

*Villiers*

# WORKSHOP MANUAL

MARKS

**4F, 6F & 9F**

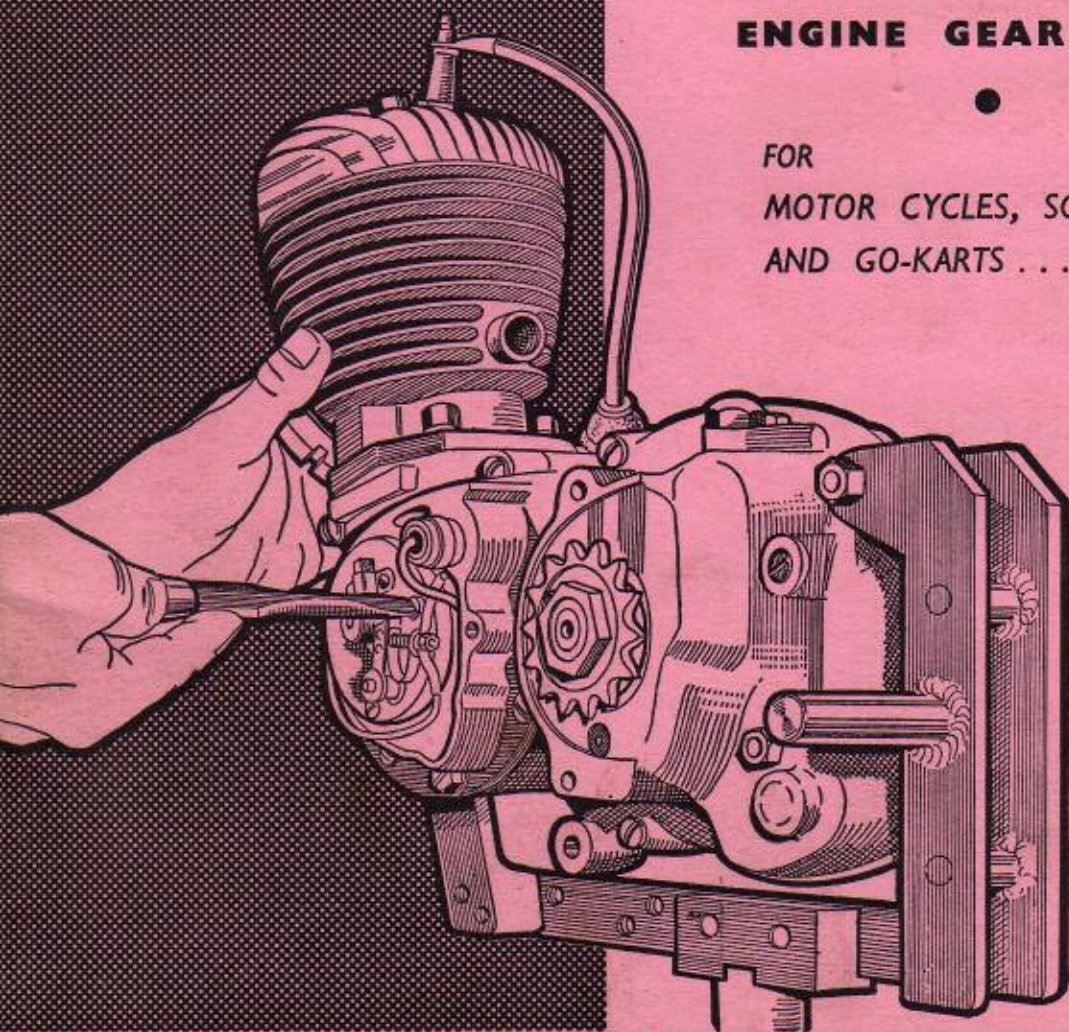
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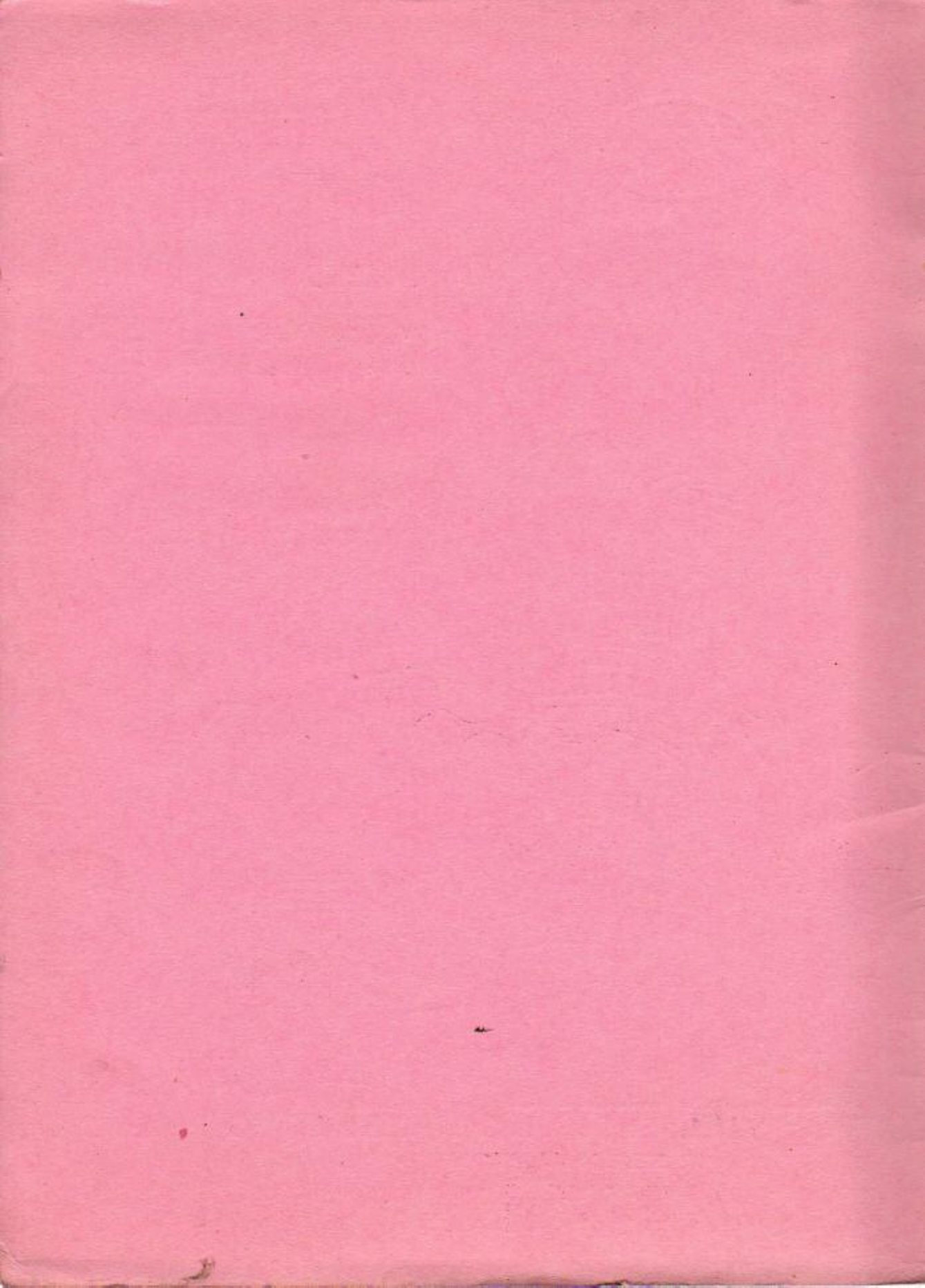
**ENGINE GEAR UNITS**

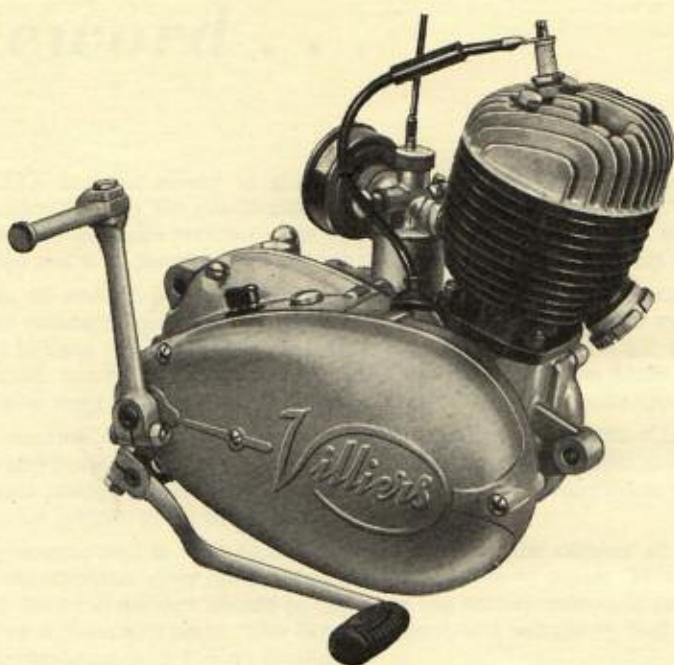
FOR  
MOTOR CYCLES, SCOOTERS  
AND GO-KARTS . . .



6/-  
NET

**THE VILLIERS ENGINEERING CO. LTD.,  
WOLVERHAMPTON • ENGLAND**





MARKS **4F, 6F & 9F**  
98 c.c.      98 c.c.      98 c.c.

## **ENGINE GEAR UNITS**

FOR

**MOTOR CYCLES, SCOOTERS, GO-KARTS**

THE VILLIERS ENGINEERING CO. LTD.  
MARSTON ROAD, WOLVERHAMPTON, ENGLAND

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## ENGINE GEAR UNITS

MOTOR CYCLES, SCOOTERS, CO-CARATS

THE VIERERS ENGINEERING CO. LTD.  
HARRISON ROAD, WILMINGTON, ENGLAND

# Foreword . . .

**Q**UANTITY and the ability to give long and reliable service are the primary considerations in the production of all Villiers engines, but when servicing eventually becomes necessary it is very important that the correct tolerances are maintained and it is, therefore, essential that only genuine Villiers spares are used.

The Marks 4F and 6F power units covered by this manual have for some years been fitted as standard equipment by manufacturers of lightweight motor cycles and scooters and to meet the demand for an engine for KARTS a new 98 c.c. Unit, the Mark 9F model, has recently been introduced. This is basically the Mark 6F Unit modified to give more power. Details are given under "Engine Specifications."

Routine attention is covered by a separate publication, V.E.C.80, "Operating Instructions and Spare Parts List." It is suggested that the reader obtains this booklet which contains numerous exploded drawings which, used in conjunction with this manual, will, we believe, prove invaluable.

Every engine-gear unit is built to a works specification, the number of which is stamped on the crankcase door immediately above the left-hand cover. This number, together with the serial number, should be quoted in any correspondence in connection with repairs or replacement parts. Our Service Department will gladly deal with any problems in connection with Villiers products.

## ENGINE SPECIFICATIONS

### Mark 4F Unit

This unit consists of a 98 c.c. two-stroke engine and two-speed gearbox with two plate cork insert clutch, the clutch with primary driving chain and gears being contained in one common casing. The gear selector mechanism consists of a sliding sleeve with "face" dogs which engages either the top or bottom gears when operated through a bell crank lever connected to a "Bowden" type cable, the control lever being fitted to the handlebar of the motor cycle.

The majority of the units in service are fitted with the Junior Type 6/0 carburetter, but current production units have the later Type S.12 carburetter as standard equipment.

### Mark 6F Unit

This unit differs from the Mk. 4F model only with respect to method of changing the gear. The change is made by foot lever instead of by a hand operated cable. The positions of the three frame fixing lugs are as for the Mk. 4F unit, but the clutch-case is deeper to accommodate the foot gear-change spindle and therefore the Mk. 6F unit will not fit all existing frames primarily built for the Mk. 4F model.

### Mark 9F Unit

This model is interchangeable with the Mk. 6F unit and although the capacity is the same the power output is greater, this being obtained by (1) cylinder head giving a higher compression ratio, (2) Cylinder having modified porting, and (3) Type S.19 carburetter having a larger size of choke.

# TECHNICAL DATA

Cylinder Bore, Standard	...	...	47 mm = 1.8504"/1.8499"
Cylinder Bore, Oversize	...	...	As above, plus .015" or .030"
Stroke	...	...	57 mm = 2.244"
Capacity	...	...	98 cc = 6 cu. ins.
Compression Ratio	...	...	Mks. 4F and 6F 8.0-1. Mk. 9F 9.15-1
Engine Sprocket	...	...	17 teeth $\times$ $\frac{3}{8}$ " pitch
Clutch Sprocket	...	...	42 teeth $\times$ $\frac{3}{8}$ " pitch
Primary Drive Ratio	...	...	2.47-1
Primary Chain	...	...	"Renold" No. 110 037 $\times$ 56 pitches
Gear Ratios	...	...	Top 1-1, Bottom 1.715-1
Final Drive Sprocket	...	...	14 teeth $\times$ $\frac{3}{8}$ " pitch $\times$ .305" dia. roller for "Coventry" chain No. 112045
Chain-line Final Drive	...	...	2.56"

## BALL AND ROLLER BEARINGS

Driveshaft, left and right-hand	...	...	25 $\times$ 52 $\times$ 15 mm, No. 6205, 3 spot ball bearing
Clutchshaft, left-hand	...	...	25 $\times$ 52 $\times$ 9 mm, No. 6005, 3 spot ball bearing
Clutchshaft, right-hand	...	...	20 $\times$ 42 $\times$ 9 mm, No. 6004, 3 spot ball bearing
Crankpin Roller	...	...	$\frac{1}{8}$ " dia. $\times$ $\frac{1}{8}$ " long, 28 per set
Crankpin Diameter, Std.	...	...	.6565"/.65625"
Crankpin Diameter, O/S	...	...	.6575"/.65725"
Connecting Rod Big End Diameter	...	...	Std. 1.0323"/1.0318"
Connecting Rod Big End Diameter	...	...	O/S 1.0333"/1.0328"
Connecting Rod Side Clearance	...	...	Total .010"/.006"

## SMALL END BEARINGS

Gudgeon Pin Diameter	...	...	.3660"/.3657"
Gudgeon Pin Bush in Piston	...	...	.3665"/.3660"
Gudgeon Pin Bush in Con. Rod	...	...	.3666"/.3661"

## PISTON AND PISTON RINGS

Compression Ring, Std. Size	...	...	1.8504" dia.
End Gap, in position	...	...	.007"/.011"
Maximum Permissible Gap	...	...	.03"
Ring Clearance in Groove	...	...	Total .0062"/.0042"
Oversize Piston Rings	...	...	Std. plus .015" and Std. plus .030"
Piston Skirt Clearance in Cylinder Bore	...	...	Mks. 4F and 6F: min. .0038", max. .0048"
Piston Skirt Clearance in Cylinder Bore	...	...	Mk 9F: min. .0048", max. .0058"

## CARBURETTER

	Marks 4F and 6F		Mark 9F
	Type 6/0, Junior	Later Type S.12	Type S.19
Taper Needle, Std.	...	...	...
Needle Setting	...	...	...
Throttle	...	...	...
Main Jet	...	...	...

## IGNITION

Contact Breaker Point Gap	...	...	.015"/.012"
Points Commence to Open	...	...	$\frac{1}{8}$ " before top dead centre
Sparking Plug	...	...	Mks. 4F & 6F Lodge H.14 Point Gap .025"/.018"
Sparking Plug	...	...	Mk. 9F Lodge 3HN Point Gap .025"/.018"

## LIGHTING SETS

Rectifier Type, Wiring Diagram	...	...	M.2540D
Direct Type, Wiring Diagram	...	...	M.2539D

## LUBRICATION

Engine	...	...	Petrol Mixture. For the first 500 miles 1 part Castrol XL (S.A.E.30) oil to 16 parts petrol and subsequently 1 part to 20 parts
Gearbox and Chaincase	...	...	Castrol "D" (S.A.E.140) oil filled to level plug

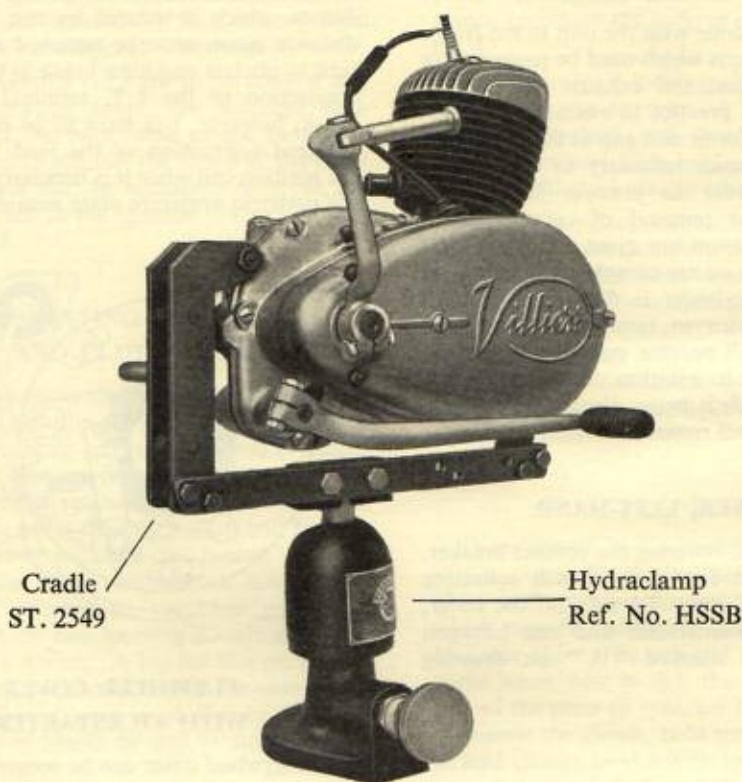


FIG. 1

## DISMANTLING

When a major overhaul is called for, including the fitting of replacement bearings for the crankshaft and clutchshaft, the complete unit should be removed from the motor cycle frame. It is possible to completely dismantle the unit whilst in the frame, but as it is advisable to use heat on some components to assist in removal of bearings, the job can more easily be done when the unit is removed from the frame and then dismantled on a bench, or better still mounted in a cradle as illustrated in Fig. 1. The cradle is fixed to a "HYDRACLAMP" Ref. No. HSSB which is bolted to the bench and allows the unit to turn a full circle and also to swing bringing

the shafts vertical to facilitate assembly of the gearbox and setting of the contact breaker.

To facilitate removal of the unit, disconnect the complete exhaust system using a CEE spanner Ref. E.7872 to release the nut securing the exhaust pipe to cylinder. It will also be necessary to remove the gear control body from the handlebar when dealing with the Mark 4F unit. If the carburetter is not to be dismantled, remove after releasing clip screw and secure out of the way to cycle frame. Before commencing to dismantle pressure wash the unit with white spirit or one of the available proprietary cleaning agents.

## DECARBONISING

This can be done with the unit in the frame and the only parts which need be removed are the cylinder head and exhaust pipe. It is, however, usual practice to examine the compression rings for fit and gap at the same time so that it becomes necessary to remove the cylinder in order to uncover the piston. Instructions for removal of cylinder head, cylinder and piston are given, but is recommended that as we are completely dismantling the unit, the cylinder is not removed until immediately prior to removal of crankcase door. This will prevent possible damage to the piston due to rotation of the crankshaft whilst the clutch is being dismantled and the magneto flywheel removed.

## COVER, LEFT-HAND

In addition to covering the contact breaker, this component carries the clutch operating lever adjuster screw. To take off the cover, remove two countersunk and one hexagon headed screws marked "A" on drawing Fig. 2.

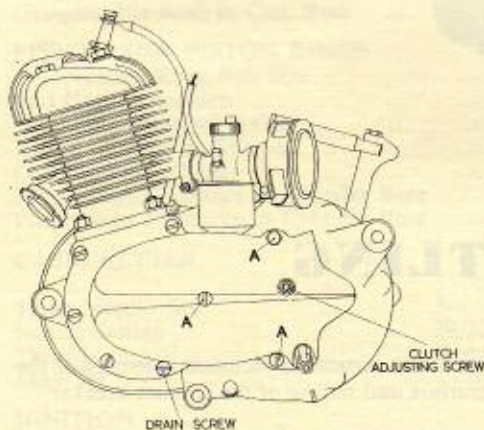


FIG. 2

## CONTACT BREAKER ASSEMBLY AND CONDENSER

The contact breaker adaptor is located in the spigotted extension of the crankcase door and is secured by three round head screws. Contact breaker assembly must be removed if it is intended to separate the crankcase door from the gearcase in order to replace the

left-hand driveshaft ball bearing. The condenser, which is secured by one screw, and distance piece, must be removed at the same time to obviate making a break in the soldered connection to the L.T. terminal "D." A break, however, will have to be made in the soldered connection of the lead "E" from the ignition coil when it is necessary to remove the magneto armature plate assembly. Fig. 3.

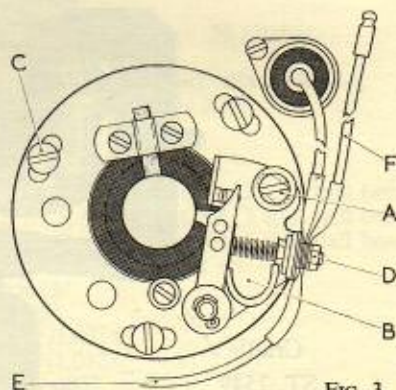


FIG. 3

## FLYWHEEL COVER WITH KICKSTARTER

The flywheel cover can be removed with the kickstart lever, shaft, etc., in situ. There is no need to dismantle the starter components except for replacement purposes. The flywheel cover is fixed to the clutchcase by four screws and is located by one dowel at the front and two dowels at the rear end. Early type Mark 4F units have the cover secured by four countersunk headed screws, but in later Mark 4F and all Mark 6F and Mark 9F units two studs with hexagon nuts are fitted at the starter end of the cover. The starter shaft, with return spring and spring cover, can be withdrawn after removal of kickstart lever clamp bolt and nut.

## FLYWHEEL MAGNETO

To remove the flywheel unscrew the centre nut anti-clockwise using a  $\frac{3}{8}$ " Whit. socket and torque spanner. The centre nut is imprisoned in the flywheel and acts as an extractor. Use the torque wrench in conjunction with a strap wrench to hold the flywheel. Remove the woodruff key from driveshaft, otherwise this will foul the oil seal in clutchcase and also prevent removal of armature plate assembly.



The armature plate is located at the rear on a spigot and secured by four cheese head screws and "shakeproof" washers.

If new lighting coils are to be fitted it will be necessary to break the soldered connections of the twin cable to the twin plug sockets and to remove the screw of the cable clip. It will also be necessary to break the soldered joint at the ignition coil of the lead "E," fig. 3.

### SEPARATING GEARCASE AND CLUTCHCASE

Before releasing the five screws in the clutchcase and the two in the gearcase on other side of unit, the circlip on protruding end of clutchshaft must be removed. This will release the starter pinion, ratchet, etc., which must be removed to allow the clutch-shaft ball bearing to come away with the clutch-case. Having removed the seven countersunk head screws previously referred to, the cases will come away from the two locating dowels after tapping with a mallet. A lug for this purpose is provided at the starter end of the clutchcase. The gearchange lever must also be removed in the case of Marks 6F and 9F units.

### ENGINE SPROCKET AND PRIMARY CHAIN

This is no joining link in the chain, consequently the chain cannot be removed until the engine sprocket together with the clutchshaft assembly have been withdrawn. Flatten the sprocket nut lockwasher and before attempting to turn anti-clockwise the locknut,

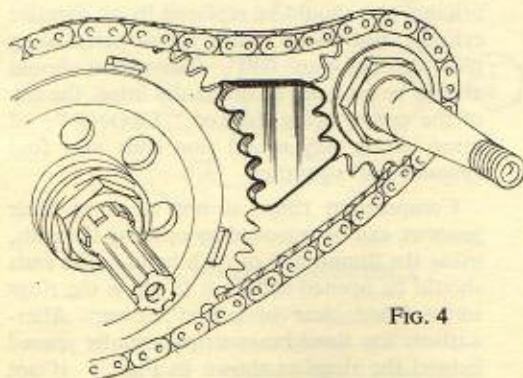


Fig. 4

place between the teeth of the clutch and engine sprockets the locking plate ST.2634-C, fig. 4.

Alternatively, if locking plate is not available, place ring spanner on locknut, replace magneto flywheel and woodruffe key, and holding flywheel with left-hand hammer the spanner anti-clockwise to loosen nut.

After removal of locknut and lockwasher, the sprocket with chain will pull off the woodruffe key. At the same time the clutchshaft assembly should be withdrawn from the high gear wheel. As the shaft is pulled out, the sliding dog clutch will drop away from the operating plate and should be put on one side until required, together with the centre clutch operating rods.

### CLUTCH AND GEARS

There should be no need to dismantle the clutch except for replacement of the clutch plate and sprocket having the cork inserts which may be reduced in thickness sufficient to cause slip. The original thickness of the corks when new is  $\frac{1}{16}$ ", the projection each side of the plate or sprocket being equal. To dismantle the clutch, hold the shaft vertically in lead clamps in vice with spring on top and remove splined lockwasher next to spring retaining nut. Then remove the hexagon nut anti-clockwise which will release the clutch spring, spring locating bush, outer clutch plate, and clutch sprocket with centre ball race. The clutch cotter can now be withdrawn from the slot in shaft and the remaining clutch plates, removed from clutchshaft. There is no need to remove remaining circlip and brass washer unless it is necessary to replace the low gear wheel. If it is found that the cork inserts in either the sprocket or clutch plate are worn down to the plate thereby causing clutch slip, the component should be returned to the Service Department for exchange with a re-corked assembly.

### FINAL DRIVE SPROCKET

This sprocket fits a splined extension of the high gear-wheel and is secured by a hexagon locknut and locking screw. To prevent the sprocket turning whilst the locknut is being unscrewed, the gearcase should be mounted in the cradle ST.2549 and use made of the locking plate S.T.2551C/3, Fig. 5.

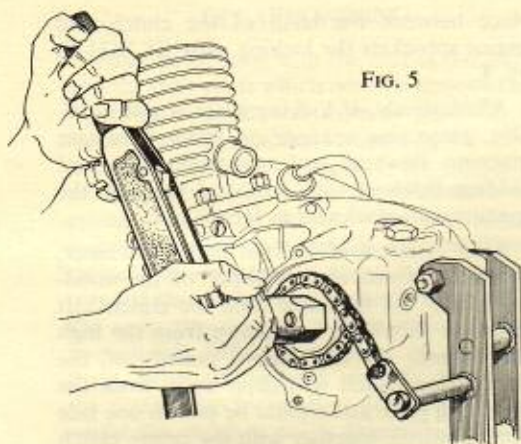


FIG. 5

Remove the cheese-head locking screw and using the torque spanner turn the locknut anti-clockwise to unscrew. After removal of the locknut the sprocket can be pulled off the splines and the distance piece between the sprocket and ball bearing should be left in situ until the high gear-wheel has been pushed or tapped through the bearing into the gearcase. The distance piece will protect the lip of the oil seal and need not be removed unless it is intended to replace the ball bearing. To facilitate removal of ball bearings for both high gear-wheel and right-hand driveshaft immerse the gearcase in boiling water for a minute or two. This will expand the housings sufficiently to allow the bearings to be easily pushed out.

#### CYLINDER HEAD AND CYLINDER

Remove spark plug from cylinder head, followed by the four fixing bolts and washers. In the case of the Mark 9F unit there are three bolts and one stud, the latter being used where a steady stay is fitted. A slight sideways tap with a mallet may be necessary to break cylinder head joint, after which head and joint washer are removed. Now remove cylinder base fixing nuts and spring washer and lift cylinder clear of piston. Do not twist cylinder round piston, otherwise damage to piston rings may occur should ends foul the edges of cylinder ports. As cylinder comes free of piston do not let piston skirt swing against the connecting rod; if this is allowed the skirt will possibly be distorted. Remove paper joint washer and rest piston on SUP-

PORT PLATE ST.2535D (Fig. 1, Mk. 9E Manual) so that bottom of skirt is not damaged against the crankcase.

#### PISTON

Use a pair of thin nosed pliers to take out both gudgeon pin circlips, and if it is found that the gudgeon pin cannot be pushed out by

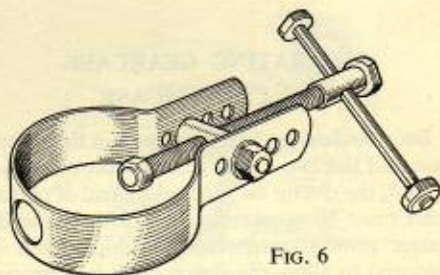


FIG. 6

the hand, this may be due to carbon deposit on the pin, between bush in con-rod and piston bosses or alternatively because the circlip grooves in piston bushes are burred. If after examination and correction the pin cannot be moved, use should be made of band type extractor, Fig. 6.

A steel expander ring, fitted behind the lower compression ring, centralises piston in bore of cylinder, thereby eliminating noise caused by piston slap whilst engine is warming up. Gap between ends of compression rings when new and in position in the cylinder is .007"/.011". When wear increases gap to .03" ring should be replaced, and if it is found that with a new ring, gap is more than .011" this indicates a worn cylinder bore. Any cylinder having a bore of .008" or more above the original size should be replaced by an oversize cylinder and piston, stock rebore sizes being plus .015" or plus .030". The piston should always be replaced as originally fitted, the top of the crown being marked "FRONT"; if fitted wrong way round ring ends may foul cylinder port openings.

Compression rings, if not stuck in their grooves, can be removed by opening the ends, using the thumb nail of each hand. The ends should be opened sufficient to allow the rings to be lifted clear of piston crown. Alternatively use three brass strips, equally spaced behind the rings as shown in Fig. 7. If not

fitting new rings it is desirable to refit each ring in its original groove.

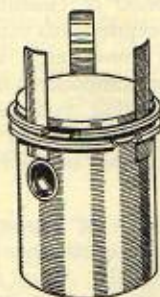


FIG. 7

### CRANKCASE DOOR

The crankcase door, which is located by two dowels in face of the gearcase, is secured by six countersunk headed screws and one hexagon headed screw at the bottom. The hexagon headed screw is also the crankcase drain screw. After removal of these seven screws, fit the extractor ST.2618-C, Fig. 8, using the three fixing screws normally used to secure the contact breaker adaptor. Turning the extractor centre screw clockwise will withdraw the crankcase door, leaving the ball bearing on the driveshaft. For removing the bearing from shaft use extractor ST.2350/2B. (Fig. 14, 9E Manual).

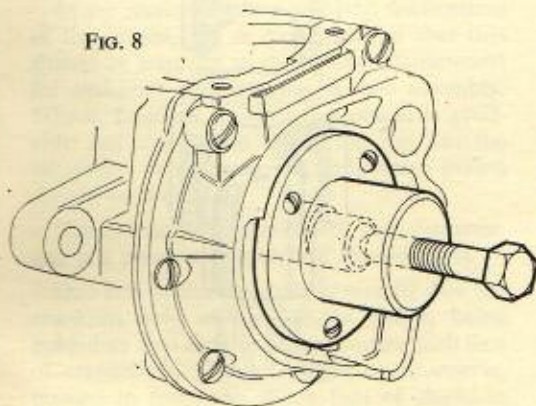


FIG. 8

### DRIVING SHAFT ASSEMBLY

The crankshaft assembly can now be withdrawn by tapping the magneto end with a mallet. The ball bearing should remain in

the gearcase. This can be removed when the gearcase is heated up for removal of the bearing for the high gear wheel. Special tools and fixtures and a lot of experience is necessary before the dismantling and re-assembly of the driving shaft can be satisfactorily carried out. It is recommended that when a replacement is necessary, due either to long service or other cause, the assembly complete with connecting rod should be returned to the Service Department for exchange with a reconditioned assembly.

### COUNTERSHAFT

This can be removed whilst the gearcase is separated from the clutchcase. The countershaft is provided with renewable bushes and rotates on a spindle which is a press fit in the gearcase. A special fixture is used in the works to ensure correct alignment and centres. Where it is necessary to fit a new spindle the gearcase should be returned to the Service Department for attention. The clutch bridge which supports one end of the spindle is detachable after removal of the two securing bolts, the nuts of which are on the outside of the gearcase. The bridge is a tight fit on end of countershaft spindle, and to facilitate removal two tapped holes (one each side of the centre hole) are provided in the bridge. Using two screws  $\frac{1}{4}$ " dia. x 26 TPI x 1" long the bridge can be forced off end of spindle.

### GEAR CONTROL

#### Mark 4F Unit

The sliding dog clutch on the clutchshaft is actuated by a cable, the control lever being mounted on the handlebar of the machine. The components inside the gear-case consist of (1) gear selector lever, (2) gear operating plate and (3) forked joint for gear selector with return spring. After clutch shaft has been removed, the gear operating plate can be lifted from its fulcrum pin in the selector lever. The lever will come away from the spindle after the pin securing lever to forked joint has been removed. The stop pin and bearing pin for the selector lever are a tight fit in the gearcase and should not be removed. The bearing pin extension which carries the lever is eccentric to the body. When originally assembled the bearing pin is turned by means of the slotted end to give a correct setting for

the necessary movement of the sliding dog clutch and selector lever; do not attempt to alter the setting.

To detach the control cable first unscrew from gearcase the guide for forked joint. Before the guide can be pulled up far enough to expose the cable nipple, the two screws of the midway adjuster sleeve on the cable must be screwed right in after releasing the lock-nuts. Also, the centre screw and top cover plate of the handlebar control body must be removed, and after unscrewing the cable adjuster free from control body the inner cable with nipple can be lifted out of the control lever. All this has in effect shortened the outer casing of the control cable and will allow sufficient movement of the guide to fully uncover the cable nipple at the gear end and which can now be detached.

#### Marks 6F and 9F Units

The movement of the sliding dog clutch on the clutchshaft is actuated by the foot operated gear-change lever. The gear operating plate is the same component used in the Mark 4F unit, but apart from this all items comprising the gear-change mechanism are different. The movement of the gear selector lever is controlled by a spring loaded plunger which engages with either the high gear, low gear, or neutral position vee grooves in the selector lever. The plunger box should be unscrewed from the gearcase and the plunger and spring removed before attempting to withdraw the selector lever from the bearing spindle. The pedal shaft can be withdrawn from the bush in gearcase after removing split pins from ends of the link rod. On some units a short control lever is fitted instead of the usual foot operated lever. The method of fixing is the same for either type of lever and care should be taken of the oil sealing ring which is fitted on the pedal shaft and behind the lever.

#### RE-BUILDING THE UNIT

It is assumed that, after dismantling, all components including oil seals and sealing rings have been thoroughly cleaned, examined and replacements made available where necessary. Do not fit new oil seals until they are mentioned in the re-building sequence of operations. Undamaged seals need not be disturbed but special care must be taken when

fitting components which pass through, or come into contact with, the sealing lip.

The best method of cleaning metal components is by pressure wash using white spirit, the parts being immediately dried by compressed air. For components of the electrical ignition and lighting systems use Carbon Tetra-chloride (C.T.C.), or if not available, use white spirit. Dry off as for metal components.

All moving parts of engine and gearbox should be liberally oiled when re-assembling using clean engine oil. All oil seals should be well lubricated with engine oil before fitting and contact areas on shafts smooth and polished.

#### GEARCASE

The oil seals for the crankshaft and high gear-wheel must be replaced if the sealing lips are found to be damaged or worn. New seals should be fitted with the open side of seal facing inwards, i.e. towards the crankcase and gearcase respectively. For the crankcase seal use tool ST.1118C and for the gearcase ST.2620C. Figs. 9 and 10.

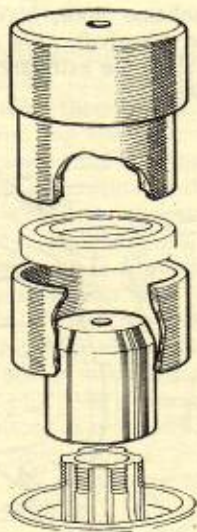


FIG. 9

When using tool ST.1118C place the guide sleeve in bottom of bearing housing and push the pressure bush down until the head contacts the sleeve.

When fitting the gearcase seal, using tool ST.2620C, place the guide sleeve against the outside of casing, and the end of protection sleeve against the ball bearing. The oil seals are more easily fitted if done whilst the gearcase is still hot after having been immersed in boiling water and immediately before fitting the right-hand driveshaft with ball bearing and the ball bearing for the high gear-wheel.

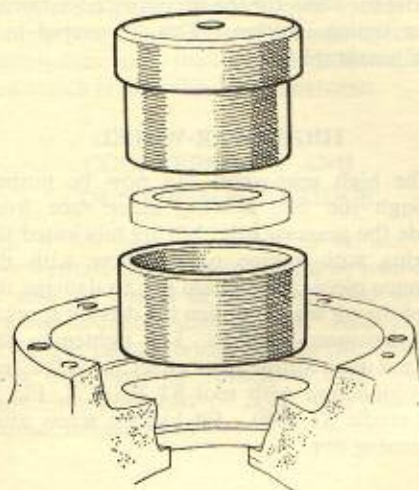


FIG. 10

### CRANKSHAFT ASSEMBLY

In the section dealing with the dismantling of the assembly it is recommended that this should be returned to the Service Department for exchange with a reconditioned assembly. Where, however, suitable equipment is available and the person doing the job has the necessary experience, the following points should be noted:—

The crankpin is parallel, of one diameter, and is a press fit in each half driving shaft.

One end of the crankpin is pressed into the crankpin hole of one of the shafts, being guided so that the pin is kept square with face of crankshaft. The crankpin, is, of course, pushed in from the inside face of shaft, to prevent possibility of the roller track being damaged when passing through the interference hole.

Crankpin and connecting rod .001" over-size are necessary when the original driveshafts are used.

Standard size crankpin and connecting rod should be used *only* with new driveshafts. After assembly of rollers, press the other half-shaft on the crankpin.

Side clearance between connecting rod big end and crank web .010/.006" total.

The pressure in assembling the crankpin must obviously be applied directly over the crankpin and not on the centre of the drive-shaft as this would cause distortion of the whole assembly.

After assembly the shafts are placed between centres, rotated by the con. rod, and alignment checked by clock gauges. Correctness of alignment is obtained by tapping with lead hammer the balance weights of the crankshaft halves until the eccentricity of the shafts as shown on the clock gauges is not more than .001" measured against the crank webs. Refit the ball bearings on both sides of crankshaft webs, pressure being applied to the inner race only which must go right up to the shoulder of shaft. Support each half drive shaft underneath the ball bearing which should be well lubricated with engine oil before assembly of crankshaft into crankcase/gearcase.

Whilst the gearcase is hot place the magneto end of crankshaft assembly in position. The ball bearing must go to the bottom of the housing.

### CRANKCASE DOOR

Lubricate with engine oil the ball bearing on the left-hand driveshaft. Heat the door in boiling water and after drying smear with secotine the joint faces of door and crankcase. Locate the joint washer on the two dowels in face of crankcase and placing the door over the ball bearing locate on the two dowels and secure by the six countersunk and one hexagon headed screws. The latter is also the crankcase drain screw and a fibre washer should be fitted under the head. Check for end play of crankshaft assembly, turning the crankshaft by the connecting rod. If found to be too tight, a tap with a mallet on each end of shaft usually corrects matters.

### CYLINDER AND PISTON

To maintain engine efficiency it is advisable to remove carbon deposits from the inside and edges of the ports, particularly the exhaust port. Do not, however, alter the shape or

sizes of the ports and take care not to scratch or damage the cylinder bore. *Do not remove the ring of carbon usually found at the top of cylinder bore.* This carbon extends to the point reached by the top compression ring at the top of the piston stroke. The carbon acts as a compression seal and protects the top compression ring which projects beyond the piston land. Remove any accumulation of road dirt etc. from between the cylinder fins and all traces of carbon in the bore by pressure washing in white spirit. Dry off and then paint outside with cylinder black and hang up to dry.

Having removed all carbon from piston crown and ring grooves and examined ring pegs for wear and tightness, the compression rings can be fitted with the expander ring behind the lower compression ring. The piston can now be fitted to the connecting rod. Fit one of the gudgeon pin circlips and place piston over the small end of connecting rod. The word FRONT stamped on piston crown should, of course, be at the front of unit. Smear engine oil on the gudgeon pin and push through piston boss, then connecting rod and other piston boss until end of gudgeon pin butts against the circlip already fitted. Fit other circlip and make sure that both circlips lie snugly in the grooves. Always use new circlips for replacement purposes.

Clean joint faces of cylinder base and crankcase and fit new gasket. Do not use any joining solution. Smear cylinder bore and piston skirt with engine oil and holding cylinder over piston with exhaust port facing forward, guide piston into cylinder at the same time compressing each ring into its groove. The ends of the rings must, of course, register with the peg in each groove. Whilst lowering the cylinder do not turn on the piston to avoid ends of rings fouling the ports. Fit the four cylinder base nuts and washers and tighten diagonally.

Temporarily fit magneto flywheel to end of crankshaft, without the woodruff key, and turn over crankshaft by holding the flywheel to make sure that everything is free.

#### CONTACT BREAKER ADAPTOR

Before fitting the adaptor examine the oil seal and replace if the sealing lip is found to be worn or damaged. Fit the seal with the open side towards the ball bearing and position the

seal so that the metal casing is flush with outside face of adaptor. The clip holding the cam lubricating pad and the cup head screw and washer prevent end movement of the seal.

Lightly smear the faces of crankcase and adaptor with secotine and after fitting joint washer secure adaptor by three screws and shakeproof washers. The adaptor can be fitted in one position only as the three screws are unequally spaced. The three slotted holes in adaptor allow for the necessary adjustments when timing ignition. This is covered in a later paragraph.

#### HIGH GEAR-WHEEL

The high gear-wheel can now be pushed through the ball bearing inner race from inside the gearcase after having lubricated the bearing with engine oil. Follow with the distance piece, taking care not to damage the lip of the oil seal, and then the driving spocket with hexagon locknut. For tightening the locknut use a torque spanner set at 950 lbs./ins. in conjunction with tool ST.2551C/3, Fig 5, and cradle ST.2549. Fit locking screw after tightening nut.

#### GEAR CONTROL

##### Mark 4F Unit

Before the clutch-shaft can be put into the gearcase it is necessary to assemble the gear selector lever, together with the forked joint, return spring and pin for forked joint with split pin. The gear operating plate has to be fitted to the selector lever at the time of fitting the clutch-shaft end into the high gear-wheel. The guide for forked joint is screwed into the gearcase after the control inner cable nipple has been fitted in the slotted end of forked joint. To enable this to be done the over-all length of the cable outer casing has to be reduced by screwing in the cable midway adjusters and removal of cable nipple from the handlebar control body as already mentioned in the paragraph dealing with the dismantling of the control. After the inner cable has been fitted at the unit end the cable adjuster in the handlebar control body can be screwed in and the slack in cable taken up by the midway adjusters. Final adjustment must be made after the re-fitting of the control cable to the machine.

### Marks 6F and 9F Units

The control components have to be fitted before the clutch-shaft as in the case of the Mark 4F unit, but also these must be fitted before the countershaft bridge as otherwise there is insufficient room for the link rod to be assembled. Fit the gear selector lever on the fixed spindle, then the link rod and pedal shaft assemblies, making sure that the two split pins in link rod are fitted. In top of gearcase fit the gear selector plunger, with spring and plunger box. The fitting of the gear operating plate is done when the clutch-shaft with sliding dog clutch is assembled into gearcase.

### COUNTERSHAFT AND COUNTERSHAFT BRIDGE

If it has been necessary to replace the countershaft bushes these should be reamed to give a running fit and well oiled before placing on countershaft spindle. After fitting to spindle, replace bridge and the two securing bolts with nuts on outside of case. After tightening, stab end of bolts with punch to prevent nuts turning.

### CLUTCH-SHAFT

Assuming the shaft to be completely dismantled, proceed to assemble in the following order:—

Oil the shaft and fit the 20 tooth gear-wheel with driving dogs over the splined shoulder. Next fit the brass pressure washer with splined hole and follow with the circlip. The outer clutch plate with six holes is next fitted, followed by the tanged plate with cork inserts, the tangs pointing away from the final drive sprocket. Next comes the dished plate with splined centre hole, the dished side being towards the tanged plate. The cotter should now be placed in the slot in shaft and fitting the clutch sprocket with cork inserts and centre ball race will prevent the cotter falling out.

The remaining outer clutch plate, with spring locating bush and spring can now be fitted and the assembly up to this point should be placed in a tool for compressing the spring to allow the retaining nut and splined lockwasher to be fitted. A suitable tool SST.858, Fig. 11, is available from the Service Department.

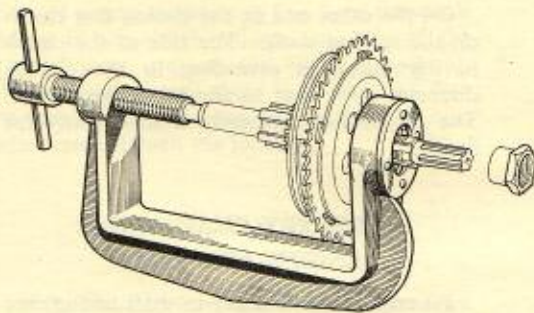


FIG. 11

Place the clutch-shaft in the tool, spring first, and turning the centre screw clockwise compress the spring until the threaded portion of shaft protrudes sufficiently to take the hexagon headed locknut. The locknut must be screwed on far enough to allow the lockwasher to fit on the splined shaft. Whilst in the tool the nut should be adjusted to give a dimension of 3.665" MIN./3.680" MAX. measured from the shoulder of shaft (high gear-wheel end) and including the lockwasher against clutch spring nut. A gap gauge SST.858/4, Fig. 12, is available. The assembly can now be completed by fitting the 20 x 42 x 9 mm. ball bearing, kickstarter pinion, kickstarter ratchet, spring, retaining washer and circlip.

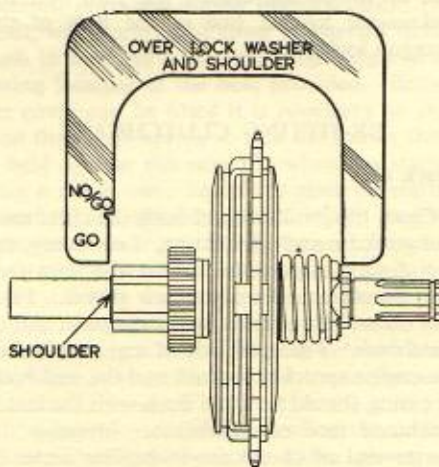


FIG. 12

On the other end fit the sliding dog clutch on the splined shaft. The side of the clutch having the dogs extending to the outside diameter goes next to the loose gear-wheel. The clutch-shaft assembly is now ready for fitting.

### PRIMARY CHAIN AND ENGINE SPROCKET

Fit engine sprocket key in shaft taking care not to damage lip of oil seal. There is no joining link in the chain and therefore this has to be fitted over both the engine and clutch sprockets before the clutch-shaft can be assembled into the gearcase. Lay the unit on its side so that the crankshaft is vertical and the open side of gearcase uppermost. The clutch-shaft should be held so that the left-hand end of shaft is over the hole in the high gear-wheel and the engine sprocket with chain attached loosely located on crankshaft. Position the gear operating plate on the selector pivot pin and in groove of the sliding dog clutch (the larger portion of the plate goes above the pivot pin with the unit in the normal running position). Let the end of clutch-shaft into the high gear-wheel and at the same time push the engine sprocket onto the key in shaft taking care not to damage the lip of oil seal. Next fit a new sprocket lockwasher followed by the locknut and before finally tightening fit the locking plate ST.2634-C, Fig. 4, between the engine and clutch sprockets. Using a torque spanner on the hexagon nut pull up to 950 lbs./inches, and turn over the lockwasher against one of the flats of the hexagon locknut.

### RE-FITTING CLUTCHCASE

#### Mark 4F

Clean the joint faces of both the clutchcase and gearcase and after fitting, if necessary, the two dowels in gearcase, smear the joint face with Secotone and apply a new gasket. Fit a new oil seal if required in the magneto end of clutchcase. The open side of seal should face the engine sprocket locknut and the seal body or casing should be fitted flush with the inside machined face of clutchcase. Immerse the starter end of clutchcase in boiling water in order to expand the ball bearing housing, dry off, and having entered the bearing outer race

in the housing, locate the case on the two dowels and then fit the seven securing screws. After tightening all the screws the clutchshaft ball races must not project beyond the joint face for the flywheel cover. The races must be flush or slightly under. If the ball race projects it will be necessary to remove the clutchcase and various components on the clutchshaft in order to tighten the clutch spring nut. This will not be necessary if the clutchshaft is assembled to the gauge dimensions previously given.

#### Marks 6F and 9F

The procedure for fitting is exactly as for the Mark 4F unit, but an additional bearing bush is provided to take the gear-change pedal shaft which should already be in position in the gear-case. After fitting place the oil sealing ring over projecting end of shaft, then the gear-change lever with clamp bolt and nut.

### MAGNETO

A spigot is provided at the back of the armature plate which fits a recess in the wall of the clutch-case. The armature plate is secured by four cheese-head screws and is positioned so that the gap in the circular plate is in line with the boss in clutch-case and in which is screwed the high tension terminal holder with high tension lead. Be sure that the felt washer is in position and that the spring loaded pad makes contact with ignition coil. Under the bottom left-hand fixing screw is fitted the clip holding the twin leads from the lighting coils to the twin plug sockets. To prevent the flywheel fouling the leads these must be placed between the lugs provided for this purpose. The low tension lead from the ignition coil goes through matching holes in the clutch-case and gearcase and is connected to the low tension terminal screw of the contact breaker assembly, see Fig. 3.

On the Mark 9F unit for KARTS an additional lead is attached to the low tension terminal screw. This lead which terminates with a snap connector is provided to comply with the regulation calling for an ignition cut-out switch, see Fig. 3, letter "F"

Clean the tapered portion of crankshaft, also the hole in the flywheel cam, and fit the woodruff key in shaft.



Place the unit in the cradle ST.2549 and fit magneto flywheel on shaft turning centre nut clockwise to tighten. A torque spanner set at 700 lbs. inches, should be used in conjunction with a strap wrench to prevent flywheel turning.

### TIMING CONTACT BREAKER

This can be done more accurately before re-fitting cylinder head. The cam which lifts the contact breaker rocker arm is formed on end of crankshaft. Turn crankshaft until the rocker arm is fully raised and check point gap. This should be between .012" and .015". If too wide or too narrow release screw "A," Fig. 3, and move the bracket "B" as required and check with feeler gauge. Tighten screw "A" and then check break of points in relation to position of piston. The points should commence to break when the piston is  $\frac{1}{4}$ " BEFORE top of stroke (not top of cylinder bore) when turning the crankshaft anti-clockwise looking at contact breaker end. To obtain this setting it will, no doubt, be necessary to rotate the adaptor plate and to enable this to be done release the three screws "C." Turn adaptor clockwise to advance and anti-clockwise to retard the ignition. When correct setting has been obtained tighten screws "C."

### CYLINDER HEAD

Clean top face of cylinder and place in position a new gasket followed by the cylinder head which has previously had all carbon removed from inside. Fit head with spark plug at rear and tighten head bolts diagonally using a torque spanner set at 220 lbs. ins. Fit spark plug to prevent entry of foreign matter.

### LEFT-HAND COVER AND CLUTCH LEVER

Smear clutch operating rods with engine oil and insert in clutchshaft, the short rod being fitted first. Screw clutch lever adjuster with locknut into clutch cover and on the protruding screw inside the cover hang the clutch lever, having previously greased the locating groove. Place the cover in position and secure with two countersunk and one hexagon

headed screws as shown in Fig. 2. Afterwards screw in the clutch adjuster screw until the top of lever contacts the sprocket locknut. Then unscrew until there is at least  $\frac{1}{16}$ " free movement at cable end of clutch lever and afterwards tighten the locknut.

### FLYWHEEL COVER WITH KICKSTARTER

If the kickstart lever and shaft etc., have not been dismantled from the flywheel cover all that is necessary is to fit a new gasket which has been smeared on both sides with Secotone. The gasket is necessary to prevent leakage of lubricating oil from the gearcase into the cover surrounding the magneto. Locate the gasket on the two dowels provided. Follow with the flywheel cover with kickstart shaft, lever, etc., assembled, and secure with two countersunk headed screws and nuts and washers on the two studs at the starter shaft end of cover, the nuts being tightened first. If the starter has been dismantled proceed with assembly as follows:

Insert return spring in the cover so that one end protrudes through the small hole. Both ends of spring are the same so that it does not matter which end goes inside the cover. Place cover and spring on kickstart shaft, the closed end of cover going on first, and locate the projecting end of spring in the hole in shaft. There are two similar holes in shaft but the one which takes the end of spring is the one near the flat side of the wheel. The hole approximately halfway round the wheel is for location purposes during manufacture. The shaft, with spring and cover is inserted in the bush in flywheel cover, the projecting end of spring locating in the hole provided. Before the cover can be fitted it is necessary to pre-load the return spring so that the starter shaft is held against the stop pin when the starter lever is not in use. To do this place the starter lever on the splined end of shaft, roughly horizontal and with the pedal end forward. Turn the lever anti-clockwise roughly half a turn, and with the lever in this position locate the cover on the three dowels and insert two of the securing screws. Turning the shaft anti-clockwise as described should locate the web in starter gear-wheel underneath the stop pin in the clutch-case, thereby holding the starter wheel out of mesh with the starter pinion on the clutch-shaft. Having secured the cover by the remaining screw and nuts, the starter

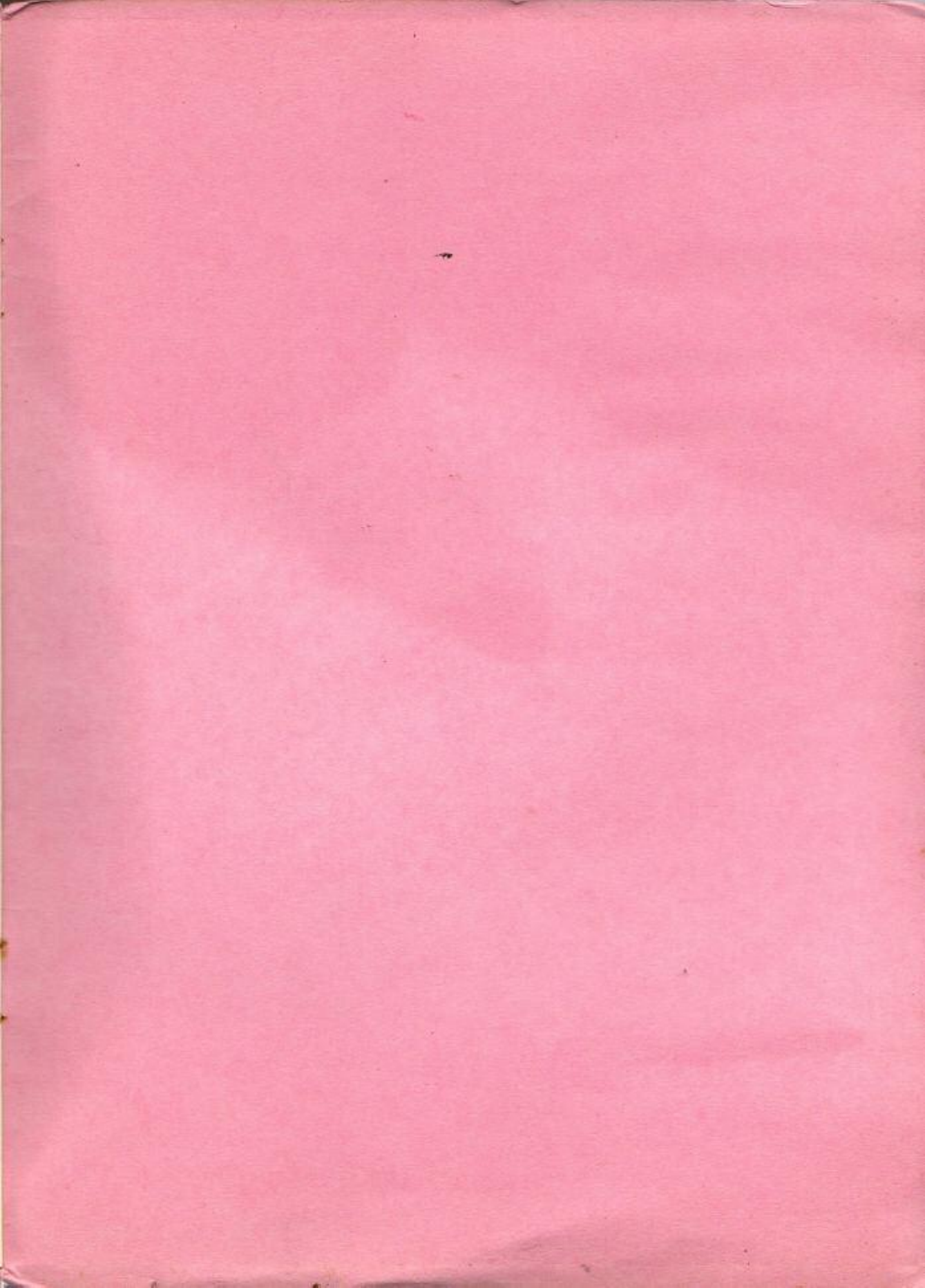
lever should be removed and re-fitted in the original position which is usually about 15° from the vertical.

### CARBURETTER

Fitting the carburetter completes the assembly of the unit. The carburetter should be placed reasonably vertical and pushed right home on the cylinder stub before tightening

the clip screw, otherwise air leaks may occur causing hard starting and erratic running.

The type S.12 carburetter is now fitted to all Mark 4F and Mark 6F units, but for the Mark 9F unit the larger type S.19 carburetter is used. Full details concerning operation, construction and settings are given in the Villiers publications V.E.C.80 (Junior and S.12 carburetters) and V.E.C.109 (S.19 carburetter) which are obtainable from the Service Department.



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