



INSTRUCTION MANUAL

ROYAL STAR
FIREBIRD SCRAMBLER
LIGHTNING
THUNDERBOLT
SPITFIRE Mk. IV SPECIAL

MODEL A50.R
MODEL A65.FS
MODEL A65.L
MODEL A65.T
MODEL A65.S

Instruction Manual

for



500cc ROYAL STAR A50.R

650cc LIGHTNING A65.L

650cc SPITFIRE Mk. IV SPECIAL A65.SP

650cc FIREBIRD SCRAMBLER A65.FS

650cc THUNDERBOLT A65.T

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This Instruction Manual is intended to acquaint the B.S.A. owner with details of the controls, general maintenance and technical data which may be required for normal operation of the machine.

It does not contain the information necessary to carry out stripping for major overhauls, but if any owner feels competent to carry out this type of work, a comprehensive Service Manual and an illustrated Spares Catalogue can be obtained from his B.S.A. spares stockist or local dealer.

Owners in the British Isles can obtain these publications direct from B.S.A. Motor Cycles Ltd., Service Department, Birmingham 11. Always quote full engine and frame numbers when ordering.

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TECHNICAL DATA

Engine Number	On left side of crankcase below cylinder base.				
Frame Number	...	...	On left side of front engine lug.				
			Royal Star	Lightning	Thunder- bolt	Firebird Scrambler	Spitfire Mk. IV Special
ENGINE DETAILS:							
Bore (mm.)	...	...	65.5	75	75	75	75
Stroke (mm.)	...	...	74	74	74	74	74
Capacity (c.c.)	...	...	499	654	654	654	654
Capacity (cu. in.)	...	...	30.5	40	40	40	40
Valve clearance:							
inlet (in.)	...	...	.008	.008	.008	.008	.008
exhaust (in.)	...	...	.010	.010	.010	.010	.010
Valve timing with .015 clearance:							
inlet							
opens b.t.d.c.	...	...	40	51	51	51	51
closes a.t.d.c.	...	...	60	68	68	68	68
exhaust—							
opens b.b.d.c.	...	...	65	78	78	78	78
closes b.t.d.c.	...	...	35	37	37	37	37
Compression ratio	...	...	9.0	9.0	9.0	10	9.0
ELECTRICAL:							
Ignition timing, (degrees, fully advanced)			34	34	34	34	34
Contact points gap (in.)	...	...	.015	.015	.015	.015	.015
Sparking plugs:							
Champion type	...	...	N.4	N.3	N.4	N.3	N.3
gap (in.)	...	...	.020/.025	.020/.025	.025/.025	.020/.025	.020/.025
Battery capacity (a.h.)	...	...	10	10	10	—	10
TRANSMISSION:							
Engine sprocket	...	...	28T	28T	28T	28T	28T
Clutch chainwheel	...	...	58T	58T	58T	58T	58T
Gear ratios	...	...			(see page 00)		
Clutch friction plates	...	...	6	6	6	6	6
Chains (front)	...	...			3/8 in. pitch triple		
Chains (rear)	...	...			5/8 in. pitch × 3/8 in.		
WHEELS:							
Front brake	...	...		8 in. dia. (2 leading-shoe, except on Royal Star and Thunderbolt)			
Rear brake	...	...		7 in. dia. × 1 1/8 in. wide			
Front tyre and pressure	...	...	3.25–19	Ribbed, 23 p.s.i.; 3.50–19 K70, 23 p.s.i.; 4.00–19 K70, 21 p.s.i.			
Rear tyre and pressure	...	...		4.00–18 K70, 21 p.s.i.			

TECHNICAL DATA—(continued)

	Royal Star	Lightning	Thunder- bolt	Firebird Scrambler	Spitfire Mk. IV Special
CAPACITIES:					
Fuel tank (gallons) ...	4 or 3	4 or 3	4 or 3	2	2 or 5
Fuel tank (litres) ...	18 or 13.5	18 or 13.5	18 or 13.5	9	9 or 22.5
Oil tank (pints) ...	5	5	5	5	5
Oil tank (litres) ...	3	3	3	3	3
Gearbox (pints) ...	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{7}{8}$
Gearbox (litres) ...	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
Primary chaincase (pints)	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$
Primary chaincase (c.c.)	140	140	140	140	140
Front forks (pints) ...	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	$\frac{1}{3}$
Front forks (c.c.) ...	200	200	200	200	200
CARBURATION:					
Carburettor type ...	626	930	928	930	932
Carburettor bore (mm.)...	26	30	28	30	32
Carburettor main jet ...	200	190	230	190	190
Carburettor pilot jet ...	25	20	20	25	20
Throttle valve ...	$3\frac{1}{2}$	$2\frac{1}{2}$	$3\frac{1}{2}$	$2\frac{1}{2}$	3
Needle position ...	2	2	1	3	2
Needle jet ...	.106	.106	.106	.106	.107
GENERAL DETAILS:					
Overall length, (in.) ...	$85\frac{1}{4}$	$85\frac{1}{4}$	$85\frac{1}{4}$	85	$85\frac{1}{4}$
(cm.) ...	216.5	216.5	216.5	216	216.5
Wheelbase (in.) ...	56	56	56	56	56
(cm.) ...	142	142	142	142	142
Ground clearance, below engine—unladen (in.) ...	8	8	8	$7\frac{1}{2}$	8
(cm.) ...	20.2	20.2	20.2	19	20.2
Seat height—unladen (in.)	32	32	32	32	32
(cm.) ...	81.3	81.3	81.3	81.3	81.3
Overall height—Western handlebars (in.) ...	44	44	44	44	44
(cm.) ...	111.7	111.7	111.7	111.7	111.7
Overall height—Standard handlebars (in.) ...	$40\frac{1}{2}$	$40\frac{1}{2}$	$40\frac{1}{2}$	$40\frac{1}{2}$	$40\frac{1}{2}$
(cm.) ...	103	103	103	103	103
Weight (lbs.) ...	391	391	391	386	384
(Kg.) ...	4 gal. tank 177	4 gal. tank 177	4 gal. tank 177	175	173.5

TAKING OVER THE MACHINE

Before running the machine make sure that the oil tank, gearbox, primary chaincase and front forks are properly topped-up with oil and that the battery is filled and charged (see appropriate chapters for filling instructions). Normally these preparations will be carried out by the dealer who is selling the machine and the new owner has only to arrange the controls to his liking and the machine is ready for the road.

FUELS

For engines with a compression ratio of 10 it is essential to use 100 octane petrol (gasoline).

Fuels containing alcohol must not be used in fibre-glass tanks.

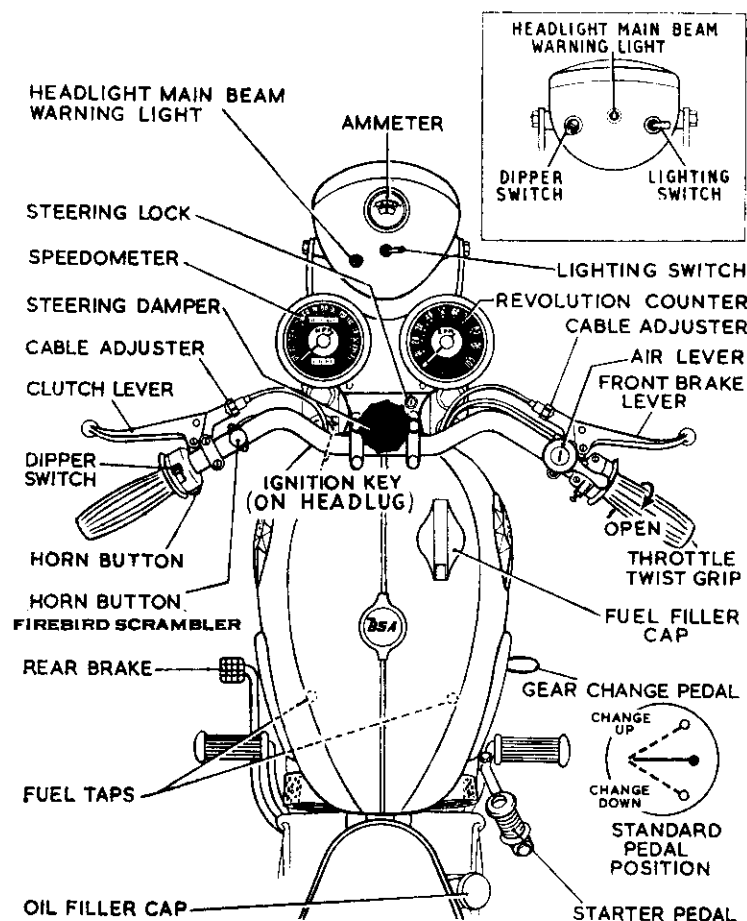


FIG. 1. The controls (specification details vary according to model).

The new rider should make sure that he is quite familiar with all the controls before attempting to ride the machine. Most of the controls are adjustable and should be positioned so that they can be reached without moving the hands from the grips or the feet from the footrests. Handlebars and footrests should be adjusted so that a comfortable and natural riding position is achieved. The handlebars are clamped to the fork yoke at their centre, and can be adjusted for position after the bolts have been slackened. Make sure that these bolts are tight after completing the adjustment. The footrests are mounted on taper lugs and after the nuts have been removed, can be set in the desired position. Note that the nut on the left footrest has a left-hand thread and must therefore be turned in a clockwise direction to unscrew it. After any adjustment is completed, reset the brake pedal stop so that the pedal is situated comfortably below the foot.

It is well worth while spending some time in setting both handlebars and footrests correctly, because badly positioned controls cause poor control of the machine and bring discomfort on long journeys.

HANDLEBAR CONTROLS:

Throttle Twist Grip:—Mounted on the right handlebar, it controls the throttle opening and consequently the engine speed. To open the throttle (i.e., to increase engine speed) turn the grip so that the top moves towards the rider. Excess slackness in the cables can be removed by means of an adjuster incorporated in each cable at the carburetter (twin carburetter models) or mid-way on the cable (single carburetter models).

The rotary stiffness of the twist grip can be varied by means of the adjuster screw and locknut. It is set for average requirements when leaving the factory, but can be re-adjusted to suit individual preference.

Front Brake:—The lever is mounted on the right handlebar in front of the throttle control. Grip the lever gently to operate the brake. Finger adjustment for the cable is provided at the adaptor on the lever.

An additional adjuster is provided at the brake plate on *Thunderbolt* and *Royal Star* models.

Air Control (Carburetter):—Situating immediately above the front brake lever, and controls the amount of air admitted to the carburetter (see starting instructions, page 9).

When closed (moved away from rider) a rich mixture is provided for cold starting purposes. For normal running, the lever should be turned clockwise as far as possible. Cable adjustment is provided mid-way in the cable.

Clutch:—The lever is mounted on the left handlebar. Grip the lever to free the clutch, i.e., disengage the drive between the engine and the rear wheel. Finger adjustment for the clutch cable is provided at the adaptor on the lever.

Headlight Dipper Switch:—Incorporated in an annular housing at the left handlebar grip. Switches from main to dipped headlight beam as required. The housing can be adjusted for position after releasing the locking screw.

Firebird Scrambler only—a push-button dipper switch is mounted on the top of the headlight (left-side).

Horn Button:—Mounted in the same housing as the headlight dipper switch.

Firebird Scrambler only—an independent horn button is attached to the left handlebar.

OTHER HAND CONTROLS:

Fuel Taps:—These are located under the rear end of the tank, one on each side. To turn on the petrol, pull out the knurled button and lock in position by turning anti-clockwise. Both taps communicate with the main supply in the tank, but if one tap only is used, a reserve supply remains which can be fed to the carburetter when the second tap is turned on.

Lighting Switch:—The three positions of the switch are: (a) all lights off; (b) pilot, tail, and instrument lights on; (c) head, tail and instrument lights on, with the separate switch on the handlebar controlling the main and dipped headlight beams.

In all switch positions, the charging rate from the alternator varies with the condition of the battery, decreasing as the battery becomes fully charged and vice versa.

Firebird Scrambler only—the main and dipped headlight beams are controlled by a push-button switch on top of the headlight (right-side).

Ignition Switch:—This is operated by a detachable key, which when in the anti-clockwise position, switches off the ignition and can be withdrawn. Always place in this position when the engine is stationary and remove the key when leaving the machine. Turn the key to the clockwise position to switch on the ignition and leave in this position when the engine is running. The switch is located on the left side of the steering head.

Tickler (Carburetter):—Each carburetter float chamber is fitted with a spring-loaded plunger which, when depressed, prevents the float from rising, thus rapidly replenishing the level of fuel in the chamber. The plunger (or tickler) should be used for a brief interval only, otherwise the level of fuel in the float chamber will rise excessively, resulting in flooding of the carburetter, and loss of fuel (see starting instructions, page 9).

Steering Lock:—Carried in the top fork yoke. To operate the lock, turn the handlebars to the left, then turn the key in the lock to release the plunger, which registers in a special lug on the frame. The machine cannot then be driven or wheeled away.

Steering Damper:—This is situated above the steering column at the centre of the handlebars, and tightening down the knob increases the damping action. At high speeds, or when a sidecar is fitted, the damper should be tightened slightly and adjusted to requirements.

FOOT CONTROLS:

Gearchanging Pedal:—Operated by the right foot, the gearchange mechanism is of the positive stop type and, following a change of gear, the lever returns to its central position as soon as foot pressure is released.

Neutral position is between first and second gears and downward movement of the lever selects a lower gear, while an upward movement selects a

higher one. The pedal can be re-positioned ———— by means of a pinch bolt.

Starter Pedal:—This is on the right side of the machine and depression of the pedal rotates the engine.

Rear Brake Pedal:—Operated by the left foot. The pedal is equipped with an adjustable stop which should be set so that the pedal pad lies comfortably below the foot, ready for instant use. Any adjustment of this pedal position may require re-adjustment of the rear brake.

Stop Light Switch:—Actuated by an extension from the brake pedal and concealed behind the left side panel, this switch controls the stop-light in the tail lamp. Whenever the brake pedal is adjusted, check that the switch still functions and if necessary, re-position the extension arm slightly to ensure this condition.

INSTRUMENTS (according to specification):

Speedometer:—The "trip" mileage can be reset to zero by rotation of the control knob on the side of the instrument.

Revolution Counter:—Driven from the engine mainshaft this records the engine revolutions per minute.

Ammeter:—This instrument indicates the charging rate from the alternator or the discharge rate from the battery. The rates are shown as (+) i.e., charge, or (—) i.e., discharge.

DRIVING

TO START THE ENGINE

Stand astride the machine and make sure that the gears are in the neutral position, which lies between the first and second gears. If there is any doubt about this depress the gearchange pedal fully two or three times to engage successively lower gears, at the same time easing the machine backwards and forwards to allow the gears to rotate a little, and so facilitate gear engagement. When it is certain that first gear is obtained, raise the pedal through half of its normal stroke, so selecting the neutral position. Should the machine be in gear it will move forward as the starter pedal is depressed.

Turn on the petrol and if the engine is quite cold, depress the carburetter tickler(s) momentarily. Note that it is neither necessary nor desirable to oscillate the tickler(s) rapidly, as this may damage the float(s). Close the air control lever, thus giving a rich mixture for starting.

Switch on the ignition by turning the key in a clockwise direction, see Fig. 1. Open the twist grip a small amount only, as excessive opening may prevent easy starting, and push down the starter pedal slowly, until resistance is felt; then, without releasing the pressure on the pedal, give a firm downward swing which should set the engine in motion. If the engine fails to start at the first attempt, repeat this procedure, being careful to avoid rapid kicking at the pedal which will serve no purpose and may damage the operating mechanism. The ignition control is set automatically in the retarded position for starting, and advances as the engine speeds up.

Note that while it is necessary to use the air control lever when starting

from cold, this should not be necessary when the engine is warm, and should certainly not be so if a restart is made after a short wait only. On certain occasions, such as when the engine is not fully warmed up, or when it has cooled down a little during a temporary halt, it may be necessary for the engine to be only partially choked, when the lever should be set in its mid-way position, and the rider is advised to study this point. When starting with a warm engine, and during normal running, the lever should be set in its fully open position, so that the carburettor air slides are also kept fully open.

ENGAGING FIRST GEAR

With the engine running slowly, disengage the clutch by gripping the left handlebar lever and after a brief interval press down the gearchange pedal as far as it will go, so selecting first gear. If the pedal will not move through its full travel, so that the gear does not engage, ease the machine backwards or forwards slightly, maintaining a light pressure on the pedal, until the gear is felt to engage.

MOVING OFF

Open the throttle slightly, and gently release the clutch lever part way, until the clutch can be felt to take up the drive, and the machine tends to move forward. Open the throttle a little more to prevent the possibility of stalling the engine, and slowly release the clutch lever as the machine moves away. Until the lever is completely released the clutch is not fully engaged, so that the engine should not be speeded up excessively or the clutch remain partly engaged, for longer than is necessary to get the machine away in first gear.

CHANGING GEAR (UP)

When the machine is moving steadily with the clutch fully engaged, the next operation is to engage second gear. Close the throttle, disengage the clutch, and raise the gearchange pedal as far as it will go, the three movements being performed simultaneously. Immediately the gear is felt to engage, re-open the throttle and re-engage the clutch.

CHANGING GEAR (DOWN)

Disengage the clutch, open the throttle slightly and press the gearchange pedal down as far as it will go. Re-engage the clutch as soon as the gear is felt to engage. Violent pressure on the gear lever is unnecessary, a steady movement of the pedal being most effective.

NOTES ON GEARCHANGING

When changing gear, not only should a suitable road speed be selected at which to perform the operation, but the gearchange should be timed in such a way that the relative speeds of the engine and gearbox coincide as closely as possible.

For this reason, when changing up, the throttle is momentarily closed when disengaging the clutch, so removing the power drive from the gearbox, allowing it to slow down to the slower speed at which it will operate in the next higher gear.

When changing to a lower gear, the engine speed has to be increased relative to the gearbox speed, and the throttle should not therefore be closed, but even opened slightly, while making the change. As soon as the clutch lever is gripped, the engine will automatically increase in speed, so that the lower gear will engage quietly at the correct speed.

Changing gear, therefore, whilst appearing complicated, is mainly concerned with the synchronization of engine speed and road speed, by co-ordination of hand and foot operations. After a little practice, smooth and quiet gear-changes will be possible at all times, and eventually become a purely automatic action.

USING THE GEARBOX

Correct use of the gearbox must be made in order to obtain best results in all-round performance, especially with regard to acceleration and hill climbing capabilities (particularly motor-cycles fitted with a sidecar) and to the attainment of maximum speeds by sports models.

It is not always appreciated that the power delivered by an internal combustion engine depends upon engine speed. Hence, on a machine travelling uphill, the engine speed will fall as a result of the increased load, with a corresponding fall in power output. In order to maintain sufficient power, a lower gear must be selected in order to increase the engine speed and so obtain more power.

Similarly, for good acceleration from moderate speeds in top gear, more power is required and, here again, the solution is to change down to a lower gear. It is better to allow the engine to "rev" in a lower gear than to labour in a higher one.

It follows that the engine speed must be kept high in order to develop maximum power and this means that for maximum acceleration and maximum speed, the engine must be driven up to peak r.p.m. in the gears. In particular, to attain maximum speed, it is essential to obtain peak r.p.m. in third gear, before changing into top gear.

NOTE:—Maximum safe r.p.m. for all models — 7,250

TO STOP THE ENGINE

Select the neutral gear position and close the throttle, so reducing the engine speed to "tick-over". Turn the ignition switch to the "off" position.

RUNNING-IN

The rider who has just purchased a new machine will do well to remember that all the internal parts are just as new as the enamel and plating which can be seen, and they must be well "run-in" before the engine can be given any really hard work.

The "running-in" process is the most important period in the life of the engine, and the handling it receives during the first 1,000 to 1,500 miles will determine the service it will provide in return.

Running-in should commence at one-third to half-throttle, and for the first 500 miles the speeds should not exceed those given on the "running-in" label. Thereafter the throttle opening may be progressively increased as the mileage builds up, until at the end of the running-in period full throttle can be employed.

If excessive speeds are used in the early stages, there is risk of seizure and other troubles, and in any case, until the machine has been properly run-in, it cannot be expected to give its best performance.

Smooth throttle control and selection of the correct gear for the prevailing conditions will ease the work of the engine. In particular, avoid violent acceleration, and do not allow the engine to labour on hills in a high gear, when a change to a lower gear would ease the load. This ensures that all parts of the machine are properly run-in and are quite free.

When running-in is completed, balance the wheels (see page 47).

Do not let the oil level in the tank fall below the minimum mark, as economy in oil may prove very expensive at a later date and running consistently with the level too low may cause the oil to become unduly hot. It must be remembered that the oil cools as well as lubricates, and a new engine tends to run a little hotter than one that is well run-in. After the first 250 miles, and again at 500 miles, drain and refill the oil tank with fresh oil and clean the filters. The correct grades of oil are given in the lubrication chart. The oil in the gearbox should also be changed after the first 500 miles.

Further oil changes should be carried out in accordance with the instructions under "Routine Lubrication" page 14.

During the running-in period it is advisable to check the various adjustments such as valve clearances, contact breaker gaps, clutch adjustment, etc., rather more frequently than usual, and to check the tightness of all nuts and bolts to make sure that the initial bedding-down does not loosen any components.

ROUTINE MAINTENANCE

NOTE:—It is important that, after the specified mileage, the machine is returned to your B.S.A. dealer for inspection in accordance with the details given on the Guarantee Registration card.

Subsequently the following list of items requiring attention will serve as a guide as to when maintenance should be carried out. The method of carrying out the various adjustments will be found under the appropriate headings in the later chapters. The mileage figures quoted are based on normal road work but for machines used for competition purposes, the periods between servicing should generally be reduced.

Whenever any work is carried out on the machine, attention to detail and scrupulous cleanliness must be observed. All joints must be clean and gaskets in good condition before reassembly. Threads must be kept clean and free from grit, and exposed threads should be oiled or greased before assembly. Good fitting spanners should be used at all times and nuts must be tightened firmly, but spanners of greater than standard length should not be employed as they may cause failure through over-tightening.

Take care when cleaning the machine that dirt is not introduced into the carburettors, hubs, etc. Do not attempt to rub off any dirt or mud as this will damage the enamel or plating. Wash off any dirt with a copious supply of clean water, preferably from a hose. Any oily areas should be treated with a proprietary detergent before being hosed down. Dry the machine with a piece of clean rag and if possible clean it on a warm dry day so that all moisture is removed. Finally, polish with a good quality polish such as "Autobrite."

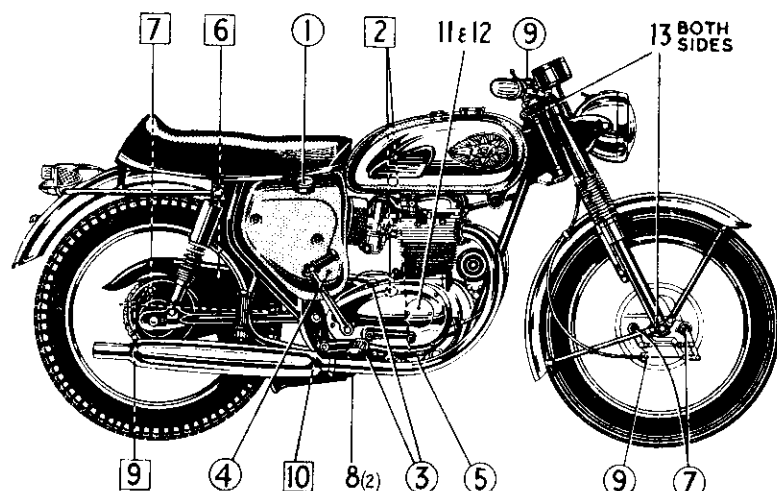
Every Week	Page
Examine battery acid level	49
Check brake adjustment	45
Check tyre pressures	4

Every 2,000 Miles	Page
Check and tighten all nuts and bolts	
Examine pump ball valve	18
Check valve clearances	18
Clean and adjust spark plugs	19
Check adjustment of primary chain	36
Check clutch operation	38
Check adjustment of rear chain	37
Check wheel alignment	38
Check adjustment of steering head	48
Check contact breaker points gap	23
Check lights	49
Clean air filter	20

Every 5,000 Miles	Page
Clean and adjust contact breaker points	49
Examine auto-advance unit	24

Every 10,000 Miles	Page
Examine brake linings, clean brake drums.	
Examine front fork for correct action	47
Check headlight beam setting	49
Examine rear suspension for correct action	48

As Required	Page
Ignition timing	21
Petrol tap filters.	



Figures within squares refer to the left side of the machine.

Figures within circles refer to the right side of the machine.

FIG. 2. Lubrication diagram (one front brake cam lever only is fitted to the Thunderbolt and Royal Star).

ROUTINE LUBRICATION

REF. NO.		Page
	Daily	
1	Check oil level in tank	17
	Every 1,000 Miles	
2	Check oil level in primary chaincase	35
	Every 2,000 Miles	
3	Check oil level in gearbox	33
4	Drain and refill the oil tank	16
4	Clean oil tank filter	16
5	Clean crankcase filter	17
6	Lubricate rear chain	37
7	Lubricate brake cam spindles (front and rear)	45
8	Grease central stand (two points).	
9	Lubricate exposed cables and joints (oil or grease).	
10	Lubricate brake pedal pivot (oil).	
11	Lubricate contact breaker cam	23
	Every 5,000 Miles	
12	Lubricate auto-advance mechanism	24
3	Drain and refill the gearbox	33
2	Drain and refill the primary chaincase	35
	Every 10,000 Miles	
13	Drain and refill the front forks	47

RECOMMENDED LUBRICANTS					
OILS				Front Forks and Primary Chaincase	GREASE
Engine			Gearbox		
Brand	Summer	Winter	All Year		
Mobiloil	BB	A	Mobilube GX 90	Arctic	Mobilgrease MP
Shell	X100-40	X100-30	Spirax 90 E.P.	X100-20	Retinax A
Castrol	XXL	XL	Hypoy 90 E.P.	Castrolite	Castrolase LM
Esso	Esso Motor Oil 40/50	Esso Motor Oil 20W/30	Esso Gear Oil 90 E.P.	Esso Motor Oil 20W/30	Esso Multi-purpose grease H
B.P. Energol	S.A.E. 40	S.A.E. 30	B.P. Gear Oil 90 E.P.	S.A.E. 20	Energrease L2
Regent	Havoline S.A.E. 40	Havoline S.A.E. 30	Multigrade Lubricant 90 E.P.	Havoline S.A.E. 20W	Marfak Multi-purpose 2

The grade of lubricant used depends to a certain extent on the use to which the machine is being put and the ambient temperature. The chart gives recommendations for conditions in temperate countries. In countries where the climatic conditions are extreme, some alteration may be necessary bearing in mind that the higher the temperature the higher is the S.A.E. number required.

All the above are mineral oils, but if it is desired to use vegetable oil then the engine and oil tank must be thoroughly cleaned out with flushing oil before changing over. In no circumstances must the two types of oil be mixed. If they are, a sludge will be formed which may damage the engine.

It is always advisable to make sure that the oil is warm before driving the engine hard. When taking part in competitive events advantage should be taken of any warming-up period to get the engine warm and the oil circulated.

RECOMMENDED ENGINE OILS FOR U.S.A. ONLY

Where B.S.A. engine oil is available, we recommend its use in B.S.A. motorcycles.

ENGINE

THE LUBRICATION SYSTEM

The lubrication system is of a dry sump type, i.e., the oil is contained in a

compartment remote from the engine. One set of gears in the double-gear pump, situated within the inner timing cover, draws oil from the tank through a gauze filter and delivers it under pressure past a non-return valve, to the timing side main bearing, big-end bearings, camshaft and other parts.

The oil then drains down through another gauze filter in the bottom of the crankcase (Fig. 4) to a small sump from which it is drawn by a second set of gears in the pump via the ball valve (Fig. 4), and returned to the tank. If the tank filler cap is removed whilst the engine is running, the returning oil should be seen issuing from the pipe (Fig. 3). The flow of oil will in all probability contain air bubbles, but this is a normal condition and is due to the larger capacity of the return pump. **If there is no flow from the pipe, stop the engine immediately, and investigate the cause (see "Pump Ball Valve", page 18.)**

The rocker mechanism is lubricated by means of a by-pass feed from the oil return pipe, the oil draining to the crankcase by way of passages in the cylinder block.

OIL TANK AND FILTER (FIG. 3.)

Access to the rubber-mounted oil tank is provided by removal of the panel on the right side of the machine. It is quickly detachable and is held in position by snap-fasteners.

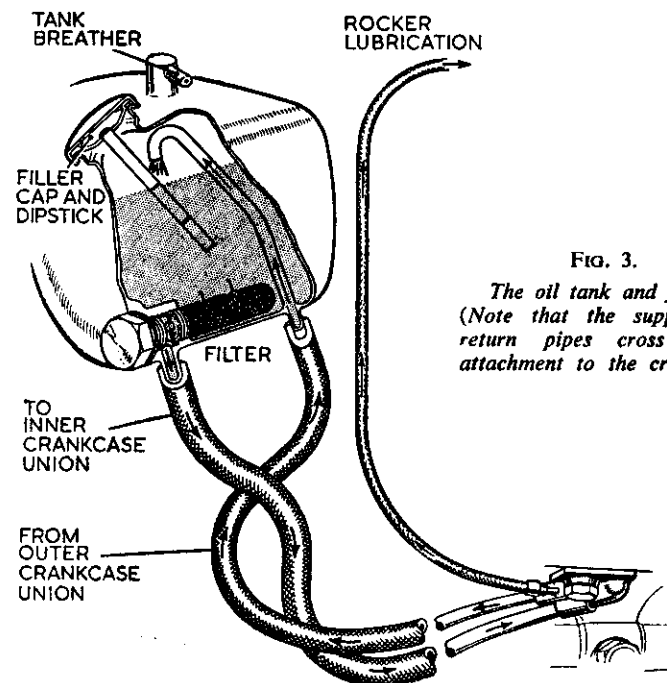


FIG. 3.

*The oil tank and filter.
(Note that the supply and return pipes cross before attachment to the crankcase.)*

Unscrew the filter, which is fitted in the 1 drain off the oil into a suitable receptacle, for which purpose it may be advisable to make a small chute of sheet metal or cardboard. Lean the machine to the right to drain off any remaining oil.

Wash the filter in petrol and before it is replaced make sure it is quite dry and that the "O" ring is intact. Tighten firmly to secure an oil-tight joint. Refit the panel in position, locking in position with the snap-fasteners.

NOTE:—The operation of draining the tank will be simplified if it is drained while the oil is still warm, and is therefore best carried out immediately after a run.

Refill the tank with engine oil in accordance with the recommendations contained in the lubrication chart (page 15).

The tank capacity is approximately 5 pints and the maximum and minimum oil levels are shown on the dipstick attached to the filler cap.

OIL PIPES

If at any time the oil pipes are disconnected it is essential that they are crossed over when reconnected, (i.e., the outer pipe from the tank is attached to the inner connection at the crankcase, Fig. 3).

CRANKCASE FILTER (FIG. 4)

This is integral with the small sump carried below the crankcase, and removal of four nuts and spring washers allows the filter to be withdrawn. Wash thoroughly in petrol and make sure that all the petrol has evaporated before

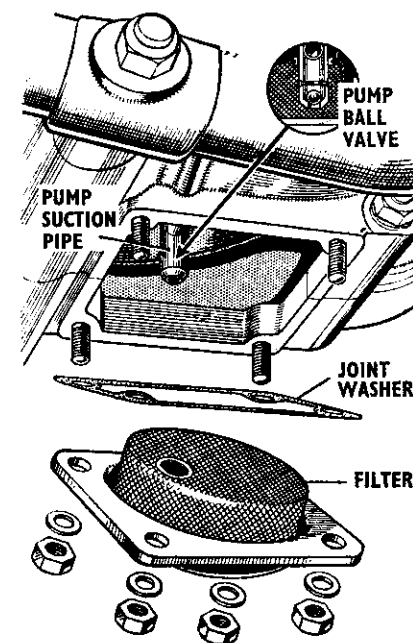


FIG. 4. Crankcase filter and pump ball valve.

replacing. Check also that the joint washer is in good condition, renewing if necessary, so that the joint is made oil-tight.

PUMP BALL VALVE (Fig. 4)

When the crankcase filter is removed, the end of the pump suction pipe is exposed. It carries a small ball which acts as a non-return valve, and it is advisable at this time to check that the ball is free on its seating by inserting a piece of wire into the valve orifice. If the ball adheres to its seating, there will not be a return flow of oil to the tank and the crankcase may become flooded. The returning oil can be seen issuing from the pipe if the oil tank filler cap is removed whilst the engine is running (see page 16). Alternatively, if the crankcase contains an excessive quantity of oil after, say an overnight stop (indicated by voluminous smoke from the exhaust when starting up), this may be due to the ball not seating properly, caused by a particle of foreign matter, so allowing oil to pass through the pump to the crankcase.

Following replacement of the crankcase filter, it will ensure immediate lubrication of internal parts if a small quantity of engine oil (say, half a pint) is added to the crankcase before starting the engine. This oil can be inserted through the timing plug aperture in the front of the crankcase (Fig. 8) or added to the rocker box, in which case ample time must be allowed for the oil to drain down into the crankcase. It will also be necessary to allow sufficient space in the oil tank to receive the additional quantity of oil.

OIL PRESSURE CONTROL VALVE

Mounted on the right side of the crankcase below the timing covers, this valve regulates the pressure in the lubricating system. It is pre-set during manufacture and should not need attention until such time as the engine is dismantled for overhaul, when the valve may also be dismantled in accordance with instructions given in the Workshop Manual.

VALVE CLEARANCES

It is necessary to remove the petrol tank in order to lift off the rocker cover, and thus expose the adjusting screws on the ends of the rocker arms.

Turn off the petrol taps, unscrew the pipe connections, and disconnect the strap beneath the front of the tank (fitted to steel tanks only). The latter is held in position by a captive bolt and nut, which is exposed when the rubber cap is removed. Unscrew the nut and note carefully the sequence in which the various components are withdrawn so that they can be re-assembled in the same manner, and remove the tank.

Next remove the high-tension leads and the sparking plugs, to enable the engine to be rotated easily without any resistance due to compression. Take off the rocker cover, taking care not to damage the gasket between the cover and cylinder head.

The valve clearance is measured by means of feeler gauges inserted between the valve stem and rocker adjusting screw (Fig. 5), and as the cams are of special design it is essential that the following procedure is adopted, otherwise the clearances are likely to be inaccurately measured. Rotate the engine slowly by means of the starter pedal until one inlet valve is fully open. This is the correct position for checking the inlet clearance on the other cylinder.

Rotate the engine again and adopt the same procedure for the two exhaust valves. Correct clearance, which in all cases should be checked or adjusted when the engine is quite cold, are: inlet .008 in.; exhaust .010 in. For competition purposes only, these figures can be increased to .010 in. and .012 in. for inlet and exhaust respectively.

If adjustment is found to be necessary, first slacken the locknut. The adjusting screw should then be screwed up or down until the gap between the end

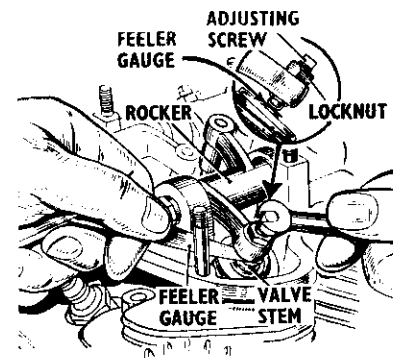


FIG. 5. Measuring the valve clearance.

of the valve stem and the screw is just sufficient for the appropriate feeler gauge to enter. Retain the adjuster in this position, and tighten the locknut securely against the rocker arm.

SPARK PLUGS

The sparking plug is of great importance to satisfactory engine performance and it is necessary that it should be the correct type and in good condition.

Champion plug types N.3 or N.4 are recommended according to model (see page 4).

For competition purposes suitable racing plugs should be fitted.

The condition of a sparking plug can be helpful in determining the condition and tune of an engine, and it is recommended that the plug be removed from time to time for examination.

A plug running at the correct temperature in a healthy engine will be indicated by blackish or greyish/tan deposits on the end of the plug body and earth electrode. The firing-end of the insulator will vary from a very light tan to a darkish brown.

A sooty deposit on the firing-end of the plug is generally an indication of over-rich mixture, whereas a fine light grey deposit on the end of the plug and a whitish appearance on the firing-end of the insulator may indicate a lean mixture. If carburation appears correct, but the plug insulator at the firing-end is black with carbon or oily deposit, this is generally an indication

that the grade of plug in use is too cold.

Plugs should be cleaned on an abrasive blast machine and afterwards the sparking surfaces of the electrodes on standard type plugs should be dressed with a fine file in order to restore clean, flat, parallel faces. It is most important that the gap should be reset to specification; .020 to .025 in. Gap adjustment should be made by bending the side wire. The threads of the plug, and the gasket seat, should be wiped clean before refitting plug to the engine. The upper portion of the insulator should also be wiped clean after fitting and prior to connecting the high-tension cable. It is good practice to wipe periodically the top of the insulator with a clean cloth in order to remove any accumulation of grime or dust, etc., as such deposits can be conductive and result in poor plug performance.

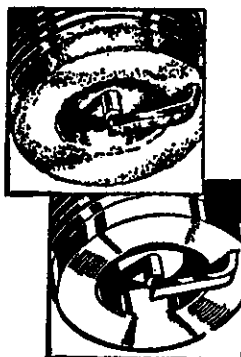
The special non-detachable steel gaskets fitted to Champion standard sparking plugs are designed to last the life of the plug.

When refitting the plug, screw in as far as possible by hand, and then use a box-spanner for final tightening to avoid possibility of damage to the insulator. An adjustable spanner should not be used.

FIG. 6. The spark plug.

(ABOVE)—Fouled with burnt oil, or soot.

(BELOW)—Correct.



AIR FILTERS (FIG. 7)

The filters can be detached from the carburettor intake, and the ends of the perforated band are held together by means of a small nut and bolt which must be unscrewed before the band can be opened to allow the whole filter unit to be dismantled. The element must be washed thoroughly in petrol and dried.

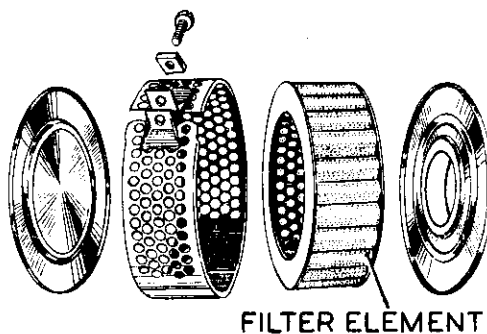


FIG. 7. The air filter dismantled into its component parts.

IGNITION TIMING

It is unusual for the ignition timing to alter and it is not advisable to interfere with the setting unless it is strongly suspected of being incorrect. The importance of accurate ignition timing cannot be over-emphasized. Care and patience must be used to ensure that the final setting is in accordance with recommendations.

Before checking the timing, the contact breaker gaps must be set to the correct clearance, since any variation in the gaps from the recommended clearance will effect the timing (opening the points advances the timing; closing them retards it). The correct gap when the contact breaker points are in the fully open position is .015 in., and if different from the setting they must be re-adjusted (see page 23).

As a preliminary operation, remove both sparking plugs so that the engine can be rotated without resistance due to compression and engage top gear to enable the engine to be turned either backwards or forwards by moving the rear wheel.

In order to assist the owner in setting the piston in the correct timing position, the flywheel is specially machined to accept a timing plug (supplied in the toolkit) which can be inserted through an aperture in the front of the crankcase (Fig. 8). First, set the right-hand piston at the top of its compression stroke (both valves closed). Remove the detachable cover (A), and insert the plug loosely. Rotate the engine backwards **very slowly** until the timing plug is felt to engage in the flywheel timing keyway, then add and tighten the fixing nuts.

The engine will now be locked in position with the right-hand piston correctly positioned for timing. Note that the timing plug is reversible, but the correct timing will be obtained when the plug is fitted with the symbol A50 in the upper position only. **This applies to all models.** The plug **must not** be fitted with the symbol A65 at the top. In some instances, the timing plug is unmarked and must be fitted with the "cut-away" portion at the top.

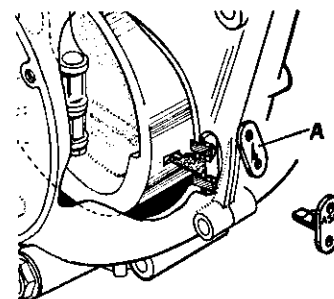


FIG. 8. Using the timing plug.

The next step is to set the auto-advance mechanism of the contact breaker in the fully advanced position. (The governor weights in the mechanism will automatically have returned to the retarded position when the engine is stationary.) Remove the central securing bolt (Fig. 9), withdraw the washer and temporarily replace the latter with another washer having a hole just large enough to fit over the cam bearing, thus allowing the washer to bear against the side face of the cam. Replace the bolt, but before tightening rotate the cam to its limit in an anti-clockwise direction, hold in position,

and tighten the bolt. This will lock the auto-advance mechanism in the **fully advanced position**, which is the correct position for timing the ignition.

Both of the contact breaker assemblies are independently adjustable and each can be set to give correct ignition timing for its own cylinder.

Now check that the upper pair of contact breaker points are just opening. If incorrect, slacken the two screws (A) and (B) securing the plate which carries the contact breaker assembly, and adjust the eccentric pin (C) until the points are just opening (Fig. 9). Retighten the screws and check the whole setting carefully. The best way of determining the precise point of opening of the contact breaker points is to connect a small battery and bulb in series with the points.

When the right-hand cylinder has been timed, first temporarily remove the timing plug, rotate the engine through one revolution, and replace the timing plug. Check that the lower pair of contact points are just opening. If not, repeat the above procedure to the lower contact breaker assembly.

Do not forget to remove the timing plug before attempting to turn the engine, nor to remove the special washer fitted temporarily behind the contact breaker central bolt, otherwise the auto-advance mechanism will be inoperative.

It cannot be too strongly emphasized that the ignition timing must be correctly set for satisfactory engine performance, and that any attempt to "improve" on the setting given below should be avoided, as it has been determined after careful development.

The fully advanced ignition setting for all models is 34 degrees, measured at the crankshaft.

IGNITION TIMING BY "STROBELIGHT"

Whilst the previous method of timing the ignition will give quite good results in experienced hands, the best method of obtaining a precise ignition setting is by means of a "strobelight", an instrument possessed by most B.S.A. dealers.

Provision is made on all twin cylinder engines for the use of this device, comprising a pointer on the interior of the chaincase cover and a marker line on the alternator rotor, both of which are exposed after the removal of the circular cover on the front of the chaincase (see Fig. 19).

The strobelight must be connected in accordance with the manufacturers instructions and it is important to note that an independent battery must be used for this operation and not the one on the machine.

Check the right side cylinder first. With the engine running at a speed high enough to ensure that the automatic ignition control has moved the ignition timing to the fully advanced position, the line and pointer should coincide when examined under the flashing light of the strobelight, if the ignition setting is correct. Should adjustment be required slacken the two screws (A) and (B) Fig. 9, securing the plate which carries the contact breaker assembly, and adjust the eccentric pin (C) until the points are just opening and the above condition is obtained.

Retighten the screws securely. Now check the left side cylinder and if

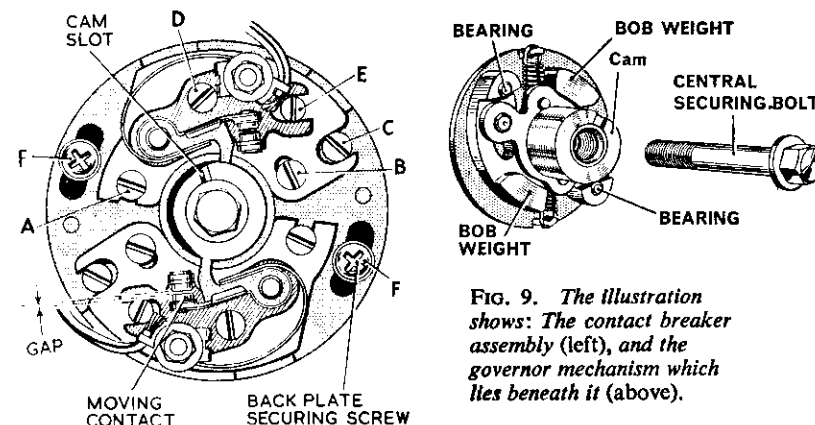


FIG. 9. The illustration shows: The contact breaker assembly (left), and the governor mechanism which lies beneath it (above).

adjustment is required, repeat the above procedure to the lower contact breaker assembly.

CONTACT BREAKER (Fig. 9)

The unit is contained within a separate compartment and becomes accessible when the inspection cap is removed from the timing cover. It is driven from the intermediate timing gear and the compartment is fitted with a special seal to prevent any possibility of engine oil finding its way on to the contact points. If it becomes necessary to replace the seal, it must be fitted so that the lip which bears on the shaft faces the interior of the crankcase. Separate coils are used for each cylinder necessitating two pairs of contact points which are operated by a single cam.

Cleaning

The contacts must be absolutely clean at all times. If they are burned or blackened, clean with a fine carborundum stone or very fine emery cloth, afterwards wiping away any trace of dirt or metal dust with a clean, petrol-moistened cloth. Cleaning of the contacts is made easier if the moving contact is withdrawn and it can be lifted off its pivot after unscrewing the nut which secures the end of the spring. When reassembling, make sure that the insulating pivot bushes and washers are correctly replaced.

Gap Setting

When the points are fully open, the gap should be set to .015 in. To check the setting first remove the sparking plugs, so that the engine can be rotated slowly until the upper rocker arm is on the peak of the cam. In this position the gap will be at its maximum, when the setting can be verified with the aid of a feeler gauge. If incorrect, slacken the fixing screw (D) and adjust the plate carrying the fixed contact point by means of eccentric pin (E) until the gap is correct. Retighten the screw and check for adjustment. Repeat this procedure for the other pair of points. The gaps should be checked and reset if necessary after the first 500 miles and thereafter in accordance with "Routine Maintenance", page 13.

Lubrication

Apply a very small amount of thin grease to the exposed surface of the cam. Do not use an excessive quantity, because it is most important that the contact

points are kept free from lubricant, otherwise misfiring and difficult starting may occur. At the same time, turn the engine until the cam slot is uppermost and apply **one spot** of clean engine oil for the purpose of lubricating the cam spindle. A further **single spot** of oil should be applied to the governor weight pivot posts.

Lubrication should take place after the first 500 miles and thereafter in accordance with "Routine Lubrication", page 14.

AUTO-ADVANCE UNIT (FIG. 9)

When attention is being given to the contact points, it is also a convenient time to inspect the bob-weights of the governor mechanism which automatically advances and retards the ignition timing. When the engine is stationary, the timing is fully retarded and as the engine speed increases, it becomes progressively advanced, until fully advanced at normal road speeds.

To expose this mechanism, remove the two screws (F) Fig. 9, and detach the contact breaker back plate complete with contact points etc. It is not necessary to unscrew the central bolt, because although the whole mechanism is retained on a tapered shaft, to do so may release the unit, requiring complete retiming of the ignition. If however, the mechanism is to be taken out, remove the central bolt and insert an extractor bolt into the threads specially provided for this purpose. The bolt is available as a B.S.A. Service Tool No. 61-5005 and should be screwed in as far as possible, when a sharp jerk on the end of the spanner will release the unit.

Make sure that the bob-weights move freely and that if the cam is turned by hand to the advanced position (weights fully extended outwards) and released, the springs withdraw the weights to the inner position (retarded). Lubricate their bearings with a spot of light oil if necessary, but do not over-lubricate or the excess may find its way on to the contact points. Note that the ignition timing should be checked after the contact breaker back plate is replaced, when slight re-setting of the plate may be required.

DECARBONISATION

Decarbonisation should be carried out only when there are definite symptoms that excessive carbon build up inside the combustion chamber is interfering with performance. The usual indications are an increasing tendency to "pink" (a sharp metallic knocking when under load), a general falling-off in power noticeable mainly on hills, and a tendency for the engine to run hotter than normal.

It is customary to attend to the valves during decarbonisation, as this provides a reasonable interval between valve overhaul, and avoids the necessity for dismantling the engine especially for this purpose at a later date.

On machines used in competitive events, the need to remove the cylinder head is more likely to be indicated by the condition of the valves, which are subjected to considerable stress at high engine speeds. The exhaust valve especially should be replaced at reasonable intervals.

If for any reason, maximum safe engine speed has been exceeded the valves should be regarded with suspicion. It is difficult to determine the mechanical condition of a valve by visual inspection, and if in doubt a new valve should be fitted.

PRELIMINARY WORK

It is necessary to remove the petrol tank in order to carry out decarbonisation, and advisable to remove both side panels, which are quickly detachable, each being held in position by two snap-fasteners.

Turn off the petrol taps, and unscrew the pipe connections at both ends (bolt fixing at the carburetter), taking care not to lose the sealing washers, otherwise it will be impossible to remake a petrol-tight joint.

Disconnect the strap beneath the front of the tank (steel tanks only). The latter is insulated from direct contact with the frame by rubber mountings on the top tube and is held in position by a captive bolt and nut, which are exposed when the rubber cap is removed. Unscrew the nut, and note carefully the sequence in which the various components are withdrawn, so that they can be reassembled in the same manner, and remove the tank. Next, remove the high-tension leads from the sparking plugs, and then unscrew the plugs from the cylinder head.

Remove the air filters from the carburetters which can now be taken off, and, to save disturbing the slides etc., can remain attached to their cables and tied up out of the way. Examine the special heat-resistant gaskets fitted between the carburetter flanges and the head (or manifold in the case of single carburetter models), and if there is any sign of leakage or damage on the faces they must be replaced, otherwise it will be difficult to obtain correct carburation. Similarly the paper washer at each side of the gasket should be replaced if necessary. The face of the carburetter flange incorporates a synthetic rubber ring to preserve an air-tight joint, and this too, should be examined for soundness.

Next, disconnect the oil feed pipe to the rockers at its union on the back of the cylinder head, and then remove the engine steady between the frame front and cylinder head.

Remove the exhaust pipe connections followed by the pipes themselves.

The exhaust pipes are a push-fit in the head, and any tendency for the pipes to adhere to the head or the silencers, due to carbon, can be overcome by the application of a soft mallet, which will avoid damage to the plating.

REMOVING THE ROCKERS AND CYLINDER HEAD

The rocker assembly is enclosed by an aluminium cover, which can be lifted off its studs after the six nuts have been removed. If the engine is in the frame it will be necessary for the front centre stud to be unscrewed in preparation for cylinder head removal. Examine the gasket carefully, and replace with a new one if there is any sign of damage, in order to ensure an oil-tight joint.

Now remove the push rods. These must be dealt with individually, the engine being first rotated so that the normal valve clearance is present, and the rocker adjusting screw and the push rod are not subjected to spring pressure. Unscrew the adjuster completely, when the rocker arm can be depressed sufficiently for the push rod to be taken out (Fig. 10).

Two of the cylinder head bolts cannot be removed without first dismantling the exhaust rocker assembly. Take off the nut and spring washer from the end of the spindle and tap it out of its supports, applying a soft punch to

avoid damage to the threads. Note that the rockers are spring-loaded at their outer ends with a thrust washer at the inner end. It is essential that the washers are fitted in their correct relationship with the rockers, to ensure that the adjusting screws are central with the valve stem, and that the push rods are positioned correctly.

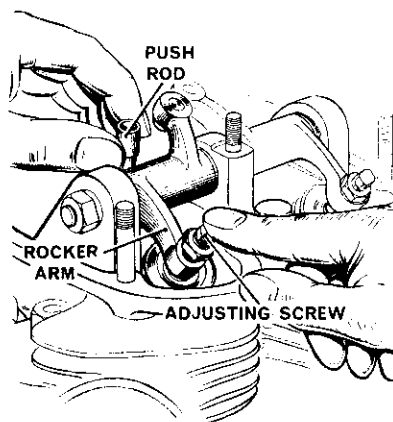


FIG. 10. Removing the push rods. Each rod and rocker must be treated individually.

The inlet rockers need not be disturbed. If however, the inlet rocker spindle is removed, it is preferable to replace it in the same mountings.

There are nine attachment points between the cylinder head and barrel, five of which are by means of bolts, and, following the removal of the exhaust rockers, all can now be removed. The remaining four fixing points are by studs, and their nuts are directly accessible. Gently tap the underside of the exhaust ports with a soft mallet to free the joint, and lift the head clear.

Note that a split metering pin is used at the centre mounting of the inlet rocker spindle to regulate the flow of oil to the rockers etc. If defective, this pin must be replaced by another of the same diameter for which purpose it will be necessary to unscrew the oil feed union at the back of the head. Do not disturb unnecessarily.

CYLINDER HEAD GASKET

Examine this carefully for defects. Dark stained patches, especially between the cylinder bores, may indicate a leakage of gas. Any signs of burning at the edges of the gasket round the cylinder bores will be self-evident, and in either of these instances the gasket must be replaced with a new one.

Solid copper gaskets should be annealed before re-using (see page 32).

REMOVAL OF THE VALVES (FIG. 11)

The operation is greatly simplified if the proper tool is used, and this is available as B.S.A. Service Tool No. 61-3340. The illustration shows the application of the valve spring compressor, when it is only a matter of closing the spring sufficiently for the split collets to be removed. A sharp tap on the top of the tool may be necessary to free the collets.

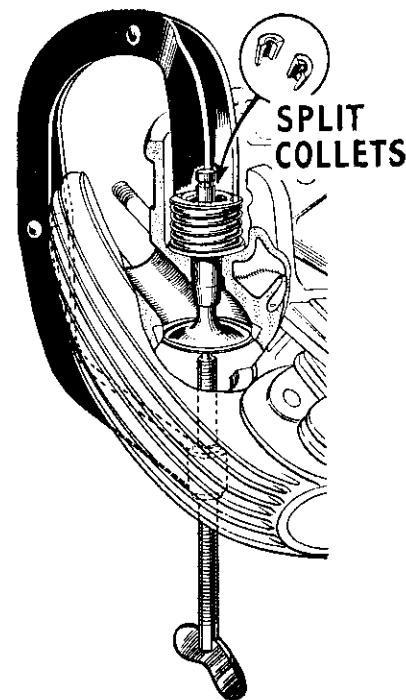


FIG. 11. Removing a valve with the aid of Service Tool No. 61-3340.

The valve stems must also be examined for wear. If an appreciable ridge has formed at the end of the portion bearing in the valve guide, the valve must be replaced.

DECARBONISING

Scrape all the carbon from the combustion chambers, taking great care not to scratch the soft aluminium surface or to damage the sparking plug threads. The ports must also be scraped free from carbon, and every care taken not to damage the valve seat faces with the decarbonising tool. A suitable instrument for this job is an old screwdriver, the edges of which have been rounded by wear, and provided that a little patience is employed, all traces of carbon can be removed to leave the surfaces smooth and unmarked.

On no account must the cylinder head be submerged in a solution of caustic soda in an effort to dissolve the carbon, because of the harmful effects of this solution on aluminium.

Plug the push rod tunnel with clean cloth to keep out foreign matter, depress the starter pedal gently until the pistons are at the top of their stroke, and remove all the carbon from the crowns and valve pockets. Here, too, great care must be used not to damage the soft aluminium surfaces. The piston crowns and combustion chambers can be polished with fine metal polish. Finally, rotate the engine to lower the pistons to the bottom of the bore and wipe all loose carbon from inside the bore.

THE VALVE SPRINGS

These tend to lose their efficiency due to heat and other causes, especially in the case of the exhaust springs, and if they are found to have shortened appreciably they should be replaced. It is false economy to continue to use them when they are at the end of their useful life.

The correct free lengths of these springs when new are; outer spring $1\frac{3}{4}$ in.; inner spring $1\frac{1}{8}$ in.

REPLACING THE VALVE GUIDES

If the valve guides are worn, the old ones may be driven out from inside the cylinder head using a drift with a pilot portion which is a good fit inside the guide. It is advisable to warm the head for this operation. Specially made drifts for this job are available as B.S.A. Service Tool No. 61-3382. New guides should be driven in from the top, until the largest diameter fits firmly against the head.

When new guides have been fitted, it is essential that the valve seats are refaced with a proper valve seat cutter, to make sure that the seat is concentric with the guide bore. The valve seat angle is 45 degrees. B.S.A. Service Tools for this particular task are No. 61-3293 for the pilot and No. 61-3299 for the cutter.

EXAMINATION OF THE VALVES AND SEATS

If the valves and their seats are only discoloured or lightly pitted, then it will be sufficient to grind them in with a little fine grinding paste, but if there is considerable evidence of pitting then the faces must be restored with the proper equipment. This also may be an indication that the engine has been run with insufficient valve clearance, or with incorrect mixture from the carburettor, or late ignition timing.

An excessively pitted valve must be refaced by mechanical means, as attempts to grind-in the valve with paste will only result in the removal of too much metal from the seats in the head, with consequent "pocketing" and its attendant adverse effect on performance. This is all the more important with an aluminium head, where the valve seats are cast in position and cannot be replaced.

It is probable that the seats in the head will be in good condition, as the valves are usually the first to require attention, but if they are badly pitted, the seats should be refaced with a proper seat cutter.

VALVE GRINDING

Grinding with fine-grade paste should be sufficient to ensure that a good gas seal is created. If the valves are in poor condition, but not bad enough to warrant machine grinding, start with the coarse-grade of paste and finish off with the fine, being careful to remove all traces of the coarse paste before changing over.

Smear a small quantity of grinding paste on to the face of the valve and return the valve to the same seat from which it was removed. Grip the valve head with the special suction cup available as B.S.A. Service Tool No. 61-5035 and rotate the valve backwards and forwards whilst maintaining a light pressure. Grinding should be continued until the mating surfaces of the valve and seat show a uniformly matt metallic surface all round.

Valves and seats must be thoroughly cleansed of all traces of grinding paste before reassembly.

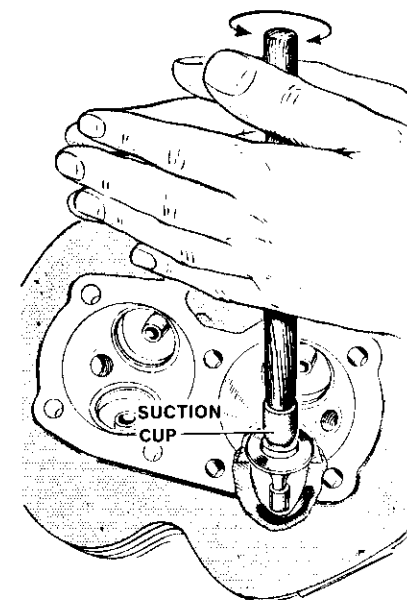


FIG. 12. Grinding-in the valves, showing the method of using B.S.A. Service Tool

REPLACING THE VALVES

Smear a little engine oil on the valve stem and replace the valve. Refit the valve spring retaining cup against the cylinder head, followed by the springs and the top collar. Using the same tool as for dismantling the valves, compress the springs until the two collets can be inserted, when the springs can be gently released.

A coat of grease on the exposed end of the valve stem will assist in keeping the collets in position as the spring is released. Make sure that the collets are correctly seated in the recess on the valve stem. One end of the outer spring has reduced pitch coils (i.e., the coils are closer together) and the springs must be assembled with this end nearest to the cylinder head seating.

REMOVING THE CYLINDER BLOCK

Unless the condition of the engine indicates that the piston rings, or cylinder bores require attention, it is not advisable to disturb the cylinder block. Symptoms indicating faulty piston rings might include heavy oil consumption, poor compression (but only if the valves are in good order, otherwise they are much more likely to be the cause) and excessive piston slap when warm. The latter might be due to worn bores which can be checked without removing the block if the pistons are moved to the bottom of their stroke, thus exposing the bores for examination and measurement.

If it is decided to take off the block, first set the pistons at the bottom of their stroke, then remove the nuts round the cylinder base flange and gently lift the block upwards until the pistons slide out from the bores. It is as well

to have an assistant to steady the pistons as they emerge, to avoid possible damage. As soon as the block has been withdrawn, cover the crankcase mouth with a clean piece of cloth to keep out any foreign matter. Scrape the paper washer off the cylinder base flange and/or the crankcase face.

The tappets are retained in the block by means of circlips at their upper end.

CHECKING THE CYLINDER BLOCK

Examine the cylinder block carefully for wear, and if a deep ridge has formed at the top of the bores or the wear exceeds a maximum permissible figure of .010 in. then a rebore will be necessary. Pistons and cylinder blocks $\frac{1}{2}$ mm. and 1 mm. oversize are available for rebore purposes.

The cylinder block will also require a rebore if there are any deep scores, as these will cause loss of compression and excessive oil consumption.

THE PISTONS

It is not necessary to remove the pistons or the rings unless they require replacement or further dismantling of the engine is to be carried out, in which case, first prise out one of the gudgeon pin circlips in each piston, by inserting a suitably pointed tool into one of the notches provided in the piston for this purpose. Before removing the gudgeon pin it is necessary for the pistons to be warmed by wrapping in a cloth which has been immersed in boiling water and wrung out. Alternatively, an electric iron can be applied to the piston crowns until thoroughly warm. When the piston is warm remove the gudgeon pin with the aid of a suitable extractor.

Mark the inside of each piston to enable it to be replaced the correct way round, and in the same bore from which it was removed.

If there are any obvious high spots on the piston, indicated by highly polished areas, they should be smoothed down with a smooth file. While it is important that all serious high spots are removed, this form of attention should not be overdone. An adequate running-in period is the best safeguard against piston troubles.

Warm each piston before refitting its gudgeon pin, which should be dipped in engine oil before insertion. On no account must the replacement of the circlip be overlooked. Always use new ones and make certain they are pressed firmly into their grooves, because if they should come adrift, the cylinder bore will be damaged.

While the pistons are removed it is a good opportunity to check the connecting rods for any signs of wear. The rods should revolve freely without any signs of up and down movement at the big-end. Rotate the crankshaft until the crankpins are uppermost. With each connecting rod set vertically in turn, grasp it firmly and try to move it up and down. If any play can be detected the big-end bearings will require replacement. Do not confuse sideways movement at the little-end with up and down play. The big-end should have approximately .020 in. side-play and this permits some sideways movement at the other end of the connecting rod.

THE PISTON RINGS

The faces of the piston rings in contact with the cylinders should possess a smooth metallic surface, and any sign of discolouration or shiny portions means that the rings are defective and must be replaced. They must also

possess a certain amount of springiness, so that the ends lie about $\frac{1}{16}$ in. apart when released from the block. The rings should be free in their grooves but if they are stuck, they must be prised free and removed from the piston, when all carbon can be cleared from the grooves and the inside of the rings. Care is necessary when removing and replacing the rings as they are brittle and only permit a minimum amount of movement.

To check the piston ring gaps, place each ring in turn in the least worn part of the bore from which it was removed, and temporarily insert the piston, pushing it against the ring to make sure it is truly located in the cylinder bore. Withdraw the piston and measure the gap between the ends of the ring with the aid of a feeler gauge (Fig. 13). The correct gaps are .007—.012 in. (500 c.c.) and .008—.013 (650 c.c.), and although an increase of a few thousandths of an inch is not important, any large increase means that the ring should be replaced. It is unlikely that new rings will have gaps of less than the amount specified, but if so, the gaps can be opened out to the correct figure with the careful use of a very fine file. Make sure that the edges of the joint are smooth after filing. The lower compression ring has a taper contact face and a replacement must be fitted in the correct manner, as marked.

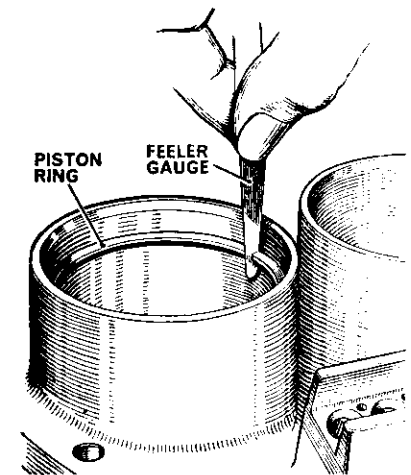


FIG. 13. Checking the piston ring gap. The ring must be fitted parallel with the end-face of the bore.

REPLACING THE CYLINDER BLOCK (Fig. 14)

Fit a new paper gasket to the crankcase face, lightly smearing with jointing compound before doing so. Before replacing the block, prepare two pieces of wood, $\frac{1}{2}$ in. square by about 8 in. long, so that they can be laid across the crankcase mouth under the pistons, one in front and one behind. These will enable the pistons to be held square while the block is lowered, and at the same time prevent them from descending into the crankcase.

It will simplify the fitting of the block if the piston rings are compressed into their grooves with the aid of "slippers" as shown in the illustration. Apply a liberal coating of clean engine oil to the pistons and position the ring gaps equally round the piston. Using two slippers compress the rings so that they are just free to move, then replace the block, removing the slippers after the rings have entered the bores. Remove the two wooden bars and

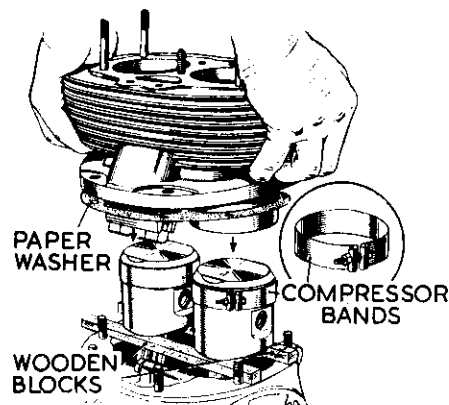


FIG. 14. Replacing the cylinder block. The compressor bands are B.S.A. Service Tools:—
61-3682 (500 c.c. engines),
61-3707 (650 c.c. engines).

lower the cylinder block into position. Replace all nuts and washers round the cylinder base flange, tightening down firmly and evenly to a torque setting of 18-20 lb./ft.

Check at regular intervals (see "Routine Maintenance") because loose nuts may result in damage to the flange.

REASSEMBLING THE CYLINDER HEAD

If it has been decided to fit a new gasket, this can now be placed in position.

The gasket is of solid copper and if the old one is being used again, it should be annealed before fitting by heating to a dull red appearance and plunging edgewise into cold water.

Having ground the valve seats and replaced the valves, springs, etc., in position, the head can now be lowered into position and bolted down. To ensure even distribution of pressure with consequent freedom from distortion,

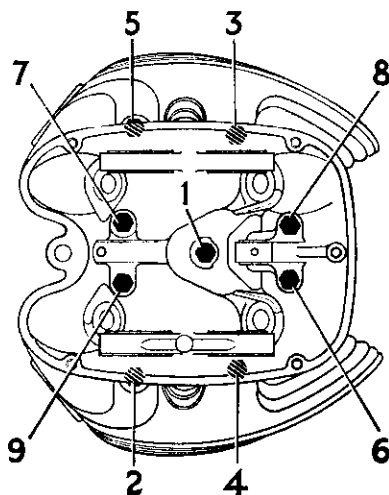


FIG. 15. The sequence of tightening the cylinder head bolts. Numbers 7 and 9 require prior removal of the exhaust rocker spindle.

tighten the bolts and nuts in rotation, as shown in Fig. 15. This sequence should be followed several times, tightening a little more each time, until all fixing points are really tight. The bolts should be tightened with a torque spanner set to 28-30 lb./ft., and the nuts at 31-33 lb./ft. When the machine has covered its first 250 miles after decarbonisation, or when new, check the tightness of the cylinder head bolts and nuts. The engine must be quite cold when this is done.

The push rods are in pairs of different lengths, the longest operating the exhaust rockers from the two centre tappets, and the rods can now be loosely placed in position. Tap the rocker spindles into place with their rockers, thrust washers and springs in their correct order, and tighten the spindle end nut. The spindles should be assembled in the same mountings from which they were removed.

Each rocker must be dealt with in turn. As the engine is rotated slowly, the push rods will be seen to rise and fall according to the action of the camshaft on the tappets. As soon as one of the push rods has reached its lowest position, insert the appropriate rocker ball-end into the cup on the upper end of the rod, and screw up the adjuster on the opposite arm of the same rocker to give approximately the correct valve clearance. Repeat this procedure for the remaining rockers and push rods, and when all are in position, set the valve clearances accurately in accordance with the instructions given on page 18.

Having decided whether or not a new gasket is necessary for the rocker cover joint, this can be fitted in position and the rocker cover replaced. Excessive tightening of the nuts should be avoided, otherwise the cover may be damaged. The two domed nuts must be replaced on the studs from which they were removed. Connect the oil feed pipe to the rockers.

Examine the sparking plugs, cleaning and adjusting if required as described on page 19. Replace these, and then connect their leads, making certain they are coupled to the correct plug.

FINAL REASSEMBLY

The carburettor flange gaskets must be replaced in the correct order before fitting the carburetters and the air filters should be dismantled and cleaned, as detailed on page 20, before replacing on the carburetters. Use a torque setting of 10 lb./ft. for the carburettor flange nuts.

Now refit the exhaust system, making sure that the pipes are pushed into their original positions in the cylinder head before tightening their connections, and then add the engine steady, locking this securely at both ends.

The petrol tank rubber blocks must be replaced in the same position on the frame tube.

The central nut should be screwed up tightly, as its design ensures that the rubber bush cannot be compressed excessively. Replace the strap beneath the front of the tank and, finally, replace the petrol pipes and the side panels.

THE GEARBOX

LUBRICATION

The correct oil level is given on the dipstick attached to the filler cap (Fig. 16).

NOTE:—For the level to be correct, the machine should be standing on its wheels on horizontal ground.

To drain the oil, which should preferably be undertaken while the oil is warm after a run, the drain plug must be removed from the boss beneath the box (Fig. 16). Examine the rubber "O" ring before replacing the plug and renew if necessary. The gearbox capacity is approximately $\frac{1}{8}$ -pint, and after adding this quantity, the level should then be checked on the dipstick. Suitable oils for gearbox lubrication are given on page 15.

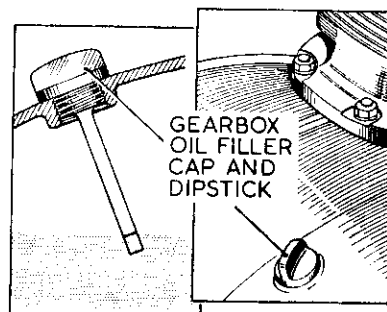
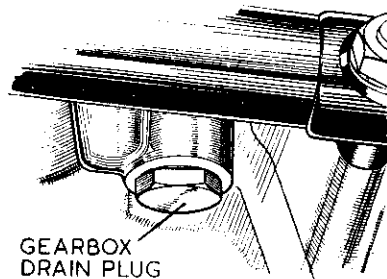


FIG. 16. The gearbox oil level and drain plugs.



REPLACING THE STARTER PEDAL SPRING (FIG. 17)

This spring is enclosed within the outer timing case and becomes readily accessible when the cover is removed.

The starter shaft carries the spring retainer plate, which must be prised off the shaft, so releasing the spring. Note that the inner end of the spring hooks over a special anchor stud, which should remain undisturbed, otherwise its fixing nut on the inside of the case may be released. Fit the new spring loosely in position, with the inner hook looped round the anchor stud, and replace the plate so that its tongue overlaps the spring coils and engages with the outer spring hook. Turn the plate in an anti-clockwise direction (i.e., against the spring pressure), until it is possible to push the plate on to the flats on the spindle. Press firmly into position to provide correct clearance when the timing cover is replaced.

RATIOS

Sprockets used for standard ratios are: engine 28 teeth, clutch 58 teeth. Engine and clutch sprockets are not variable, but changes in gear ratios can be made by altering the gearbox sprockets, which range from 17 teeth to 21 teeth inclusive.

Standard gear ratios for the various models are as follows:—

Model	Gearbox Sprocket	Rear Wheel Sprocket	Top Gear
ROYAL STAR	18T	47T	5.41
LIGHTNING	20T	47T	4.87
THUNDERBOLT	20T	47T	4.87
FIREBIRD SCRAMBLER ...	20T	47T	4.87
SPITFIRE Mk. IV SPECIAL	20T	47T	4.87

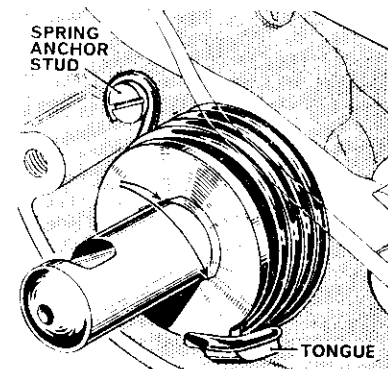


FIG. 17. The starter pedal return spring.

THE CHAINS AND CLUTCH

PRIMARY CHAINCASE

There is a small, but regular oil supply from the primary chaincase through the non-adjustable metered feed on to the rear chain, so that the oil level can be expected to fall very slowly.

The chaincase cover is retained by screws of varying lengths and one of these (Fig. 18), identified by its red painted head, determines the oil level. To replenish with oil, first remove this screw and then the filler cap. Add oil of the correct grade (see "Recommended Lubricants", page 15) and allow to stand until any surplus oil has drained off. Replace the level screw, together with the filler cap. For draining purposes, the screw (also painted red) at the lowest point on the chaincase, should be removed. This screw must be replaced firmly to prevent accidental loss of oil. Too little oil will not lubricate the primary chain properly and, alternatively an excessive quantity may cause the clutch to slip.

The chaincase capacity is $\frac{1}{4}$ -pint of an S.A.E. 20 oil, and to ensure a correct level the machine should be standing on its wheels on horizontal ground.

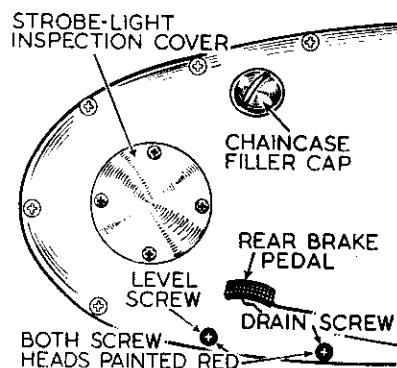


FIG. 18. The primary chaincase oil level.

PRIMARY CHAIN ADJUSTMENT (FIG. 19)

Excessive slackness in the primary chain is undesirable and an adjustable slipper-type tensioner is provided on the lower run of the chain.

The chain is in correct adjustment when the slackness, measured at the mid-way position between the sprockets, is not less than $\frac{1}{8}$ in. but does not exceed $\frac{1}{4}$ in. It is most important that the chain should never be taut, as this will cause excessive loading of engine and gearbox bearings and possible breakdown of the bearing tracks.

The adjustment can be checked without removing the chaincase cover. Unscrew the filler cap, when the chain can be felt and its slackness gauged with the fingers. If adjustment is necessary, remove the adjuster cap nut (below the chaincase), slacken the locknut and tighten the adjuster screw by means of the flats provided for the purpose (Fig. 19). When the chain slackness is correct, re-tighten the locknut, replace and tighten the cap nut securely, and be sure to replace the special oil seal washer if it has been removed.

PRIMARY CHAIN REMOVAL

The unit construction of the engine and gearbox allows the use of fixed centres between clutch and engine sprockets, so that a pre-stretched, endless chain of the triple-row type is fitted and a spring link connection is not

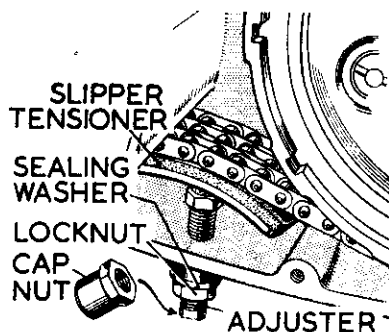


FIG. 19. Adjustment of the primary chain.

provided. Because of this, in order to remove the chain, it is necessary to remove the chain, clutch, and generator together and full details for this operation are given in the Workshop Manual.

REAR CHAIN LUBRICATION

Lubrication is provided by a chain oiler from the rear of the primary chaincase, which provides a metered supply of lubricant, and should keep the chain in good condition. This supply is dependent on correct maintenance of the oil level in the primary chaincase (see page 35). If maximum life is to be achieved, however, periodically remove the chain and wash it thoroughly in petrol to remove all dirt and grease. Allow the chain to dry completely then immerse it in a tray containing warm graphited grease. When replacing the chain make sure that the spring clip of the connecting link has its closed end pointing in the direction of travel of the chain (i.e., forwards on the top run).

REAR CHAIN ADJUSTMENT

Put the machine on its centre stand. To adjust the chain, the rear wheel must be moved. First, the nut securing the torque arm to the brake plate must be slackened slightly so that the plate may pivot freely. Slacken the spindle (B) Fig. 20, on the right-hand side of the machine, a few turns, and then nut (A) just sufficiently to allow the wheel to move.

Slacken the locknuts (C) and unscrew the adjusters (D) to tighten the chain. With the wheel in its lowest position, there should be a total up and down movement of $1\frac{1}{4}$ in. in the centre of the chain at its tightest point. Ensure that the wheel spindle is against the adjusters and that the wheels are in line (see "Wheel Alignment").

Tighten the nut (A) first, then the spindle (B) and finally the nut securing the torque arm to the brake plate. Re-check the chain adjustment and the wheel alignment.

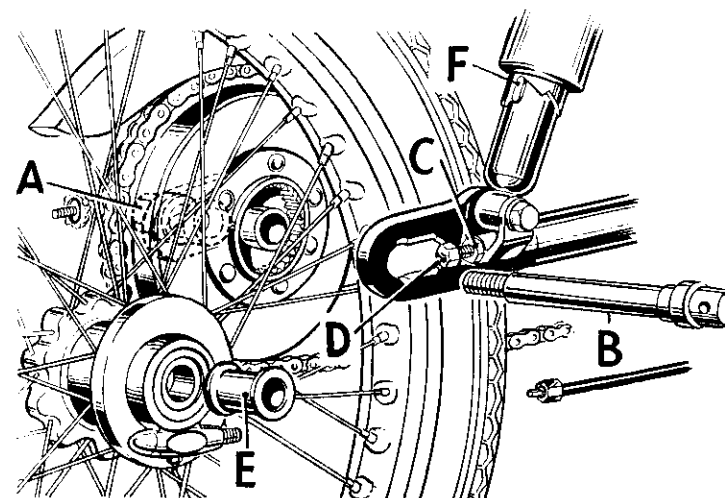


FIG. 20. Rear wheel removal, also showing the position of the adjuster bolts for moving the wheel.

WHEEL ALIGNMENT

It is advisable to check the wheel alignment whenever the rear chain is adjusted, and this is checked preferably by means of a long straight-edge placed along the sides of the wheels, but it must be remembered that the edge must be stepped to clear the stand and to suit the difference in tyre sizes between front and rear wheels. Apply the straight-edge at a point as much above ground level as possible and keep in a horizontal position. With the front wheel set straight ahead, the straight-edge should touch both wheels at two points.

CLUTCH SPRING PRESSURE

The clutch is contained within the primary chaincase and its springs are controlled by sleeve nuts, each of which can be screwed up in turn. It must be emphasized that each nut must be tightened exactly the same amount in order to preserve parallelism of the plates. A normal setting of the nuts is such that the spring register face is level with the outer face of the spring cup. This position is given as a guide only and it is a simple matter to vary it according to circumstances.

To check that the plates are running parallel with each other, depress the clutch lever, and operate the starter pedal so that the clutch plates rotate without turning the engine, when it can be seen whether or not the plates spin truly. If not, the sleeve nuts must be adjusted separately, either inwards or outwards, until each spring exerts the same pressure and true running is obtained.

Do not forget to replenish the chaincase with oil to the correct level (see "Primary Chaincase").

CLUTCH OPERATION

The clutch is controlled from the right side of the crankcase by means of a push rod traversing the hollow gearbox mainshaft, and with increasing mileage the position of the rod and its operating lever may have to be reset.

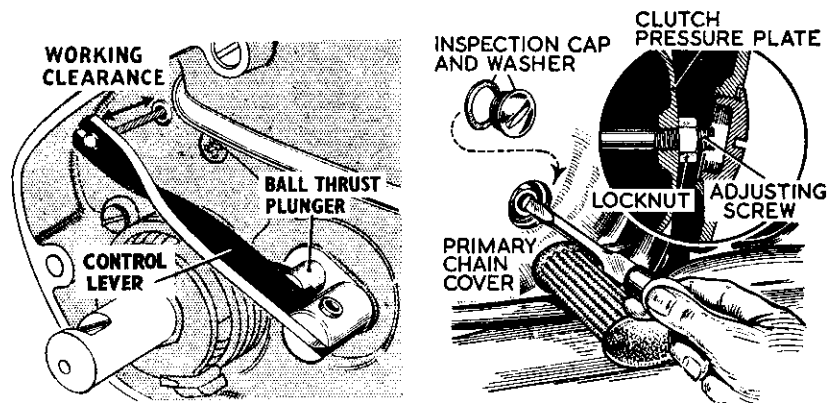


FIG. 21. The clutch operation.
(left) the control lever and its plunger
(right) method of adjustment of push rod.

When this becomes necessary, remove the inspection cap from the primary chaincase to reveal the adjusting screw and locknut at the centre of the clutch pressure plate. Slacken the cable adjustment at the handlebar and screw the adjusting screw inwards until all movement has been taken up. **Light pressure is all that is required.** Then unscrew the adjuster by one-half to three-quarters of a turn and tighten the locknut. This ensures a satisfactory working clearance for the control lever (Fig. 21). Any slackness in the cable can now be taken up by means of the finger adjustment at the handlebar lever. This should be set so that there is definite but not excessive amount of free play at the lever to ensure that the clutch is fully engaged. If the play is excessive the clutch will not disengage fully, resulting in a tendency for the machine to move forward when in gear with the clutch disengaged and for noisy gear engagement. Conversely, if there is no play present, the clutch will be liable to slip.

Should it be desired to examine the clutch control (and this should rarely be required) remove the gearchange and starter pedals followed by the outer timing cover. Slacken the cable adjuster at the handlebar and disconnect the cable at the control lever so that the latter can be moved aside for inspection of the push rod end and the ball thrust plunger, which is a sliding fit in the crankcase (Fig. 21). The end of the rod should be flat and if the ball shows signs of undue wear it should be replaced with another of 7/32 in. diameter. Smear with grease before assembly. Replace the plunger in the crankcase and reconnect the cable to the control lever, adjusting at the handlebar as required.

THE CLUTCH CABLE

The clutch cable is fitted with a quickly detachable connection at the timing case (Fig. 22).

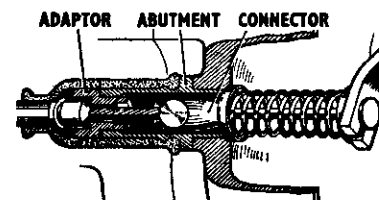


FIG. 22. The clutch cable connection.

Disconnect the cable at the handlebar and draw back the rubber sleeve at the gearbox end of the cable to expose the abutment which carries the cable adaptor. The latter can be drawn out of the abutment, and removed from the cable, when the abutment itself can be taken out of the case. This will expose the cable connector, and the cable can be disconnected or renewed as required.

CLUTCH PLATES (FIG. 23)

The clutch is of the multi-plate type, comprising steel plates carrying special friction pads bonded in position, alternating with plain steel plates. Normally, the pads will not require renewal until after a considerable mileage has been covered, but when this becomes necessary, new plates can be fitted with the clutch in a partially dismantled condition. Do not wash the friction plates in trichlorethylene because it may attack the bonding between plate and pads.

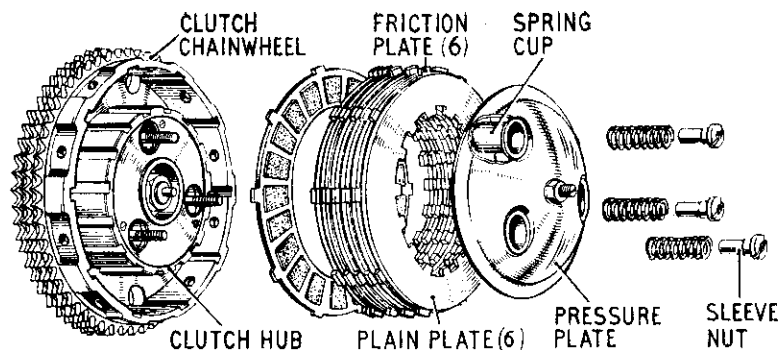


FIG. 23. Assembly of the clutch plates.

The plates are contained in the chainwheel mounted on the gearbox main-shaft, and it therefore requires removal of the primary chaincase cover to expose the clutch.

Examine the plates, and if the plain ones are scored they should be replaced by new ones. It will be obvious if the friction pads are excessively worn, but as an indication of the amount of wear which has taken place, they were approximately $\frac{1}{8}$ in. thick when new.

After reassembly, check that the plates run parallel with each other when the clutch is disengaged (see "Clutch Spring Pressure", page 38). Re-adjust the clutch control as detailed under "Clutch Operation", page 38.

Do not forget to replenish the chaincase with oil to the correct level (see "Primary Chaincase", page 35).

THE AMAL CARBURETTERS

An exploded view of a carburetter is shown in Fig. 24. Opening the twist grip throttle control raises the throttle slide, thus controlling the supply of air to the engine. The tapered needle controlling the supply of fuel is attached to the throttle slide so that a balanced mixture is always provided. The needle has three grooves at its upper end and it is secured in the throttle slide by the spring and by the circlip which locates in one of these grooves. The throttle valve size and the needle position are carefully set before despatch from the factory and no alteration to these settings is necessary or desirable. The air valve is controlled by the handlebar lever and is used to restrict the air supply when starting the engine from cold.

Mixture control at tick-over, and low speeds is controlled by the pilot jet which has an adjustable air supply. An adjustable throttle stop is also provided to regulate the slow-running speed.

For normal road purposes, the standard settings will prove suitable. Under racing conditions the main jet size may require some alteration to comply with atmospheric conditions, and the fuel used. Always check the carburation in the following order and always at normal engine temperature:—

- (1) Main jet for power at full throttle.
- (2) Pilot jet for idling.
- (3) Throttle cutaway for correct pick-up from idling.
- (4) Needle position for good acceleration from quarter to three-quarter throttle.
- (5) Finally re-adjust the pilot jet setting.

MAIN JET SIZE

The smallest jet which gives the greatest maximum speed should be selected, keeping in mind that if too small a jet is fitted overheating may occur. Provided that the correct sparking plug is being used, see page 4, it can provide an indication of whether the mixture is correct. After a run at full throttle stop the engine at once, without allowing it to run slowly, and remove the plug. If the plug end is grey put in a bigger main jet. The plug end should be a smooth jet black, but if it is a sooty black the mixture may be too rich. The air lever must be fully open during these tests.

Alternative methods of checking the main jet size are as follows: ride at low speed in top gear and then open the throttle wide when, if the carburetter is properly jetted, the machine should accelerate steadily to maximum speed. If the engine misfires (below maximum speed) reduce the throttle opening and if the speed increases, the jet is too large. Fit a size smaller jet and repeat the test.

If it is suspected that the jet is too small, ride at full throttle in top gear and if the engine misfires and the speed does not increase when the throttle opening is reduced, then the jet is too small. This condition should be corrected as soon as possible otherwise piston seizure may occur.

PILOT JET ADJUSTMENT

Screwing in the pilot air screw restricts the air supply, thus giving a richer mixture, and unscrewing it weakens the mixture. The best way to adjust is to screw in the pilot air screw until the mixture is obviously too rich and the engine starts to run irregularly, then unscrew the adjuster until the engine runs evenly. When the proper adjustment has been determined, the engine may be running too fast and in this case the throttle stop should be unscrewed until a steady and even tick-over is achieved. If considerable alteration to the throttle stop has been made, the pilot air screw should be re-adjusted. Do not attempt to obtain an excessively slow tick-over as it will probably become unreliable under different atmospheric conditions.

The throttle stop and pilot air screws are fitted with rubber "O" rings to retain the adjustment and if these screws are taken out the rings must be carefully retained.

THROTTLE VALVE CUTAWAY

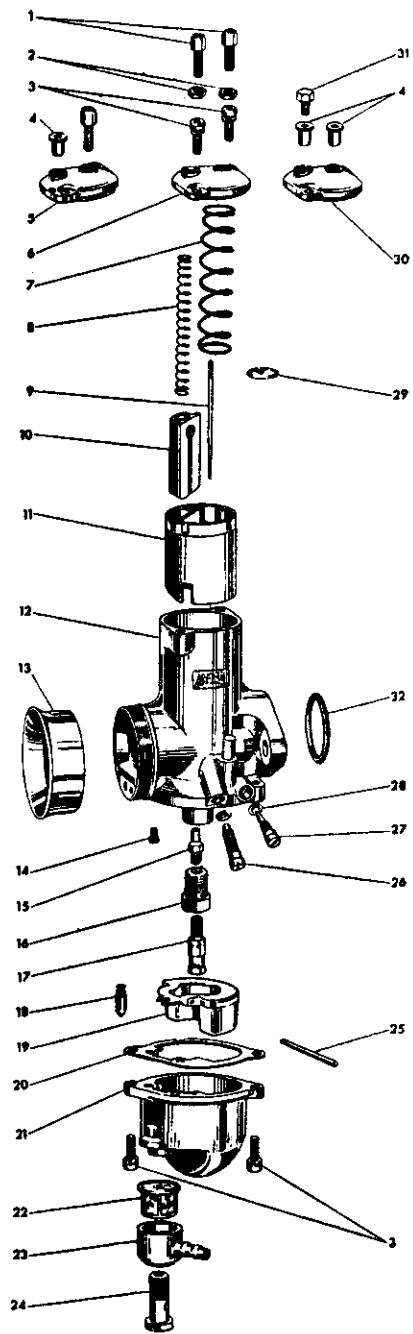
When the pilot adjuster is correctly set, open the throttle progressively up to quarter-throttle, and observe any points where the exhaust note becomes irregular. If such a point is reached leave the throttle in that position and close the air lever slightly; this will indicate whether the spot is rich or lean. To cure richness fit a throttle valve with more cutaway on the intake side, and less cutaway to counteract leanness.

JET NEEDLE POSITION

The needle jet is the major controlling factor from quarter to three-quarter throttle. Run the machine at these throttle openings and test for rich or

9. NEEDLE
10. AIR SLIDE
11. THROTTLE SLIDE
14. PILOT JET
15. NEEDLE JET
16. NEEDLE JET HOLDER
17. MAIN JET
18. FLOAT NEEDLE
19. FLOAT
21. FLOAT BOWL
26. THROTTLE STOP SCREW
27. PILOT AIR SCREW

FIG. 24. The Amal carburetter. (Settings for the various models are given on page 5)



lean spots as described above. The needle can be raised or lowered by re-locating the spring clip in one of the grooves at the top of the needle. Raising the needle gives a richer mixture and vice versa, but normally the needle should only be moved one notch at a time.

Finally, re-adjust the pilot jet and then a properly balanced mixture should be obtained throughout the full throttle range.

The jets are exposed after removal of the float bowl, the main jet requiring a suitable spanner for removal, and a small screwdriver is necessary for the pilot jet. Removal of the float bowl will be simplified if the carburetter is first withdrawn from its studs, when the two screws securing the bowl are readily accessible.

The settings given on page 5 are those normally recommended and will be suitable for most atmospheric conditions. They are intended for use at altitudes of 0—3,000 feet. Above this height some reduction in main jet size is necessary to provide a balanced mixture. At altitudes of 3,000—6,000 feet a reduction in main jet size by 5% is usually necessary, and for every 3,000 feet increase over 6,000 feet a further 4% reduction is required.

WHEELS

TYRES

At weekly intervals and always before setting out on a long journey, the inflation pressures should be checked carefully. Under-inflation will not only seriously affect the life of the tyre, but will also affect the steering of the machine.

Correct pressures are given in the "Technical Data" pages, and it should be noted that these are given for a rider of 154 lb. weight. If the rider's weight or additional load in the form of a pillion passenger or luggage exceeds 154 lb. increase the tyre pressures as follows:—

FRONT TYRE:—Add 1 lb. per sq. in. for every 28 lb. increase above 154 lb.

REAR TYRE:—Add 1 lb. per sq. in. for every 14 lb. increase above 154 lb.

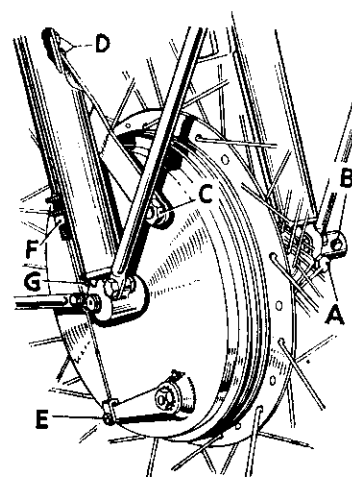


FIG. 25. Front wheel removal. (Thunderbolt and Royal Star only).

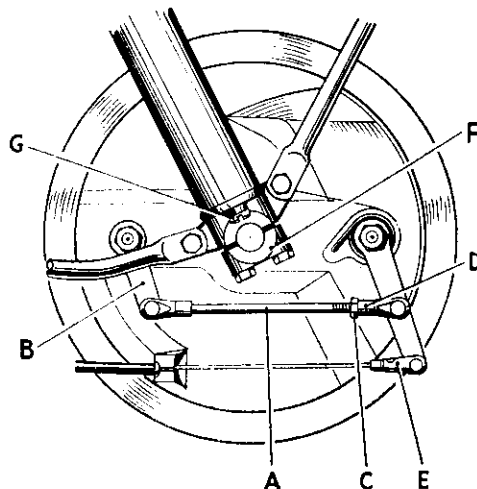


FIG. 26. *Front wheel mounting, showing the brake linkage. (Lightning, Firebird Scrambler and Spitfire Mk. IV).*

HUBS

Both hubs are fitted with ball journal bearings which do not require adjustment. The bearings are packed with grease during assembly and no further greasing is required until the hubs are dismantled for overhaul.

SPEEDOMETER DRIVE

The speedometer is driven from the back wheel spindle by means of a reduction gear unit, the ratio depending upon tyre size. If the tyre is changed to a different size then a different reduction gear unit will be required, otherwise the speedometer will give incorrect readings.

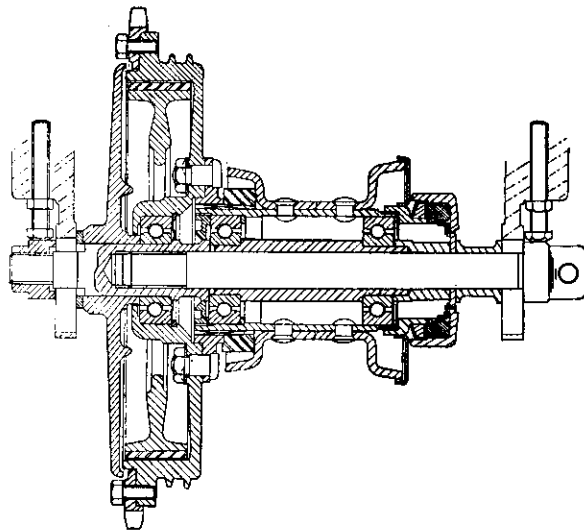


FIG. 27. *Section through rear hub.*

BRAKE CAMS

The cam spindles on both wheels are fitted with grease nipples, but it must be emphasized that greasing must not be carried to excess. All that is required is a single application of a hand grease gun (see page 14).

BRAKE ADJUSTMENT

For obvious reasons the brakes should always be kept at maximum efficiency and for this to be maintained the brakes should be adjusted whenever the hand lever or foot pedal movement has become excessive. Shoes should be just clear of the drum when the brake is off, but close enough for immediate contact when the brake is applied. The brakes must not be adjusted so closely, however, that they are continually in contact with the drum, otherwise excessive heat may be generated, resulting in deterioration of braking efficiency.

Rear Brake:—A finger adjuster is provided at the rear end of the brake rod.

Front Brake (Lightning, Firebird Scrambler, Spitfire Mk. IV):—A finger adjuster is provided at the handlebar lever (Fig. 1).

Normally, this is the only adjustment to be made, but if the brake linings have been replaced or the brake assembly dismantled for any reason it will be necessary to reset the shoes.

Remove the link rod (A) Fig. 26 coupling the two brake cam levers, for which purpose the pivot pins and split pins must first be extracted.

Apply the front brake by operation of the handlebar lever, which can be retained in this position with the aid of a stout rubber band, thus ensuring firm contact between the brake shoe and drum. Operate the short brake cam lever (B) by means of a suitable spanner until its brake shoe also is firmly in contact with the brake drum.

Slacken the link rod locknut (C) and adjust the length of the rod by movement of the clevis (D) until the two pivot pins can just be inserted into the clevises.

Replace the split-pins, using new ones for this purpose and retighten the locknut on the link rod.

Overall adjustment of the brake is made at the handlebar.

Front Brake (Thunderbolt and Royal Star only)

Finger adjusters are provided at both ends of the brake cable. One is mounted on the cable abutment on the brake plate at (F) Fig. 25, and can be adjusted after slackening the ring-type locknut. Relock this nut after any adjustment has been made.

The second adjuster is at the handlebar lever and is shown in Fig. 1.

If necessary, the brake cam lever can be fitted on a different serration, or turned over, to give a "half-way" position to provide further cable adjustment.

FRONT WHEEL REMOVAL AND REPLACEMENT

(Lightning, Firebird Scrambler, Spitfire Mk. IV)

Uncouple the brake cable by withdrawing the pivot pin and split pin from the clevis (E) at the cam lever (Fig. 26).

Remove the fork leg end caps (F) and, as the bolts are removed, support the wheel in order to avoid damage either to the bolts or to their sockets.

Lower the wheel towards the ground until the brake plate comes clear of the tongue on the fork leg when the wheel is free and can be removed.

When replacing the wheel, first engage the brake plate slot with the fork leg tongue and then add the fork end bolts. The latter register in grooves at both ends of the spindle which must be correctly positioned before the bolts can be inserted.

A new split pin should be used at the clevis (E).

IMPORTANT:—The fork end caps are not identical and must be assembled on the same leg from which they were removed. To assist identification, numerals are stamped on the cap and the leg and these must coincide.

Royal Star and Thunderbolt only

First disconnect the brake cable by withdrawing it from the slotted clevis at (E) Fig. 25, and unscrewing it from the bracket at (F). Remove the torque arm nut (C), slacken nuts (D) and the pinch bolt (A). Insert a tommy bar in the hole in the head of the spindle at (B) and unscrew the spindle, noting that it has a left-hand thread and therefore unscrews in a clockwise direction. Support the wheel as the spindle is withdrawn, and when it is clear the wheel can be pulled away from the right-hand fork leg and removed from the machine.

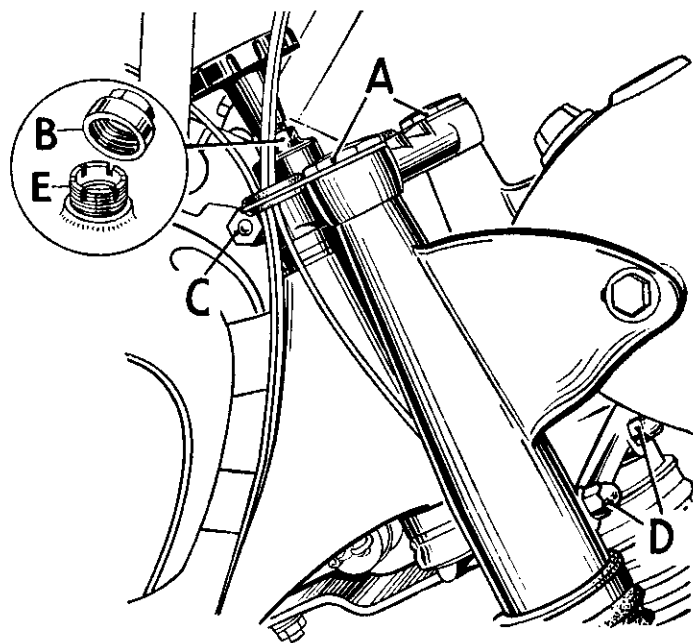


FIG. 28. Steering head adjustment.

After removal do not let the wheel fall on to the brake drum side of the hub. Although the bush is pressed in, it may, if subjected to a sharp blow, be forced back into the hub. If this should happen the bush can be retrieved and re-positioned with the aid of the wheel spindle.

When the wheel is replaced it is most important that after the spindle has been tightened but before the pinch bolt is tightened, the forks are depressed once or twice to enable the left-hand fork end to position itself on the spindle. If this precaution is not observed, the fork leg may be clipped out of position and it will not function correctly.

REAR WHEEL REMOVAL

Removal of the wheel does not affect the chain or brake adjustment. Remove the spindle (B) Fig. 20. It has a normal right-hand thread and therefore unscrews in an anti-clockwise direction. The distance bush (E) falls clear when the spindle is removed and the wheel can then be pulled away from the brake drum and withdrawn from the machine.

When detaching the rear wheel it is unnecessary to touch the hexagon nut (A) on the left-hand side.

WHEEL BALANCING

Wheels which are out of true or out of balance will have a detrimental effect on steering. Wheel truing is a job best left to the specialist, but the spokes should be examined occasionally to see that none of them show any signs of working loose. Single spokes can often be retightened or replaced without affecting the true of the wheel, but if a number of spokes have been affected the wheel should be re-trued.

As soon as the machine has been run-in, the wheels should be balanced, and they should be re-balanced whenever new tyres or other components have been fitted.

Support the machine so that the wheel is off the ground and make sure that it spins freely. If there is any sign of stiffness investigate the cause, as unless the wheel is free it will be impossible to balance it correctly. Rotate the wheel slowly and allow it to settle. Mark the uppermost point of the tyre. Repeat the operation to check that the wheel always stops in the same position.

The point marked is obviously the lightest point on the wheel and weight must be added at this point until the wheel is properly balanced. Specially designed weights are available which can be added to the spoke (or spokes) that are nearest to the mark until the wheel becomes balanced, and shows no tendency to stop in any particular position.

FRONT AND REAR SUSPENSION

FRONT FORKS

Under normal conditions the only servicing which the front forks require is occasional renewal of the oil. The need for this may be indicated by excessive movement of the front forks but it should only be necessary after considerable mileage.

Remove the cap nut (A) Fig. 28, and the drain screw (G) Figs. 25 and 26 in the lower end of the fork sliding member.

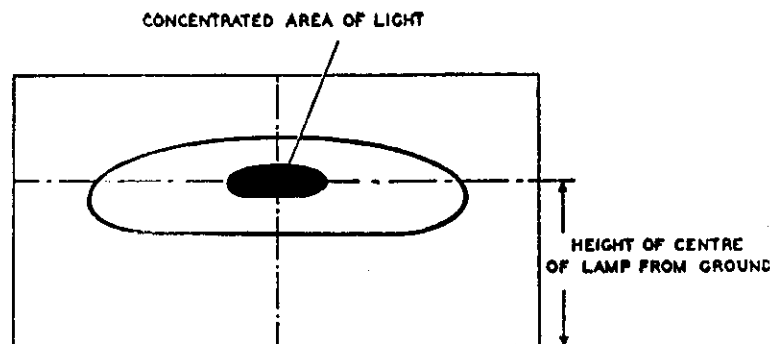


FIG. 29. Headlight beam setting pattern.

Allow all the oil to drain out, then apply the front brake and depress the forks a few times to drive out any oil remaining in the system.

Make sure that the sealing washers are in good condition and replace the drain screws. Raise the cap nuts (A) a few inches and pour $\frac{1}{3}$ -pint of an S.A.E. 20 oil into each leg. Replace the cap nuts and tighten firmly.

Recommended grades of oil are given in the Lubrication Chart, page 15.

STEERING HEAD ADJUSTMENT

The steering head should be tested occasionally for play and to ensure that it rotates freely. Support the crankcase on a box so that the front wheel is clear of the ground, then grasp the front fork legs and attempt to push them backwards and forwards. If any play is detected the steering head must be adjusted.

Unscrew the steering damper and remove the top cap (B) Fig. 28. Slacken the clamping nuts (C) and (D), then tighten down the sleeve (E) until the adjustment is correct. Hold the handlebars lightly and move them round slowly. The steering should be free, and the forks must rotate smoothly. If the movement is "lumpy" it is a sign that the adjustment is too tight, or that the ballraces are damaged. When the adjustment is correct tighten the clamping nuts (C) and (D), replace the cap (B) and the steering damper.

REAR SUSPENSION

The two suspension units comprise a telescopic damper unit and a totally enclosed coil spring. The pressure on the spring can be varied by means of a three-position cam adjuster at the lower end of the unit (F) Fig. 20. The springs can therefore be adjusted to suit the load conditions or nature of the ground. A special spanner is provided in the toolkit for adjusting the cam ring.

The hydraulic dampers require no attention whatsoever. They are sealed during manufacture and if they suffer damage or become ineffective they must be replaced.

The complete suspension units can be removed from the frame after detaching the two pivot bolts. The top spring housing is retained by two collets and the spring must be compressed before they can be removed. B.S.A. Service Tool No. 61-3503 will be necessary for this operation.

THE ELECTRICAL EQUIPMENT

Electrical energy in the form of rectified alternating current passes through the battery from the Lucas A.C. lighting/ignition unit, which comprises a 6-pole alternator and rectifier. The rectifier converts the alternating current output of the alternator to uni-directional current which is essential for battery charging.

RECTIFIER

The nuts clamping the rectifier plates together must not under any circumstances be slackened, as the pressure has been carefully set during manufacture to give correct rectifier performance. A separate nut is used to secure the rectifier to the frame of the motor-cycle.

BATTERY TOPPING-UP

At weekly intervals (see "Routine Maintenance", page 12), and more frequently in warm climates, check the electrolyte level in the battery cells; if necessary, add distilled water to maintain the level indicated by the line. Do not add the water while the battery is on charge (either on or off the machine), nor use naked lights when examining the condition of the cells.

BATTERY—MAINTAINING CONDITION

Never leave the battery in a discharged condition. If the motor-cycle is to be out of use for any length of time, have the battery fully charged, and every two weeks give it a short refreshing charge at .7 ampere to prevent any tendency for the plates to become permanently sulphated.

The A.C. lighting/ignition unit has been designed for positive (+) earth systems. If the battery connections are reversed the equipment will be damaged, and it is therefore most important that, whenever the battery leads are being attached, the positive (+) lead must be connected to the frame.

ZENER-DIODE

This unit is mounted on a light alloy finned casting below the steering head and if at any time it is disturbed it is important to note that the fixing nut must not be subject to a tightening torque of more than 28 lb./in. or less than 24 lb./in. In addition, its seating face must be flat and free from burrs.

CONTACT BREAKER UNIT

The contact breaker points must always be kept free from grease or oil, and the gaps checked at intervals. It is also advisable to check the gaps after the first 500 miles (see page 23).

LIGHTING EQUIPMENT—HEADLIGHT BEAM SETTING (Fig. 29)

When the motor-cycle carries its normal load the headlight driving beam should be projected straight ahead and parallel with the road surface.

NOTE:—This instruction may require amendment to suit local (overseas) lighting regulations.

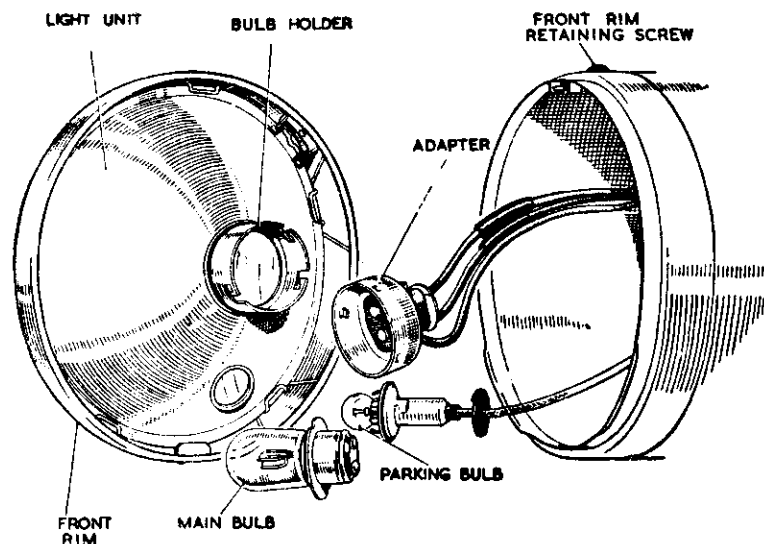


FIG. 30. Headlight dismantled for bulb removal.

When checking setting:—

- Front of motor-cycle should be square with screen;
- Motor-cycle should be carrying normal load and standing on level ground;
- Recommended distance for setting is at least 25 feet.

To make an adjustment, slacken the screws securing the headlight and move it until the correct setting is obtained. Finally retighten the securing screws.

With the Lucas pre-focus bulbs fitted in these lamps, the filament is correctly positioned during manufacture in relation to the focal point of the reflector. No further focusing is necessary.

BULB REPLACEMENT—HEADLIGHT (FIG. 30)

Bulb No. 446, 12 volt, 50/40 watts, pre-focus. To gain access to the headlight bulb, slacken the front rim retaining screw situated at the top of the fixing rim. Disengage and withdraw the front rim and light unit assembly, removing the upper edge first. Press the adapter inwards and turn it to the left. Lift off the adapter and withdraw the defective bulb. After fitting the replacement bulb reverse the above procedure to reassemble the light.

PARKING LIGHT

Bulb No. 989, 12 volt, 6 watts. Disengage and withdraw the front rim and light unit assembly. The parking light bulb holder and bulb can then be withdrawn from the reflector in which it is a push-fit.

HEADLIGHT BEAM WARNING LIGHT

Bulb No. 281, 12 volt, 2 watts. Disengage and withdraw the front rim and

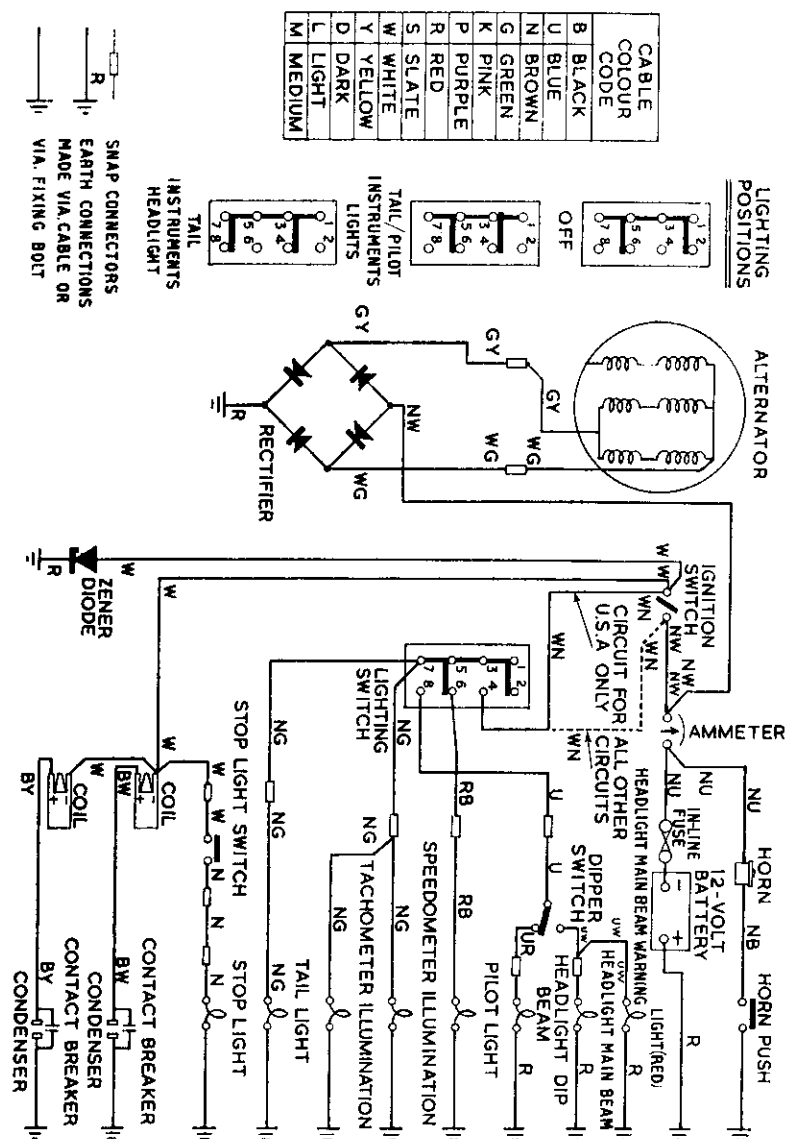


FIG. 31. Wiring diagram (except Firebird Scrambler)

light unit assembly. The bulb holder is a push-fit in its housing and to remove the bulb, depress and turn.

STOP-TAIL LIGHT

Bulb No. 380, 12 volt, 6/21 watts. Access to the bulb is gained by removing the two lens retaining screws. When fitting the replacement bulb, note that the securing pins are offset to ensure correct insertion into the bulb holder.

CIRCUIT DIAGRAM

A diagram of the electrical circuits appears on page 51 and 53. The rubber insulation of the wires is individually coloured, and these colours are indicated on the diagram.

CABLE HARNESS

As the lighting and ignition switch connections are of the plug-and-socket type, the cables are supported within the headlight by a carrier clip to prevent accidental disengagement of the connections. Occasionally inspect the clip to make sure that the cables are properly retained.

ELECTRICAL EQUIPMENT

Firebird Scrambler only

These models are fitted with a modified form of the standard electrical equipment described on pages 49 to 52, and provision is made for the fitting of a capacitor which enables the engine to be run with or without a battery. Hence, for use in competitive events, the rider can remove the battery if he so desires.

A capacitor is also suitable for emergency operation in case of battery failure, since engines can be started without the battery and run as normal, with full use of the standard lighting.

In operation, the energy pulses from the alternator are stored by the capacitor, to ensure that sufficient current flows through the ignition coil at the moment the contact points open, thus ensuring an adequate spark.

RUNNING WITHOUT THE BATTERY

Before running the engine with the battery disconnected, it is essential that the battery negative (—) lead is bound up with insulating tape to prevent short-circuiting by contact with the frame of the machine, otherwise the capacitor will be ruined.

NOTE:—When a capacitor is fitted periodically check that it is serviceable by disconnecting the battery, when the engine should continue to run in the normal manner with full lighting also available.

SPECIAL NOTE—The capacitor is not supplied as standard equipment, but suitable leads are provided for the addition of the capacitor, if required. Normally, these leads are inoperative and are taped to the main harness.

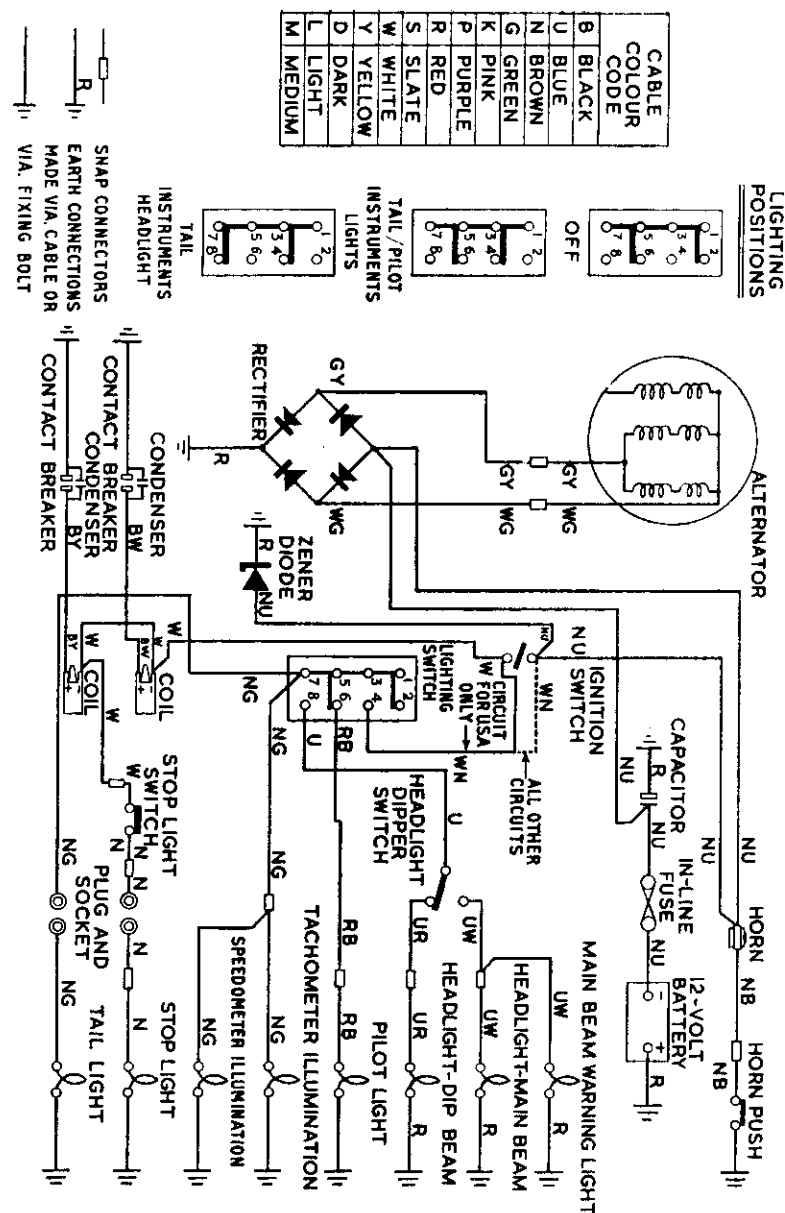


FIG. 32. Wiring diagram (Firebird Scrambler only).