INSTRUCTIONS FOR TOP OVERHAUL.

It will facilitate top overhaul if the operations are carried out in the following order :—

1. When necessary to remove airscrew and nose cowling, take out split pin, remove nut and washer on spinner. Remove spinner and lock-plate. Unscrew nuts from airscrew bolts and remove front plate. The Airscrew can now be withdrawn from the hub, and nose cowling removed.
2. Disconnect carburettor muff heater pipe and remove exhaust manifold.
3. Pull out hinge pins securing air cooling chute and remove same.
4. To remove rocker boxes, pull the knurled nut away from the box to disengage the locking pin which prevents knurled portion from turning, and unscrew whilst holding same clear of the box. The box can then be removed. (The single knob fastening is spring locked and self extracting.)
5. Disconnect petrol feed pipes.
6. Disconnect H.T. Leads from Sparking Plugs and remove plugs from engines.
7. Disconnect altitude and throttle controls at levers on induction manifold. Disconnect the interconnecting rod between throttle and magneto controls and remove induction system.
8. Free the locking tab washers, slack off locknut and unscrew the push rod ball sockets from the rockers. This will leave an aperture through which the push rods can be withdrawn by passing through the rocker.
9. The push rod cover tubes fit over the tappet guides and the tappet may drop, thus preventing the cover tube from being withdrawn. To remove push rod cover tube compress same in telescopic fashion from the crankcase end and when clear of tappet guide make sure that the tappet is not obstructing removal, or tube will be damaged. A cowling pin will serve to lift tappet out of the way, unless the tappet is on a cam, in which case turn the engine till camshaft permits tappet to return to normal position.
10. Remove cylinders together with the cylinder heads by unscrewing the four nuts securing each cylinder to the crankcase.
11. Remove the piston rings by inserting three narrow strips of thin metal under ring and sliding ring over same. Take care not to expand rings more than necessary, and when removed place them in their respective cylinder already removed.
12. To extract gudgeon pin circlips use special tool Pt. No. C.F.A. 834. The gudgeon pin can then easily be withdrawn and the piston removed.

CYLINDER HEADS.

13. To detach the cylinder head from the cylinder free the locking tabs and remove the eight nuts securing each cylinder head, easing the head away from the cylinder. Should any difficulty be found in separating the two units, place a piece of wood on bench or in vice and holding cylinder

over it bring the cylinder head down on to the end lightly but smartly, and the head will then detach itself.

N.B. Do not try to prise apart at joint or joint faces will become damaged.

14. Remove spring clips on end of rocker pins, and slide rocker arms off. Depress valve spring collars and remove the split collets from the valve stems, thus releasing valves and springs.

15. Decarbonize and clean all parts, after which inspect carefully for pitting of valves or valve seatings. If pronounced signs of pocketing are noticed a valve seat skimming tool should be used to restore the face of the seating before the valve is ground in. Should valve be pitted, skim face lightly to the correct angle. **Before cutting seating in cylinder head** check up valve stem dimensions and valve guide tolerance (as per Appendix C), so that if a new guide is necessary this is fitted and the seating **correctly aligned from the new guide.** Valves can now be ground in, using a fine abrasive. Ensure that stem of valve is smooth by polishing if necessary. Carefully remove all traces of the abrasives used before assembling. To check efficiency of valve seating insert valves and springs and fill ports with paraffin or petrol and see that the valve is not allowing same to pass the seating. Check dimensions of rocker bushes, carefully wash out the ball cup in end of rocker which carries the ball with a flat on it to ensure no grit or foreign matter is present to interfere with the free movement of the ball. Examine springs and after cleaning all parts reassemble valves in heads and rocker gear.

CYLINDERS.

See that they are free from scoring, and check up for wear and/or ovality. (See Appendix C.)

PISTONS.

Check piston ring grooves for wear. Check pistons for ovality and for any signs of cracks.

Piston rings should be checked for tension (the gap should be approximately 12 m/m when ring is free), look for signs of uneven wear or blowing. Place piston rings in respective cylinder and use the crown of the piston to square up the ring in cylinder, then check gap.

INDUCTION PIPE AND CARBURETTOR.

Examine induction pipe for corrosion and seal up ports and test under water with a pressure of 20 lbs. per square inch. Dismantle, clean and reassemble Carburettor. (See Appendix E.)

MAGNETOS AND SPARKING PLUGS.

Clean and inspect magnetos and make any adjustments necessary to contact point gaps as per instructions in Appendix F.

Clean and test sparking plugs as per instructions in Appendix H. The sparking plugs should function correctly under a pressure of 90 lbs. per square inch.

Examine H.T. Leads and replace if showing signs of perishing or burning. See that terminal ends are in good order.

FILTERS.

Clean petrol and oil filters and drain oil tank.

REASSEMBLY.

Prepare all parts before commencing reassembly and having procured any new washers, lock tabs or dermatine rings necessary, reassemble in the following order.

Fit cylinder heads to cylinders, taking care that the joint washer is correctly fitted, and pull all nuts uniformly tight, taking a turn on each one in sequence.

Do not pull one side down tight before the rest.

Lock the nuts by turning up the tab washers.

Refit pistons on connecting rods, oiling these parts in the process, and see that the gudgeon pin circlips are fitting snugly in their grooves.

Fit piston rings after filling grooves with oil and note that the scraper ring is fitted with its largest diameter nearest the crown of the piston. Oil piston all over the walls before fitting cylinder.

Fit dermatine ring to cylinder base and see that it is not stretched too much or it will not allow cylinder to correctly fit to crankcase. Oil cylinder bores. Set piston rings so that the gaps are equidistant and gently slide cylinder over piston, holding the rings compressed until covered by cylinder. See that cylinder does not ride on any of the cowling fittings. Tighten nuts holding cylinder, and lock same with their tab washers.

Fit cylinder Baffle Plate.

Replace push rod cover tubes.

Replace push rods and cup sockets.

Set clearances ·004 in., taking care to see that the camshaft is not lifting tappet.

Secure lock nuts of adjustable tappet cups on rockers and lock by means of the tab washers.

Replace induction system and connect up controls.

Replace sparking plugs, connect H.T. Leads.

Replace side cooling chute.

Refit exhaust system and connect heater pipe.

Connect petrol feed pipes.

Fill rocker box covers with engine oil to level indicated.

Fit front cowling and airscrew.

Having completed assembly, fill tank with fresh oil and run up the engine at approximately 1000 r.p.m. for about 15 minutes to permit oil to reach all working parts before opening up to full throttle.

INSTRUCTIONS FOR COMPLETE OVERHAUL.

1. To remove engine from airframe proceed as follows :—

   Remove propeller as instructed in notes on top overhaul, then take off machine cowling, air intake and exhaust system. Disconnect all oil pipes, petrol pipes and engine controls, tachometer drive, oil pressure pipe, switch wires from magnetos and earthing wire from engine. Remove the nuts securing the stirrups to air frame and attach sling to lifting rings in top cover of engine.

2. Hoist engine clear of airframe, taking care that nothing fouls the machine. Next remove the engine bearer feet from the engine and replace with workshop bearer feet, which may be made of steel or from angle iron, and place on an engine stand in the inverted position. **Do not** turn engine with cylinders uppermost at this point.

   Remove rest of engine cowling, sparking plugs and H.T. Leads.

   Remove rocker box covers and drain off oil.

3. Next remove airscrew hub as follows. Take off the sleeve and turn back lock tab securing the hub nut.

   Replace airscrew on bolts to prevent crankshaft from turning, and pass special spanner Pt. No. C.F.B. 807 through centre of airscrew.

   Remove nut and airscrew and screw on extractor Pt. No. C.F.B. 806 to hub as far as possible.

   Next, tighten up centre screw of the extractor with spanner Pt. No. A.A. 802 until hub is withdrawn off crankshaft. A sharp tap on end of this screw will assist in this operation.

4. Remove starter or any other special attachments on rear end of engine, or take off the crankshaft cover plate if no accessory is fitted at this point.

5. The next operation is to turn the engine over so that the cylinders are uppermost. (A reversible stand is recommended, and stands as used in our own works can be supplied by us for this purpose at reasonable cost.)

   These stands have wheels and a handle, also tray for small parts and tools, and the engine can be turned over on a pivoted bearer frame so that all parts can easily be reached. (Photo and prices can be had on request.)

   Remove magnetos and platforms, remove securing circlips and nuts on end of vertical magneto driving shaft, using special locking device Pt. No. C.F.A. 840 to hold shaft from turning.

   Remove Simms couplings. Next extract cover plate (by means of the two extractor holes in them, using two crankcase bolts) and remove Woodruff keys. **Do not** remove housings at this stage, as this would leave magneto driving shafts unsupported except at one end.

6. Remove induction system, cylinders, piston rings, etc., as instructed under top overhaul notes on preceding pages. Pistons need not be removed at this stage, but care should be taken that they are not damaged by allowing them to knock against the crankcase.

7. Remove the nuts securing tappet guides and extract tappets and guides. Unscrew cap nut from oil filter body and withdraw complete with the filter elements. To clean, remove split pin and withdraw conical elements from perforated spindle.

8. Remove the two nuts and the two special bolts securing oil filter body. Draw body carefully off the perforated tubes. Remove petrol pumps and guide plates with their plungers, or the blanking plates if pumps are not fitted by unscrewing the nuts securing them to crankcase.

9. Remove timing gear cover. Turn engine over on stand and remove all nuts securing the cover to the crankcase.

10. Remove oil pump by unscrewing the nuts arranged around the pump. **Special Note.** The large slotted nut **must not be unlocked or removed.**

11. Next extract the split pins, nuts and washers from connecting rod big ends, take off caps and withdraw rods complete with pistons. To do this it is necessary to turn crankshaft to let rods and caps clear the oil retainers in the crankshaft.

12. Unscrew crankshaft thrust nut with serrated spanner Pt. No. C.F.B. 818, noting that engines up to No. F. 65 inclusive, have right handed threads and a locking plate to the airscrew hub. On all other engines this thread is L.H. and therefore no locking plate is fitted. Remove oil thrower, unlock and remove the bolt and D. washer from the idler gear spindle and withdraw gear wheel, taking care of the needle rollers of which there are 48 in all.

13. Unlock and remove the eight bolts securing the thrust ring to crankcase and front main bearing cap. Next unlock and remove nuts securing the main bearing caps. Remove crankshaft and remaining halves of bearings. Take rear plate of thrust housing from crankshaft.

14. Remove lock wire and the four slotted nuts securing camshaft bearing and withdraw camshaft complete with bearing.

15. Magneto driving shafts may now be tapped out of crankcase and the oilthrowers removed from shafts in the process.

16. Dismantle the oil pump by removing the rotor and piston, unlock the nut and remove oil pressure spring and piston.

17. Turn back locktab and unscrew bolt securing camshaft wheel and camshaft, remove washer and withdraw wheel from the shaft by means of the special extractor Pt. No. C.F.B. 829 and slide bearing from the wheel

18. Dismantle cylinder heads, valve gear and pistons as instructed in notes on Top Overhaul. If a gudgeon pin is found to be tight, tap it out carefully with a drift, preferably a piece of hard wood, so as not to damage gudgeon pin bore.

19. Remove split pins and slotted nuts and withdraw bolts and oil baffle plates from crankshaft.

20. Unlock and remove the Hexagon-headed plug in main oil gallery at front end and the slotted plug at the rear end above oil pump.

Do not remove the five Domed Nuts on side of Crankcase.

21. For Carburettor instructions see Appendix " E."
22. ,, Magneto ,, ,, ,, " F."
23. ,, Fuel Pump ,, ,, ,, " G."

INSPECTION OF PARTS.

All parts after being thoroughly cleaned should be subjected to careful inspection and checked against the tolerances and clearances permitted as laid down in Appendix " C."

It will be noted that these are divided into tolerances permitted for parts which will be subject to inspection at 300 hour periods (top overhaul) and tolerances for parts which will only be inspected at 600 hour periods.

Points worth attention are :—

1. **CYLINDER HEADS AND VALVE GEAR.** Check over as instructed for Top Overhaul, Section 4.
2. **CYLINDERS, PISTONS AND RINGS, Etc.** Check over as instructed for Top Overhaul, Section 4.
3. **CONNECTING RODS.** Check bore at small end for wear and ovality, also for alignment. Check big end bearings for adhesion of white metal, cracks and/or scoring. Check on crankshaft for clearances both on sides and diametrically as per Appendix " C." **On no account should the rod or bearing shells be " faced off " to take up wear.** Fit a new bearing if required.
4. **CRANKSHAFT.** Check for scoring and ovality on journals. Should the scoring be deep, or ovality beyond the limits in Appendix " C," the shaft should be re-ground.

   Check also the hub end of shaft for any signs of " picking up." Carefully ease off and refit hub, using a very fine abrasive and remove all traces of the abrasive.
5. **CRANKCASE.** Check over for general condition, tightness of studs, and after checking main bearings for cracking and scoring assemble them in crankcase and check for clearances on shaft as per Appendix " C." Do not use excessive force when tightening cap and never face off cap to take up wear in the bearing. They are quite cheap and should be replaced.
6. **TOP COVER TO CRANKCASE.** Check for general condition and any signs of cracks.
7. **CAMSHAFT.** Check for signs of undue wear on cams and general condition of bearing faces. Carefully stone any rough edges on cams.
8. **BALL RACES.** After washing thoroughly check for roughness, pitting, or wear. Replace if any signs are present, as they will rapidly become worse.

9. **GEARS.** Check for wear, chipping and pitting. Where chipping is only slight stone smooth. If chipped on contact faces, or badly worn replace. See Appendix " C " for backlash tolerances.

10. **NEEDLE ROLLER RACE.** The Idler gear wheel runs on a needle roller race, and this should be carefully checked for wear or chipping of rollers and for dimension of tracks on roller journals.

11. **TAPPETS AND GUIDES.** Check fit of tappets in guides and condition of tappet heels and bearing surfaces.

12. **INDUCTION SYSTEM.** Check for leaks, both externally and into heater box as instructed in Notes on Top Overhaul.

13. It is recommended that all rubber joints be renewed at this period to ensure good oil seals and a clean engine. It will well repay the small expenditure involved.

14. The gitseals on the magneto driving shafts and the Amal pump diaphragms should be renewed as they have given their useful life.

    Replace all tab washers, circlips and locking plates and any other jointing which may have suffered by removal.

15. Please assist us in giving service by ordering all replacement parts promptly and quoting part numbers to be found stamped or etched on parts. These part numbers have prefix letters such as C.F.A., C.F.B., etc.

Always Quote Engine Number on your Requisitions.

REASSEMBLY.

After replacements have been obtained where necessary all parts should be examined for cleanliness and laid out on a clean and preferably metal covered bench.

The crankcase having been washed clean and all particles of dirt, etc., blown away by compressed air jets where available, assembly may be commenced.

If in good condition the Laminated Copper Cylinder head washers may be annealed at 600° C. and taken into use again. See that they are perfectly flat and not damaged or turned up at the edges. Fit new washer between carburettor and Induction Manifold, and new inlet port washers to secure a gas-tight joint.

See that the spring clips locking rockers on their pins have not lost their tension and are snug fits in their grooves. Replace any doubtful ones.

Assembly can now be carried out in the reverse order to that laid down for dismantling.

USEFUL HINTS FOR REASSEMBLY.

During reassembly all parts should be thoroughly oiled.

If a new camshaft bearing bush has been fitted, check end float according to table of clearances (Appendix " C."). When oil pump is secured rotate camshaft, which should turn very freely.

The oil throwers fitted to the magneto driving shafts **are not interchangeable** —being stamped L.H. and R.H. These should be read as looking at the engine from the rear end with cylinders below crankshaft.

The clearance between these throwers and ball race housings is important and must be within the prescribed limits. (See Appendix " C.")

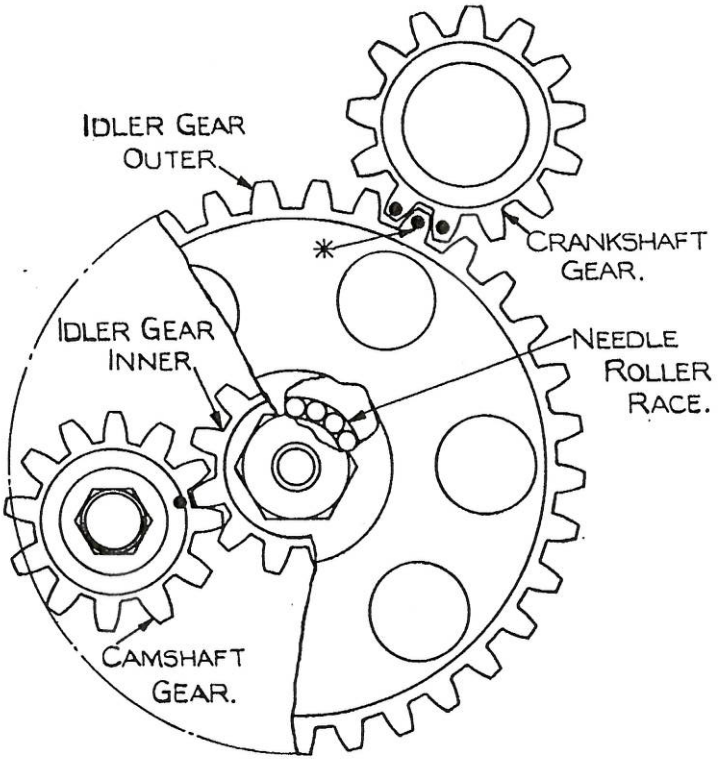
A check on this should be carried out by assembling the shafts complete before fitting them into crankcase. The nuts securing the magneto drive housings are locked by the flats arranged around the inside of the magneto platforms.

The camshaft must be fitted **before** the tappets and guides as otherwise the tip of guides will probably be damaged or broken when inserting camshaft.

Assemble the back plate of thrust housing to crankshaft **before** laying the shaft in the main bearings. This should be free to rotate by hand. The bolts securing thrust housing must be pulled evenly tight.

To assemble the idler gear place the needle rollers on the spindle, keeping them in place with clean grease.

Engage wheel with camshaft and crankshaft gear wheels with identification marks together. (See illustration.)



The above illustration shows the method of gear marking carried out before the engines leave our works.

In the event of a new idler gear being fitted the dot marked * on the above illustration must be stamped on the gear after timing has been carried out in accordance with instructions, page 2, Section 6, of this Manual.

If at any time a **new idler wheel** is required, proceed with the **fitting and timing** as follows :—

Set the rockers on No. 1 cylinder to a clearance of .055 in. Then set the camshaft so that the exhaust has just closed and the inlet is about to open.

Next turn the crankshaft to a position 3° before T.D.C. Now drop the idler in various positions (without fitting rollers) until one is found where the wheel is concentric with the spindle. This may be checked by using a roller which should fit in anywhere round the circumference. Now turn the engine until the marked teeth of the crankshaft wheel are in mesh with the idler. Stamp the idler tooth which is between these teeth.

To time with idler which has been marked in the above manner, turn the crankshaft and the camshaft until the marked gaps face the idler centre. Then place the idler in with the marked tooth engaging with the marked gap in crankshaft wheel. If the camshaft wheel does not engage, turn the engine back slightly (counter-clockwise facing gears) until it does.

NOTE. The rear set of idler gear rollers should be fitted in position and held there by some clean grease. The front set may be pushed in after the wheel is in position.

If at any time the spindle which acts as the inside track for the needle roller race is changed during overhaul a check must be made of end thrust. (See Table of Clearances, Appendix " C.")

When refitting connecting rods see that all of their numbers correspond with those on crankshaft webs to ensure that the " bleed holes " in connecting rods face towards the camshaft.

The connecting rods should be free on the crankshaft and care should be taken when tightening the bolts to avoid undue force, using spanner Pt. No. A.A. 814.

The same remark applies to the main bearing caps. Use spanner Pt. No. A.A. 802 and spanner Pt. No. A.A. 814 for front bearing nuts.

With the main bearings and connecting rods fitted an oil pressure test is recommended to prime the oil system and at the same time to ascertain if there is any unusual leakage through the crankshaft oil retainers or oil gallery.

Test with a pressure of 60–80 lbs. rotating crankshaft slowly and verify that the " bleed holes " in connecting rods are clear.

Turn engine over and assemble the cylinders, etc., as per instructions under the section dealing with top overhaul.

If any new parts have been fitted to the Simms couplings or magnetos have been changed, check up to see that clearances are correct and if necessary introduce shims as required. The impulse magneto is of particular importance as any end thrust on to same may render the impulse unit inoperative.

If any check is made to see if impulse unit is working correctly this must be done with engine in normal position as the impulse mechanism will only function satisfactorily if the magneto is in suspension.

The magnetos are set to spark at 30° before top dead centre when fully advanced. This marking will be found on the timing ring of the airscrew boss.

When refitting airscrew the hub nut must be pulled dead tight and the airscrew may be used to keep the crankshaft from turning whilst the nut is tightened.

Rocker boxes should be filled with engine oil to level indicated when engine is in position for test.

Test in accordance with Air Ministry instructions for tests after complete overhaul.

If at any time a **new idler wheel** is required, proceed with the **fitting and timing** as follows :—

Set the rockers on No. 1 cylinder to a clearance of .055 in. Then set the camshaft so that the exhaust has just closed and the inlet is about to open.

Next turn the crankshaft to a position 3° before T.D.C. Now drop the idler in various positions (without fitting rollers) until one is found where the wheel is concentric with the spindle. This may be checked by using a roller which should fit in anywhere round the circumference. Now turn the engine until the marked teeth of the crankshaft wheel are in mesh with the idler. Stamp the idler tooth which is between these teeth.

To time with idler which has been marked in the above manner, turn the crankshaft and the camshaft until the marked gaps face the idler centre. Then place the idler in with the marked tooth engaging with the marked gap in crankshaft wheel. If the camshaft wheel does not engage, turn the engine back slightly (counter-clockwise facing gears) until it does.

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If at any time the spindle which acts as the inside track for the needle roller race is changed during overhaul a check must be made of end thrust. (See Table of Clearances, Appendix " C.")

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The connecting rods should be free on the crankshaft and care should be taken when tightening the bolts to avoid undue force, using spanner Pt. No. A.A. 814.

The same remark applies to the main bearing caps. Use spanner Pt. No. A.A. 802 and spanner Pt. No. A.A. 814 for front bearing nuts.

With the main bearings and connecting rods fitted an oil pressure test is recommended to prime the oil system and at the same time to ascertain if there is any unusual leakage through the crankshaft oil retainers or oil gallery.

Test with a pressure of 60–80 lbs. rotating crankshaft slowly and verify that the " bleed holes " in connecting rods are clear.

Turn engine over and assemble the cylinders, etc., as per instructions under the section dealing with top overhaul.

If any new parts have been fitted to the Simms couplings or magnetos have been changed, check up to see that clearances are correct and if necessary introduce shims as required. The impulse magneto is of particular importance as any end thrust on to same may render the impulse unit inoperative.