Kenmore Air [illegible]
Seattle Washington

SERVICE MANUAL
FRANKLIN AIRCRAFT ENGINE

MODEL 6A8-215-B8F & B9F ENGINE

Franklin

AIRCOOLED MOTORS, INC.

SYRACUSE 8 NEW YORK U.S.A.

CABLE ADDRESS AIRCOOLED

Service Instructions

FRANKLIN AIRCRAFT ENGINES

MODEL 6A8-215-B8F & B9F ENGINE

INSPECTION, MAINTENANCE

AND

OVERHAUL INSTRUCTIONS

AIRCOOLED MOTORS SYRACUSE 8, NEW YORK

TABLE OF CONTENTS

I – INTRODUCTION

Years of Franklin engineering experience plus the highest quality in materials and workmanship, together with the most modern manufacturing methods are back of every Franklin engine shipped from our factory.

It is the purpose of this manual to furnish ready reference and practical information on the operation, inspection, preventive maintenance and complete overhaul of the model 6A8-215-B8F and 6A8-215-B9F Franklin engines and their accessories. The name and data plate located on top of the propeller shaft housing at the crankcase and indicates the engine model.

An effort has been made to arrange the material in the manual so that the description, function, inspection and repair of the component parts of the engine and its accessories are completely covered in their individual sections.

In referring to locations on the engine, it is assumed that the observer’s position is at the fan end of the engine looking toward the propeller end. Hence, the propeller end will be referred to as the front of the engine irrespective of the position the engine occupies in the aircraft. Cylinders number 1, 3 and 5 are on the left side of the engine and cylinders number 2, 4 and 6 are on the right side of the engine.

It is recommended on the interest of safety, operating economy and maximum service life of the engine that the operation limits, inspections, tolerances, maintenance and overhaul instructions and methods be strictly adhered to. It is also recommended that existing instructions of the various aircraft, propeller and accessory manufacturers regarding the servicing of their products be rigidly followed.

Additional or revised information, together with the latest service bulletins, will be issued as they become available. Please keep us advised of your current mailing address to insure prompt receipt of this material.

To insure that your best interests be served and satisfaction be guaranteed, we recommend that replacements be made with genuine Franklin parts only.

Please address all service inquiries or comments to Service Division, Aircooled Motors, Inc., Syracuse 8, New York. They will receive prompt and courteous attention.

II – WARRANTY

Aircooled Motors, Inc. warrants each new Franklin engine or new part manufactured by it against defects in material or workmanship under normal use, but its obligation under this warranty is specifically limited to replacing or repairing at its factory any such engine or part which shall, within 90 days after delivery thereof to the original purchaser and prior to 50 hours of operation, be returned to Aircooled Motors, Inc., with its permission, transportation charges prepaid, and which upon examination by Aircooled Motors, Inc., is determined by Aircooled Motors, Inc., to be defective.

This warranty shall not apply to any such engine or parts which have been repaired or altered outside Aircooled Motors, Inc. factory in any way so as to affect, in its judgment, its operation, or which have been subjected to misuse, neglect, improper maintenance or accident, or which shall have been operated at a speed exceeding the factory rated speed.

Aircooled Motors, Inc. makes no warranty with respect to ignition apparatus, carburetors, instruments, trade accessories, or other equipment which it does not itself build or manufacture inasmuch as such equipment is usually guaranteed by the respective manufacturers thereof.

The foregoing is the exclusive warranty made by Aircooled Motors, Inc. There are no other warranties expressed or implied, in fact or in law, made by Aircooled Motors, Inc.

AIRCOOLED MOTORS, INC.
Syracuse 8, New York

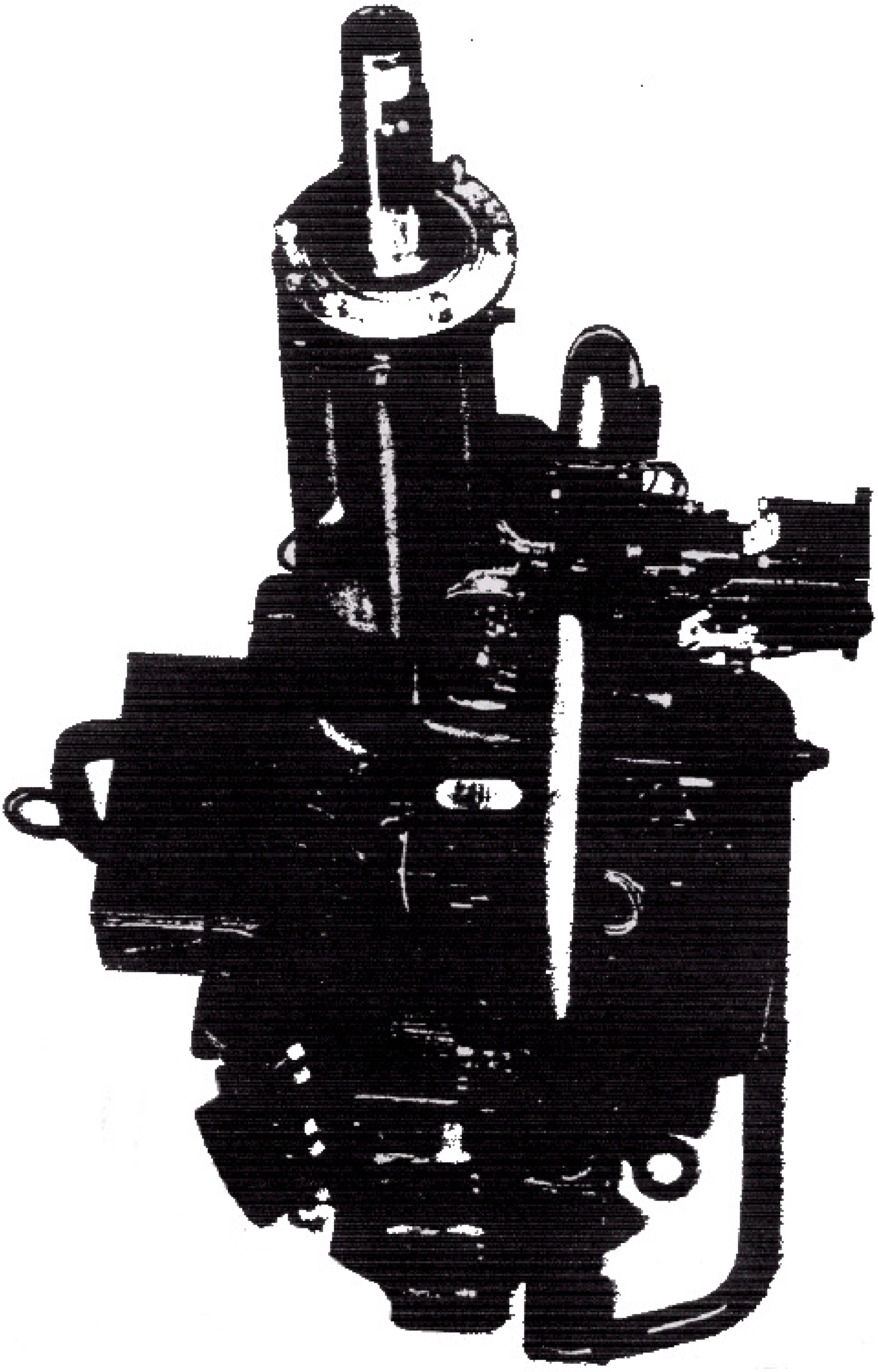

Figure 1. Three Quarters Right-Front View of Engine

III – REPLACEMENT PARTS AND SHIPPING INSTRUCTIONS

When contacting your authorized Franklin distributor or the factory concerning parts or service, please give both the engine model and the engine serial number as stamped on the data plate on the engine. This information will insure prompt, accurate service and prevent undue delay.

When returning parts to your Franklin distributor or the factory, attach a tag to each part with your name, address and the model and serial number of the engine from which the part was removed, together with the date of your original letter in reference tot he part in question. This will assure the prompt handling of your service requests. When shipping parts to the factory, be sure they are shipped prepaid and that they are carefully packed to prevent damage.

Information regarding parts available in oversizes or undersizes and their dimensions can be obtained in the Parts Book of the 6A8-215-B8F and B9F engines. Should any problem arise which presents the need for special information, we suggest you contact the nearest Franklin Authorized Distributor or the factory and every effort will be made to assist you.

IV – ENGINE SPECIFICATIONS

Models	6A8-215-B6F and 6A8-215-B9F	
Number of Cylinders	6	
Bore	5 in.	
Stroke	4.25 in.	
Piston Displacement	500 cu. in.	
Compression Ratio	7:1	
Rated Speed in RPM	2500	
Rated Brake HP at RPM	215 at 2500	
Idle Speed in RPM	500 to 600	
Crankshaft Rotation	Clockwise	
Propeller Shaft Rotation	Clockwise	
Propeller to Crankshaft Ratio	1:1	
Propeller Shaft Spline Size	SAE 20	
Maximum Cylinder Temperature (Bayonet Type Connection)	525° F	
Maximum Oil Temperature	260° F	
Oil Pressure	50 PSI Maximum	
Oil Pressure at Idle	20 PSI Minimum	
Oil Capacity (See Lubrication Section)	Engine numbers below 240666 -11 quarts maximum	
Oil Specifications	Free Air Temperature	Viscosity
	Above 40°F	SAE 40
	Below 40°	SAE 20
Maximum Operating Time Between Oil Changes	25 hrs. (More often if operating conditions warrant.)	

Valve Clearance with Lifters Bled Down And Engine Cold	.040 in.
Ignition – Model 6A8-215-B8F	2 Magnetos
Model 6A8-215-B9F	1 Magneto and 1 Distributor
Firing Order	Cyls .1 – 4 – 5 – 2 – 3 – 6
Spark Timing on Cylinder No. 1	
Both Eismann Magnetos	32° BTC
Auto-Lite Distributor	2° BTC
Scintilla Magneto	32° BTC
Spark Plugs	Auto-Lite A-4
Spark Plug Gap	.014” to .018”
Magneto Breaker Point Gap (Eisemann)	.019” to .021”
Distributor Point Gap (Auto-Lite)	.020”
Fuel Minimum Octane	80 Nonleaded Aviation
Fuel Pressure	2 to 9 PSI
Starter	12 Volt
Generator	35 Amperes Maximum
Maximum Drop on Magneto or Distributor	100 RPM

V – TABLE OF LIMITS AND TOLERANCES

DESCRIPTION OF FIT OR DIMENSION	LIMITS MINIMUM	INCHES MAXIMUM	MAXIMUM PERMISSIBLE AFTER WEAR
Crankcase – Dia. of Main Bearing Bore	3.172	3.173	
Crankcase – Dia. of Camshaft Bearing Bore	1.376	1.377	
Crankcase – Valve Lifter Bore	1.0005	1.0010	
Crankcase on Oil Connector Dowel – Fit	.001L	.000	.0015L
Crankcase on Propeller Shaft Housing Dowel Fit	.0001T	.0008T	.000
Crankshaft – Main Journal Diameter	2.999	3.000	
Crankshaft – Main Bearing Inside Diameter	3.0018	3.0038	
Crankshaft in Main Bearing Fit	.0018L	.0048L	.006L
Crankshaft Main Bearing Thickness	.0846	.0851	
Crankshaft Connecting Rod Journal Diameter	2.374	2.375	
Crankshaft Connecting Rod Bearing Inside Diameter	2.374	2.375	
Crankshaft in Connecting Rod Bearing Fit	.0011L	.0036L	.006L
Crankshaft – Main Journal Fillet Radius	.155	.165	.155
Crankshaft to Propeller Shaft Pilot Diameter	3.124	3.125	
Crankshaft – Thrust Washer Thickness	.078	.080	
Crankshaft End Play in Crankcase on Engines Having Thrust Washers Only	.006	.016	.025
Crankshaft – Diameter at Gear and Fan Hub	2.500	2.501	
Crankshaft Gear Inside Diameter	2.500	2.5005	
Crankshaft Fit in Crankshaft Gear	.0005L	.001T	.001L
Crankshaft Gear Runout from Bore to Pitch Diameter		.003T1R	
Crankshaft Gear Backlash with Camshaft Gear	.004	.012	.015
Crankshaft to Propeller Shaft Bolt Hole Diameter	.3115	.3125	
Camshaft Journal Diameter	1.3745	1.3750	
Camshaft Fit in Crankcase	.001	.0025	
Camshaft – Distance from Thrust Shoulder to Face of Gear	1.190	1.192	
Camshaft End Play in Crankcase	.006	.010	.015
Camshaft Gear Runout from Bore to Pitch Diameter		.003T1R	
Camshaft Fit in Camshaft Gear	.001T	.0025T	.000
Camshaft – Distance from Machined Face of Crankcase To Nearest Face of Ignition Drive Gear	2.940	2.945	
Camshaft – Diameter of hole for Accessory Drive Shaft	.4990	.4995	
Timing Gear Case Fit on Oil Seal	.0025T	.0075T	.002T
Connecting Rod Bore Diameter – Large End	2.4995	2.5000	
Connecting Rod Bearing Thickness	.0612	.0617	
Connecting Rod Fit on Crankpin	.0011L	.0036L	.006L
Connecting Rod Side Clearance on Crankshaft	.0055	.0115	.015
Connecting Rod Piston Pin Bushing Inside Diameter	1.1097	1.1099	
Piston – Bore Diameter for Piston Pin	1.1092	1.1094	
Piston Pin Outside Diameter	1.1090	1.1082	

TABLE OF LIMITS AND TOLERANCES (CONT.)

DESCRIPTION OF FIT OR DIMENSION	LIMITS MINIMUM	INCHES MAXIMUM	MAXIMUM PERMISSIBLE AFTER WEAR
Piston Pin Fit in Piston	.000	.0004L	.0006L
Piston Diameter at Skirt (Lower End)	.49975	.4998	
Piston (at Skirt) – Fit in Cylinder	.002L	.0035L	.0045L
Piston (Top and Middle) – Ring Groove Width	.1005	.1015	
Piston Ring (Top and Middle) – Width	.0930	.0935	
Piston Ring (Top and Middle) – Fit in Grooves	.007L	.0085L	
Piston – Lower Ring Groove Width	.1885	.1895	
Piston Ring (Lower) – Width	.1860	.1865	
Piston Ring (Lower) – Fit in Groove	.002L	.0035L	.008L
Piston Ring Gap (All Rings)	.013	.023	.045
Piston Ring Plug – Fit in Piston Pin	.001L	.003L	.004L
Piston Pin Fit in Connecting Rod Bushing	.0005L	.0009L	.0025L
Piston Pin End Clearance in Cylinder with Plugs Installed	.010L	.023L	.030L
Cylinder Liner – Finished Inside Diameter	5.000	5.001	
Cylinder – Valve Guide Holes Diameter	.6235	.6245	
Valve Guide – Fit in Cylinder	.0025T	.004T	.002T
Valve Seat Insert (Inlet) – Fit in Cylinder	.004T	.006T	
Valve Seat Insert (Exhaust) – Fit in Cylinder	.005T	.007T	
Valve Stem Fit in Guide (Inlet and Exhaust)	.0025L	.0043L	.006L
Hydraulic Valve Lifter – Fit in Crankcase	.001L	.002L	.005L
Valve Rocker Pin Fit in Bushing	.002L	.0035L	.0055L
Valve Rocker Pin Fit in Stamped Support	.0015L	.001T	.0025L
Valve Rocker Pin Fit in Aluminum Block Support	.0005T	.002T	.000
Valve Rocker End Play between Supports	.005	.008	(.006 Desired)
Valve Rocker Cold Clearance with Valves when Lifter is Bled Down		.040	Reset
Propeller Shaft Journal Diameter (Model B8F)	2.9995	3.000	
Propeller Shaft Journal Diameter (Model B9F)	2.9527	2.9533	
Propeller Shaft Fit in Plain Bearing	.0013L	.0037L	.005L
Propeller Shaft Ball Bearing Fit on Shaft (Model B8F)	.0001T	.0009T	.0001T
Propeller Shaft Ball Thrust Bearing Fit on Shaft (Model B9F)	.0001L	.0011T	.0001L
Oil Seal Sleeve Fit on Propeller Shaft	.0005L	.0035L	.005L
Propeller Shaft on Crankshaft Fit	.000	.002L	.0025L
Ball Thrust Bearing Fit in Sleeve (Model B9F)	.002L	.0002T	.002L
Bearing Sleeve Fit in Propeller Shaft Housing (Model B9F)	.008T	.010T	.008T
Ball Bearing Fit in Nose Plate (Floating Assembly – Model B8F)	.001L	.0002T	.001L
Oil Pump Drive Shaft Fit in Pump Body	.001L	.0025L	.005L
Oil Pump Drive Gear Fit on Shaft	.000	.0015T	.0005L
Oil Pump Shaft Gear Fit on Shaft	.0015T	.0025T	.001T

TABLE OF LIMITS AND TOLERANCES (CONT.)

DESCRIPTION OF FIT OR DIMENSION	LIMITS MINIMUM	INCHES MAXIMUM	MAXIMUM PERMISSIBLE AFTER WEAR
Oil Pump Drive Gear to Driven Gear Backlash	.004	.008	.012
Oil Pump Shaft Gear to Drive Gear on Camshaft Backlash	.004	.012	.015
Oil Pressure Relief Valve Plunger Fit in Body (Used with Small Pump)	.0005L	.003L	.0035L
Oil Pressure Relief Valve Plunger Fit in Body (Used with Large Pump)	.001L	.003L	.0035L
Accessory Drive Shaft Fit in Bushing	.0005L	.0015L	.0025L
Tachometer and Ignition Drive Gear – Fit on Accessory Drive Shaft	.0005T	.015T	.0005T
Tachometer Drive Connector Fit in Driven Gear	.0012T	.002T	.0005t
Tachometer Drive Connector Sleeve Fit in Housing	.0015L	.0035L	.0055L
Tachometer Drive Gear Backlash with Driven Gear	.015	.035	.035
IGNITION DRIVE PARTS FOR MODEL B8F			
Magneto Drive Shaft Bushing (Large) Fit in Propeller Shaft Housing	.000	.001L	.0015L
Magneto Drive Coupling End Play with Magneto Assembled on Engine	.002	.017	.017
Magneto Drive Shaft (With Gear) – Clearance between Gear and Large Bushing		.010	Adjust
Magneto Drive Shaft Gear Backlash with Gear on Accessory Drive Shaft	.004	.008	.012
IGNITION DRIVE PARTS FOR MODEL B9F			
Ignition Drive Thrust Washer Fit on Shaft	.000	.002T	.001L
Ignition Drive Shaft Bushing – Inside Diameter	.5015	.5020	
Ignition Drive Shaft Bushing – Outside Diameter	.8115	.8120	
Ignition Drive Shaft Fit in Bushing	.0005L	.0015L	.003L
IGNITION DRIVE PARTS FOR MODEL B9F (CONT.)			
Ignition Drive Shaft Bushing Fit in Housing	.000	.001L	.002L
Magneto Drive Coupling Fit on Shaft	.0005T	.0015T	.000
Distributor Drive Coupling Fit on Shaft	.0005L	.0015L	.0025L
Ignition Drive Gear Backlash with Gear on Accessory Drive Shaft	.004	.008	.012
Distributor Shaft Fit in Coupling	.0035L	.005L	.006L
Distributor Drive Tongue Fit in Coupling	.004L	.007L	.010L

VI – RECOMMENDED TIGHTENING TORQUE VALUES
6A8 – 215 – B8F & B9F
ENGINES

		STUD DRIVE		NUT ON THRU BOLT		CAPSCREW OR NUT ON STUD IN ALUMINUM OR MAGNESIUM	
Size	Thread	Ft. Lbs.	In. Lbs.	Ft. Lbs.	In. Lbs.	Ft. Lbs.	In. Lbs.
1/4	20	5-20	60-240			5 –7	60 – 85
	28			8 –10	95 – 120	5 –7	60 – 85
5/16	18	10 –25	120 – 300			12 –15	145 – 180
	24			15 –20	180 – 240	12 –15	145 –180
3/8	16	10 –25	120 – 300			20 – 25	240 – 300
	24			25 – 30	300 – 360	20 – 25	240 – 300
7/16	14	15 – 30	180 – 360			25 – 30	300 – 360
	20			32 – 35	385 – 420	25 –30	300 – 360

SPECIAL APPLICATIONS

				Ft. Lbs.	In. Lbs.
	Cylinder Hold-Down	Nuts	7/16 – 20	32 – 35	385 – 420
	Rocker Adjusting Screw	Jam Nut	3/8 – 24 5/16 – 24	10 – 12	120 – 145
	By-Pass Plate Hold-Down	Screw	5/16 – 18	15 – 20	180 – 240
	Oil Pan to Crankcase	Screw	5/16 – 18	5 – 6	60 – 75
	Timing Case to Crankcase	Screw	5/16 – 18	5 – 6	60 – 75
	Oil Pan to Timing Case	Bolt	5/16 – 24	8 – 10	95 – 120
	Top Rail Camshaft Bearing	Bolts	5/16 –24	10 – 12	120 – 145
	Magneto Carburetor	Bolts	5/16 – 24	10 – 12	120 – 145
	Fan to Starter Wheel	Bolts	5/16 – 24	10 – 12	120 – 145
	Spark Plug		14 MM	15 – 20	180 – 240
(A)	Nose Plate Stud Nose Plate Dowel	Stud	3/8 – 16	10 – 17	120 – 204
(B)	Nose Plate Stud (steel to steel)		3/8 – 16	15 – 25	180 – 300
	Starter Wheel Assembly to Starter Gear Hub	Capscrews	5/16 – 24	15 –20	180 –240

VII – PERIODIC INSPECTIONS AND OVERHAUL PERIODS
6A8 – 215 – B8F and 6A8 – 215 – B9F ENGINES

	PRE-FLIGHT and DAILY	25 Hours	50 Hours	100 Hours
Propeller Nut & Blades (Visual)	X			
Ignition Wires and Terminals (Visual)	X			
Accessible Nuts, Cap Screws & Fasteners (Visual)	X			
Fuel and Oil Level	X	X	X	X
Engine Controls (Free Movement & Full Range)	X	X	X	X
Oil Leaks	X	X	X	X
Fuel Leaks	X	X	X	X
Propeller Nut (Check for Tightness & Safetying)		X	X	X
Ignition Wires & Terminals (Check for Tightness, Chafing & Soldered Connections – Clean)		X	X	X
Accessible Nuts, Cap Screws & Fasteners (Check for Tightness & Safetying)		X	X	X
Engine Controls (Check Free Movement, Full Range & Linkage System, Lubricate)		X	X	X
Oil Change (More Often if Operating Conditions Warrant)		X	X	X
Propeller Track		X	X	X
Exhaust System (Check for Leaks & Tightness)		X	X	X
Drain Plugs & Filler Caps (Check for Tightness, Safetying & Gasket Condition)		X	X	X
Cooling Air Baffles (Check for Obstructions and Leaks)		X	X	X
Filters, Strainers & Sumps (Inspect & Clean)		X	X	X
Compression Check (Check all Cylinders by Pulling through Propeller)		X	X	X
Engine Mounts (Check for Tightness & Wear)		X	X	X
Equalizer Pipe Hose Connection (Check for Tightness of Clamps and Condition of Hose)		X	X	X
Magneto Breaker Points & Distributor (Check Condition of Rotor, Distributor, Point Condition and Gap)				X
Magneto Timing & Synchronization				X
Generator (Lubricate Bearings)			X	X
Spark Plugs (Clean and Regap)			X	X
Cylinder Fins (Check for Breaks – Clean)				X
Carburetor (Clean and Drain)				X
Fuel Lines (Check for Chafing – Blow Out)				X
Generator (Check Connections, Charging Rate and Belt Tension)				X
Starter (Check Connections and Operation of Bendix Drive)				X
Cooling Fan and Hub (Inspect Mounting Bolts, Cap Screws and Neoprene Bushings)			X	X
Scintilla Magneto (Lubricate Cam Follower Felt) See Magneto Section				X
Auto-Lite Distributor (Fill Oil Cup and Lubricate Rotor Felt)				X
Valve Clearance (Check and Adjust)	Every 200 Hours Minimum			
Eisemann Magnetos (Check Rubber Shock Absorber Drives – Replace if Necessary)	Every 300 Hours Minimum			

OVERHAUL PERIODS:

The periodic inspections and general operating characteristics of the engine will indicate the necessity of overhaul. No definite period has been set for a complete major overhaul. Most engines will require a major overhaul after 600 hours to 700 hours of normal operation.

VIII – ENGINE LUBRICATION GENERAL

The primary purpose of engine lubrication is to prevent metal-to-metal contact between moving parts. The friction accompanying such metal-to-metal contact would result in a loss of power, rapid wear, and a temperature rise that might cause parts to fail. The action of the oil is to coat each metal surface with a film. Between the two films, other layers of the oil slide along over each other, thus replacing the high friction of metal-to-metal contact by the low internal friction of the oil.

In the process of circulating through the engine, oil absorbs heat from the various parts. Most of this heat is dissipated when the oil flows through the oil cooler.

It is very important that an oil of the proper viscosity be used, since the use of too light an oil will cause a breakdown of the oil film, with resultant failure of the moving parts. Using too heavy an oil will impair circulation and insufficient lubrication will result.

Operating conditions will control the period between oil changes, however, the maximum time should not exceed 25 hours.

The S.A.E. letters on an oil container do not determine the quality of the lubricant. The refiner's reputation is your best guide to the quality of the product.

Proper lubrication of your engine should be given your most careful attention since improper lubrication is evidenced only after the damage to the engine has occurred and is often very costly. Using the proper grade of a good lubricant is cheaper than repair bills. We strongly recommend that our specifications and service instructions be strictly followed.

ENGINE OIL SPECIFICATIONS FOR MODEL 6A8-215-B8F AND 6A8-215-B9F ENGINES:

SAE 40 when free air temperature is 40°F or above.

SAE 20 when free air temperature is below 40°F.

LUBRICATION SYSTEM – GENERAL:

This engine is of the wet sump type and the maximum capacity of the oil pan for engines using the floating type oil inlet screen is 11 quarts. Note: (All engines through number 24065 were built using the floating screen.)

Engines having an engine number higher than 24065 were built using a non-floating type of oil inlet screen and the oil capacity of engines using this type of inlet screen has been increased to 12 quarts maximum.

If at any time the floating type oil inlet assembly is replaced by the non-floating unit as used in engines after number 24065, the oil stick and filler cap should be marked for the 12 quart maximum capacity.

He gear type oil pump delivers oil under pressure to the oil pressure relief valve housing. This housing is located on the outside of the crankcase at the right rear of the engine adjacent to #2 cylinder. Excessive oil pressure in the lubricating system of the engine is controlled by a spring loaded plunger in the oil pressure in the oil pressure relief valve housing. The plunger and spring can be removed for inspection by unscrewing the large hexagon nut on the relief valve housing. If at any time the oil pressure relief valve housing is removed from the crankcase, be sure to use only the specified gasket properly installed between the crankcase and the housing when reinstalling the unit. Failure to do so may result in oil being forced directly back into the oil pan instead of through the engine lubricating system.

Oil delivered by the pump is directly through a drilled passage running the full length of the right crankcase half, from which lubrication is supplied to the six hydraulic valve lifters in this section. Oil is also directed forward to provide engine oil under pressure for propeller pitch operation and to furnish lubrication to the propeller shaft bearing when the plain type bearing is used.

A vertical drilled passage in the right crankcase half connects with the main oil passage of that section and directs oil to the inlet pipe of the oil cooler. Thus, the major portion of the oil delivered by the pump passes through the oil cooler to the left crankcase half section, which also has a horizontal drilled passage running the length of the crankcase.

After leaving the cooler, the oil flows to the main bearings and connecting rod bearings and to the left bank of hydraulic valve lifters, through which it is directed to the rocker arm bearings, valves and valve springs on the odd numbered cylinders.

The rocker arm bearings, valves and valve springs on even numbered cylinders are lubricated in a similar manner through the right bank of hydraulic valve lifters.

The connecting rods are provided with spray holes to keep the cylinder walls and piston pins in a heavy oil spray at all times. Timing and accessory drive gears are continuously bathed in oil.

LUBRICATING SYSTEM – INPECTION & SERVICING:

Determine the quantity and general condition of the oil in the engine sump by inspecting the oil level as indicated on the oil level gauge or dip stick. The dip stick is graduated on one side for land operation and on the reverse side for water operation. This inspection should be made at least daily, or more often if operating conditions warrant. Care should be taken to read the proper side of the dip stick when checking the oil level. This will insure the engine from being operated with either too much or too little oil in the pan. A good quality oil should be added to bring the quantity to or near the full mark. Do not attempt to operate the engine with an insufficient quantity of oil in the sump, or with the oil level over the required mark.

The oil filler cap is located on the top of the crankcase on the right side, near the front of the engine. On later engines, an additional filler cap is located on the propeller shaft housing. When the filler cap is removed, inspect the gasket for condition. Replace if worn. Do not neglect to reinstall the filler cap and lock in position. The period for changing the oil will vary with operating conditions. However, the maximum time between oil changes should not exceed 25 hours.

Always drain the oil while the engine is warm. To drain the oil remove the sump drain plug, located at the bottom of the sump pan at the right rear of the engine. Reinstall the sump plug and secure with safety wire to the tab provided. Refill the sump with a good grade of oil of the recommended viscosity. Use only clean containers and funnels. Inspect the filler cap gasket and reinstall immediately to eliminate the possibility of foreign material being accidentally dropped into the crankcase. Check the level of the fresh oil in the sump by inspecting the dip stick. Replace the dip stick firmly into place.

When starting an engine, always remember to observe the oil pressure gauge. If the oil pressure gauge does not start to indicate within 20 seconds, and tapping the gauge glass with the fingers does not have an immediate effect, stop the engine at once and investigate the cause.

The maximum oil temperature should not exceed 260°F. The oil pressure during normal operation should be 50 lbs. per square inch maximum, with a minimum oil pressure of 20 lbs. per square inch in the idle range.

SUMMARY – ENGINE LUBRICATION – GENERAL

Oil capacity (See Lubrication Section)	Engine numbers through 24065 – 11 quarts maximum Engine numbers above 24065 – 12 quarts maximum
Oil pressure – Normal Operation	50 lbs. per square inch maximum
Oil pressure – Idle	20 lbs. per square inch maximum
Oil temperature	260°F Maximum
Viscosity – At air temperatures above 40°F	SAE 40
Viscosity – At air temperatures below 40°F	SAE 20

The oil level measuring stick is calibrated for both land and water operation. Be sure to read the correct side of the stick when measuring the oil.

IX – CRANKCASE

The crankcase assembly is made up of two castings of high strength aluminum alloy. (See Fig. 2) It has two machined pads on the top surface for attaching the oil cooler.

A #40 silk thread approximately 22 – ¼ in. long is placed between the parting surfaces of the top rail of the crankcase at assembly. This thread is placed below the top rail attaching bolts and should be held taut while tightening the two crankcase halves. The silk thread acts as an oil seal at this location.

The two crankcase halves are joined internally by four special heat-treated bolts located at each cam bearing boss. The crankcase is joined externally by eight studs. On later engines oil seals are located between crankcase halves around the main bearing studs. Six of these studs also serve as mounting studs for #1, #3 and #5 cylinders. Eleven bolts join the crankcase halves at the top rail location.

When assembling the crankcase halves, observe that the eight aligning dowels fit in their respective holes and draw up the crankcase assembly nuts evenly.

It is very important that the four 5/16”-24 castle nuts on the bolts located below the camshaft bearings and the two 7/16”-20 elastic stop nuts at each end of the case be drawn up evenly and torqued to the specified limits to prevent warpage of the crankcase.

When the crankcase is disassembled at engine overhaul, it is important that the three plugs at the ends of the oil galleries be removed and the main oil galleries and oil passages be thoroughly cleaned before the plugs are reinstalled.

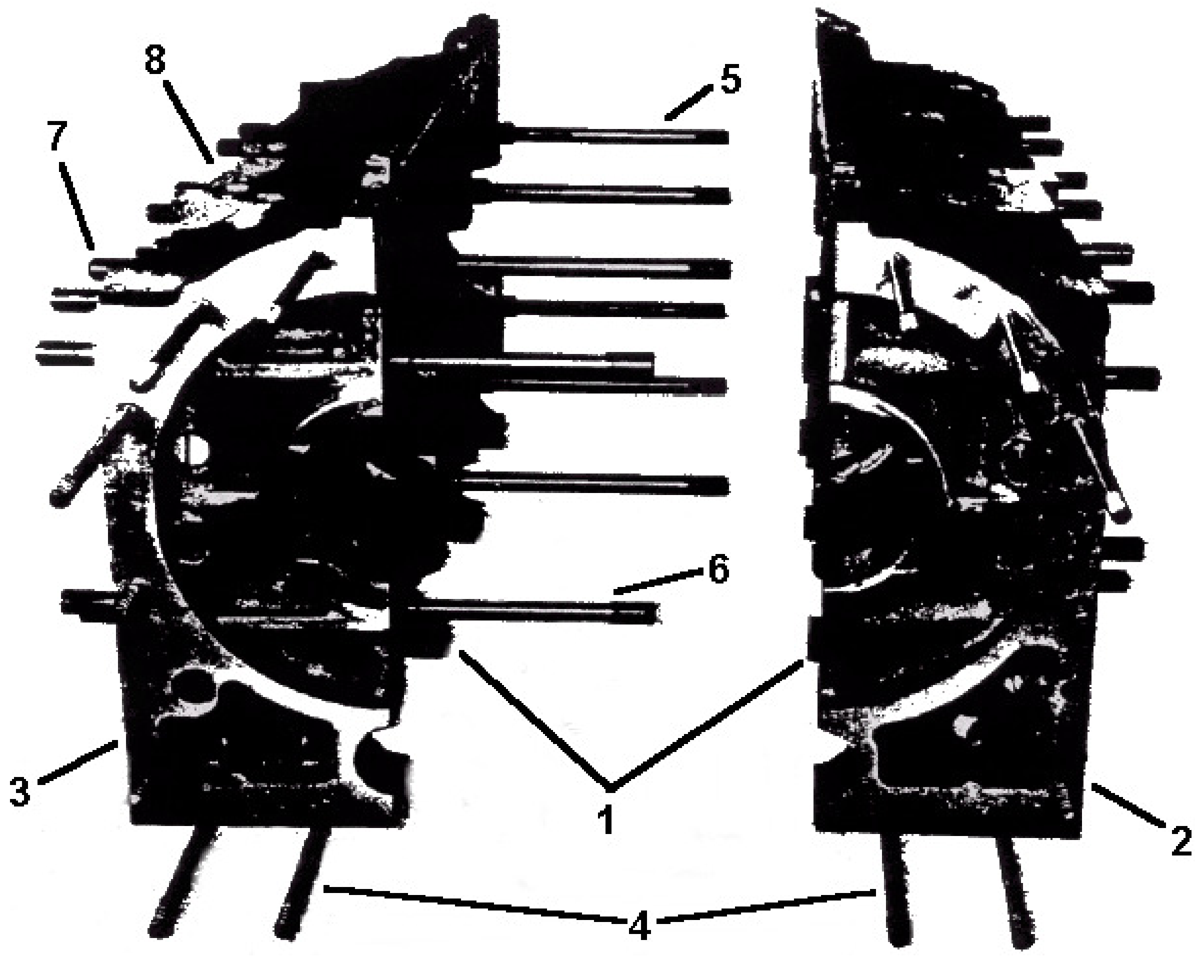

Figure 2. Crankcase

1. Thrust Washers
2. Oil Passage Plug
3. Oil Passage to Propeller Shaft Housing
4. Propeller Shaft Housing Studs
5. Crankcase and Cylinder Studs
6. Crankcase Studs
7. Cylinder Studs
8. Oil Cooler Mounting Pads

X – CRANKSHAFT

The crankshaft is a one piece, six throw, alloy steel forging, heat treated to withstand high stress. (See Fig. 3) It is drilled for lightness and to supply lubrication to all the bearings.

The fillets ground on the crankshaft have a .110" to .125" radius on the main bearing journals and a .155" to .165" radius on the connecting rod bearing journals. These fillets reduce the tendency toward localization of stress and for this reason it is important that fillet specifications be observed if the crankshaft is ever reground.

The crankshaft is supported in the crankcase by four split steel-backed, plated main bearing shells of .0846" to .0851" wall thickness after plating. These bearing shells have a crush fit to secure them in the crankcase bore and insure rigid support for the crankshaft. (See Fig. 3) These bearings are referred to by number with the #1 bearing being nearest the cooling fan end of the engine.

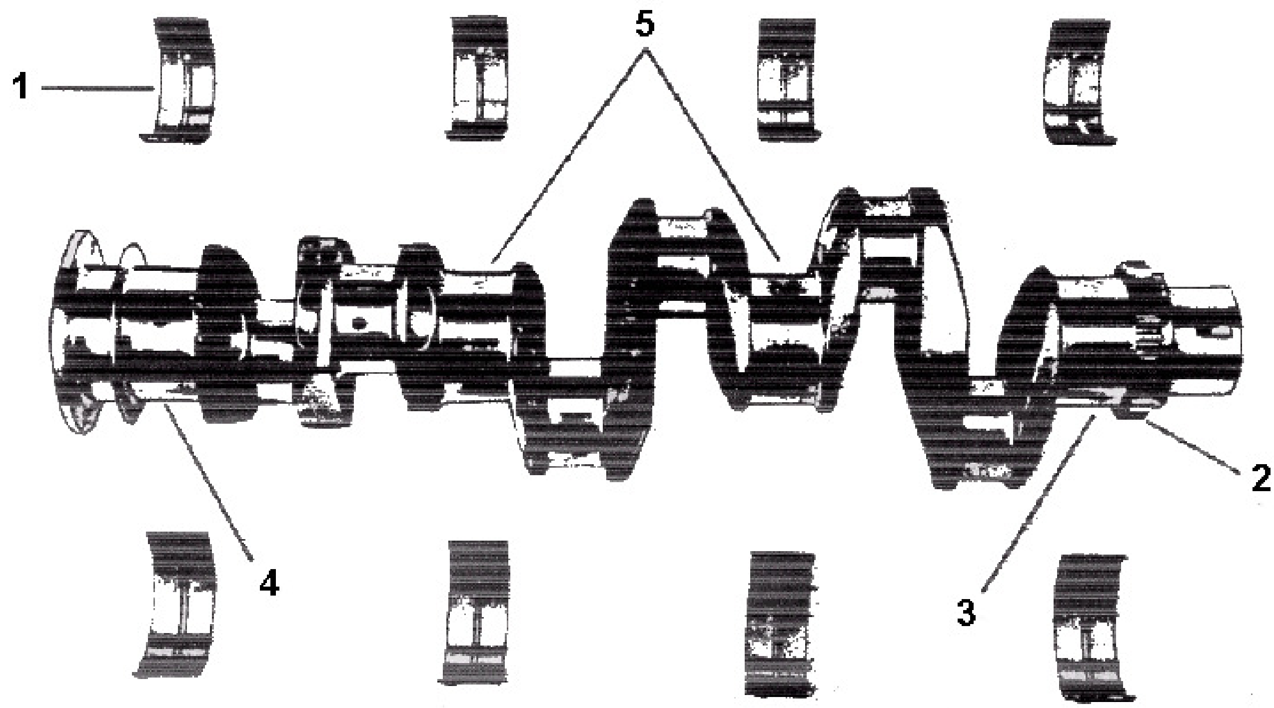

Figure 3. Crankshaft and Main Bearings

1. Crankshaft Bearing Halves
2. Crankshaft Gear
3. Rear Main Bearing Journal
4. Front Main Bearing Journal
5. Center Main Bearing Journal

On the early engines, the crankshaft endplay, when fitted in the crankcase, is .006" to .016" and is controlled by two split thrust washers located and doweled to the inner and outer front wall of the crankcase sections at the #4 main bearing. The crankshaft endplay should be checked with each crankcase half separately, as well as after assembly, to make sure that the .006" minimum is obtainable.

Engines numbered 23501 and up do not have the thrust washers, as the propeller thrust is taken by a ball thrust bearing in the end of the propeller shaft housing. In these installations, the only crankshaft endplay is that which occurs in the ball thrust bearing itself. This endplay varies from .003" to .010".

The main bearing journal diameter is machined to 2.999" to 3.000" and the connecting rod bearing journal is 2.374" to 2.375". When assembled in the crankcase, the clearance between the crankshaft journals and main bearings is .0022" to .0048". The maximum permissible crankshaft runout when supported on two journals is .002" total indicator reading.

A flange is provided with eight holes at the front of the crankshaft for attaching the propeller shaft. Four Woodruff key seats are cut in the rear main bearing journal extension for driving the crankshaft gear and cooling fan. Before installation at the factory, every crankshaft is 100% magnetically inspected and tested for dynamic and static balance.

XI – CAMSHAFT ASSEMBLY

The camshaft incorporates six intake and six exhaust lobes and has four bearing journals. (See Fig. 4) The oil pump drive gear is located between the second and third cam lobes and is machined integrally with the shaft. On the later engines, the fuel pump drive cam is also machined integrally with the shaft. On earlier engines, the fuel pump cam as well as the magneto and tachometer drive gears were incorporated in an extension shaft, which is pressed into a hole in the front end of the camshaft and pinned or keyed into place.

The four cam journals are ground to a diameter of 1.3745” to 1.3750” and have a clearance fit in the crankcase of .001” to .0025”. No bearing shells are used in this installation, as the journals bear directly in a machined bore in the aluminum alloy crankcase. The permissible runout of the two center camshaft journals when the shaft is supported on two journals is .002” total indicator reading.

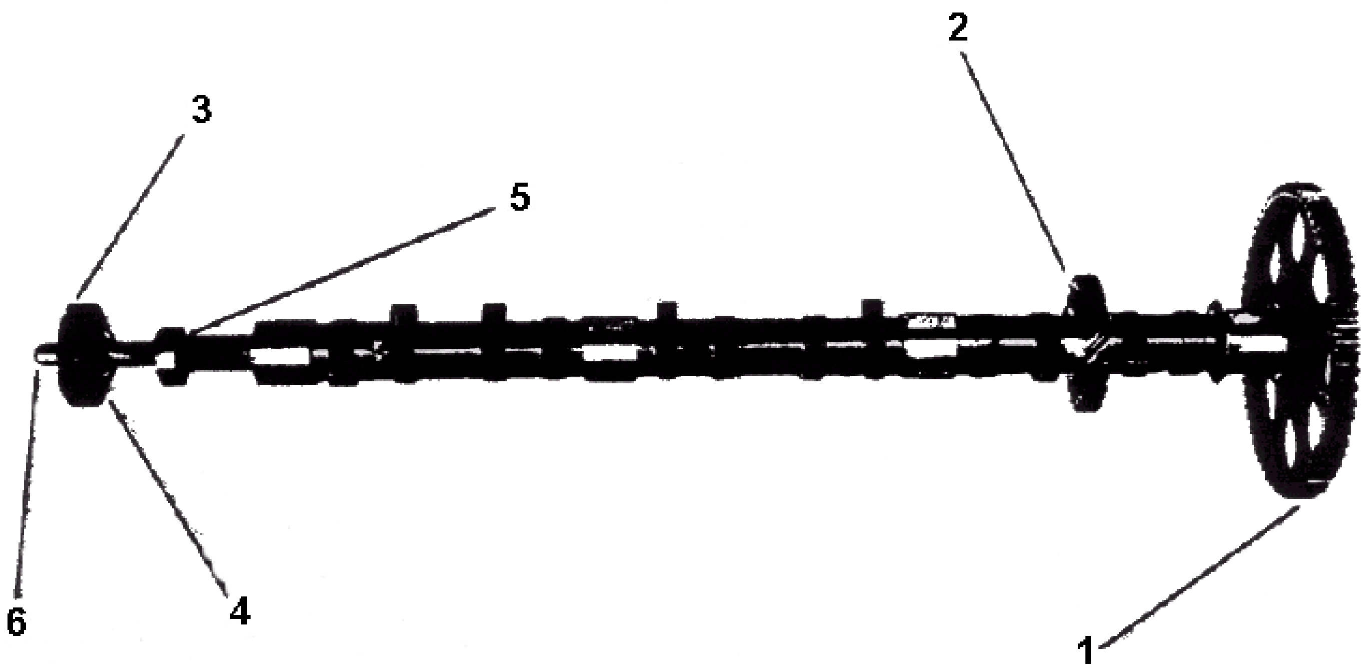

Figure 4. Camshaft Assembly

1. Camshaft Gear
2. Oil Pump Drive Gear
3. Ignition Drive Gear
4. Tachometer Drive Gear
5. Fuel Pump Cam
6. Accessory Drive Shaft

The 66 tooth, camshaft gear is pressed on the rear end of the camshaft with the two “0” timing marks facing away from the shaft. The early shafts incorporated a shoulder that located the gear longitudinally. On later engines, there is no shoulder on the shaft and the gear is pressed on to a distance of 1.190” to 1.192” from the face of the gear hub to the face of the positioning flange on the camshaft. A Woodruff key takes the cam driving torque and positions the gear radially on the shaft. The permissible backlash between the camshaft gear and the drive gear on the crankshaft is .004” to .012”. When assembled in the crankcase, the two “0” marked teeth on the cam gear should straddle the single “0” marked tooth on the crankshaft gear to obtain proper valve timing.

When assembled in the crankcase, the camshaft endplay should be .006” to .010”. The endplay should be checked in each crankcase half separately as well as after assembly to make sure that the .006” minimum is obtainable.

The helical magneto drive gear and the bevel tachometer drive gear are pressed on an accessory drive shaft. (See Fig. 4) The accessory drive shaft assembly is pressed into the front end of the camshaft and keyed in position. A Woodruff key is also used to position the magneto drive gear on the accessory drive shaft. After assembly, the distance from the rear face of the magneto drive gear to the thrust face of the camshaft positioning flange is 23.722” to 23.720”. When assembled to this distance, the backlash between the tachometer drive and driven gears is .015" to .035". The backlash of the magneto drive gear with its mating gear is .004" to .008". The magneto drive gear may also be checked for proper location with the camshaft assembled in the engine. The distance from the front machined face of the crankcase without the gasket to the nearest face of the magneto drive gear should be 2.940" to 2.945". The forward end of the accessory drive shaft is supported by a plain bearing in the propeller shaft housing.

The 24 tooth, helical, oil pump drive gear that is between the second and third lobes on the camshaft has a backlash with its mating gear of .004" to .012".

Some engines have steel camshafts and other engines have cast iron camshafts. The early engines have cams with a base circle that is larger than the base circle on the cams in the later engines. Therefore, when ordering replacements for any of the valve actuating parts, be sure to order correctly in accordance with the information in the parts book.

XII – TIMING GEAR CASE

The timing gear case is fastened to the rear end of the crankcase and houses the camshaft drive or timing gears. On the early engines, a cast case was used, but all of the later engines have a stamped steel timing gear case.

An oil seal is installed in the 4.1235" to 4.1265" diameter hole in the timing gear case. The seal is a .0025" to .0075" press fit in the case and is assembled with sealing compound around the outer diameter of the seal. The inner diameter of the seal has a spring loaded lip that seals against the cooling fan hub. When installing a new oil seal, it is important to place the open face of the seal toward the inside of the case.

On early engines, the timing gear case was fastened to the crankcase by 5/16"-18 cap screws. Later engines use studs down each side of the case and elastic stop nuts with a filler strip between the outer face of the case and the nuts. CAUTION: The third screw hole from the top on the left side of the crankcase is tapped through to the #1 cylinder bore. On engines using the cap screws, it is very important that a 5/8" long screw be used in this position. A longer screw may protrude through to the cylinder bore and cause damage to the cylinder and piston.

A composition gasket is installed between the timing gear case and the crankcase. When installing the new gasket, the ends will extend below the bottom of the crankcase and must be trimmed flush with the lower face of the crankcase before the oil pan is installed. A filer plate that provides extra stiffness for the lower timing gear case flange must also be in place before the oil pan is installed.

XIII – CONNECTING ROD

The connecting rods are an alloy steel forging, magnetically inspected before being assembled on the crankshaft. (See Fig. 5).

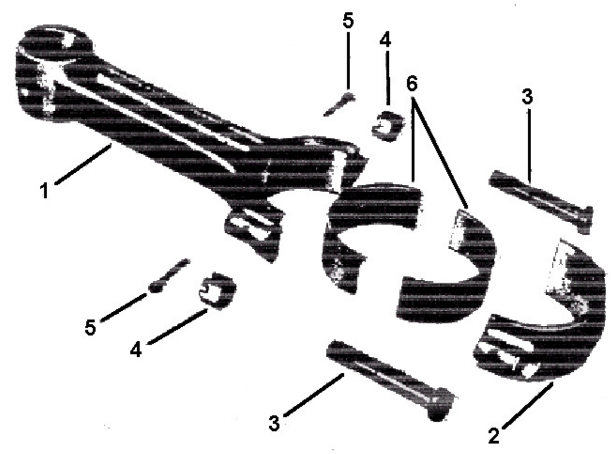

Figure 5. Exploded View of Connecting Rod Assembly

1. Connecting Rod Upper Section
2. Connecting Rod Cap
3. Connecting Rod Bolts
4. Slotted Nuts for Connecting Rod Bolts
5. Cotter Pin for Connecting Rod Bolts
6. Connecting Rod Lower Bushing

The rods are assembled in matched pairs so that the opposing crank throws carry rods within 1/8 ounce of the same weight. Each rod is numbered on both the upper and lower sections so that they may always be reassembled in the same position. The crank throws are numbered consecutively from the rear to front, hence the #1 rod goes on the crank throw nearest the cooling fan end of the engine.

The lower bushing is of the steel backed split type and the halves are interchangeable. When assembling the lower cap to the rod, cylinder position numbers on the bosses should be on the same side of the rod. It is important at assembly to see that the tongue on the back of the bushing fits the slot provided in the connecting rod, to prevent binding or movement of the bushing halves when installed. The wall thickness of the bushing is .0612" to .0617". The bushings are a crush fit when assembled in the connecting rods. When assembled to the crankshaft, they have a clearance of .0011" to .0036" on the crankpins and an inside diameter of 2.3761" to 2.3776".

The connecting rod cap is assembled to the rod by two alloy steel, 3/8"-24 rolled thread, upset head bolts. The bolts are installed with the thread end toward the piston pin bushing. The side clearance between the connecting rods and the crankshaft cheeks is .0055" to .0115".

Two holes are drilled in the upper half of the crankpin bearing section of the connecting rod. These holes index with two holes in the bearing bushing. The holes permit oil to spray upward against the cylinder walls and piston. Three holes are drilled in the upper end of the connecting rod and piston pin bushing to furnish a passage for lubrication to the piston pin.

The piston pin bushing is a press fit in the 1.1775" to 1.1785" hole of the connecting rod. After installation, it is bored to 1.1097" to 1.1099". The bushing must be installed with the three drilled holes indexing with the three holes in the connecting rod upper boss. Clearance between the piston pin and bushing is .0005" to .0009".

XIV – PISTON, PISTON PIN AND RINGS

PISTONS:

The permanent mould cast aluminum pistons are of a special design, which controls expansion to a high degree, permitting a close fit between piston and cylinder wall. (See Fig. 6). This feature provides for long cylinder, piston and ring life and eliminates piston slap.

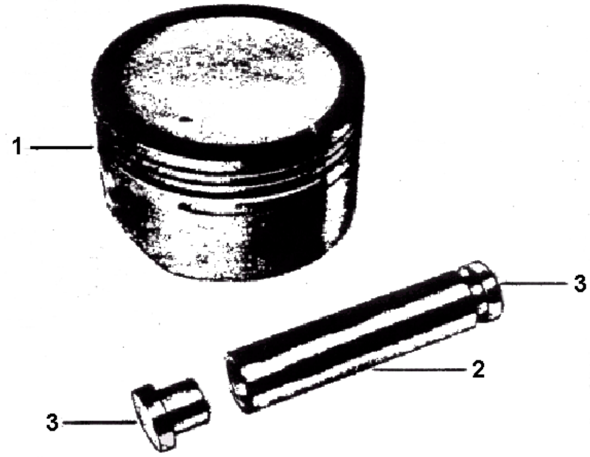

Figure 6. Piston, Piston Pin and Piston Pin Plug:
1. Piston 2. Piston Pin
3. Piston Pin Plugs

The clearance between the piston and cylinder wall, taken at the bottom of the piston skirt is .002" to .0035" and taken at the top of the skirt, just below the slot, is .003" to .0045". This clearance can best be taken by using a long feeler gauge, which will reach the length of the cylinder liner. The piston should be installed, without the rings, in its normal running position within the cylinder and the clearance taken at the top and bottom of the cylinder bore. A .002" feeler gauge should indicate no drag when checking piston clearance. (See Fig. 7)

If at any time the piston with rings installed should be inserted by hand in the cylinder bore, do not push the piston into the top of the cylinder as the top groove piston ring will expand above the upper rim of the liner and lock the piston in the combustion chamber.

Figure 7. Checking Clearance Between Piston and Cylinder Wall

The piston ring groove widths are as follows: Top and middle--.1005" to .1015". Bottom groove--.1885" to .1895".

The diameter of the piston pin holes in the piston is 1.1092" to 1.1094". Pistons are plated all over with the exception of the piston pin holes.

The pistons are stamped for location on the bottom of the piston pin boss. The number corresponds to the cylinder location on the engine in which they are installed.

PISTON PIN:

The hollow piston pins are of alloy steel, heat treated and magnetically inspected. They are of the full floating type and are a palm push fit in the piston at room temperature (70°F). They are finished inside to a diameter of .750" to .751" and ground outside to a diameter of 1.1090" to 1.1092". The piston pin ends must be square with their axis within .002" total indicator reading to insure a proper bearing surface for the end plugs. Two aluminum plugs are installed in the ends of the piston pin. The outside diameter of the plugs, where they fit inside the pin, is .7480" to .7490". The piston pins, when installed, give the piston pin with buttons assembled an end clearance in the cylinder bore of .010" to .023". This clearance is best checked by using a feeler gauge.

PISTON RINGS:

The piston is provided with three ring grooves to accommodate three Perfect Circle piston rings. (See Fig. 8 for ring installation diagram). The lower groove has holes drilled through the piston wall to the inside of the piston for oil return.

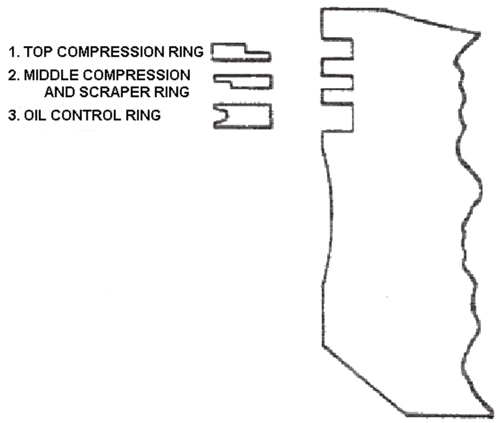

Figure 8. Piston Ring Installation

The top ring is a compression ring with a width of .0930” to .0935”. It has an undercut on the inside diameter of one face, around the circumference of the ring. The ring must be installed with its undercut facing the top of the piston.

The middle ring is a compression scraper ring with a width of .0930” to .0935”. Its undercut is on one edge of the out circumference. This ring must be installed with the undercut facing the bottom of the piston. This is important, as reversing the ring at installation will cause it to scrape the oil toward the combustion chamber, resulting in high oil consumption and fouled spark plugs.

The lower groove ring is an oil control ring of the slotted type, with a width of .1860” to .1865”. It may be installed in any position in the lower groove.

The piston ring gap for all three rings, when measured in the cylinder, should be .013” to .023”. The top and middle rings have a side clearance when installed in their respective grooves of .007” to .0085”, and the bottom ring .002” to .0035”. When the pistons are installed on the engine, the ring gaps are staggered in relation to each other, before installing the cylinders. The rings should also be checked for freedom in the ring grooves before installing the cylinders.

XV – CYLINDER ASSEMBLY

CYLINDER:

Franklin cylinders are a one-piece aluminum alloy sand casting, incorporating deep, closely spaced fins to insure ample cooling under the various operating conditions of the engine. The piston bore of the cylinder is fitted with a nickel-iron liner, which extends the full length of the cylinder barrel section and projects 1 in. below the cylinder flange lower face. On the early engines, the liner is held in position by two lock pins, located in the base flange of the cylinder casting 90° to each other and held solidly in place by two lock screws each. To prevent oil leaks, the lock pins and lock screws are coated with a liquid jointing compound at assembly. The lock pins or lock screws should never be removed, replacement is necessary only when installing a new liner. On initial assembly the lock pins are installed before final grinding and honing of the cylinder barrel operation, and is, therefore, finished to size on the inside of the cylinder bore when the bore diameter is ground to size.

On later engines, the liner has a flange or shoulder that positions it in the cylinder. When the cylinder is installed on the engine, this shoulder fits into the chamfer on the crankcase. The liner shoulder is clamped between the cylinder mounting flange and the crankcase, and any movement of the liner in the cylinder is prevented. No lock pins are used on this type of installation. On the latest engines, the liner shoulder is omitted, and the liner is held in position by a step which is machined in the cylinder bore in the crankcase.

The cylinder bore is finish-honed to a diameter of 5.000” to 5.001”. The final finish is a fairly coarse honing operation to insure satisfactory seating of the piston rings, contacting the liner surface. Tests have proven that with the use of good lubricants, changed regularly, the liners will show little wear over a long period of operation.

During initial assembly, the aluminum cylinder casting is heated and held for two hours at a temperature between 625°F to anneal the casting and prepare it for installation of the liner, valve seat inserts, valve guides and exhaust port tube, all of which are installed while the casting is in the heated condition.

VAVLE GUIDES:

The intake and exhaust valve guides are a high quality cast iron and are installed, as previously explained, when the cylinder casting is heated. The outside diameter of the valve guides is .6270” to .6275”, giving a shrink fit on the cylinder head of .003” to .004”. When installed, the distance from the machined top surface of the cylinder down to the top of the guide is .318” to .354”. The later engines have guides with a locating shoulder that position the guide properly when it is assembled in the cylinder. The inside diameter of both guides is .4063” to .4073”. The early engines had sodium cooled exhaust valves that required a guide with an inside diameter of .4375” to .4385”. When ordering replacement guides, make careful reference to the parts number. The valve guides should be concentric with the valve seats within .002 total indicator reading.

To replace the guides, heat the cylinder to a temperature of 625° to 650°F. Support the cylinder on the head end, with supports close to the guide to be pressed out. Press the guides out from inside the cylinder head. Measure the internal diameter of the hole in the cylinder—standard inside diameter of reamed guide holes on both the intake and exhaust is .6235” to .6245”, and install oversize guides in necessary. Intake and exhaust valve guides can be obtained in three oversizes: .001”, .002” and .005”. After selecting the proper size guide, and with the cylinder heated to 625° to 650°F, install the new guide by coating it with white lead and pressing it into position until the top of the guide is .318” to .354” below the machined top surface of the cylinder head, or, on the later engines, until the guide shoulder bottoms in the counterbore in the spring well.

VALVE SEAT INSERT (INLET):

The inlet valve seat insert in the aluminum cylinder head is made of iron alloy on the early engines. The later engines have alloy steel inserts faced with Stellite. The seat insert is installed when the cylinder is heated to 625° to 650°F by being pressed into the 2.312” to 2.313” reamed hole in the cylinder head. The outside diameter of the inlet valve seat insert is 2.317” to 2.318”, giving a shrink fit between the intake valve seat insert and the reamed hole of .004” to .006”. When the insert is properly seated and the shrink fit obtained, the seat is further secured by rolling over the aluminum material of the cylinder surrounding the insert. The inlet valve seat is then ground to a 30° angle with a seat face width of 1/16”.

VALVE SEAT INSERT (EXHAUST):

The exhaust valve seat insert is of stainless steel on early engines. The later engines have alloy steel inserts faced with Stellite. The exhaust valve seat insert is installed in the same manner as the inlet valve seat insert and the aluminum cylinder head material rolled over it. The seat insert is then ground to a 45° angle with a face width of 3/32”.

The outside diameter of the exhaust valve seat insert is 1.937” to 1.938”. The inside diameter of its reamed hole in the top of the cylinder head is 1.931” to 1.932”, giving a shrink fit of .005” to .007”.

The seat inserts may be replaced by cutting them out to a thin shell. Care must be used when removing the shell, not to damage the reamed hole in the cylinder head. The Stellite faced seat inserts are extremely hard and ordinarily should not need to be removed. If removal does become necessary, a high speed steel tool is required to cut through the face. Heat the cylinder to 625° to 650°F for two hours and press in the new inserts. It is important that the inserts bottom flush in the reamed hole and that they are held in position during the time the cylinder is cooling. If it should become necessary to replace the valve seat inserts, the operation must be performed with the proper tools and care must be taken to hold the seat face widths to the specified dimensions, using narrowing stones or cutters if necessary.

EXHAUST PORT TUBE:

The stainless steel exhaust port tube, being a shrink fit in the exhaust port opening of the cylinder, is installed when the cylinder is heated to install the previously mentioned units. The inside diameter of the exhaust port opening in the cylinder head is 1.609” to 1.610”; the outside diameter of the exhaust port tube is 1.614” to 1.615”, giving a shrink fit of .004” to .006”. The exhaust manifold lock tab, which is welded to the exhaust port tube, must be at a 45° angle to the vertical centerline of the cylinder and point toward the outside fin section of the cylinder. At installation the raised bead on the exhaust port tube must seat flush against the exhaust port opening. A flange secured to the studs on the exhaust port opening by two 5/16-24 Stover lock nuts completes the assembly. If removal of the tube ever becomes necessary, the easiest method is to collapse the tube by striking it near the bead with a punch.

CYLINDER FASTENINGS:

Studs are installed on the cylinder assembly to secure the exhaust port tube and the inlet manifold. On the early engines, studs were also used to secure the valve rocker supports. Capscrews are used to secure the rocker supports on later engines.

The inlet manifold studs are 5/16”-18 NC on the stud end, 5/16”-24NF3 on the nut end, and are 29/32” high installed.

The exhaust tube studs are 5/16”-18 NC and are 13/32” high installed.

The rocker support studs where used are 5/16” as above and are 1½” high installed.

CYLINDER OIL SEAL RING:

When installing the cylinder on the crankcase, inspect the cylinder pad surfaces on the crankcase and on the cylinder flange for nicks and burrs. See that these surfaces are clean. The oil seal ring is installed on the cylinder liner and pushed back so that it is snug against the cylinder flange all around. It is important to check the cylinder liner to see if it has a locating shoulder at the cylinder flange or not. If the shoulder is present on the liner, a seal ring with a 1/16" cross-section diameter is used. If the liner has no shoulder a 3/32" cross-section diameter ring is used. When replacing cylinder seal rings, the parts book will indicate which ring to order by specifying the engine serial numbers using each type.

CYLINDER HOLD-DOWN NUTS:

The cylinder is attached to the crankcase by using eight special washers and eight 7/16-20 elastic stop nuts. These nuts must be drawn down evenly and properly torqued to secure a good seal on the crankcase cylinder pad.

CYLINDER FINS:

It is very important from a cooling standpoint that a maximum flow of air have free access to and around the cylinders. For this reason the entire cylinder fin area should be kept clean and free from any obstructions. The engine cowling should be periodically checked for leaks and securely tightened in its correct position.

HELICOILS:

Stainless steel helicoil spark plug inserts are used to accommodate two spark plugs in the head of the cylinder. Their use greatly improves spark plug thread wear and maintenance.

XVI – VALVES AND VALVE SPRINGS

VALVES:

Two conventional type poppet valves are employed for each cylinder. The alloy steel inlet valve has a stem diameter of .4038" to .4030" and a face angle of 30°. The ground face must be concentric with the stem within .0015" total indicator reading. The early engines had Stellite faced inlet valves. Inlet valves on the later engines as well as the service replacement inlet valves are not Stellite faced.

The exhaust valve has a special corrosion resistant steel head welded to the stem, and the seat is faced with Eatonite. The stem diameter is .4038" to .4030" and the face is ground to an angle of 45°. A few of the early engines used a Stellite faced valve with a sodium filled stem. The stem diameter of this exhaust valve is .4350" to .4342". The ground face of the exhaust valve must be concentric with the stem within .0015" total indicator reading. Both the plain and sodium filled valves are furnished for service replacement. Careful reference to the parts book will insure that the correct part is ordered. It is important that the small stem valve never be assembled in the large bore valve guide as damage to the engine will result.

VALVE SPRINGS:

The valve spring arrangement consists of an inner and outer coil spring, cupped bottom washer, shouldered upper washer for the purpose of centering both springs and a split key or keeper for the upper shouldered washer. (see Fig. 9)

Shims are available in .016 in. and .031 in. thickness for installation under the lower cupped washer to give correct spring load. The inner or smaller spring free length is 1-31/32 in. and the outer or larger spring is 2-3/32" in.

The valve spring force, when compressed to the indicated lengths is as follows: Inner spring compressed to 1.688 in. = 20 to 24 lbs. And at 1.188 in. = 59 to 65 lbs. Outer spring compressed to 1.781 in. = 44 to 48 lbs. And at 1.281 in. = 121 to 127 lbs.

With the valve and valve springs assembled in the cylinder, the valve should support a weight of 72 to 80 lbs. before the valve starts to leave the seat in the cylinder. Adjustment for assembled weight is made by adding or removing shims UNDER the bottom spring washer only. Valve travel from the closed to the full open position must be a minimum of .520 in. to insure proper operation. With the valve in its full open position on the engine, the spring coils should not be solid, otherwise serious trouble with valve operating parts may be experienced.

XVII – VALVE ACTUATING MECHANISM

The valves are actuated from the camshaft through hydraulic valve lifters, lifter rods and valve rocker assemblies, which contact directly on the valve stems. (see Fig. 10)

Lubrication to the rockers and valves is accomplished without use of external oil lines since the oil flows through drilled passages in the lifters, lifter rods, adjusting screws and rockers to insure satisfactory lubrication to these parts and the valves themselves.

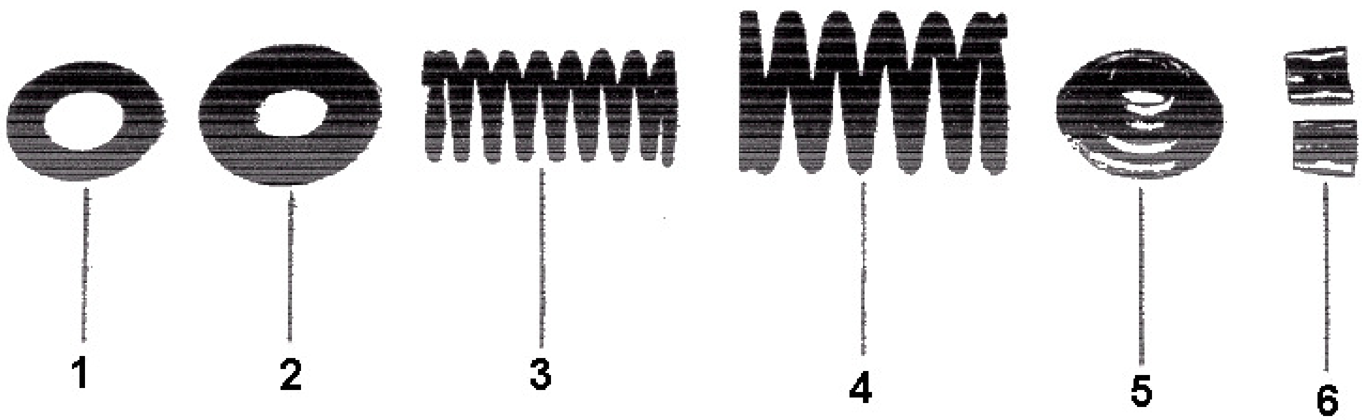

Figure 9. Valve Springs

1. Bottom Washer Shim
2. Bottom Washer
3. Inner Valve Spring
4. Outer Valve Spring
5. Upper Washer
6. Valve Spring Upper Washer Key

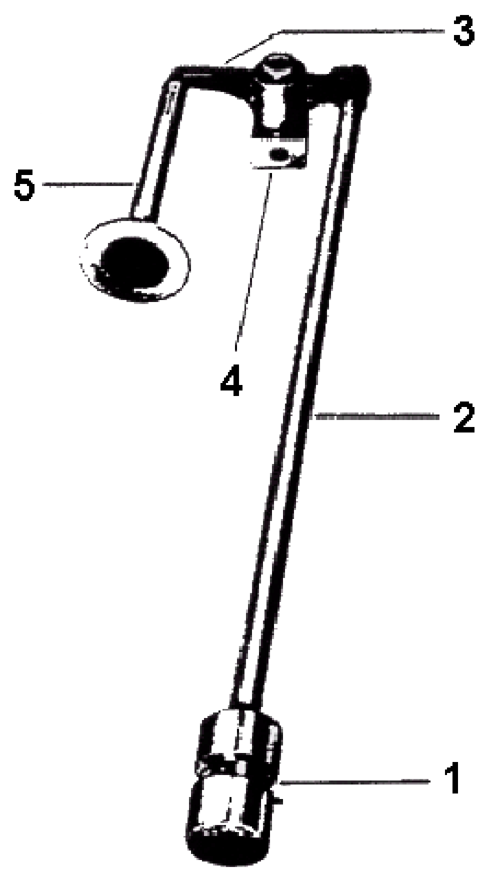

Figure 10. Valve Train

1. Hydraulic Valve Lifter
2. Valve Lifter Rod
3. Valve Rocker
4. Valve Rocker Support
5. Valve

Caution must be taken when replacing lifter units, lifter rods and adjusting screws that they are of the proper type for the 6A8-215-B8F and 6A8-215-B9F engines. The lifter body clearance in the crankcase guide hole is .001” to .002”.

HYDRAULIC LIFTER:

The hydraulic lifters have proven to be dependable through years of usage. The illustrated views show the simplicity of construction together with the few parts that comprise the assembly. (See Fig. 11)

Oil under pressure from the engine lubrication system enters the lifter body chamber through two inlets in the annulus around the body. This annulus indexes with a hole drilled in the lifter guide hole in the crankcase. The lifter body chamber is thus filled with oil under pressure. A spring loaded valve, located under the return spring, lifts off its seat due to the pressure of the oil in the lifter body chamber and allows oil to fill the lifter piston chamber. When the valve is closed, the oil in the piston chamber, being non-compressible, completes a lifting mechanism that operates against the lifter rod as positively as though the whole lifter unit were a single solid piece. As the valve train expands and contracts with changes in engine temperature, the lifter adjusts its own length to compensate for the changes. Accurately determined clearance to within one ten-thousandths of an inch between the piston and the bore of the lifter body permits the escape or leakdown, as it is commonly called, of a small amount of oil from the chamber. This leakage automatically compensates for any expansion in the valve train, allowing positive valve seating. When the valve train contracts, the piston return spring holds the piston outward. This relieves pressure on the oil in the piston chamber and on the valve under the return spring. The valve moves from its seat and permits the intake of oil from the engine lubrication system through the lifter body. Thus the lifter unit corrects its length each time the valve closes, to maintain zero clearance.

HYDRAULIC LIFTER (SERVICING):

To disassemble the hydraulic lifter, remove the retainer ring from the top of the lifter body. This is done by prying one end out with a small knife blade or similar tool. If the tappet is full of oil and the piston is tight against the ring, first press the piston down slightly by pushing hard against the cupped socket, forcing some of the oil out past the piston. When the retainer ring is removed, the action of the return spring pushes the lifter piston out of the lifter body. In this position, the piston return spring and valve cage may be easily removed. With the lifter parts separated, give them a thorough cleaning. During the cleaning process, do not enlarge the holes or change the dimensions of the piston or of the bore of the lifter body by using any tool or material with an abrasive action. This is important as it would change the leak-down rate and affect the proper operation of the unit. After the lifter parts are cleaned and dried, a simple check can be made to test the action of the lifter valve assembly and the leak-down rate, which is controlled by the clearance between the piston and the lifter body.

Install the valve assembly and piston, without the return spring, in the lifter body. Place the unit on a bench and tap the piston head sharply with the forefinger. If the unit is in good condition, the piston will rebound sharply, due to the cushion effect of the air compressed in the lifter body chamber. If the piston does not react in this manner, it would indicate improper seating of the valve or excessive clearance between the piston and lifter body. When reassembling the unit, it is very important to replace the same parts removed from that particular unit as they are a matched assembly.

When installing the hydraulic lifters, no oil should be in the chamber. When the lifters are installed dry, the two small holes extending through the piston skirt vent the air very quickly and oil from the engine lubricating system operates the lifters. The outside of the lifter body should be coated lightly with oil, however, before the lifters are installed in the crankcase.

Very infrequent servicing is required and it is advisable not to disturb the lifters unless there is a direct cause traceable to lifter performance. Always replace the lifters in their original locations on the engine.

LIFTER ROD AND TUBE:

The lifter rod is of seamless steel tubing. It has a ball end which contacts the cup in the lifter plunger. A cup on top of the lifter rod contacts the ball end of the valve rocker adjusting screw.

If either tips on the lifter rod show appreciable wear, the lifter rod should be replaced. The holes in the tips and the hollow rod must be free of foreign matter, as oil from the engine must pass through the lifter rod to lubricate the rocker arms and valve assemblies.

To test the ball ends and cups for looseness in the lifter rod, drop the rod lightly from a horizontal position on a steel plate and observe the tone. A ringing sound indicates that they are tight and a dull vibrating sound indicates looseness.

The lifter rod should be straight and true within .010” total indicator reading. There is a difference in length between lifter rods on early and late model engines. The engine serial number is necessary to identify the correct rod length for that particular model. Refer to the parts book for correct part number and references.

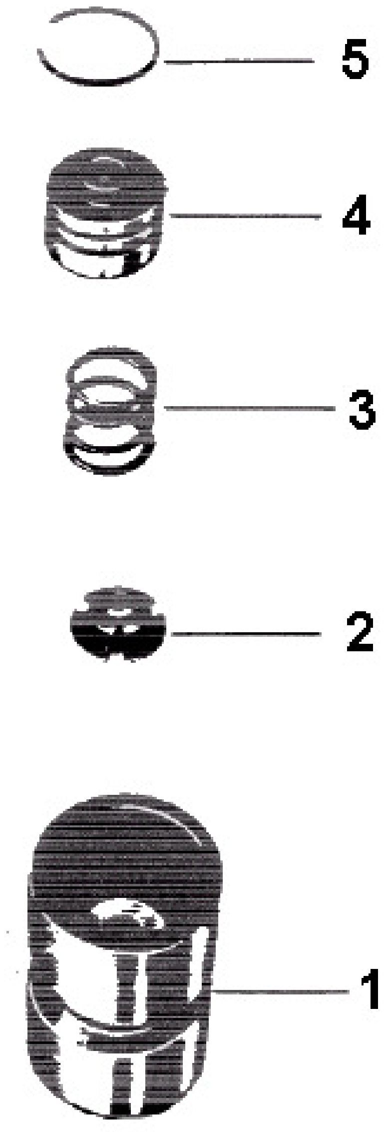

Figure 11. Exploded View of the Hydraulic Valve Lifter

1. Lifter Body
2. Valve Cage
3. Return Spring
4. Piston
5. Retainer Ring

The lifter rod is encased in a tube which contains a coiled spring type circlet fitted in the recess of the bead on the crankcase end of the tube. This circlet centers the lower end of the push rod on the lifter cup and serves as a guide to position the rod during installation and engine operation. Two composition packings provide an oil seal at the cylinder head and crankcase end of the lifter rod tube. When installing the tube, both seals must be properly seated at the cylinder head and at the crankcase end. Tubes that are bent or badly dented should be replaced.

VALVE ROCKERS, ROCKER PINS AND SUPPORTS:

Each valve rocker is supported by a rocker pin. The rocker pins, in turn, are supported by blocks which are secured to the cylinder head by studs or capscrews. The aluminum support blocks are secured to the cylinder head entirely by studs and jam nuts on factory assembled engines. The later engines employ stamped valve rockers and stamped supports. The stamped supports are secured to the cylinder head entirely by capscrews and tab lock washers.

Either the stamped or forged type valve rocker may be used with either the stamped or machined supports if the proper fasteners are employed. The stamped supports require capscrews only, as no studs are available with sufficient length to secure this type support. The aluminum block supports may be secured by studs and jam nuts as in the original installation, or by special short capscrews furnished for service replacement.

The stamped type rocker has a 3/8”-24 adjusting screw and jam nut, and the forged type rocker has 5/16”-24 adjusting screw and nut. The stamped and forged rockers also require different length lifter rod assemblies. Consult the parts book carefully when ordering any valve actuating parts to insure that a correct combination of valve rocker, lifter rod, and camshaft is obtained.

If the valve rockers and supports have been removed, it is important to see that a welch plug is installed in the bore of each rocker pin just inboard of the support screw hole. The absence of this plug will eliminate the safety feature of having an oil cross feed between the two rockers in case the oil passage to one rocker gets plugged. The oil hole in the rocker pin should face down toward the cylinder head for the same reason.

The exhaust and intake valve rockers are very similar in appearance, but they may be identified by the oil holes at the valve actuating pad. The intake rocker has a single hole I the pad that directs oil onto the valve stem tip. The exhaust rocker has a similar hole in the pad, but it also has as additional hole approximately 90° from the other that supplies oil directly out the end of the rocker arm. The rockers should always be reassembled in their correct positions for proper engine operation.

The valve rocker is positioned by means of the adjusting screw so that, on a cold engine, the rocker arm clearance with the valve stem tip is .040” when the hydraulic lifter is bled down. This valve clearance adjusting operation is described in detail under section XXIX Engine Assembly, beginning Page 45.

XVIII – PROPELLER SHAFT AND PROPELLER SHAFT HOUSING ASSEMBLY

PROPELLER SHAFT:

The propeller shaft is a hollow, one-piece alloy steel shaft with an SAE #20 Spline. It is machined from a forging, heat treated, and shot peened so that it will withstand high stresses. Every shaft is 100% magnetically inspected at the factory before being installed on an engine. The propeller shaft is attached to the crankshaft by eight special 5/16”-24 x 1-1/8” bolts which are safetied by 1/16” x 5/8” cotter pins. With the propeller shaft mounted on centers, the runout of the face of the mounting flange should not exceed .002” total indicator reading.

Two types of propeller shafts have been used. The model 6A8-215-B8F (Serial nos. up to 23500) has a shaft with a bearing journal which is 3.0000” to 2.9995” in diameter and 1-3/4” wide. Model 6A8-215-B9F engines (no. 23500 and up) have a shaft with bearing journal diameter of 2.9533” to 2.9527” and a width of 31/32”. Each of these shafts requires a different bearing and oil seal. See the following section, Propeller Shaft Nose Plate Assembly, for details.

PROPELLER SHAFT NOSE PLATE ASSEMBLY:

The nose plate assembly supports or secures the propeller shaft bearing, and contains the propeller shaft oil seal and oil seal sleeve. Three different designs of nose plate assemblies have been used. These assemblies are not interchangeable without further modification of the engine. (See Figure 12)

The nose plate on the first engines supports a plain bearing and allows all of the propeller thrust to be taken at the thrust washers in the crankcase. The plain bearing is pressed into the nose plate and secured with a pin. Care must be taken when assembling the bearing in the plate to insure that the oil hole in the bearing mates with the oil passage in the nose plate. The nose plate is accurately positioned in the shaft housing by a dowel and secured by 3/8”-24 studs and nuts. The 2-3/4” inside diameter by ½” wide nose seal is coated with sealing compound around the outer diameter and pressed into the 3.747” to 3/748” diameter recess in the nose plate with the open end of the seal toward the inside of the housing. Care must be taken when assembling the oil seal sleeve to insure that the counterbored end goes toward the inside of the housing to provide a clamp for the oil slinger.

A later group of engines (Serial #23281 to #23500) employs a nose plate that supports a ball bearing. The plate is so designed that it floats in the shaft housing, and the ball bearing takes the propeller thrust when it is in reverse pitch only. The normal propeller thrust is taken by the thrust washers in the crankcase. The nose plate is positioned by four special studs which allow the plate assembly to move in and out a distance determined by the crankshaft endplay. The portion of the plate that pilots in the propeller shaft housing is grooved to take an oil seal ring. The nose seal has the same diameters as the seal in the earlier installation, but it is only 7/16” wide. In this installation the oil seal sleeve also serves as a clamp for the ball bearing inner race. When properly assembled there is a space of approximately 3/16” between the nose plate and the face of the housing. Engines with serial numbers above 23500 have a nose plate that clamps a ball thrust bearing in the end of the propeller shaft housing. This bearing supports the end of the propeller shaft and takes all propeller thrust in both the normal and reverse directions. No thrust washers are used in the crankcase, as the shaft is positioned by the ball thrust bearing. In order to obtain a correct nose plate and thrust bearing installation, the following assembly procedure should be employed. With the propeller shaft and the shaft housing already assembled, install the ball thrust bearing, in the annular space between the propeller shaft journal and the steel liner in the shaft housing. The face of the bearing having the recess in the outer race should face the inside of the housing. A driver is necessary to assemble the bearing snug against the shaft flange and the shoulder in the housing, as a .0003” tight to .002” loose fit exists on the bearing outer race and a .0011” tight to .0001” loose fit exists on the bearing inner race. The nose plate assembly containing a ½” wide nose oil seal and the oil seal sleeve is temporarily installed without using a gasket. The space remaining between the machined faces of the propeller shaft housing and the nose plate is measured with a feeler gauge with the plate being held firmly against the ball bearing race by lightly tightening two nuts against the nose plate. After obtaining the clearance measurement, refer to the table below and select the combination of gaskets required to assemble with the proper amount of crush.

Clearance Measurement	Gaskets Required
.015” to .020”	One 1/64” and two .004”
.021” to .026”	One 1/32”
.027” to .030”	One 1/32” and One .004”
.031” to .034”	One 1/32” and Two .004”
.035” to .038”	One 1/32” and Three .004”

Remove the nose plate assembly, install the gaskets selected, and reassemble the nose plate assembly. The propeller control cylinder or the substitute spacers are installed next. Plain washers are used and the assembly is secured by 3/8”-24 nuts on the six studs. When the oil seal sleeve is assembled in the oil seal, the flanged end should be toward the inside of the propeller shaft housing as this forms the clamp for the bearing inner race.

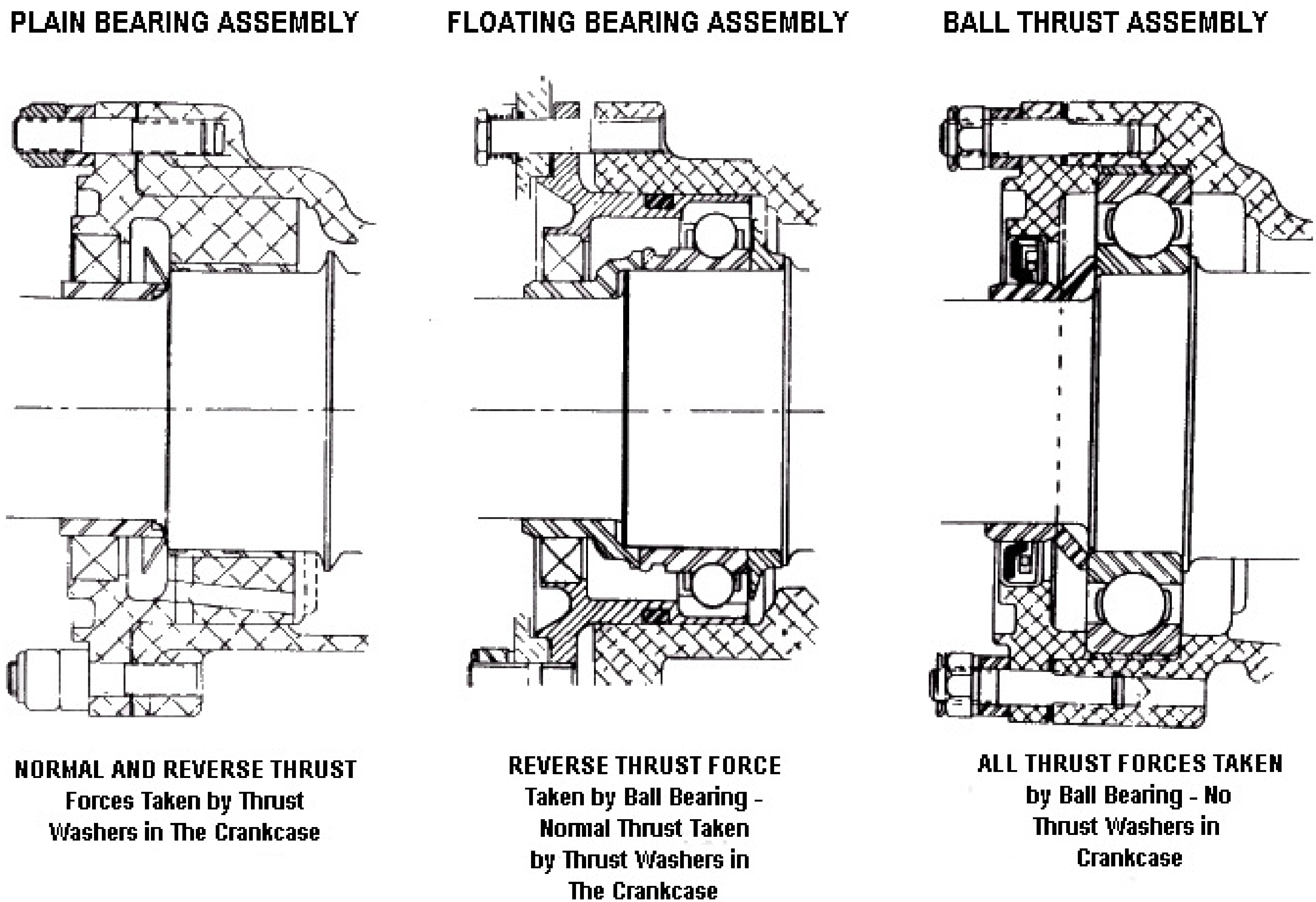

Figure 12. Propeller Shaft and Nose Plate Assembly

PROPELLER SHAFT HOUSING:

The propeller shaft housing (See Fig. 16) is a casting which is attached to the front of the crankcase assembly by fourteen 5/16”-24 elastic stop nuts using plain washers. Two dowels align the propeller shaft housing to the crankcase.

When assembling the housing to the crankcase, examine the mating surfaces carefully and use a new gasket to insure an oil tight joint. It is important to install the small connector pipe gasket, as failure to do so will impair the oil supply to the propeller shaft housing.

The propeller shaft housing supports the ignition drive assembly, the distributing zone and the crankcase breathing tube. It also incorporates the engine name and date plate; the engine front mounting bracket; mounting pads for two fuel pumps, a tachometer drive; two magnetos and the propeller shaft nose plate assembly.

On the 6A8-215-B9F model, the housing also incorporates an oil filler cap and supports the drive assembly for one magneto and one distributor.

A cast in steel tube, in the right wall of the propeller shaft housing, carries engine oil under pressure to the nose plate assembly for operation of the controllable pitch propeller and to furnish pressurized lubrication when the plain type propeller shaft bushing is used.

NOTE: The propeller shaft housing, the propeller shaft, and the nose plate assembly parts are not interchangeable between the model 6A8-215-B8F and B9F engines. The engine serial number should be noted and careful reference made to the parts book when ordering replacement parts.

XIX – FAN, STARTER GEAR AND GENERATOR DRIVE

COOLING FAN:

The alloy casting cooling fan is mounted on the rear of the engine and rotates in the same direction (clockwise as viewed from the rear of the engine) and at the same rate of speed as the crankshaft.

The fan is attached to the starter gear wheel by eight 5/16”-24 NF-3 bolts. These bolts are supplied in three lengths, 1-7/8”, 2” and 2-1/8”, to accommodate the balancing washers. The bolts are installed from the front face of the starter gear wheel, i.e., the side on which the ignition timing marks are stamped. A plain washer is installed under the b9olt head. A special washer 1/16” thick is placed on the bolt next to the rear face of the starter gear wheel. The composition conical bushing and the spacer on which the bushing rides, the starter gear wheel, another conical bushing, a special 1/16” washer and a 5/16”-24 elastic stop nut complete the fan to starter gear wheel assembly.

After the eight mounting holes are equipped with the above attaching arrangement, the assembly is statically balanced. Special 1/8” or .025” thick balancing washers and balancing bolts in the available lengths are installed to bring the assembly to a static balance, and the bolts are then properly torqued. It is very important that the units be installed in the same location from which they were removed if the cooling fan is removed from the starter gear wheel.

STARTER GEAR ASSEMBLY

The heat-treated starter ring gear is installed on the starter gear wheel by heating the ring gear to 600°F. After the ring gear is shrunk on the wheel, it is pinned in position with a 3/16” x 7/32” dowel pin, which is staked over, thus forming a permanent assembly.

STARTER GEAR HUB:

The alloy steel starter gear hub has an inside diameter of 2.500” to 2.5005” and is a shrink fit on the 2.500” to 2.501” outside diameter of the rear hub of the crankshaft. It is heated to 200°F. and is installed with two ¼” x 7/8” Woodruff keys. The hub is bolted to the rear end of the crankshaft with six special 3/8”-24 NF-3 x ¾” drilled head capscrews using plain 5/16” washers. The eight mounting holes are not equally spaced, therefore, the assembly can only be mounted in one position.

When the cooling fan is being installed on the hub it is important to see that all burrs are removed from the inside diameter of the generator drive sheave and that the mating faces of the starter gear wheel, sheave, and fan hub are free from dirt and grit. The starter gear wheel should be tapped with a soft nose hammer as it is assembled on the pilot diameter on the hub to insure that the wheel and the sheave fit snugly against the face of the hub. It is essential that the eight capscrews are evenly tightened to the proper torque, so that the fan assembly and pulley are clamped firmly against the hub. Before securing the screws it is advisable to run the engine for about five minutes and recheck the capscrew torque. If the torque values are not changed, the screws should be safetied. If the screw torque has dropped at all, it should be brought up to the proper value and the check repeated.

GENERATOR BELT REPLACEMENT:

When replacing the generator belt, it is important to note that only the eight capscrews securing the starter gear wheel to the starter gear hub need be removed. The starter gear wheel with the cooling fan assembly attached can then be removed from the engine and the replacement generator belt installed on the generator belt sheave. Adjust the generator belt tension with the generator adjusting link after the starter gear wheel is reinstalled on the engine. The generator belt should be adjusted to have a ½" to 5/8" dip under a steady thumb pressure exerted on the belt midway between the sheave and generator pulley.

XX – LUBRICATION SYSTEM – DETAILS OF UNITS

OIL PUMP:

The oil pump is a gear type, positive displacement pump and it is driven by a gear on the camshaft. The pump body, to which is attached the oil inlet pipe and the oil inlet screen unit, is mounted on pads below the lifter guides at the right rear of the inside of the crankcase. The pump is secured to the pads by 5/16"-18 capscrews and is located by a dowel and the pump inlet nipple.

The oil pump gears are both seven tooth spur gears and mate with a .004" to .008" backlash. These gears are 1-1/4" long on the early engines and 1-3/4" long on the later engines. The 1-3/4" driven gear in the pump is made of two identical gears, each 7/8" long placed on the same stationary shaft. If the pump having the short gears is replaced by the pump having the long gears, the entire pump assembly, the oil inlet pipe and the oil pump relief valve parts must also be replaced. Refer to the Parts Book in order to obtain the correct replacement parts since these parts for the early and late type engines are not interchangeable.

The oil pump shaft gear is a 16 tooth, helical gear that meshes with the oil pump drive gear on the camshaft. The permissible backlash between the two gears is .004" to .012".

On early engines, the oil pump cover assembly includes the pump cover, the oil inlet pipe and the oil screen stop. (See Fig. 13). The later pump cover is cast, and the inlet pipe is fastened to it by two ¼"-20 capscrews. In both cases, the oil inlet pipe is supported by a bracket at the screen end.

The oil screen unit is held in position on the oil inlet pipe by a cotter pin and special wire clip. When assembled, the oil screen unit should be free to move within the limits of the stop on the inlet pipe. The position of the unit when resting on the lower stop should be ½" to ¾" from the bottom of the oil pan. This clearance can be estimated by inspection through the oil drain hole in the bottom of the pan.

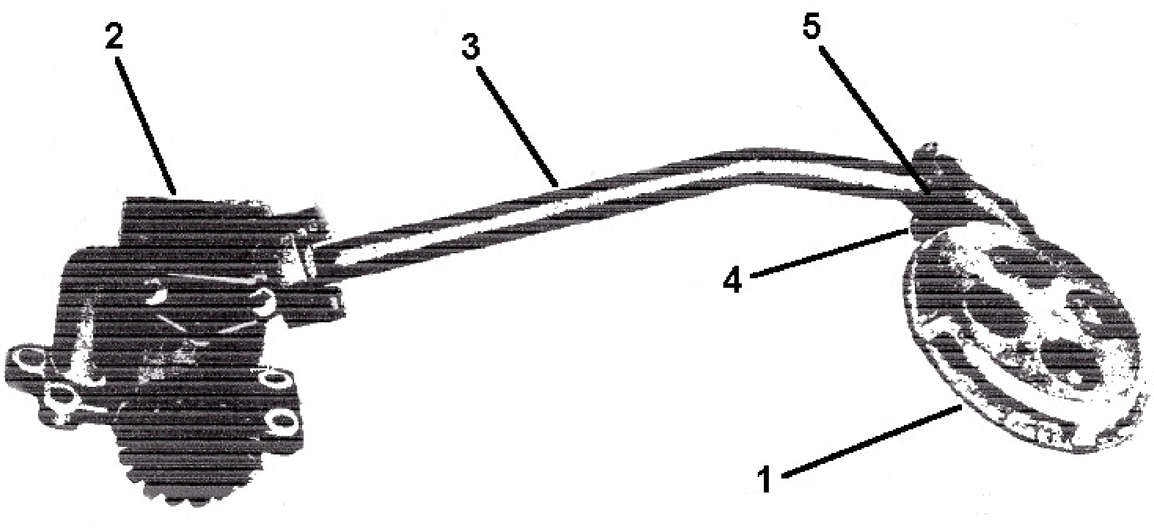

Figure 13. Oil Pump and Inlet Assembly

1. Oil Inlet Screen
2. Oil Pump
3. Oil Inlet Pipe
4. Oil Inlet Screen Clip
5. Oil Inlet Screen Stops

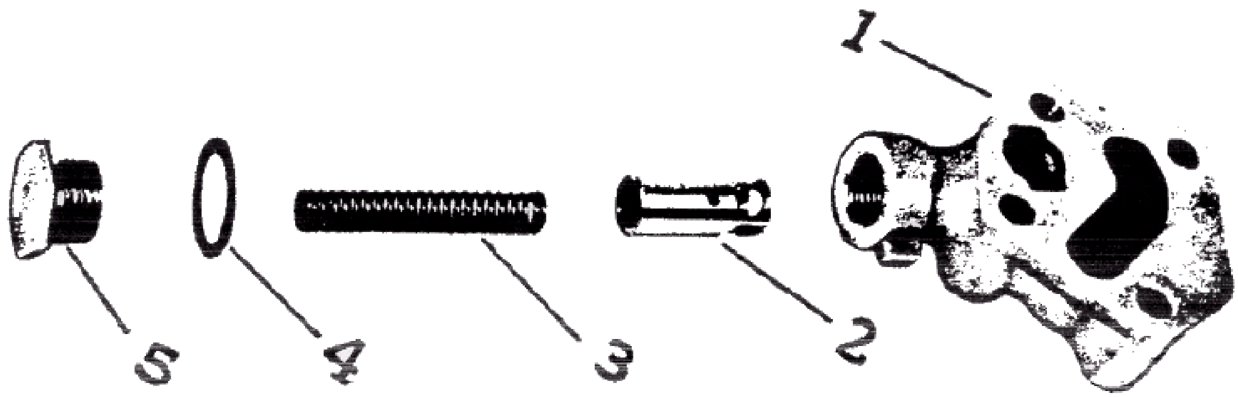

Figure 14. Oil Pump Pressure Relief Valve

1. Relief Valve Housing
2. Relief Valve Plunger
3. Relief Valve Spring
4. Copper Gasket
5. Relief Valve Spring Nut

OIL PUMP PRESSURE RELIEF VALVE:

The oil pressure relief valve housing, containing the relief valve plunger and spring, is mounted on the outside of the crankcase, at the right rear of the engine. (See Fig. 14) The operation of the oil pressure relief valve is to bypass oil directly into the crankcase whenever the pressure in the oil system exceeds the specified limits. When the oil pressure has stabilized, the spring tension will return the valve to the closed position and maintain the original pressure within specified limits.

Inspection of the oil pressure relief valve plunger and spring can be made by removing the hex nut on the relief valve housing. Inspect the plunger and bore for smoothness. The approximate free length of the spring is 2-11/32", and the force exerted when it is compressed to 1-21/32" should be 10 to 11 pounds. On the later engines, the pressure relief valve parts are larger to accommodate the larger oil pump employed. The approximate free length of the spring is 4" and the force exerted when it is compressed to 3-5/32" should be 13 to 14 pounds. After inspection, clean and reassemble the parts, using a new copper gasket under the nut.

OIL COOLER RELIEF VALVE:

A passage drilled across the two crankcase sections between the rear and center cylinder pads connects the right and left main oil passages. In the left crankcase section a ball type oil cooler relief valve is installed. This valve is designed to open under a pressure differential of 15 to 18 pounds per square inch. Its purpose is to by-pass the oil through the passage drilled across the crankcase should the oil flow through the cooler be retarded. In this manner, the engine would continue to receive lubrication independent of the cooler's operation in the event a cooler obstruction occurs. (See Figure 15)

The cooler relief valve incorporates a 9/16" steel ball. Held against a seat in the crankcase transverse oil passage by a spring, which has a free length of approximately 3-11/32 in. When compressed to 3-3/16 in., the spring should exert a force of 2 to 2.25 lbs. The ball and spring are held in position with an adapter threaded into the crankcase. A washer under the adapter seals it at the crankcase. The adapter has as outside thread of ¾"-16 NF-3 and an inside thread of 5/8"-18 NF-3 to take the oil temperature bulb fitting. Later engines have a plug in this position instead of the adapter, as the oil temperature bulb is fitted into the oil cooler outlet.

When the valve is removed for inspection, in the event the crankcase is tilted from the horizontal position, it will be advisable to see that the steel ball does not enter the left main oil passage, otherwise it will be necessary to remove the propeller shaft housing or timing gear case from the engine and remove one of the two plugs at the front or rear of the left main oil passage to dislodge the ball.

OIL PAN:

The stamped oil pan is attached to the bottom of the crankcase and serves as the reservoir for the engine lubrication oil. A baffle is located on the rear inside wall of the oil pan to prevent the camshaft gear from churning the oil in the pan and thus cause oil foaming.

The ¾”-14 square head oil drain plug has a standard pipe thread and is safetied to a tab by steel lacing wire.

A composition gasket is installed between the oil pan and bottom crankcase surface. A solid aluminum flange plate under the flange of the oil pan assures good support and a tight oil seal at this parting line. The oil pan is attached to the crankcase by 26 5/16”-18 hex head capscrews. Seven 5/16”-24 bolts are used at the rear of the engine to attach the oil pan to the timing gear case. The bolts are installed with the bolt heads against the timing gear case flange. To insure a proper fit and prevent oil leaks, the timing gear case gasket is trimmed flush with the crankcase bottom surface and the trim point joints coated with sealing compound.

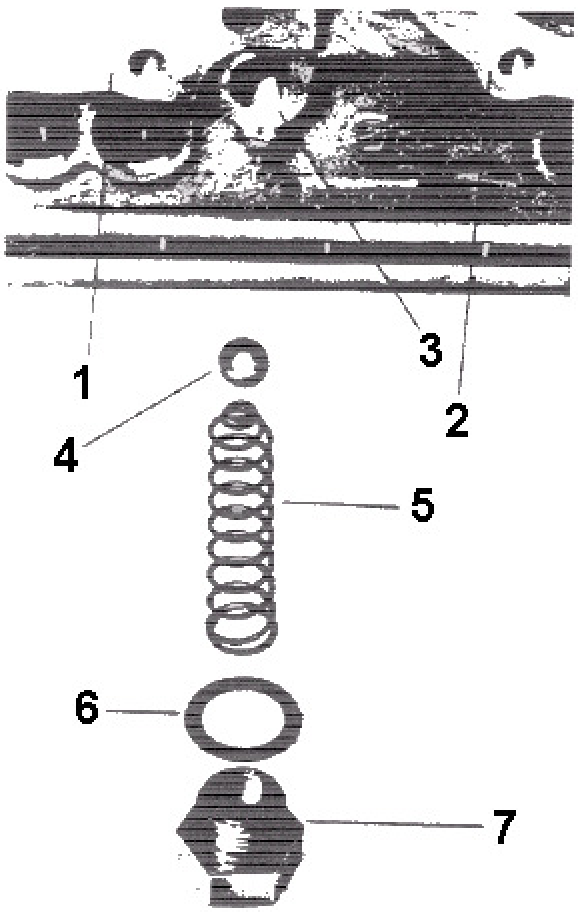

Figure 15. Oil Cooler Relief Valve

1. No. 3 Cylinder Pad
2. No. 1 Cylinder Pad
3. Oil Cooler Relief Valve Hole
4. Oil Cooler Valve Ball
5. Oil Cooler Valve Spring
6. Washer
7. Oil Temperature Bulb Adapter

XXI – INLET MANIFOLD SYSTEM

The manifold on the 6A8-215-B8F and B9F engines is composed of seven major units: a cast distributing zone, on which the carburetor is mounted, two aluminum alloy distributing zone pipes 2-1/4 in. outside diameter joining the distributing zone to the manifold inlets, two cast inlet manifolds, one to the even side and one to the odd side cylinder inlet ports, two aluminum manifold equalizer pipes, 1-5/8 in. outside diameter, joining the inlet manifolds, one for the odd cylinder side and one for the even cylinder side.

The distributing zone supports the carburetor and is fastened to a pad on the under side of the propeller shaft housing by four 5/16”-18 capscrews.

The distributing zone pipes connect the distributing zone with the manifold runners. The flanged ends of the pipes fit into the recesses in the zone. The pipes are sealed with rubber packings where they join the zone and the manifold runner. The packings are held in place by flanges which are secured by ¼” studs and Elastic stop nuts or by ¼”-20 capscrews.

The two equalizer pipes connect the ends of the manifold runners and complete the inlet manifold system. An adapter on the runner end of each pipe permits the use of the same rubber packing and flange that is used on the distributing zone pipes. The equalizer pipes are joined at the center line of the engine beneath the cooling fan by a short length of hose which is secured with hose clamps.

The importance of properly installing the packings, gaskets, and connections on the inlet manifold system cannot be too highly stressed. The system must be sealed against the entrance of unmetered air, as the carburetor will only supply fuel in proportion to the air flow that passes through its venturi system, hence, the entrance of outside air at atmospheric pressure into the lower pressure of the induction system will cause the engine to overheat due to a lean fuel-air mixture.

CAUTION: It is important that the manifolds be properly aligned with the mounting pads on the cylinders. If proper alignment is not obtained, manifold leaks will occur or a manifold casting may be cracked when the mount screws are tightened. To obtain proper alignment, the cylinder hold-down nuts should not be completely tightened when the cylinder is first assembled on the engine. The manifold runners should be temporarily assembled on the cylinders without any gaskets and the mount screws tightened. The cylinder hold-down nuts should then be tightened to the proper torque. The manifold runners should then be removed for later assembly with gaskets.

XXII – IGNITION AND TACHOMETER DRIVES
IGNITION DRIVE ON MODEL 6A8-215-B8F ENGINES:

The two Eisemann impulse type magnetos that furnish the ignition on the B8F model are driven by a gear and cross shaft that are supported by bosses and plain bearings in the propeller shaft housing (See Fig. 16). The cross shaft is driven by the 36 tooth, helical gear on the camshaft assembly that meshes with the 12 tooth gear, which is integral with the ignition drive cross shaft. The permissible backlash between these two gears is .004" to .008".

The ignition drive parts are assembled as follows: The 5/8" outside diameter ignition shaft bushing is pressed into the .6245" to .6255" diameter hole in the left hand ignition drive boss in the propeller shaft housing. The oil hole in the bushing must index with the oil passage in the boss. The .9370" to .9365" outside diameter bushing is assembled in the .9370" to .9375" hole in the right hand boss and secured with a ¼"-20 x 5/8" set screw. The bushing oil hole must index with the oil passage in the boss. Both bushings are then reamed through to an inside diameter of .5015" to .5020". The large right hand bushing is then removed to permit assembly of the gear and shaft. Before the shaft is assembled, the .4995" to .5000" inside diameter shouldered thrust washer is pressed on the shaft until it is tight against the gear with the shoulder end away from the gear. The large right side bushing is slipped on the shaft and the entire assembly installed in the propeller shaft housing. A .010" feeler gauge is placed between the gear and the end of the large diameter bushing. The set screw is tightened and secured with the jam nut before the feeler is removed. It is extremely important that the set screw be tightened only very lightly against the bushing. Overtightening will cause the bushing to bind on the shaft and cause wear or damage tot he drive. The beveled portion of the bushing must be down and the oil holes must index when the bushing is installed.

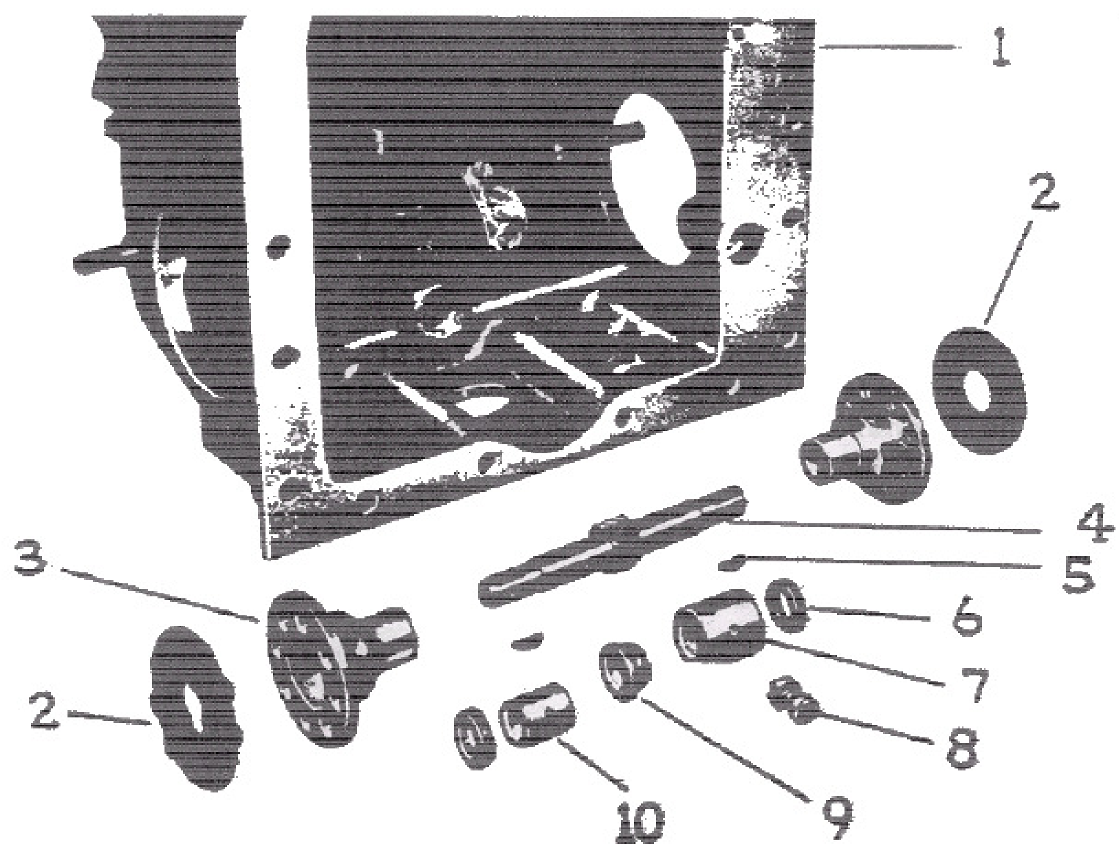

Figure 16. Propeller Shaft Housing and Exploded View of Magneto Drive

1. Propeller Shaft Housing
2. Magneto Drive Shock Absorbers
3. Magneto Drive Couplings
4. Magneto Driven Shaft gear or Cross-Shaft
5. Woodruff Keys
6. Magneto Coupling Spacers
7. Cross-Shaft Bushing (Even Side)
8. Set Screw and Jam Nut
9. Cross-Shaft Thrust Washer
10. Cross-Shaft Bushing (Odd Side)

In order to complete the assembly, the correct thickness spacer must be selected to obtain the proper magneto coupling end play. Seven different spacers are provided that vary in thickness from .115” to .175” in .010” increments with “I” marked on the thinnest and “VII” marked on the thickest. A trial spacer of approximately .145” thickness should be installed on both ends of the cross shaft. The magneto couplings are then temporarily installed on the shaft with the Woodruff keys placed in any of the slots provided. One magneto with the rubber drive shock absorber in place is also temporarily placed on the mount pad studs with no gasket under the flange. Care must be taken to have the rubber shock absorber buttons properly engaged and bottomed in the recesses provided. The cross shaft end play should all be taken up by holding the thrust washer tight against the boss, i.e., push the cross shaft toward the left or odd number cylinder side of the engine and hold. If the space between the faces of the mounting pad and the magneto mounting flange is .007” to .017” when the faces are held parallel, the spacer is satisfactory. If the distance from the pad to the flange is more than .017” a thinner spacer is needed. If the distance is less than .007”, a thicker spacer is required.

The above procedure should be applied to each magneto separately. After the proper spacers are obtained, the magnetos should be installed on the propeller shaft housing with the correct 1/32” thick gasket and the mount nuts tightened to the proper torque. The end clearance between each magneto coupling and its spacer should be .002” to .017” when the cross shaft is pushed over as far as the thrust washer will permit. Approximately .008” is preferred.

When a new magneto is installed on an engine that is already completely assembled or in an airplane it is important that the proper magneto drive coupling end clearance be maintained. This may be accomplished by removing both magnetos from the engine and following the procedure previously described.

It is very difficult to make a final check on the clearance between the end of the drive couplings and spacers after the magnetos are assembled on the engine. This clearance should be satisfactory if the measurements previously described are properly made and a 1/32” gasket is used. As a check, the crankshaft should be rotated in the normal direction and the impulses on both magnetos should “snap”. If an impulse fails to snap, it is an indication that there is insufficient magneto coupling end clearance and the impulse is binding. In this case, the magneto should be removed and the spacer thickness rechecked.

Three keyways are machined in each end of the ignition drive cross shaft to permit the proper timing alignment of the two magnetos. Magneto timing instructions are given in Section XXIII Ignition System – Model 6A8-215-B8F on Page 35.

IGNITION DRIVE ON MODEL 6A8-215-B9F ENGINES:

The split ignition furnished by one Scintilla magneto and one battery ignition distributor is driven by a gear and cross shaft that is supported by a separate ignition drive housing or carrier. (See Fig. 17). The ignition drive may be assembled in the drive housing on the bench and installed as a unit in the propeller shaft housing. The ignition drive housing has an adapter flange on the distributor end that mounts on the right or even cylinder side ignition pad on the propeller shaft housing. Cap screws through the flange secure the assembly.

The ignition drive assembly should be made as follows: The ignition drive housing is placed on a bench with the flanged end up. The steel thrust washer is placed in the spotface provided on the inner face of the lower support boss.

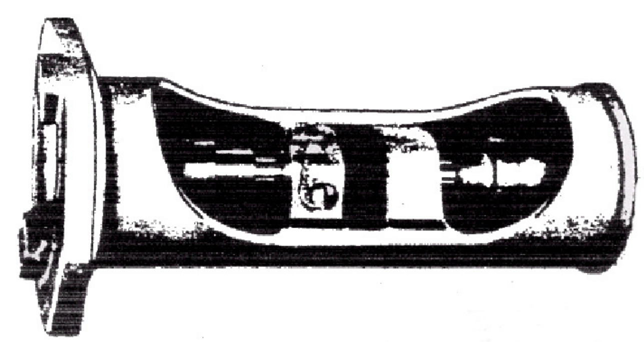

Figure 17. Ignition Drive Assembly for the Model 6A8-215-B9F Engine

The 24 tooth helical gear is placed on the washer. A Woodruff key is placed in the keyway in the center of the shaft. With the small (.4985” to .4975”) end down, the shaft is pressed through the gear and thrust washer until the key hits the washer. Care must be taken to align the key in the shaft with the keyway in the gear as it is pressed through. The bushing is then pressed in until there is .006” to .025” clearance between the end of the bushing and the face of the gear. Care must be taken to align both the oil and set screw holes in the bushing with the holes in the housing. The bushing is held in place by a set screw which is secured by both a jam nut and safety wire. Care must be taken to tighten the set screw only lightly to prevent binding of the bushing on the shaft. Woodruff keys are installed in both ends of the shaft.

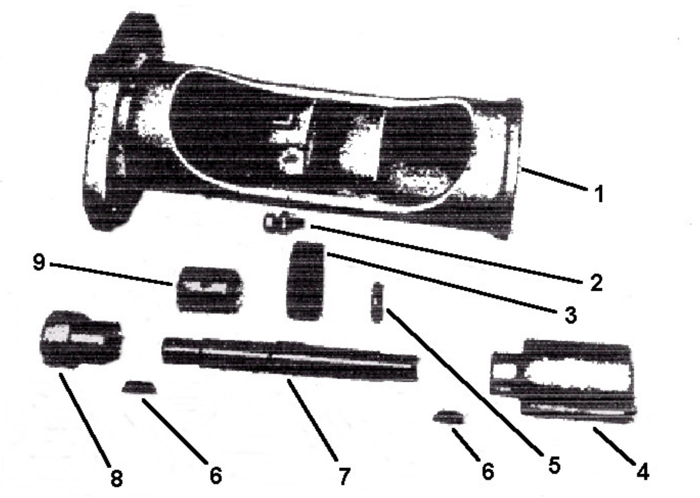

Figure 18. Exploded View of Ignition Drive

1. Ignition Drive Housing
2. Set Screw and Jam Nut
3. Ignition Drive Gear
4. Magneto Drive Coupling
5. Ignition Drive Shaft Thrust Washer
6. Woodruff Keys
7. Ignition Drive Shaft
8. Distributor Drive Coupling
9. Ignition Drive Shaft Bushing

The magneto drive coupling is pressed onto the end of the shaft that bears directly in the housing. The distributor drive coupling is hand assembled on the end of the shaft which is supported by the bushing. The entire assembly may now be installed in the propeller shaft housing. When assembled in the engine, the backlash between the ignition drive gear on the cross shaft is .004” to .008”.

TACHOMETER DRIVE ASSEMBLY:

The tachometer drive assembly consists of a tachometer drive connector, .3742"”to .3745"”outside diameter, which is pressed into the .3732"”to .3737"”reamed sleeve. The sleeve is installed in the tachometer drive housing and a bevel gear pressed on the unslotted end of the connector, with a .004” to .006” clearance between the gear and housing boss. The boss has two oil grooves to supply lubrication. A composition packing ring is installed at the connector end. This packing should not bottom on the sleeve shoulder as it would cause binding of the sleeve. It is important that the tachometer rotate freely and have .015” to .035” backlash when installed on the engine. If adequate backlash is not present, an additional gasket should be put under the tachometer drive assembly flange.

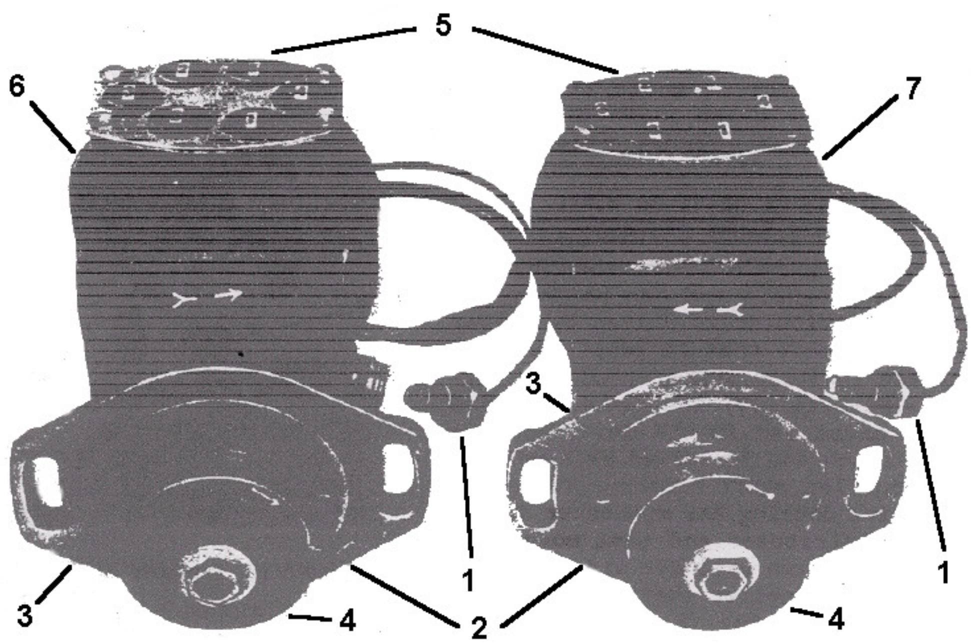

Figure 19. Eisemann Model LA-6 Magnetos

1. Ground Lead Contactor
2. Impulse Coupling Stop Pin
3. Impulse Coupling
4. Magneto Drive Shock Absorber
5. Cylinder Numbers for High Tension Ignition Wires at Cable Plate
6. Right Magneto
7. Left Magneto

XXIII – IGNITION SYSTEM – MODEL 6A8-215-B8F

The ignition on the model 6A8-215-B8F engine is supplied by two model LA-6 Eisemann magnetos (See Fig. 19). The magnetos are mounted on pads, which are located on either side of the propeller shaft housing. The high tension current is carried from the distributor, which is incorporated in the magneto, to the spark plugs by 7 mm high tension cable, containing 19 strands of tinned copper wire. The left magneto fires the intake-side spark plugs and the right magneto fires the exhaust-side spark plugs.

A wiring diagram for the Model B8F engine is shown in Figure 22.

IMPULSE STARTER ON THE LA-6 MAGNETO:

The impulse starter is an automatic device, which operates only during engine starting, and serves a two-fold purpose. It automatically retards the timing of the ignition spark to prevent engine “kicking” during starting, and it intensifies the spark to insure easy starting.

At starting speeds, the impulse starter automatically locks the magnet rotor twice during each revolution. With the rotor blocked, the magneto drive member continues to turn with the engine winding up the impulse starter spring. When the spring is completely wound up, the starter automatically unlocks the rotor and the unwinding of the impulse starter spring rapidly rotates the magnet rotor to its normal position. This rapid rotation of the magnet rotor causes a spark of high intensity to be generated at a time later than normal.

When the engine starts and the magneto comes up to speed, the impulse coupling latches are moved by centrifugal action to their disengaged position. The magneto then continues to operate in the normal manner.

MAGNETOS – INSTALLATION:

SEE SECTION XXII, PAGE 32 FOR DETAILS ON OBTAINING PROPER MAGNETO DRIVE COUPLING END CLEARANCE.

Remove the valve cover from #1 cylinder, left rear of engine, to observe the valve action. Rotate the crankshaft in the normal direction, clockwise, as viewed from the cooling fan end of the engine. Observe the #1 cylinder inlet valve, left hand valve when facing the cylinder head. When the inlet valve has been depressed and returned to its normal position, the #1 cylinder is on the compression stroke. Continue to turn the crankshaft until the 32º magneto timing mark on the front rim of the starter gear wheel at the rear of the engine, is in line with the timing pointer. The engine is in the correct timing position to install the magnetos, i.e. 32º before top dead center of #1 cylinder on its compression stroke. As the right and left magnetos differ from each other in their direction of rotation, it is very important that the correct magneto be installed in the proper position on the engine. When facing the magneto drive shaft on the engine, the drive on the left side of the engine rotates clockwise and on the right side of the engine counter-clockwise. To identify the magnetos, two methods can be used. The arrow on the magneto housing should point toward the rear of the engine, and the impulse coupling stop pin or dowel should be toward the rear of the engine. (See Fig. 19).

Install the composition shock absorbing drive member on the magneto, engaging the eight buttons in the counterbore on the face of the impulse coupling on the magneto. Remove the distributor cover on the magneto to expose the distributor electrode and breaker points. Turn the magneto rotor shaft in the reverse direction of normal rotation, to avoid engaging the impulse unit, until the arrow mark on the distributor rotor gear indexes with the punch mark on the breaker cam gear. (See Fig. 20). This setting applies to the left magneto only. The center line mark on the rotor gear of the right magneto is indexed with the punch mark on the breaker cam gear. (See Fig. 21). The magneto is now in position to fire #1 cylinder. Install a gasket between the magneto and propeller shaft housing and install the magneto on the engine drive, with the mounting studs approximately in the center of the magneto flange slots. Install the special 5/16” plain washers and 5/16”=24 elastic stop nuts, leaving the nuts loose enough so that the magneto may be moved

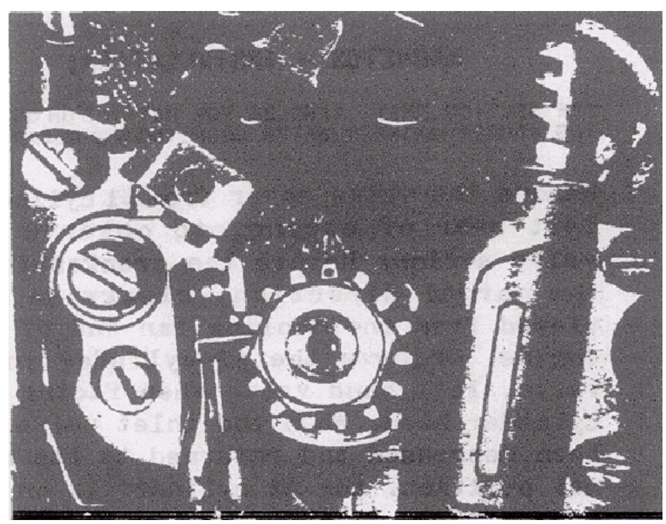

Figure 20. Timing Marks on Left Magneto

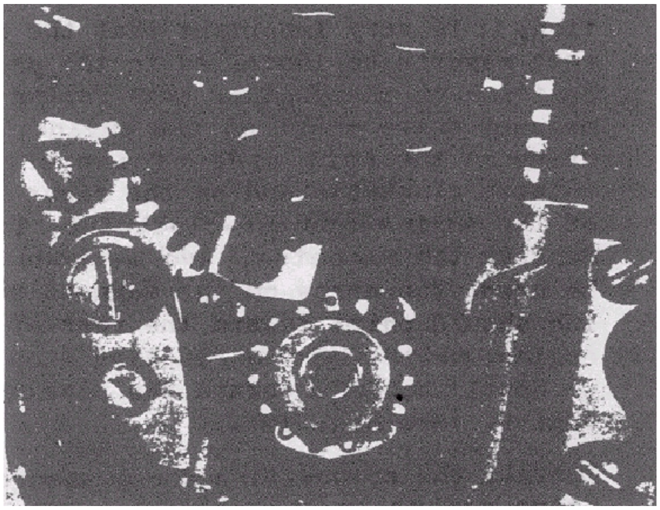

Figure 21. Timing Marks on Right Magneto

in its slots by lightly tapping it. Using a timing light, .0015 in. feeler stock or thin cellophane, tap the magneto until the points are just separating. With the magneto housing in this position, tighten the stud nuts. This procedure applies to the installation of either the left or right magneto.

MAGNETO – MINOR INSPECTION (ON ENGINE):

Remove the two screws which hold the cable plate to the end plate. Also remove the end plate. The entire distributor section of the magneto may then be removed to allow inspection of the magneto operating components. Care should be taken in removing the distributor section to pull it straight back from the main housing until dowels, distributor rotor and coil contactor are in the clear before attempting to swing it to the side.

Wipe out any accumulation of foreign material inside the distributor plate with a cloth moistened in carbon tetrachloride. Be sure that the carbon brush and the coil connector are free. Inspect visually the coil, distributor rotor and gear, coil and breaker leads, and breaker assembly. If the interior of the magneto appears excessively oily, the magneto should be removed from the engine for thorough cleaning and possible replacement of the oil seal. The distributor rotor and gear should be free, but without excessive backlash or endplay.

The breaker contact points should be clean and free from oil. If the contacts appear in good condition, it should not be necessary to check breaker timing. When, however, the contacts show signs of wear, the breaker timing should be readjusted.

To adjust the breaker contacts, turn the engine crankshaft until the cam follower bears on the top of #1 cylinder cam lobe, thus giving maximum contact point separation. Loosen slightly the two screws which secure the breaker assembly in the end plate, and by means of the breaker adjusting eccentric, set the contact for a separation of from .019” to .021”. Retighten the breaker securing screws and recheck contact separation. Cars should be exercised that setting gauge is free from dirt and oil.

Always check the magneto to engine timing whenever adjustment or replacement of the breaker point is made.

Reassemble the distributor section end plate, making sure that the carbon brush is properly located and not broken, and that the dowels enter squarely.

MAGNETO TIMING CHECK:

To check the timing of the magnetos when they are installed on the engine, proceed as follows. Turn the crankshaft in the normal direction of rotation, clockwise as viewed from the fan end of the engine. Observe that action of the inlet valve on #1 cylinder. When the inlet valve has been depressed by the lifter rod and returned to the closed position by the valve spring, the #1 cylinder is on the compression stroke. Continue to turn the crankshaft until the impulse coupling is released. This will occur at approximately top dead center of #1 cylinder and can be identified by an audible click at the magneto. Turn the crankshaft in the reverse direction of normal rotation until the 32º mark on the starter gear has passed the timing pointer by a few degrees or far enough to compensate for backlash in the gears. Do not turn the crankshaft more than this amount as the impulse coupling will become reengaged, giving an incorrect breaker point position.

Remove the magneto distributor cover to observe the action of the breaker points. Using timing light, .0015 in. feeler stock or cellophane to determine breaker point opening, turn the crankshaft in the normal direction of rotation, until the 32º mark is reached. The breaker points on both magnetos should be just opening at this position of the crankshaft. If adjustment is necessary to obtain the correct setting, it must be made by moving the magneto in its flange slots. Do not adjust the timing of the magneto points in relation to the crankshaft position by moving the points through the eccentric adjusting screw. It is always good practice to check the breaker points maximum opening as outlined in section Minor Inspection (Page 36) before checking the magneto timing.

SPARKPLUGS:

The approved sparkplug for both model 6A8-215-B8F and B9F engines is the Auto-Lite A-4. The spark gap should be maintained at .014” to .018”.

SUMMARY – IGNITION SYSTEM FOR MODEL 6A8-215-B8F:

Ignition is supplied by two magnetos

Magneto make and model	Eisemann LA-6

Left Magneto fires intake-side spark plugs

Right magneto fires exhaust-side spark plugs

Ignition lead wiring diagram	Figure 22
Cylinder firing order	1, 4, 5, 2, 3, 6
Magneto timing	32º BTC
Magneto breaker point gap	.019” to .021”
Approved spark plug	Auto-Lite A-4
Spark plug gap setting	.014” to .018”
Maximum RPM drop on single magneto operation	100 RPM

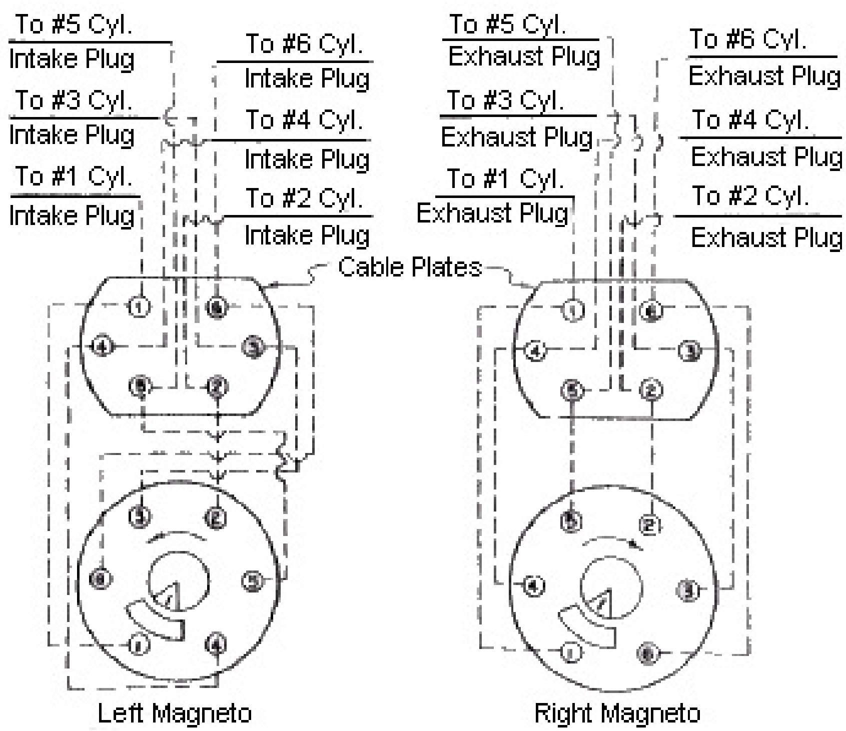

Figure 22 Wiring Diagram for the Model 6A8-215-B8F Engine Cylinder Firing Order 1, 4, 5, 2, 3, 6

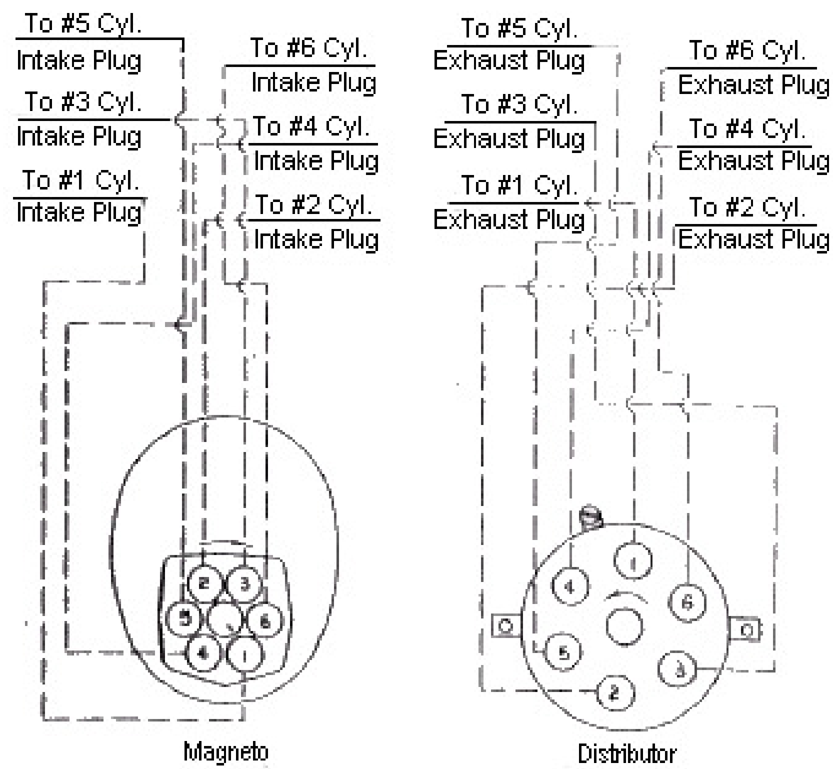

Figure 23 Wiring Diagram for the Model 6A8-215-B9F Engine Cylinder Firing Order 1, 4, 5, 2, 3, 6

XXIV – IGNITION SYSTEM – MODEL 6A8-215-B9F:

The ignition on the Model 6A8-215-B9F engine is supplied by one Model S6LN-31 Scintilla magneto and one Model 1AM-4001 Electric Auto-Lite distributor and 12 volt coil. The distributor is mounted on the adapter on the right side of the propeller shaft housing, and the ignition coil is mounted on two bosses provided on the housing just above the distributor. The magneto is mounted on the pad on the left side of the propeller shaft housing. The distributor furnishes ignition for the exhaust-side spark plugs and the magneto furnishes ignition for the intake-side spark plug.

NOTE: The Eisemann (used on B8F engine) and Scintilla (used on B9F engine) magnetos are not interchangeable. The Eisemann magneto is constructed and installed so that it turns 1½ times engine speed while the Scintilla magneto turns ½ times engine speed.

A wiring diagram for the Model B9f engine is shown in Fig. 23.

DISTRIBUTOR AND MAGNETO INSTALLATION:

The distributor and magneto must be installed with the proper sequence of operations if correct ignition timing is to be obtained with a minimum of effort. The distributor should be installed first, in a new installation or if the timing of the ignition drive assembly has been disturbed. The crankshaft is turned in the normal direction of rotation until the intake valve on #1 cylinder has opened and closed, indicating that the #1 piston is on the compression stroke. The shaft is rotated further until the 2º timing marks on the rim of the starter gear wheel is lined up with the pointer. The engine is then in the correct position to install the distributor. If it is already installed, the entire ignition drive assembly is removed from the propeller shaft housing. With a gasket in place, the distributor is installed on the flanged end of the ignition drive housing with the distributor cap clips pointing toward the flange mount capscrews holes. The terminal for the low tension coil wire should be toward the upper or closed side of the housing. The distributor housing clamps are installed and secured lightly with cap screws. The distributor cap is removed by loosening the screws holding the spring clips. Snapping the clips off of the cap without loosening the screws may break the cap. With the distributor cap removed, assume the distributor to be a clock face and position the distributor finger so that it points toward two o'clock. With a gasket in place the entire ignition drive assembly is now installed in the propeller shaft housing being assembled into the mounting hole on the right or even cylinder side. As the ignition drive gears mesh, the distributor finger will move counter clockwise slightly and point toward the one o'clock position. The ignition drive housing is secured to the mounting pad with cap screws.

The distributor housing clamp screws are loosened just enough so that the housing is free to turn. Move the distributor housing counter-clockwise, if necessary, to place the follower on the flat of the cam. Do not move the rotor as it should remain in the full retard position. Rotate the distributor housing slowly in the clockwise direction until the breaker points just open as indicated by a timing light, .0015" feeler gauge, or piece of cellophane. Tighten the distributor clamp screws, but do not safety as it may be necessary to readjust the distributor timing after the magneto is installed.

The crankshaft should be turned from the 2° position in the reverse rotation direction until the 32° timing mark has been passed by a sufficient distance to allow for the removal of all the backlash in the drive gears. The shaft is then turned in the normal direction of rotation until the 32° timing mark on the starter gear wheel is in line with the pointer. The crankshaft is now in the correct position for the installation of the magneto.

Remove the magneto cover by removing the three cap screws. Turn the magneto rotor in the direction indicated by the black arrow on the hard rubber cam which is nearest the tip of the distributor finger. This direction should be counter-clockwise when viewed from the drive end. The rotor should be turned to the position where the mark through the arrow on the cam and the mark on one of the magnet pole pieces line up with a mark on the magneto housing which is marked with an "L" (See Fig. 24). The magneto is now in position to fire #1 cylinder and should be installed in this position. The splined magneto drive is installed in the drive coupling so that the mounting studs are near the center of the slots in the mounting flange. The mount nuts should be tightened lightly so that the magneto may be shifted within the limits of the slots. The magneto should be rotated until the points are closed and then rotated slowly in the opposite direction until the points just open, as indicated by a timing light, .0015" feeler, or piece of cellophane. The mount nuts should then be tightened securely.

NOTE: With reference to Fig. 24 the magneto direction of rotation is considered from the attaching end.

The timing on both the magneto and distributor should now be checked. The crankshaft should be rotated backwards well past top dead center. When the shaft is rotated in the normal direction, the distributor points should open as the 2° mark passes the pointer, and the magneto points should open as the 32° mark passes the pointer. In making the final adjustments,

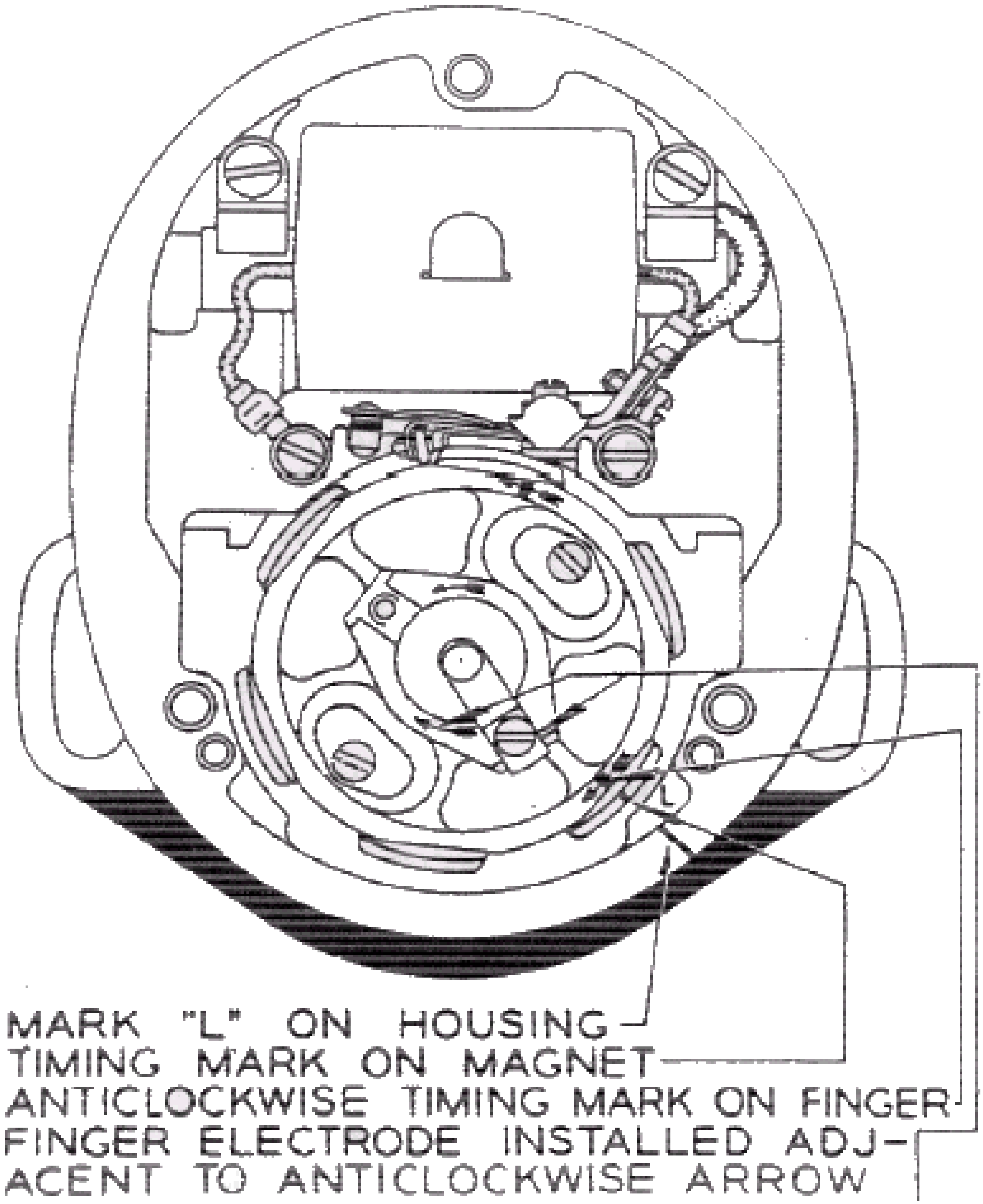

Figure 24. Timing Marks on the Scintilla S6LN-31 Magneto

the magneto should be timed perfectly before the distributor is adjusted. After the correct timing is obtained, the distributor cap and magneto cover should be replaced and the distributor cap screws safetied.

S6RN-31 MAGNETO BREAKER ADJUSTMENT:

The maximum opening of the breaker point gap on the Scintilla magneto is determined by the original design and construction of the magneto.

To check the breaker assembly for proper adjustment, connect one lead of a timing light to the live terminal of the breaker and the other lead to the magneto housing. Turn the magneto until the timing mark on the magnet pole piece lines up with the timing mark on the magneto housing marked with an "L" (See Fig. 24). In this position, the breaker points should be just on the instant of opening as indicated by the timing light going out. If the timing light does not go out when the marks are lined up, adjustment may be made by loosening the breaker terminal screw which is nearest the points. The elongated hole in the breaker support will permit movement of the lower breaker point until the light just goes out when the marks are lined up.

PERIODIC LUBRICATION OF IGNITION UNITS:

A check should be made on the magneto every 100 hours to see if the felt lubricator around the breaker cam follower is dry. If it is dry, the felt should be lubricated with a few drops of SAE 40 oil. The felt should show oil when squeezed, but oil should not drip off the pad.

The distributor lubrication should also be checked every 100 hours. The felt wick under the distributor rotor should be saturated with SAE 30 oil. The oil cup for the distributor shaft lubrication should be filled when the distributor is installed and refilled at the 100-hour checks with SAE 30 oil.

SUMMARY – IGNITION SYSTEM
FOR MODEL 6A8-215-B9F:

Ignition is supplied by one magneto and one distributor.

Magneto make and model	Scintilla S6LN-31
Distributor make and model	Auto-Lite 1AM-4001

Magneto fires intake side spark plugs

Distributor fires exhaust side spark plugs

Ignition lead wiring diagram	Figure 23
Cylinder firing order	1, 4, 5, 2, 3, 6
Magneto timing	32° before top center
Distributor timing (Static only)	2° before top center

Magneto breaker points are adjusted to timing marks only.

Distributor breaker gap	.020"
Approved spark plug	Auto-Lite A-4
Spark plug gap setting	.014" to .018"
Maximum drop on magneto	100 RPM
Maximum drop on distributor	100 RPM

To remove the distributor cap, remove the cap clip screws, do not snap clips off. Make final ignition timing adjustments by timing magneto first, then distributor. Lubricate magneto and distributor as instructed every 100 hours.

XXV – FUEL PUMPS

Fuel is supplied to the carburetor by two AC diaphragm type fuel pumps. The pumps are mounted on pads on the under side of the propeller shaft housing just below the ignition units. They are actuated by a fuel pump cam on the end of the engine camshaft that works against follower arms on each pump.

The pumps for the left and right hand sides are not interchangeable, without modification, due to the location of the fuel inlets and outlets. Each pump should be installed so that the outlet port is nearest the carburetor and the inlet port nearest the fan end of the engine.

Care must be taken when installing the pump to make sure that the gasket is flat against the mount pad. The two 3/8"-16 cap screws must be properly torqued and secured with lock washers. These capscrews should be checked for tightness at the 25 hour engine checks.

XXVI – CARBURETION

The Model MA4-5 Marvel-Schebler carburetor number 10-3007 used on the 6A8-215-B8F and B9F engines is of the float type and incorporates an accelerating pump and a mixture control unit. (See Fig. 25). The carburetor is made up of two major units – a cast aluminum throttle body and bowl cover, and a cast aluminum fuel bowl and air entrance.

The carburetor is attached to the distributing zone on the inlet manifold system of the engine by four studs with plain washers and four 5/16”-24 elastic stop nuts.

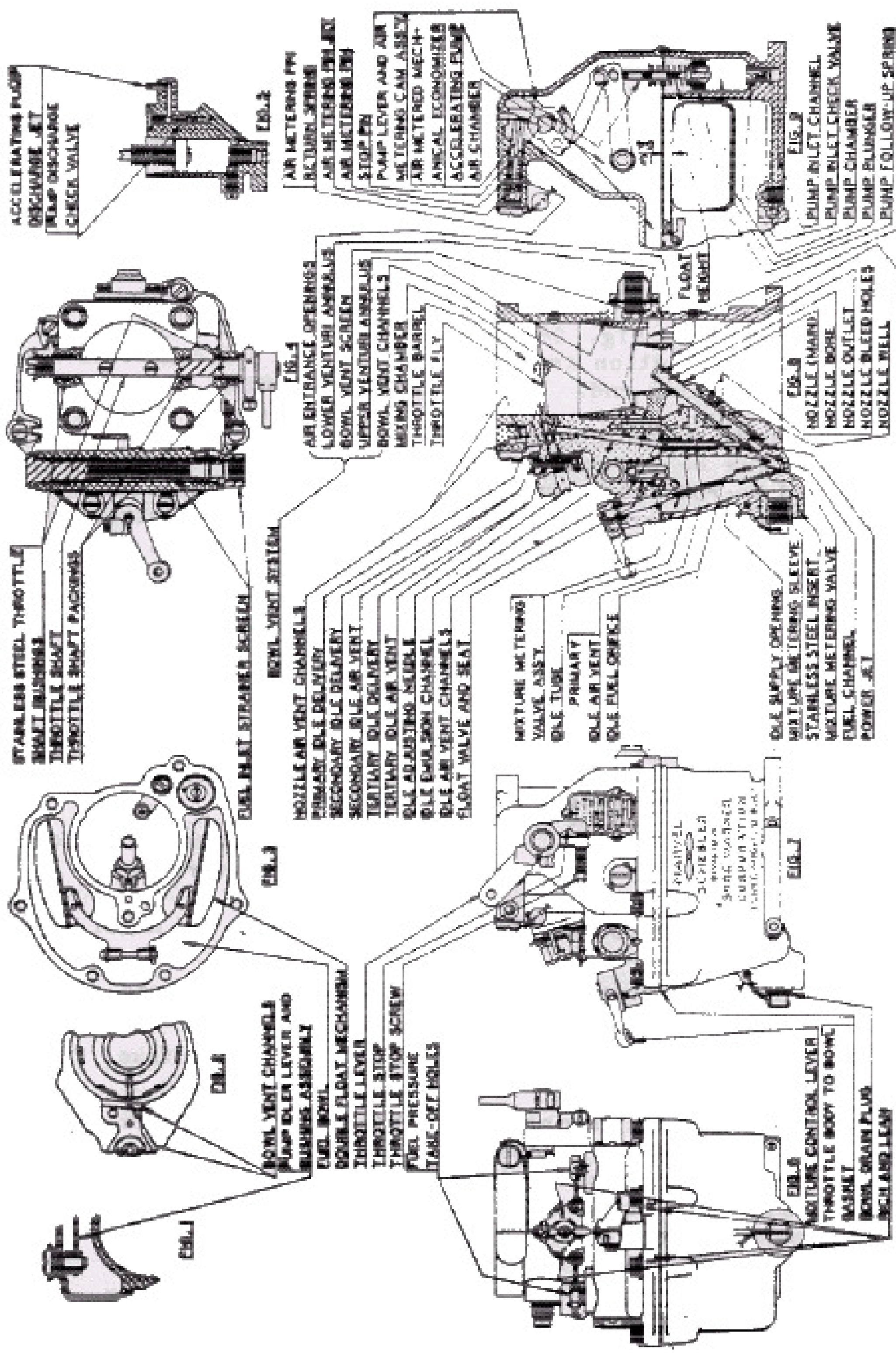

Figure 25. Schematic Drawing of the NW-5 Carburetor

IDLE ADJUSTMENTS:

The only adjustment that is ordinarily made on the carburetor while it is on the engine is to obtain proper idle conditions. The engine should be thoroughly warmed up before making the idle adjustment. The idle speed or throttle stop screw should be set so that the engine idles at approximately 550 RPM. Turn the idle mixture adjusting arrow towards the rich position (indicated by letter R) until the engine “rolls” from richness, then turn the arrow slowly towards the lean position (indicated by letter L) until the engine “lags”, or runs “irregularly” from leaness. 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, move the arrow 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. It should be noted that on leaving the factory, the arrow has been set at approximately midway between the “rich” and the “lean” setting and the carburetor should function with the arrow in this position. It may be necessary, however, to vary this position slightly in either direction dependent upon the individual engine requirements.

FLOAT HIEGHT:

The float height is set at the factory and can be checked by removing the throttle body and bowl cover and float assembly and turning upside down. The proper setting of the two floats should measure 13/64” from the bowl cover gasket to the closest surface of each float. Be sure to check both floats to proper dimension making sure that the floats are parallel to the bowl cover gasket.

ASSEMBLY PRECAUTIONS:

When the carburetor is disassembled for cleaning, extreme care should be taken not to enlarge or damage any of the jet holes. Damage or enlargement of the jets will change the metering characteristics of the carburetor and affect engine operation. A new gasket should be used between the two sections of the carburetor when it is reassembled.

CAUTION: Care must be taken when reassembling the mixture metering valve assembly to see that the metering valve pilots properly into the valve body. The metering valve is actuated by a flexible shaft and it is possible for the valve to be assembled without sliding properly into the valve body. If this occurs, the carburetor will meter extremely rich.

USE OF MIXTURE CONTROL IN FLIGHT:

The primary use of the mixture control is to allow the pilot to compensate for the increase in richness of the fuel air mixture caused by an increase in altitude. In order to obtain the best power setting for any given altitude, establish the desired cruise power setting in level flight. Move the mixture control slowly out and in until the maximum RPM is obtained. The engine will then be operating at the best power mixture for that altitude and throttle setting.

The mixture control may also be employed to obtain lower fuel consumption if it is properly and carefully used. At altitudes of 1000 feet or above, the mixture may be leaned until a slight drop in engine speed is noted. This drop should not exceed 25 RPM. If the engine runs rough, or if the oil temperature increases appreciably, the mixture has been made too lean for safe engine operation. Refer to the fuel consumption chart (Fig. 26) for safe power settings and corresponding fuel consumption. CAUTION: The mixture control should always be in the full rich position at altitudes of less than 1000 feet so that if full power is needed in an emergency near the ground, the engine will operate properly and will not overheat.

USE OF THE FUEL CONSUMPTION CHART:

Reference to the fuel consumption chart (Fig. 26) indicates the fuel consumption rates that may be expected at various altitudes and power settings. The upper cross-hatched portion of the chart labeled SAFE – ALL OPERATION represents the use of a full-rich mixture. The center portion of the chart labeled SAFE – CRUISE ONLY represents operation with the mixture leaned out manually. Fuel flows shown for this area should be obtained only within the range of cruise power settings indicated. The double cross-hatched portion at the bottom of the chart labeled DANGER indicates fuel flows at which it is dangerous to operate with any power setting.

The following example illustrates the use of the chart. Assume that it is desired to cruise at a manifold pressure of 25” Hg., an engine speed of 2200 RPM, and at an altitude of 2000 feet. The horizontal scale across the bottom of the chart shows four combinations of manifold pressure and RPM that will give a normal recommended cruise condition which is approximately 75% of rated power. The power setting of 25” and 2200 RPM is found as one of the 75% power combinations on the bottom scale. From this point, follow the vertical line up until the 2000 foot mark is reached. The horizontal line through this point indicates the fuel consumption rate on the scale to the left. In this case it is 19 gallons per hour for full rich operation.
As this fuel flow is higher than is necessary for safe cruise operation, the mixture control may be moved

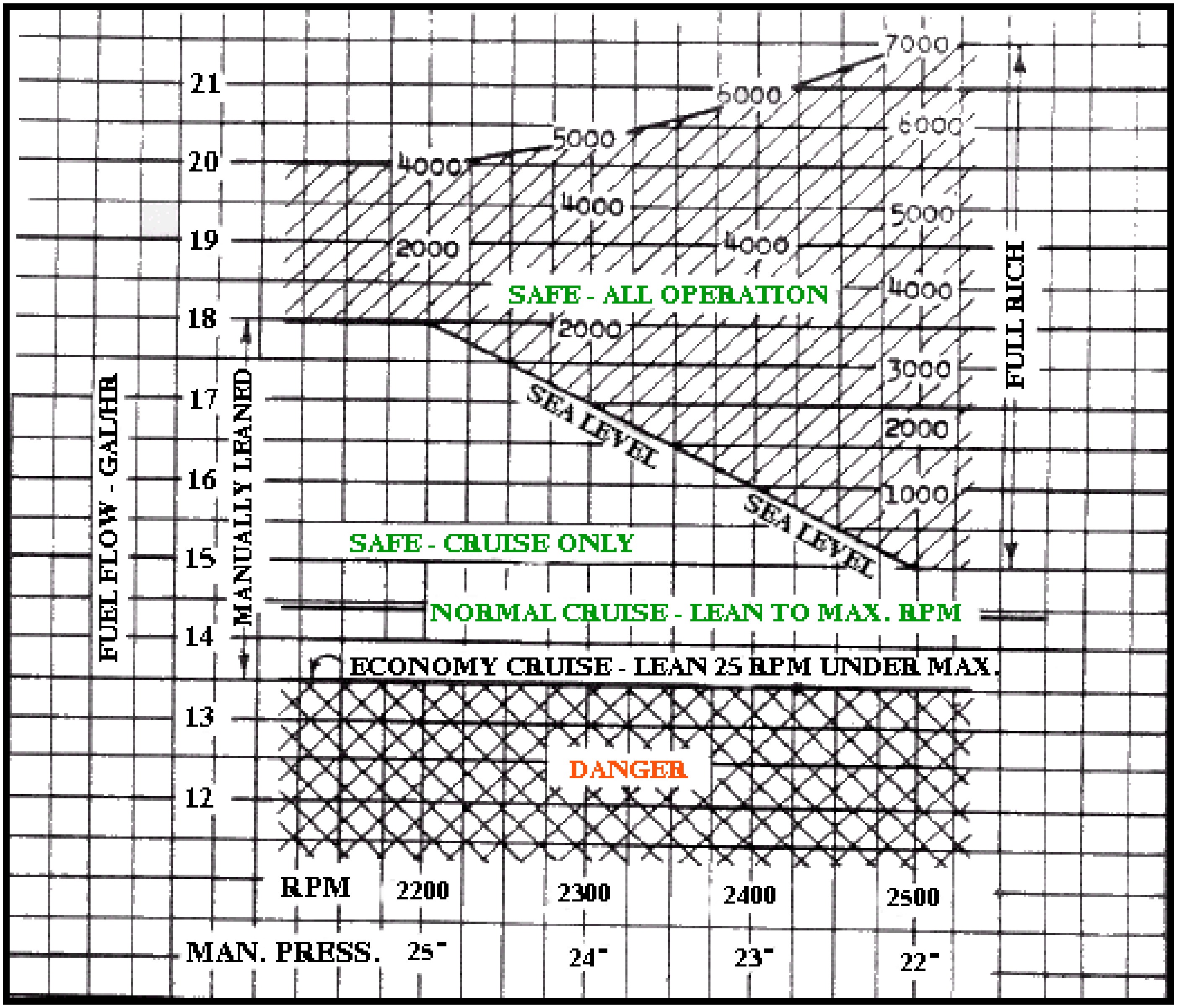

FIGURE 26. Fuel Consumption Chart for the Model 6A8-215-B8F and B9F Engines at a 75% Power Cruise

out and in slowly until the maximum RPM is obtained. The throttle position remains fixed during this adjustment, but the slightly increased engine speed may be reduced to the original setting of 2200 RPM by use of the propeller control. The fuel-air mixture thus obtained will give the best engine power at the given altitude and throttle setting. This point is indicated by the horizontal line on the chart labeled NORMAL CRUISE and will give a fuel consumption of approximately 14.5 gallons per hour, as indicated on the scale to the left.

If maximum economy is desired, the mixture may be carefully leaned out further until the engine speed drops a maximum of 25 RPM from the best power speed. The fuel flow obtained at this setting is shown to be 13.5 gallons per hour.

It will be noted that the power settings which employ the highest manifold pressure and lowest RPM produce the highest full-rich fuel consumptions. However, the normal cruise fuel flow of 14.5 or the maximum economy fuel flow of 13.5 gallons per hour may be obtained with any power setting shown on the chart if the manual mixture control is employed as instructed.

COLD STARTING:

To start a cold engine, prime by pumping the throttle in and out two or three times. With the mixture control in the full rich position, the throttle only slightly open, and the switch on, crank the engine with the starter. If the starter will not turn the engine over, shut off the ignition and battery switches and pull the propeller through two complete revolutions by hand. Additional cranking with the starter should start the engine. In extremely cold weather, it may be necessary to pump the throttle a few times after the engine has initially started.

HOT STARTING:

To start a hot or warm engine, put the mixture control in the full rich position and close the throttle. The engine should start at the first turn. Do not pump the throttle when attempting to start a hot engine, as this will cause flooding and make starting difficult.

XXVII – GENERATOR AND VOLTAGE REGULATOR

GENERATOR:

The 6A8-215-B8F and B9F engines are equipped with Auto-Lite model GGS-4801A, 35 ampere generator. This generator is belt driven from a sheave mounted on the end of the crankshaft and furnishes the electrical energy necessary to keep the 12 volt battery charged and operate the electrical equipment in the airplane. It is mounted so that it will pivot on two bolts supported by brackets on the right rear of the crankcase. The inboard side of the generator is supported by an adjusting link that allows the generator drive belt to be adjusted to the proper tension.

The generator should be checked at least every 100 hours to see that the belt and brackets are tight and the electrical connections are secure. The drive end bearing oil cap should be filled with engine oil at each 50 hour check period.

VOLTAGE REGULATOR:

The voltage regulator is a device that regulates the generator current and voltage output to the battery and electrical units. It protects the generator from overload and the battery from overcharging. It also acts as a reverse current relay to prevent battery current from flowing back through the generator when it is not operating, causing the battery to discharge and the generator to burn out. The regulator used on the model 6A8-215-B8F and B9F engines is the Auto-Lite model VRX-4401A.

If the generator is not charging properly, all connections and wiring from the generator to the voltage regulator and the battery should be checked. The connections should be dry and tight and the wiring should be free from frayed spots or cuts. If the wiring and general condition of the generator is satisfactory, the trouble may be in the voltage regulator. Ordinarily, the voltage regulator is not serviced but is replaced by a new regulator of the proper type. A low charging rate and a fully charged battery indicate normal regulator operation. A discharged battery will normally produce a high charging rate.

The electrical accessories may be serviced in an engine shop that has complete electrical repair and testing equipment. Usually, the most satisfactory procedure, however, is to take the accessory needing service to a registered service station that handles the make of equipment involved.

XXVIII – STARTING MOTOR

The model 6A8-215-B8F and 6A8-215-B9F engines are equipped with 12 volt starters.

The later models incorporate insulating pads between the starter and the crankcase and come equipped with an insulating blanket and cooling air blast tube.

CAUTION: In order to insure proper starter gear engagement do not use the insulating strips between the starter and crankcase with other than the Auto-Lite MCJ-4002 starter.

LUBRICATION AND SERVICING:

Add three to five drops of medium engine oil to the oiler in the commutator end head every 100 hours.

The starter ordinarily requires very little servicing. The brushes should be replaced when worn to half of their original length. The starter should be disassembled and inspected at 300 hours. Any worn Bendix drive parts should be replaced. The armature shaft should be lubricated sparingly with light oil before it is reassembled.

XXIX – 6A8-215-B8F and B9F ENGINE ASSEMBLY

The following procedure is intended to serve as a guide in assembling the 6A8-215-B8F and B9F engine after it has been completely dismantled and inspected and is ready for assembly. The method outlined is similar to the procedure used when the engine was originally assembled at the factory. It is assumed that the units being installed have been thoroughly inspected, cleaned and reconditioned and that they conform to the tolerance specifications recommended. As the following assembly procedure is given as a guide only, the foregoing sections on the various engine components must be consulted for the details of operation, locations, etc.

CRANKSHAFT:

Coat the crankshaft plug with bonding compound. Later engines employ two plugs, both of which are installed in the flanged end of the crankshaft. The welch plug is pressed in first and expanded into place. Then the cup plug is installed. Coat the crankshaft rear hub with Anti-Seize. Install the two Woodruff keys in the forward key slots and one key in a rear key slot to align the crankshaft gear during the installation. Heat the crankshaft gear to 200℉ for one-half hour and install it on the crankshaft. Use a soft hammer to bottom the gear on the crankshaft hub.

CAMSHAFT:

Heat the camshaft gear to 200℉ for one-half hour. Coat the rear hub with Anti-Seize compound. Install the Woodruff key and press the camshaft gear on the camshaft.

CRANKCASE:

Cover the oil cooler mounting pads on the crankcase halves with tape. Attach the engine rear mounts to the two crankcase halves. Install the main bearing shells and thrust washers in the crankcase halves. On engines with serial numbers from 23000 to 23500, check crankshaft in both open halves for end play. This clearance is controlled by the thickness of the thrust washers. Check for clearance between the crankshaft throws and the crankcase walls by rotating the shaft in each crankcase half. Check camshaft in both open halves of the crankcase for end play. Check for clearance between the oil pump gear on the camshaft and the crankcase walls. Install the holding fixture on the crankshaft front flange. Place the crankshaft in a nose down position on the holding fixture base. Install a matched set of connecting rods on the crankshaft, placing the machined surface on the rod bolt boss toward its adjacent or nearest main bearing journal on the crankshaft. The connecting rods are numbered relative to their cylinder position on the crankshaft and the numbers are positioned so that they can be read through the bottom of the crankcase when the oil pan is removed. After the connecting rod bolts have been torqued, check the rods side clearance on the crankshaft. Install the cotter pins with their heads toward the rear of the crankshaft. On the engines where used, coat the inside surfaces of the two split crankshaft thrust washers with grease to hold them in position during assembly of the crankcase. Oil the crankshaft and camshaft bearings. Install the right crankcase half on the crankshaft. Install the camshaft by indexing the zero on the crankshaft gear between the two zeros on the camshaft gear. Install new oil seal rings on engines having the countersink at the main bearing studs before installing left crankcase half. Install the left crankcase half. Install an adapter plate on the two rear through studs and the washers and elastic stop nuts on the front two through studs. Draw the two crankcase sections together, leaving a space at the top rail to insert the oil seal thread. Wind a few turns of the oil seal thread around a tag, place the tag on the rear surface of the crankcase and draw the thread taut from the front of the crankcase, inside the top rail bolt holes. Draw the two sections together by torquing the elastic stop nuts and adapter nuts. Install the internal bolts in the crankcase with the head of the bolt on the right side of the engine. Torque the nuts and install the cotter pins. Install the top rail bolts, observing that the oil seal thread is taut and in the correct position between the crankcase mating halves. Torque the top rail bolts. Recheck the end play of the camshaft. Also recheck the crankshaft end play on engines having thrust washers. Check the backlash between the crankshaft and camshaft gears. Install the two dowels, which are a press fit in the top rail lifter eyes. They should be drawn into place by pulling with a long bolt and two washers. Stake the dowels on both sides. Install the oil filler cap, dip stick and oil pressure relief valve assembly on the crankcase.

PISTON & CYLINDERS WITH VALVES INSTALLED:

Install a set of pistons, balanced within plus or minus 1/8 oz. between any two, beginning with the front pistons and cylinders and working back toward the rear of the engine, the #1 piston and cylinder being installed last after the adapter plate is removed from the cylinder pad. Oil the piston pin bushing and install the piston with the piston location number on the piston pin boss facing the front of the engine. Install the rear piston pin plug. Install the piston rings and stagger the rings gaps. Oil the cylinder wall and piston rings. Using a ring compressor, install the correct numbered cylinder as indicated on the cylinder flange. When the cylinder skirt is just over the bottom groove ring, install the front piston pin plug, which will be on the bottom when on the assembly stand. Do not fully torque the cylinder nuts at this time. When all the cylinders are installed on the crankcase, temporarily attach the intake manifolds without gaskets tot he intake ports on the cylinders for the purpose of aligning the cylinders, while torquing the cylinder hold-down nuts. This procedure assures a flush fit at the manifold to inlet port location, thus eliminating the possibility of induction leaks. Remove the inlet manifolds.

VALVE ACTUATING UNITS:

Install the hydraulic lifters. Oil the outside diameters of the lifter rod tube oil seals after they are installed on the tubes. Press the lifter rod tubes into position on the engine with the wire circlet in the inboard bead of the tube and the top of the tube flush to below flush with the machined top surface of the cylinders. Install the lifter rods. Install the rocker support blocks with the hole in the rocker pi9ns facing down toward the crankcase and the rocker arms installed on the pins. Torque the rocker support block nuts or cap screws. Rotate the crankshaft to eliminate torquing the nuts while the lifters are on the peak of their respective cam lobes. Check the side clearance of the rocker arms. Set the valve clearance to .040”. Insert .040” feeler stock between the valve stem tip and the rocker arm, with the piston on top center of its compression stroke and the rocker arm and lifter rod fully depressed against the spring tension of the valve lifter. This clearance is adjusted by the rocker arm adjusting screw, which is locked in position by a lock nut.

TIMING GEAR CASE, OIL PUMP AND OIL PAN:

Trim the crankcase oil seal thread flush with the rear and front crankcase surfaces. Remove the outer Woodruff key from the crankshaft rear hub and install the rear oil slinger, cupped face to the rear of the engine. Install two Woodruff keys on the crankcase rear hub. Install the timing gear case with its oil seal pressed into position. Trim the timing gear case gasket flush with the bottom of the crankcase surface. Tighten the timing gear case in position at this time, using a pilot in the oil seal to center the case properly about the crankshaft. On engines using cap screws, it is very important that the third screw from the top on the left hand side be only 5/8” long.

Install the oil pump with the oil inlet pipe and oil inlet screen unit attached (See Fig. 13). The oil inlet pipe to oil pump attaching capscrews are safetied. A cotter pin and wire clamp attach the oil screen unit to the oil inlet tube. The oil pump to crankcase cap screws are torqued and then safetied. Install the oil inlet pipe front bracket. The bracket mounting cap screws are then torqued and safetied. Coat the top surface of the oil pan, between the bolt holes, with non-hardening gasket compound. Install the gasket between the oil pan and crankcase. Install the solid aluminum plate under the oil pan mounting flange. Torque the oil pan nuts and cap screws. Observe that the #1 cylinder flange does not project over the rear crankcase surface and interfere with the fit of the timing gear case.

PROPELLER SHAFT AND PROPELLER SHAFT HOUSING:

Place the engine in a horizontal position and install the propeller shaft. The head of the propeller shaft to crankshaft attaching bolts should face the front of the engine. At first assembly of the crankshaft and propeller shaft it is necessary to check the alignment of the bolt holes. Install and torque the bolts and castellated nuts. The nuts are then safetied with cotter pins.

Install the propeller shaft housing connector gasket, propeller shaft housing gasket and propeller shaft housing, carefully aligning the two dowel pins. Observe that the #6 cylinder flange does not project over the crankcase front face. Torque the attaching nuts. Install the propeller shaft housing nose plate and gasket with the propeller shaft bearing, oil slinger, if used, oil seal and oil seal sleeve installed. Torque the nuts. Refer to Propeller Shaft Nose Plate Assembly in Section XVIII, On Page 26, for details on the installation of the three different types of propeller shaft bearings.

STARTER GEAR HUB, STARTER, GENERATOR, FAN STARTER GEAR AND GENERATOR DRIVE:

Heat the starter gear hub to 200°F for one-half hour and install on the rear end of the crankshaft. Install the tab washer ring and capscrews. Torque the capscrews. Install the starter motor, timing mark pointer and generator. Install the generator belt and generator drive sheave. Adjust the generator belt tension to give a ½” to 5/8” dip under a steady thumb pressure after the fan and starter gear assembly have been installed. Torque the eight cap screws to 20 ft. lbs. and safety. NOTE: Recheck torque and safety after completing run in.

INDUCTION SYSTEM, CARBURETOR, FUEL PUMPS AND TACHOMETER:

Install the inlet manifold, observe that all the screw plugs are installed and tight and that the manifolds and gaskets fit flush to the inlet ports on the cylinders. Install the equalizer pipes and hose. Install the distributing zone and pipes. Observe that all connections are properly fitted to eliminate induction leaks. Install the carburetor with the mixture control lever toward the crankcase. Install the fuel pumps with their marked inlet port toward the rear of the engine. Turn the crankshaft when tightening the fuel pumps so that the cam arm of the pump being tightened is on the flat of the actuating cam on the camshaft. Install the tachometer drive and check for backlash between the tachometer drive gears. If adequate backlash is not present, an additional gasket should be put under the tachometer drive assembly flange.

MAGNETOS AND OIL COOLER:

Install the right and left magnetos or the magneto and distributor as outlined in Sections XXIII and XXIV of this manual on pages 35, 39. The magneto drive gears should be prelubricated with a light coat of cup grease. Install the spark plugs and connect the ignition wires. Before installing the oil cooler, force about one gallon of the regular specified engine lubrication oil down each port on the top of the crankcase at the oil cooler mounting pad location, under about 20 PSI. Remove the oil pan drain plug and drain off the excess oil. Replace the plug and safety. Install the oil cooler, making sure that the cooler connection oil seals are firmly in position.

VALVE COVERS AND MISCELLANEOUS:

Before installing the valve covers, make the following inspection. Examine the top surface of the cylinder for nicks or scratches. Examine the raised bead on the valve covers for nicks or warpage. Place the valve cover on the cylinder head without the gasket and check for contact with a .003” feeler gauge. Use a gasket of the proper type and in good condition. Draw the cover down evenly by tightening the screws in a criss-cross fashion, a few turns at a time. This procedure is important to prevent warping and bending of the cover.

The engine is now ready for installation on the test block or aircraft, depending on the extent of the overhaul made.

Disassembly for overhaul can be conveniently accomplished by performing the outlined procedure in reverse.

Clearances and torque limits are listed on page 8, 9, 10, 11 of this manual.

XXX – ENGINE TESTING

The procedure outlined is intended to serve as a guide for testing the engine after it has been overhauled.

Running Schedule

RPM	Duration
1250	15 min.
1400	15 min.
1600	15 min.
1800	15 min.
2000	40 min.
2200	40 min.
2400	40 min.
2500-2600	30 min.
	3 hrs. 30 min. Total

Check acceleration.
Check ignition at full throttle. Maximum drop 100 RPM.
Check mixture control.
Check idle speed.
Shut down with idle cut-off.

Intentionally left blank