRICTION PLUG
 200817 PLUG RETAINER
 171596 PLUG SPRING

275553 HI-SPEED ADJUSTING NEEDLE & KNOB
 132691 ADJUSTING NEEDLE GLAND
 171113 ADJUSTING NEEDLE PACKING
 275251 AIR BLEED PLUG & TUBE
 170778 AIR BLEED GASKET
 200210 SHOCK ABSORBER
 275159 STEERING HANDLE SUPPORT
 200208 PIVOT BEARING LINER
 132679 PIVOT BEARING CLAMP SCREW
 120054 PIVOT BEARING CLAMP SCREW LOCKWASHER
 102221 PIVOT BEARING R.H.
 102222 PIVOT BEARING L.H.
 102364 PIVOT BEARING 5" LONGER
 195350 CLAMP SCREW ASSEMBLY
 200139 CLAMP SCREW BUTTON WASHER
 120999 CLAMP SCREW BUTTON

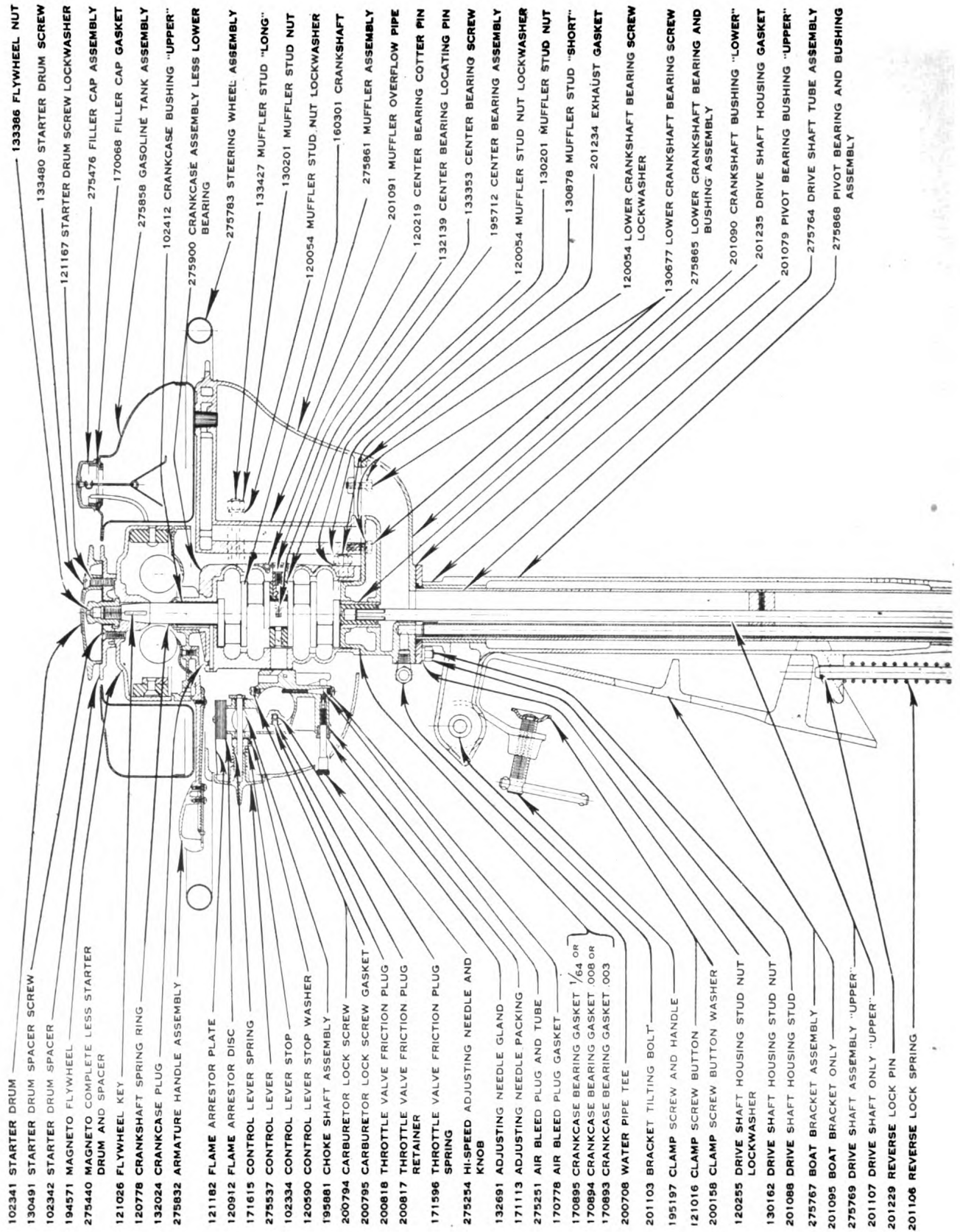
275476 FILLER CAP ASSEMBLY
 170068 FILLER CAP GASKET
 200794 CARBURETOR PLUG SCREW
 200795 CARBURETOR PLUG SCREW GASKET
 200060 MUFFLER COVER ONLY
 275567 CRANKCASE ASSEMBLY—LESS LOWER BEARING
 132139 CENTER BEARING LOCATING PIN
 200289 CENTER BEARING LOCK SCREW
 120132 CENTER BEARING LOCK SCREW LOCKWASHER
 275129 MUFFLER ASSEMBLY—WITH COVER
 275130 MUFFLER ASSEMBLY—LESS COVER
 200187 MUFFLER OVERFLOW PIPE
 275565 CENTER BEARING ASSEMBLY
 131185 EXHAUST RELIEF COVER SCREW
 120052 EXHAUST RELIEF COVER SCREW LOCKWASHER
 200051 EXHAUST RELIEF COVER
 200145 CRANKCASE BEARING GASKET
 275960 LOWER CRANKSHAFT BEARING & TUBE
 275992 LOWER CRANKSHAFT BEARING & TUBE 5" LONGER
 130968 LOWER CRANKSHAFT BEARING STUD (SHORT)
 130159 LOWER CRANKSHAFT BEARING STUD (LONG)
 130162 LOWER CRANKSHAFT BEARING STUD NUT
 120255 LOWER CRANKSHAFT BEARING STUD NUT LOCKWASHER
 200515 STEERING HANDLE SUPPORT RUBBER BALL
 133331 STEERING STOP PIN
 132324 PIVOT BEARING CLAMP SCREW
 171562 PIVOT BEARING TENSION SPRING
 200180 DRIVE SHAFT TUBE
 200181 DRIVE SHAFT TUBE 5" LONGER

275126 DRIVE SHAFT ASSEMBLY
 200178 DRIVE SHAFT ONLY
 275127 DRIVE SHAFT ASSEMBLY 5" LONGER
 200179 DRIVE SHAFT ONLY 5" LONGER



- 160292 BOAT BRACKET RIVET
- 195895 BRACKET ADJUSTING BOLT
- 160909 BRACKET ADJUSTING BOLT WING NUT
- 195646 BOAT BRACKET ASSEMBLY
- 102219 BOAT BRACKET R.H.
- 102220 BOAT BRACKET L.H.
- 195647 BOAT BRACKET ONLY (LESS CLAMP SCREWS & BUTTONS)
- 130185 PUMP BODY CLAMP SCREW
- 120255 PUMP BODY CLAMP SCREW LOCKWASHER
- 133323 DRIVE SHAFT TUBE SCREW
- 200863 PUMP BODY BEARING UPPER
- 275313 PUMP BODY & BEARING ASSEMBLY—UPPER
- 200413 PUMP BODY ONLY—UPPER
- 101937 PUMP IMPELLER (UPPER)
- 276065 PUMP DEFLECTOR & PIN
- 101938 PUMP IMPELLER (LOWER)
- 133325 PUMP BODY SCREW—LONG
- 133456 PUMP BODY SCREW—SHORT
- 200553 PUMP IMPELLER ANCHOR (LOWER)
- 102224 PUMP BODY LOWER
- 120320 DRIVE SHAFT SPRING RING
- 171527 DRIVE SHAFT GREASE SEAL
- 200823 DRIVE SHAFT GREASE SEAL WASHER
- 133322 PUMP BODY TO GEAR HOUSING SCREW
- 195563 GEAR HOUSING & BUSHING ASSEMBLY
- 131448 DRIVE SHAFT GEAR
- 132534 PROPELLER GEAR
- 200491 PROPELLER SHAFT THRUST WASHER
- 131671 PROPELLER GEAR PIN
- 130314 GEAR HOUSING GREASE PLUG
- 120384 PROPELLER GEAR KEY
- 120855 PROPELLER SHAFT GEAR SPACER
- 133453 PROPELLER SHAFT
- 275157 GEAR HOUSING ASSEMBLY COMPLETE—LESS PROPELLER
- 275309 GEAR HOUSING ASSEMBLY COMPLETE—LESS PROPELLER—5" LONGER
- 275307 LOWER UNIT ASSEMBLY COMPLETE—WITH BRACKET & PIVOT BEARING
- 275308 LOWER UNIT ASSEMBLY COMPLETE—WITH BRACKET & PIVOT BEARING—5" LONGER
- 132124 PIVOT BEARING CLAMP SCREW
- 120034 PIVOT BEARING CLAMP SCREW LOCKWASHER
- 171565 PIVOT BEARING BUSHING RUBBER
- 171617 PIVOT BEARING BUSHING RUBBER 5" LONGER
- 200486 PIVOT BEARING BUSHING
- 171332 PIVOT BEARING THRUST WASHER
- 200261 MUFFLER TUBE
- 200262 MUFFLER TUBE—5" LONGER
- 137447 MUFFLER SET SCREW
- 275165 WATER PIPE ASSEMBLY
- 275166 WATER PIPE ASSEMBLY 5" LONGER
- 200351 WATER PIPE BUSHING
- 133324 GEAR HOUSING SCREW
- 120950 DRIVE SHAFT PINION GEAR KEY
- 171331 GEAR HOUSING CAP GASKET
- 133326 GEAR HOUSING CAP SCREW
- 195564 GEAR HOUSING CAP & BUSHING
- 102227 PROPELLER CONE CUP
- 200568 PROPELLER CONE
- 171526 PROPELLER SHAFT GREASE SEAL
- 121127 PROPELLER CONE CUTCH WASHER
- 131628 DRAIN SCREW
- 170778 DRAIN SCREW GASKET
- 130053 PROPELLER SHEAR PIN
- 200670 PROPELLER NUT
- 121113 PROPELLER NUT COTTER PIN
- 170754 PROPELLER SPRING
- 200175 PROPELLER

Figure 12. Parts of Zephyr engine and manufacturer's part numbers.



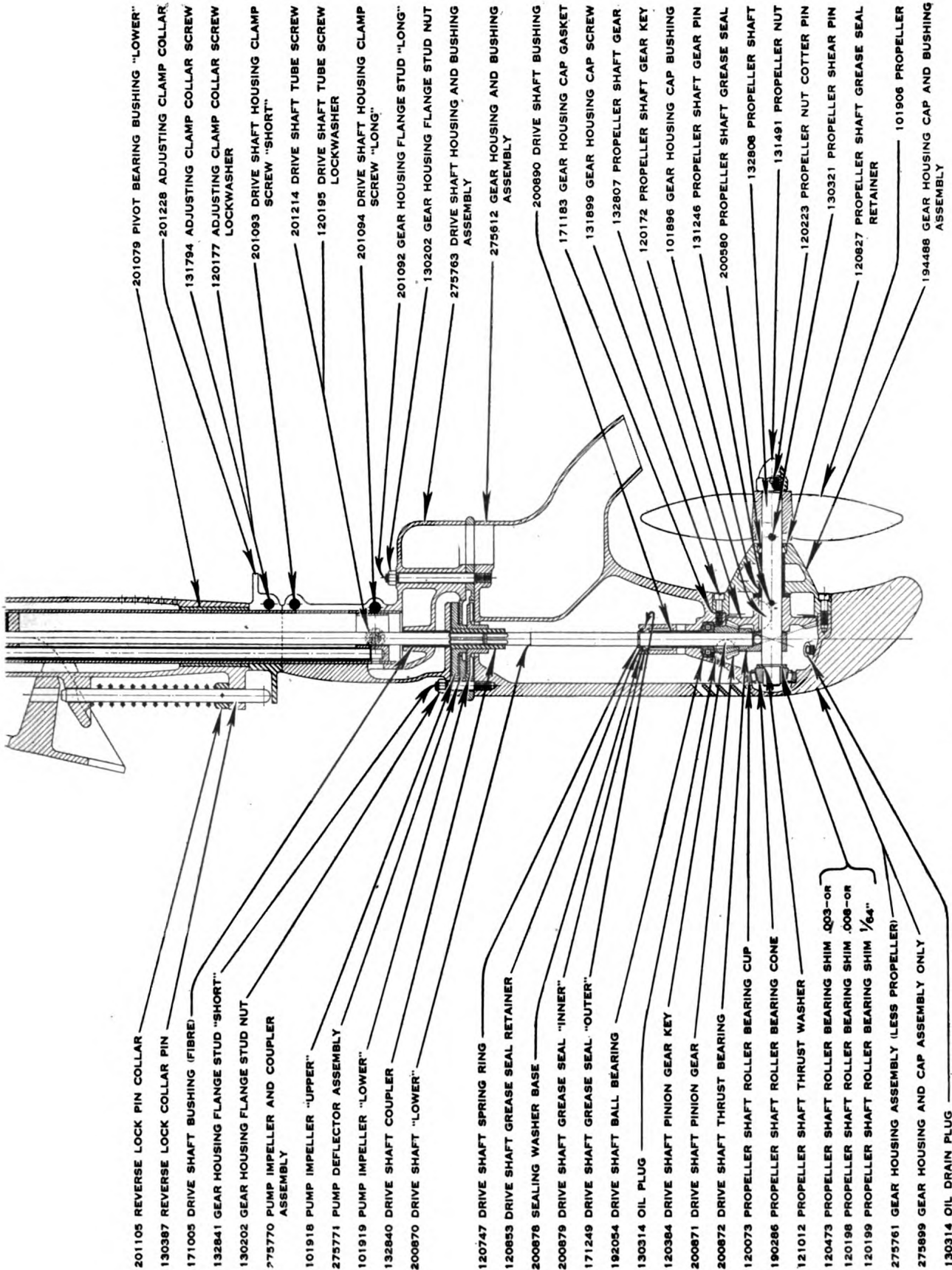


Figure 13. Parts of Lightfour engine and manufacturer's part numbers.

SHIPMENT AND STORAGE

1. Processing Materials Required

Grade C wrapper
 Waterproof paper
 Wax sealer
 Rust preventive lubricant AXS-936
 Rust preventive compounds
 Insulation compound AXS-3-182

(See TM 5-9711 for specifications and supplies of materials.)

2. Processing Equipment Required

Brushes, paint, flat, 3-inch
 Cans, open-top (for processing materials)
 Spraying and fogging equipment

3. Inspection

Every unit must be given a final inspection to make certain it is in first-class mechanical condition. Check each unit of equipment to make certain that all required tools, spare parts, catalogs, accessories and attachments are on hand. Consult check list, section III.

4. Cleaning

a. Steam-clean the unit thoroughly. If steam-cleaning equipment is not available, use any other effective method, such as alkaline or solvent washing to remove dirt, oil, and excess grease. If paint has deteriorated or is damaged in cleaning, remove loose paint and rust and repaint the area.

b. If the engine has been operated in salt water, the following treatment will assist in reducing corrosive effects to a minimum. Flush cooling system with fresh water, either by attaching a hose to the water scoop or by operating the engine in a barrel of fresh water for several minutes. Rinse outside of engine with fresh water and wipe lower parts of unit with an oily cloth.

5. Lubrication

Drain gear case and refill with clean lubricant. Lubricate the unit according to WDLO 55-1030.

6. Processing

a. ENGINE. With engine running, fog suffi-

cient AXS-934 through the intake to stop engine. Remove spark plugs and fog approximately two ounces of AXS-934 into each cylinder as engine is rotated by hand.

b. SPARK PLUGS. Clean, test, and adjust the spark plugs. If serviceable, apply AXS-934 to the points and threads, and replace; if not serviceable, install new spark plugs processed in the same manner. Drain fuel tank and drain all water from cooling system.

c. OPENINGS. Cover all openings in gear case and engine with nonhydroscopic tape or Grade C wrapper.

d. EXTERIOR SURFACE OF ENGINE. After engine has cooled, spray its entire surface with Insulation Compound AXS 3-182. This will give protection to entire unit, including pins, bolts, nuts, screws, linkage, and similar small parts.

e. UNIT. Inclose the unit in a moisture-vapor barrier containing the required amount of dehydrating agent (AXS-778) to give protection for 18 months.

f. SPARE PARTS, TOOLS, AND MANUALS. Apply USA-2-82 or AXS-673 to all spare parts and tools. Wrap manuals in Grade C wrapper, and place in motor chest with a bundle of clean, dry wiping rags or waste.

7. Packing

Secure the unit and other equipment in the motor chest with thumbscrews or straps. No other tying or blocking is necessary.

8. Export Box Construction

Construct nailed wood shipping box to inclose chest in accordance with U. S. Army Specification 100-14 (latest revision). Bore 1/2-inch holes in each corner of the outside box to permit drainage and ventilation.

9. Operation after Storage

a. Remove spark plugs, clean, and adjust.

b. Rotate engine by hand to scavenge cylinders. Replace spark plugs.

c. Check gear case for proper lubricant level.

d. Mix gas and oil thoroughly in a separate container and fill tank.

e. Prime engine and start.

APPENDIX II

REFERENCES

FM 21-6, List and Index of War Department Publications.

TM 55-320, Marine Craft Inspection and Preventive Maintenance Service.

TM 9-2810, Motor Vehicle Inspections and

Preventive Maintenance Services.

W.D. Lubrication Order No. LO 55-1030, Engine, Gasoline, Marine, Outboard Evinrude. (Zephyr Models 4359, 4361, 4362, 4363; Lightfour Models 4375, 4376, 4377.)

	Paragraph	Page
Accessories	5	4
Admission and compression stroke	6-A	7
After-operation services	29	15
Assembling engine	10-A	9
Attaching engine to boat (see fig. 8)	11	9
Automatic exhaust relief (see fig. 6)	8	8
Before-operation services	27	14
Breaker points, cleaning and adjustment	46	20
Check list, monthly and semiannual maintenance services	30	15
Clutch, propeller protection (see fig. 10)	15-B	12
Compression test	47	20
"Co-pilot" (relief steering mechanism)	13-B	11
Cycle of events in engine (see fig. 4)	6	7
Data, tabulated, Lightfour and Zephyr models	4	4
Demolition, methods	18	12
During-operation services	28	14
Engine:		
Care of engine that has been submerged	17	12
Cold weather care	16	12
Operation in shallow or obstructed waters	15	11
Trouble shooting:		
Engine cranks hard	39	18
Engine knocks	35	17
Engine loses power	37	18
Engine misses	36	18
Engine overheats	34	17
Engine runs but boat makes little progress	41	19
Engine runs but propeller does not revolve	38	18
Engine vibrates	40	19
Engine won't start	33	17
General	32	17
Exhaust relief, automatic (see fig. 6)	8	8
Flywheel (and magneto) (see fig. 7)	9	8
Removal and Replacement	45	20
Forms:		
WD AGO 55-124	2, 25-A	1, 14
WD AGO 55-125	2, 25-B	1, 14
WD AGO 468	2	1
Fuel, mixture controls, adjustment	4-A	20
Fuel and oil mixture	22	13
Handle, steering	13-A	11
Inspection standards	26	14
Inspections, technical	31	17
Lightfour model:		
Data, tabulated	4	4
Description	3	1
Diagram, cut-away, with manufacturer's part numbers (see fig. 13)		
Pin, propeller shear-off	15-C	12
Reversing heavy duty model on rubber boat	13-D	11
Lubrication:		
Fuel and oil mixture	22	13
General	21	13
Idle or stored equipment	24	13
Propeller gear case	23	13
Lubrication Order LO 55-1030 (see fig. 11).		
Magneto and flywheel	9	8
Adjusting points (see fig. 7)	46	20
Maintenance, preventive:		
After-operation services	29	15
Before-operation services	27	14
During-operation services	28	14
General	25	14
Inspection standards	26	15
Monthly and semiannual services	30	15
Weekly services	29	15

	<i>Paragraph</i>	<i>Page</i>
Maintenance responsibilities:		
First echelon	20-A	13
Second echelon	20-B	13
Monthly services	30	15
Oil, mixture with fuel	22	13
Parts furnished	5	4
Pin, propeller shear-off	15-C, 49	1, 20
Power and exhaust stroke	6-B	7
Preparation of new or rebuilt equipment for service.....	10	9
Preventive maintenance:		
After-operation services	29	15
Before-operation services	27	14
During-operation services	28	14
General	25	14
Inspection standards	26	14
Monthly and semiannual services	30	15
Weekly services	29	15
Propeller protection clutch	15-B	12
Pump, water (see fig. 5).....	7	8
Records	2	1
References	App. II	27
Removing engine from boat.....	14-B	11
Reversing engine	13-C	11
Rubber boat bracket (see fig. 9).....	13-D	11
Rust preventive, removal	10-B	9
Semiannual services	30	15
Shallow waters, operation in	15	11
Shear-off pin, propeller:		
Description	15-C	12
Installation	49	20
Shipment of engine	App. I	26
Spark plugs, installing and wiring	10-C, 44	9, 19
Spark testing	43	19
Starting and stopping engine	12	10
Starting cold engine	12-D	10
Steering	13	11
Steering handle	13-A	11
Stopping engine	12-I	11
Storage of engine	App. I	26
Stroke:		
Admission and compression	6-A	7
Power and exhaust	6-B	7
Tabulated data	4	4
Technical inspections	31	17
Tools	5	4
Trouble shooting, general	32	17
Valves, mixture	12-G	10
WD AGO Form 55-124.....	2, 25-A	1, 14
WD AGO Form 55-125.....	2, 25-B	1, 14
WD AGO Form 468.....	2	1
War Department Lubrication Order LO 55-1030 (see fig. 11).		
Water pump	7	9
Weekly services	29	15
Zephyr model:		
Clutch, propeller protection	15-B	12
Data, tabulated	4	4
Description	3	1
Diagram, cut-away, with manufacturer's part numbers (see figs. 12 and 13).		

