OPERATORS HANDBOOK

AND PARTS CATALOG

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Franklin

AIRCRAFT ENGINES

MODEL 4AC-199

AIRCOOLED MOTORS CORPORATION ● SYRACUSE, NEW YORK

HAGELIN AIRCRAFT MOTORS CO.
FRANKLIN DISTRIBUTORS
SALES AND SERVICE
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GRAND CENTRAL AIR TERMINAL

AIRCOOLED MOTORS CORPORATION
SYRACUSE, NEW YORK

OPERATORS HANDBOOK & PARTS CATALOG

FRANKLIN MODEL 4AC-199 AIRCRAFT ENGINE

This handbook is intended as a practical working manual for the guidance of owners and mechanics in operating, servicing, and maintaining Franklin aircraft engines.

Obviously, it is impossible to cover every operating eventuality in detail; however, should any problem arise which presents the need for special handling, or which requires special information, contact the nearest Franklin Parts and Service Station, or the factory for instructions. Your inquiry will receive prompt, courteous attention and an immediate reply. A list of Franklin Parts and Service Stations appears on the opposite page.

When you contact your Franklin Service Station or factory concerning parts or service, please give the engine number. THIS IS IMPORTANT. It will insure prompt; accurate service and prevent undue delay.

When returning parts to your Franklin Service Station or the factory, attach tag to EACH PART, with your name, address and ENGINE NUMBER from which the part was removed, together with the date of your original letter in reference to the part in question. This will assure the speedier handling of your service request. Also, when shipping parts to the factory, be sure they are shipped prepaid.

In the event of failure of any engine part, do not attempt repairs without factory permission if any adjustment is expected.

We suggest that you study this handbook thoroughly. Strict adherence to the instructions and recommendations it contains will assure you a high degree of satisfaction with the performance of your Franklin aircraft engine.

NOTE: The publication date of this operator's handbook is April 25, 1945. Its contents supersede all previous instructions, clearance data, and parts prices which may have been issued on Franklin Aircraft Engine, Model 4AC-199. When and if changes are made in the data contained in this handbook, currently dated replacement sheets for insertion in your manual will be made available.

WARRANTY

Aircooled Motors Corporation warrants each new Franklin engine or part to be free from defects in material and workmanship, when properly installed, serviced and used under normal conditions, for ninety (90) days, or in no case to exceed fifty (50) hours of operation, after the shipment of each engine or part from its factory.

This warranty is limited to replacing or repairing at its factory, any part or parts which have been returned to its factory with transportation charges prepaid and which, in the opinion of Aircooled Motors, are defective.

This warranty is expressly in lieu of all other warranties and representations, expressed or implied, and all other obligations or liabilities on the part of the Aircooled Motors Corporation.

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

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

Aircooled Motors Corporation makes no warranty with respect to ignition apparatus, carbureters, instruments or other trade accessories, - inasmuch as these are usually warranted specially by their respective manufacturers.

Aircooled Motors Corporation reserves the right to make any changes in prices or specifications of engine or parts, without notice and without incurring any responsibility with regard to engines or parts previously sold or replaced.

AIRCOOLED MOTORS CORPORATION

Syracuse, New York

SPECIAL NOTICE

MODEL DESIGNATIONS ARE AS FOLLOWS

85 H.P. at 2500 R. P. M.

4AC-199-D2	Comp. Ratio 6.3 to 1 dual ignition
4AC-199-D3	Comp. Ratio 6.3 to 1 dual ignition with starter and generator

90 H.P. at 2500 R. P. M.

4AC-199-E2	Comp. Ratio 7 to 1 dual ignition
4AC-199-E3	Comp. Ratio 7 to 1 dual ignition with starter and generator

At the factory an accurate record is kept of every engine shipped. It is essential that the operator or service station send us all of the symbols as well as the serial number of the engine in question, when ordering parts, or requesting information. From these symbols and the serial number, we can readily determine the horse power, compression ratio, type of pistons, and capacity of the oil pan, as well as other pertinent information, which permits us to render fast, accurate service.

GENERAL INDEX

4AC-199

Specifications

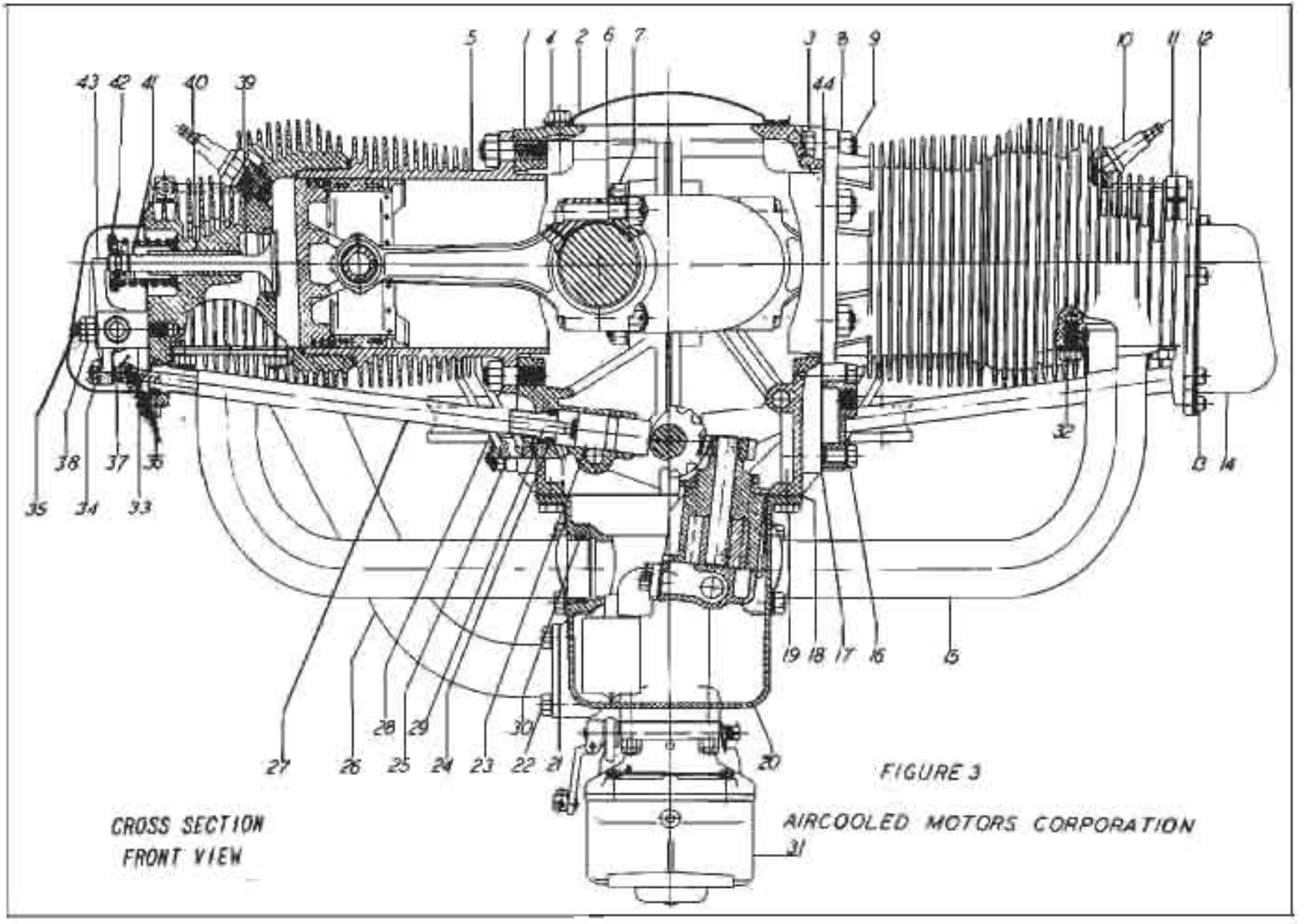
FRANKLIN MODEL 4AC-199 AIRCRAFT ENGINE

TYPE: Four cylinder, overhead valve, direct drive horizontally opposed, air cooled.

APPROVED TYPE CERTIFICATE	No. 226

SYMBOL	RATING
4AC-199-E2-E3	90 H. P. @ 2500 R. P. M.
4AC-199-D2-D3	85 H. P. @ 2500 R. P. M.

BORE	4 1/4"
STROKE	3 1/2"
COMPRESSION RATIO	7 to 1 or 6.3 to 1
PISTON DISPLACEMENT	199 Cubic Inches
FUEL (Recommended)	6.3:1 Ratio, 73 octane or better 7:1 Ratio, 80 octane or better (AFD Method Aviation Gasoline containing not more than 1 c.c. of lead per gallon)
OIL RECOMMENDED	SAE 20
OIL PRESSURE	35 to 45 pounds
OIL TEMPERATURE (Safe Maximum)..	240°
OIL CONSUMPTION (Rated Power)...	1.8 Oz. per hour
OIL SUMP CAPACITY	2 sizes of pans are furnished, of 5 and 8 quarts capacity.
CRANKSHAFT ROTATION	Counter-clockwise, facing propeller
VALVE CLEARANCE	.040 (no oil in lifter, fully depressed)
FIRING ORDER	1-4-2-3
MAGNETO	Eisemann
SPARK ADVANCE	28°
SPARK PLUGS	Champion J-10
CARBURETOR	Marvel-Schebler, MA-3F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CROSS SECTION
FRONT VIEW
FIGURE 3
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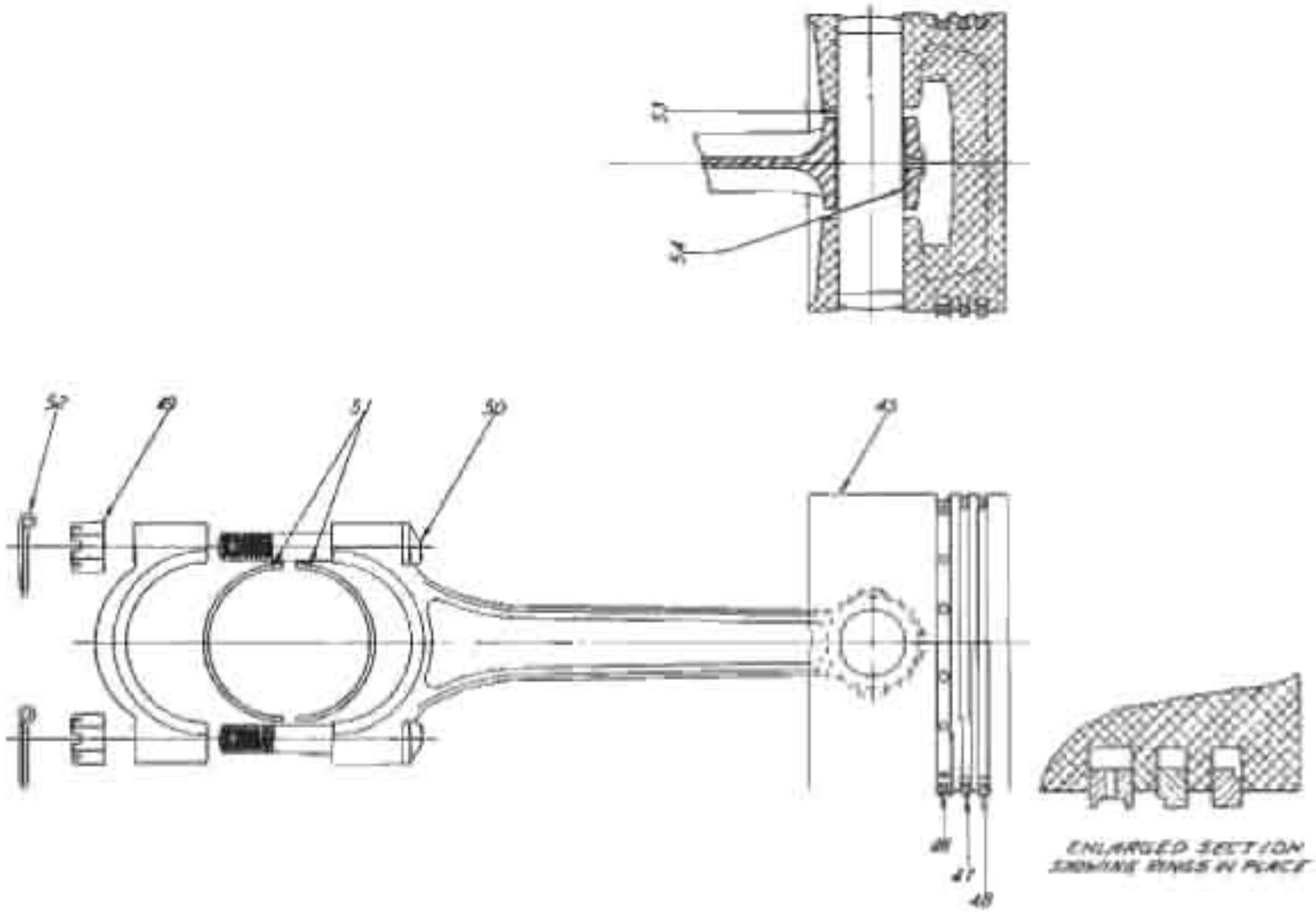


CONNECTING ROD AND
PISTON ASSEMBLY

FIGURE 4

AIRCOOLED MOTORS CORPORATION
SYRACUSE, N.Y.

PART I

ENGINE DESCRIPTION

CRANKCASE: The crankcase is a two-piece casting of high strength aluminum alloy, with removable top cover and oil pan, allowing ready inspection of, and access to connecting rods, connecting rod bearings and other internal working parts.

The crankcase has three main bearings, the two front ones being extra wide.

Both camshaft and main bearings are of the interchangeable, steel back, precision type. Camshaft bearings are babbitt lined while crankshaft bearings are copper lead lined.

Propeller thrust is taken by washers on both sides of the front main bearing saddle so design permits either tractor or pusher operation.

Cast on the crankcase are four bosses, designed to allow various types of mounting brackets to be bolted on the case. This arrangement allows the plane manufacturer considerable latitude in his installation design, and insures a light yet extremely rigid mounting, permitting removal of engine without dismantling.

CRANKSHAFT: The one piece, alloy steel forging, four throw, three bearing crankshaft is counterweighted as well as statically and dynamically balanced. It is drilled for lightness and to provide pressure lubrication of all bearings. Furthermore, the propeller hub inner flange is forged as an integral part of the shaft, which extends 3-21/32" beyond the inner flange, so as to provide full bearing support for the propeller.

This type of construction eliminates many propeller hub assembly parts, and propeller trackage difficulties.

CAMSHAFT AND TIMING GEARS: The camshaft is a one-piece steel forging. The eight hardened cams provide a firing order which insures maximum smoothness.

The camshaft gear is of "Celeron" with an aluminum rim while the crankshaft gear is of steel.

CONNECTING RODS: Alloy steel, drop forged connecting rods are of conventional design with a bronze bushing pressed in the piston pin end. The big end is fitted with a steel back precision type copper lead bearing, and is drilled to throw oil spray on the cylinder wall and piston pin. In order that oil spray may properly lubricate the piston pin, three holes have been drilled

through the bosses and bronze bushing.

PISTONS: The pistons used in the Franklin 4AC-199 series engines have recently been developed by the ever-progressive Franklin Engineering Department. These pistons are cast of carefully selected, aircraft quality, aluminum alloy, and contain an alloy steel strut that controls expansion of pistons within extremely narrow limits, permitting piston clearances of .003 of an inch, without the slightest danger of pistons seizing. This feature gives Franklin engines greater efficiency, longer cylinder, piston and ring life and eliminates piston slap.

Piston pins are of the full floating type. Perfect Circle Piston Rings are used as follows: - one type "200" in the upper groove, one type "70" in the middle groove and one type "85" in the lower groove.

VALVE MECHANISM ASSEMBLY: Each cylinder is equipped with two alloy steel overhead valves, steel or iron valve seats, and alloy iron valve guides.

Valve springs are made of the best grade Swedish wire, 100% magnafluxed.

Valve rockers are force-feed lubricated; oil spray in the cover lubricates the valve stems, guides and springs.

CYLINDERS: Cylinder heads are aluminum alloy, screwed and shrunk on iron alloy barrels. Heads and barrels have generous cooling fins.

OIL RESERVOIR: The oil reservoir is an aluminum pan, held to the bottom of the engine with 21 cap screws, and may be either 5 or 8 quarts capacity. Being a wet sump engine, it requires no extra tanks or plumbing for the oil system.

HYDRAULIC VALVE LIFTERS: Wilcox-Rich hydraulic valve lifters operate automatically and eliminate valve adjustments between top overhauls. They are controlled by engine oil pressure and compensate for the expansion of cylinder and valve gear up to .200 backlash.

LUBRICATION SYSTEM: The oil pump is of the unit-gear type, incorporating unusually wide gears. The oil pump cover incorporates the oil pressure relief unit. The spring is so calibrated as to give the required oil pump pressure without adjustment.

Oil is pressure-fed to the hydraulic valve lifters, main bearings, connecting rod bearings and valve rocker mechanisms. Valve stems, guides and springs are lubricated by spray, from rockers. Cylinder walls and piston pins are lubricated by oil spray from holes drilled in the big end bearing of the connecting rods. Timing and accessory drive gears are continuously bathed in oil,

The oil pump pressure relief valve is located in the pump casting and is set at the factory to give correct oil pressure of 35 to 45 pounds.

The oil strainer is located inside the oil pan at the inlet to the oil pump. The oil level gauge is located in the lower right rear of the crankcase.

CARBURETION: The carburetor is of the up-draft type. The gasoline vapor mixture from the carburetor passes through the distributing zone which is cast in the oil pan. The distributing zone is bathed in oil; vapor mixture is thus warmed, and at the same time the oil temperature is decreased.

Individual intake pipes connect the intake port with the distributing zone. Primer connections are provided to facilitate cold weather starting.

IGNITION: The engine is equipped with dual magnetos fitted with impulse starter couplings, assuring easy starting under all conditions.

TEST: Each engine is carefully run-in, inspected and thoroughly tested at full throttle - under full load, before being shipped. When shipped from the factory, it is ready for installation and operation.

PART II

INSTALLATION

SECTION 1. - UNPACKING FRANKLIN ENGINE

Franklin aircraft engines are shipped in standard Franklin crates, except for the carburetor, which is detached and packed separately in the crate. Each engine is equipped with all accessories ready to install in the airplane. Each engine is fastened in the crate by means of bolts through the regular mounting lugs.

After taking off the top lid of the crate, the engine is removed by simply loosening the four bolts which hold it to the bottom of the crate.

The oil sump has been drained and the various oil holes plugged before shipment. Naturally, a certain amount of oil will remain in the oil galleries and in the hydraulic lifters, because it is impossible to remove all of the oil unless the engine is totally dismantled.

SECTION 2. - MOUNTING

The engine installation diagram (Fig. 1) shows a typical engine mounting. It applies to the model covered in this handbook. It will be noted that the engine is bolted to the mounting at four points. Eight rubber biscuits are supplied to insulate the engine from the mount at these four points.

If, for any reason, it is necessary to remove the engine from the ship, care must be taken when replacing it, to see that the rubber biscuits are in good condition at each mounting point, in order to insure proper alignment of the mounting lugs and even tension on the crankcase.

SECTION 3. - FUEL SYSTEM

The Marvel-Schebler MA-3A aircraft carburetor is used on Franklin 6AC-264 and 6AC-298 Aircraft Engines.

The gasoline inlet boss on the carburetor carries 1/4" pipe tap. To eliminate any possibility of foreign matter entering the carburetor, a commercial type gasoline strainer should be used between the gasoline tank and the carburetor.

The gasoline line is supplied by the plane maker. However, in special installations care should be taken that a pipe of at least 1/4 inch inside diameter be used. Copper tubing is not recommended because of possible fatigue failure.

The shut-off cock should be installed as close to the carburetor as possible to eliminate any possibility of vapor-lock troubles during hot weather.

SECTION 4. - OILING SYSTEM

A 5/8" - 18 SAE thread-tapped hole is provided at the bottom of the oil pan alongside the carburetor for connecting the oil temperature gauge bulb.

Oil pressure gauge connection is located on the by-pass plate at the left front of the crankcase and is 1/8 inch pipe thread.

SECTION 5. - IGNITION SYSTEM

The Eisemann Magneto is standard equipment.

It is recommended that extreme care be used when installing the magneto grounding wire which runs from the magneto breaker cap through the switch to the engine mount. This is to prevent any premature starting of the engine, which might occur should the wiring be faulty. The magneto is shorted through this wire when the ignition switch is in the "off" position.

The Eisemann magneto is equipped with an impulse coupling which retards and intensifies the spark. This assures easy starting as the crankshaft is turned slowly.

The magnetos should be removed and thoroughly inspected at each top and major overhaul period, special attention being given to the weight pins in the impulse couplings.

SECTION 6. - MOUNTING THE PROPELLER

An unusual feature of the Franklin aircraft engine, is the fact that the propeller hub is an integral part of the crankshaft. This design eliminates many hub assembly parts, permits of easy mounting and removal of propeller, and assures proper propeller tracking.

The propeller is mounted by simply backing the propeller on to the crankshaft up to the rear propeller flange, which is forged on to the shaft, affixing the front duralumin plate, passing the bolts through the front plate, propeller and rear flange and tightening the bolts in place. If care is used to tighten the bolts evenly, proper trackage will result. The tips of the propeller should track within 1/8".

To remove the propeller, simply remove the propeller hub bolts and pull the propeller off.

Another precaution to observe when installing the propeller is to locate it relative to a particular cylinder, so that a man starting the engine will be able to pull it through compression in a normal manner.

Any propeller of approved design may be used on Franklin aircraft engines. It should load the engine sufficiently so that the full throttle R. P. M. do not exceed the C. A. A. rated speed during take-off and climb.

However, a propeller should never be used that overloads the engine excessively as then the engine would not be able to deliver rated power.

If a wooden propeller is used and for no apparent reason the engine does not turn up to rated power, the propeller should be checked for warpage. If warped, the propeller should be replaced by a new one of the same design.

Engine must not be operated at any time above rated speed even though in level flight full throttle speed might exceed rated speed by as much as 350 R. P. M. on some types of airplanes. If the engine speed rises above rated speed, PULL BACK THROTTLE UNTIL IT DOES NOT EXCEED RATED SPEED.

PART III

GENERAL OPERATION

For all-around satisfactory operation, it is essential that the engine be correctly installed in the airplane and properly maintained, and - as with all engines, it is of utmost importance that a good quality fuel and lubricating oil be used at all times. To insure trouble-free operation, it is essential that both gasoline and lubricating oil be free of dirt, grit, dust or foreign matter of any kind.

SECTION 1. - FUEL

A good quality of gasoline should be used and care should be take that the fuel contains no water or foreign matter. If there is any doubt about the cleanliness of the gasoline, it is advisable to strain it through a fine gasoline screen or chamois before using it.

SECTION 2. - LUBRICATION

A. The importance of using a good quality lubricating oil in the Franklin engine, or in any other engine for that matter, cannot be over-emphasized. We have found that in the long run the very best lubricating oils result in lower maintenance expense.

It is essential that the oil be of the correct viscosity, SAE 20, that it be free from corrosive constituents which might cause pitting of the bearings and other important parts; and that it have the proper low pour point so that starting and warming up will be easier on the engine in cold weather.

The proper oil level should be maintained at all times. (See "Specifications").

When necessary to measure the oil simply unscrew oil level gauge. When replacing be sure to seat firmly.

The use of improper oil may result in high oil temperatures and oil consumption, low oil pressure and the formation of considerable carbon and sludge. Excessive carbon is usually the cause of sticking valves and rings, scored pistons, clogged oil lines and strainers. It will also clog hydraulic lifters, rocker arms, etc.

No particular brand of lubricating oil is recommended by Aircooled Motors Corporation. We do recommend that a high grade S.A.E. 20 oil be used.

B. RECOMMENDED OIL CHANGES

While any number of Franklin engines have operated over 100 hours satisfactorily without the oil being changed, it is not recommended as a general practice. It is suggested that for the average operator the oil be changed every 25 hours unless service experience indicates otherwise.

To drain the oil, simply remove the plug at the rear end of the oil pan.

To clean the oil strainer, remove the oil pan and take out the two cap screws which attach the oil pump inlet elbow to the oil pump proper.

NOTE On later type oil pan, an oil pump screen inspection plate has been incorporated so that it is unnecessary to remove oil pan to inspect oil pump screen.

The oil pan should be drained while hot, as more of the oil will then drain out of the system. Clean oil cans should be used when filling the engine with fresh oil. The oil should not be left standing uncovered because foreign matter may thus get into the engine and cause considerable damage.

The oil pump and screen should be cleaned at intervals of approximately 100 hours. This is best done as follows:-

1. Warm the oil thoroughly in flight.

2. Drain the oil from the engine.

3. Remove all the screws from the oil pan and remove the pan. This exposes the oil pump for inspection and permits the removal of the oil screen elbow, to which oil pump screen is attached. SEE ABOVE NOTE

When the oil pan has been removed, the interior of the engine should be inspected for sludge. If this inspection shows an undue amount of sludge on the walls of the crankcase, it is recommended that the pump be installed, pan put in place again, and the engine run for 20 or 30 minutes with a low viscosity oil, such as SAE 10; then drained while hot, followed by another inspection of the interior of the engine.

The cleanliness of the interior of the engine is a very important factor in prolonging its life. It is impossible to prevent the formation of some sludge and grit after many hours of operation. However, it should be removed as often as practical in order to prevent serious engine wear.

C. TOP CYLINDER LUBRICATION MAY BE USED

The chief purpose of top cylinder lubrication is to prevent excessive wear on the contact surfaces of the upper portion of the cylinder walls, rings, pistons, valve guides and stems.

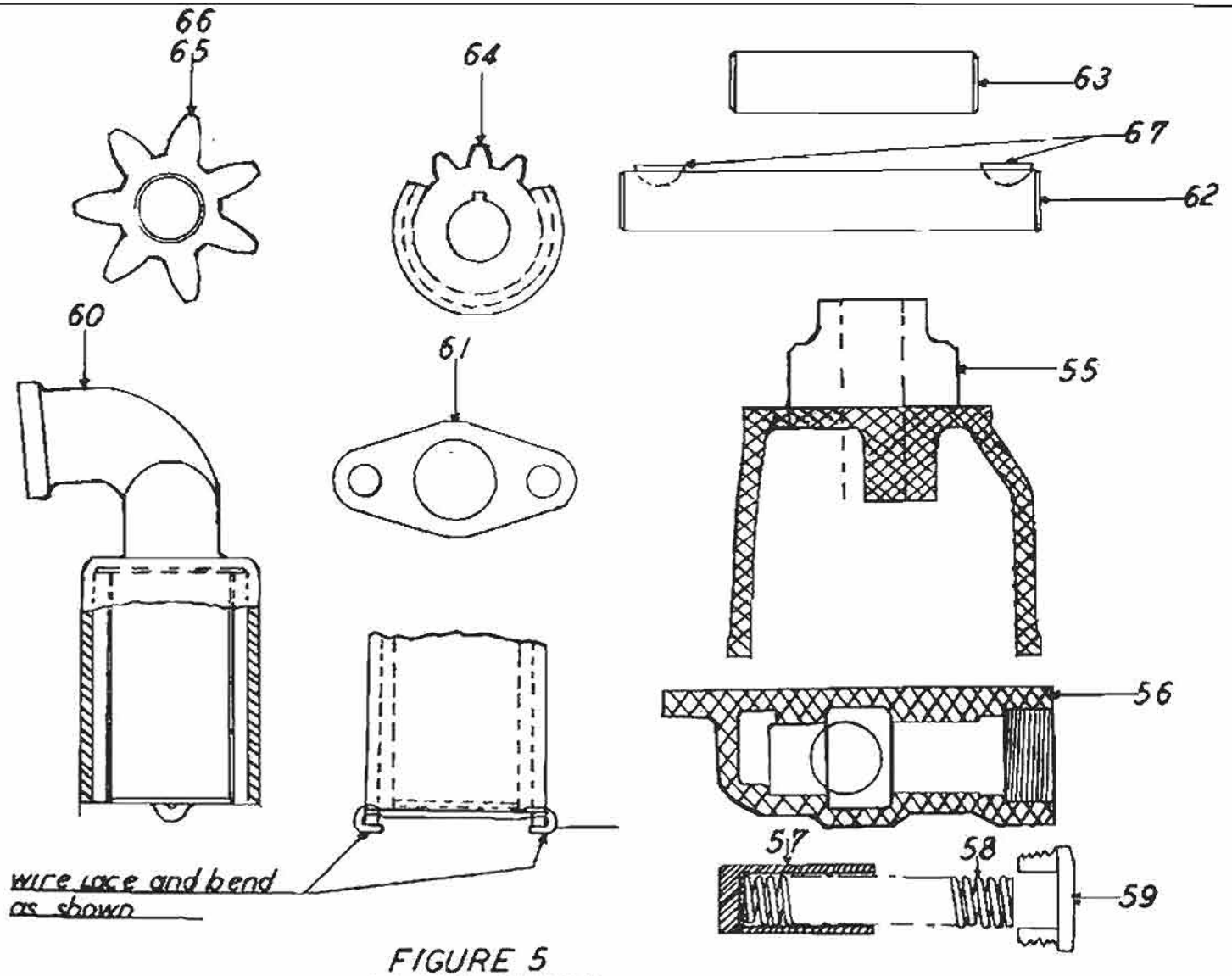


FIGURE 5
OIL PUMP ASSEMBLY
AIRCOOLED MOTORS CORPORATION

Franklin engines as a general rule do not require the use of top cylinder lubricants inasmuch as they are equipped with a positive pressure lubrication system to the entire valve mechanism; however, the occasional use of a top cylinder lubricant will tend to prevent the accumulation of sludge on the internal parts of the cylinder assemblies and, therefore, prolongs the proper functioning of the component parts.

The simplest method of applying top cylinder lubricant is to mix it with the gasoline in proportions recommended by the makers of the lubricant.

D. MAGNETO LUBRICATION

EISEMANN MAGNETO: The 15 m/m open-type ball bearings at each end of magnet rotor and two 8/8 closed-type ball bearings on distributor shaft are packed with a high-melting acid-free grease. The factory application should last for at least 500 hours under normal operating conditions.

Apply one drop of medium grade crankcase oil to breaker cam wick after each 500 hours of operation.

SECTION 3. - STARTING

FRANKLIN ENGINES ARE EQUIPPED WITH MARVEL CARBURETORS and are easy to start when the correct procedure is used.

In hot summer weather, priming is unnecessary. The engine will ordinarily start after being pulled through two or three revolutions with the throttle cracked slightly - just off idle.

Furthermore, in the fall and spring when the engine has been running for less than an hour, previous to the time of starting it will also start without any priming.

If the engine fails to start in hot weather, it is usually due to overloading. In other words, there may be too much raw gasoline in the cylinders. This can be detected by a dull, hollow explosion, - or by a considerable amount of gasoline dripping from the carburetor drain. This can be remedied by turning the switch to the "off" position, opening the throttle wide and cranking the engine backward six or seven revolutions. Then crack the throttle, turn ignition switch to "on" and start the engine.

If the engine has any tendency to kick or start while being pulled through with the switch in the "off" position, it is an indication that the wiring has failed somewhere in the switch circuit of the magneto; i. e., primary connection, switch or switch to ground.

Standard equipment on 6AC-264 and 6AC-298 Franklin engines includes electric starters and generators. Starter incorporates

Bendix type drive and solenoid starting switch. Switch button will usually be mounted in a convenient place on the instrument panel. Follow the same procedure as when hand cranking. In warm weather it will in most cases be unnecessary to prime the engine. Simply crack the throttle, turn on switch and push the starter button.

Whenever it is necessary to prime the engine, regardless of the type of carbureter, the number of priming strokes required is governed by temperature, the type of gasoline, and whether or not the engine has been recently run. In other words, the extent of priming should be governed by experience and varies somewhat with different engines.

In extremely cold weather, it is advisable to drain the oil from the crankcase at the end of the day's operations. Before starting the engine, the oil should be heated, then poured into the engine, and the engine started immediately, before the oil has a chance to become cold.

SECTION 4. - HARD STARTING

An engine in good condition should start promptly, regardless of the air temperature, provided the preceding instructions are carefully followed. If, however, the engine fails to start, check the following: All controls for proper functioning, carbureter strainer and fuel line for dirt and water, wiring for loose connections, broken insulation and cleanliness and spark plugs and breaker points for condition and gap settings, (See Part IV, Section 2, "25 Hour Inspection.") The improper functioning of one or more of these items is usually the cause of the difficulty.

If the engine has seen considerable service, and all of these items function properly, it is an indication that a top overhaul is needed. (See Part V, "Top Overhaul")

SECTION 5. - WARMING UP THE ENGINE

After starting, run the engine slowly (600 to 1000 RPM) in order to warm it up gradually until the oil temperature has reached 90 to 100 degrees F. In extremely cold weather it may not be possible to reach this temperature. The oil pressure is also a good indication of operating temperature of the engine. In other words, if the pressure is 40 to 45 pounds maximum, it is safe to fly the ship.

Do not operate the engine at full throttle on the ground any longer than necessary. Continued running under these conditions may overheat the engine. Revolving propellers do not cool aircraft engines adequately while running on the ground for long periods at full throttle.

SECTION 5A. - PROPER USE OF CARBURETOR ALTITUDE CONTROL

The engine should be thoroughly warmed with the altitude mixture control in the "Full Rich" position. It should remain in this position during take-off and climb and at all times during flight when the ship is below an altitude of 3,000 feet. Upon reaching an altitude of 3,000 feet, and if it is desirable to gain more altitude, the throttle should be placed in the "Full Open" position and the altitude mixture control manipulated slowly and left at that position at which the engine reaches its maximum R. P. M. Then the throttle may be closed sufficiently to bring the engine back to the normal R. P. M. for this particular maneuver or cruising. During the descent, the mixture control should be closed or placed at the "Full Rich" position.

We wish to stress the importance of the judicious use of the altitude control. The improper use of this device may well cause burned and warped valves, piston failure and combustion chamber corrosion or even power plant failure.

SECTION 6. - OIL PRESSURE

Oil pressure should register immediately after starting. If there is no indication on the oil pressure gauge after 15 to 20 seconds, stop the engine and check the oil supply. Do not continue to run the engine unless normal oil pressure is obtained. The normal oil pressure may be slightly higher in cold weather, though it should not change much more than 20% from the normal (35 - 45 pounds). In other words, it should not drop or increase more than 7 to 9 pounds in continued flight. If the oil pump does not deliver proper pressure, either the oil pump relief valve plunger is sticking or the clearance on the main bearings is excessive.

SECTION 7. - STOPPING ENGINE

Always allow the engine to idle for a short time after running at full throttle before turning off the ignition switch, in order that the "cooling off" may not be too rapid.

SECTION 8. - IDLE ADJUSTMENT

The engine should idle between 500 and 600 RPM. Slower idling speeds may permit the engine to stall in long glides in cold weather. This idling speed should be obtained by adjusting the adjusting lever stop screw on the carbureter, not by turning the idling mixture adjustment screw on the carbureter.

However, if the engine still will not idle properly, an adjustment of the idle mixture screw may be necessary. Turning the idle screw clockwise makes the mixture leaner.

For easier starting in cold weather, it may be necessary to enrich this idle adjustment by turning it counter-clockwise.

SECTION 9. - TREATMENT OF NEW ENGINE

Careful treatment of a new engine will prolong its life. Every Franklin aircraft engine is run in for approximately seven hours after it has been assembled at the factory, but in order to insure long life, it is suggested that during the next 25 hours of operation, it not be run at full throttle any longer than is necessary.

If the engine is inclined to be stiff, it is advisable to use top cylinder lubricant in the gasoline during the first 25 hour period. Some owners prefer to change their oil frequently during the first 25 hours. This procedure has the effect of flushing the engine which is desirable. Under no circumstances use oil having a SAE number in excess of 20 in a new engine.

IMPORTANT: - The first 25 to 30 hours of service are the most important in the life of an engine. When an engine is carefully run in during this period, it will invariably operate longer without requiring major service work.

PART IV

MAINTENANCE & INSPECTION

Franklin engine design incorporates the most modern features of engineering and construction. Each engine is sturdily built of high quality materials and workmanship. Like any other well built piece of machinery, it will repay proper treatment and attention with the utmost satisfaction in performance and operating economies. To obtain this satisfaction, it should be properly operated, maintained and inspected. That is the owner's responsibility.

SECTION 1. - TEN HOUR INSPECTION

Remove and clean gasoline strainer. When replacing the glass bowl, be sure to get all the air out of the gas line by first fastening the glass bowl loosely, so that when the gas is turned on it will leak out. This flow of gasoline will force all of the air out through the gascolator and obviate air lock. As the gasoline begins to overflow, tighten the bowl so as to stop the gasoline leak.

Wipe off spark plugs and ignition cables at frequent intervals, removing dirt and soot which might well cause a short circuit.

Inspect ignition cable terminals at both the spark plug and magneto to see that they are clean and tight.

SECTION 2. - TWENTY-FIVE HOUR INSPECTION

Many owners prefer to drain the oil every 25 hours, which is good practice and is recommended.

We suggest that the oil, after being drained from the crankcase, be strained through a 20 mesh, or finer screen, to make certain that no metallic particles are present. The presence of metallic particles serves as a warning that some part in the interior of the engine requires attention and possible replacement.

Check and lubricate controls in order to make certain that they operate through the full range without binding.

Check and clean spark plugs. Gaps should be set to approximately .020 for the J-10 Champion plugs. Standard specifications of Franklin aircraft engines call for the use of Champion J-10 spark plugs.

Extreme care should be exercised to prevent the possibility of stripping the thread in the aluminum alloy cylinder head when the spark plug is tightened in position. In other words, do not tighten the spark plugs excessively.

Check all high tension cables and terminals. If either terminal is corroded, the cable assembly should be replaced. It is also very important that the insulation on the cable be in good condition, otherwise a high tension spark might jump from the cable to the engine, thus causing it to misfire.

Check propeller track.

Check the breaker points in the magneto every 25 hours.

SECTION 3 - ONE HUNDRED HOUR INSPECTION

At this point, after making the customary 25 hour inspection, the following additional inspection is recommended.

Remove the valve covers and check the valve guides for wear. This is done by pressing over on the side of the spring with a screw driver to see how much they move back and forth. Excess clearance on the guides means that the valves cannot seat properly, because the action of the rocker arm will push the valve sidewise in the guide. Furthermore, the excess clearance around the exhaust valve stem will permit the exhaust gas to push off the lubrication on the stem and result in excessive wear.

Excessive clearance on the intake stem means that the engine will receive excess air at this point. This will cause too lean a mixture and will result in increased cylinder head temperature, warped valves, etc. (See Part VII, "Table of Fits and Clearances".)

Remove, dismantle and clean the carburetor thoroughly. Dirt in the carburetor may prevent the engine from turning up properly or might cause a forced landing.

It is recommended that this work be done by an experienced carburetor man; however, the average mechanic, if he is careful, can do a satisfactory job. It is extremely important to remember that in cleaning the carburetor jets, they should be blown out with air - not cleaned with wire - as the jets may be made oversize, with the result that the carburetor would not meter properly.

Clean out all gas lines, strainer, etc. It is desirable to remove the gas tank shut-off in the tank and clean the small strainer which is attached. The gas tank should be washed out with clean gasoline in order to remove any trace of sediment.

Remove and thoroughly clean the oil screen.

PART V

TOP OVERHAUL

SECTION 1. - NEED FOR TOP OVERHAUL

While in many cases top overhaul may not be required between major overhaul periods, good practice indicates that a top overhaul every 250 hours will insure continued maximum performance and operating economy.

The following inspection and adjustment should be made before "revving up" the engine to full throttle on the ground in order to determine the possible need for a top overhaul:

A. See that spark is set at the correct position. Settings are given with specifications in front of book and on the name plate attached to the engine.

B. Check over the various items covered in the 10, 25, and 100 hour checks.

C. See if the carbureter throttle lever opens the throttle valve all of the way when against the forward stop.

D. While the engine is cool and ignition switch is off, test the compression of each cylinder. A good plan is to have one person turn the propeller slowly, while another listens for blowing valves in the exhaust ports and through the carbureter inlet. This test should be made with the throttle wide open.

E. After checking as above, and making any necessary adjustments, start the engine and warm it up until the temperature of the oil is approximately 100 degrees F., - then open the throttle and note the maximum RPM. * If the engine does not turn up to required minimum speed with proper propeller attached, it is possible that a top overhaul is necessary.

* Tachometers should be checked for accuracy from time to time.

SECTION 2. - TOP OVERHAUL

The top overhaul of the Franklin aircraft engine is easily accomplished without removing the engine from the ship.

First, place the ship in a clean, protected spot free from dust and dirt. Take off the cowling over the engine and then remove the air housings. The engine should then be dusted off with compressed air, if possible, then washed completely with gasoline and a brush.

After taking out the spark plugs, remove the cylinders from the engine. This is more easily accomplished by first removing the valve lifter rod tubes with special puller listed in parts catalog. The cylinder will probably require a gentle rap with a wooden hammer in order to break the gasket loose from the crankcase.

The cylinder should then be slightly raised from the crankcase, taking care to see that the piston, as it emerges from the cylinder, does not drop down and hit the crankcase, causing possible injury to the crankcase or pistons. Immediately after removing cylinders, it is advisable to remove the propeller. Otherwise, if the propeller is turned while the cylinders are off, the pistons or crankcase may be damaged.

Scrape all carbon from the interior of the cylinder head while the valves are still in place. This will protect the valve seats, thus eliminating the possibility of damage to the surface of the seat.

To remove a valve place a wood block 7 inches long inside the cylinder and rest the whole on a bench so as to support the valves. Using tool No. 11258 depress the valve springs and remove the split cones. Remove washers, springs, and retaining rings. The valves may then be pushed into the cylinder.

Clean all parts with gasoline and inspect the valves and magnaflux for cracks, burning and stem wear. Also examine the valve seats carefully for cracks and burning.

Do not re-face the valve seats unless absolutely necessary as a re-facing operation sometimes removes more material from the seat than is required. However, in the case of badly burned seats, re-facing is essential. It may even be necessary to install new seats. If so, the cylinder should be returned to the factory because these valve seats are shrunk into position, an operation requiring tools which are seldom available in the field. (See Part VI, Section 2F, last paragraph, for cylinder exchange. Also refer to Parts Price List.)

Before re-seating the valve, the valve guide should be inspected. If more than .004 wear is found, the valve guide should be replaced because it is impossible to properly seat the valve if the valve guide has excessive clearance.

For the method of changing guides, see instructions in Part VI, Section 2F, "Cylinder Assembly".

If it is absolutely necessary to reface the valve seats, two reseating cutters must be used - a 30° x 1-15/16" cutter for the intake seats and a 45° x 1-1/2" cutter for the exhaust seats. The pilot bar should be of 3/8" diameter for both intake and exhaust valves.

If cutters are employed, remember that they should be used sparingly. If extreme care is not used, they will remove an excessive amount of metal. Furthermore, care must be taken to see that they cut evenly. Otherwise, the seat will be wavy and will require an excessive amount of hand-lapping to remove the wave.

As previously mentioned, the re-seating operation of the valve seats is one which must be done with a great deal of care, because an extra wide valve seat means that the aluminum which is rolled over to help hold the seat in position is cut away. This means that the seat has nothing but a shrink fit to hold it in position. If the aluminum is cut away, it will be necessary to install new valve seats.

The carbon should be carefully cleaned from the valves, care being taken not to scratch the seats. It is also important to use emery cloth not coarser than No. 150 on the valve stems, since coarse cloth tends to remove the gloss from the stems together with the surface hardening produced by many hours of operation on the engine.

If the valves are burned, pitted or grained, intake valves should be refaced to a 30 degree angle, and exhaust valves to a 45 degree angle.

After refacing the valves and seats, they should be lapped-in by using a very fine grinding compound: A final check for leaks should be made by pouring gasoline in the ports - or with air pressure directed to the combustion chamber.

VALVE SPRINGS

Valve springs should be carefully examined for cracks after they have been thoroughly cleaned with gasoline. After they have been installed, they should be checked for loading.

The valve springs, when assembled to the cylinders, should support 50 to 60 pounds when the valve is on its seat. If the spring weight does not support at least 48 pounds, the spring should be removed and washers placed under the spring in sufficient numbers to bring tension up to the required limits. A weak spring tends to cause uneven firing under part throttle operation, while more than 60 pounds tends to overload the hydraulic unit. If a thickness of more than two 1/16" washers is

needed to bring the spring to the necessary tension, it means that the spring has weakened to a point where it must be replaced.

For cylinders machined with 1/8" deeper valve spring recess and equipped with 3/32" longer valve springs, the valve springs should support 50 to 60 pounds when the valve is on its seat. Old recesses are 25/32" deep and the new are 27/32" deep.

Dampers in the older valve springs (1-27/32" long) should be 31/32" long. If any are found to be longer, they should be ground off to proper length. Dampers in the later type springs (1-15/16" long) should be 1-1/8" long.

Rusty springs should all be replaced because they are apt to crack through and break. NOTE SEE BULLETIN NO. 23.

CYLINDERS

The cylinders should be checked for taper and out-of roundness by using an inside micrometer.

A cylinder which is worn more than .002 or .003 should be returned to the factory and exchanged for a cylinder of normal size; that is, 4.000 to 4.001. Measurements should be taken upward to a distance of approximately five inches (5") from the lowest edge of the cylinder skirt. Above that point an inward taper will probably be noted - that is normal.

This method of handling excess clearance is less costly to the operator than it is to re-grind the cylinders and use oversize pistons, because, under the exchange cylinder plan, it is customary to use the original pistons as they seldom wear out.

Before assembly, be sure that all parts are absolutely clean and in first-class condition. As the parts are being put together, oil all bearings and other contact surfaces in order to avoid the possibility of scuffing when the engine is first started.

If the valve leak test (see Part V, Section 2, "Top Overhaul") shows the valves to be right, - and if the cylinder has normal clearance, the valve mechanism can be reassembled to the unit.

Make sure that the oil hole in the rocker pin bearing is directed toward the cylinder.

Do not install the valve rocker caps on the cylinder until the cylinders have been installed on the crankcase. Otherwise it will be impossible to see whether the lifter rods are lining up properly at the ball end of the valve adjusting screws.

Do not tighten cylinder hold-down cap screws until cylinder tie plate has been installed across both cylinders to allow proper alignment of cylinders with crankcase. Cap screws should be tightened down evenly to insure an even pressure of cylinder to crankcase. Failure to do this often causes cracking of cylinder base flange.

ASSEMBLY OF CYLINDERS TO CRANKCASE

Before assembling the cylinders to the crankcase, the interior of the crankcase and cylinders should be inspected and cleaned.

New gaskets should always be used. The possible saving in using an old cylinder gasket may be more than offset by the added cost of an oil leak.

Cover the piston rings and the cylinder walls with a liberal coating of lubricating oil.

Use a band type of ring clamp over the piston rings before attempting to pilot the cylinder over the piston, then push very carefully. Otherwise the rings may be cocked and broken.

Draw up evenly on each of the cylinder holddown stud nuts.

The next important step is to properly adjust the valve clearance. With the No. 1 cylinder at the firing position and using special tool No. 10687, (See Parts Price List), PULL BACK ON THE ROCKER ARM UNTIL ALL THE OIL IS FORCED OUT OF THE HYDRAULIC LIFTER. This condition will be apparent when continued pressure no longer alters the gap between the valve stem and the rocker arm. At the time measurement is made make sure pressure is not applied severely enough to spring the rocker and obtain a false reading.

With the rocker arm in this position, it is a simple matter to adjust the screw on the push rod end to a point where a .040 gap is measurable between the top of the valve and the rocker arm.

If the engine has been totally dismantled and the hydraulic lifters cleaned and washed out, it will be unnecessary, of course, to squeeze the oil out of the lifter inasmuch as there will be no oil beneath the piston of the hydraulic lifter unit.

Clean all the spark plugs and check the gaps to see that they are .020 for the Champion J-10 or C-10-S (shielded) plugs. Care should be taken that there are no burrs on the threads of the spark plugs. This can be noticed if the plugs go in hard. In other words, if a plug cannot readily be screwed into position with the fingers, it is evident that there is a burr in the plug which is preventing its entrance. In this event, the plug should be carefully removed and the burr filed off. Also, extreme care should be taken to see that the plug is started straight, - as experience has shown that cylinders have been ruined because the plug was started in cocked, and forced in with a wrench.

When installing the exhaust stacks and air housings on the engine, be sure that the nuts on the studs, which hold the exhaust stacks in position, are not tightened excessively. Bring the nuts up to a snug position without forcing.

It is recommended that the engine be run in on the following schedule:

1000	R.P.M.	-	30 minutes	1500	R.P.M.	-	20 minutes
1100	"		" "	1600	"		" "
1200	"		" "	1700	"		" "
1300	"		" "	1800	"		" "
1400	"		" "	1900	"		" "

PISTON RINGS

At the time of top overhaul, install new piston rings. The average piston ring begins to lose its effectiveness at about the same time as the valves. Remove the old rings and thoroughly clean the ring grooves before new rings are installed. The top of the piston should be cleaned with Crocus cloth dipped in kerosene.

It is not necessary to remove the piston from the rod in order to install new piston rings.

Should it be desirable to remove a 4AC-199 piston from the connecting rod, simply push out the piston pin. If the piston is badly scratched, it can usually be re-finished with Crocus cloth; however, if the scratches are very deep and numerous, it is best to replace it with a new piston.

To install the piston pin, it is necessary only to push the pin through the piston and connecting rod.

If a new piston is required, it should be purchased with the pin fitted, insuring proper clearance between the piston and the piston pin.

Before installing rings, it will usually be noticed that there is a highly glazed finish in the cylinder barrel. This glaze should be broken by a spring loaded cylinder hone such as manufactured by the Automotive Maintenance Machine Co., of North Chicago, Illinois.

Be sure that the hone used is of the Spring loaded type and not of the Positive type.

After honing, the cylinders should be steam cleaned if possible. In any event, extreme care should be taken to see that all abrasive is removed from cylinders.

When the glaze is broken, the new rings will quickly find their seats. But, if the glaze is not broken, they will require several hundred hours to seat. In the meantime, excessive blow-by may damage the rings.

Perfect Circle Piston Rings are standard equipment on Franklin engines. Three different types of rings are used, a 3/32" type "200" is used in the top groove, a 3/32" type "70" in the middle groove and a 3/16" type "85" oil ring in the groove immediately above the piston pin.

It will be noticed that there is an oil ring groove below the pin in which no ring was installed. This oil ring groove was incorporated in the design to permit the installation of an added oil ring if it is impossible to properly control the oil with the regular ring combination, due to excessive clearance between piston and cylinder.

UNDER NO CIRCUMSTANCES SHOULD THIS ADDED OIL RING BE USED WITHOUT FIRST CONTACTING OUR SERVICE DEPARTMENT FOR INSTRUCTIONS.

NOTE Later type pistons have no lower oil ring groove below piston pin.

EXTERNAL OIL LINES

As a precautionary safety measure, it is recommended that all external oil lines be replaced at each top overhaul. Supports and clamps should be installed to prevent breakage from vibration.

PART VI

COMPLETE OVERHAUL

A complete overhaul should not be required before 500 hours, - the recommended point.

However, unusual operating conditions may cause excessive wear resulting in high oil consumption. The appearance of metal particles in the oil, or erratic operation in flight, may make a complete overhaul advisable before that time.

SECTION 1. - COMPLETE DISASSEMBLY

To dismantle an engine completely, it must be first removed from the plane.

Remove the propeller by simply taking out the bolts which hold it to the hub and crankshaft. Remove the exhaust pipes, throttle controls, gasoline line, engine bolts, etc. Then the engine may be easily lifted out of the plane by two persons.

The engine should be dismantled on a bench or on an assembly stand.

Because it is obviously impossible to do a first-class job unless all parts are thoroughly cleaned, the exterior of the engine should be thoroughly washed with gasoline before any work is undertaken. It is usually a good plan to have several clean boxes or cans available in which to place the parts as they are removed from the engine. Each part should be thoroughly washed with gasoline.

CAUTION: To prevent damage to parts, always use a fibre drift or mallet whenever it is necessary to separate or drive parts together.

A. REMOVING CYLINDERS

Remove the cylinders and dismantle assemblies, as explained in Part V, "Top Overhaul".

B. REMOVING PISTONS

See Part V, "Top Overhaul".

C. REMOVING ACCESSORIES

Remove the magneto, carburetor, crankcase cover, oil pan and timing gear case cover. To remove the crankshaft, it is first necessary to remove the starter ring gear and hub assembly with puller #10688. Then, take off the three nuts on the top side of the case; next, back-off the main bearing stud nuts and the camshaft bearing stud nuts.

Also, remove the through bolt at the propeller end under the crankshaft. The two halves of the crankcase will now come apart, and the crankshaft, as well as the camshaft, can be lifted out. Care should be taken in separating the halves of the crankcase as they are piloted on dowels. It may be necessary to tap lightly with a wooden mallet.

To remove the oil pump, proceed as outlined in Part III, Section 2B, "General Operation". (Also see fig. 5)

SECTION 2. - INSPECTION & REPLACEMENT OF PARTS

After disassembly, all parts should be cleaned and laid out in groups for inspection. As they are examined, make a list of all parts to be replaced. The correct fits and clearances for the parts are shown in Part VII, "Table of Fits and Clearances".

A. HYDRAULIC LIFTER ASSEMBLY

The cam followers should slide freely in the guide bosses in the crankcase.

These cam followers seldom have to be replaced for wear; however, they may require replacement due to "parking"; which occurs when the cam followers have not been rotating in the guide bosses, with the result that the cam marks a straight line across the faces.

The hydraulic valve lifter units usually last indefinitely; however, if they appear weak or incapable of holding pressure, they should be replaced.

B. VALVE LIFTER ACTUATING UNIT

To properly assemble the hydraulic valve lifter unit, use a short piece of lacing wire, preferably copper, and insert it in the small hole at the bottom of the lifter cylinder. This will raise the ball check from its seat and allow the unit to compress easily. After the unit has been pushed together, the spring should be snapped into the cylinder by pushing and twisting, in a clockwise direction, on the spring. This clockwise twisting motion should be used on both assembly and disassembly.

C. PUSH RODS

The ball end must fit tightly to the inside of the hydraulic unit. Otherwise, it will work up and down and cause erratic valve operation. If the ball end and cup end are not smooth and free from wear, they should be replaced. Push rods should also be checked for straightness. If bent, should be replaced. Care must be taken to make certain that the push rod fits into the hydraulic valve lifter unit.

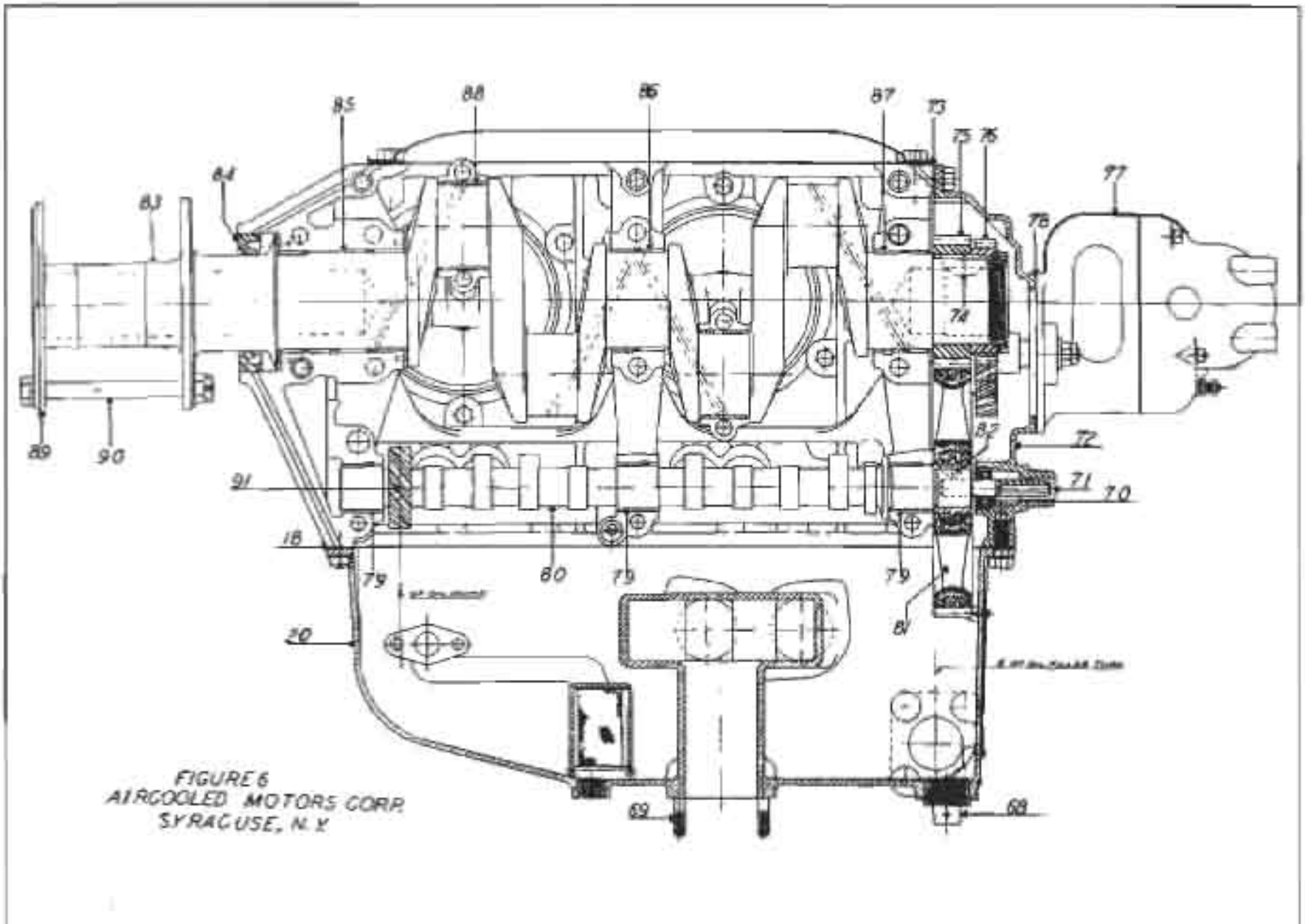


FIGURE 6
AIRCOOLED MOTORS CORP.
SYRACUSE, N. Y.

D. CAMSHAFT ASSEMBLY

The camshaft should be examined for wear on the bearing and cam surfaces. If the edges of the cams are worn, or chipped, the camshaft should be replaced.

Inasmuch as the camshaft bearings are of the interchangeable precision type, these bearings should be replaced when replacing crankshaft bearings.

E. CAMSHAFT GEARS

An improved type aluminum rim Celoron gear is now available and should be installed in place of the plain Celoron gear on this model. It will seldom be necessary to replace the aluminum rim type. However, at each overhaul this gear should be carefully examined for excessive wear and backlash between the crankshaft and camshaft gear teeth.

F. CYLINDER ASSEMBLY

Examine all cylinder parts following the instructions given in Part V, "Top Overhaul".

As a rule it is not necessary to replace valve guides until after 450 to 550 hours of service; however, if it should be necessary to replace them, all cylinders requiring new valve guides should be returned to the factory for guide replacement.

We recommend this because the guides are shrunk into the aluminum cylinder under heat at definite limits. When this work is done at the factory, the guide and the cylinder hole are carefully checked and oversize valve guides selected to give the proper fit.

However, because of time limitations, some operators will desire to make the guide replacement themselves. The best method of removing valve guides is to heat the cylinder head to 450° - 500° F. Drive guide into the cylinder, using a 3/8" pilot with shoulder to fit top edge of guide. It is imperative that this method be used to push out the guide, because, if it is pushed out the other way, the lower part of the guide will tend to make the guide hole in the cylinder oversize. While cylinder is still hot, cover the new guide with white lead and drive into cylinder head. After cylinder has cooled, the guide will have shrunk in place and is ready for valve installation, having been finished to size at the factory.

When installing new guides, use a special replacement part which is .001 oversize. If the guide hole becomes damaged, we can supply .002 and .005 oversize guides, which may be used after reaming the guide hole oversize.

Scored or worn cylinders are usually rebored and fitted with oversize pistons. In Franklin aircraft engines, however, it is recommended that the cylinder assemblies be returned to the factory and exchanged for cylinders with new cylinder barrels, ground and honed to standard size, new valve seats, new valve guides and new valves. This exchange is offered because the pistons usually last indefinitely. If dirt has entered the engine, the ring groove wear may necessitate piston replacement.

Under this plan of cylinder exchange (See Parts Price List) the operator receives cylinder assemblies capable of giving exactly the same service as new cylinders. In the long run this is much more economical than to attempt to re-grind the cylinders and install oversize pistons.

G. ROCKER ARMS

The rocker arms usually operate indefinitely, provided they have all been adequately lubricated; however, if the rocker arm bushing is badly worn, it should be replaced. Also, if the barrel end of the rocker arm is worn, the rocker arm assembly should be replaced.

However, in case only the rocker arm bushing needs to be replaced, this should be done at the factory where the bushings are precision-bored to the correct diameter.

H. PISTON & RINGS

The pistons should be carefully examined and cleaned. The piston pin should be a push fit at a temperature of 120° F. When the engine was originally built at the factory, the pin was snug-push fit into the piston. If the pin is looser than .0006 in the piston, it should be replaced with a .001 oversize pin. If the pistons are badly scratched, or the ring grooves worn, a new piston should be used. If the ring grooves are in good condition and the piston only slightly scratched, rub with a Crocus cloth, dipped in kerosene, or a fine oil stone.

Use new piston rings when top or major overhauling the engine. The new rings should fit freely into the ring grooves of the piston. Otherwise there may be a tendency for the rings to stick when the engine is again placed in operation.

I. PISTON PINS

The piston pin should be carefully examined to see that the aluminum plugs fit tightly in the pin proper. If they do not fit tightly, it will be necessary to replace the entire pin assembly. Marking of the cylinder walls by the aluminum piston pin plugs in no way interferes with the proper functioning of the piston.

Piston pins should be magnafluxed at time of top or major overhaul.

J. CRANKCASE

The crankcase is cast in two pieces of high-strength aluminum alloy, divided through the center line of the camshaft and crankshaft. Each half is piloted to the other with hollow dowels through which the bearing studs pass. There are eight main bearing studs and three camshaft bearing studs. In addition, there are two through bolts and one stud at top of case.

On the propeller end of the castings are packing grooves in which are laid part number 24x31, a synthetic rubber packing. There is also, a short groove at the top of magneto end of case. Thirteen inches of this material are furnished when ordering service packing. This packing prevents oil seepage through the ends of the case.

At this point it is advisable to see that the crankshaft oil seal is in perfect condition. Scratches in the material may cause annoying oil leaks. If any scratches are evident, a new seal should be installed. Installation of crankshaft oil seal should be done carefully. Apply Permatex to the surface of the seal coming in contact with the crankcase. The seal should be pushed into the crankcase so as to be flush with outer surface of the snout. If pushed in too far, it will seal the oil drain which may cause serious leakage.

After the crankshaft and camshaft have been installed and the two halves of the case bolted together, care should be taken to see that crankshaft and camshaft turn freely without any binding. Be sure that halves of case are drawn together tight in order to eliminate oil leaks.

K. TIMING GEARS

We recommend replacing the Celoron camshaft gear and the Celoron magneto gears at time of major overhaul.

See "S" on Electrical Equipment.

L. TIMING GEAR CASE

The timing gear case should be thoroughly examined, - primarily with the idea of detecting checks or cracks. Also be sure the tachometer drive oil seal is in serviceable condition. If the rubber seal appears torn or incapable of sealing the tachometer drive shaft properly, it will be necessary to replace the old seal. The best way to do this is, pick out the old seal with a sharp pointed tool and tap the new seal into position with a small wooden block.

If the propeller has ever been broken, the ship nosed over, or the ship has ever had a crash landing, the studs should be removed from the timing gear case, and the magneto faces of the timing gear case checked on a face plate, at time of next major overhaul. When starter and generator are used, the generator face should also be checked. If face is warped out of shape, more than .003 of an inch, the case should be replaced.

M. CRANKCASE COVER

Examine the crankcase cover for checks or cracks. It is always best to use a new gasket when replacing cover.

N. EXTERNAL OIL LINES

Clean out all fittings. Make certain they are clear; otherwise the valve mechanism will not receive the proper amount of oil. As a safety precaution, it is our recommendation that these oil lines be replaced with new lines at time of overhaul. Also supports and clamps should be installed to prevent breakage from vibration.

O. OIL PUMP ASSEMBLY

The oil pump should be carefully examined to see that the gears are not worn, or the pump body scored. Though it will rarely be necessary, we recommend that a new pump be installed if there is any indication that it is not in first-class condition.

P. INTAKE PIPES

Examine the intake pipes for cracks, giving special attention to the beaded flanges at the cylinder end and rubber packings at each end.

Q. CONNECTING ROD ASSEMBLY

All connecting rods should be carefully examined and magnafluxed for cracks. The cap bolts and nuts should be thoroughly inspected to see that the threads are in good condition. Otherwise they should be replaced. Connecting rods should be magnafluxed if possible.

The small bushing in the upper end of the rod should be examined to see that it is not out of position. This condition can be corrected by lining up the oil holes in the connecting rod with the holes in the bushing. It should also be examined for wear. In the 6AC-264, the inside diameter should not exceed .861. In the 6AC-298, this diameter should not exceed .984. If bushings are larger than these dimensions, the connecting rod should be returned to the factory where new bushings, precision bored to the right dimension, will be installed.

After 450 to 550 hours of operation, we recommend that new connecting rod bushings be installed; however, before ordering bushings, measure the diameter of the crank pins to see that they are not worn excessively. See Crankshaft below for permissible wear measurement.

R. CRANKSHAFT

If the crank pin journals have worn .001 or .0015 out of round, and are more than .001 tapered, it will be necessary to have the crankshaft re-ground to one of the standard undersizes. This re-grinding should be done only where proper facilities are available. It is important in re-grinding that all fillets be carefully ground to .125-.135 radius and be free from grinding marks. After re-grinding, the shaft should be checked for balance and must be magnafluxed for cracks.

The main journals should be measured for wear. If such inspection shows the diameter to be less than 2.248, or tapered in excess of .0015 or out of round more than .001, the shaft should be re-ground .010 undersize or 2.2395 - 2.2400.

Main bearing bushings should be examined carefully for wear or cracks. Also examine the thrust faces on the front main bushing.

S. ELECTRICAL EQUIPMENT

Aircooled Motors Corporation has adapted high production automotive electrical equipment for use on Franklin aircraft engines, bringing for the first time electrically equipped aircraft to the airport operator and private owner at a price he can afford to pay.

By using automotive electrical equipment, the airport operator and private owner has available the service of many hundreds of automotive electrical equipment stores throughout the nation. The reliability of present day automotive equipment is known to every automobile driver. With reasonable care the electrical equipment on Franklin aircraft engines should give hundreds of hours of trouble-free service.

W A R N I N G

BEFORE WORKING ON ELECTRICAL EQUIPMENT, DISCONNECT ONE OF THE BATTERY LEADS TO PREVENT INADVERTENTLY TURNING PROPELLER.

ALWAYS BE SURE PROPELLER IS CLEAR BEFORE STARTING ENGINE.

GENERATOR

The generator on your Franklin engine has a three brush, fused, positive ground circuit, equipped with two-stage regulator that needs no adjustment. If for any reason the generator does not charge, inspect the fuse and replace if burned out.

If the fuse has burned out, it indicates an overload or an open circuit in the electrical system, and the cause of overload or open circuit should be determined. The generator must not be run if the circuit is open.

When the airplane is used for short flights and frequent starts, the third brush should be set to generate not more than eight (8) amperes. If the airplane is used for long flights, the third brush should be set to generate four (4) amperes. To generate more current, move the third brush in direction of rotation.

The generator should be oiled at each 100 hour check and the brushes should be examined at each 50 hour check. If the brushes are worn near the brush holders, they should be replaced or damage to the commutator may occur. At this point, it is advisable to have your nearest Auto-Lite distributor turn down the commutator. Never use sandpaper, or emery cloth on the commutators.

Your generator is driven by a special shock absorbing gear. This gear should be examined at each top overhaul period, the gear removed from the driving hub and the rubber shock absorbers replaced.

See "T" for generator gear backlash.

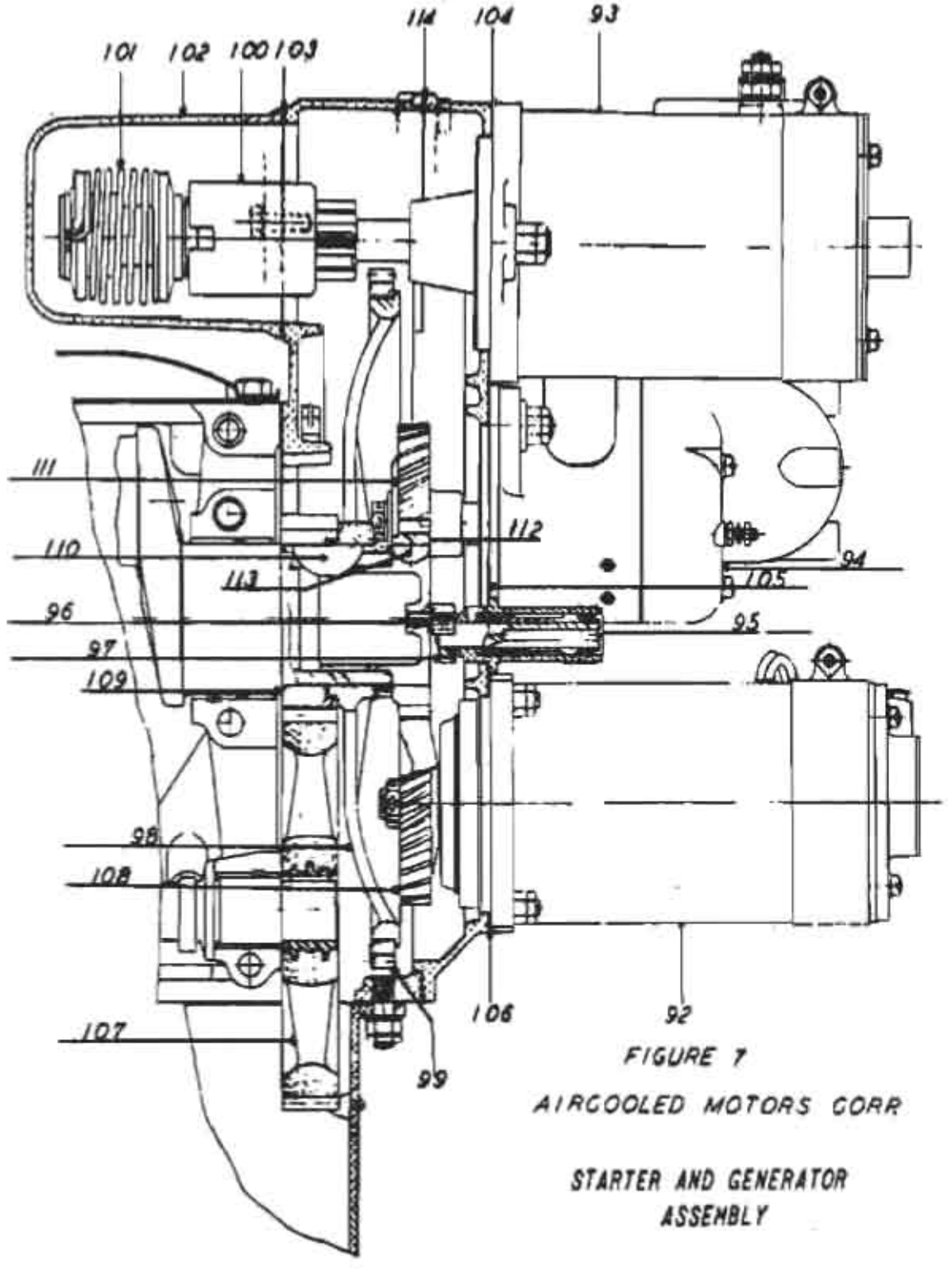
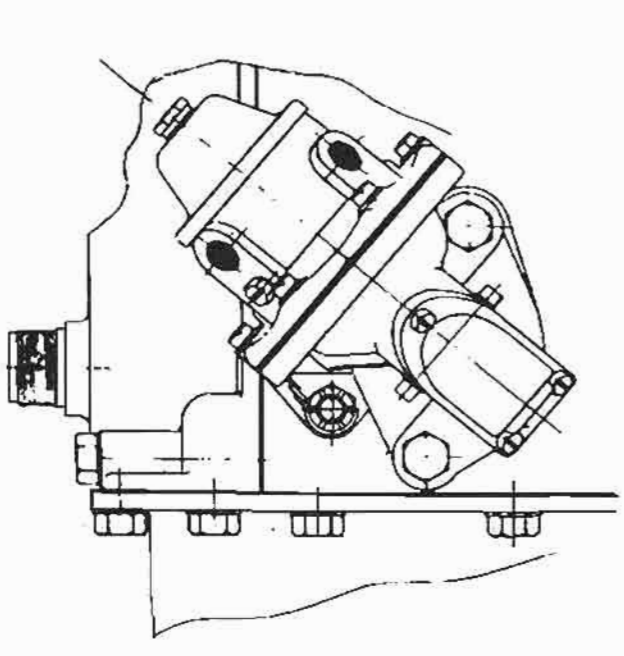


FIGURE 7

AIRCOOLED MOTORS CORR

STARTER AND GENERATOR ASSEMBLY

FUEL PUMP ASSEMBLY



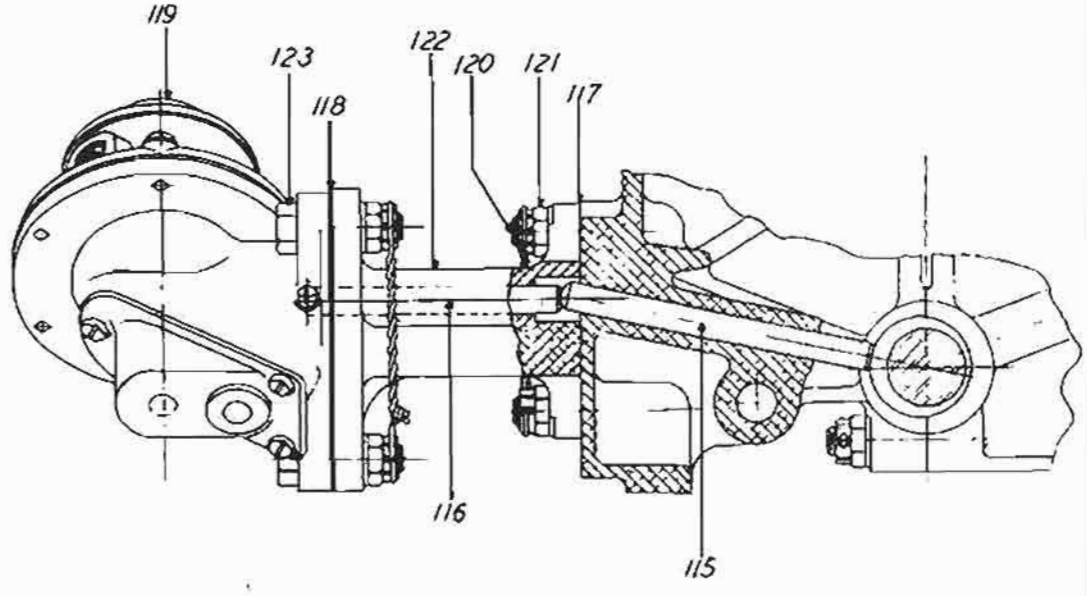


FIGURE 8

AIRCOOLED MOTORS CORP.

STARTER

Your starter is controlled by a solenoid starter switch mounted on the starting motor with push button control mounted on the dash. The starting unit will require little attention.

Check the brushes and commutator at each major overhaul period, following same instructions as for generator.

Check all wiring on both starter, generator and battery for possible shorts and loose connections at each 100 hour check.

If any evidence of oil is found in starter, remove starter and replace oil seal at drive end.

T. ACCESSORY CASE

Your starter, generator, tachometer drive and both magnetos are carried on one accessory case. The alignment of all the gears depends upon the proper alignment of this case. Care should be taken to use factory gaskets of the proper thickness and material. Also be careful not to distort case or dowels upon removal or replacement.

The recommended procedure for removing and reassembling starter, generator and magneto gears is as follows:

1. Remove starter, generator, and both magnetos.
2. Remove timing gear case.
3. Fasten block portion of gear puller (using special tool, part #10688) to generator and magneto drive gear hub with two 5/16 inch cap screws.
4. Hook gear puller jaws over end of puller block and pull the gear and hub.
5. Remove starter gear lock.
6. Fasten gear puller jaws in the two larger divisions of the starter gear webbing and pull the gear.
7. To reassemble the starter gear, heat gear in oven to 300° F. White lead should be applied on starter gear hub and the gear dropped on crankshaft, care being taken that the slot in the gear lines up with the key in the shaft. This method prevents scoring or feathering of gear hub which is liable to occur when pressed on cold. Then install the lock and lock ring.
8. Line up the slot in the magneto and generator drive gear assembly with the key in the shaft and drive up tight to the shaft. Drive only on the hub. If pressure is put on the gear it will be thrown out of alignment.

When replacing the accessories, replace the generator first, allowing approximately .004 backlash. This can be determined through the magneto openings in the case. Next, replace the tachometer drive allowing approximately .006 backlash to be checked through

magneto opening. Magnetos should now be timed and drive gears should be allowed approximately .002 backlash. Magneto gear backlash may be checked through starter opening. The starter Bendix Drive will not require backlash check.

In extreme instances: If the proper backlash cannot be secured, it is possible to scrape the openings in the accessory case, thus allowing the accessory in question to shift enough to secure proper backlash.

RE-ASSEMBLY AFTER COMPLETE OVERHAUL

Before starting re-assembly of the engine, all steel parts should be magnafluxed for checks and cracks. This should be done by an operator well versed in the use of magnafluxing equipment.

The use of new gaskets throughout is recommended. We do not recommend the use of any gasket paste or liquid except in connection with crankshaft oil seal. When used, this material often gets into the engine and may cause considerable damage by plugging oil passages.

It is important that assembly of the engine be undertaken in a clean, light place, free from drafts which would tend to blow dirt on or into the engine. The crankcase should first be carefully washed with clean gasoline and blown out with compressed air. Wipe out the camshaft and crankshaft bearing seats carefully. Install bearing shells, with special attention that oil holes in shells line up with drilled holes in case; now oil liberally. Install oil seal on crankshaft. Lay crankshaft and camshaft in one half of the case, being sure that gear marks on both shafts coincide.

Make certain that hollow dowels are replaced if they were removed. Next put the synthetic rubber packing in the grooves at front and back.

Place other half of case in position; put flat washers and nuts on all the bearing studs and draw all nuts up snugly. Next put the two long tie bolts through top of case with flat washers under nuts. If crankshaft turns freely, nut should be tightened and safetied. Again check crankshaft to see that it does not bind.

It is also necessary to check the oil seal at propeller end of case before drawing the cases together.

The next operation concerns the installation of the connecting rods. Wash them carefully and install bushings. Care should be used in the assembly of connecting rods to the crankshaft. It is important that the parting surfaces be in good condition because the life of the bearing is greatly dependent upon the amount of crush imparted to it by the cap. Be sure that the oil holes in the shell, which are used in the connecting rod, line up with the squirt holes drilled in the rod. Oil the crank pins

before installing the rod. After rods are in place, check them for freedom and proper fit. If the rod is tight, it is probably because the bearing is riding the fillet. This condition can be corrected by removing the connecting rod and cutting a radius on both edges of the bearing insert. After rods are properly installed, mount the pistons and proceed with installation of cylinders as outlined on Page 18.

Next install the timing gear case. We recommend the use of a new gasket. It is important that great care be used in slipping the oil seal over the tachometer drive spigot because rough handling may damage the oil seal. Make sure that all dowel pins are in place before tightening timing gear case to the block as these dowels control the alignment of the magnetos with the crankshaft.

CAUTION: Be sure that engine is set on No. 1 center. This can be determined by pressing in on the two valve tappets on No. 1 cylinder and rotating the crankshaft several degrees in each direction to make sure that they do not move. If either valve lifter moves, the crankshaft must be turned over one full revolution to be in proper time. This position is indicated by the mark on the propeller hub flange on the crankshaft.

In addition to the top center mark on the flange, there is another mark on the flange 28° before top center. When setting magnetos, the 28° timing mark should coincide with the parting line of the crankcase.

The right hand magneto, viewed from the pilot's seat, fires the spark plugs over the exhaust ports and the left hand magneto fires the plugs over the intake ports.

The most accurate way to time the magneto is as follows:

Remove the distributor cap from the magneto. Turn shaft until impulse clicks on No. 1 cylinder. Then turn backwards until points are nearly closed. Put a piece of .001 shim stock between points and turn backwards until shim stock is tight between points. Install magneto on timing gear case but do not tighten nuts. Rock magneto until shim stock is just free and tighten nuts, safety with palnuts.

If .001 shim stock is not available, a piece of cellophane may be used; however, if cellophane is used, care should be taken to remove any wax that may have been deposited on the points from the cellophane.

Installation of piston rings, see Part V, "Top Overhaul".

Installation of cylinders, see Part V, "Top Overhaul".

Installation of high tension wires, Firing Order 1-4-2-3

After the assembly has been completed, run the engine in, in accordance with the instructions given in Part V, Section 2, "Top Overhaul".

Three special tools: A gear puller, inlet manifold packing assembly tool, valve lifter rod tube puller and setting tool.

PART VII

TABLE OF FITS AND CLEARANCES

MODEL 4AC-199

	Min.	Desired	Max.	Max. Permissible After Wear
1. Crankshaft bearings center and gear end	.0015	.002	.0035	.006
2. Crankshaft bearings propeller end	.0015	.002	.0035	.006
3. Crankshaft thrust bearings and clearance	.004	.008	.012	.014
4. Connecting rod and crank pin	.001	.0015	.0025	.006
5. Piston pin and rod	.0005	.0007	.0009	.002
6. Piston and piston pin	.0000	.0001 tight	.0002 tight	.002
7. Cylinder and piston (Sterling) (4.000 dia.	.0025	.0030	.0035	.007
(4.250 dia.	.00275	.0030	.00375	.007
8. Camshaft small bearing	.001	.002	.0025	.004
9. Camshaft end movement	.002	.004	.006	.010
10. Valve rockers and pins	.002	.003	.0035	.006
11. Valve lifters and crankcase	.001	.001	.002	.004
12. Valve stems and guides	.0025	.0034	.0043	.006
13. Oil pump drive shaft and pump body	.001	.0015	.0025	.004
14. Oil pump driven gear and shaft	.001	.0015	.002	.004
15. Oil pump gears, pump body and cover	.0035	.004	.0075	.009
16. Backlash - camshaft and crankshaft gears	.000	.001	.002	.006
17. Piston ring and groove - top - Perfect Circle	.0055	.0062	.007	.009
18. Piston rings and groove - second - Perfect Circle	.0035	.0042	.005	.007
19. Piston ring and groove - third - Perfect Circle	.002	.00275	.0035	.0055
20. Piston ring - butt clearance	.025	.029	.035	.050 – .012 to .014
21. Side clearance - connecting rod and crankshaft	.006	.009	.012	.014
22. Push rod and crankcase (Fuel Pump)	.002	.002	.006	.008

Track Housing to Gear 0.004 to 0.006

PART VIII

TORQUE WRENCH SPECIFICATIONS

Model 4AC-199

	Size	Ft. Lbs.	Inch Lbs.
Connecting rod bolt nuts	3/8-24	25-30	300-360
Cylinder hold-down nuts & cap screws	3/8-24	33	395
Cylinder hold-down nuts & cap screws	7/16-20	40	480
Main crankshaft bearing stud nuts	3/8-24	30	360
Camshaft bearing stud nuts	5/16-24	20	240
Long through crankcase bolt nuts	5/16-24	20	240
Oil pump by-pass plate cap screws	5/16-18	15	180
Rocker support stud nuts	5/16-24	10-12	120-145
Oil pan fillister head screws	5/16-18	5-6	60-75
Crankcase cover cap screws	5/16-18	5-6	60-75
Rocker adj. screw nuts	5/16-24	10-12	120-145
Spark plugs in cyl. heads	14 m.m.	15	180
Magneto flange stud nuts	5/16-24	7-8	85-95
Starter flange stud nuts	3/8-24	20	240
Generator flange stud nuts	1/4-28	5	60
Oil pump to crankcase cap screw	1/4-20	5-6	60-75
Gear case to crankcase cap screws	5/16-18	10-12	120-145
Gear case to cover cap screws	1/4-20	5-6	60-75
Inlet pipe flange to cyl. head cap screw	5/16-18	15	180
Inlet pipe flange to oil pan cap screw	5/16-18	15	180
Motor mount to crankcase stud nuts	5/16-24	20	240

PARTS and SERVICE

IMPORTANT!

Save time and shipping expense by ordering all parts from the Distributor in your territory. Send your order directly to him. Be sure to specify model and serial number of engine for which parts are ordered.

AUTHORIZED FRANKLIN PARTS & SERVICE STATIONS

ALABAMA

Southern Airways Sales Co., Inc.
Municipal Airport, Birmingham, Ala.
Telephone: 9-2142

CALIFORNIA

Hagelin Aircraft Motors Co.
933 Airway, Glendale 1, Calif.
Telephone: Citrus 1-1651

Stinson Flying Corporation
Belmont Airport, Belmont, Calif.
Telephone:

CANADA

Cub Aircraft Co., Ltd.
Hamilton, Ontario, Canada
Telephone: 5-1133

Leavens Bros. Air Services, Ltd.
Barker Airport, Toronto, Canada
Telephone: MELrose 5791-2

FLORIDA

D. H. Wallace
Municipal Airport, Clarcona, Fla.
Telephone: Orlando County 31814

Palm Beach Aero Corporation
Lantana, Florida
Telephone: 9892

GEORGIA

Aviation Supply Corporation
Atlanta Municipal Airport
Hapeville, Georgia
Telephone: Calhoun 1107-8

Blevins Aircraft Corporation
Atlanta Municipal Airport
Hapeville, Georgia
Telephone: CA 1672

ILLINOIS

Snyder Aircraft Corporation
Municipal Airport, Chicago, Ill.
Telephone: Portsmouth 5900

Tufts-Edgecumbe, Inc.
Pal-Waukee Airport, Des Plaines, Ill.
Telephone: Wheeling 33-34-35

INDIANA

Muncie Aviation Corporation
Muncie Airport, Muncie, Indiana
Telephone: 2-2236

IOWA

Hunter Flying Service
Municip. Airport, Cedar Rapids, Iowa
Telephone: 3-1436

Beacon Airmotive Equipment Co.
LeMars, Iowa
Telephone: 351

KANSAS

Harte Flying Service
Municipal Airport, Wichita, Kansas
Telephone: 6-6114

KENTUCKY

Louisville Flying Service, Inc.
Bowman Field, Louisville 5, Ky.
Telephone: Highland 0070

MAINE

Airways, Inc.
Municipal Airport, Waterville, Maine
Telephone: 2300

MARYLAND

Baltimore School of Aeronautics, Inc.
Curtiss-Wright Airport
Baltimore, Maryland
Telephone: FORest 3377

MASSACHUSETTS

E. W. Wiggins Airways, Inc.
Metropolitan Airport,
Norwood, Mass.
Telephone: CANton 0770

Jennings Bros. Air Service
Worcester Airport,
North Grafton, Mass.
Telephone: 768

MICHIGAN

Barr Aviation Company
Detroit City Airport, Detroit, Mich.
Telephone: ARlington 9584

Michigan Central Airlines, Inc.
Bishop Airport, Flint, Michigan
Telephone: 4-2621

MINNESOTA

Von Dusen Aircraft Supplies
2004 Lyndale Avenue, South
Minneapolis 5, Minnesota
Telephone: Kenwood 1852

MISSOURI

Ong Aircraft Corporation
Ong Airport, Kansas City, Mo.
Telephone: Republic 1123

Springfield Flying Service, Inc.
Municipal Airport, Springfield, Mo.
Telephone: 2418

St. Louis School of Aeronautics
Lambert Airport, Robertson, Mo.
Telephone: Terryhill 53130

Supply Division, Inc.
Lambert Airport, Robertson, Mo.
Phone: Terryhill 5-3880 (St. Louis)

SPECIFY MODEL and SERIAL NUMBER of ENGINE

NEW YORK

F & G Engine Company
105 Jericho Turnpike,
Mineola, L. I., N. Y.
Telephone: Garden City 1532

Buffalo Aeronautical Corporation
Buffalo Airport, Buffalo 11, N. Y.
Telephone: HUmboldt 5302

Niagara From The Air, Inc.
Bell Aircraft Airport,
Tonawanda, N. Y.
Telephone:

Ithaca Flying Service, Inc.
Ithaca, New York
Telephone: 8-625

Standord Aviation, Inc.
Walden, New York
Telephone:

NORTH CAROLINA

Piedmont Aviation, Inc.
Smith Reynolds Airport
Winston-Salem 1, North Carolina
Telephone: 3-2444

Carolina Aircraft Sales
Brockenbrough Field
Charlotte, North Carolina
Telephone: 4-7862

OHIO

Philip A. Meinke
Municipal Airport, Willoughby, Ohio
Telephone: 831

Midwest Aviation Corporation
Norton Field, Columbus, Ohio
Telephone: EV-4921

Tri-State Aviation Corporation
Cincinnati Airport, Sharonville, Ohio
Telephone: Sycamore 8500

Tuscarawas County Aviation, Inc.
Municipal Airport
New Philadelphia, Ohio
Telephone: 22031

OKLAHOMA

J. H. Burke Aviation Service
Wiley Post Airport
Oklahoma City, Oklahoma
Telephone: 8-2136

OREGON

A. W. Whitaker
5001 N. E. Union Avenue
Portland, Oregon
Telephone: Garfield 2317

PENNSYLVANIA

Krantz Aeronautical Corp.
Port Erie Airport, Erie, Pa.
Telephone: 32-198

SOUTH CAROLINA

Hawthorne Aero Supply
Orongeburg, South Carolina
Telephone: 1128

TENNESSEE

Southern Air Service
Municipal Airport, Memphis, Tenn.
Telephone: Long Distance, Station
No. 2, Glover, Miss.

TEXAS

Lou Foote Flying Service
Lancaster, Texas
Telephone: W-1131

Hangar Six, Inc.
Stinson Field, San Antonio, Texas
Telephone:

Southwest Aircraft
Meacham Field, Fort Worth 6, Texas
Telephone: 61179

Aircraft Sales Company
Meachem Field, Fort Worth, Texas
Telephone. 6-5491

VIRGINIA

Richmond Air Transport & Sales Corp.
R. E. Byrd Municipal Airport
Richmond, Virginia
Telephone:

Virginia Cub Distributors
Shadwell, Virginia
Telephone. RURAL 7131

WASHINGTON

Northwest Aircraft Distributor Co.
Vancouver, Washington
Telephone. 1960-W

WEST VIRGINIA

Glenn T. Clark
Clark Field, Winfield, W. Va.
Telephone: St. Albant 912W2

WISCONSIN

Stanislaw's, Inc.
Municipal Airport, Kenosha, Wis.
Telephone:

SOUTH AMERICA

Mesbla S. A, Rio de Janeiro, Brazil

PART IX

PARTS PRICE LIST

FRANKLIN AIRCRAFT ENGINES

MODEL 4AC-199

Revised as of May 1, 1947

REMEMBER: WHEN YOU CONTACT YOUR DISTRIBUTOR OR THE FACTORY FOR PARTS OR SERVICE, PLEASE GIVE THE ENGINE NUMBER AND THE APPROXIMATE DATE OF ITS DELIVERY TO YOU.

PART NO.	DESCRIPTION	REF. NO.	NO. PER ENGINE	PRICE EACH $	
	I				
	CAMSHAFT				
11125	Camshaft	80	1	23.52	
10219	Camshaft & Tachometer Drive Assembly (Without Starter & Generator)	80	1	20.00	
10725	Camshaft Gear (Aluminum Rim)	81-107	1	6.00	
17708	Camshaft Bushing (#2 & 4 Half)	79	3	.30	
17707	Camshaft Bushing (#1 & 3 Half)	79	3	.38	
6x15	#6 Woodruff Key (Gear to Shaft)	82	1	3.20	per C
5449	Tachometer Drive Connector (Without Starter & Generator)	71	1	.60	
	II				
	CARBURETOR				
10585	Carburetor (Altitude Adjustment) (Marvel A 10-2302)	31	1	42.35	
5452	Carburetor Gasket		1	.06	
5137	Carburetor Stud	69	4	.57	
23x14	Palnut 1/4-28) Carburetor to		4	.60	per C
3x211	Nut 1/4-28) Oil Pan		4	1.40	per C

PART NO.	DESCRIPTION	REF. NO.	NO. PER ENGINE	PRICE EACH $
	III			
	CONNECTING RODS			
10462	Connecting Rod Assembly (Includes Piston Pin Bushing, Cap, Bolts & Nuts)		4	16.00
17738	Connecting Rod Bushing (Piston End) NOTE: See Instruction Book on Piston Pins	54	4	.22
17684	Connecting Rod Bolt	50	8	1.00
12201	Connecting Rod Bolt Nut	49	8	.36
8x112	Cotter Pin - 3/32 x 3/4	52	8	.30 per
10037	Connecting Rod Bushing	88-51	8	.90
10381	Connecting Rod Bushing (.010 Undersize)		8	1.28
10382	Connecting Rod Bushing (.020 Undersize)		8	1.29
	IV			
	CRANKCASE			
10507	Crankcase Assembly (Without Provision For Fuel Pump)	1	1	236.98
10517	Crankcase Assembly (With Provision For Fuel Pump)	1	1	236.98
10108	Crankshaft Bearing Stud (Inside Lower Front & Center)	6	4	.92
10109	Crankshaft Bearing Stud (Front Upper With Dowel)	6	1	1.65
10111	Crankshaft Bearing Stud (Lower Front With Dowel)		1	1.29
10482	Crankshaft Bearing Stud (Lower Rear)		1	1.30
10483	Crankshaft Bearing Stud (Upper Rear)		1	1.17
10107	Camshaft Bearing Stud		3	.78
17709	Crankcase Dowel		2	.19
10167	Crankcase Stud (Front Tie)	3	1	1.07
5095	Crankshaft Bearing Stud Washer		8	.02
5573	Crankcase Breather Tube (Rigid)		1	1.00
10192	Cylinder Hold-Down Stud 7/16	9	16	.91
10207	Cylinder Hold-Down Stud 3/8		16	.42
3x84	Nut - 5/16-24 Castle) Tie Bolt Cam-		6	5.50 per
5x22	Washer - 5/16 Plain) shaft Bearing stud		8	.66 per
2x412	Hex Head Screw - 5/16-24 x 7-3/16 (Tie Bolt)		2	1.28

PART NO.	DESCRIPTION	REF. NO.	NO. PER ENGINE	PRICE EACH $	
23x21	Nut - 3/8-24 Slotted (Crankshaft Bearing Stud)	7	8	.36	
24x31	Synthetic Rubber Packing		9-1/8"	.09	
19x17	Shakeproof Washer - 5/16		16	.50	per C
17x11	Pipe Bushing - 1/4 x 1/8 (In By-Pass Plate)		1	.45	
8x118	Cotter pin - 1/16 x 5/8 (Tie Bolt & Camshaft Bearing Stud)		6	.84	per C
7x32	Pipe Plug 1/4 Slotted Headless		3	.11	
2x171	Hex Head Screw - 5/16-18 x 1-1/8 (By-Pass Plate to Crankcase)		4	3.23	per C
10489	Oil By-Pass Plate Gasket (Pressure Connection)	17	1	.02	
10491	Oil By-Pass Plate Gasket (When Oil Cooler Is Used) Special for Monocoupe)	17	1	.02	
10472	Oil By-Pass Plate (Pressure Connection)	16	1	4.40	
10474	Oil By-Pass Plate (When Oil Cooler Is Used) Special for Monocoupe (1/4" Pipe)	16	1	3.87	
10371	Crankcase Bearing Stud Packing		1	.08	
10105	Crankcase Bolt, Stud & Oil Header Packing		4	.11	
32x13	Lacing Wire (.041 Steel)		20"	.02	per ft.
28x811	Brass Dowel - 1/8 x 1/4		8	2.10	per C
8x112	Cotter Pin		4	.30	per C
10968	Oil By-Pass Plate) When Oil Cooler Is	16	1	4.62	
10969	Oil By-Pass Plate Gasket) Used 3/8" Pipe	16	1	.02	

V

CRANKCASE COVER

10170	Crankcase Cover (With Oil Filler Hole)	2	1	5.62	
10070	Crankcase Cover	2	1	.75	
10071	Crankcase Cover Gasket		1	.46	
2x169	Crankcase Cover Screw	4	12	3.10	per C
19x17	Crankcase Cover Screw Washer		12	.50	per C

PART NO.	DESCRIPTION	REF. NO.	NO. PER ENGINE	PRICE EACH	
	VI				
	CRANKSHAFT, GEARS & BUSHINGS				
10458	Crankshaft	83	1	90.20	
10063	Crankshaft Thrust Washer		4	.47	
10249	Crankshaft Gear (Engine With Starter & Generator)	75-109	1	5.25	
10248	Crankshaft Gear (Engine Without Starter & Generator)	75-109	1	4.95	
6x110	#16 Woodruff Key - Gear to Shaft	74-110	1	7.00	per C
10062	Crankshaft Bushing (Gear End #2 & 4)	87	1	1.18	
10393	Crankshaft Bushing .010 Undersize (Gear End #2 & 4)	87	1	1.35	
10394	Crankshaft Bushing .020 Undersize (Gear End #2 & 4)	87	1	1.47	
10061	Crankshaft Bushing (Gear End #1 & 3)	87	1	1.15	
10391	Crankshaft Bushing .010 Undersize (Gear End #1 & 3)	87	1	1.34	
10392	Crankshaft Bushing .020 Undersize (Gear End #1 & 3)	87	1	1.90	
10060	Crankshaft Bushing (Center #2 & 4)	86	1	1.47	
10389	Crankshaft Bushing .010 Undersize (Center #2 & 4)	86	1	1.32	
10390	Crankshaft Bushing .020 Undersize (Center #2 & 4)	86	1	2.11	
10059	Crankshaft Bushing (Center #1 & 3)	86	1	1.38	
10387	Crankshaft Bushing .010 Undersize (Center #1 & 3)	86	1	1.16	
10388	Crankshaft Bushing .020 Undersize (Center #1 & 3)	86	1	2.19	
10058	Crankshaft Bushing (Prop. End #2 & 4)	85	1	1.16	
10385	Crankshaft Bushing .010 Undersize (Prop. End #2 & 4)	85	1	1.34	
10386	Crankshaft Bushing .020 Undersize (Prop. End #2 & 4)	85	1	2.19	
10057	Crankshaft Bushing (Prop. End #1 & 3)	85	1	1.26	
10383	Crankshaft Bushing .010 Undersize (Prop. End #1 & 3)	85	1	1.98	
10384	Crankshaft Bushing .020 Undersize (Prop. End #1 & 3)	85	1	2.05	
10040	Crankshaft Oil Seal	84	1	4.03	

PART NO.	DESCRIPTION	REF. NO.	NO. PER ENGINE	PRICE EACH
	VII			
	CYLINDER ASSEMBLY			
11059	Cylinder Assembly (Sodium Exhaust Valve)	5	4	85.00
10829	Cylinder Assembly	5	4	75.00
10481	Cylinder Gasket	44	4	.03
10194	Cylinder Tie Plate		2	.40
10213	Cylinder Tie Plate Gasket		4	.02
3x94	Nut - 3/8-24 (Cylinder to Crankcase)	8	16	5.00 per C
3x92	Nut - 7/16-20 (Cylinder to Crankcase)	8	16	6.00 per C
23x12	Palnut - 7/16-20 (Cylinder to Crankcase)		16	1.00 per C
23x11	Palnut - 3/8-24 (Cylinder to Crankcase)		16	.90 per C
	CYLINDER EXCHANGE POLICY: Upon return to the factory, transportation prepaid, of old, cylinder in usable condition, subject to inspection at the factory, including valves, guides, seats, springs, & Rock assemblies complete, we will exchange identical factory conditioned cylinder assemblies.			
	VIII			
	MANIFOLDS			
10100	Inlet Pipe (Cylinder #4)(Used With 5 qt. Oil Pan)	15	1	1.51
10099	Inlet Pipe (Cylinder #3)(Used With 5 qt. Oil Pan)	15	1	1.51
10098	Inlet Pipe (Cylinder #1 & 2) (Used With 5 qt. Oil Pan)	15	2	.86
10212	Inlet Pipe (Cylinder #4) (Used With 8 qt. Oil Pan)	15	1	1.43
10211	Inlet Pipe (Cylinder #3) (Used With 8 qt. Oil Pan)	15	1	1.43
10210	Inlet Pipe (Cylinder #1 & 2) (Used With 8 qt. Oil Pan)	15	2	1.05
7354	Inlet Pipe Packing	30	8	.15
10101	Inlet Pipe Flange		8	.14
10150	Exhaust Pipe Flange		4	.11

PART NO.	DESCRIPTION	REF. NO.	NO. PER ENGINE	PRICE EACH $	
10151	Exhaust Pipe Gasket		4	.09	
10191	Exhaust Pipe Flange Stud		8	.31	
3x93	Nut - 5/16 x 24 (Exhaust Flange to Cyl.)		8	3.70	per C
2x169	Hex Head Screw - 5/16-18 x 5/8 (Inlet Pipe to Cylinder & Oil Pan)	32	16	3.10	per C
19x17	Exhaust Pipe Shakeproof Washers		24	.50	per C

IX

OIL PUMP

10998	Oil Pump Assembly (Includes Following Items)	55	1	43.00	
5033	Oil Pump Relief Valve Spring Nut	59	1	1.04	
10997	Oil Pump Relief Valve Spring	58	1	.10	
14732	Oil Pump Relief Valve Plunger	57	1	1.14	
10048	Oil Pump Body	55	1	8.90	
10055	Oil Pump Cover	56	1	10.78	
10672	Oil Pump Drive Gear	66-91	1	3.22	
10673	Oil Pump Driven Gear	65	1	5.87	
10066	Oil Pump Shaft Gear	64	1	4.59	
6x114	#212 Woodruff Key (Gears to Shaft)	67	2	5.10	per C
17735	Oil Pump Stationary Shaft	63	1	.41	
17734	Oil Pump Drive Shaft	62	1	1.11	
10095	Oil Pump Screen Assembly	60	1	1.50	
10093	Oil Pump Inlet Elbow Assembly		1	3.50	
10091	Oil Inlet Elbow Gasket	61	1	.02	
2x315	Hex Drilled Head Screw - 1/4-20x3/4 (Inlet Elbow to Pump)		2	26.55	per C
5x21	Plain Washer 1/4 (Inlet Elbow to Pump)		2	.72	per C
32x13	Lacing Wire - .041 Steel (Inlet Elbow to Pump)		4"	.02	per ft.
2x316	Hex Drilled Head Screw 1/4-20 x 3-3/8 (Pump to Crankcase)		4	65.00	per C
5x21	Plain Washer 1/4 (Pump to Crankcase)		4	.72	per C
32x13	Lacing Wire - .041 Steel (Pump to Crank-case)		8"	.02	per ft.

10066 Can Be Serviced With 18180
Use 17590 In Place Of 10673 When Stock Exhaustes

PART NO.	DESCRIPTION	REF. NO.	NO. PER ENGINE	PRICE EACH $	
	X				
	OIL LINES, GAUGE, FILLER PIPE & CAP				
11690	Valve Case Oil Pipe Assembly	28	4	1.37	
10205	Valve Case Oiler Double Elbow (In Crankcase)	25	2	.68	
13x42	Valve Case Oiler Flared Tube Elbow (In Cylinder)		4	.32	
11677	Valve Case Oil Pipe Clamp		4	.10	
11674	Valve Case Oil Pipe Support		2	.20	
19x15	Shakeproof Lock Washer - #10) Valve		2	.70	per C
12x18	Rd. Hd. Screw - #10-32 x 5/8) Case Oil		2	.18	per C
3x32	Hex Nut - #10-32) Pipe Clamp to Support		2	1.60	per C
11676	Valve Case Oil Pipe Sleeve		4	.03	
	Special For Stinson-With 5 Qt. Oil Pan				
10744	Oil Filler Tube and Gauge Assembly		1	5.25	
10236	Oil Filler Tube Gasket	21	1	.04	
10562	Crankcase Breather Flexible Tube - To Engine #200769		1	1.11	
11081	Crankcase Breather Flexible Tube - Engine #200769 and up		1	1.33	
10665	Crankcase Oil Gauge Hole Plug		1	1.00	
2x167	Filler Tube to Oil Pan Cap Screw 5/16-18 x 3/4	22	4	3.00	per C
8x17	Cotter Pin - 3/32 x 1/2 (Breather Tube to Crankcase)		1	.24	per C
8x115	Cotter Pin - 3/32 x 1-1/4 (Breather Tube to Tube)		1	1.14	per C
19x17	Shakeproof Washer 5/16 (Filler Tube to Oil Pan)		4	.50	per C
	Other Installations-With 5 Qt. Oil Pan				
10665	Crankcase Oil Gauge Hole Plug		1	1.00	
10562	Crankcase Breather Flexible Tube - To Engine #200769		1	1.11	
11081	Crankcase Breather Flexible Tube - Engine #200769 and up		1	1.33	
10237	Oil Level Gauge Assembly	26	1	.51	
10236	Oil Filler Tube Gasket	21	1	.04	

PART NO.	DESCRIPTION	REF. NO.	NO. PER ENGINE	PRICE EACH $	
10214	Oil Filler Tube		1	4.34	
10590	Oil Level Gauge Assembly (Filler in Crankcase Cover)		1	1.14	
10682	Oil Filler Cap (On Crankcase Cover)		1	.67	
	Special For Stinson-With 8 Qt. Oil Pan				
10753	Oil Filler Tube and Gauge Assembly		1	5.63	
	XI				
	PISTONS, PINS AND RINGS				
10479	Pistons 7:1 Compression Ratio	45	4	5.08	
10541	Pistons 6.3:1 Compression Ratio	45	4	5.91	
11842	Piston Pin Assembly	53	4	2.98	
11841	Piston Pin Plug		8	.80	
10520	Piston Pin Assembly (.001 Oversize)		4	2.10	
10521	Piston Rings (Top Groove)	48	4	.50	
10522	Piston Rings (Middle Groove)	47	4	.50	
10523	Piston Ring (Bottom Groove)	46	4	.65	
	XII				
	PROPELLER PLATE, BOLTS AND NUTS				
10685	Propeller Bolt	90	6	.50	
5038	Propeller Hub Front Plate	89	1	4.15	
5x23	Propeller Hub Bolt Nut Washer		6	1.30	per C
3x81	Propeller Bolt Nut		6	6.80	per C
5517	Propeller Hub Name Plate		1	.95	
	XIII				
	TIMING GEAR CASE				
10123	Timing Gear Case (Crankcase End)	72	1	14.50	
10124	Timing Gear Case (Accessory End)		1	20.40	
10084	Timing Gear Case (Without Starter & Generator)	72	1	17.56	
10085	Timing Gear Case Gasket (Inner)	73-114	1	.12	
10120	Timing Gear Case Gasket (Outer)	114	1	.27	

Pattern 10124 Changed To Remove Tennam
When Stock Exhaustes, Service Cases In Pairs

PART NO.	DESCRIPTION	REF. NO.	NO. PER ENGINE	PRICE EACH
2x149	Hex Head Screw - 1/4-20 x 5/8		12	2.50 per C
2x168	Hex Head Screw - 5/16-18 x 2-3/8		2	7.70 per C
2x170	Hex Head Screw - 3/8-16 x 1		2	6.00 per C
2x318	Drilled Head Screw - 5/16-18 x 7/8		8	25.40 per C
5x22	Plain Washer - 5/16		8	.66 per C
19x14	Shakeproof Lockwasher - 1/4		12	.66 per C
19x17	Shakeproof Lockwasher - 5/16		2	.50 per C
19x113	Shakeproof Lockwasher - 3/8		2	1.30 per C
28x83	Dowel - 1/4 x 3/4		2	.14
32x13	Lacing Wire - .041 Steel		20"	.02 per ft.
28x71	Timing Gear Case Oil Retainer (Without Starter & Generator)		1	.70

XIV

VALVE MECHANISM

10932	Exhaust Valve (Sodium)	39	4	9.99
10007	Exhaust Valve	39	4	2.28
10008	Inlet Valve	39	4	1.20
10450	Valve Guide - .001 Oversize) For) Valves	40	8	.54
10451	Valve Guide - .002 Oversize) #10007) &	40	8	.54
10452	Valve Guide - .005 Oversize) #10008	40	8	.54
11273	Exhaust Valve Guide - .001 Oversize) For		8	.63
11274	Exhaust Valve Guide - .002 Oversize) Valve		8	.63
11275	Exhaust Valve Guide - .005 Oversize) #10932		8	.63
10032	Valve Spring Washer Retaining Key		16	.03
10188	Valve Spring (1-27/32" Long)	41	8	1.25
17726	Valve Spring Washer (Upper) For	42	8	.29
10824	Valve Spring (1-15/16 Long) #10824	41	4	1.00
10730	Valve Spring Washer (Upper) For	42	8	.66
10189	Valve Spring Washer (Bottom) #10188		8	.03
10202	Valve Spring Bottom Washer (1/32 Shim)		As Req.	.02
10770	Valve Spring Bottom Washer (1/64 Shim)		As Req.	.01
10201	Valve Retaining Ring (Not Used With #10932)		8	.02
10026	Valve Lifter	23	8	3.14
10771	Valve Lifter Unit		8	1.60
10772	Valve Lifter Body		8	1.54
10027	Valve Lifter Rod	29	8	.71
10028	Valve Lifter Rod Tube	27	8	1.60
17864	Valve Lifter Rod Tube Packing	24	16	.12
10014	Valve Rocker Adj. Screw	37	8	.44
3x214	Valve Rocker Adj. Screw Lock Nut	34	8	2.00 per C
10021	Rocker Shaft Stud	35	12	.35
10799*	Valve Rocker Support (Center)	33	4	1.99
10025	Valve Rocker Support (Outer)	33	8	1.05

PART NO.	DESCRIPTION	REF. NO.	NO. PER ENGINE	PRICE EACH $	
18012*	Valve Rocker Pin	38	4	1.44	
3x93	Nut - 5/16-24) Rocker Pin		12	4.00	per C
5x22	Washer - 5/16) to		12	.66	per C
23x15	Palnut - 5/16-24) Cylinder		12	.90	per C
27x18	Rocker Pin Expansion Plug		4	4.80	per C
10031	Valve Cover	14	4	.81	
17727	Valve Cover Gasket	12	4	.12	
10052	Exhaust Valve Rocker Assembly	43	4	4.66	
10053	Inlet Valve Rocker Assembly	43	4	2.55	
12x24	Fillister Head Screw - 1/4-20 x 1/2 (Valve Cover & Tie Plate to Cylinder)	13	32	1.26	per C
19x14	Shakeproof Lockwasher - 1/4 (Valve Cover & Tie Plate to Cylinder)		32	.54	per C

NOTE: It is essential that axis of valve rocker bushing and barrel end of rocker arm be parallel; otherwise, the valve rocker contacts valve stem off center, causing excessive guide wear, ultimately bad valve seat condition.

*IMPORTANT - When valve rocker pin #18012 is used with old style valve rocker support #10024, the portions of the support separating the small oil holes from the large center hole should be filed or cut away approximately 3/32" x 3/32" to allow oil to flow to the valve rocker pin. See Bulletin No. 15.

PART NO.	DESCRIPTION	REF. NO.	NO. PER ENGINE	PRICE EACH $	
	XV				
	STARTER, GENERATOR AND MAGNETO GROUP				
17762	Starter Drive Shaft Cover Assembly - With Breather Tube		1	5.24	
10750	Starting Motor (Delco-Remy)		1	34.50	
5136	Generator Stud		8	.30	
5632	Starter Gasket	104	1	.06	
5633	Starter Drive Shaft Cover - Without Breather Tube	102	1	2.80	
5634	Starter Drive Shaft Cover Gasket	103	1	.08	
5637	Generator Gasket	106	1	.06	
10118	Starting Motor (Electric Auto-Lite)	93	1	28.90	
10135	Tachometer Housing Gasket		1	.01	
17742	Tachometer Drive Gear	96	1	1.30	
17743	Tachometer Driven Gear	97	1	1.35	
17744	Tachometer Drive Connector	70-95	1	1.04	
17745	Tachometer Connector Sleeve		1	2.02	
10144	Tachometer Drive Housing		1	4.69	
10208	Tachometer Drive Packing		1	.21	
10207	Starting Motor Stud		2	.42	
11272	Starter Gear & Hub Assembly	98-99	1	17.48	
10591	Generator Gear Assembly	108	1	11.83	
10598	Generator Gear Shock Absorber		6	.10	
10599	Generator Gear Hub		1	5.07	
10600	Generator Gear		1	6.45	
10119	Generator	92	1	52.00	
2x150	Hex Head Screw - 1/4-20 x 3/4 Starter Cover to Timing Case		2	3.40	per C
2x166	Hex Head Screw - 1/4-20 x 1/2 Tachometer Housing to Timing Case		2	1.90	per C
3x211	Nut -- 1/4-20) Generator to Timing Case		4	1.40	per C
23x14	Palnut - 1/4-20)		4	.60	per C
3x94	Nut - 3/8-24) Starter to Timing Case		2	5.00	per C
23x11	Palnut - 3/8-24)		2	.90	per C
19x14	Shakeproof Lockwasher - 1/4 - Starter Cover & Tachometer Housing to Timing Case		4	.54	per C
10225	Magneto	77-94	2	51.75	
11048	Magneto - Shielded (Includes High Tension Wire Assembly) (Left)		1	86.25	
11049	Magneto - Shielded (Includes High Tension Wire Assembly (Right)		1	86.25	

PART NO.	DESCRIPTION	REF. NO.	NO. PER ENGINE	PRICE EACH $
10707	High Tension Wire Support - Shielded		1	.36
11667	Magneto & Tachometer Drive Gear Assembly	76-112	1	14.47
17750	Crankshaft Gear Nut		1	.96
17751	Crankshaft Gear Nut Lock Washer		1	.17
5256	Magneto Stud		4	.43
10952	Magneto Driven Gear	111	2	4.38
5512	Magneto Gasket	78	2	.11
10397	High Tension Wire Assembly (Cyl. #1 & 3)		1	4.92
10398	High Tension Wire Assembly (Cyl. #2 & 4)		1	4.92
3x93	Nut - 5/16-24 Hex.)		4	3.66 per C
5x19	Plain Washer 5/16) Magneto to Timing		4	.90 per C
23x15	Palnut - 5/16-24) Case		4	.90 per C
5546	Spark Plug (Champion J-10)	10	8	.65
10542	Spark Plug - Champion C-10-S Shielded	10	8	1.30*
5255	Spark Plug Wrench		1	.60 Net
11846	Spark Plug Gasket		8	.05

XVI

OIL PAN

11069	Oil Pan Assembly - 8 Quarts - No Filler Hole	20	1	59.00
11068	Oil Pan Assembly - 8 Quarts - With Filler Hole	20	1	75.48
11065	Oil Pan Assembly - 5 Quarts - No Filler Hole	20	1	49.75
11064	Oil Pan Assembly - 5 Quarts - With Filler Hole	20	1	50.31
10087	Oil Pan Gasket	18	1	.43
10239	Oil Pan Drain Plug - 5 Qt. Pan	68	1	.23
	8 Qt. Pan	68	2	.23
2x167	Hex Head Screw - 5/16-18 x 3/4 8 Qt. Pan Only		12	3.00 per C
3x93	Oil Pan Stud Nut - 5/16-24 -5 Qt.Pan	19	3	4.00 per C
	8 Qt.Pan	19	7	4.00 per C
5x22	Plain Washer - 5/16 Use With 3x93.			
	5 Qt.Pan		3	.66 per C
	8 Qt.Pan		7	.66 per C
12x29	Hex Head Screw - 5/16-18 x 3/4			
	5 Qt. Pan		18	2.10 per C
	8 Qt. Pan		2	2.10 per C
19x17	Shakeproof Lock Washer - 5/16 - Use With 12x29 - 5 Qt. Pan		18	.50 per C
	8 Qt. Pan		14	.50 per C

PART NO.	DESCRIPTION	REF. NO.	NO. PER ENGINE	PRICE EACH $
23x15	Palnut - 5/16-24 Use with 3x93			
	5 Qt. Pan		3	.90 per C
	8 Qt. Pan		7	.90 per C
32x13	Lacing Wire - .041 Steel (Drain Plug)			
	5 Qt. Pan		3"	.02 per ft.
	8 Qt. Pan		6"	.02 per ft.
10206	Oil Pan Stud (In Timing Case) (Generator & Starter Only)		3	.42
10368	Oil Pan Stud - 8 Quart (In Crankcase)		4	.39
10719	Oil Pan Screen Hole Cover		1	1.23
10718	Oil Pan Screen Hole Cover Gasket		1	.05
5113	Oil Pan Screen Hole Cover Stud		4	.30
3x211	Nut - 1/4-28) Screen Hole Cover		4	1.40 per C
23x14	Palnut - 1/4-28) to Oil Pan		4	.60 per C
10751	Oil Filler Tube Hole Cover		1	1.50
5x21	Washer - 1/4 Plain (Screen Hole Cover to Pan)		4	.72 per C
	XVII			
	FUEL PUMP			
10362	Fuel Pump Push Rod (Outer)	116	1	1.08
10361	Fuel Pump Push Rod (Inner)	115	1	.84
10360	Fuel Pump Gasket	118	1	.03
10359	Fuel Pump Bracket Gasket	117	1	.02
10551	Fuel Pump	119	1	7.98
2x410	Hex Head Screw -)	123	2	4.00 per C
	5/16-24 x 1-1/8) Pump to			
3x84	Nut - 5/16-24) Bracket	121	2	5.50 per C
5x22	Plain Washer - 5/16)		2	.66 per C
32x13	Lacing Wire - .041 Steel		9"	.02 per ft.
10193	Engine Mounting Bracket Stud		1	.34
	XVIII			
	MOUNTING			
17709	Engine Mounting Bracket Dowel		4	.19
10168	Engine Mounting Bracket		4	2.25
10193	Engine Mounting Bracket Stud		8	.34
10246	Engine Mounting Rubber Bushing		8	.15
10358	Engine Mounting & Fuel Pump Bracket	122	1	6.73
10501	Engine Mounting Washer		8	.04
10736	Engine Mounting Washer (For Stinson)		8	.05
3x84	Hex Nut 5/16-24 Bracket to Crankcase		9	5.50 per C

PART NO.	DESCRIPTION	REF. NO.	NO. PER ENGINE	PRICE EACH $	
5x22	Plain Washer Bracket to Crankcase		9	.66 per C	
32x13	Lacing Wire - .041 Steel		22"	.02 per ft.	

XIX

TOOLS

10688	Gear Puller	19.00	Net
10738	Inlet Manifold Packing Assembly Tool	1.45	Net
11258	Valve Lifter Rod Tube Puller & Setting Tool	3.00	Net

All Prices subject to change without notice. Prices shown in this handbook are for the United States only. All prices are F. O. B. Syracuse, New York.

PARTS PRICE LIST IN NUMERICAL ORDER

Part No.	Description	Price Each
2x149	Hex Head Screw - 1/4-20 x 5/8	$ 2.50 per C
2x150	Hex Head Screw - 1/4-20 x 3/4	3.40 per C
2x166	Hex Head Screw - 1/4-20 x 1/2	1.90 per C
2x167	Hex Head Screw - 5/16-28 x 3/4	3.00 per C
2x168	Hex Head Screw - 5/16-18 x 2 3/8	7.70 per C
2x169	Crankcase Cover Screw	3.10 per C
2x170	Hex Head Screw - 3/8-16 x 1	6.00 per C
2x171	Hex Head Screw - 5/16-18 x 1 1/8	3.23 per C
2x315	Hex Drilled Head Screw - 1/4-20 x 3/4	26.55 per C
2x316	Hex Drilled Head Screw - 1/4-20x3-3/8	65.00 per C
2x318	Hex Drilled Head Screw - 5/16-18x7/8	25.40 per C
2x410	Hex Head Screw - 5/16-24 x 1-1/8	34.50 per C
2x412	Hex Head Screw - 5/16-24 x 7-3/16	128.00 per C
3x32	Hex Nut - 10-32	1.60 per C
3x81	Propeller Bolt Nut	6.80 per C
3x84	Nut - 5/16-24 Castle	5.50 per C
3x92	Nut - 7/16-20	6.00 per C
3x93	Nut - 5/16 x 24	3.70 per C
3x94	Nut - 3/8-24	5.00 per C
3x211	Nut - 1/4-28	1.40 per C
3x214	Valve Rocker Adj. Screw Lock Nut	2.00 per C
5x19	Plain Washer 5/16	.90 per C
5x21	Plain Washer 1/4	.72 per C
5x22	Washer - 5/16 Plain	.66 per C
5x23	Propeller Hub Bolt Nut Washer	1.30 per C
6x15	#6 Woodruff Key	3.20 per C
6x19	#61 Woodruff Key	3.90 per C
6x110	#16 Woodruff Key	7.00 per C
6x114	#212 Woodruff Key	5.10 per C
7x32	Pipe Plug 1/4 Slotted Headless	10.50 per C
8x17	Cotter Pin - 3/32 x 1/4	.24 per C
8x112	Cotter Pin - 3/32 x 3/4	.30 per C
8x115	Cotter Pin - 3/32 x 1 1/4	1.14 per C
8x118	Cotter Pin - 1/16 x 5/8	.12 per C
12x18	Round Head Screw - 10-32 x 5/8	.18 per C
12x24	Fillister Head Screw - 1/4-20 x 1/2	1.26 per C
12x29	Hex Head Screw - 5/16-18 x 3/4	2.10 per C
13x22	Flared Tube Nut - 3/16	3.00 per C
13x42	Valve Case Oiler Flared Tube Elbow	31.50 per C
15x54	Copper Tubing - 3/16 x 19 1/2"	.21
17x11	Pipe Bushing - 1/4 x 1/8	45.36 per C
19x14	Shakeproof Lockwasher - 1/4	.54 per C
19x15	Shakeproof Lockwasher - 10	.70 per C
19x17	Shakeproof Lockwasher - 5/16	.50 per C
19x113	Shakeproof Lockwasher - 3/8	1.30 per C
23x11	Palnut - 3/3 - 24	.90 per C

Part No.	Description	Price Each
23x12	Palnut - 7/16-20	$ 1.00 per C
23x14	Palnut - 1/4-28	.60 per C
23x15	Palnut - 5/16-24	.90 per C
24x31	Synthetic Rubber Packing	.09
27x18	Rocker Pin Expansion Plug	4.80 per C
28x71	Timing Gear Case Oil Retainer	.70
28x83	Dowel - 1/4 x 3/4	13.80 per C
28x811	Brass Dowel - 1/8 x 1/4	2.10 per C
32x13	Lacing Wire - .041 Steel	.02 per ft.
5033	Oil Pump Relief Valve Spring Nut	1.04
5038	Propeller Hub Front Plate	4.15
5095	Crankshaft Bearing Stud Washer	.02
5113	Oil Pan Screen Hole Cover Stud	.30
5136	Generator Stud	.30
5137	Carburetor Stud	.57
5255	Spark Plug Wrench	.60 Net
5256	Magneto Stud	.43
5449	Tachometer Drive Connecter	.60
5452	Carburetor Gasket	.06
5512	Magneto Gasket	.11
5517	Propeller Hub Name Plate	.95
5546	Spark Plug	.65
5573	Crankcase Breather Tube (Rigid)	1.00
5632	Starter Gasket	.06
5633	Starter Drive Shaft Cover - Without Breather Tube)	2.80
5634	Starter Drive Shaft Cover Gasket	.08
5637	Generator Gasket	.06
7354	Inlet Pipe Packing	.15
10007	Exhaust Valve	2.28
10008	Inlet Valve	1.10
10014	Valve Rocker Adj. Screw	.44
10021	Rocker Shaft Stud	.35
10025	Valve Rocker Support (outer)	1.05
10026	Valve Lifter	3.14
10027	Valve Lifter Rod	.71
10028	Valve Lifter Rod Tube	1.60
10031	Valve Cover	.81
10032	Valve Spring Washer Retaining Key	.03
10037	Connecting Rod Bushing	.90
10040	Crankshaft Oil Seal	4.03
10048	Oil Pump Body	8.90
10052	Exhaust Valve Rocker Assembly	4.66
10053	Inlet Valve Rocker Assembly	2.55

Part No.	Description	Price Each
10055	Oil Pump Cover	$ 10.78
10057	Crankshaft Bushing (Prop. end #1 & 3)	1.26
10058	Crankshaft Bushing (Prop. end #2 & 4)	1.16
10059	Crankshaft Bushing (Center #1 & 3)	1.38
10060	Crankshaft Bushing (Center #2 & 4)	1.47
10061	Crankshaft Bushing (Gear end #1 & 3)	1.15
10062	Crankshaft Bushing (Gear end #2 & 4)	1.18
10063	Crankshaft Thrust Washer	.47
10066	Oil Pump Shaft Gear	4.59
10070	Crankcase Cover	.75
10071	Crankcase Cover Gasket	.46
10084	Timing Gear Case (Without Starter & Generator)	17.56
10085	Timing Gear Case Gasket (inner) (Without Starter & Generator)	.12
10087	Oil Pan Gasket	.43
10091	Oil Inlet Elbow Gasket	.02
10093	Oil Pump Inlet Elbow Assembly	3.50
10095	Oil Pump Screen Assembly	1.50
10098	Inlet Pipe (Cylinder #1 & 2) (Used with 5 Qt. Oil Pan)	.86
10099	Inlet Pipe (Cylinder #3) (Used with 5 Qt. Oil Pan)	1.51
10100	Inlet Pipe (Cylinder #4) (Used with 5 Qt. Oil Pan)	1.51
10101	Inlet Pipe Flange	.14
10105	Crankcase Bolt, Stud & Oil Header Packing	.11
10107	Camshaft Bearing Stud	.78
10108	Crankshaft Bearing Stud (Inside Lower Front and Center)	1.10
10109	Crankshaft Bearing Stud (Upper Front with Dowel)	1.65
10111	Crankshaft Bearing Stud (Lower Front with Dowel)	1.29
10118	Starting Motor	28.90
10119	Generator	52.00
10120	Timing Gear Case Gasket (Outer)	.27
10123	Timing Gear Case (Crankcase End)	14.50
10124	Timing Gear Case (Accessory End)	20.40
10135	Tachometer Housing Gasket	.01
10140	Tachometer Drive Gear	1.30
10141	Tachometer Driven Gear	1.35
10143	Tachometer Connector Sleeve	2.02
10144	Tachometer Drive Housing	4.69
10150	Exhaust Pipe Flange	.11
10151	Exhaust Pipe Gasket	.09
10167	Crankcase Stud (Front Tie)	1.07
10168	Engine Mounting Bracket	2.25

Part No.	Description	Price Each
10170	Crankcase Cover (With Oil Filler Hole)	5.62
10188	Valve Spring - 1-27/32" Long	1.25
10189	Valve Spring Washer (Bottom)	.03
10191	Exhaust Pipe Flange Stud	.31
10192	Cylinder Hold Down Stud 7/16	.91
10193	Engine Mounting Bracket Stud	.34
10194	Cylinder Tie Plate	.40
10201	Valve Retaining Ring	.02
10202	Valve Spring Bottom Washer (1/32 Shim)	.02
10205	Valve Case Oiler Double Elbow (In Crankcase)	.68
10206	Oil Pan Stud (In Timing Case) (Generator & Starter Only)	.42
10207	Starting Motor Stud	.42
10208	Tachometer Drive Packing	.21
10210	Inlet Pipe (Cylinder #1 & 2) (Used with 8 Qt. Pan)	1.05
10211	Inlet Pipe (Cylinder #3) (Used With 8 Qt. Pan)	1.43
10212	Inlet Pipe (Cylinder #4) (Used With 8 Qt. Pan)	1.43
10213	Cylinder Tie Plate Gasket	.02
10214	Oil Filler Tube	4.34
10219	Camshaft & Tachometer Drive Assembly (Without Starter & Generator)	20.00
10225	Magneto	51.75
10236	Oil Filler Tube Gasket	.04
10237	Oil Level Gauge Assembly	.51
10239	Oil Pan Drain Plug	.23
10246	Engine Mounting Rubber Bushing	.15
10248	Crankshaft Gear (Engine Without Starter & Generator)	4.95
10249	Crankshaft Gear (Engine with Starter & Generator)	5.25
10358	Engine Mounting & Fuel Pump Bracket	6.73
10359	Fuel Pump Bracket Gasket	.02
10360	Fuel Pump Gasket	.03
10361	Fuel Pump Push Rod (Inner)	.84
10362	Fuel Pump Push Rod (Outer)	1.08
10368	Oil Pan Stud - 8 Qt. (In Crankcase)	.39
10371	Crankcase Bearing Stud Packing	.08
10381	Connecting Rod Bushing (.010 Undersize)	1.28
10382	Connecting Rod Bushing (.020 Undersize)	1.29
10383	Crankshaft Bushing(.010 Undersize) (Prop. end #1 & 3)	1.98
10384	Crankshaft Bushing (.020 Undersize) (Prop. end #1 & 3)	2.05
10385	Crankshaft Bushing (.010 Undersize) (Prop. end #2 & 4)	1.84
10386	Crankshaft Bushing(.020 Undersize) (Prop. end #2 & 4)	2.19
10387	Crankshaft Bushing (.010 Undersize) (Center #1 & 3)	1.16

Part No.	Description	Price Each
10388	Crankshaft Bushing (.020 Undersize) (Center #1 & 3)	$ 2.19
10389	Crankshaft Bushing (.010 Undersize) (Center #2 & 4)	1.32
10390	Crankshaft Bushing (.020 Undersize) (Center #2 & 4)	2.11
10391	Crankshaft Bushing (.010 Undersize) (Gear end #1 & 3)	1.34
10392	Crankshaft Bushing (.020 Undersize) (Gear end #1 & 3)	1.90
10393	Crankshaft Bushing (.010 Undersize) (Gear end #2 & 4)	1.35
10394	Crankshaft Bushing (.020 Undersize) (Gear end #2 & 4)	1.47
10397	High Tension Wire Assembly (Cyl. #1 & 3)	4.92
10398	High Tension Wire Assembly (Cyl. #2 & 4)	4.92
10450	Valve Guide .001 Oversize) For Valves	.54
10451	Valve Guide .002 Oversize) #10007 &	.54
10452	Valve Guide .005 Oversize) #10008	.90
10457	Connecting Rod Bushing (Piston End)	.20
10458	Crankshaft	90.20
10462	Connecting Rod Assembly	16.00
10472	Oil By-Pass Plate (Pressure Connection)	4.40
10474	Oil By-Pass Plate (When Oil Cooler is Used)	3.87
10479	Pistons 7:1 Compression Ratio	5.08
10481	Cylinder Gasket	.03
10482	Crankshaft Bearing Stud (Lower Rear)	1.30
10483	Crankshaft Bearing Stud (Upper Rear)	1.17
10489	Oil By-Pass Plate Gasket (Pressure Connection)	.02
10491	Oil By-Pass Plate Gasket (When Oil Cooler is Used)	.02
10501	Engine Mounting Washer	.04
10507	Crankcase Assembly (Without Provision For Fuel Pump)	236.98
10517	Crankcase Assembly (With Provision For Fuel Pump)	236.98
10520	Piston Pin Assembly (.001 Oversize)	2.10
10521	Piston Ring (Top Groove)	.50
10522	Piston Ring (Middle Groove)	.50
10523	Piston Ring (Bottom Groove)	.65
10541	Pistons 6.3:1 Compression Ratio	5.91
10542	Spark Plug - Champion C-10-S Shielded	1.30*
10551	Fuel Pump	7.98
10562	Crankcase Breather Flexible Tube	1.11
10585	Carburetor (Altitude Adjustment)	42.35
10590	Oil Level Gauge Assembly (Filler in Crankcase Cover)	1.14
10591	Generator Gear Assembly	11.83

Part No.	Description	Price Each
10598	Generator Gear Shock Absorber	$ .10
10599	Generator Gear Hub	5.07
10600	Generator Gear	6.45
10665	Crankcase Oil Gauge Hole Plug	1.00
10672	Oil Pump Drive Gear	3.22
10673	Oil Pump Driven Gear	5.87
10682	Oil Filler Cap (On Crankcase Cover) 5 Qt. Pan	.67
10685	Propeller Bolt	.60
10688	Gear Puller	19.00 Net
10707	High Tension Wire Support - Shielded	.36
10718	Oil Pan Screen Hole Cover Gasket	.05
10719	Oil Pan Screen Hole Cover	1.23
10725	Camshaft Gear (Aluminum Rim)	6.00
10730	Valve Spring Washer (Upper) - For #10188	.66
10736	Engine Mounting Washer (Stinson)	.05
10738	Inlet Manifold Packing Assembly Tool	1.45 Net
10744	Oil Filler Tube & Gauge Assembly (5 Qt.)	5.25
10750	Starting Motor (Delco-Remy)	34.50
10751	Oil Filler Tube Hole Cover	1.50
10753	Oil Filler Tube & Gauge Assembly (8 Qt.)	5.63
10770	Valve Spring Bottom Washer (1/64 Shim)	.01
10771	Valve Lifter Unit	1.60
10772	Valve Lifter Body	1.54
10799	Valve Rocker Support (Center)	1.99
10824	Valve Spring (1-15/16 long)	1.00
10825	Valve Spring Washer (Upper) - For #10824	.29
10829	Cylinder Assembly	75.00
10932	Exhaust Valve (Sodium)	9.99
10952	Magneto Driven Gear	4.38
10968	Oil By-Pass Plate	4.62
10969	Oil By-Pass Plate Gasket	.02
10997	Oil Pressure Relief Valve Spring	.10
10998	Oil Pump Assembly	43.00
11048	Magneto - Shielded (Left)	86.25
11049	Magneto - Shielded (Right)	86.25
11059	Cylinder Assembly (Sodium Exhaust Valve)	85.00
11064	Oil Pan Assembly (5 Qt.) With Filler Hole	50.31
11065	Oil Pan Assembly (5 Qt.) No Filler Hole	49.75
11068	Oil Pan Assembly (8 Qt.) With Filler Hole	75.48
11069	Oil Pan Assembly (8 Qt.) No Filler Hole	59.00
11081	Crankcase Breather Flexible Tube	1.33
11125	Camshaft	23.52
11220	Starter Drive Shaft Cover Assembly With Breather Tube	5.24
11273	Exhaust Valve Guide - .001 Oversize) For	.63
11274	Exhaust Valve Guide - .002 Oversize) Valve	.63
11275	Exhaust Valve Guide - .005 Oversize) #10932	.63
11272	Starter Ring Gear & Hub Assembly	17.48

Part No.	Description	Price each
11667	Magneto & Tachometer Drive Gear Assembly	14.47
11674	Valve Case Oil Pipe Support	.20
11676	Valve Case Oil Pipe Sleeve	.03
11677	Valve Case Oil Pipe Clamp	.10
11690	Valve Case Oil Pipe Assembly	1.37
11841	Piston Pin Plug	.80
11842	Piston Pin	2.98
11846	Spark Plug Gasket	.05
12201	Connecting Rod Bolt Nut	.36
14732	Oil Pump Relief Valve Plunger	1.14
17183	Starter Gear & Hub Assembly	17.48
17684	Connecting Rod Bolt	1.00
17707	Camshaft Bushing (#1 & #3 Half)	.38
17708	Camshaft Bushing (#2 & #4 Half)	.30
17709	Crankcase Dowel	.19
17726	Valve Spring Washer (Upper)	.29
17727	Valve Cover Gasket	.12
17734	Oil Pump Drive Shaft	1.11
17735	Oil Pump Stationary Shaft	.41
17738	Connecting Rod Bushing (Upper)	.22
17742	Tachometer Drive Gear	1.30
17743	Tachometer Driven Gear	1.35
17744	Tachometer Drive Connector	1.04
17745	Tachometer Connector Sleeve	2.02
17750	Crankshaft Gear Nut	.96
17751	Crankshaft Gear Nut Lock	.17
17762	Starter Drive Shaft Cover Assembly	5.24
17864	Valve Lifter Rod Tube Packing	.12
18012	Valve Rocker Pin	1.41

I DESCRIPTION

Volts - GAS-4157 - 6
GDY-4106 - 12
Rotation - Clockwise at the drive end
Ventilated - No
Control - Third brush and two charge regulator
Poles - 2
Brushes - 3

II LUBRICATION & GENERAL INSPECTION

A. Inspection

1. Remove the head band.

2. Inspect the commutator. If the commutator is dirty or discolored it can be cleaned by holding a piece of 00 sandpaper against it while turning the armature slowly. Blow the sand out of the generator after cleaning the commutator. If the commutator is rough or worn the generator should be removed from the car and completely overhauled as outlined in section IV.

3. Inspect the brushes and brush holders. The brush holders should swing freely on their pivots. If the brushes are oil soaked or if they are worn to less than one half of their original length the generator should be given a tune-up inspection as outlined in section III.

B. Lubrication

1. Commutator End

The commutator end ball bearing should be given a few drops of medium engine oil at regular intervals.

2. Drive End

The drive end ball bearing has no provision for external lubrication.

C. Wiring

1. Visual Inspection

Inspect all wiring from the generator to the regulator, from the regulator to the battery and from the battery to ground for worn or frayed insulation, broken wires and for loose or corroded connections. Repair or replace any defective wiring.

2. Voltage Drop Test

Run the generator at about 50% of its maximum output and measure the voltage drop from the regulator terminal to the battery terminal. This drop should not be more than .1 volt at a 10 ampere charging rate or .05 volt at a 5 ampere charging rate. There should be no voltmeter reading when the drop is measured from the generator frame to the battery ground post. If larger readings are obtained the high resistance should be eliminated.

D. Operation

1. Run the generator at near maximum output and note the commutator action. If there is excessive arcing between the brushes and commutator remove the generator for a tune-up inspection as outlined in section III.

2. Test the regulator as outlined in the regulator specifications.

E. Replace the generator head band.

III TUNE-UP INSPECTION

A. Remove the generator from the engine and take off the head band.

B. Inspect the commutator as in II A2.

C. Brushes

1. Inspection

Each brush and brush holder should swing freely and should be free from oil and dirt. Brushes that are oil soaked or are worn to less than one half of their original length should be replaced.

To remove the brushes take out the brush screw. Make sure the new brushes are assembled so that the beveled face of the brush fits the commutator. Check the alignment to make sure the brush edge is parallel with the commutator segments. If the alignment is off or if the brush holders do not swing freely the commutator end plate should be inspected as described in section IV.

After new brushes are installed they should be sanded to make sure of the proper fit on the commutator. To sand brushes cut a strip of 00 or 000 sandpaper the exact width of the commutator. Slip this strip under a brush and pull so that the brush is forced toward the brush arm. Be careful not to break the edge of the brush and repeat the sanding on the other brushes.

2. Check brush spring tension.

Measure with a spring scale hooked under the brush screw tight against the brush and pull on a line parallel with the face of the brush. Take the reading just as the brush leaves the commutator. Brush spring tension should be 15 to 20 ounces with new brushes.

If the tension is too great the brushes and commutator will wear excessively while if the tension is too little there will be a tendency to arc at the commutator.

3. Run in new brushes.

New brushes should be run in to make sure of a perfect brush fit before output tests are made on a generator. To run in new brushes the generator should be run under load long enough to secure a perfect brush fit.

D. Check armature end play

Armature end play should be held between .003" to .010". If the end play is too great it can be reduced by installing thrust washers on the armature shaft just inside of either end head. Make sure when installing thrust washers that the brushes are correctly centered on the commutator.

E. Bench Test - GAS-4157

1. Field Coil Draw

3.80 to 4.20 amperes at 6.0 volts

2. Motorizing Draw

4.46 to 4.94 amperes at 6.0 volts

This test is made with the field lead grounded to the generator frame.

3. Output Test (Without regulator)

8.0 Amps., 7.6 Volts at 1445 Max. R.P.M.

7.4 Volts 12.2 to 14.2 Amperes maximum output
8.0 Volts 13.3 to 15.3 Amperes maximum output

To adjust the maximum output advance or retard the third brush by applying pressure to the base of the brush mounting stud.

F. Bench Test - GDY-4106

1. Field Coil Draw
   2.23 to 2.47 amperes at 13.0 volts
2. Motorizing Draw
   3.20 to 3.54 amperes at 13.0 volts

This test is made with the field lead grounded to the generator frame.

3. Output Test (Without regulator)
   2.0 Amps., 13.4 Volts at 1215 Max. R.P.M.
   14.6 Volts, 5.8 to 6.7 Amperes maximum output
   15.0 Volts, 6.0 to 7.0 Amperes maximum output

To adjust the maximum output advance or retard the third brush by applying pressure to the base of the brush mounting stud.

G. Reassembly

Remount the regulator on the generator and reassemble the generator on the engine then follow the general inspection from lubrication to end.

IV COMPLETE OVERHAUL

To completely overhaul the generator it should be removed from the engine and taken to the bench.

A. Disassembly

1. Remove the head band.
2. Remove the drive gear.
3. Remove the commutator end cover and take out the screw in the end of the armature shaft.
4. Remove the two frame screws at the commutator end and slide the commutator end plate off of the armature shaft. Disconnect the leads at the brush.
5. Lift the drive end and armature out of the frame and field.
6. Press the armature shaft out of the drive end head.

B. Inspection

1. Armature

Inspect the armature and commutator for evidences of wear. Inspect the insulation and the soldering to make sure all coils are in proper working order. Check the windings for ground, shorts and open circuits.

If the commutator is rough or worn it should be turned down in a lathe. When turning mount the shaft on the bearing seats and not on the shaft centers. After turning undercut the mica clean and squarely to a depth of 1/32 inch.

If the solder has been thrown it should be resoldered and any other visible fault should be repaired. It is recommended that faulty armatures be replaced if they cannot be repaired without rewinding.

2. Frame and Field

Inspect the insulation on the field coils and leads and replace any faulty part. Check the field coils for grounds and for open

circuits. Inspect the leads for broken wires and for frayed insulation.

If the field coils are faulty and must be replaced remove the pole piece screws. Assemble the new coils on the pole pieces and tighten securely with pole piece screws that have been dipped in boiled linseed oil. As the screws are tightened the frame should be struck with a rawhide hammer a few times to properly settle the pole pieces.

3. Commutator End Plate

Remove the third brush plate and clean both plates thoroughly. Inspect the brush arms and pivots to see that they are not bent or corroded. Check the insulated brush holders for grounds. Clean the bearing thoroughly and inspect it for wear. Repack the bearing 1/2 full with a high melting point grease before assembling.

4. Drive End Head

Disassemble and clean the bearing and retainers. Inspect each part for wear or failures.

Pack the ball bearing 1/2 full with a high melting point grease and reassemble the drive end head.

C. Assembly

1. Assemble the drive end head on the armature shaft.
2. Assemble the drive end head and armature to the frame and field making sure the dowel pin is in place.
3. Assemble the commutator end plate on the armature shaft making sure the dowel pin is in plate.
4. Fasten the end heads with the thru bolts.
5. Assemble the commutator end bearing and retainer and fasten with the shaft screw.
6. Assemble the commutator end cap cover and gasket.
7. Connect the brush leads to the brush screws.
8. Add a few drops of medium engine oil to the commutator end oiler.

D. Follow the tune-up inspection from III C3 to end.

MZ-4087 MBG-4009 STARTING MOTOR for Air Cooled Motors

I SPECIFICATIONS

Rotation - Clockwise at the drive end
Volts - MZ-4087 - 6
MBG-4009 - 12
Drive - Left hand inboard Bendix
Starting Switch - Solenoid - mounted on motor
Poles - 4
Brushes - 4

II LUBRICATION & GENERAL INSPECTION

The head band should be periodically removed and the following operations performed.

A. Inspection

1. Commutator

If the commutator is dirty it can be cleaned by holding a piece of 00 sandpaper against it while turning the armature slowly. Blow the sand out of the motor after cleaning.

If the commutator is rough or worn the motor should be removed for a complete overhaul as outlined in section IV.

2. Brushes

The brushes should slide freely in their holders and should not be oil soaked. If the brushes are oil soaked or are worn to less than one half of their original length they should be replaced as outlined in section IV.

B. Lubrication

The oiler in the commutator end cap should be 3 to 5 drops of medium engine oil.

C. Wiring

Check the wiring for broken wires, frayed insulation and for corroded connections. Particular attention should be paid to the ground connections.

D. Starting Switch

Check the starting switch to see that the switch closes when the control button is operated and that the voltage drop across the switch does not exceed .05 volts per 100 amperes.

E. Replace the Head Band

III TUNE-UP INSPECTION

This inspection should include all of the items of the lubrication and general inspection except that the motor should be removed from the engine and the work done on the bench.

At this inspection the Bendix should be removed from the shaft and cleaned. If the Bendix is worn or the spring is distorted the worn parts should be replaced. When reassembling the Bendix on the shaft the shaft should be given a light wipe of oil.

The motor should be tested for no load current draw and for lock torque on the bench and then cleaned and remounted.

The no load specifications are:
MZ-4087 - 70 Max. Amps., 5.5 Volts, 4300 Min. R.P.M.
MBG-4009 - 55 Max. Amps., 11.0 Volts, 7300 Min. R.P.M.
The stall torque specifications are:
MZ-4087 - 560 Amps., 4.0 Volts, 11.8 Pounds Feet
MBG-4009 - 520 Amps., 8.0 Volts, 14.7 Pounds Feet

IV COMPLETE OVERHAUL

For a complete overhaul the motor should be removed from the engine and taken to the bench for the following operations:

A. Disassemble

1. Remove the head band.
2. Remove the Bendix drive.
3. Remove the screws holding the commutator end plate. Lift the brushes out of the holders and slide the commutator end plate off of the motor.
4. Remove the screws holding the drive end head and slide the head off of the armature shaft.
5. Lift out the armature.
6. Remove the solenoid switch.

B. Inspection

1. Armature

Inspect the windings to see that they are firmly in place and are properly staked to the commutator. Inspect the insulation to see that it is not frayed or worn. Check for opens, shorts and grounds and inspect the bearing seats for wear.

2. Commutator End Plate

Inspect the grounded brushes to see that they are not oil soaked and are not worn to less than 1/2 of their original length. If necessary to install new brushes remove the rivets holding the brush holders and brush terminals. When re-riveting be sure the rivets fit the holes snugly in order to hold the holder firm and to make a good ground contact.

Inspect the brush holders to make sure they are not distorted or out of alignment.

Inspect the bearing and if found to be worn excessively replace the end plate.

3. Frame and Field

Inspect the field coils and terminal post insulation for grounds and check the field coils for open circuits.

If it is necessary to replace the field coils remove the pole piece screw and install the new coil on the pole piece. Dip the pole piece screw in boiled linseed oil before assembling and tighten securely. Hit the frame a few sharp blows with a rawhide hammer as the screws are tightened to properly align the pole pieces.

Inspect the insulated brushes and replace if they are found to be oil soaked or worn out. To replace the brushes unsolder the brush pigtail from the loop in the field coil and open up the loop slightly. Insert the new brush lead and clinch the loop tightly then solder to make a good connection.

4. Drive End Head

Inspect the bearing for wear and replace if found to be worn. Use only the proper arbor to install new bearings to be sure of the correct bearing fit.

5. Starting Switch

Connect the starting switch to a battery, rheostat and voltmeter and check its opening and closing voltage.

6 volt switch chouls close at 4.0 to 5.0 volts
6 volt switch should open at 0.5 to 2.0 volts
12 volt switch chould close at 8.0 to 10.5 volts
12 volt switch should open at 1.5 to 4.0 volts

6. Bendix Drive

The Bendix drive should be disassembled and cleaned. When reassembling replace any worn part.

C. Assembly

1. Place armature in the frame and field and assemble the fibre washer on the drive end of the shaft.

2. Soak the drive end bearing and remove the excess oil. Assemble the drive end head on the shaft and fasten to the frame with the four screws and lock washers.

3. Assemble the steel thrust washer on the commutator end of the shaft and fasten commutator end plate on the frame. Have the bearing oiled before assembling.

4. Assemble the brushes in their holders and fasten the head band in place.

5. Assemble the Bendix drive and lock the shaft nut with the cotter pin.

6. Assemble the starting switch and connector to the frame and terminal post.

D. Check armature end play

The armature end play should be 1/16" maximum. To adjust remove the commutator end plate and change the thrust washer to one of the following:

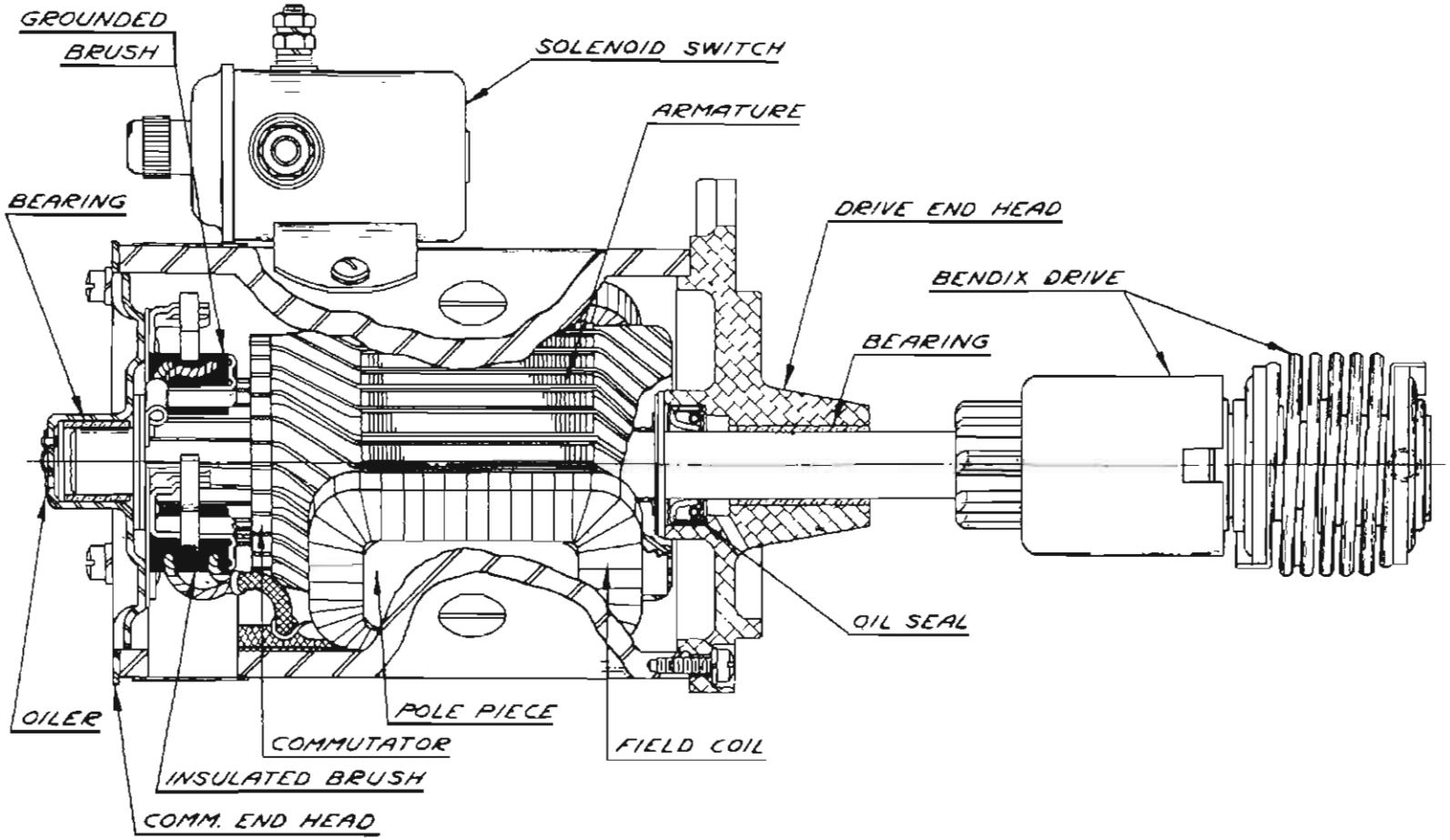
MU-54 1/32" thick
MU-54A 1/64" thick
MU-54B 3/64" thick

E. Check the brush spring tension. This tension should be between 42 and 53 ounces with new brushes. Measure the tension with a spring scale hooked under the brush spring at the bend and take the reading just as the spring leaves the brush. The scale should be pulled on a line parallel to the face of the brush. Adjust the brush spring tension by bending the brush spring at the spring post.

F. Bench test the motor as in III

G. Assemble the motor on the engine

H. Lubricate and check the wiring as in II B and II C



MZ-4087
FILE A-118A

THE ELECTRIC AUTO-LITE COMPANY

TWO CHARGE REGULATOR
for
Air Cooled Motors

The two charge regulator is a combination circuit breaker and voltage regulator.

The circuit breaker unit consists of an electromagnet and a set of contacts. The electromagnet has two windings, one of which has many turns of fine wire and is connected across the generator like a voltmeter. The other winding has a few turns of heavy wire and is connected in series with the generator output. One of the contacts is mounted on an armature that is operated by the electromagnet while the other contact is stationary. These contacts are connected in the charging circuit so that the circuit between the generator and battery is made or broken by the contacts.

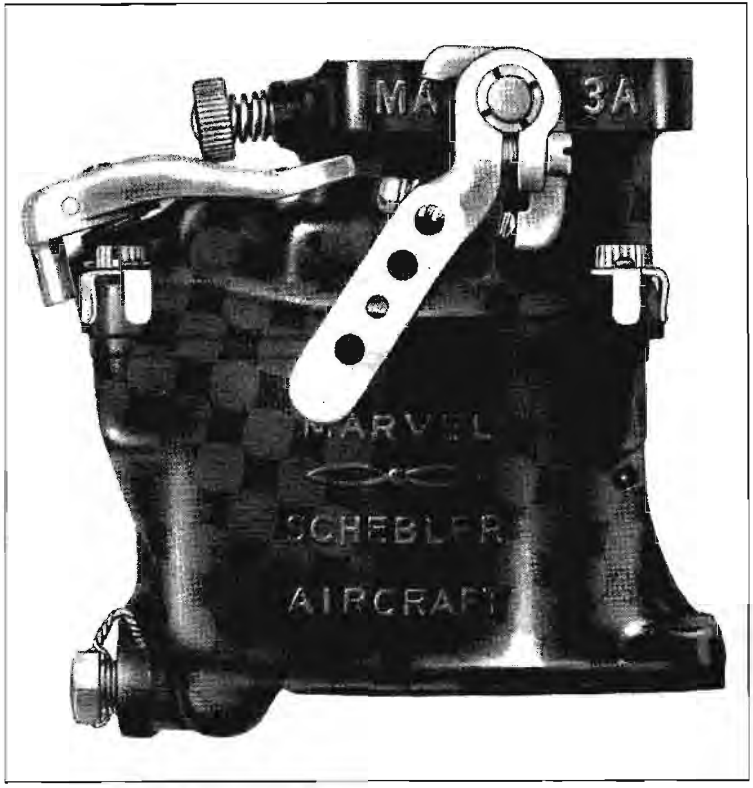
When the generator is stopped the circuit breaker contacts are held open by the armature spring. If the generator is started the generated voltage is gradually built up as the generator speed is increased. When the voltage reaches the value for which the circuit breaker is calibrated there is sufficient magnetism in the shunt coil to overcome the spring tension and pull the armature down. This closes the circuit from the generator to the battery and allows the generator to charge. If the speed of the generator is reduced so that its voltage falls below that required to charge the battery the current flows from the battery to the generator. This reverses the magnetism created by the series coil and opposes the magnetism created by the shunt coil. With the reduced pull on the armature the spring opens the contacts and disconnects the circuit between the generator and battery.

The regulator unit consists of a set of contacts that are held together by an armature spring. The magnetic unit has one coil consisting of many turns of fine wire which is connected in the charging circuit so that its magnetism depends on the generated voltage.

When the generator is started the regulator contacts are held together and the field circuit is grounded directly which results in a maximum field current. As the generator charges the battery the voltage rises until there is enough magnetism created in the regulator coil to pull the armature down and open the contacts. With the contacts opened the field circuit is grounded thru a resistance. This lowers the field current and reduces the output by about one half. The generator continues to charge at this reduced rate until an additional load is put on the circuit. With the increased load the voltage of the system is lowered below that required to hold the regulator contacts open and the spring closes the contacts. With the contacts thus closed the generator again charges at its maximum rate.

Due to the necessity for special instruments and information needed to check and adjust these units it is recommended that they be referred to an Official Auto-Lite Service Station for any adjustments or repairs.

MARVEL-SCHEBLER
CARBURETER
Model MA-3A



AS USED ON...
FRANKLIN AIRCRAFT ENGINES
Model 4AC-199, 90 H.P. and Model 6AC-298, 130 H.P.

★The Marvel-Schebler, Aircraft Model MA-3A Updraft Carbureter, as used on Franklin Aircraft Engines, is of the plain-tube fixed jet type and provides twelve outstanding design features, as follows:

1. Manual Altitude Control for better performance and economy in flight.
2. Double float mechanism provides accurate fuel metering under extreme angles of flight.
3. Improved idle system—with primary and secondary idle air vents—produces proper air and fuel emulsion for starting and idling.
4. Safety throttle lever spring holds throttle in "open" position for take-off in case of throttle control failure.
5. Double venturi mixing chamber improves acceleration of engine mixture distribution.
6. Fuel inlet strainer screen prevents entry of dirt or foreign matter.
7. Accessible bowl drain plug—located at lowest point of the fuel bowl—provides for draining of water condensation.
8. Safety locking prevents loosening of parts.
9. Special stainless steel throttle shaft bushings prevent sticking of throttle and excessive wear.
10. Simplified fuel passages prevent vapor locking of high test gasolines in carbureter channels.
11. No dirt can enter carbureter passages or fuel bowl when an efficient air cleaner is used, because all air vents open into main air entrance.
12. Back Suction Economizer which provides maximum fuel economy.

MARVEL-SCHEBLER CARBURETER DIVISION, BORG-WARNER CORPORATION • FLINT, MICHIGAN, U. S. A.

Printed in U.S.A. June, 1945

FOLDER NO. 157

OPERATING *and* MAINTENANCE INSTRUCTIONS

CONSTRUCTION

The carbureter is made up of two major units—a cast aluminum throttle body and bowl cover, and a cast aluminum fuel bowl and air entrance.

OPERATION

Idle System (Fig. 4)

With the **throttle fly** slightly open to permit idling, the suction or vacuum above the throttle on the manifold side is very high. Very little air passes through the **venturi** at this time, and hence, with very low suction on the **main nozzle,** it does not discharge fuel. This high suction beyond the throttle, however, causes the idle system to function, as the **primary idle delivery** delivers into the high suction zone above the throttle. Fuel from the **fuel bowl** passes through the **fuel channel power jet,** and into the **main nozzle bore,** where it passes through the **idle supply opening** in **main nozzle** through the **idle fuel orifice** in **idle tube,** where it is mixed with air which is allowed to enter **idle tube** through the **primary idle air vent** and **secondary idle air vent.** The resultant rich emulsion of fuel and air passes upward through the **idle emulsion channel** where it is finally drawn into the **throttle barrel** through the **primary idle delivery** opening, subject to regulation of the **idle adjusting needle,** where a small amount of air passing the **throttle fly** mixes with it, forming a combustible mixture for idling the engine. The **idle adjusting needle** controls the quantity of rich emulsion supplied to the **throttle barrel,** and therefore controls the quality of the idle mixture. Turning the needle counterclockwise away from its seat richens the idle mixture to the engine, and turning the needle clockwise towards its seat leans the idle mixture.

On idle, some air is drawn from the **throttle barrel** above the **throttle fly** through the **secondary idle delivery** opening and blends with the idling mixture being delivered to the engine, subject to regulation of the **idle adjusting needle.** The **secondary idle delivery** begins to deliver idling mixture to the engine as the throttle is opened, coming into play progressively and blending with the **primary idle delivery** to prevent the mixture from becoming too lean as the throttle is opened and before the **main nozzle** starts to feed.

Metering (Fig. 4)

All fuel delivery on idle, and also at steady propeller speeds up to approximately 1000 R.P.M., is from the idle system. At approximately 1000 R.P.M. the suction from the increasing amount of air now passing through **primary and secondary venturi** causes the **main nozzle** to start delivering, and the idle system delivery diminishes due to lowered suction on the idle delivery openings as the **throttle fly** is opened for increasing propeller speeds, until at approximately 1400 R.P.M. the idle delivery is practically nil, and most of the fuel delivery from that point on to the highest speed is from the **main nozzle.** However, the fuel feed at any full throttle operation is entirely from the **main nozzle.** The idle system and the **main nozzle** are connected with each other by the **idle supply opening.** The amount of fuel delivered from either the idle system or **main nozzle** is dependent on whether the suction is greater on the idle system or main nozzle, the suction being governed by throttle valve position and engine load. The **main nozzle** feeds at any speed if the throttle is open sufficiently to place the engine under load, which drops the manifold suction. Under such conditions of low manifold suction at the throttle fly, the main nozzle feeds in preference to the idle system because the suction is multiplied on the main nozzle by the restriction of the venturi.

Main Nozzle (Fig. 4)

The main nozzle is supplied with fuel which passes from the fuel bowl through the **metering sleeve** and the **fuel channel.** The fuel then passes upward through the **nozzle bore** where it is mixed with air drawn from the **nozzle air vent** and **nozzle bleed holes** and is then discharged from the **nozzle outlet** as an air and fuel emulsion, into the mixing chamber. Air passing through the **nozzle air vent** sweeps fuel from the **nozzle well** and **nozzle bore** under very low suction and therefore satisfies any sudden demand for nozzle fuel delivery. The **nozzle and idle air vent entrance** is provided with an **air vent screen** to prevent clogging of vents with bugs and foreign matter.

Back Suction Economizer (Fig. 3)

In order to provide a leaner mixture to obtain full economy in the cruising range, the **back suction economizer** is provided. This device has no moving parts and consists of connecting channels from the **throttle barrel** to the sealed **fuel bowl.** The **economizer hole** at the **throttle barrel** is located accurately with respect to the **throttle fly,** so that in the cruising range this hole is brought into communication with the manifold suction above the **throttle fly** which suction is transferred to the sealed **fuel bowl** thru the **economizer channels.** The suction in the **economizer channels** is modified by the **atmospheric bowl vent,** which places on the **fuel bowl** a differential suction, which is between manifold suction and atmosphere. This back suction diminishes the fuel flow to the **nozzle** and **idle system.**

Altitude Control (Fig. 3 and 4)

The **altitude control** consists of **altitude control lever,** to which is attached the **altitude metering valve assembly.** The **altitude metering valve assembly** is provided at its lower end with **altitude metering valve** which rotates in stationary **altitude metering sleeve. Altitude metering sleeve** is provided with a slot thru which the fuel enters and fuel metering is accomplished by the relative position between one edge of the flatted **altitude metering valve** and one edge of the slot in the **altitude metering sleeve.** When **altitude control lever** is in the position nearest to carbureter flange a full power mixture is provided for take-off. To make the mixture leaner for altitude compensation, move the **altitude control lever** away from the carbureter flange. With the **altitude control lever** in the leanest position, sufficient compensation for 14,000 feet is provided.

Use of Altitude Control

The altitude adjustment should not be used under 3000 feet. When adjusting altitude control for altitudes higher than 3000 feet, move control in and out slowly with the throttle full open until the highest R.P.M. is attained. The carbureter mixture will then be correctly adjusted for all throttle positions and loads at that particular altitude.

Caution

Always have altitude control in the full rich position which will be in towards the instrument panel when coming in for a landing, so that if full power is required in an emergency near the ground the engine will operate satisfactorily and will not over-heat because of too lean a mixture.

Adjustment of Carbureter

If, after checking all other points on engine, it is found necessary to readjust the carbureter, proceed as follows:

With engine thoroughly warmed up, set Throttle Stop Screw so that engine idles at approximately 550 R.P.M. Turn Idle Adjusting Needle out slowly until engine "rolls" from richness, then turn needle in slowly until engine "lags," or runs "irregularly" from leanness. This step will give an idea of the idle adjustment range and of how the engine operates under these extreme idle mixtures. From the lean setting, turn needle out slowly to the richest mixture that will not cause the engine to "roll" or run unevenly. 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 Throttle Stop Screw to the desired point. The Idle Adjusting needle should be from ¾ to 1 turn from its seat to give a satisfactory idle mixture.

CAUTION: Care should be taken not to damage the **idle needle seat** by turning the **idle adjusting needle** too tightly against seat, as damage to this seat will make a satisfactory idle adjustment very difficult.

Float Height

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. Proper setting of the two floats should measure 7/32" from bowl cover gasket to closest surface of each float. Be sure to check both floats to proper dimensions, making sure that the floats are parallel to the **bowl cover gasket.**

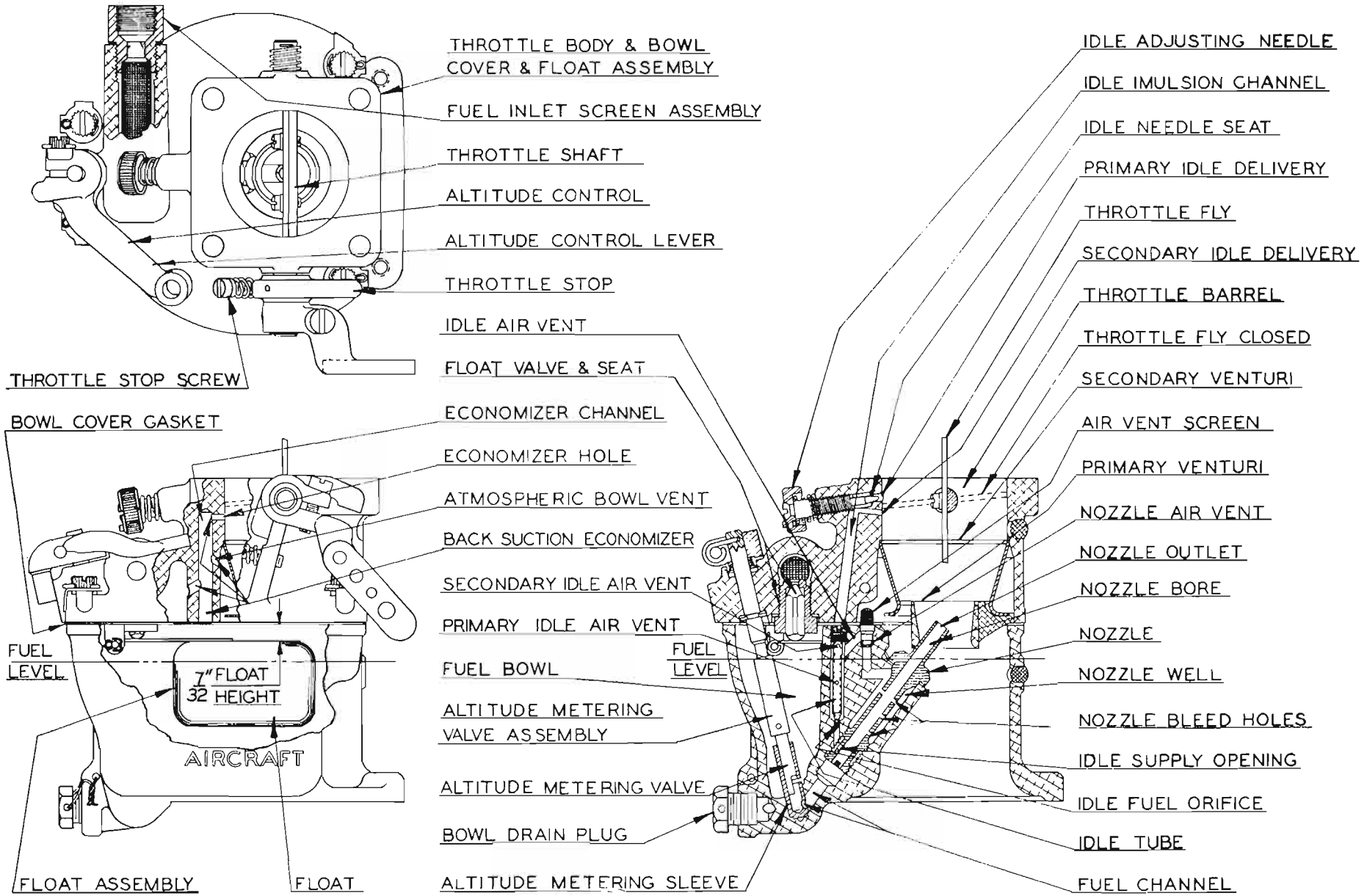
Starting—Cold Engine

Open and close **throttle** two or three times depending on air temperature, and set **throttle stop** approximately 3/32" from **throttle stop screw.** With the **throttle** in this position, turn the engine over two or three times before the ignition is turned on This will draw a finely emulsified mixture of air and fuel thru the manifold into the combustion chamber, then if the ignition is turned on, the engine should start on the next turn over and with the **throttle stop** 3/32" from the **throttle stop screw** there should be sufficient throttle opening to keep the engine running. The carbureter is calibrated to give the richest mixture at this throttle opening and therefore a cold engine will run the smoothest with the **throttle** in this position For this reason the engine should be allowed to warm-up for several minutes before opening the **throttle** further.

Starting—Hot Engine

To start a warm or hot engine, pull the **throttle stop** against the **throttle stop screw** in the idling position. If the engine has just been shut off, turn on the ignition and the engine should start on the first turn, but if the engine has been shut off for several minutes it may be necessary to turn the engine over once or twice before turning on the ignition. A warm or hot engine should start and continue to run with the throttle in the idling position.

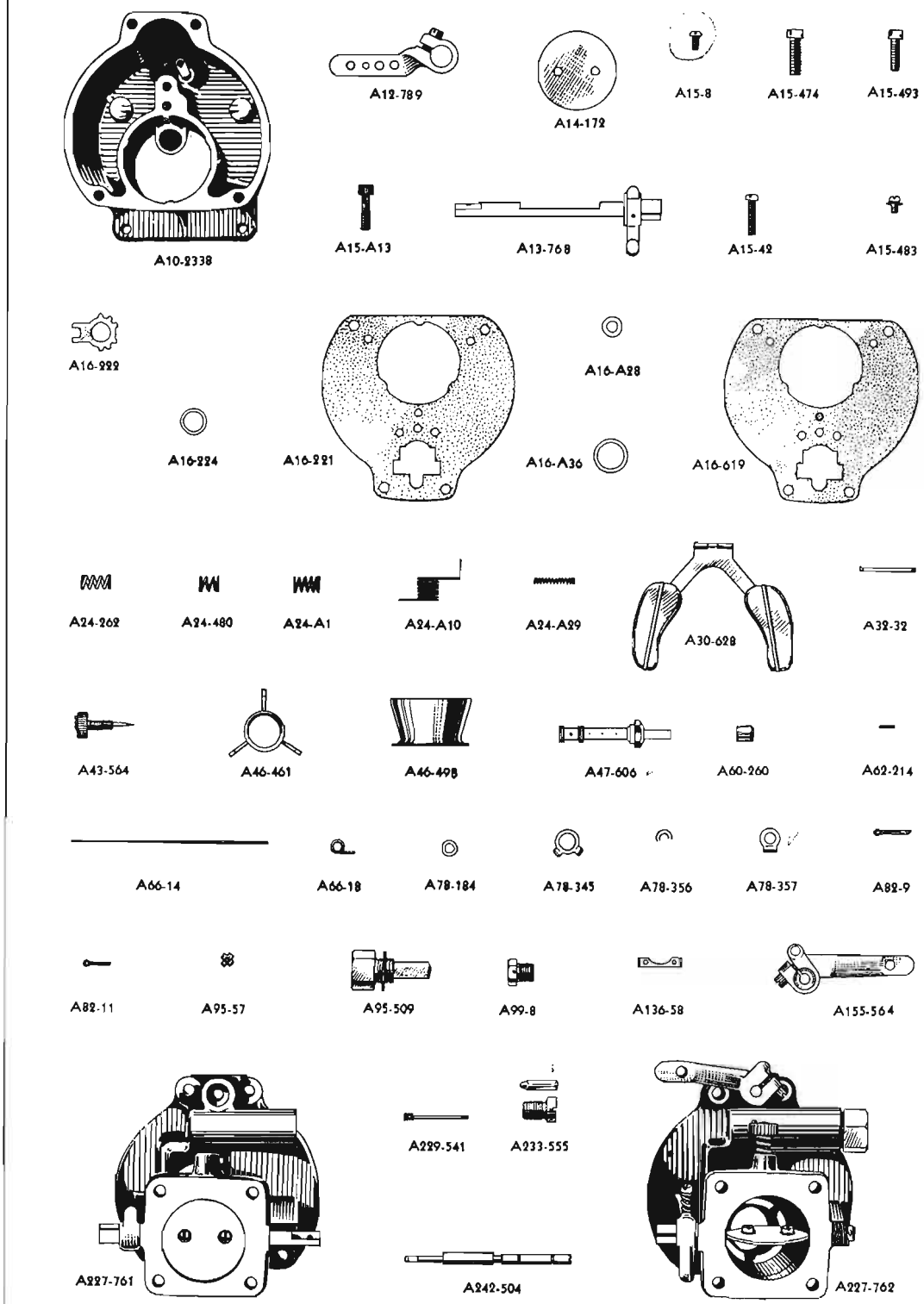
MARVEL-SCHEBLER CARBURETER DIVISION
BORG-WARNER CORPORATION
Flint, Mich., U.S.A.


THROTTLE BODY & BOWL COVER & FLOAT ASSEMBLY
FUEL INLET SCREEN ASSEMBLY
THROTTLE SHAFT
ALTITUDE CONTROL
ALTITUDE CONTROL LEVER
THROTTLE STOP
IDLE AIR VENT
FLOAT VALVE & SEAT
ECONOMIZER CHANNEL
ECONOMIZER HOLE
ATMOSPHERIC BOWL VENT
BACK SUCTION ECONOMIZER
SECONDARY IDLE AIR VENT
PRIMARY IDLE AIR VENT
FUEL BOWL
ALTITUDE METERING VALVE ASSEMBLY
ALTITUDE METERING VALVE
BOWL DRAIN PLUG
ALTITUDE METERING SLEEVE
THROTTLE STOP SCREW
BOWL COVER GASKET
FUEL LEVEL
7/32" FLOAT HEIGHT
AIRCRAFT
FLOAT ASSEMBLY
FLOAT
FUEL LEVEL
IDLE ADJUSTING NEEDLE
IDLE IMULSION CHANNEL
IDLE NEEDLE SEAT
PRIMARY IDLE DELIVERY
THROTTLE FLY
SECONDARY IDLE DELIVERY
THROTTLE BARREL
THROTTLE FLY CLOSED
SECONDARY VENTURI
AIR VENT SCREEN
PRIMARY VENTURI
NOZZLE AIR VENT
NOZZLE OUTLET
NOZZLE BORE
NOZZLE
NOZZLE WELL
NOZZLE BLEED HOLES
IDLE SUPPLY OPENING
IDLE FUEL ORIFICE
IDLE TUBE
FUEL CHANNEL

SERVICE STATION DIRECTORY

Akron, Ohio.....Hopkins & Kipp Auto Electric, Inc. 359 Bowery
Amarillo, Texas.....The E. S. Cowie Electric Co. 700 Van Buren St.
Ann Arbor, Mich.....A. & L. Battery & Elec. Service 529 Main
Atlanta, Ga...Carbureter & Ignition Co., 137 Mariette St.
Baltimore, Md.....Stephen Seth & Co., 882 Park Ave.
Battle Creek, Mich.....Haddock Brothers, 19 Green St.
Baton Rouge, La.....United Service Co., 1202 Main St.
Birmingham, Ala.....Birmingham Elec. Battery Co. S. 23rd & Ave. B
Bluefield, W. Va.....Grosclose Auto Elec. Service Mercier at McCulloch
Boise, Idaho.....Oakley Automotive, 1101 Idaho St.
Boston (2), Mass...W. J. Connell Co., 121 Brookline Ave.
Butte, Mont...Berry's Auto Supply Co., 114 E. Broadway
Buffalo, N. Y.....H. W. Wolcott Co., Inc., 1597 Main St.
Charlotte, N. C.....Woodside Motor Co. Box 1555, 214 W. 3rd
Canton, Ohio..Carbureter Sales & Service, 328 Walnut St.
Chattanooga, Tenn.....Auto Elec. & Magneto Co. 522 Broad Street
Chicago, Ill...Albany Park Service Station, 2919 Lawrence
Chicago, Ill...Borg-Warner Int'l Corp., 310 S. Mich. Ave.
Chicago, Ill.....Illinois Auto Electric, 2101 Indiana Ave.
Chicago, Ill.....Marvel Carbureter Sales 5829 W. Madison St.
Chicago, Ill.....Pellet Magneto Co., 2450 S. Wabash
Chillicothe, Ohio.....Oil & Battery Service Company
Cleveland, Ohio.....Hart Ignition Company 6535 Carnegie Ave.
Columbus, Ohio...Long & Stouder Co., 189 E. Spring St.
Dallas, Texas...H. H. Whelan Company, 2616 Ross Ave.
Dayton, Ohio..H. C. Haenggi Company, 410 S. Ludlow St.
Denver, Colo...Auto Elec. Appliance Co., 1290 Acoma St.
Denver, Colo.....Central Supply, Lincoln & 12th
Des Moines, Iowa.....Standard Bearings Co. 1014 Grand Ave.
Detroit, Mich. .Dix Auto Electric Service, 3925 W. Vernor
El Paso Texas.....Western Battery & Magneto 618 Montana Street
Erie, Pa.....Briggs-Hagenlocher, Inc., 209 W. 12th St.
Evansville, Ind.....Moutoux Auto & Machine, 311 Locust
Flushing, N. Y.....The Durham Aircraft Serv., Inc. Northern Blvd. at Prince St.
Fort Wayne, Ind.....Harold's Carbureter & Electric 323 E. Berry
Flint, Mich.....Ross Sales & Service, 1531 Detroit St.
Flint, Mich.....Kennedy Motor Parts, 1208 N. Saginaw
Flint, Mich.....Lawson Carbureter & Electric Service 115 E. 14th St.
Great Falls, Mont...Starter & Battery Co., 512 First Ave.
Gainesville, Fla.....White Electric & Battery Service 722 W. University Ave.
Grand Rapids, Mich.....Electric Service Station 53 Commerce Ave., S. W.
Harrisburg, Pa...Automotive Elec. Service, 209 S. 17th St.
Houston, Texas..Moore Brothers Co., Inc., 1515 Milam St.
Indianapolis, Ind.....Gulling Auto Electric Co. 450 N. Capitol Ave.
Jackson, Mich...Hill Piston Service Co., 622 E. Mich. Ave.
Jacksonville, Fla.....Lovejoy Company, 16 E. Ashley
Kansas City, Mo....Beach Wittmann Co., 1820 McGee St.
Lexington, Ky., Kentucky Ignition Co., Rose & Vine Sts.
Little Rock, Ark.....555, Inc., 2nd to 3rd on Broadway
Louisville, Ky....Kentucky Ignition Co., 737 S. Third St.
Los Angeles, Calif.....Marvel Carb. Sales 2222 S. Figueroa St.
Marion, Ind.....Glasser Electric Co., 1002 S. Washington
Memphis, Tenn.....McGregor's, Inc., 1071 Union Ave.
Memphis, Tenn.....Automotive Elec. Service Co. 982 Linden Ave.
Miami, Fla.....Patten Sales Co., P. O. Box 4061
Milwaukee, Wis.....Wisconsin Magneto Co. 918 N. Broadway
Minneapolis, Minn.....Fowler Electric Co. 2901 Nicollet Ave.
Nashville, Tenn.....United Service, 1515 Broadway
New Orleans, La.....New Orleans Auto Supply Co. 1029-1041 Dryades St.
New Philadelphia, Ohio.Tuscarawas County Aviation, Inc. Municipal Airport
New York City, N. Y.....Schebler Carbureter Co. 109 W. 64th Street
Oklahoma City, Okla.....American Electric Ignition Co. 735 N. Broadway
Omaha, Neb....Carl A. Anderson, Inc., 16th & Jones Sts.
Orlando, Fla.....Al Huppel, 445 W. Central Avenue
Philadelphia, Pa.....Marvel Carbureter Sales Co. 3957 N. Broad St.
Pittsburgh, Pa.....Automotive Ignition Co. 49171 Baum Blvd.
Pontiac, Mich...Auto Elec. Shop, Inc., 286 S. Saginaw St.
Portland, Ore.....H. E. Chase Co., 1340 W. Burnside St.
Richmond, Va.....Richmond Battery & Ignition Corp. 1319 W. Broad
Roanoke, Va.....W. B. Clements, Inc., 321 Luck Ave.
St. Louis, Mo.....Medart Auto Electric Co. 3134 Washington Blvd.
Saginaw, Mich.....Russell Electric, 1917 Michigan
Salt Lake City, Utah, Automotive Serv. Co., 475 S. Main St.
San Francisco, Calif.....Pacific Automotive Co. 116 Van Ness Ave.
San Francisco, Calif..H. G. Makelim Magneto Repair Co. 1583 Howard St.
San Antonio, Texas....Westbrook Carbureter Elec. Co. 301 S. Main Ave.
Seattle, Wash.....Huletz Auto Electric, 1509 Broadway
Shreveport, La...Chain Battery & Automotive Supply Co. Marshall at Colton Streets
Sioux City, Iowa (Under Des Moines) Standard Bearings Co., 127 Sixth St.
Spokane, Wash.....Gill Automotive Co., 167 S. Lincoln
Syracuse, N. Y.....The Durham Co., 943 W. Genesee St.
Terre Haute, Ind.....Terre Haute Battery & Electric 32 N. Fifth St.
Tampa (2), Fla.....Bob Deriso Service, Inc. Marion at Harrison
Toledo, Ohio...Toledo Auto Elec. Co., 35 Seventeenth St.
Toledo, Ohio..Fort Meigs Auto Elec. Co., 1310 Monroe St.
Tulsa, 5, Okla.....Tom Gorman Co., 214 E. Tenth St.
Toronto, Ont., Can...Auto Elec. Serv., Ltd., 1009 Bay St.
Vancouver, B. C., Can...Bob Bodie, Ltd., 657 Hornby St.
Vincennes, Ind.....Auto Electric Corp., 14 S. Sixth St.
Warren, Ohio.....Automotive Inc. of Warren 147 Pine Avenue, S. E.
Washington, D. C.....D. C. Speedometer Repair Co. 2113 14th St., N. W.
Waycross, Ga.....Waycross Battery & Elec. Co. 611 Albany Ave.
Winchester, Va.....The Valley Service Station, Inc. 22 Amherst St.
Winnipeg, Manitoba, Can....Beattie Auto Elec. Co., Ltd. 176 Fort Street

SERVICE PARTS PLATE



REFER TO SERVICE PARTS LIST BEFORE ORDERING PARTS

SERVICE PARTS LIST

MODEL MA-3A

as used on

FRANKLIN AIRCRAFT ENGINES

A10-2302—Model 4AC-199 90 H.P., Model 6AC-298 130 H.P. (Without Fuel Pump)

A10-2302P—Model 6AC-298 130 H.P. (With Fuel Pump)

Part No.	Description
A10-2302	Carbureter—Model 4AC-199 90 H.P., Model 6AC-298 130 H.P. (Without Fuel Pump)
A10-2302P	Carbureter—Model 6AC-298 130 H.P. (With Fuel Pump)
A10-2338	Carbureter Body & Bowl Assembly
A12-789	Throttle Lever & Screw Assembly
A13-768	Throttle Shaft & Stop Assembly
A14-172	Throttle Fly
A15-8	Screw (No. 4-36x1/4 Round Head) (Float Bracket) 2 Req'd.
A15-A13	Screw (Special Altitude Lever)
A15-42	Screw (No. 8-32x3/4 Fill. Head) (Throttle Adjusting)
A15-474	Screw (No. 12-24x3/4 Flat Fill. Head) (Throttle Body to Bowl) 4 Req'd.
A15-483	Screw (No. 6-32x1/4 Fill. Head) ("Sems") (Throttle Fly) 2 Req'd.
A15-493	Screw (No. 10-24x5/8 Flat Fill. Head) (Throttle Lever)
A16-A28	Gasket (Altitude Valve Head)
A16-A36	Gasket (Strainer Assembly)
A16-221	Gasket (Throttle Body to Bowl)
A16-222	Gasket (Nozzle)
A16-224	Gasket (Float Valve Seat)
A16-619	Gasket & Screen Assembly
A16-624	Gasket Assortment
A24-A1	Spring (Idle Screw)
A24-262	Spring (Throttle Adjusting Screw)
A24-480	Spring (Altitude Valve Head)
A24-487	Spring (Throttle Opening)
A29-113	Clip—Venturi Retaining
A30-628	Float & Lever Assembly
A32-32	Float Lever Shaft
A43-564	Idle Needle Assembly
A46-461	Venturi (Primary)
A46-498	Venturi (Main)
A47-606	Nozzle (Main)
A60-260	Bushing (Throttle Shaft)
A66-14	Lock Wire (Bowl Drain Plug)
A66-18	Lock Wire (Altitude Valve Head)
A78-184	Washer (Altitude Valve Packing Retainer—1) (Altitude Valve Thrust—1)
A78-345	Washer, Special Lock (Bowl Cover Screw) 4 Req'd
A78-356	Washer (Horse Shoe) (Altitude Valve Head)
A78-357	Washer, Lock — Special (Altitude Lever)
A78-360	Washer (Lock No. 12) (Thr. Body to Bowl Screw) (4 Req'd)
A82-9	Pin—Cotter (Bowl Cover Screw—4)
A82-11	Pin—Cotter (Float Lever Shaft—1) (Altitude Lever—1)
A82-14	Pin—Cotter (Throttle Opening Spring)
A95-57	Screen (Nozzle & Idle Air Vent)
A95-509	Strainer Assembly
A99-8	Plug (Drain Bowl)
A136-58	Float Bracket
A155-564	Lever Assembly (Altitude Control)
A227-925	Throttle Body & Plugs Assembly
A227-762	Throttle Body Assembly Complete
A229-541	Idle Tube Assembly
A233-555	Float Valve, Seat & Gasket Assembly (Matched)
*A233-557	Float Valve, Seat & Gasket Assembly (Matched)
A242-506	Altitude Metering Valve Assembly

* Used with Fuel Pump Equipment

Printed in U.S.A. June, 1945

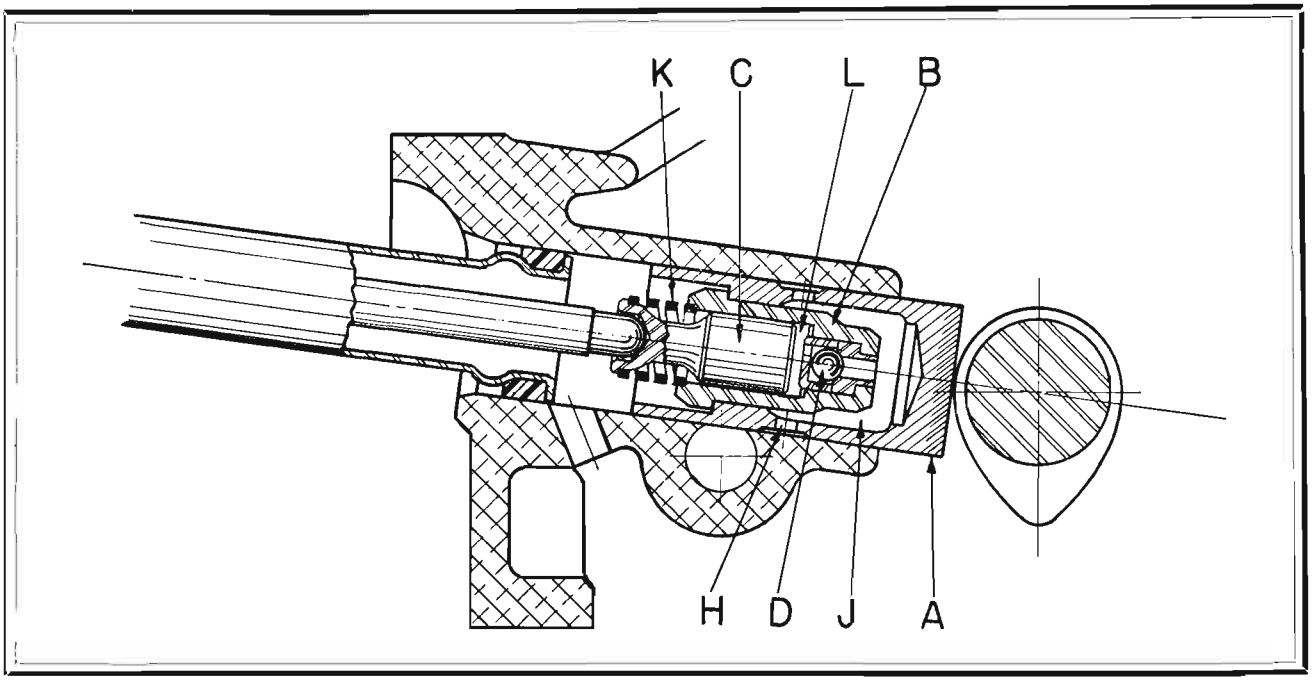


Fig. 1: ZERO-LASH HYDRAULIC LIFTER in Franklin Aircraft Engines

OPERATION OF Zero-Lash TRADE MARK HYDRAULIC LIFTERS IN FRANKLIN AIRCRAFT ENGINES MODELS 4AC-176 4AC-199 — 6AC-264 — 6AC-298 — 12AC-806

CONSTRUCTION

The Zero-Lash Hydraulic Lifter consists of:

1. The outer portion or body (A) Fig. 1, similar to manually adjusted types of lifters except for having a straight, machined hole to receive the hydraulic unit instead of a threaded hole for an adjusting screw
2. The hydraulic unit itself, comprising cylinder (B), plunger (C), ball check valve (D), and plunger spring (K).

OPERATION

(Refer to Fig. 1)

Oil under pressure from the lubricating system of the engine is supplied to the Zero-Lash Hydraulic Lifter through hole (H) to the supply chamber (J).

With the face of the lifter on the base circle of the cam, and the engine valve seated as shown in Fig. 1, the light plunger spring (K) lifts the hydraulic plunger (C) so that its outer end contacts the push-rod socket taking up the clearance at this point, and all along the valve train, giving zero lash. As the plunger (C) moves outward, increasing the volume of the oil in the pressure adjusting chamber (L), the ball check valve moves off its seat and oil from the supply chamber (J) flows in and fills chamber (L).

As the camshaft rotates, the cam pushes the lifter body outward, tending to decrease the volume of chamber (L) and forcing the

April 10, 1941

SERVICE BULLETIN NO. 10

Franklin Aircraft Engines

EXHAUST VALVES

A very few exhaust valve failures have been reported by Franklin operators, which prompts us to issue this bulletin to assist in preventing such failures. From the information obtainable it is apparent that the cause can be traced to incorrect valve clearance, incorrect magneto setting, low grade fuel, excessively worn valve guides, or hydraulic valve lifters which are not functioning. All of these items are covered in the Operator's Handbook furnished with each engine, but we desire to call particular attention to the following important recommendations:

Valve Clearance: .040". is the proper clearance between valve rocker and valve stem with piston in firing position and all oil forced out of hydraulic valve lifter by pulling back on valve rocker with a valve setting tool until continued pressure no longer alters the gap between valve rocker and valve stem. Improper setting will result in damage to valves and seats.

Valve Guides: All valve guides should be measured at time of top and major overhauls. If excessive clearance is found between valve stem and guide, the guide should be replaced. Too much clearance will cause the valve to seat improperly and eventually result in valve failure.

Magneto Setting: Check magneto settings frequently. Under certain operating conditions the spark setting sometimes advances automatically due to breaker lever fibre wear. In the Operator's Handbook, under Maintenance & Inspection, it is recommended that breaker points in the magnetos be checked every 25 hours. This means the spark setting should also be checked. Great care should be taken to note whether detonation is present -- If it is, the setting should be retarded until it disappears. Excessive spark advance should be avoided -- The settings recommended in Operator's Handbooks were determined by exhaustive engineering tests.

Fuel: For Models 4AC-150 (50 H. P.) and 4AC-171 (60 H. P.) the recommended aviation fuel is 70 octane or better with not more than 1 cc of lead.

For Models 4AC-150A (60 H. P.) and later models having 6.3:1 compression ratio, the recommended aviation fuel is 73 octane or better with not more than 1 cc of lead.

For all models having 7:1 compression ratio, the recommended aviation fuel is 80 octane or better with not more than 1 cc of lead.

Many operators are finding that most satisfactory and economical results are obtained by using 80 octane gasoline in engines having 6.9:1 and 6.3:1 compression ratios. There is apparently more or less confusion regarding gasoline knock ratings and it is therefore urged that only aviation gasoline rated by the new AFD method be used. This approximates the ASTM method. A gasoline rated by the AFD method is usually lower in octane rating than that rated by the CFR or the Motor method. A 73 octane fuel AFD is usually found to be 80 octane CFR.

Several of the gasoline manufacturers are making changes due to the National Defense Program, which, no doubt will cause some confusion. If in doubt about the octane number, always use a fuel on the high side of rating rather than on the low side.

It takes but a few minutes of operation with a low octane grade of gasoline, to cause serious trouble, such as warped valves, corrosion in the cylinder heads and pistons.

Hydraulic Valve Lifters: If a lifter fails to function, the clearance between valve stem and valve rocker will be approximately .100" which results in the valve striking the valve seat at very high velocity. This will produce a noise that is easily distinguished and the valve lifter should be corrected or replaced immediately to prevent damage to valve and seat.

Valve Springs: The valve springs on your engine have been designed and selected with utmost care. For that reason it is most important that the spring weight be kept within the range specified in your Operator's Handbook. A spring with insufficient tension will permit the valve to bounce with erratic closing, where a spring with excessive tension will over-load and many times cause the valve to fail.

Only the highest grade material and best quality workmanship obtainable go to make up Franklin valves. Strict adherence to the above recommendations will eliminate delayed flight programs and unnecessary expense.

AIRCOOLED MOTORS CORPORATION

SYRACUSE NEW YORK U S A

May 1, 1941

SERVICE BULLETIN NO. 11

FRANKLIN ENGINES

Models 4AC-176-F2 and F3
4AC-199-E2 and E3, 6AC-264-F2 and F3, 6AC-298-F2 and F3

The gasoline specifications of the aviation industry have been and still are passing through stages of evolution. The National Emergency has done much toward establishing a universally acceptable method of rating fuels for octane value, but has created a new condition having a serious bearing on the specifications of fuels.

Heretofore manufacturers of gasolines in most cases used a clear base stock having an octane value of 73 for aviation fuels. By the addition of 1/2 cc tetraethyl lead, the octane value of this fuel was lifted to 80 octane and 2½ cc's of lead brought it to 87 octane. It has been brought to our attention recently that in some cases clear base stocks, having an octane value of 65, were being used requiring 1 cc of lead to raise the octane value of the fuel to 73. These base fuels required approximately 2 cc's of lead to produce a value of 80 octane and 4 cc's is required to develop a fuel having an octane number of 91. All octane values mentioned herein are based on the new AFD Method which now has national acceptance. (Approximately equal octane values are arrived at with ASTM and AFD Methods.)

PLEASE NOTE:

Inasmuch as the above listed Franklin models were designed and built and must, for reasons beyond our control, continue to be built to operate on 80 octane fuel having a lead content of not more than 1 cc per gallon, we, therefore, call your attention to the fact that these engines will not function satisfactorily with fuels containing tetraethyl lead in excess of 1 cc per gallon , nor with fuels having an octane value, AFD Method, of less than 80.

Our Models 4AC-150, 4AC-171 require aviation fuel having an octane value of at least 70, containing not more than 1 cc of tetraethyl lead. Model 150A requires aviation fuel having an octane value of 73, containing not more than 1 cc of lead.

Furthermore, we will not be responsible for the damage to an engine or mal-function of an engine caused by the use of fuels not conforming to our recommendations.

For restrictions imposed in connection with the purchase of materials for commercial aviation purposes, due to the National Emergency, precludes our obtaining special metals for certain engine parts having high lead resistance characteristics. It is hoped that the increased production in certain branches of the steel industry will alleviate existing conditions.

AIRCOOLED MOTORS CORPORATION

SYRACUSE NEW YORK U S A

May 1, 1941

SERVICE BULLETIN NO. 12

OPERATING RECOMMENDATIONS FOR FRANKLIN ENGINES

PROPER USE OF ALTITUDE CONTROL CARBURETERS

1. FUEL

Franklin engines should be operated only on fuels meeting general specifications recently issued, which essentially specify that the fuel must be of aviation grade having an octane value of 80 AFD Method and containing not more than 1 cc tetraethyl lead per gallon.

2. LUBRICATION

Only a good quality of lubricating oil of correct viscosity, SAE 20 for year around operation should be used. The oil should be free from corrosive constituents and foreign matter, which may pit the bearings, score the cylinder walls or cause excessive wear of piston rings. The proper oil level should be maintained at all times. The oil should be changed every 25 hours. It is further recommended that the oil pump and screen be cleaned at intervals of 100 hours.

3. OVERHAUL PERIODS

For long run economy, engines should be top overhauled at 250 hours and major overhauled at 500 hours. Refer to operator's handbook for detailed recommendations.

4. WARMING UP THE ENGINES

Engines should be thoroughly warmed on the ground before take-off is made. (App. 1200 R.P.M.)

5. CRUISING

Engines should not be cruised in excess of the R.P.M. limit designated on the tachometer dial or face by aircraft manufacturers for their respective models conforming to C.A.A. regulations.

6. ON LANDINGS

Engines should be idled from 45 to 60 seconds on the ground before cutting the switches to allow the valves and heads to cool, thereby obviating the possibility of distortion of these parts.

7. PROPER USE OF ALTITUDE CONTROL

PLEASE NOTE:

Several manufacturers are using Franklin engines equipped with manually adjustable altitude carbureters. In some instances this device is labeled "Mixture Control" and "Full Rich" and "Lean" positions indicated. We wish to point out that the mixture control is an altitude mixture adjustment control, the function of which is to lean the mixture for higher altitude operation and that this device can in no way increase the richness of the mixture beyond the point to which the carbureter has been calibrated for sea level operation. In other words, the altitude adjustment does not function as does the choke on an automobile carbureter. Furthermore, the altitude adjustment should not be used below an altitude of 3,000 feet.

The operating procedure is as follows:

The engine should be thoroughly warmed with the altitude mixture control in the "Full Rich" position. It should remain in this position during take-off and climb and at all times during flight when the ship is below an altitude of 3,000 feet. Upon reaching an altitude of 3,000 feet, and if it is desirable to gain more altitude, the throttle should be placed in the "Full Open" position and the altitude mixture control manipulated slowly and left at that position at which the engine reaches its maximum R.P.M. Then the throttle may be closed sufficiently to bring the engine back to the normal R.P.M. for this particular maneuver or cruising. During the descent, the mixture control should be closed or placed at the "Full Rich" position.

We wish to again stress the importance of the judicious use of the altitude control. The improper use of this device may well cause burned and warped valves, piston failure and combustion chamber corrosion or even power plant failure.

AIRCOOLED MOTORS CORPORATION

SYRACUSE NEW YORK U S A

May 1, 1941

RECOMMENDED SPECIFICATIONS FOR AVIATION GASOLINES

FOR FRANKLIN ENGINES

Octane by Method AFD (1C)	80 Min.
Tetraethyl Lead, cc per gal.	1 Max.
Distillation	
10% evaporated, degrees Fahrenheit	158 Max.
50% " " "	212 "
90% " " "	257 "
Sum of 10 plus 50 per cents	307 Min.
Distillation recovery, per cent	97 "
" residue " "	1.5 Max.
" loss " "	1.5 "
Acidity of distillation residue	Neutral
Color	Blue
Vapor Pressure, psi	7.0 Max.
Corrosion:	
Copper strip	No grey or black discoloration
" dish	" " " " " ;
	residue on evaporation of 100 ml. not to exceed 5 mg.
Gum, accelerated, mg. per 100 ml.	6. Max.
Sulphur, per cent	.05 "
Freezing Point, degrees Fahrenheit	-76 "

Suppliers desiring complete manufacturing specifications may obtain them upon request to ...

AIRCOOLED MOTORS CORPORATION

SYRACUSE NEW YORK U S A

May 1, 1941

Following is a list of companies who have advised us that they are distributing aviation fuel having an octane value of 80, AFD Method, containing not more than 1 cc of lead per gallon:

State	Brand	Distributing Co.
Maine	Esso Aviation Gasoline 80	Colonial Beacon Oil Co.
New Hampshire	" " " "	" " " "
Vermont	" " " "	" " " "
Massachusetts	" " " "	" " " "
Connecticut	" " " "	" " " "
New York	" " " "	" " " "
Pennsylvania	" " " "	Standard Oil Co. of Pa.
New Jersey	" " " "	" " " " N. J.
Delaware	" " " "	" " " " " "
Maryland	" " " "	" " " " " "
Washington, D. C.	" " " "	" " " " " "
Virginia	" " " "	" " " " " "
West Virginia	" " " "	" " " " " "
North Carolina	" " " "	" " " " " "
South Carolina	" " " "	" " " " " "
Ohio	" " " "	Standard Oil Co. (Ohio)
Kentucky	" " " "	Standard Oil Co. (Ky.)
Georgia	" " " "	" " " "
Alabama	" " " "	" " " "
Florida	" " " "	" " " "
Mississippi	" " " "	" " " "
Tennessee	" " " "	Standard Oil Co. of La.
Arkansas	" " " "	" " " "
Louisiana	" " " "	" " " "
Texas	Humble Aviation Gasoline 80	Humble Oil & Refining Co.
Maine	Aero Mobilgas 80	Socony-Vacuum Oil Co. Inc.
New Hampshire	" " "	" " " " "
Vermont	" " "	" " " " "
Massachusetts	" " "	" " " " "
Rhode Island	" " "	" " " " "
Connecticut	" " "	" " " " "
New York	" " "	" " " " "
New Jersey	" " "	" " " " "
Pennsylvania	" " "	" " " " "
Delaware	" " "	" " " " "
West Virginia	" " "	" " " " "
Ohio	" " "	" " " " "
Indiana	" " "	" " " " "
Michigan	" " "	" " " " "
Illinois	" " "	" " " " "
Missouri	" " "	" " " " "
Arkansas	" " "	" " " " "
Louisiana	" " "	" " " " "
Oklahoma	" " "	" " " " "
Texas	" " "	" " " " "
California	Stanavo	Standard Oil Co. of Calif.
Oregon	"	" " " " "
Washington	"	" " " " "
Arizona	"	" " " " "
Nevada	"	" " " " "
Utah	"	" " " " "
Idaho	"	" " " " "
Montana (Western half of state only)	"	" " " " "

Shell Oil Company aviation gasoline, we understand, is distributed in all 48 states.

Other manufacturers distributing aviation gasoline conforming to our recommendations will be added from time to time.

AIRCOOLED MOTORS CORPORATION

SYRACUSE NEW YORK U S A

June 16, 1941

SERVICE BULLETIN NO. 13

ADDITIONS AND CORRECTIONS

TO

BULLETINS 11 & 12

FUEL

Supplementing bulletins recently issued concerning recommended fuels - 80 octane aviation gasoline produced by THE TEXAS COMPANY and the GULF OIL CORPORATION is satisfactory to use in Franklin aircraft engines. We understand these gasolines are nationally distributed throughout all 48 states.

It has been brought to our attention that there is an error in our bulletins #11 and #12 with reference to Models 4AC-176-B2 and 4AC-176-B3. These models have been approved to operate on aviation gasoline having an octane rating of 73 and containing not more than 1 cc of tetraethyl lead per gallon. Since these bulletins were issued, we have added several new models to our line which also are designed to operate on aviation gasoline having an octane rating of 73 and containing not more than 1 cc of tetraethyl lead per gallon (AFD method). These new models have the following designations: 4AC-199-D2, 4AC-199-D3, 6AC-264-D2, 6AC-264-D3, 6AC-298-D2, 6AC-298-D3.

Under no circumstances should a fuel of lower octane rating than specified be used but when it is impossible to obtain 80 octane fuel, it is permissible to blend 73 octane aviation gasoline containing no tetraethyl lead with 87 octane aviation gasoline in equal proportions.

OIL

It is apparent that gum in lubricating oil has a tendency to hold lead on valve stems and valve seats in engines having 7:1 compression ratio. Therefore, the use of aviation oil is recommended in Franklin aircraft engines of this ratio.

SPARK PLUGS

In view of the difficulty experienced as a result of lead oxide deposits on spark plugs, one of the major spark plug manufacturers suggests that:

"Lead oxide is the most common cause of spark plug failure. This oxide coating forms on the electrodes and insulator from the burning of the fuel, and when hot becomes a conductor of electricity which "shorts" the plug. Certain types of fuel cause these deposits.

Lead oxide may be recognized by the whitish or brownish appearance of the electrodes and insulator. By removing this coating the plugs will function satisfactorily.

Analyzing our spark plug returns, we find that a large percentage of the plugs bear evidence of oxide fouling. Replacing the plugs is NOT the remedy. Cleaning the plugs IS the remedy.

Under present conditions, with the trend to smaller and smaller spark plugs and high octane gasoline, the plugs should be cleaned at least every 25 hours. Then fewer adjustments and replacements will result; better service will be assured."

We thoroughly concur with these statements and call attention to the fact that cleaning spark plugs every 25 hours has always been recommended in our Operator's Handbooks. Hot spark plugs due to oxidation may well be the cause for engines overrunning; that is, operating after the switches have been cut.

AIRCOOLED MOTORS CORPORATION

SYRACUSE NEW YORK U S A

February 16, 1942

SERVICE BULLETIN NO. 16

CONCERNING THE USE OF GASOLINE WITH HIGH LEAD CONTENT

Gasoline producers advise that in order to provide the necessary high octane gasolines in quantities sufficient to meet the requirements of our armed forces, the amount of tetraethyl lead per gallon will be greatly increased in aviation gasolines of 73 and 80 octane ratings. Amounts have not yet been determined nor have we been advised definitely what octane gasolines will be available.

This increased lead content will not immediately cause detrimental effects but undoubtedly it will be necessary to top overhaul all small aircraft engines more frequently than has been customary in the past in order to remove lead and carbon deposits from valves, valve seats, valve guides, cylinder heads and spark plugs. This must be done to prevent valve sticking, with resultant burning, and to permit engines to operate at top efficiency and full power.

An explanation concerning the purpose of tetraethyl lead and its results, as prepared by a fuel expert, follows: -

> "Tetraethyl lead is the trade name given to a special fluid which is added to gasoline for the purpose of suppressing detonation. This fluid consists of approximately 63% tetraethyl lead as such, and 36% ethylene dibromide and ethylene dichloride. A trace of organic dye is added for the purposes of identification. Ethylene dibromide and ethylene dichloride serve to combine with the lead and prevent the deposition of lead in the combustion chamber and upon the valve seat and stem. This reaction, however, is only partially complete, with the result that a portion of the lead is actually deposited on the exhaust equipment. The unreacted bromine and chlorine combines with the hydrogen in the fluid to form hydrobromic and hydrochloric acids. Naturally these acids are extremely corrosive. The presence of these acids with attendant high temperatures is extremely harmful to the life of the valve equipment."

Recommendations contained in previous service bulletins and operators' handbooks should be adherred to insofar as octane ratings are concerned and operators should continue to purchase aviation gasoline with the lowest lead content possible

in the octane ratings specified. Under no circumstances should lower-than-specified ratings be used - a higher rating is preferable.

In view of this unavoidable condition, it will be necessary for all owners and operators to carefully note the performance of their engines and at the first indication of falling off in RPMs or sticking valves, the cylinders should be removed and given a thorough top overhaul. It is impossible for us to recommend a definite period for top overhaul inasmuch as operating conditions vary with each installation, particularly with regard to engine cooling, but under severe operating conditions when using highly leaded gasoline, it may be found necessary to top overhaul as frequently as every 100 hours.

If you have sold your airplane since the original red engine card was mailed to us, kindly advise the name and address of the new owner, together with NC number of the airplane and serial number of the engine so that we can mail him a copy of this bulletin.

February 13, 1942

SERVICE BULLETIN NO. 17

CRANKCASE COVER OIL LEAKS

When reassembling crankcases for Models 4AC-176, 4AC-199, 6AC-264 and 6AC-298, the small round rubber packing should be allowed to protrude approximately 1/16" where the crankcase cover meets the crankcase at the propeller end at the center. The application of Permatex sealer at this point will also assist in eliminating oil leakage.

CAMSHAFT GEAR

All plain Celoron camshaft gears should be replaced with the aluminum rim type gear on Model 4AC-176 (80 HP only) and 4AC-199 engines at the first major overhaul (500 hours).

STICKING VALVES

Valves that have become stuck in their guides as a result of corrosion, usually caused by engines not being operated for some time, can generally be freed by the use of a penetrating oil, such as Keystone #2 manufactured by Keystone Lubricating Co., Philadelphia, Pa., or its equivalent, applied to the valve stems. This precaution may save the unnecessary expense of replacing bent valve rockers, valve lifter rods, etc.

VALVE SPRINGS

A recent change has been made, increasing the length of the valve springs and deepening the recess in the cylinder head. The new length is 1-15/16" as against 1-27/32" for the old spring. The difference in length is so small that care must be exercised to prevent incorrect assembly. The new longer springs cannot be used in cylinders with shallow recesses but old springs may be used in cylinders with deeper recesses by using two #10202 washers (1/32") in the recesses under valve springs. Correct spring weight is 50 to 60 pounds and travel .390" to .410".

DISCARD USED LOCK WASHERS

As a precautionary safety measure, all lock washers must be replaced with new whenever removed after being in use.

TORQUE WRENCH SPECIFICATIONS

	Size	Ft. Lbs.	Inch Lbs.
Connecting rod bolt nuts	3/8-24	25-30	300-360
Cylinder hold-down nuts & cap screws	3/8-24	33	395
Cylinder hold-down nuts & cap screws	7/16-20	40	480
Main crankshaft bearing stud nuts	3/8-24	30	360
Camshaft bearing stud nuts	5/16-24	20	240
Long through crankcase bolt nuts	5/16-24	20	240
Oil pump by-pass plate cap screws	5/16-18	15	180
Rocker support stud nuts	5/16-24	10-12	120-145
Oil pan fillister head screws	5/16-18	5-6	60-75
Crankcase cover cap screws	5/16-18	5-6	60-75
Rocker adj. screw nuts	5/16-24	10-12	120-145
Spark plugs in cyl. heads	14 m.m.	15	180
Magneto flange stud nuts	5/16-24	7-8	85-95
Starter flange stud nuts	3/8-24	20	240
Generator flange stud nuts	1/4-28	5	60
Oil pump to crankcase cap screw	1/4-20	5-6	60-75
Gear case to crankcase cap screws	5/16-18	10-12	120-145
Gear case to cover cap screws	1/4-20	5-6	60-75
Inlet pipe flange to cyl. head cap screw	5/16-18	15	180
Inlet pipe flange to oil pan cap screw	5/16-18	15	180
Motor mount to crankcase stud nuts	5/16-24	20	240

SPARK PLUG INSERTS

Spark plug inserts are now available for all models. The design provides for left hand threads in the cylinder head and installation under heat to insure a tight fit and prevent turning out when spark plug is removed.

Because of special fixtures and tools required, it will be necessary to send cylinders to the factory for spark plug insert installation. However, when necessary, due to time limitations, cylinders may be exchanged. Prices will be furnished on request.

AIRCOOLED MOTORS CORPORATION

SYRACUSE NEW YORK U S A

August 20, 1942

SERVICE BULLETIN NO. 20

EXTERNAL OIL PIPES

As a precautionary measure, it is recommended that all external oil pipes be replaced with new at each top overhaul. The expense involved is very small when compared to possible engine damage, due to lack of oil resulting from oil pipe breakage.

Vibration usually causes oil pipe failure and we now have available clamps and supports, designed to minimize this vibration. These can be installed without removal of pipes, and it is recommended that the set listed below, applicable to your engine, be purchased at the first opportunity.

Part No.	Name	No. Required Per Engine	Price Each
	MODEL 4AC-176 ENGINES		
11677	Valve Case Oil Pipe Clamp	4	$ .29
11805	Valve Case Oil Pipe Support	2	.39
19x15	Shakeproof Lock Washer) Clamp	2	.01
12x18	Round Head Screw) to	2	.01
3x32	Hex Nut) Support	2	.01
11676	Valve Case Oil Pipe Sleeve (Rubber)	4	.05
	MODEL 4AC-199 ENGINES		
11677	Valve Case Oil Pipe Clamp	4	.29
11674	Valve Case Oil Pipe Support	2	.39
19x15	Shakeproof Lock Washer) Clamp	2	.01
12x18	Round Head Screw) to	2	.01
3x32	Hex Nut) Support	2	.01
11676	Valve Case Oil Pipe Sleeve (Rubber)	4	.05
	MODEL 6AC-298 ENGINES		
11677	Valve Case Oil Pipe Clamp (Double)	4	.29
11675	Valve Case Oil Pipe Clamp (Single)	2	.33

Part No.	Name	No. Required Per Engine	Price Each $

MODEL 6AC-298 ENGINES (CONT'D)

11674	Valve Case Oil Pipe Support	4	.39
19x15	Shakeproof Lock Washer) Clamp	4	.01
12x18	Round Head Screw) to	4	.01
3x32	Hex Nut) Support	4	.01
11676	Valve Case Oil Pipe Sleeve (Rubber)	6	.05

The rubber sleeve, No. 11676, can be installed on oil pipes now on engines by slitting one side of the sleeve lengthwise to permit wrapping around the pipe.

The support should be assembled to the upper cylinder hold-down screw or stud nearest the pipes and clamps placed around rubber sleeves on pipes and fastened to the support.

A SUGGESTION ON THE LEAD PROBLEM

Laboratory tests have shown that varying the speed of an engine in flight helps to prevent lead in gasoline from building up on valves, valve guides, pistons, etc. It is, therefore, suggested that continuous operation of an engine, over long periods of time, at a certain RPM be avoided. Also, after landing, idling the engine for several minutes should prove to be beneficial.

CAB WARNS AGAINST USE OF LOW GRADE FUELS

The following is a quotation from a recent National Aeronautic Association NEWSLETTER:

"Stating that it has received 'far too many reports' of aircraft engine failures caused by use of unspecified fuels, the Civil Aeronautics Board labeled such carelessness not only dangerous but unpatriotic. The Board asserted that the use of low grade fuel other than the quality specified by the engine manufacturer amounts to practically willful damage to aviation equipment that might be useful in the war effort. It was emphasized that under these circumstances 'it should be sufficient to point out that an operator using such fuels must accept full responsibility for doing so.'"

December 7, 1942

SERVICE BULLETIN NO. 21

FRANKLIN AIRCRAFT ENGINES

CAMSHAFT GEARS

A few of the early 80, 85, 90, 120, and 130 HP Franklin engines were equipped with an all-celoron camshaft gear. We have been recommending that this gear be replaced at the first major overhaul by a new aluminum rim celoron gear which is designed to withstand more severe operation than the all-celoron type.

Indications are that the life of this gear will not be as long as was expected. Therefore, it is recommended that all Model 4AC-199 engines below serial #200533, all Model 4AC-176 (80 HP) engines below serial #125270, all Model 6AC-264, and all Model 6AC-298 engines below serial #400131 be examined to determine the type of camshaft gear. This can be accomplished by removing the starter or any of the other accessories.

If the gear is found to be of the all-celoron type we recommend, as a precautionary measure, that the new aluminum rim type #10725 be installed immediately.

AIRCOOLED MOTORS CORPORATION

SYRACUSE NEW YORK U S A

June 12, 1943

SERVICE BULLETIN NO. 23

FRANKLIN AIRCRAFT ENGINES

CRANKSHAFT REGRINDING

Improper regrinding may cause crankshaft failure under severe operation. Proper facilities and an appreciation of the necessity of accurate workmanship are highly essential. All fillets should be carefully ground to .125 - .135" radius, free from grinding marks. Expert magnafluxing and checking for alignment and balance are also important.

SPARK PLUG INSERTS

Tests have proven the Heli-coil insert to be very satisfactory. Stripped spark plug holes can be repaired with this type insert if sufficient stock is left in the cylinder head. Do not attempt repairs with special inserts but ship cylinders to the factory for expert and prompt reconditioning.

It is important that a spark plug wrench be used only to loosen and tighten spark plugs. They should always be carefully removed straight out with the fingers and likewise started into the spark plug holes and turned down to within the last one or two turns with the fingers. Recommended torque wrench specification for tightening is 15 foot pounds. Care and patience save valuable time and material now on the critical list.

MAGNAFLUXING

It is recommended that crankshafts, camshafts, valve rockers, piston pins, valve rocker pins, connecting rods, and valves be magnafluxed at each major overhaul. If the necessary equipment is not available in your territory, do not hesitate to ship the parts to the factory. A little delay is preferable to an accident.

RECOMMENDED CHANGES IN SPARK ADVANCE

On Models 4AC-176-B2, 4AC-176-BA2, 4AC-176-F2, and 4AC-176-F3 retarding of spark setting from 28° to 26° has been approved and recommended by Civil Aeronautics Administration as a preventive measure against detonation. It is a recognized fact that gasoline

cannot be purchased today that will meet specifications for which engines were designed. Tests have proven that no appreciable loss in power will result from this retarded setting and life of cylinders and pistons may be prolonged considerably.

VALVE MECHANISM

MODELS 4AC-176, 4AC-199, 6AC-264, 6AC-298

It is always good practice to tag all valves, springs and washers, when disassembled from cylinders, to assure their being reassembled on the same cylinder. Certain changes have been made that make this procedure necessary. There are, of course, occasions when this is not possible. Therefore, a resume of specifications and changes follows. We suggest that a careful study of them be made. If there are any points not perfectly clear, do not hesitate to consult the Service Department.

1. All valve spring upper washers of the stamped type should be replaced with the machined type - #10730 with valve spring #10188 (short type) and #10825 with spring #10824 (long type). When this is done, the valve spring damper should be ground off 1/8" on the prong ends to insure sufficient valve rocker travel. Valve rocker breakage will result if this is not done.

2. It is essential that valve lifter rods be inserted in the hydraulic valve lifter unit cups. Especial care should be taken to prevent rods riding on the edge of the cup. Damaged valve lifters and possible broken valve rockers or valves may result if this condition exists.

3. A change in the depth of valve spring recesses in cylinder heads and length of valve springs has been made. The difference in length is only 3/32" and care must be taken to prevent incorrect assembly. The new long springs #10824 cannot be used in cylinders with shallow recesses, but the shorter springs #10188 may be used in cylinders with deeper recesses by using two #10202 valve spring bottom washers in the recesses under valve springs. See Illustrations No. 1, 2, and 3.

   If doubt exists concerning the combination after assembly, check for clearance between valve spring coils (See Illustration No. 4) before adjusting valve clearance (See Illustration No.5) This clearance between coils should be at least .010", with the spring fully compressed.

STAMPED TYPE UPPER
VALVE SPRING WASHER

NO. 1

NO. 2

NO. 3

NO. 4

NO. 5

VALVE SPRING TENSION

Model 4AC-150, 4AC-150-A and 4AC-171 valve springs should support 63 to 68 pounds without allowing valve to open when assembled to cylinders. Before assembly to cylinder, springs should weigh as follows:

	Compressed to	Weight
Inner Spring	1 5/16"	63 - 68 lbs.
Inner Spring	1 11/16"	25 - 28 lbs.
Outer Spring	1 13/16"	32 - 35 lbs.
Outer Spring	1 7/16"	65 - 70 lbs.

Model 4AC-176, 4AC-199, 6AC-264 and 6AC-298 valve springs should support 50 to 60 pounds without allowing valve to open when assembled to cylinder. Before assembly to cylinder, springs should weigh as follows:

	Compressed to	Weight
Short Spring #10188 (1 27/32")	1 17/32"	44 - 50 lbs.
Short Spring #10188 (1 27/32")	1 5/32"	98 - 106 lbs.
Long Spring #10824 (1 15/16")	1 5/8"	46 - 52 lbs.
Long Spring #10824 (1 15/16")	1 1/4"	108 - 116 lbs.

Additional copies will be furnished upon request.

AIRCOOLED MOTORS CORPORATION

SYRACUSE NEW YORK U S A

LITHO. IN U.S.A.

April 8, 1944

SERVICE BULLETIN NO. 24

RECOMMENDED CHANGE IN SPARK ADVANCE

Supplementing Service Bulletin No. 23 on this subject, retarding of spark setting from 28 degrees to 26 degrees has been approved and recommended by Civil Aeronautics Administration on Model 4AC-199-E3 engines.

SPARK PLUGS

References have been made in service bulletins and operator's handbooks concerning the proper care and handling of spark plugs. However, the spark plugs are so common and sometimes so easily forgotten until trouble develops that too much emphasis cannot be put upon the importance of correct procedure.

1. Do not attempt to remove or install spark plugs until cylinder heads have been allowed to cool. Damage to spark plug hole threads may take place.

2. Frequent inspection and removal of lead and carbon deposit will insure good operation and may save costly delay resulting from stripped spark plug hole threads caused by an excessive amount of lead on that portion of the spark plug extending into the combustion chamber. Scrape all surfaces free of deposit or clean with spark plug cleaning apparatus. This should be done every 25 hours or less.

3. Check gap and adjust carefully to .020 clearance. Excessive clearance may cause difficulty with engine starting. If worn sufficiently to prevent correct adjustment, discard and install new plug.

4. Use care when reinstalling the spark plug. Turn in with fingers as far as possible and complete installation with spark plug wrench furnished with the engine. Whenever possible a torque wrench should also be used. The correct torque is 15 foot pounds.

5. Only spark plugs that have been tested and have received Civil Aeronautics Administration approval for operation in Franklin engines should be used. For Models 4AC-150, 4AC-150-A, 4AC-171, 4AC-176, 4AC-199, 4ACG-199, 6AC-264, and 6AC-298 the approved spark plugs (14 mm.) are Champion J-10, Champion C-10-S (shielded), and Simmonds-Benton 4D3-S (shielded).

6. Tests have proven that the use of a solid copper gasket between spark plug and cylinder head helps to keep temperature down and reduces detonation to a minimum. The solid gasket is also desirable for use with cylinders incorporating the Heli-coil insert in the threaded hdes for the spark plugs. Solid copper gaskets are obtainable as standard equipment with new spark plugs.

CYLINDER REMOVAL

To facilitate cylinder removal on Models 4AC-176,4AC-199,6AC-264 and 6AC-298 engines,first pull the valve lifter rod tubes up through the cylinder head valve case by using a puller designed for this purpose. This is one of the very few special tools necessary for completely overhauling these Franklin engines.

When reassembling a cylinder to the crankcase,check both surfaces of the cylinder and the crankcase to make sure they are smooth and free from scratches. If any oil leakage at cylinder base has been experienced, check the crankcase to make certain surfaces at cylinder holes are true. The use of Clearset No. 66, manufactured by Babbitt Industrial Specialties has been found helpful in eliminating oil leakage. Apply a small quantity to each side of the cylinder base gasket.

Use extreme care in tightening cylinder hold-down nuts or cap screws to avoid cracking the cylinder flange. Tighten each nut or cap screw separately a little at a time and use a torque wrench, applying not more than the pressure specified.

PREVENTION OF CRANKSHAFT FAILURE

Tests have proven that properly shot blasting the cheeks and crankpin fillets of crankshafts prolongs life and greatly reduces the possibility of fatigue failures in service. Such failures have been encountered most frequently on early ninety horsepower engine crankshafts incorporating crankpin fillets smaller than 1/8 inch inch in radius. Failures have occurred less frequently on other 4 cylinder engines. Therefore, in collaboration with the Civil Aeronautics Administration, we recommend that all Franklin crankshafts not already so processed be shot blasted during or before the next overhaul.

August 10, 1944

SERVICE BULLETIN NO. 25

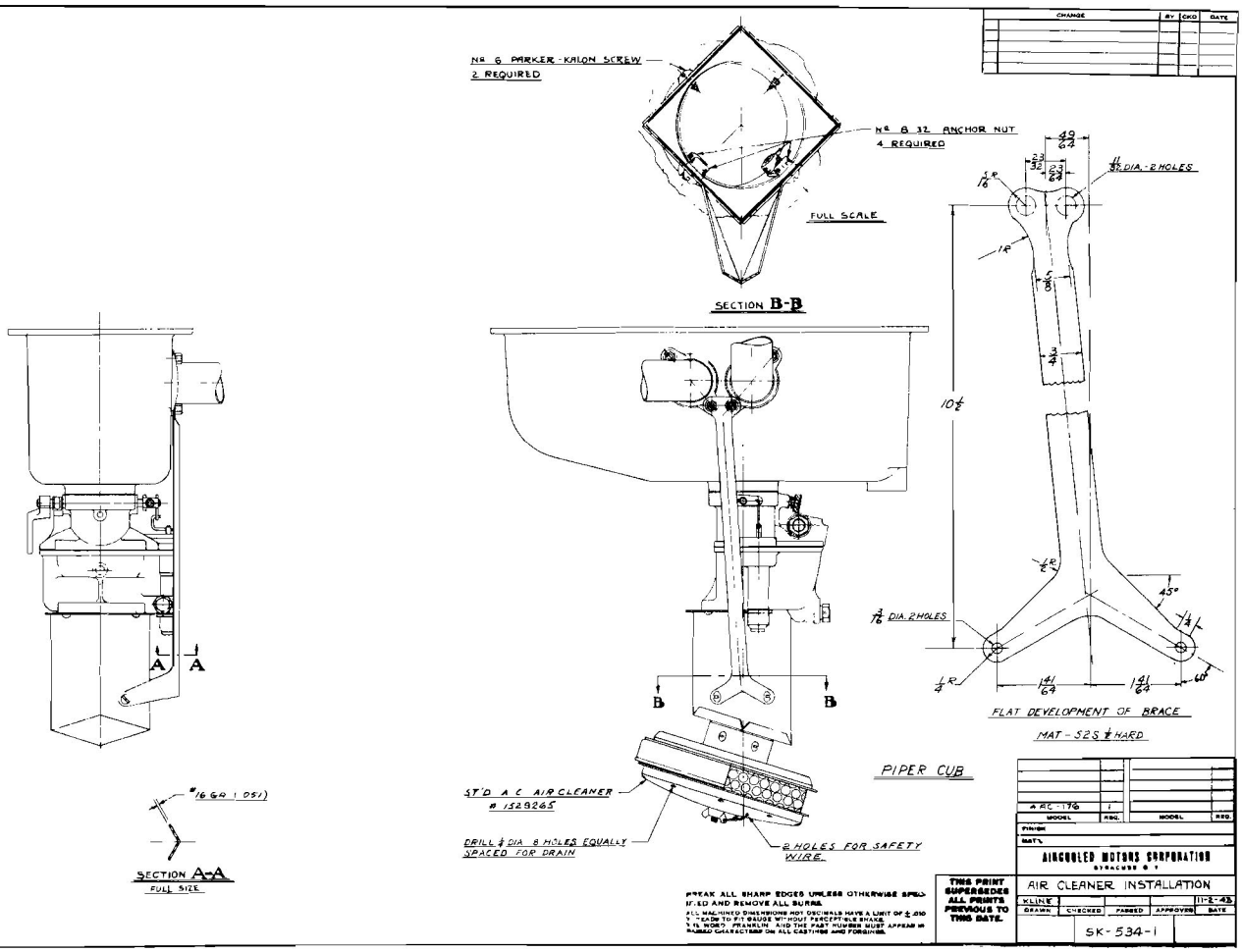
FRANKLIN AIRCRAFT ENGINES

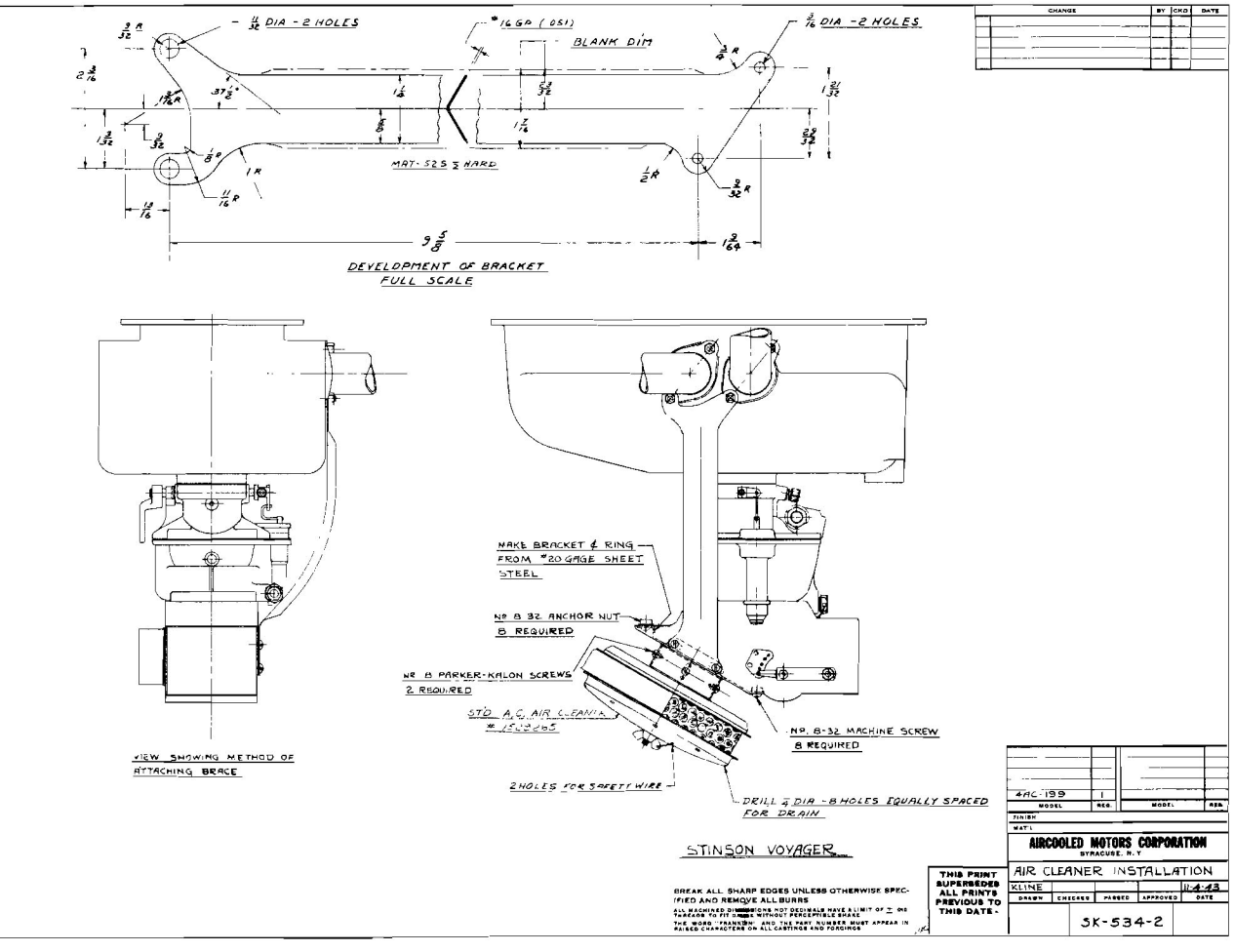
AIR CLEANER

Operation of airplanes from temporary fields, necessitated by the closing of many airports to all civilian flying, has emphasized the need of a carburetor air cleaner to prevent induction of dirt and thereby prolong the life of the engine.

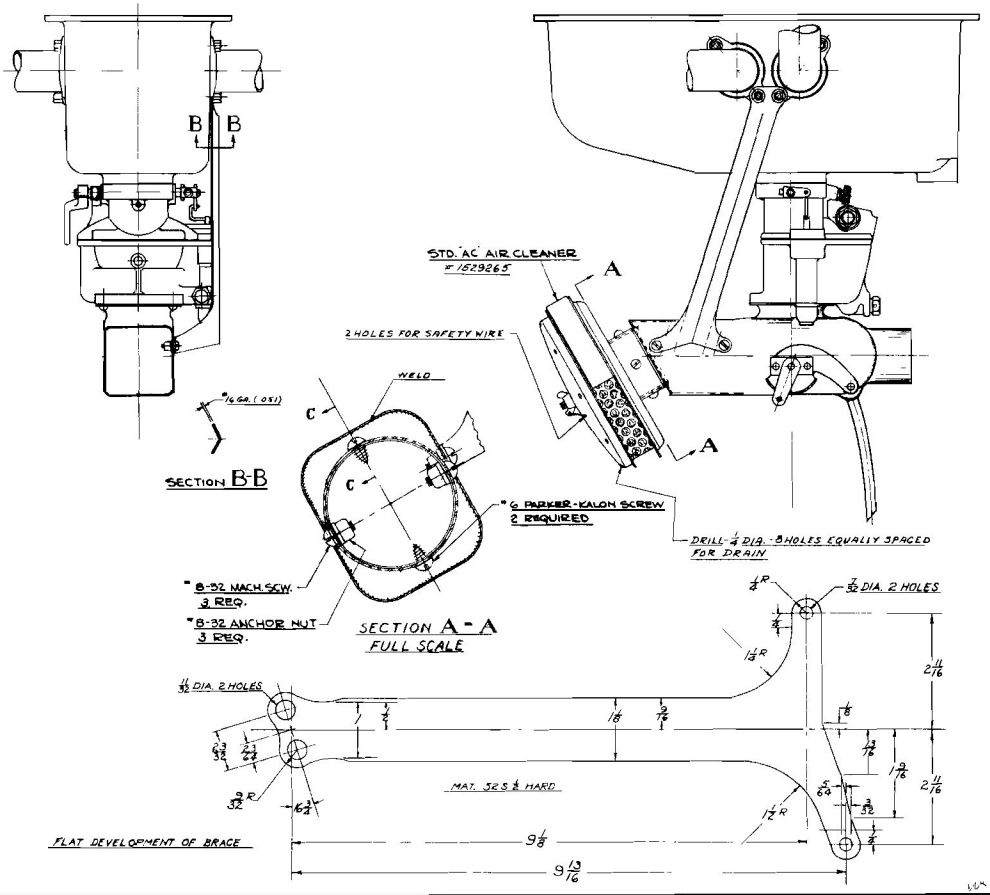
An air cleaner designated as AC #1529265 and manufactured by AC Spark Plug Division, Flint, Michigan, has been tested and found satisfactory. Installation on various airplanes as illustrated in the sketches shown below has been approved by the Civil Aeronautics Administration and we recommend immediate attention to this item as one that will prove to be beneficial.

Prints of drawings shown will be gladly furnished on request.


CHANGE
BY
CKD
DATE
№ 6 PARKER-KALON SCREW
2 REQUIRED
№ 8 32 ANCHOR NUT
4 REQUIRED
FULL SCALE
SECTION B-B
11/32 DIA. - 2 HOLES
10½
7/16 DIA. 2 HOLES
45°
60°
FLAT DEVELOPMENT OF BRACE
MAT - 52S ½ HARD
PIPER CUB
STD A C AIR CLEANER
1529265
DRILL ¼ DIA 8 HOLES EQUALLY SPACED FOR DRAIN
2 HOLES FOR SAFETY WIRE
SECTION A-A
FULL SIZE
BREAK ALL SHARP EDGES UNLESS OTHERWISE SPECIFIED AND REMOVE ALL BURRS.
THIS PRINT SUPERSEDES ALL PRINTS PREVIOUS TO THIS DATE.
4 AC-176
AIRCOOLED MOTORS CORPORATION
SYRACUSE N Y
AIR CLEANER INSTALLATION
KLINE
11-2-43
SK-534-1


CHANGE
BY
CKD
DATE
11/32 DIA - 2 HOLES
BLANK DIM
7/16 DIA - 2 HOLES
MAT - 52S ½ HARD
DEVELOPMENT OF BRACKET
FULL SCALE
VIEW SHOWING METHOD OF ATTACHING BRACE
MAKE BRACKET & RING FROM #20 GAGE SHEET STEEL
№ 8 32 ANCHOR NUT
8 REQUIRED
№ 8 PARKER-KALON SCREWS
2 REQUIRED
STD A C AIR CLEANER
1529265
№ 8-32 MACHINE SCREW
8 REQUIRED
2 HOLES FOR SAFETY WIRE
DRILL ¼ DIA - 8 HOLES EQUALLY SPACED FOR DRAIN
STINSON VOYAGER
BREAK ALL SHARP EDGES UNLESS OTHERWISE SPECIFIED AND REMOVE ALL BURRS
THIS PRINT SUPERSEDES ALL PRINTS PREVIOUS TO THIS DATE -
4AC-199
AIRCOOLED MOTORS CORPORATION
SYRACUSE, N.Y
AIR CLEANER INSTALLATION
KLINE
11-4-43
SK-534-2

CHANGE	BY	CKD	DATE



AERONCA

4AC-176	1	
MODEL	REQ.	
FINISH		
MAT'L.		

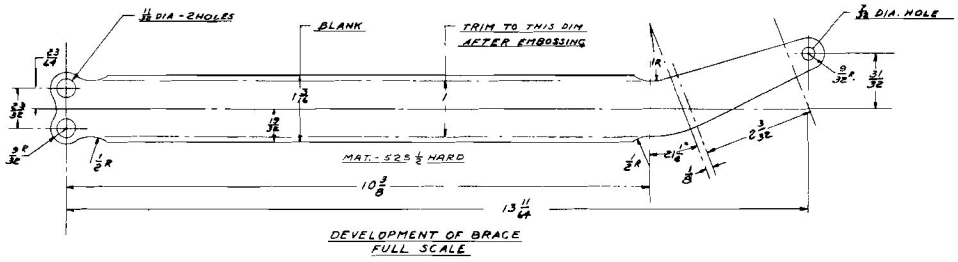
AIRCOOLED MOTORS CORPORATION
SYRACUSE, N.Y.

INSTALLATION-AIR CLEANER

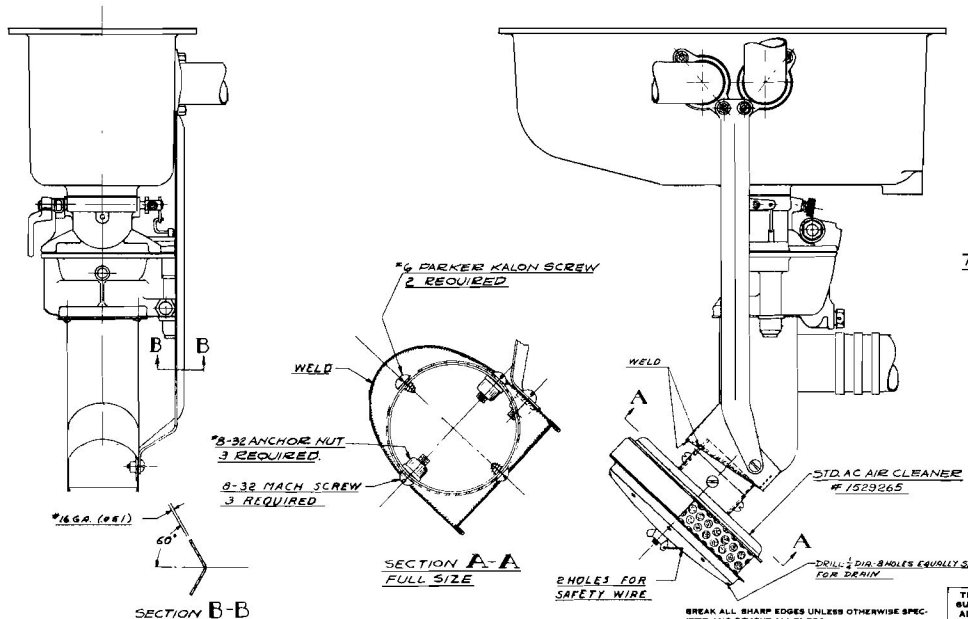
TAYLOR				11-26-43
DRAWN	CHECKED	PASSED	APPROVED	DATE

5K-534-3

CHANGE	BY	CKD	DATE



DEVELOPMENT OF BRACE
FULL SCALE



TAYLORCRAFT - "65"

4AC-176	1		
MODEL	REQ.	MODEL	REQ.
FINISH			
MAT'L.			

AIRCOOLED MOTORS CORPORATION
SYRACUSE, N.Y.

INSTALLATION-AIR CLEANER

TAYLOR				11-26-43
DRAWN	CHECKED	PASSED	APPROVED	DATE

5K-534-4

THIS PRINT SUPERSEDES ALL PRINTS PREVIOUS TO THIS DATE -

BREAK ALL SHARP EDGES UNLESS OTHERWISE SPECIFIED AND REMOVE ALL BURRS.

ALL MACHINED DIMENSIONS NOT DECIMALS HAVE A LIMIT OF ± .010 THREADS TO FIT GAUGE WITHOUT PERCEPTIBLE SHAKE.

THE WORD "TRAFALLIC" AND THE PART NUMBER MUST APPEAR IN RAISED CHARACTERS ON ALL CASTINGS AND FORGINGS.

CONVERSION OF MODEL 4AC-176-F3 (80 HP) ENGINE

Tests recently conducted by our Engineering Department have proven that conversion of the Model 4AC-176-F2 (or 3) 80 HP engine from a compression ratio of 7:1 to 6.3:1 is highly advantageous and eliminates possibility of damage from detonation.

Engine designation with this lower compression ratio is known as 4AC-176-D2 (or 3) and it develops rated 80 HP at 2650 RPM. Approval has been received from the Civil Aeronautics Administration, and we recommend that immediate action be taken by all owners of Franklin 80 HP engines installed in Culver Model LFA airplanes to avail themselves of this opportunity. The work involved is practically the same as for a top overhaul, and can be accomplished by a competent aircraft engine mechanic. Cylinders should be carefully checked and if any unusual condition is noted, it is suggested that they be shipped to the factory for reconditioning.

The new name plate will be stamped to specify use of 80 octane gasoline. Lower octane gasoline should either be drained from the tanks or mixed half and half with 91 octane.

Parts required for this change are pistons, piston rings, piston pins, valve case oil pipes, gaskets, packings and name plate. This material can be obtained for a limited time at a special price of $29.00 F.O.B., Syracuse, New York. It is suggested that a check or money order accompany the purchase order with priority to save time.

It will be sincerely appreciated if you will advise the name and address of any new owners of airplanes equipped with Franklin engines in order that we may mail them copies of this bulletin. Many transfers of ownership have taken place since the beginning of the war concerning which we have not been advised.

AIRCOOLED MOTORS CORPORATION

SYRACUSE NEW YORK U S A