Villiers

WORKSHOP MANUAL

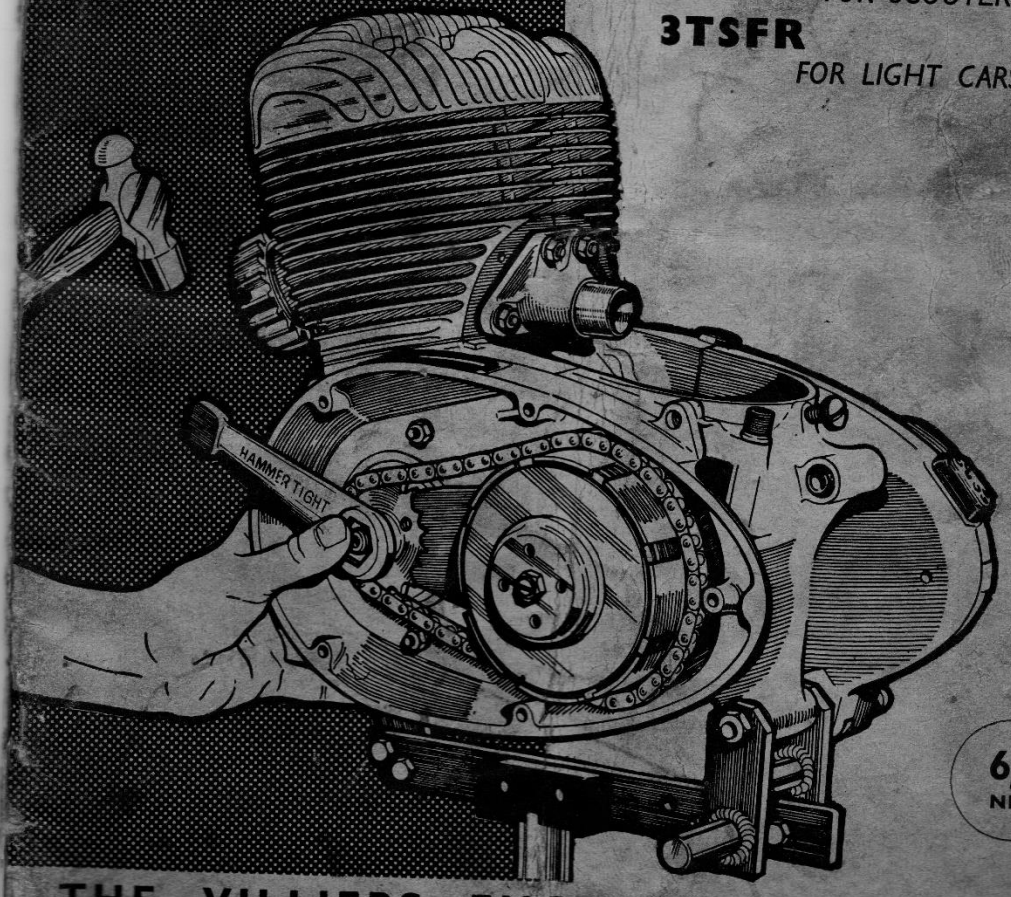
TWO-STROKE ENGINE GEAR UNITS

MARKS

2T & 3T
FOR MOTOR CYCLES

2TSF & 3TSF
FOR SCOOTERS

3TSFR
FOR LIGHT CARS



6/-
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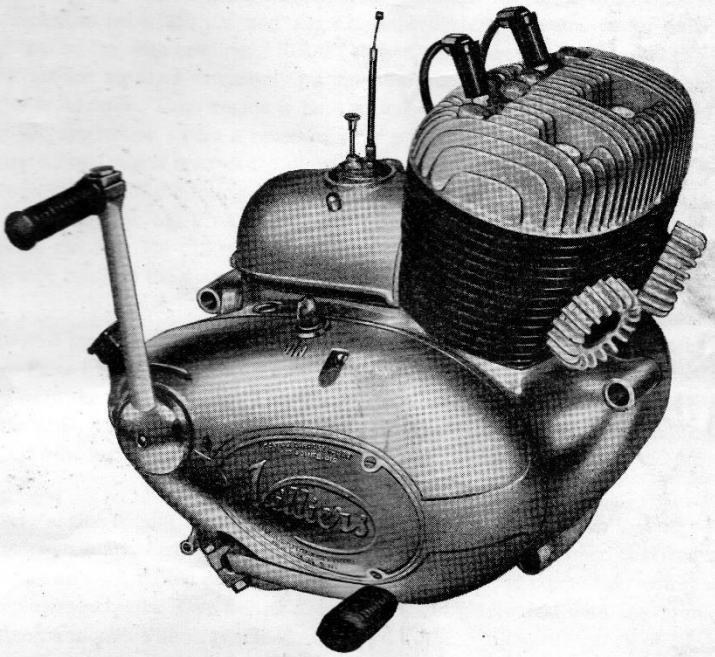
THE VILLIERS ENGINEERING CO. LTD.,
WOLVERHAMPTON · ENGLAND

WORKSHOP MANUAL



MARKS 2T, 3T, 2TSF, 3TSF & 3TSFR

ENGINE-GEAR UNITS

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

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Foreword . . .

QUALITY 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 2T and 3T units are produced specifically for motor cycle application, the capacities being 250 c.c. and 324 c.c. respectively. The same power units but with cooling fan with cowling, " SIBA " starter, and known as the Mark 2TSF and 3TSF models are used extensively by manufacturers of scooters where the electric starter is essential. Each engine is built in unit with a four-speed gearbox and for light car application where a reversing gear is compulsory, the " SIBA " reversing starter is fitted which reverses the direction of engine rotation, the drive being taken through the first of the four gear ratios only. This model is identified by the letters SFR following the Mark on the number plate attached to the rear half chaincase. The 250 c.c. and 324 c.c. models are interchangeable as complete units, the main difference being in the diameter of the cylinder bore.

Routine maintenance of the units is dealt with in the " Operating Instructions and Spare Parts List " Ref. V.E.C.116, and it is recommended that the reader obtains a copy from the Villiers Service Department, together with Service Instruction Sheets for the SIBA " Dynastart," Ref. V.E.C.549, also booklets V.E.C.27 & 68, and Service Bulletin No. MC/43.

Every engine is built to a works specification, the number of which is stamped on the nameplate attached, usually to the inner chaincase. 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.

TECHNICAL DATA

MKS. 2T & 3T UNITS.

SEE SEPARATE SHEETS COVERING MKS. 2TSF, 3TSF & 3TSFR UNITS.

	Mk. 2T	M. 3T
Cylinder Bore, Standard	50 mm=1.9705″/1.9700″	57 mm=2.245″/2.2445″
Cylinder Bore, Oversize	As above, plus .015″ or .030″	
Stroke	63.50 mm=2.50″	63.50 mm=2.50″
Capacity	250 c.c.=15.25 cu. ins.	324 c.c.=19.17 cu. ins.
Compression Ratio	8.2-1.	7.25-1
Engine Sprocket	20 teeth × ⅜ pitch	25 teeth × ⅜ pitch
Clutch Sprocket	43 teeth × ⅜ pitch″	
Primary Drive Ratio	2.15-1	1.72-1
Primary Chain	Renold No. 110 038 × 60 pitches	62 pitches
Gear Ratios, Standard	1, 1.32, 1.9, 3.06-1	
Gear Ratios, Wide	1, 1.4, 2.02, 3.6-1	
Final Drive Sprocket	18 teeth × ½″ pitch	19 teeth × ½″ pitch
Final Drive Chain Line	To suit " Renold " Chain No. 110 046, ½″ pitch × .305″ wide	2.11/16″

BALL & ROLLER BEARINGS

MK. 2T and MK. 3T

Driving Shaft, left-hand Outer (1)	25 × 52 × 15 mm, No. 125, 3 spot ball bearing
Driving Centre, right-hand, Outer(2)	25 × 52 × 15 mm, No. R.125, Roller bearing
High Gear Pinion, Gearbox	¼″ dia. × ¼″ long roller, 38 per set
Cam Barrel Bearing, Gearbox	$\frac{3}{16}$″ dia. × $\frac{3}{16}$″ long roller, 24 per set
Clutch Sprocket Race	$\frac{3}{16}$″ dia. × $\frac{3}{16}$″ long roller, 24 per set
Crankpin Roller, (early type)	¼″ dia. × ¼″ long, 52 per set
Crankpin Roller (current type with cage)	¼″ dia. × $\frac{5}{16}$″ long, 18 per set
Crankpin Diameter, Standard	.7983″/.7980″
Crankpin Diameter, O/Size	.7993″/.7990″
Con Rod Big End Diameter, Standard	1.2986″/1.2981″
Con Rod Big End Diameter, O/Size	1.2996″/1.2991″
Con Rod Big End, Side Clearance, Total	.012″/.008″
Centre Shaft, dia. of ends, Standard	.980″/.9797″
Centre Shaft, dia. of ends, O/Size	.981″/.9807″

SMALL END BEARINGS

MK. 2T & MK. 3T.

Gudgeon Pin, Diameter	.493″/.4927″
Gudgeon Pin Bush, in Piston	.4935″/.4930″
Gudgeon Pin Bush, in Con Rod	.4936″/.4931″

PISTON AND PISTON RINGS

	MK. 2T	MK. 3T
Compression Ring, Standard Size	1.9705 dia.	2.245″″ dia.
End Gap, in Position	.011″/.007″	.012″/.008″
Maximum Permissible Gap	.03″	.03″
Ring Clearance in Groove. Total:	.0042″/.0022″	.0042″/.0022″
Oversize Piston Rings	Std. plus .015″ and Std. plus .030″	
Piston Skirt Clearance in Cylinder Bore	Min. .0035″	.0041″

CARBURETTER (Motor Cycle Unit)

	MK. 2T	MK. 3T
VILLIERS	Type S.22/2	Type S.22/2
Taper Needle	No. 3½	No. 3½
Needle Setting	No. 3 groove	No. 3 groove
Throttle	No. 3	No. 3
Main Jet	170 c.c.	180 c.c.
Pilot Jet	35 c.c.	35 c.c.

IGNITION (Motor Cycle Unit)

Contact Breaker Point Gap	.012″/.015″ (Villiers Magneto)
Points Commence to Open	$\frac{3}{16}$″ Before Top Dead Centre
Sparking Plug	Lodge HH.14
Sparking Plug Gap	.018″/.025″
Wiring Diagram	Drg. No. M.2825C, 6 volt rectifier and battery

LUBRICATION

Engine	Petroil 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	Castrol XL (S.A.E.30) oil. Fill to dipstick level.
Chaincase	Castrolite (S.A.E.20) oil. Fill to oil level plug.

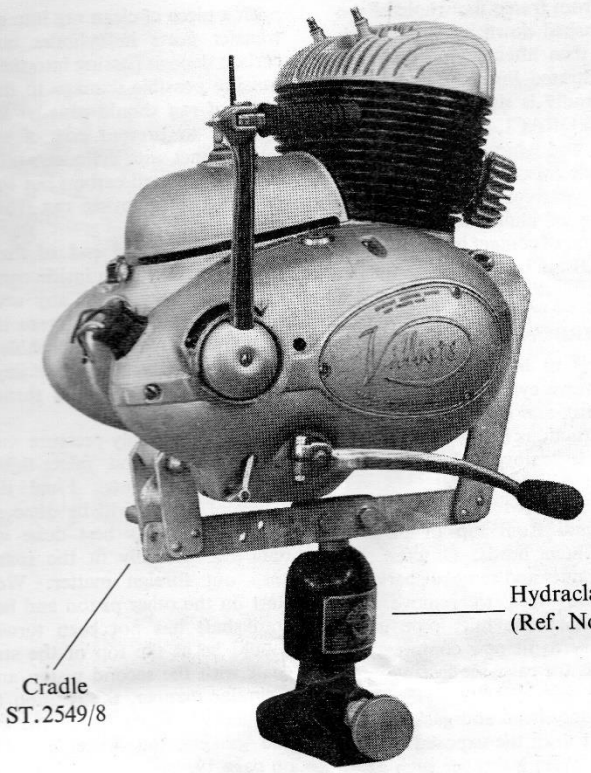


Fig. 1

REMOVAL OF UNIT

When a major overhaul is necessary, calling for dismantling of crankcase and/or gearbox, the complete unit must be removed from the frame. Before this can be done, however, it will be necessary to detach various components and to take certain precautions. First detach the battery negative lead, then the six pin plug with cables from the right-hand cover of the unit followed by the high tension leads from the sparking plugs, and the EARTH terminal attached to the chain-case/gearbox fixing screw. The two high tension ignition coils and rectifier are normally mounted on frame and need not be disturbed. Disconnect the fuel pipe at the tap end, and after unscrewing carburetter cover screw pull the cover with air filter off the locating flange on carburetter and the two locating dowels in cylinder face. The cover can then be lifted to allow the top ring of carburetter to be unscrewed. The throttle with control cable can be lifted out to allow cover to be removed and put on one side for cleaning of air filter. Replace carburetter throttle and cable and after releasing clip screw remove carburetter from inlet pipe and secure to frame out of the way if no work on the carburetter is necessary. Detach silencers and exhaust pipes, using CEE spanner, part number E.8676, to unscrew the exhaust pipe nuts from cylinders. Remove the rear wheel driving chain, clutch control cable, and also the four frame fixing bolts.

After removal from frame the whole of the unit should be washed down externally with white spirit, and then after drying mounted in a cradle as illustrated Fig. 1. The bottom member of the cradle is drilled to suit the head of the " HYDRACLAMP " which is an optional extra, and which allows the unit to turn a full circle, also to swing to bring the crankshaft and gearbox mainshaft vertical to facilitate fitting of clutch assembly and timing and inspection of contact breakers. The base of the " HYDRACLAMP " is normally bolted to top of a work bench.

DECARBONISING

When the unit is to be completely overhauled, do not remove cylinders and pistons until clutch, magneto, and gearbox have been removed. The instructions below apply when it is necessary only to remove carbon deposits from cylinders and cylinder heads.

Carbon can be removed from the combustion chamber and from top of pistons after removal of cylinder heads. Unscrew the eight cylinder head nuts and remove sparking plugs. There is no need to remove the cylinders or to disturb the inlet pipe joint unless it is necessary to fit new compression rings. If the latter is the case, see instructions on page 10.

Remove one cylinder head and gasket only and turn crankshaft until the exposed piston is at top of stroke. With a scraper such as a blunt screwdriver or the square end of a 6″ steel rule, remove carbon from piston crown, at the same time taking care not to remove any aluminium or to damage the bore of the cylinder. Do not scrape away the ring of carbon which usually forms in top of cylinder bore and extending to a point reached by the top compression ring at top of stroke. This carbon acts as a seal and where a new ring is fitted helps to maintain compression until the ring is bedded in.

Clean top of cylinder face taking care not to damage the annular sealing ring which projects a few thous above the top face, and remove by air pressure all loose carbon above piston crown.

Turn crankshaft until the exposed piston is at bottom of its stroke. With the piston in this position it is possible to remove carbon from the exhaust port and exhaust outlet working from the outside, through the port itself, using a suitable tool such as an old hacksaw blade, but before starting on this push a piece of clean rag into each of the side transfer ports in cylinder bore to prevent carbon deposit passing into the crankcase and causing possible damage to the bearings. A piece of rag should also be stuffed into the cylinder to prevent end of scraper coming into contact with cylinder wall. Remove this rag and blow all carbon out through exhaust port before removing rag from the transfer ports.

With the round end of the 6″ steel rule remove carbon from inside combustion space of cylinder head and any accumulation of road dirt, etc., from between the fins. Clean carbon from sparking plug hole with a 14 mm dia. plug tap and remove any sharp edges where the thread breaks through, to avoid pre-ignition trouble.

After thoroughly pressure washing, replace cylinder head and finger-tighten the four cylinder head nuts. Final tightening and fitting of gasket will be done after checking ignition which is best done with the head removed. Loosely fit the sparking plug to keep out foreign matter. Work can now start on the other piston and head and if the crankshaft has not been turned the piston should be at the top of the stroke. Having dealt with the second piston and cylinder in a similar manner, the ignition timing should be checked before fitting the cylinder heads and gaskets, the procedure being described on page 19.

Assuming the unit has been removed from the motor cycle frame, proceed to completely dismantle in the following order:—

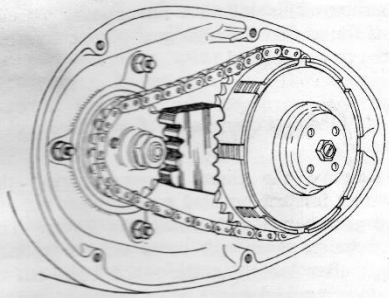
DISMANTLING FOR COMPLETE OVERHAUL

Outer Chaincase

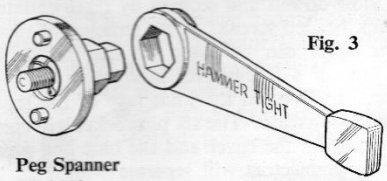
This is secured by five countersunk headed screws. Note that these vary in length. Before breaking the seal between the outer and inner chaincases place a tray underneath to catch the primary chain lubricating oil.

Clutch, Primary Chain, Engine Sprocket

Lock the engine and clutch sprockets by means of tool ST.2585B for the Mark 2T or ST.2509D for the Mark 3T unit. See Fig. 2. Release the hexagon locknut and unscrew the adjuster screw in centre of clutch end cap. In place of the adjuster screw fit the centre screw of the peg spanner ST.2552 and using the Villiers " Hammertight " spanner M.1239E turn



Sprocket Locking Tool
ST 2585B—MK 2T
ST 2509D—MK 3T
Fig. 2



Peg Spanner
ST 2552

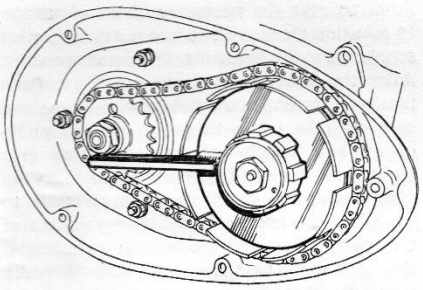
Fig. 3

"Hammertight" Spanner
M 1239E

the end cap anti-clockwise to remove and to expose the clutch plates and centre fixing nut. See Fig. 3.

Before releasing the centre nut and whilst the sprocket locking plate is still in position, unscrew the engine sprocket nut. This need not be done in the case of the Mark 2T unit as the hole in the inner chaincase is large enough to pass over the sprocket after the primary chain has been removed. The sprocket will, of course, have to be removed if the overhaul includes splitting of the crankcases.

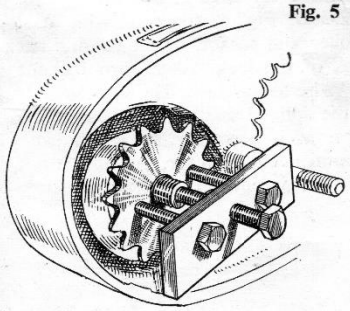
Remove the outside pressure plate followed by the four friction plates and the three intermediate plates. If the friction plates with bonded facings measure less than $\frac{1}{8}''$ thick, they should be replaced by new ones. After removal of clutch plates the hexagon centre nut is unscrewed anti-clockwise using "Hammertight" spanner M.1239E, Fig. 3. To prevent clutch-shaft rotating use clutch sleeve locking plate ST.2551-C/1, Fig. 4. Removal of the centre nut enables the remainder of the clutch components to be withdrawn, but before pulling the clutch



Clutch Sleeve Locking Plate
ST 2551—C/1
Fig. 4

sprocket off the centre which carries the open roller race place a tray underneath to catch the 24—$\frac{3}{16}''$ × $\frac{3}{16}''$ rollers. Removal of clutch sprocket from the roller race will enable a new chain to be fitted without having to remove the engine sprocket. The roller race centre must be withdrawn from the splined shaft before the inner chaincase can be removed. The engine sprocket fits a parallel shaft with woodruffe key and after removal of hexagon nut can be pulled off using an extractor as ST.2587D, Fig. 5.

Fig. 5



Sprocket Extractor ST 2587D

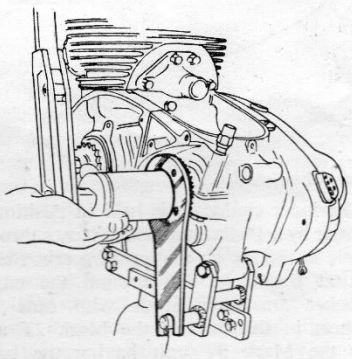
Inner Chaincase

The inner chaincase is held in position at the rear by a $\frac{1}{4}''$ dia. stud which passes through a hole in the lug on the top of gearbox shell, and at the front end around the engine sprocket are three studs with nuts and washers in the case of the Mark 2T unit. For the Mark 3T unit having the larger engine sprocket two bolts and one stud are

fitted to give the necessary chain clearance. In addition there are two countersunk headed screws normally hidden by the clutch sprocket. After the fixing bolts, nuts, etc., have been removed, the chaincase can be withdrawn, and care must be taken to avoid damage to lip of oil seal which fits over the high gear pinion extension. Unless it is intended to remove the crankshaft there is no need to withdraw the engine sprocket in the case of the Mark 2T unit as the hole in chaincase is large enough to pass over the 20-tooth sprocket. It is, however, of course necessary to first remove the primary chain as already described when dismantling the clutch. After removal of chaincase, pull away the joint washer from the left-hand crankcase and replace with new washer when re-assembling.

Removal of Final Drive Sprocket

It is not advisable to remove the sprocket unless replacement of the sprocket, high gear pinion, pinion bearing rollers or oil seal is necessary. If the unit has not been taken out of the frame and the rear driving chain is still in position, fix the brake in the "ON" position and the gearbox in first gear. However, where the unit is mounted in the cradle illustrated on page 5, use the locking plate ST.2938D, Fig. 6, together with a torque spanner and socket. After turning back the tangs of the lockwasher, turn locknut anti-clockwise to unscrew. The sprocket is located on the splined end of high gear pinion and can now, if necessary, be withdrawn. It is recommended, however, that this is not done until after removal of gear clusters from gearbox. This will save unnecessary work if it is found that the high gear pinion does not need to be replaced.



Final Drive Locking Plate ST 2938D **Fig. 6**

Right-Hand Cover and Contact Breaker Assembly

Remove the three screws securing the contact breaker housing cover. Next remove the gearchange and kickstarter levers. The gearchange lever will come off the splined shaft after loosening the pinch bolt, but to remove the kickstarter lever the countersunk headed screw in the centre of the domed cover has first to be unscrewed. The pinch bolt must then be removed before the lever can be pulled off the splined shaft.

The right-hand cover is located on two hollow dowels and secured by three countersunk headed screws. After removal of these, the cover can be eased off the dowels by means of a screwdriver inserted in the two slots provided in the joint face of the right-hand crankcase. The six pin socket will come away from the cover and the blue and green cable connectors will separate with a gentle pull. The cover can then be removed completely, there being no need to dismantle the contact breaker assemblies unless replacements are required.

Remove the kickstarter return spring with cover and leave in position the kickstart shaft oil sealing ring. Make sure the ring is in position when re-assembling the gearbox.

Ignition Cam and Flywheel

The ignition cam is held in position on the driveshaft by an external circlip and located by a key. Remove the circlip, then push end of Villiers wire screwdriver into slot in cam, to expand this sufficiently to be withdrawn off shaft. Remove the key if the flywheel has to be taken off.

When removing the flywheel it is advisable to use a strap wrench for holding the wheel whilst the centre nut is turned anti-clockwise using a torque spanner and socket. Alternatively, to remove flywheel turn the centre nut anti-clockwise using the Villiers "Hammertight" spanner M.1239E and a hammer, in which case the flywheel rim should be held by the left-hand with the thumb preventing the spanner coming off the centre nut. The centre nut after slackening will retighten and

further turning will extract the flywheel from the tapered shaft. Place flywheel on a clean surface and keep away from swarf, etc., which may be attracted to the magnets. Remove the woodruffe key from driveshaft if it is intended to remove the armature plate.

Armature Plate

The armature plate carrying the lighting and ignition generating coils is fastened to the right-hand crankcase by four countersunk headed screws and located by a small dowel. An oil seal is carried in the armature plate centre hole and a paper joint washer is fitted between the plate and the crankcase to ensure an adequate seal. Before removing the armature plate, release the cable harness retaining clip by loosening the hexagon nut and then lift plate away, complete with harness and six-pin connector socket. Care must be taken to prevent damage of the oil seal against the keyways and thread on the driveshaft; a good plan is to cover the shaft from top of tapered portion to end with "Selotape."

Dismantling the Gearbox

The gearbox can be completely dismantled without detaching the shell from the crankcases. Before proceeding to remove the end cover any oil should be drained off, a plug for this being provided in the bottom of the gearbox shell; also remove the dipstick. The end cover is secured by three nuts and studs and two bolts, location being by two dowels. Between the joint faces is a paper washer. Light tapping with a mallet may be necessary to break the joint. Continue until the dowels are cleared and in order not to disturb the gear clusters and cam barrel from their working positions end pressure should be applied at clutch end of mainshaft until the end cover, with gear assemblies etc., is well clear of gearbox. All that should remain in the gearbox shell is the high gear pinion, the speedometer drive and the spring-loaded plunger which engages with the notches in end of cam barrel. If the dogs on the high gear pinion are not worn, the pinion can remain in position. To change the pinion turn unit in cradle on its side with the open face of gearbox at top and remove final drive sprocket. The pinion is carried on a double row of rollers and only light upward pressure on the protruding end of pinion should be necessary to push this through into the shell. The rollers and thrust washer should remain in situ. When fitting a replacement pinion, protect the oil seal lip by wrapping the splined end of pinion with transparent sealing tape and before fitting, smear with a little grease the $\frac{3}{16}$" dia. balls in the thrust race at the driving dog end. The balls are prevented from falling out by the centre bush which is pressed in after the balls have been put in. The mainshaft, layshaft and cam barrel can be removed from end cover after the split pin and gear-indicator pinion have been removed. The kickstarter shaft can be withdrawn from its bush, if this has not already come away with the layshaft. Take care not to lose any of the twenty-four $\frac{3}{16}" \times \frac{3}{16}"$ rollers or the outside thrust washer which form the cam barrel bearing in the end cover. The large toothed ring gear indicator should be left in position with its pointer. Inspection of the footchange operating pawl and quadrant will show up any wear in the engaging teeth; if no wear is visible the assembly should not be dismantled, but if necessary for replacement purposes proceed as follows:—

Remove outside circlip which will allow the complete assembly to be withdrawn from the end cover. The oil seal retaining washer will fall free and the oil sealing ring remaining in the bush should be renewed if necessary when re-assembling. The ratchet spring and the operating pawl can be removed towards the splined end of operating shaft. To remove the remaining components, the lockwasher should be turned down and the hexagon nut removed. Note the order of removal of components, paying attention to small shim(s) under the plain washer. The spindle bush is pressed into the gearbox shell and should not be removed.

To dismantle the cam barrel assembly turn selector forks on barrel to the widest apart position. This will make ends of split pins accessible. Remove split pins, thus releasing the sliding gear-fork pegs. The forks will now come away from barrel. No attempt should be made to remove the cam barrel bearing pin and thrust washer from the gearbox shell. There is no need to remove the kickstarter ratchet stop, or clutch bridge, unless replacement parts are required. The speedometer drive worm-wheel and spindle

can be withdrawn after removal of hexagon plug and washer. The plug has a *left-hand* thread, and is therefore unscrewed by turning clockwise.

Removal of Gearbox

The gearbox shell or body is attached to the crankcase by four studs with nuts and washers and located by two dowels. The fixing studs are screwed into the gearbox shell and pass through holes in the crankcase halves roughly at each corner of the mating faces. After the four nuts have been removed light tapping of the gearbox shell may be necessary to clear the dowels. The paper joint washer(s) fitted between the gearbox and crankcases serve both as an oil seal and as a means of adjusting the primary chain tension. If it is known that these washers have not been disturbed since the engine was first built, the thickness overall should be noted and if new washers are required due to damage the same total thickness must be fitted to maintain the chain tension.

Contact Breaker Assembly

The two contact breaker assemblies are housed in a recess provided in the right-hand cover. This recess also houses the two condensers and the ignition switch is mounted on top of the cover. All wiring is totally enclosed and is connected to the remainder of the ignition system by two " snip-snap " connectors.

Each contact breaker assembly is carried on a separate base-plate which is adjustable for ignition timing purposes. Do not disturb the base-plate unless alterations to timing are necessary.

The contact breaker assembly comprising point bracket, rocker arm and spring connecting strip can be lifted off the base-plate after the split pin and point bracket retaining screw have been removed. Take special care to note position of insulating washers, bushes, etc. If it is necessary to remove the contact breaker base-plate the three socket-headed screws must be unscrewed, but before this can be done, however, it will be necessary to remove the filling, in screw head.

A felt pad is carried on the left-hand base-plate for lubrication of the contact breaker cam. The condensers are held in position by two clips attached to the right-hand casing by cheese-headed screws.

If necessary to remove the ignition switch, the centre screw holding the switch arm in position must first be removed, after which the switch arm and contacts can be removed from the switch body; the large hexagon locknut secures the switch body to the casing.

Removal of Cylinder Heads, Cylinders and Pistons

Remove sparking plugs and unscrew the eight cylinder head nuts. Release nuts on each head evenly in diagonal rotation. An aluminium joint washer is fitted between cylinder and head. Now remove the four nuts holding the inlet pipe to cylinders, followed by the steel washers and then the fibre insulating washers which fit the four recesses. Carefully pull the pipe off the studs followed by the joint washer. Each cylinder is now free and retained in position only by the eight long fixing studs which are all of the same length. Temporarily refit engine sprocket with key to enable crankshaft to be turned, and, steadying the cylinders, turn shaft until one piston is at top of its stroke. Lift off the cylinder on the same side and steady piston as it comes out of the bore. Whilst steadying the free piston and the remaining cylinder with one hand, turn engine until other piston is at the top. Pack free piston and connecting rod with clean rag to prevent damage and lift second cylinder clear, again making sure that piston is not damaged as it comes clear of cylinder bore. Pack clean rag around extended con. rod to prevent gudgeon pin circlips or particles of carbon falling into the crankcase.

Using a pair of thin-nosed pliers remove both circlips from the raised piston and if it is found that the gudgeon pin cannot be pushed out by 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 are burred.

Carefully turn crankshaft until second piston is raised and again pack some rag round the con. rod. Remove gudgeon pin as already described, then keep pistons with original cylinders until ready for re-assembly. A steel expander ring is fitted behind the lower compression ring, the idea being to

centralise the piston in cylinder bore and to eliminate noise due to piston slap during the warming up period. Gap between ends of compression rings when new and in position in cylinders is .011″/.007″. When wear increases gap to .03″ ring should be replaced and if it is found that gap of new ring is more than .011″ this indicates a worn cylinder bore.

Any cylinder bore 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 .03″. 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

Splitting the Crankcase Assembly

The crankcases should be split only when the big ends, main bearings, and/or oil seals require attention. Having dismantled the unit as so far described, remove from top of crankcases the steel plate fitted between two joint washers. In no circumstances must this plate be omitted when re-building the unit. The crankcases are held together by six studs with washer and nut at each end. Two studs act as dowels and must always be replaced in the correct position. Remove the nuts on the magneto side and drive out all six studs. Gently tap magneto side crankcase and, when free, lift away, easing the con. rod through slot in case. The inner race of the roller bearing will remain on the drive-shaft and the outer race in the crankcase, being retained by a circlip. Before the crankshaft assembly can be removed from the left-hand crankcase it is necessary to remove the pinch bolt and the three crankcase centre plate socket headed screws. The hexagon head of the pinch bolt is located in the carburetter well at rear of left-hand crankcase. After removal, tie the bolt to some part of the crankcase in order that this will not be forgotten when rebuilding the unit. When the bolt and the three socket screws have been removed, the crankshaft should be rotated to bring the left-hand con. rod to its lowest position. Remove engine sprocket if still fitted and using a hide mallet on end of left-hand shaft, drive out assembly, the con. rod passing through slot in case, and leaving the ball bearing which is retained by a circlip, in the crankcase.

If the bearing or its oil seal require replacing, the circlip can be removed using a screwdriver. The ball bearing will tap out of housing if the crankcase is previously heated. The oil seal is fitted from the inside and is located by a shoulder in the crankcase, the oil seal spring being on the inside, i.e., next to the ball bearing. It should be noted that the crankcase halves and the centre bearing plate are matched and should not be used except as a complete set, otherwise correct alignment of the three bearings cannot be guaranteed.

Drive-shaft Assembly

Access to the con. rod big ends, centre roller bearing and oil seal is not possible without partial or complete dismantling. The centre shaft and crankpins are a press fit in the drive-shafts and centre wheels, and special equipment is needed both for assembly and dismantling of components. It is therefore recommended that apart from removal of the outer bearings any necessary repairs or fitting of replacement parts is entrusted to the Villiers Service Department. Oversize crankpins, centre shaft and con. rods are available to enable existing drive-shafts to be reused.

Ignition Coils

The two ignition coils are housed in Bakelite cases and the base-plate should not be disturbed. The coils are usually attached to the motor cycle frame by two bolts screwed

into the base plate. Replacement ignition coil assemblies are available on an exchange basis. Note that the Marks 2T, 3T and 2H ignition coils are identical, but are NOT interchangeable with the coil used on the Mark 1H unit although similar in appearance.

Dismantling Carburetter, Type S.22/2

The carburetter has already been detached from engine and to dismantle proceed as follows:—

First unscrew the top ring and withdraw throttle and strangler slides, with cable and operating spindle from carburetter body. Close twist grip fully to release tension on throttle spring so that the inner cable nipple can be disengaged from throttle slide. The strangler slide can now be removed from spindle. The taper needle can be withdrawn after the locating circlip has been moved to one side. A note should be made of the groove in which the circlip is fitted, before removal. The throttle cable adjuster screws into the top disc and the strangler spindle is located by a spring clip. The float chamber is removed by unscrewing anti-clockwise, after which the float will drop away. The main jet is screwed into the carburetter float chamber and should not be disturbed. The fuel needle lever, fuel needle, and needle bush can be removed after the hinge pin has been withdrawn. Do not disturb the float chamber sealing washer, tickler and spring, or the throttle guide screw.

The pilot jet needle and spring may be removed for cleaning or replacement, but it is advisable to leave both the filter fixing clip and felt sealing washer on the carburetter body. A petrol resisting adhesive is used to hold the felt washer in position.

The filter gauze is retained in position between two plates, the front one of which is held by a large circlip. Two felt washers form a seating for the gauze. The tickler, spring, etc., need not be disturbed.

RE-BUILDING THE UNIT

It is assumed that after dismantling, all components, including oil seal 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 rebuilding 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 off by compressed air. For components of the electrical ignition and lighting systems use carbon tetrachloride (C.T.C.), or if not available, use white spirit. Dry off as for metal components.

All moving parts of the engine and gearbox should be liberally oiled when reassembling, using clean engine oil. All oil seals should be well lubricated with engine oil before fitting.

Crankshaft Assembly

As mentioned in the dismantling instructions, special equipment is needed for complete servicing of the assembly, and it is, therefore, recommended that the replacement of any parts, other than outer bearings, is not undertaken by the owner, but is entrusted to the Villiers Service Department. When the crankshaft assembly is completely rebuilt, including roller bearing inner race on magneto side, and before being refitted into the crankcase, a check should be made to ensure correct alignment of the component parts.

The assembly should be mounted between fixed centres and the maximum permitted misalignment is 0.001 in., measured by means of a dial gauge, at three points along the length of the assembly, i.e. (1) as near as possible to the web of the right-hand driveshaft; (2) at the centre plate (hold the plate so that it does not rotate); and (3) as close as possible to the web of the left-hand driveshaft. The total side clearance between the crank webs and the connecting rod at the big end is 0.008-0.012 in.

When the shaft assembly has been built into the crankcases a further check of the alignment should be made, with the measurement being taken as close as possible to the outer bearings, the maximum misalignment is 0.002 in. at either side.

It is most important that the crankpins are set correctly, i.e. 180° apart, otherwise it will

be impossible to obtain correct ignition timing or satisfactory running of the engine.

Crankshaft and Crankcase Assembly

Assuming that the crankshaft assembly is complete, with the magneto side inner roller race in position on shaft, the next step is to fit the oil seal and ball bearing in the left-hand crankcase housing, and the outer race of the roller bearing in the right-hand crankcase housing. To facilitate fitting the ball bearing and the outer race, heat the crankcase halves to 130°C (266°F), and make sure that the ball bearing goes to the bottom of the housing to enable the circlip to be fitted in the groove. Before fitting the outer roller race in the right-hand crankcase, fit the circlip and make sure that the race goes up to this by fitting the bearing race from the outside of crankcase.

Next place the left-hand crankcase open side up on a flat surface, preferably one having a hole into which the shaft end will go when being fitted. Next, having smeared the spigot and joint face in the centre plate with Secotine, lower the shaft end into the ball bearing, at the same time passing the left-hand con. rod through the slot in crankcase. When the con. rod is clear of crankcase turn crankshaft to the bottom position and at a point as near as possible opposite to the crankpin insert between the crank webs a tapered steel wedge to prevent possible distortion.

Turn the centre plate to bring the three screw holes in line with holes in crankcase and lower the shaft until the screws can be started about three threads. Use a hide mallet on the right-hand crankpin portion of the shaft assembly until the centre plate is home and then lightly pull up the three socket-headed screws.

Place the pinch bolt trunnion in the recess in left-hand crankcase and fit the pinch bolt with plain washer under the head. Tighten the pinch bolt to centralise the centre plate using a torque wrench set to 80 lbs/ins., then fully tighten the three socket-headed screws. Remove the wedge from between the crank webs and then check that crankshaft revolves freely and does not foul anywhere.

Place the right-hand crankcase on the same flat surface, joint face upwards, and having smeared with Secotine the joint face and also the outer diameter of centre plate, lower the crankshaft end through the roller bearing and oil seal. The con. rod must be positioned to pass through the slot in crankcase. Fit the six studs, with nut and washer at one end, making sure that the two dowel studs are in the correct position. Turn the assembly over until the crankshaft is horizontal and then fit the remaining washers and nuts to the six studs. Tighten securely in diagonal rotation and check that crankshaft rotates freely, at the same time steadying the con. rods to prevent damage. A little friction will be felt because of the oil seals, but if this is considered excessive light tapping with a mallet on each end of the crankshaft should rectify this. Replace crankcase drain screws, with new joint washers, if these have been disturbed.

Assembly of Pistons and Cylinders

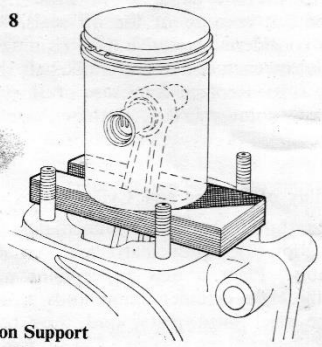
This should be done immediately after completion of crankshaft and crankcase assembly. Place a new paper joint washer over the eight cylinder fixing studs, followed by the steel joint plate, and then by the second paper joint washer. Do not use any Secotine, but to ensure that openings match in both the paper washer and steel plate fix the washer to both sides of plate with a smear of grease. In no circumstances must the steel plate be omitted.

Next, fit one circlip in each of the pistons so that both circlips are on the inside when the pistons are fitted. This enables the gudgeon pins to be fitted from the outside, making the fitting of the second circlip in each piston much easier. It is important that the pistons are fitted in their original cylinders and that the word "Front" stamped on the piston crown is towards the exhaust port at the front of the engine. It does not matter which piston and cylinder is fitted first, but before attempting to fit a cylinder check that both gudgeon pin circlips are correctly placed in the piston-bush grooves and that the expander ring is fitted behind the lower compression ring. Position the compression rings so that the slots line up with the pegs in the piston ring grooves.

Before attempting to fit a cylinder over the piston, place across the crankcase mouth a piston support plate ST.2535D, Fig. 8. Allow the piston skirt to rest on this support and it will be found easy to lower the cylinder and guide rings into the cylinder and keeping

them correctly positioned in relation to the ring pegs. Apply a liberal coating of engine oil to outside of piston skirt before fitting cylinder. Next fit cylinder head gasket, making certain that large hole registers with cylinder bore. It is possible to fit the gasket incorrectly so that it overlaps the bore, causing severe pre-ignition if not corrected. After fitting cylinder head with nuts finger-tight only, repeat operations for the second cylinder and piston.

Fig. 8



Piston Support Plate ST 2535D

Refitting Inlet Pipe

To ensure a perfect gas-tight joint between cylinder and inlet pipe, it is necessary to fit the pipe before finally tightening the cylinder head nuts. Place the thick joint washer over the four studs, followed by the inlet pipe. The four fibre washers should lie squarely in the recesses in the pipe. Fit the plain washers and lightly tighten the four nuts diagonally. These nuts should be fully tightened before final tightening of the cylinder head nuts, see later instructions regarding ignition timing. Fit a cork plug or clean rag in inlet pipe stub to prevent entry of foreign matter.

Rebuilding Gearbox

It is assumed that the gearbox has been completely stripped except for the fixed bushes, cam barrel bearing pin and thrust washer, and the two end cover locating dowels.

Push into position the high gear pinion, having the sixteen $\frac{3}{16}$″ dia. steel balls in the thrust race at the dog end of pinion. Smear some light grease on balls before gearbox mainshaft is inserted.

The oil seal for high gear pinion can now be fitted, open side towards the pinion bearing. Keep seal square when fitting and to prevent damage to lip of seal wrap a layer of transparent sealing tape on the splined extension of high gear pinion. Fit the final drive sprocket, boss first, then lockwasher with tang turned into the locating hole, followed by the sprocket locknut, finger-tight only. Final pulling up will be done after assembly of gearbox to crankcase.

The gearbox shell should now be attached to the crankcase, using two paper joint washers, and then mounted in the cradle. The attachment is only temporary in order to determine the number of joint washers necessary for correct tensioning of the primary chain, and being able to tilt the unit in the cradle will facilitate assembly of the gearbox end cover. Before proceeding with assembly of end cover, see that the spring-loaded plunger for end of cam barrel is in position. Put some grease in the bush before inserting the plunger. The speedometer drive worm-wheel can be inserted after assembly of layshaft in gearbox. Don't forget that the plug has a *left-hand* thread.

Gearbox End Cover

Assembly of the gearbox is made much easier if the end cover is built as a complete assembly including main and layshafts, cam barrel with sliding forks, and gear-operating shaft. Before attempting to fit shafts, etc., examine for tightness the nut securing gear-change return spring stop and make sure that the sealing washer is in position on the stud in the kickstart ratchet stop. The sealing washer is located between the stop and end cover and prevents escape of oil along the stud.

Next build up the gear selector mechanism on to the gear-operating spindle, making sure that the original shims are replaced, and that the gear-operating quadrant is free to revolve on the spindle without end float. Now place the gear-operating pawl with its return spring in position on the operating spindle, followed by the gear-change ratchet spring. The spindle assembly should now be fitted in its bush in end cover. Make certain that the pawl spring engages with the square stop

immediately above and that the slot in the operating plate engages with the Dee shaped stop peg to the right of the bush. Light pressure will be necessary to push the spindle home in the bush. Next fit the spindle oil seal ring in the recess at end of bush followed by the seal retaining washer and circlip. Note that there must be a total clearance of .008″/.004″ between prongs of the pawl spring and the stop in end cover. If there is too much, or no clearance, erratic gear-changing will result.

The bearing for cam barrel consists of twenty-four $\frac{3}{16}'' \times \frac{3}{16}''$ steel rollers and inner and outer thrust washers. A little grease on outer washer will keep this in position until cam barrel is fitted.

Now place the end cover, flat-wise, inside face upwards, in a vice, using clamps to prevent damage. The flat side of the end cover should be nearest the vice handle, which should not be pulled up too tight. Assemble the sliding gear forks on the cam barrel, with the long boss on the outside, or at opposite ends of the barrel. Fit the fork guide pegs and split pins, the ends of which must be turned down flat, keeping clear of the forks.

Move the gear-operating quadrant to bring the punch-mark on side of teeth in line with centre of the cam barrel bearing. Pick up the cam barrel and move the forks independently until they are in line and as close together as possible. The distance from end of barrel to boss of fork at gear end is approx. $\frac{11}{16}''$. A groove is cut in the end of the barrel at the gearwheel end for correct meshing with teeth in the gear-operating quadrant.

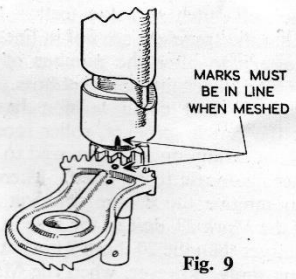


Fig. 9

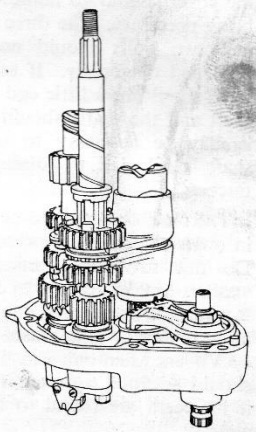
After making sure that the outer thrust washer is in position, place the end of cam barrel through the bearing, at the same time mesh the gears with the groove in barrel in line with punch-mark on quadrant, see Fig. 9. Afterwards turn both forks and cam barrel anti-clockwise until a click in the change-speed mechanism is heard. It will then be found that the forks are in line with bearings for the layshaft and mainshaft.

Now hold the mainshaft vertically, with the integral gear underneath. Fit on shaft either of the sliding gears having no dogs, gear-teeth first, i.e., fork groove at top. Next fit one of the sliding gears having dogs, which should be on top, so as to mesh with the dogs of the high gear pinion, when assembled into gearbox. Holding the mainshaft vertically over the end cover, fit the sliding gears into their respective forks and lower end of shaft into the bearing bush in end cover.

Next place kickstart in its bush, followed by the ratchet coil spring, kickstart ratchet, and the ratchet pinion. The ratchet should be put in with the shoulder not less than 90° from the ratchet stop secured to end cover. Depress the ratchet spring by pressure on the ratchet pinion, then place the other sliding gear with dogs in the bottom fork, the dogs meshing with dogs in the ratchet pinion. Pressure on the ratchet spring can now be released and the remaining sliding gear, without dogs, fitted in the empty fork, the groove being underneath.

Holding the layshaft vertically with integral gear at top, thread the shaft through the gears, the small end going into the bush in the kickstart shaft.

Finally place the pressure washer, flat face outside, on the mainshaft, making sure that



End Cover Assembly

Fig. 10

the washer is located by the splines on the shaft. Also make sure that the push rod sealing washer is in position in the bottom of the mainshaft bush. The end cover assembly can now be taken out of the vice, and to prevent the cam barrel and gears coming adrift, the gear-indicator pinion should be fitted, but before doing this place in position the oil sealing ring ref. E.9257. The pinion is fitted with the boss outside and has a punch-mark on one of the teeth. This mark must be in line with, and on the same side as the groove in end of shaft. In this position the securing split pin can be fitted and the ends opened. If the gear ring indicator has not been dismantled this should be positioned at the same time as the pinion, the punch marks on both components must be in line. Replace oil drain plug, oil filler plug-dipstick. Do not fit clutch bridge, clutch and kickstart levers at this stage. See Fig. 10.

Assembly of Gearbox

Assuming the gearbox shell to have been temporarily fitted to crankcase and mounted in the cradle, the end cover with gear assembly etc., can now be fitted. Release the clamp and incline the unit towards the magneto side about 20 degrees. Place a new joint washer over the end cover dowels. Do not use any jointing compound, but a smear of grease will keep the washer in position. The end cover assembly can now be offered up, the shafts and cam barrel located in the appropriate bearings and if the pressure washer on mainshaft has remained in position the cover should go home without any force being necessary. The three nuts and washers and two bolts should now be fitted and tightened diagonally. If assembled correctly there should be a little end float in the main-shaft and the shafts should rotate freely, but it may be necessary to turn the kickstart shaft clockwise to disengage the starter ratchet.

The clutch has now to be fitted temporarily in order to check the primary chain tension. Do not fit extra crankcase/gearbox joint washers to take up wear in chain or sprockets. Replace the worn parts, retaining the thickness and number of joint washers originally fitted by Villiers when unit was built. A new chain should be fitted together with new sprockets if the teeth are found to be hooked due to wear.

Fit the engine sprocket distance piece, taking care not to damage the oil seal, followed by the key, sprocket, spring washer and nut. This nut can be finally tightened when the primary chain has been fitted and the locking tool, Fig. 00, can be placed between the engine and clutch sprockets.

Mount the clutch roller track on the main-shaft, and with the unit inclined in the cradle towards the magneto side, grease the rollers and fit them on the track.

If the number and thickness of washers used when the engine was first built is unknown as might be the case when several owners are involved, a *new chain* must be used to check the tension, as described in the intructions which follow:—

Fit primary chain over engine and clutch sprockets and place the latter over the rollers and against the back flange. Turn the engine until the chain is at its tightest point, at which there should be a total up and down movement of the chain of approximately $\frac{1}{4}''$ at a point midway between the two sprockets. If the movement is found to be less, one or more crankcase-gearbox joint washers should be removed, but if the movement is greater, additional washers (maximum total four) should be fitted. The washers also provide the oil seal between the gearbox and crankcase so that at least one washer must always be fitted. Before the inner chaincase can be fitted the clutch sprocket and primary chain will have to be removed, but before doing this check for correct chainline. Holding the clutch sprocket squarely against the roller track, place a straight edge against the face of engine sprocket teeth and check alignment with face of clutch sprocket teeth. If it is found that the sprockets are not in line, it will be necessary to alter the number of shims fitted behind the engine sprocket boss. When the chainline and chain tension has been settled, the clutch sprocket, roller race track and primary chain must be removed to enable the inner chaincase to be fitted. There is no need to remove the engine sprocket in the case of the Mark 2T unit as the hole in chain-case is larger than the 20 tooth sprocket. This does not apply, however, when the Mark 3T unit is concerned.

Before attempting to fit the inner chaincase, the final drive sprocket locknut should be tightened. Assuming the crankcase and gear-box assembly to be mounted in the cradle

illustrated in Fig. 1, a locking plate ST. 2938D Fig. 6, should be used in conjunction with a torque spanner set at 1,200 lbs/ins. turned clockwise. After tightening the nut turn up the tabs of the lockwasher against the sides of the locknut.

ASSEMBLY OF INNER CHAINCASE

Check for tightness the three $\frac{1}{4}$″ dia. studs placed around the centre boss of left-hand crankcase in the case of the Mark 2T unit. A sprocket having 25 teeth is used on the Mark 3T unit and to give the required chain clearance the two rearmost studs are replaced by bolts. Smear some Secotine on the crankcase joint face and fit a new paper washer. Renew the oil seal if necessary, fitting this with the open side towards inside of chaincase. Carefully place the chaincase in position, taking care not to damage seal on the extension of the high gear pinion. The chaincase is secured by two countersunk headed screws and one bolt in addition to the studs and bolts already mentioned. The two screws and one bolt should be tightened first and the heads of the screws peened by stabbing the aluminium into the screwdriver slots.

PRIMARY DRIVE, CLUTCH AND CLUTCH PUSH RODS

Fit chainwheel roller track on splined end of gearbox mainshaft. Put some graphite grease on the rollers and put into position on the track. Place the primary chain over the engine and clutch sprockets and then mount the clutch sprocket on the rollers and fill in the gaps with graphite grease. Follow with the copper shim, the outside face of which should also be smeared with graphite grease to prevent sticking of clutch back-plate when clutch is withdrawn.

Fit the clutch back-plate on the splined gearbox mainshaft followed by the clutch hub, clutch sliding sleeve and the nine springs which should be well greased. Next is fitted the spring retaining washer and the hexagon headed centre nut. A short length of $\frac{3}{16}$″ dia. rod should be inserted through the hole in retaining washer and into the centre of one of the clutch springs before the centre nut is tightened. If this locating peg is not used, the clutch springs are likely to be damaged by the washer turning as the nut is tightened.

Certain clutch assemblies have a second spring inside the large ones to give increased pressure where required for three-wheel vehicles or competition engines. The retaining washer will then have two holes—the smaller one is to be used with a length of rod passing through it and inside the internal spring to locate the washer whilst tightening the sleeve nut. The two holes are positioned so that it is impossible for one of the small diameter springs to line up with a large hole through which it could protrude and cause damage.

To prevent clutch sleeve turning whilst tightening the hexagon centre nut, use locking tool ST. 2551-C/1, Fig. 4, with the extension piece under the engine sprocket boss.

Next fit the four clutch driving plates alternating with the three driven plates and followed by the outside pressure plate. Fit the two $\frac{3}{16}$″ dia clutch push rods in centre hole in mainshaft, either length first, and then place between the engine and clutch sprockets the locking plate ST. 2585B, Fig. 2, prior to tightening sprocket nut and clutch cap.

To ensure correct operation of the clutch it is necessary to fit shims in cap nut to compensate for variations in the overall thickness of the four faced and three plain clutch plates. Two thicknesses of shims are available, namely .048″ Part No. E.11019 and .064″, E.11020. To determine the shimming required, the dimension from end of sliding sleeve to face of outside pressure plate must be obtained.

Shims should be fitted in accordance with table below:—

Dimension:	*No. and Thickness of Shim:*
$\frac{9}{32}$″ or under	2—.048″
$\frac{5}{16}$″	1—.064″
$\frac{11}{32}$″	1—.048″
$\frac{3}{8}$″ or over	None

Afterwards fit adjuster screw, without the locknut, in centre of end cap, making sure that the $\frac{3}{16}$″ × $\frac{3}{16}$″ steel roller is fitted in end of screw. Next fit the remaining $\frac{1}{4}$″ dia push rod in other end of mainshaft until making contact with end of $\frac{3}{16}$″ dia push rod. Now screw in the adjuster screw to give an extension of $\frac{5}{16}$″ at the control lever end where the original clutch plates are re-fitted, or $\frac{9}{32}$″ where new faced plates are fitted. This allows for initial bedding down which invariably takes place. see sketch, Fig. 11. The dimension is taken

from end of push rod to bottom of machined slot in which fits the clutch lever. It should be possible to give about three extra turns of the screw to ensure sufficient clearance between screw and end of mainshaft for wear allowance of push rods and clutch plates. Afterwards reset screw to dimension given and then fit and tighten locknut.

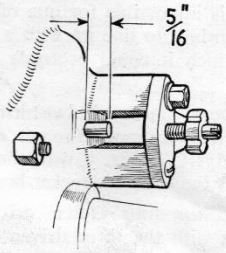


Fig. 11

The clutch bridge can now be fitted, followed by the clutch lever with adjuster screw fitted. The end of lever adjacent to the adjuster and push rod should be liberally greased. Final adjustment of the clutch lever cannot be arrived at until after the right-hand cover has been fitted.

RE-FITTING MAGNETO ARMATURE PLATE, FLYWHEEL AND CONTACT BREAKER ASSEMBLIES

The armature plate assembly is attached to the right-hand crankcase by four countersunk-headed screws, the position on the crankcase spigot being determined by a small dowel. Between the crankcase and armature plate is fitted a paper joint washer, the crankcase face being previously smeared with Secotine. The screws are prevented from turning by metal from side of hole being punched into screw slot.

The right-hand crankcase oil seal is carried in the centre of armature plate and, if necessary, should be replaced before the armature plate is fitted. The seal is fitted with the open side towards the roller bearing in crankcase. When fitting armature plate the leads at rear should be placed behind the clip provided to prevent possible damage by contact with the flywheel. Now fit key in crankshaft and carefully fit the magneto flywheel which should be held on the outside by a strap wrench whilst the centre nut is tightened clockwise using a torque wrench loaded to 750 lbs/ins. Do not overtighten. The ignition cam key can now be fitted, followed by the split cam and its retaining circlip. The recessed end face of cam goes on first and if it is found that the cam is loose on shaft this can be remedied by lightly squeezing the cam between vice jaws in order to reduce size of centre hole. Examine slot in cam for any burrs caused by screwdriver when withdrawing cam for crankshaft. Remove any burrs with an oil stone, but do not alter cam profile. The right-hand cover can now be fitted. Before locating this on the two hollow dowels, remake the two " snip-snap " connections of the cable harness taking care to match the colours and ensure that the remainder of the wiring harness with the six-pin socket is placed in position. Make certain that the wires are not trapped at any point. Secure the cover by the three countersunk headed screws. Make sure the clutch operating lever is quite free in slot in cover. To set the clutch lever insert a screwdriver in the hole in cover, to the right of the kickstarter shaft, and turn adjuster screw clockwise until the bottom end of clutch lever comes in contact with end of slot in cover. Now turn adjuster screw anti-clockwise one notch which will give approximately $\frac{1}{8}$" clearance or free movement at bottom end of lever.

If the contact breaker base-plates have been disturbed they should be refitted with the spring in position in the recess provided in each plate. Fit the three socket-head screws, but do not tighten until ignition timing is set. Next reassemble the various components of the two contact breakers taking particular care regarding position of the fibre insulating bush and washer on the bracket pin, or terminal screw. The bush fits on the inside of the point bracket lug and the washer on the outside. Next to the bush is fitted one end of the connecting spring strip and against this goes the hexagon head of the point bracket pin. Next to the fibre washer are fitted the lead terminal ends, then the " Shakeproof " washer and finally the hexagon nut which must not be overtightened to avoid damage to insulating bush. The other end of the spring strip locates on a raised pip on the rocker arm. Between the two ends of the strip is fitted the rocker spring. A light grease should be used to lubricate the rocker arm pivot and the arm should move freely on the pivot pin. Fit the

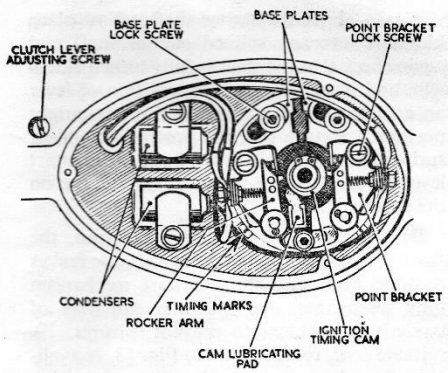
rocker retaining washer and split pin. The washer is available in four thicknesses and one should be selected which just allows the rocker arm to move freely when split pin is fitted—all end float of the rocker arm should be eliminated.

The condensers must be firmly clipped in their recess. A poor electrical contact between condenser and clip will lead to intermittent ignition troubles which may be difficult to trace. Re-grease the cam lubricating pad, using high melting point grease or heavy oil. The pad should make firm contact with the cam, otherwise excessive rocker wear and squeal will result from a dry cam.

RE-SETTING CONTACT BREAKERS AND TIMING IGNITION

There are two completely separate ignition circuits, each energised by one of the coils on the armature plate. The contact breaker assemblies are mounted on separate base-plates and each can be rotated round the centre line of ignition cam, thus giving independent timing of each cylinder. The base-plates are correctly positioned at the works and the holes in the three socket headed screws are afterwards filled with solder. Adjustment of the gap of the contact breaker points is carried out as follows:—In the section " assembly of pistons and cylinders " fitting of the heads is covered, but the cylinder head nuts are fitted finger-tight only to allow for removal of the heads in order to facilitate ignition timing. After removal of the heads and gaskets, rotate engine clockwise looking at magneto side until the left-hand (drive side) piston is in the top dead centre position. Release left-hand point bracket locking screw and adjust point gap to .012″/.015″, using the screwdriver and feeler gauge provided with the engine. Securely re-tighten locking screw. Repeat the operation with the right-hand contact breaker with the right-hand piston (magneto side) in the top dead centre position.

Should it become necessary to reset the ignition timing, the solder must first be removed from the three socket headed screws to allow the socket key to be used to release the screws. Having checked that the point gap when fully opened is .012″/.015″ rotate the engine clockwise until the left-hand piston is positioned $\frac{3}{16}$″ *before* top dead centre. Release the bottom socket headed screw and also the one securing the left-hand contact breaker bracket. Rotate the bracket until the contact breaker points commence to open. Lock the left-hand screw, rotate the engine clockwise until the right-hand piston is $\frac{3}{16}$″ *before* top dead centre and adjust the right-hand contact breaker base plate until the contact breaker points commence to open.



Twin Contact Breakers Fig. 12

After rechecking the timing for each cylinder, including the .012″/.015″ point gap tighten the three socket headed screws to prevent any movement of the base plates. Afterwards fit the three screws and cover plate to right-hand cover. See Fig. 12.

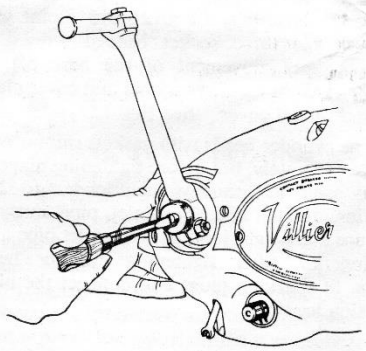
The cylinder heads with gaskets can now be fitted separately, but before tightening diagonally, using a torque wrench loaded to 220 lbs/ins, tighten the four inlet pipe nuts to ensure a gas-tight joint between inlet pipe and cylinders. After tightening cylinder head nuts, fit sparking plugs and connect the high tension leads.

RE-FITTING KICKSTARTER AND GEARCHANGE LEVERS

Check that the kickstart shaft sealing ring is in position and that the shaft is turned fully clockwise to bring the starter ratchet fully out of engagement. Liberally coat the kickstart return spring with grease and place in position over the end cover boss with the short end of spring located in the third from top of the four holes provided. Next fit the return spring cover and loop a piece of string cord round the protruding end of spring. Pull the string round anti-clockwise until end of spring is

vertically above the starter shaft. Now place kickstart lever on splined end of shaft and again check that the shaft is fully turned clockwise and if necessary adjust position of lever on splines to give its original almost upright position. Ensure that the protruding end of spring enters the hole in the back of kickstart lever before pushing the lever fully home on the splined shaft.

Before tightening the clamp bolt nut, the shaft has to be pulled outwards as far as possible to ensure the kickstart mechanism fully disengages, and that the end play of layshaft is sufficient to prevent seizures. A suitable tool, ref. ST.2561D, Fig. 13, is available from the Service Department. After tightening the clamp bolt nut the cover and its central fixing screw can be fitted. Kick engine over to check correct functioning and full return of the kickstart lever and disengagement of the kickstarter mechanism. Check this by turning the engine over by hand in the normal direction of rotation by means of the clutch assembly. Refit gearchange lever in original position on splined shaft and tighten clamp bolt nut.



ST 2561D Fig. 13

RE-FITTING OUTER CHAINCASE

Coat joint face of outer chaincase with Secotine, place joint washer in position and check that the fixing screws are in their correct holes, i.e. protruding length of thread should be approximately the same for all screws. Tighten screws in diagonal rotation. Re-fit oil level and filler plugs, replacing fibre joint washers if necessary. Check for tightness the three screws securing nameplate.

LIGHTING SET

Typical wiring diagrams are shown in Figs. 19 and 20. The output of the magneto lighting coils is converted to direct current by means of a selenium rectifier. With the switch in the "OFF" or "L" position only one lighting coil is operative, thus providing a charge to the battery, which is sufficient to more than balance the consumption of the headlamp pilot, tail and speedo bulbs. The "H" position of the switch brings into circuit the other lighting coil which is connected in parallel, thus providing the full output of the magneto. The bulbs used in conjunction with this lighting set are shown on the wiring diagram.

RECTIFIER

The central fixing bolt is isolated from electrical connection, therefore no special care need be taken to make a clean contact with the frame of the machine. The casing of the rectifier, however, should not be allowed to come into contact with the machine as it can easily be damaged. It is necessary to allow good ventilation around the rectifier and the position adopted by the machine manufacturers should not be altered. In order to preserve the tropical sealing of the rectifier, the centre bolt must not be turned, lowered or disturbed in any way. To avoid damage to the rectifier, the engine should not be run with the battery disconnected unless the cables to the outer terminals of the rectifier are first removed and insulated. Alternatively, the lighting switch may be left in the "H" position, though care must be exercised to avoid high engine speeds and consequent overloading of the lamps. The centre lead runs to earth and need not be disturbed. All connections should be soldered wherever possible, particularly the nipples in the six-pin plug and socket.

RE-ASSEMBLY AND RE-FITTING OF CARBURETTER

If the carburetter has been dismantled as dealt with on page 12, there should be no difficulty in rebuilding providing attention is given to the following points:—

Check that tickler vent hole in body is clear.

Check tightness of throttle guide screw, pilot jet, fuel needle bush and tickler spring screw in carburetter body.

Check main jet is clear and screwed firmly into bottom of float chamber.

Insert fuel needle point first, place lever in position, followed by the hinge pin.

Fit new float chamber joint washer if necessary and screw on float chamber after placing the float in position. Do not over-tighten float chamber to avoid distortion of carburetter body.

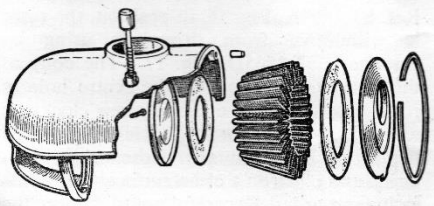
The long taper needle should be placed in the original position in throttle and located by the circlip. When fitting throttle in carburetter body, guide the end of taper needle into the needle jet (not removable). The throttle is correctly located in the body by the guide screw.

Fit new felt sealing washer if necessary, otherwise the air filter will not be fully effective.

When fitting carburetter make sure that the body is pushed fully home on inlet pipe stub before tightening the clip screw.

RE-FITTING CARBURETTER COVER AND AIR FILTER

Before re-fitting filter gauze, wash out in paraffin or petrol and then dip in petroil mixture. Fit the filter components as shown in exploded view, Fig. 14, ensuring that the two felt sealing washers are in position before fitting the front plate and then the circlip. Before the cover can be fitted the throttle with control cable and choke must be withdrawn from carburetter body, threaded through hole in cover and re-fitted in carburetter. The fuel pipe must also be threaded through hole in cover and the bottom end secured to carburetter. The gauze filter and fibre joint washers must be fitted to the banjo bolt which should not be overtightened. Locate the cover with the two dowels in cylinders and press forward so that the face makes contact with the cylinders when the knurled screw in the gearbox shell is tightened.



Air Filter Cover Fig. 14

MARKS 2TSF and 3TSF UNITS (SCOOTERS)

The technical data is generally as for the Marks 2T and 3T motor cycle units, but an extra roller bearing is provided on the right-hand driveshaft to carry the additional weight of the Siba " Dynastart " unit with fan. The dimensions of the additional bearing are 20 mm × 52 mm × 15 mm, Ref. No. R.320.

The left-hand driveshaft is extended to accommodate an additional fan situated in the cowling which is an extension of the primary drive chaincase. A seal to prevent escape of lubricating oil into the cowling is provided.

The Villers flywheel magneto fitted to the Marks 2T and 3T motor cycle unit is replaced by the Siba " Dynastart " unit, Type AZL tX12/90-1200R, which includes two contact breaker assemblies, arranged for *uni-directional* rotation only.

Instructions for point setting and ignition timing are given under their respective headings.

DECARBONISING

The instructions given on page 6 will apply when the cowling surrounding the cylinders has been removed in order to expose the heads of the cylinder head bolts. If, however, the unit is to be completely dismantled, the removal of cylinders, pistons, etc. should be left until the gearbox with attachments has been detached from the crankcase assembly.

DISMANTLING

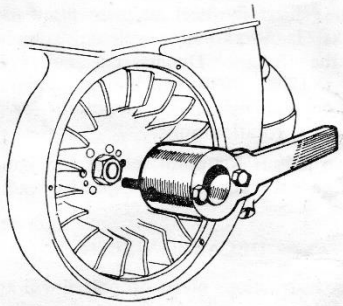
Engine Cowling

Full engine cowling is supplied by Villiers where the unit is built to the standard specification No. 595B, which includes the left and right-hand cowl top, the cowl centre, and cowl bottom plate. Some engine specifications do not call for the aforementioned cowl components, these being provided by the scooter manufacturers who also arrange for the mounting of the ignition coils.

The cowl components adopted by various scooter makers vary in design, but the method of fixing to both the left and right-hand cowl bottoms is the same for all units. Having removed the top portion of engine cowling proceed as follows:—

OUTER CHAINCASE AND LEFT-HAND COVER

This component, which is also the cowl bottom, cannot be detached until the fan has been withdrawn from the left-hand driveshaft. To do this, first remove cover plate held by three cheese-headed screws and shakeproof washers. Next attach the body of the extractor ST.2263, Fig. 15, to the face of fan, fitting the two ¼″ B.S.F. screws in the tapped holes provided. With the extractor use a torque spanner with a ½″ whit. (.820″ hex.) socket, turning anti-clockwise to release nuts securing fan to driveshaft.



Fan Extractor ST 2263 Fig. 15

After removal of fan fixing nuts, use extractor ST.2587D (Fig. 5) to pull fan off driveshaft. The chaincase cover will come away after removal of three countersunk headed screws on the outside, two ditto and one ¼″ nut on the inside of cover. Do not disturb the oil seal adaptor unless necessary to replace the oil seal, in which case the four securing nuts should not be tightened until the cover is re-assembled.

Chaincase, Inner Half

This is located on crankcase spigot and secured by three nuts and washers where a sprocket having 20 teeth is fitted. For the Mark 3TSF unit a 25 tooth engine sprocket is normally fitted, and to give the necessary chain-clearance a stud with nut and washer is fitted in the front hole only. Hexagon headed screws are fitted in the other two holes. The chaincase is also secured by two countersunk headed screws to the gearbox casing.

Before the chaincase can be pulled away it is, of course, necessary to remove the clutch, primary chain, engine sprocket, etc., the procedure being exactly as for the motor cycle Mark 2T unit.

Right-Hand Cover

This is secured to the cowl bottom by three hexagon headed screws. The cover which is a spigotted fit and is positioned by a dowel can be removed without disturbing the contact breakers, but it will be necessary to disconnect the black and red leads from the switch box, terminals A, DF & D, and also to loosen the cable clip if it is intended to completely dismantle the Siba " Dynastart " unit. The rotor and fan, however, can be withdrawn without disturbing the cowl bottom.

Ignition Cam and Rotor

The flange of the cam fits a recess in face of rotor and is secured by two cheeseheaded screws. The cam is correctly positioned by a slot in the flange, mating with a dowel. The cam is marked on flange F.C.H.X/1.

The fan is a spigot fit on rotor, is held by four countersunk headed screws, and can be pulled off spigot by using two ¼″ whit set screws in the tapped holes provided. The rotor is keyed to the tapered driveshaft and is secured by a hexagon nut. For removal of nut use a $\frac{7}{16}$″ tubular box spanner such as the " Britool " No. 5120, or, alternatively, a torque spanner which is necessary when refitting the rotor. To prevent the rotor turning a tool is available, which is secured to the face of rotor by two screws. With this tool, Ref. ST.1687A, Fig. 16, in position, the rotor is withdrawn from driveshaft using an extractor SST.1565D, Fig. 17. The body of this extractor screws into the centre hole in rotor, and turning the centre screw clockwise will draw the rotor forward. Having removed the rotor, blow out any carbon dust from inside and place on a clean surface with inside facing upwards. Be careful not to damage the windings.

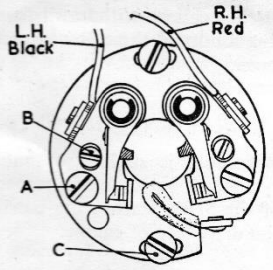
would do the job, two pairs are used to distribute the load. They are set precisely to get the best result and the brushes should be dealt with one at a time, so that the holder assemblies are never completely removed and the maker's original setting lost. All brush cable connections must lie against the stator windings in order to clear the rotor. Examine the oil seal in centre hole and replace if the lip is damaged. Before placing the stator assembly in position on driveshaft, clean the mating surfaces (bottom of stator well and end of crankcase) and coat with "Wellseal" compound to prevent leakage from crankcase. Also coat the heads of the three socket-headed screws and after fitting new shakeproof washers tighten diagonally. Next fit the woodruffe key in driveshaft and after cleaning with petrol the taper shaft, and hole in rotor, fit rotor and tighten the hexagon centre nut finger-tight only. Turn rotor by hand to make certain nothing is fouling and if the key is correctly fitted the rotor should run true. The centre nut can now be tightened, using a torque spanner set at 750 lbs/ins., the rotor being held by the tool Ref. ST.1687A, Fig. 16. The cam with flange can now be fitted to front of rotor. The flange fits in a recess, is located by a dowel and is secured by two cheese-headed screws. The cam flange is marked with the letters FCHX/I., and replaces the cam FCDX which was fitted to earlier units and for which the contact gap setting was .014″/.016″. When ordering replacement cam, specify reference FCHX/1 and set contact points to give a gap of .020″/.022″. (See later paragraph dealing with ignition timing).

Right-Hand Cover and Contact Breaker

The cover is a spigot fit in cowl bottom and secured by three screws unequally spaced to ensure cover being fitted correctly. The contact breaker base is also a spigot fit in cover to ensure concentricity with driveshaft and should be fitted with oil pad underneath the cam with the base fixing screws at top and bottom. The base, complete with two rocker arms, point brackets, etc., carried Ref. No. CB/f/12 on baseplate and is illustrated in Fig. 18. The brackets are secured to the base by the screws (A), the screws (B) are for adjustment of point gap. To widen gap turn left-hand screw (black cable) anti-clockwise and right-hand screw (red cable) clockwise. Screws (C) secure the base to the cover.

Point Setting and Ignition Timing

For engines running in one direction (uni-directional) only, it is usual to set the ignition timing to suit the right-hand (red cable) cylinder only. When this has been done the timing for the left-hand cylinder can be taken as correct. Timing is more easily carried out if the cylinder heads and gaskets are not fitted. Turn crankshaft clockwise until right-hand piston (magneto side) is at top of stroke. Release right-hand screw (A) and using a screwdriver turn screw (B) to give a point gap of .020″/.022″. Tighten screw (A) and then turn crankshaft to bring left-hand piston to top of stroke. Check point gap as for right-hand piston and tighten screw (A). Now turn crankshaft to bring right-hand piston $\frac{3}{16}$″ (.172″/.202″) BEFORE top dead centre, *not* top of cylinder bore. The depth of the step from top of piston, when at top of stroke, to top of cylinder bore should be added to the $\frac{3}{16}$″ dimension if it is desired to use the top face of cylinder as the datum line for checking the ignition timing. With the piston positioned as described the right-hand rocker arm points should be commencing to break. If this is not the case, release screws (C) and turn base-plate until points commence to break. Moving base-plate clockwise retards the ignition and vice versa. When base-plate has been correctly positioned, tighten the two screws (C), then check both point gap and timing. The oiling pad if dry should have one or two drops of oil applied at the lower end. Ensure that the pad touches the cam. Apply Secotine to joint faces of a new paper washer before fitting contact breaker cover.



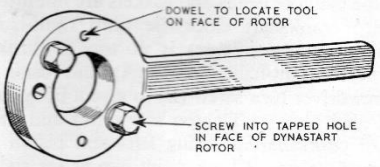
Contact Breaker Assembly Fig. 18

MK. 3TSFR UNIT (LIGHT CARS)

Technical data is generally as for the Mk. 3TSF scooter unit already dealt with. Differences exist, however, in respect to crankshaft

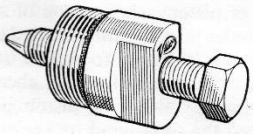
Stator

The stator is fixed to crankcase by three " Allen " socket-headed screws with " shake-proof " washers, but before undoing these remove the woodruffe key from crankshaft to avoid damage to oil seal in bore of stator.



Rotor Holding Tool ST 1687A

Fig. 16



Rotor Extractor SST 1565D

Fig. 17

The stator should be removed only when it is necessary to split the crankcase, or if oil leakage calls for a new seal to be fitted.

The procedure for dismantling crankcase is the same as for the motor cycle unit. There is, however, an extra roller bearing on the starter side, the bearing outer race being located by a circlip in the crankcase extension. The bearing inner race can be withdrawn from driveshaft using a normal three jaw extractor with centre screw.

REBUILDING THE UNIT

The procedure is similar to that for the motor cycle unit, but differs in respect of the fitting of the SIBA starter, the cowling, and the fan on drive side of engine.

Driveshaft and Crankcase Assembly

This is similar to the standard Mark 2T unit, but as previously mentioned the right-hand driveshaft is extended to suit the SIBA starter and the left-hand driveshaft is longer to accommodate the additional fan.

Gearbox and Clutch

With the exception of the gearbox end cover, this is as fitted to the Mark 2T motor cycle unit. The kickstarter, however, is eliminated where the SIBA starter is fitted and therefore a modified end cover is called for.

Left-Hand Cover—Cowl Bottom

In the back of the cover at the engine end is fitted an oil seal adaptor and if this has been removed for the fitting of a replacement oil seal, the four fixing nuts should not be tightened until after the cover has been fitted. It is important that the lip of the seal is concentric with boss of engine sprocket which projects through the seal. Clearance holes in the adaptor flange allow for this adjustment. The seal must, of course, be fitted with the open side towards inside of cowling. Coat the joint faces of flange and cover with " Wellseal" compound to ensure oil-tight joint.

Fit woodruffe key in driveshaft, then fan and spring washer, followed by one of the two locknuts. Fit body of extractor ST.2263, Fig. 15, to face of fan boss and using torque spanner set at 750 lbs/ins., tighten individually the two locknuts. Afterwards fit cover plate.

Stator (Uni-Directional) and Rotor. (For reversible starter see page 25).

A certain amount of carbon dust off the brushes will be found in the windings of both the rotor and stator. This should be removed by compressed air after lightly brushing. After a very long period of service the commutator will probably require skimming to correct for wear. This is a job which should be entrusted to qualified electrical repairers or sent to Villiers Service Department. If the brushes are worn down to the shoulder they must be replaced by new ones. Each brush is complete with spring and cable, but are not interchangeable. The two bottom brushes have their cables coming from right and left respectively and the cables are earthed to the stator by means of the screws provided. The upper pair of brushes, nearest the output cables, have the holder screws painted red and are insulated from the stator. The holes in the eyelets are larger to fit over the insulating bushes and insulating washers are fitted each side of eyelet. Although one brush, top and bottom,

bearings, speedometer drive from gearbox, type of carburetter with air cleaner and the "SIBA" starter unit. On the left-hand driveshaft, in place of the usual ball bearing is fitted a roller thrust bearing, reference R.125F, the loose thrust washer being on the outside, and against this washer fits the distance piece followed by the engine sprocket.

The four-speed gearbox gives the standard wide ratios of 1, 1.4, 2.02 and 3.6-1, but there is in service a number of units having a first gear ratio of 4-1. The speedo drive casing is attached to the gearbox, the drive being by a gear wheel meshing with the fixed pinion on the gearbox layshaft.

Power output is raised by fitting the larger Type S.25/3 carburetter having a 25 mm dia. choke. In place of the normal air cleaner and cover is fitted a combined air cleaner and silencer. The two dowels for the cover are replaced by studs which secure the air baffle plate. Apart from being larger, the carburetter is similar in design and construction to the Type S.22/ fitted to the Mk. 2T unit.

The "SIBA" Dynastart unit, Type AZL hx12/90-1200RL, includes two contact breakers on one baseplate, arranged for forward and reverse rotation, together with the necessary switch-gear box and ignition starter-switch.

Stator (Reversible)

The difference between this and the uni-directional rotor is that all the brush holders are insulated from the stator frame and holder securing screws. Care must be taken to ensure that the insulating bushes and washers are in good condition and that they are correctly replaced. It is very important that the screw heads do not make contact with the brush cables, and that the brushes should be dealt with one at a time so that the holder assemblies are never completely removed and the maker's original setting lost.

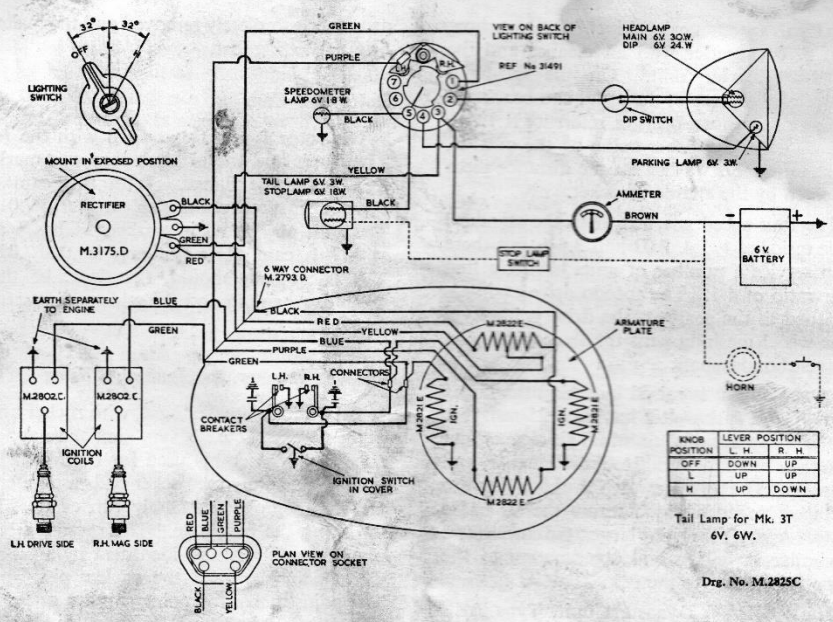
Rotor and Cam

The rotor is exactly as used with the Mk. 2TSF unit and the original cam was marked FCHX on the flange. With this cam the contact breaker point gap was .014″/.016″. The cam now fitted is marked FCHX/1 and with this cam the point gap is .020″/.022″. The latest cam should, therefore, be fitted when overhauling and the wider point setting adopted.

Contact Breaker and Ignition Timing

The contact breaker base, with rocker arms, point brackets, etc., is very similar in appearance to the assembly used for the Mk. 2TSF unit, but actually the rocker pads are different and the complete assembly carries Ref. No. ZUh8 on the baseplate. The reversing baseplate assembly is also identified by a blob of white paint between the rocker pivot pins. The adjustments for point gap are as for the uni-directional contact breakers, but for the reversing unit the method of timing is different.

After having adjusted each bracket to give a point opening of .020″/.022″, adjust the baseplate position so that the contact points of the right-hand rocker arm commence to open when the right-hand piston is .172″/.202″ *before* top dead centre with crankshaft rotating *clockwise*, looking at starter side. To time the ignition for reverse rotation, turn crankshaft *anti-clockwise* until the *right-hand* piston is .090″/.218″ *before* top dead centre. The points of the *left-hand* rocker should then be commencing to open. If the position of piston is found to be outside the tolerances given the baseplate should be adjusted to suit, but it is important that the tolerances for forward running are not exceeded.



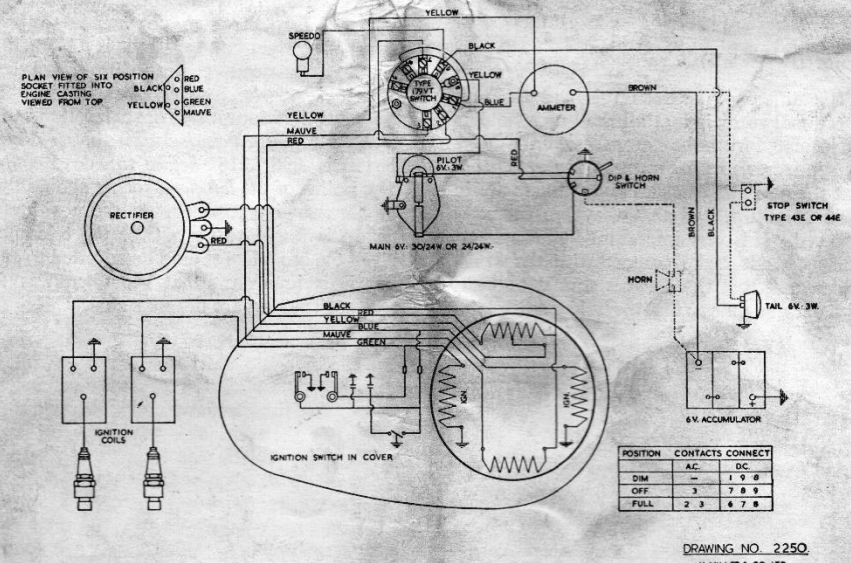
KNOB POSITION	LEVER POSITION L.H.	R.H.
OFF	DOWN	UP
L	UP	UP
H	UP	DOWN

Tail Lamp for Mk. 3T 6V. 6W.

Drg. No. M.2825C

MK 2T & 3T " Lucas " Lighting Set **Fig. 19**

Type 69/Twin Wiring Diagram No. 2250.



POSITION	CONTACTS CONNECT A.C.	D.C.
DIM	—	1 9 8
OFF	3	7 8 9
FULL	2 3	6 7 8

DRAWING NO. 2250
H. MILLER & CO. LTD.

MK 2T & 3T " Miller " Lighting Set **Fig. 20**

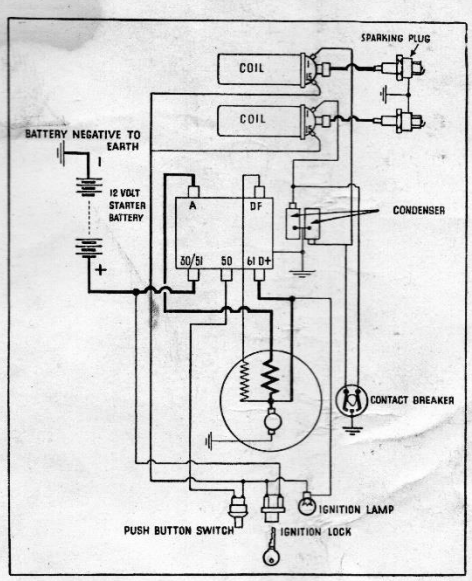
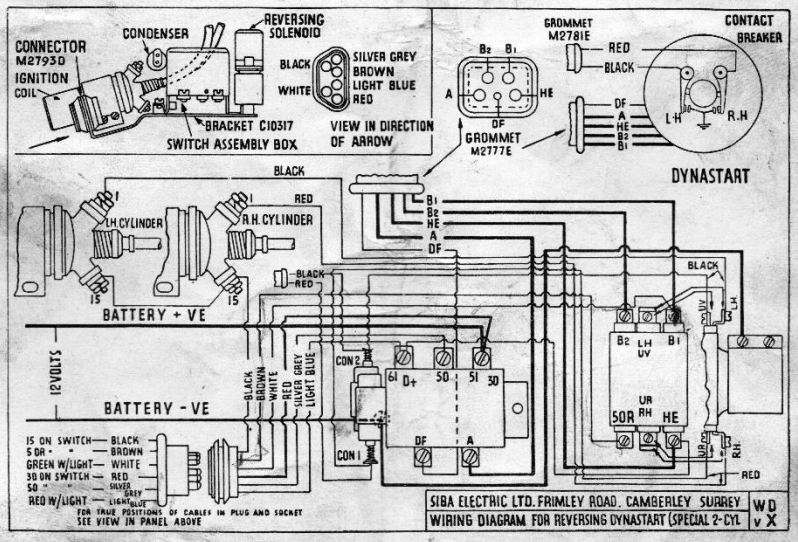


Fig. 21

MK STSF Wiring Diagram "Siba" Undirectional Dynastart



MK 3TSFR Wiring Diagram. "Siba" Reversing Dynastart **Fig. 22**

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