Publication 9274
December, 1952

SERVICE MANUAL

RUSTON

SMALL VERTICAL OIL ENGINES

VTO . VSO
VTH . VSH

RUSTON & HORNSBY LTD.
LINCOLN . . ENGLAND
(Associated with Davey, Paxman & Co. Ltd., Colchester)

Telephone: Lincoln 580 Telegrams: Ruston, Lincoln

PRICE 30/- EACH

FOREWORD

This manual has been prepared to give the best possible guidance to our Agents and their Engineers, particularly overseas, in overhauling RUSTON engines in their respective territories.

Our object is to cover all dismantling and re-assembling operations, and at the same time give dimensions and constructional details of the special tools etc., which are required. By careful study of the MANUAL, Agents and their Engineers should be able to effect engine overhauls in much the same manner as carried out in our shops.

All special tools and equipment described may be purchased from us, or if desired may be manufactured in clients' own workshops from the drawings contained herein.

The wide range of our productions compels us to have several divisions, viz:—

Small Vertical Engines.

Medium Vertical Engines.

Large Vertical Engines.

Horizontal Engines.

Locomotives.

General Products.

Each division is sub-divided into Sections, so arranged to cover, in order of method of overhaul, the particular engine, or engines it is convenient to include in the Section.

Improvement in methods of production, and in overhauling, are always being made, consequently we have adopted the loose-leaf principle so that information on the latest methods in overhaul and service practice can be added to the MANUAL, and for this purpose arrangements have been made to keep Agents up-to-date by sending them further pages, or Sections, as and when the need arises.

It will, no doubt, be realised that the adoption of the loose-leaf method of compilation precludes the consecutive numbering of pages and illustrations, therefore each section, within its sub-division, is self-contained to date, but can be added to when necessary.

Finally, we would ask that Agents do not hesitate to communicate with us in the event of any precise difficulties where the methods stated herein cannot be employed in a particular instance, when we shall be pleased to afford every possible assistance in resolving their problem. On the other hand any suggestions for improvements to the tools and equipment described, which our friends in their experience have found to save time and/or materials, would be warmly received.

CORRECTION SHEET

ISSUED DECEMBER, 1953

This Sheet replaces that issued in February, 1953

New SECTION INDEX dated December, 1953, replaces present SECTION INDEX, undated.

SECTION S.V.2 (f)

Pages 7 to 10 dated February, 1953 replaced pages dated December, 1952 which should have been destroyed.

SECTION S.V.8 (f) and (g)

Grey lead sheet dated December, 1953 replaces that dated December, 1952.

Remove page 11 dated December, 1952.

New pages 11 to 20 inclusive dated December, 1953 to be inserted between page 10 and the grey lead sheet of S.V.9.

SECTION S.V.11 (a), (d) and (e)

Grey lead sheet dated December, 1953 replaces that dated December, 1952.

Pages 5 and 6, Sub-section (*a*) dated December, 1953 replace pages 5 and 6, dated December, 1952.

New pages 19 to 28 inclusive dated December, 1953 to be inserted between page 18 and the grey lead sheet of S.V.12.

SECTION S.V.12 (a) to (g)

Remove the two sheets dated December, 1952.

New grey lead sheet and pages 1 to 22 inclusive dated December, 1953 to be inserted between page 28 of S.V.11 and grey lead sheet of S.V.13.

SECTION S.V.14 (a)

Pages 1 and 2 dated February, 1953 replaced pages dated December, 1952 which should have been destroyed.

Pages 1 and 2, Sub-section (*a*) dated December, 1953, replace pages 1 and 2, dated February, 1953.

ERRATUM

SECTION S.V.8 (a) page 4

Item 7 in the Table of Parts should read :—

Stock	$\frac{3}{8}$" B.S.F. Setscrew		One

SECTION S.V.11 (a) page 4

The last line should read :—

The adaptor required is 6-SD-84 No. 1 Swan neck.

SECTION S.V.13 (a) page 1

Line 9(a) should read :—

B.M.E.P. at 1000 R.P.M.	p.s.i.	78.8	83

SECTION S.V.13 (b) page 3

The figures for lubricating oil pressure should read :—

Lubricating Oil working pressure	p.s.i	20 to 30
	kgs/cm²	1.4 to 2.1
Lubricating Oil minimum pressure	p.s.i.	8 to 10
	kgs/cm²	0.56 to 0.7

SECTION INDEX

DECEMBER, 1953

SV I

ENGINE
DESCRIPTION

ENGINE DESCRIPTION

SVI

ARRANGEMENT OF SINGLE CYLINDER ENGINE VTH–VSH

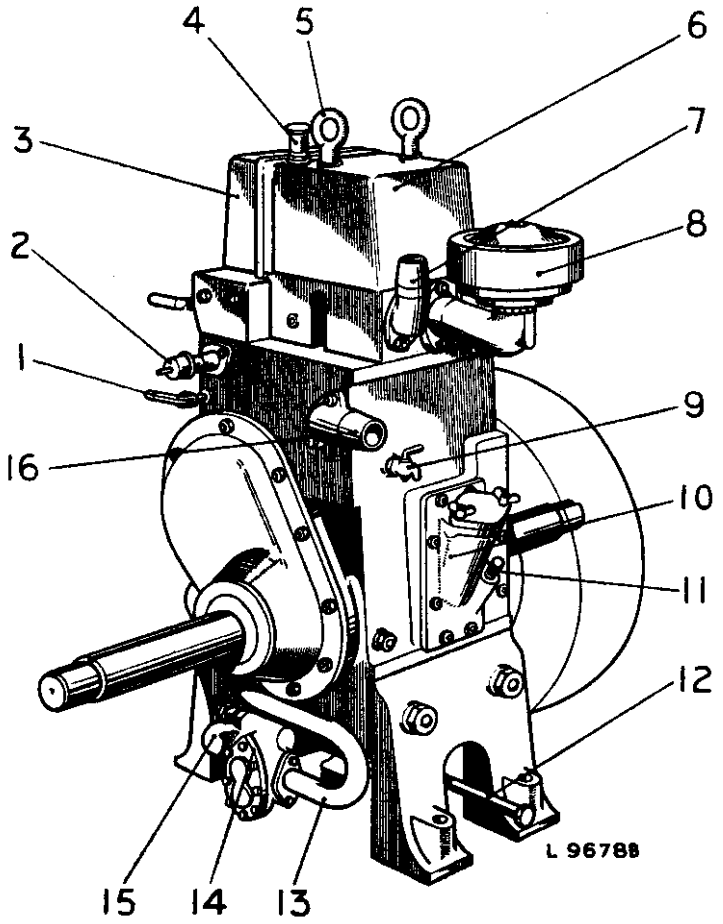


Fig. 1 Single Cylinder Engine (opposite Camshaft side)

1. Cut out lever for fuel pump
2. Speed controller
3. Valve gear cover
4. Oil cup for valve rocker lubrication
5. Eye bolt for lifting engine
6. Cylinder head cover
7. Water outlet connection
8. Air filter
9. Water drain tap
10. Lubricating oil filler
11. Dipstick
12. Lubricating oil drain pipe
13. Lubricating oil delivery pipe, pump to crankcase
14. Lubricating oil pump
15. Lubricating oil suction pipe, sump to pump
16. Water inlet connection

ARRANGEMENT OF SINGLE CYLINDER ENGINE VTH—VSH

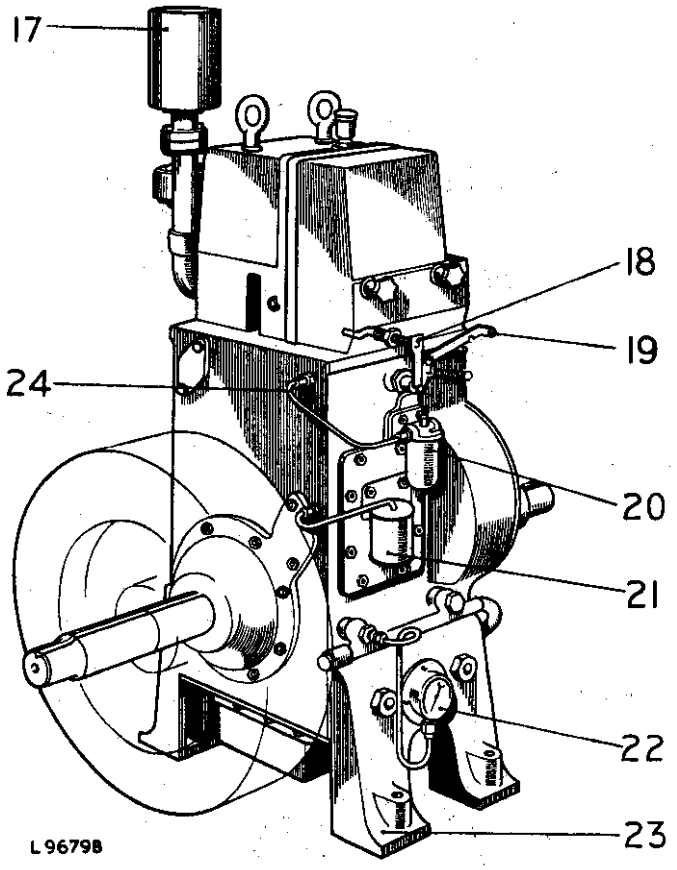


Fig. 1a Single Cylinder Engine (Camshaft side)

17. Exhaust silencer
18. Overload stop control
19. Spragging gear lever
20. Fuel oil filter
21. Injector drip can
22. Lubricating oil pressure gauge
23. Engine bearers
24. Fuel pipe from filter to pipe rail in housing

"CUT AWAY" SECTION OF RUSTON 4 VSH ENGINE

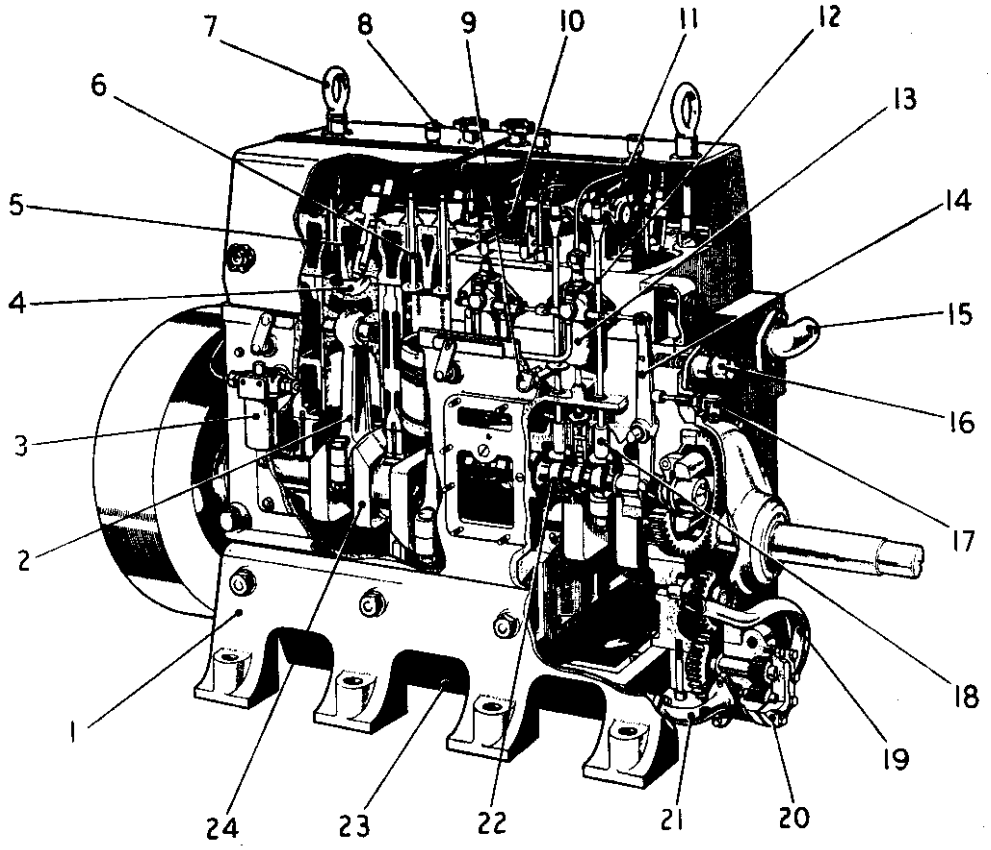


Fig. 2 Cut away section of Ruston 4 VSH engine

1. Engine bearers
2. Connecting rod
3. Fuel oil filter
4. Piston
5. Injector
6. Inlet and exhaust valves
7. Eye bolt for lifting engine
8. Lubricator for rocker lever lubrication
9. Spragging gear
10. Valve spring
11. Valve rocker lever
12. Valve push rod
13. Fuel pump
14. Governor lever
15. Water inlet connection
16. Speed control
17. Cut out lever for fuel pump
18. Valve tappet
19. Lubricating oil delivery pipe, pump to crankcase
20. Lubricating oil pump
21. Lubricating oil suction pipe, sump to pump
22. Cams and camshaft
23. Lubricating oil sump
24. Crankshaft

ENGINE DESCRIPTION

Ruston engines work on the four-stroke cycle—*i.e.* (1) suction-stroke, during which pure air is drawn into the engine cylinder, (2) compression-stroke, towards the end of which fuel is injected, (3) working-stroke, during which combustion and expansion of the charge takes place, (4) exhaust-stroke, during which the products of combustion are expelled.

Ignition of the combustible charge is efficiently effected by the rise of temperature caused by compression, and starting from cold is an easy procedure.

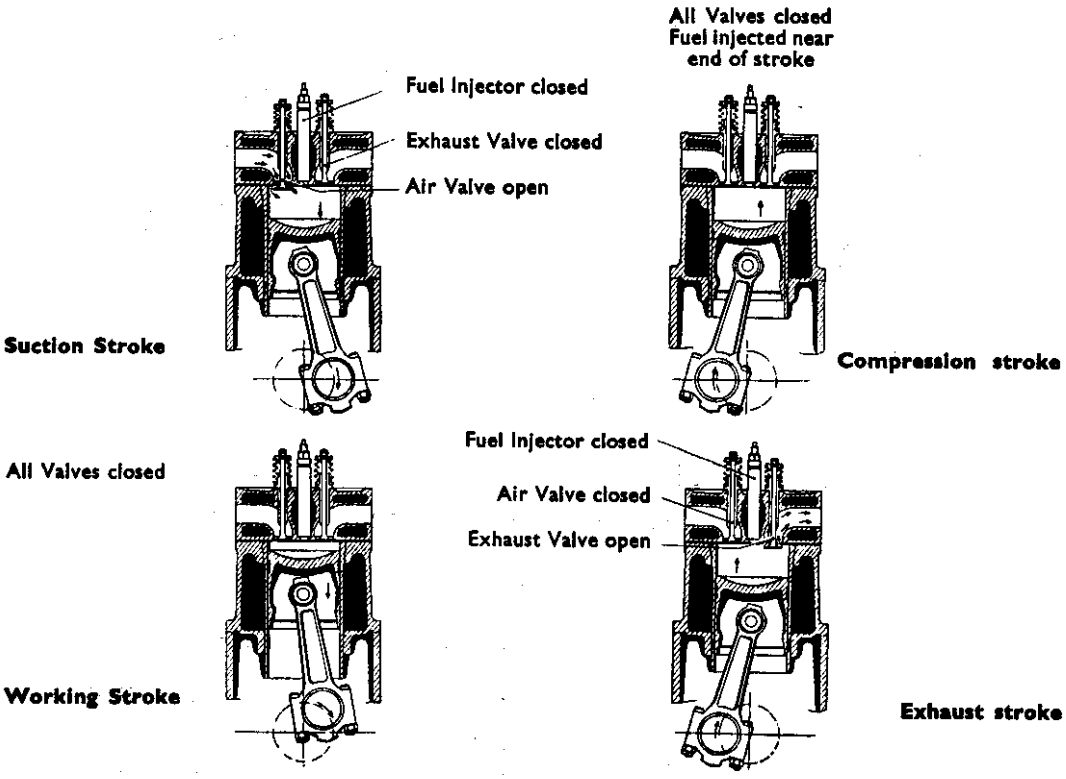


Fig. 3 **4-stroke cycle.**

SV 2

CYLINDER HEAD

CYLINDER HEAD

SV 2

CYLINDER HEAD

REMOVAL

i. Drain cooling water by drain cock at lowest point of cooling system—e.g., item 9 in single cylinder arrangemens, see Fig. 1 S.V.1.

ii. Remove head covers and support bar when fitted.

iii. Disconnect and remove fuel oil, water and air pipes.

iv. Remove water outlet, air inlet and exhaust manifolds and the injection equipment.

v. Remove cylinder head nuts.

NOTE If engines are to be serviced in large numbers it will be found helpful to have tube and ring spanners for this operation.

vi. When the cylinder head nuts have all been removed the valve rocker bracket should be lifted off.

vii. The cylinder head may now be removed.

NOTE If reasonable care is exercised it is possible to preserve cylinder head and other joints through several overhauls.

REPLACEMENT

i. ALL DAMAGED or doubtful joints must be renewed.

ii. Clean joint and joint faces and smear soft soap thinly on either side of the joint.

iii(*a*) Reverse procedure stated in **REMOVAL** and with regard to vi. above, the rocker bracket should be so positioned as to make the centre-line of the rocker pads, when looking from the end of the engine, co-incident with the centre-line of valve caps to prevent side thrust on the valve stem.

A glance at illustration Fig. 8, covering valve tappet clearances will make this point clear.

iii(*b*) On the four cylinder engine the procedure differs slightly due to the fact that two separate blocks, covering two cylinders each, are fitted. To ensure that the two heads are in line one with the other, they should be dropped on and head nuts put on finger tight only, then the air, and/or exhaust manifold complete with joints should be fitted and tightened into position.

Tighten head nuts in accordance with the note over.

IMPORTANT NOTE

All cylinder head nuts must be under even tension and this can only be ensured by TIGHTENING PROGRESSIVELY in order those nuts which are diametrically opposed.

It is recommended that the order of tightening shown in Fig. 1 be followed.

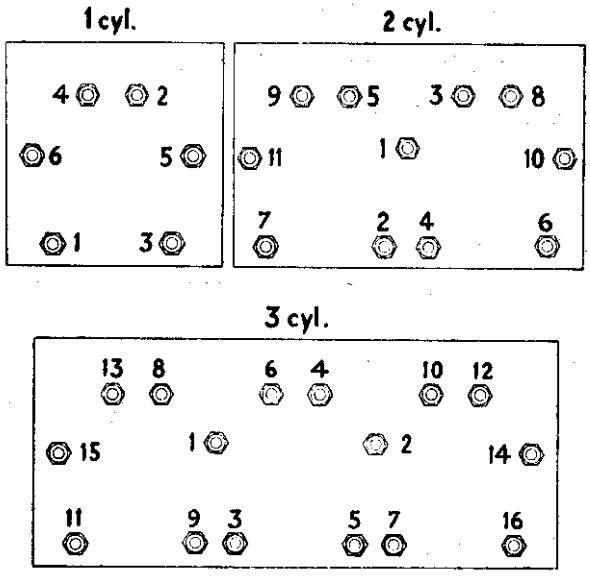


Fig. 1

Tension MUST BE applied gradually to prevent distortion.

FOLLOWING UP

After the initial run the head nuts should be further tightened whilst the engine is at running temperature, using NO MORE FORCE than is necessary to obtain a gas tight joint.

VALVE SPRINGS

The valve springs can, if necessary, be removed and replaced without disturbing the cylinder head.

REMOVAL with cylinder head on engine, but with valve gear cover off.

i. Set piston on top dead centre (Firing Stroke).

ii. Remove valve rocker bracket assembly after undoing two only cylinder head nuts.

iii. Hardened caps to be removed from valve stems.

iv(*a*) **(Exhaust Valve)** Decompress valve spring retaining collar, sufficient to remove collets.

Tool in Fig. 2 may be used or any other bar-cum-lever arrangement with a hole in it to allow the valve stem to protrude and collets to be removed.

iv(*b*) **(Inlet Valve)** Remove split pin from valve stem and spring retaining collar—then proceed as for exhaust valve.

NOTE This valve is fitted with a shroud, therefore the illustration—Fig. 3, serves to emphasize the important fact that the split pin hole in the inlet valve stem is OFF-SET to prevent the possibility of replacing the valve wrongly.

REPLACE Reverse the procedure stated above taking great care to put split pin hole in the inlet valve stem exactly in line with the slot in the pear shaped spring retaining collar.

IMPORTANT

The flywheel **MUST NOT** be turned during this operation otherwise the valves will drop into the engine cylinder and the head would then have to be removed to replace the valves in their guides.

The hardened valve cap **MUST NOT** touch collets, or retaining collar, but rest on top of valve stem.

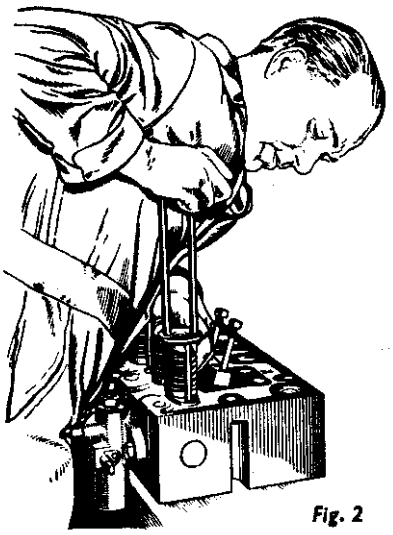


Fig. 2

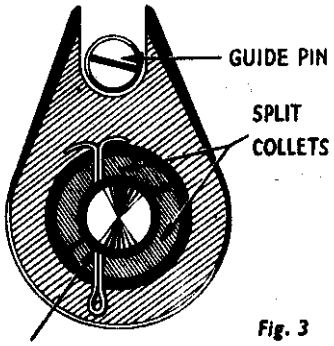


Fig. 3

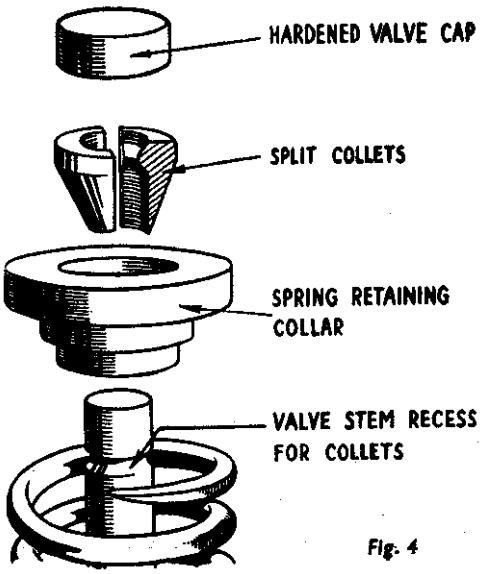


Fig. 4

INLET AND EXHAUST VALVES

The instructions assume that the cylinder head and the valve rocker gear have been removed from the engine.

REMOVAL

i. Place head on the bench on two wooden battens, not less than 1½ in. thick, to protect joint face, fuel pump and injector nozzle from damage.

ii. Remove valve springs (See Valve Springs).

iii. Withdraw valves from the underside.

REGRIND

If, upon examination, the line of contact on either valve or seating is found to be blackened, or pitted, the following procedure should be adopted:—

i. Place the head with seating in a convenient position.

ii. Smear fine, or if valves and/or seats are badly pitted, coarse carborundum paste, on the valve face (if coarse paste is required in the first instance, it will be necessary to finish with a fine abrasive). Great care must be taken to prevent abrasive from getting on the valve stem.

iii. Put a spot of oil on seating and insert valve in guide and with a joiner's hand brace and screw turn, grind the valve to seating with an oscillating movement—lifting from time to time, to grind in, in a fresh position.

NOTE A **light** spring under the head of the valve will be found extremely helpful. (See Fig. 5). The spring is just strong enough to lift the valve off its seating when pressure is released, thus enabling a fresh position to be obtained without having to reach over the head to lift the valve by hand.

Renew abrasive when it becomes inoperative.

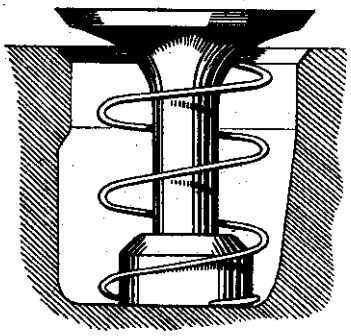


Fig. 5

CHECKING

Clean the valve and seating thoroughly and check by putting pencil lines diagonally across the seating—insert valve—apply direct pressure—move valve approximately ⅛"—lift and if **ALL** lines are found to be broken—the valve is seating correctly.

An alternative method is to clean the valve and seat of abrasive and then rotate valve with continuous circular movement with a spot of oil on the seat and if a bright unbroken line becomes evident the valve is seating correctly.

REPLACEMENT

Oil valve stem, insert in guide and fit springs as instructed on page 3.

IMPORTANT

In grinding valves and seats, always remember to remove only that amount of metal necessary to re-seat valve. To re-grind without regard to metal removed will reduce the working life of the parts concerned accordingly.

VALVE GUIDES

Inlet and exhaust valve guides are a driving fit in the cylinder head. The instruction assumes that the head has been removed from the engine.

REMOVAL

i. Stand head upside down on wooden blocks, or a frame, to give sufficient room for the valve guide to clear the bench when driven out; approximately 4" is required.

ii. Drive the guide out with tool 8224/3 IW. and a $\frac{3}{4}$" diameter steel bar about 9" long.

FITTING NEW GUIDE

i. Stand head right way up on wooden blocks.

ii. Ensure that the hole is free from burrs.

iii. Enter guide in the hole, taking care to see that it is at right angles (all ways) to the top facing.

iv. With tool (spigoted drift) and hammer, as shown in Fig. 6, drive the guide in until the faces of the bottom flange makes contact with the cylinder head facing.

Fig. 7 gives dimensions and manufacturing particulars of tool 8224/3 IW.

NOTE The diameters given are for VSO/H, figures for VTO/H diameters are $\frac{5}{8}$" and $\frac{5}{16}$" respectively, subject to the same tolerance.

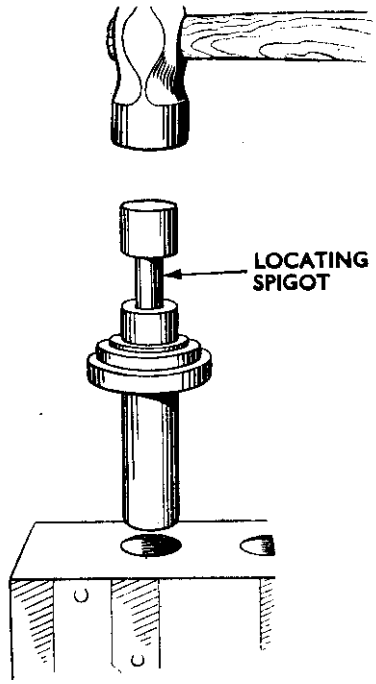


Fig. 6

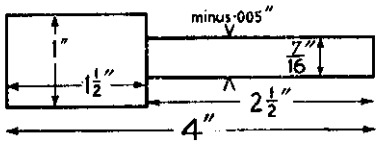


Fig. 7

VALVE TAPPET CLEARANCES

Valve tappet clearances require checking from time to time, and, of course, always after the cylinder head has been removed and replaced.

CHECKING

i. The engine should be ' COLD '.

ii. Turn flywheel until BACK-CAM position of the valve to be checked is reached. See Fig. 8.

If the engine cover has not been removed it is a good plan to put a chalk mark on the flywheel at **full-lift** and then turn the wheel 360° (one full turn).

iii. Check clearance, after applying slight pressure on top of adjusting screw, between hardened valve cap and the rocker pad. See Fig. 9.

iv. Adjust by means of the slotted screw and lock-nut—with screw driver and appropriate sized spanner.

NOTE A method which we have found most helpful in adjusting clearances, is to employ two feeler gauges, or sets of feelers, one gauge to be minus .001" and the other plus .001".

e.g.

in the case of the VTH where .006" is required a gauge .005" is the ' GO ' and .007" is the ' NO-GO '. By this means adjustment is quickly and accurately made. See Fig. 10.

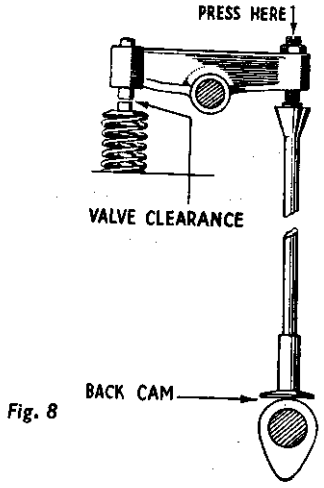


Fig. 8

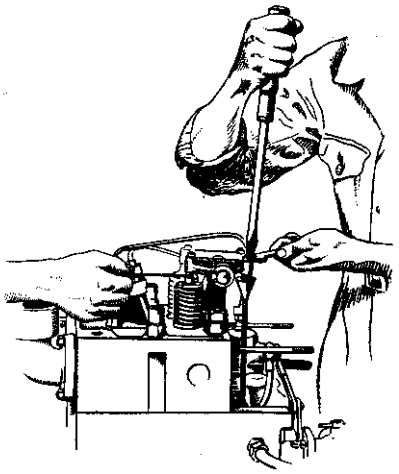


Fig. 9

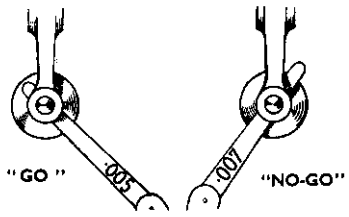


Fig. 10

CLEARANCES

VTO VTH	VSO VSH
.006 ins. .152 mm.	.007 ins. .178 mm.

TUBE FOR INJECTOR HOLE

VTH & VSH

This tube, part number 6786, the outside of which for part of its length is in contact with the water chamber, see Fig. 11, requires an expander, or special tools and treatment if and when it develops a leak or requires replacing. Tool numbers, or sizes are given below and the order of their use clearly shown. A study of the illustration, together with the following instructions will assist in carrying out the re-tubing operation quite readily.

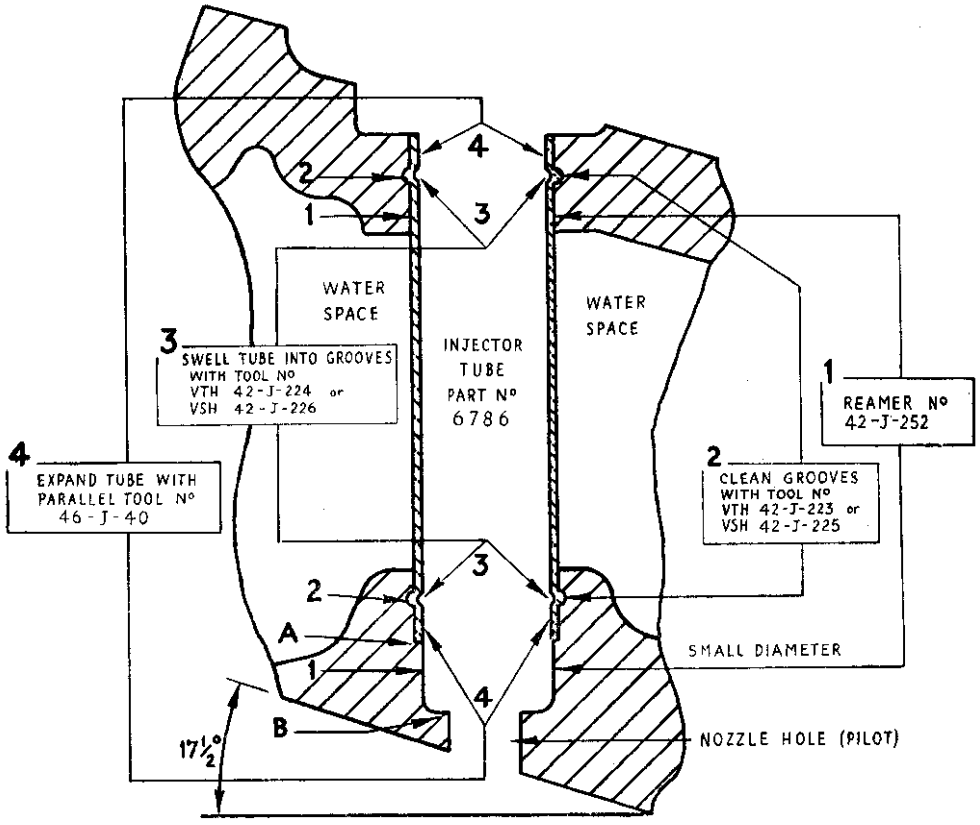


Fig. 11

5 **Final operation.** Clean hole with reamer, 1″ + .010″ dia.

No metal to be removed from shoulders 'A' and 'B' during operation 1.

LEAKING TUBE

Should the tube leak, it is always advisable to try to cure this by means of the ball and parallel expanding tools in the first instance.

The expanding operation can be carried out by hand, whilst the cylinder head is on the housing, by merely removing the injector and retaining bar. Use the ball expander first.

Tool Nos. 42-J-224 and 42-J-226 are ball expanders, whilst tool 46-J-40 is a typical double taper expander, with single inner and multi taper needle roller outers, expansion being parallel to the bore. See items 6 and 7 illustration Fig. 12.

METHOD

i. Withdraw the mandrel in the sleeve to obtain smallest possible diameter of expander.

ii. Insert the expander into the injector tube making certain that the pilot, or end of the expander enters the bottom hole.

iii. With suitable wrench exert as much pressure as possible on the tool whilst turning, as if trying to reamer the hole.

Repeat each operation a few times and then test. If the leak cannot be cured by this means then the tube will have to be replaced.

The removal and fitting of new tubes is a job requiring workshop equipment, therefore the following instructions assume that adequate facilities are available.

EQUIPMENT AND TOOLS REQUIRED

i. Drill and table with about 2 ft. head room and say 1 ft. feed, having spindle speeds of 168 r.p.m. and 600 r.p.m. approximate, head suitable for No. 4 morse taper.

ii. Angle bracket to give 17½° from horizontal. See Fig. 12.

iii. Reamer, tool No. 42-J-252 (1, Fig. 12) *i.e.*, the finishing tool for the two diameters.

iv. Tool 42-J-223 or 42-J-225 (2, Fig. 12), for cleaning top and bottom grooves.

v. Ball expander, tool No. 42-J-224 or 42-J-226, (3, Fig. 12), for swelling tube into the grooves, thus locating it.

vi. Parallel expander, tool No. 46-J-40, (4, Fig. 12), for expanding tube in the bore.

vii. Reamer, at least 7"—8" long, 1" + .010" dia. (5, Fig. 12), for clearing the hole finally.

REMOVING FAULTY TUBE

i Remove the head from the engine, strip it of accessory equipment and remove the injector studs.

ii. Mount and fix on the angle bracket 17½° from the horizontal, the parallel plane being at right angles to a line drawn through the centre of the two valves.

iii. With tool No. 42-J-252 machine the old tube out with a steady feed. This will clear the tube a little below the first swelling, and then, as may be expected, the tube will turn in the bottom groove.

iv. Remove the head from the machine and place on a bench, then by means of a narrow, slightly bent, round nosed chisel through the nozzle hole, collapse the tube until it is possible to remove it entirely.

NOTE **Great care** must be exercised during this operation to avoid damaging the holes in the casting.

FITTING NEW TUBE

i. Mount and fix head on angle plate.

ii. Clean holes out with reamer tool No. 42-J-252.

iii. Clean the grooves out with either tool No. 42-J-223 or 42-J-225. Spindle speed should be about 168 r.p.m.

NOTE Do not remove any cast iron from the grooves, or the bottoms of the holes.

iv. Drive the tube in, after clearing the hole of all drillings, etc.

v. Swell the tube into the two grooves with APPROPRIATE BALL expander, either 42-J-224 or 42-J-226, with spindle speed 600 r.p.m.

vi. Expand the tube with tool No. 46-J-40, spindle speed 600 r.p.m.

vii. Clear the hole out with the 1" + 010" reamer finally.

viii. Subject the head to a water test of 30 p.s.i.

The illustration Fig. 12 shows a two cylinder head on the angle bracket mounted on the block of a radial arm drill. Tools are shown in order of use during the expanding operation, with the exception of items 6 and 7 which show the hand operated versions of the BALL and PARALLEL EXPANDERS respectively.

The operator has completed one injector hole and is seen driving the tube in the second hole.

NOTE the angle of bracket.

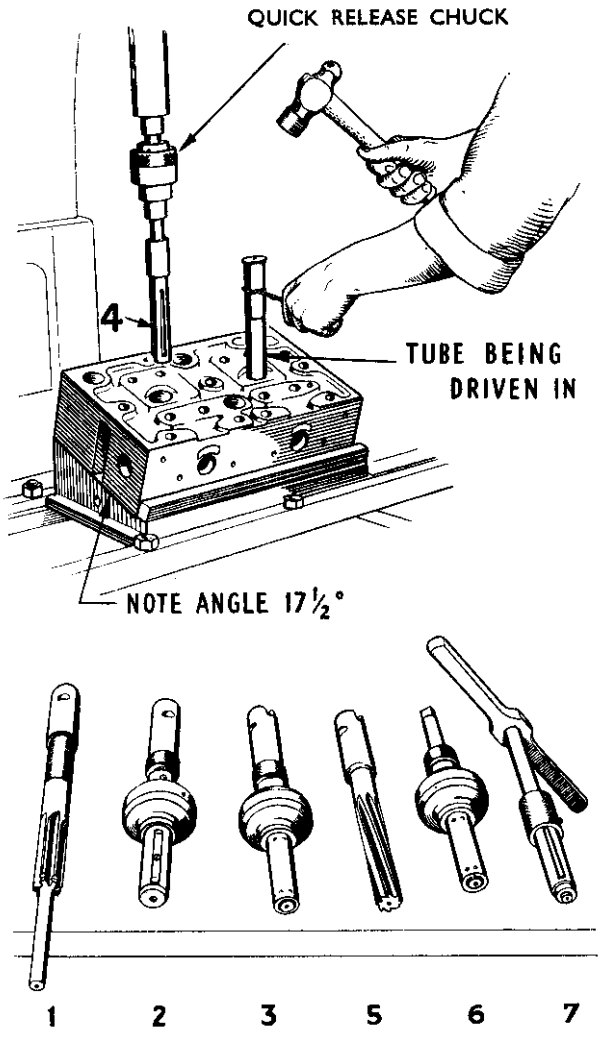


Fig. 12

VTO & VSO

To expand or renew the tube on the earlier model of this engine involves practically the same procedure, with, of course, one or two modifications and different tools.

Try to cure a leaky tube by the hand operated BALL and PARALLEL expanding tools using the same method as described for VTH and VSH.

For the method see VTH and VSH.

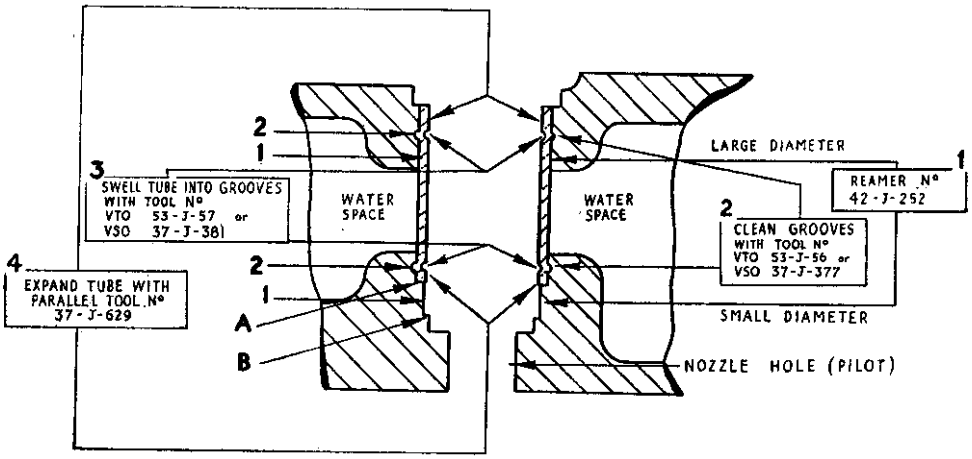


Fig. 13

5—Final operation. Clean hole with Reamer 1" + .010" dia.

No metal to be removed from 'A' and 'B' during operation 1.

EQUIPMENT AND TOOLS REQUIRED

i. As for VTH and VSH.
ii. Angle bracket NOT required.
iii. The same, *i.e.*, tool No. 42-J-252. (1, Fig. 12).
iv. Tool No. 53-J-56 or 37-J-377. (2, Fig. 12).
v. Tool No. 53-J-57 or 37-J-381. (3, Fig. 12).
vi. Tool. No 37-J-629. (4, Fig. 12).
vii. As for VTH and VSH. (5, Fig. 12).

REMOVING FAULTY TUBE

Repeat as for VTH and VSH, except that no angle bracket will be needed.

FITTING NEW TUBE

i. Mount on drill block.
ii. Clean holes out with reamer 42-J-252.
iii. Clean grooves with tool No. 53-J-56 or 37-J-377, spindle speed 168 r.p.m.
NOTE No cast iron to be removed from bottoms of holes, or the grooves.
iv. Drive tube in.
v. Swell tube into grooves with tool No. 53-J-57 or 37-J-381, spindle speed 600 r.p.m.
vi. Expand tube with tool No. 37-J-629.
vii. Clean hole finally with reamer 1" + 010" dia.
viii. Test under pressure.

VALVE SEAT INSERTS

After a long period of service the valve seats of our small vertical engines may become badly recessed due to wear and repeated grinding in, to the point where normally consideration must be given to replacing the cylinder head.

To enable such heads to be reclaimed we give herewith dimensions and full particulars of the method to be adopted for the fitting of valve seat inserts.

THE INSERTS

The inserts should be obtained from PARTS SERVICE DEPARTMENT; the INSERT PART MARK AND ENGINE TYPE AND NUMBER to be clearly stated on your order.

The insert part mark is given in column 2 on the dimensioned sketch.

THE CUTTERS

The cutters for the recess will be supplied against your order and are recommended for ensuring that the machining of the head exactly conforms to the requirements of the inserts. See Fig. 14.

Quote the tool number in column 10 when ordering.

N.B. If these cutters are employed it will be necessary to remove the valve guides and to use the hole in the head as the pilot. In consequence the dimensions of the guide bolt, Fig. 15, will have to be suitably modified.

METHOD

i. Machine cylinder heads in accordance with the dimensions and instructions given, taking care to obtain a perfectly smooth finish at the side and **bottom** of the recess. The use of the cutters described above will ensure this.

ii. "Freeze" the seating until its temperature is approximately minus (—) 10° F. or —23.4° C. (For further particulars see note below).

iii. Wipe the seating clean and press into the recess as quickly as possible, making certain that it enters squarely and that the bottom face of the seating makes contact with the face in the head.

DO NOT TOUCH THE SEATING WITH BARE HANDS.

IMPORTANT

i. DO NOT DRIVE THE SEATINGS IN WITHOUT FREEZING.

To do so results in the removal by shearing of that amount of metal which provides the TIGHT FIT upon expansion, and the insert would rapidly become loose.

ii. After grinding valve and seating together, the head of the valve SHOULD NOT PROJECT more than the amount specified on the drawing above the face of the cylinder head.

FREEZING EQUIPMENT

The equipment we employ in our Works consists of a deep, narrow tank, heavily insulated at sides and bottom, designed and supplied by the Carbon Dioxide Company Ltd., of Great Britain. The tank contains at the bottom a quantity of alcohol (methylated spirits) into which a wire basket is placed so that the inserts to be frozen are in the liquid. An amount of 'CARDICE,' *i.e.*, solid carbon dioxide (CO^2) is placed in the container and the insulated lid put into position.

NOTE

With a liquid temperature of minus (—) 58°F. (—50° C.) in the refrigerator an immersion time of approximately 30 minutes is required to give the necessary reduction in size for PRESSING IN.

PRESSING IN

A tool and plate, similar to that shown on the sketch should be used, the actual insertion being best done under a press.

It is preferable, although not essential, to employ a guide when a press is available, but if a hammer and " set " is the only means of driving the insert into position then a guide MUST BE USED.

NOTE If a suitable old valve is available it will form a useful basis for the guide and press tool if reduced under the head in the manner shown.

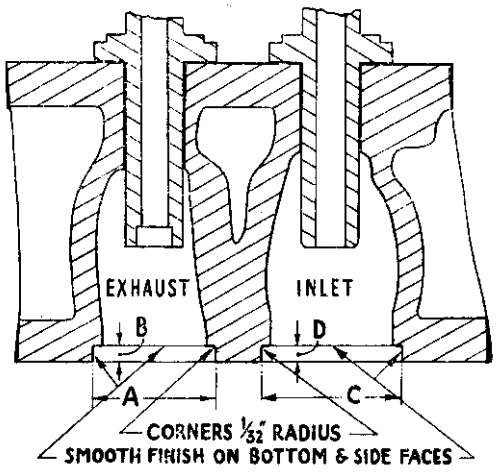


Fig. 14

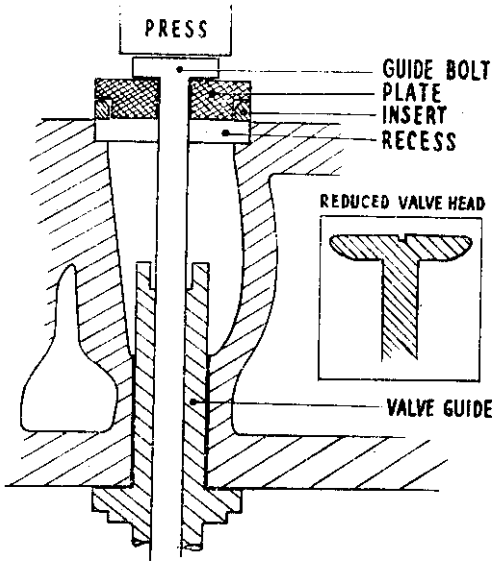


Fig. 15

Engine Type	Insert Part Mark		Exhaust Dimension.	Exhaust Limits (Thous.)		Inlet Dimension.	Inlet Limits (Thous.)	Projection.	Cutters. Tool Number.
VTO	40–313 Ref. 1	A	1½"	+0 −1	C	1½"	+0 −1	1/32"	52-J-317
		B	¼"	−0 +3	D	¼"	−0 +3		
VTH	50–1925 Ex. Ref. 2 In. Ref. 3	A	1½"	−1 +0	C	1 11/16"	−1 +0	1/32"	Ex. 52-J-317 In. 50-J-709
		B	7/32"	±1	D	7/32"	±1		
VSO	40–313 Ref. 3	A	1¾"	+0 −1	C	1¾"	+0 −1	1/32"	52-J-318
		B	9/32"	−0 +3	D	9/32"	−0 +3		
VSH	50–1926 Ex. Ref. 2 In. Ref. 3	A	1¾"	+0 −1	C	2"	+0 −1	1/32"	Ex. 52-J-318 In. 52-J-319
		B	7/32"	±1	D	7/32"	±1		

DECEMBER, 1952

SV 3

PISTON AND CONNECTING ROD

PISTON and CONNECTING ROD

SV 3

PISTON AND CONNECTING ROD

REMOVAL

i. Drain the water jacket, remove cylinder heads, manifolds, etc., and the crankcase doors, and protect the sump against falling particles.

ii. Uncouple the large-end bolts, the nuts of which may be locked by either tab washers or split pin and castle nut, according to date of installation.

iii. Withdraw piston and con rod through the liner.

iv. Remove circlips from gudgeon pin hole and soak piston in boiling water, or hot oil for a few minutes, after which the gudgeon pin may be pushed out quite easily.

GIVE ATTENTION TO PISTON AND CONNECTING ROD IN ACCORDANCE WITH S.V.4 and 5.

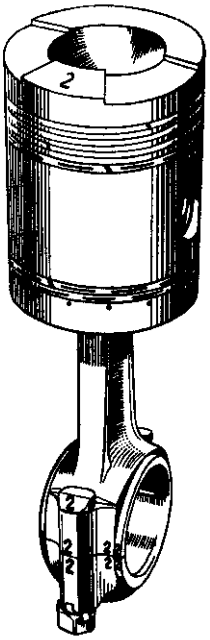


Fig. 1

REPLACEMENT

i. Study the illustration Fig. 1 which clearly shows the method of marking the parts that make up the assembly. Each part is numbered to suit the cylinder into which it is fitted. (The one shown is No. 2).

ii. Check that all parts belong to the assembly.

iii. Warm piston to facilitate fitting the gudgeon. Press this in with all numbers facing one way.

iv. Fit circlips.

v. Space the ring gaps evenly round the piston and smear with oil.

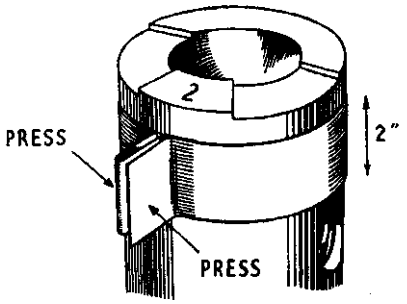
vi. The liner and crankpin should be clean and oiled.

vii. Fit piston and connecting rod into the liner, with the numbers facing the front, or camshaft side of the engine. A piston ring clip, made from 2″ wide tin or thin steel, about 20″ long to fit round the rings will facilitate getting them into the bore, see Fig. 2 and fold as shown in inset.

viii. Re-connect the large end bearing, fit split pin or tab washers as required.

NOTE Whilst the nuts should always be tight, care should be taken not to overstress the bolt, we therefore recommend that the length of spanner be limited to 10″.

ix. Replace crankcase doors and head, etc.



FOLD LIKE THIS
FOR OVERLAP

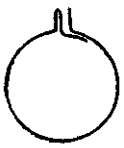


Fig. 2

DECEMBER, 1952

SV 4

SERVICING PISTON AND RINGS

SERVICING PISTON and RINGS

SV 4

PISTON RINGS

The instruction assumes that the piston is removed from the engine and has been separated from the connecting rod. See Sections S.V.3 and S.V.5.

NOTE Before attempting to remove the rings it is recommended that the piston be immersed in paraffin.

REMOVAL

Two methods of removing rings have our approval:—

i. Four spring steel blades about .020" thick and say $\frac{3}{8}$" wide. One blade placed under each ' horn ' or at the gap, the other two at equidistant points round the piston. Hacksaw blades, with the teeth ground off, are suitable.

The ring is thus held clear of the piston grooves and can be eased off.

ii. A pair of ring ' pliers,' or ' expander ' of which there are a number of excellent types on the market.

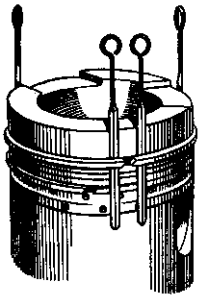


Fig. 1. Spring steel blades in use.

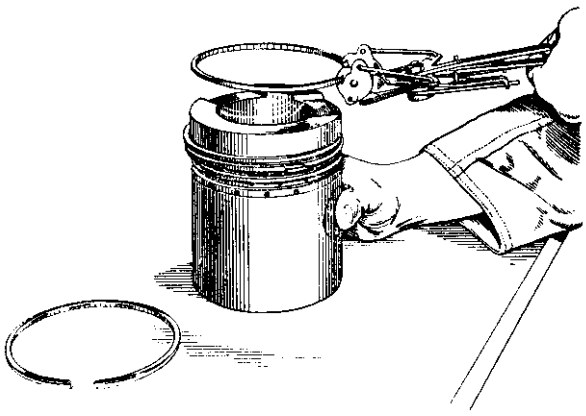


Fig. 2. Expander in use.

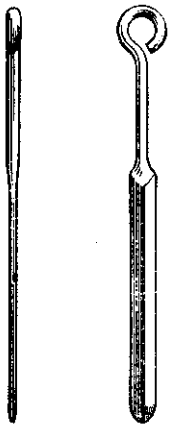


Fig. 3. A convenient shape of blade.

REPLACEMENT OR RENEWAL

i. Thoroughly clean the ring grooves.

ii. Try the ring in its groove to make sure it is free all round and is a good bed on the top and bottom faces of the groove, see Fig. 4.

iii. With " blades ' or ' expander ' fit ring in groove.

iv. Check that the ring turns freely and that the side clearance (see Fig. 4) is not excessive. If excessive proceed as for overwidth rings.

NOTE All spare piston rings leave our Works with the correct ' gap,' there is therefore no fitting to be done in this respect.

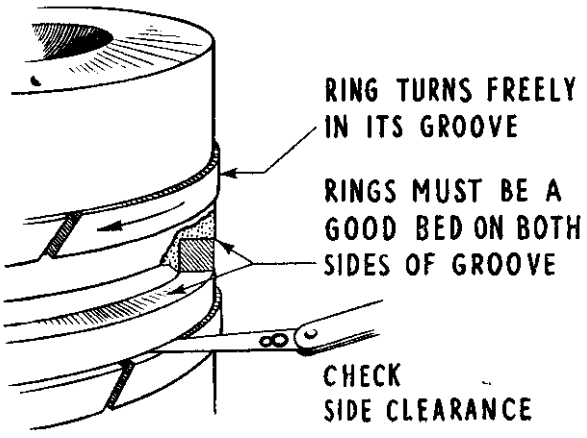


Fig. 4

FITTING OVERWIDTH PISTON RINGS

When the side clearance exceeds the maximum of eight thous. (.008″) generally as indicated in Fig. 5, or the sides become irregular and will not permit a good bed for the ring, (see Fig. 6) then **overwidth** rings should be fitted.

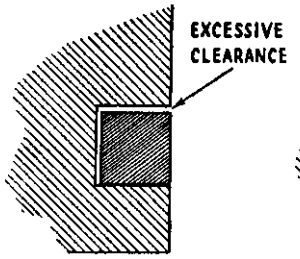


Fig. 5

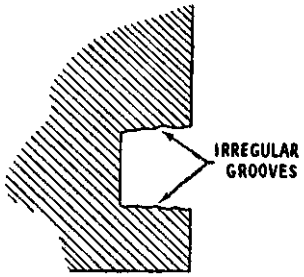


Fig. 6

The present standard piston is fitted with three .125″ ($\frac{1}{8}$″) thick pressure and three .125″ ($\frac{1}{8}$″) scraper rings, two scraper rings in one groove below the gudgeon pin.

Overwidth piston rings can be supplied as follows:—

Marks VTO and VTH $\frac{1}{8}$″ + .005″ and $\frac{1}{8}$″ + .010″ Max.
Marks VSO and VSH $\frac{1}{8}$″ + .010″ and $\frac{1}{8}$″ + .015″ Max.

The grooves should be machined so that metal is removed evenly on either side of the groove, using a tool of a size that will give the ring a side clearance of .002″.

Rings of a width greater than the maximums stated should not be fitted.

NOTE

In our experience we have found that the fitting of rings **oversize in diameter** in standard liners offers no advantage.

SERVICING CONNECTING RODS

SV 5

CONNECTING RODS

ALIGNMENT

The alignment of connecting rods should be checked during complete engine overhauls, or in the event of piston, large and/or small-end bearing troubles. The first check, particularly if trouble has been experienced with piston seizure, should be made on the bore of the connecting rod at the large end. A DUMMY shaft will be required about 6" long with diameter given in sketch Fig. 1.

PROCEDURE

i. Remove both halves of the bearing from the rod.

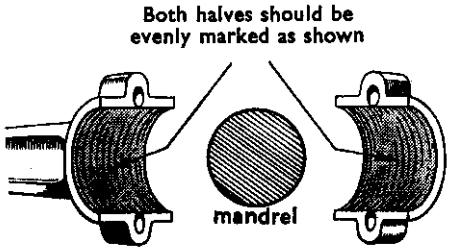
ii. Replace bottom bearing cap with nuts finger tight.

iii. Smear engineers' marking on dummy shaft, insert in rod end and tighten the nuts to the same tension as if in the engine.

iv. Dummy shaft to be turned a few times, withdrawn, and the marking examined, when any distortion will be revealed by gaps in the marking.

NOTE

Should bearing, piston or liner trouble have been experienced in the particular cylinder of which the connecting rod under examination is a part, AND AN EVEN MARKING as shown in sketch Fig. 1 is not obtained THE CONNECTING ROD SHOULD BE REJECTED.



Mandrel Size

VTH $2\frac{13}{16}$" $\begin{matrix}+ 000" \\ - 0005"\end{matrix}$

VSH $3\frac{1}{8}$" $\begin{matrix}+000" \\ -0005"\end{matrix}$

Fig. 1

Subject to the first check proving satisfactory a final check should be made as under:—

EQUIPMENT. See Fig. 3.

(1) Scribing block (2) Iron or wooden block
(3) gudgeon pins (4) clock micrometer
(5) faceplate (6) dummy large end shaft
(7) pair VEE BLOCKS.

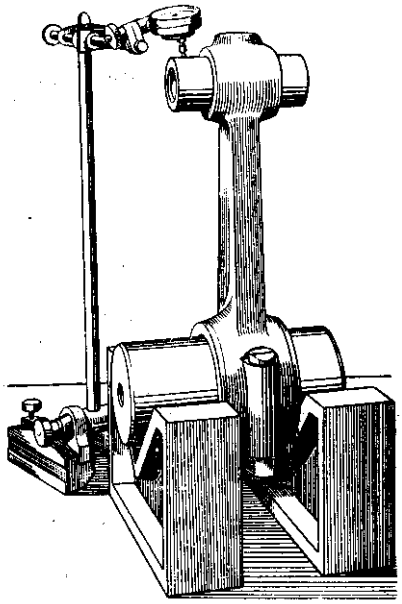


Fig. 2

CHECKING

i. Replace large end bearings in the rod.

ii. Assemble connecting rod, dummy shaft and gudgeon pin in manner indicated in Fig. 2.

iii. With clock micrometer check parallelism of dummy shaft with faceplate. NOTE carefully any discrepancy so that due allowance can be made when taking further readings.

iv. Whilst connecting rod is in the vertical position (Fig. 2) take readings on either side of the gudgeon pin, when subject to any discrepancy referred to in iii the readings should be exactly the same.

v. Lower connecting rod through 90° (Fig. 3) and take further readings on either side of the rod and the readings should be the same.

LIMITS

Connecting rods are issued from our works with the two bores parallel one with the other to within one thousandth (.001") in.; in an assumed length of 12", hence with gudgeon pin 6" long one half a thousandth (.0005") only is allowed; if this limit cannot be conformed to, then the connecting rod should be rejected, or rectified.

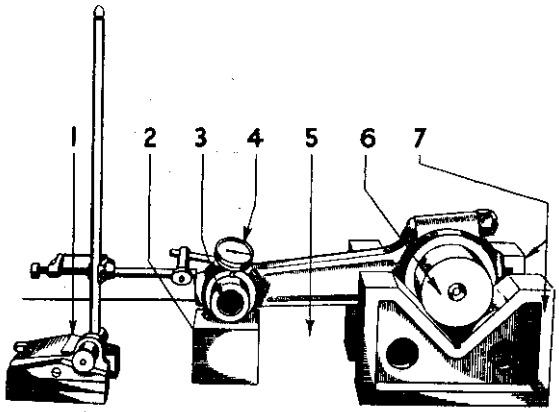


Fig. 3

ADJUSTING OR FITTING LARGE END BEARING

The connecting rod large end bearings are renewable and consist of a steel shell lined with high grade anti-friction metal.

BEARING CLEARANCE

It is important to maintain the correct bearing clearance. On a new engine the running clearance is .0015" to .004" maximum. Insufficient clearance causes excessive friction, and therefore heating, wear, and danger of damage to the bearings. Excessive clearance causes reduced lubrication pressure, hammering, and therefore excessive wear.

ADJUSTMENT

When the large end bearing clearance exceeds .006" adjust as follows:—

i. If crankpin wear is less than 0.003" oval, fit new bearing shells.

ii. If crankpin wear is more than 0.003" oval, regrind the pin and fit a suitable undersize shell.

PRE-FINISHED BEARINGS

Pre-finished shells are marked 'PF'. PF bearings may be used to replace either a similar type, or hand fitted bearings.

NOTE Before they are fitted, 'PF' bearings are not exactly round; they are broader across the horns to allow correct bedding when fitted. See Fig. 4, and also NOTE ii. on page 4.

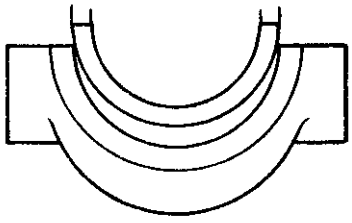


Fig. 4

IDENTIFICATION OF "FINE-BORED" CONNECTING RODS

The procedure for fitting PF bearings in new type or "fine-bored" connecting rods differs from the method used for fitting in "non-fine-bored" connecting rods. The bores of "fine bored" connecting rods are finished very smooth, giving the appearance of a ground finish, whereas the bores of "non-fine-bored" rods show tool marks.

FITTING PF BEARINGS IN "FINE-BORED" CONNECTING RODS

i. Assemble the bearings in the bore of the connecting rod. (Do **not** file the outside or scrape the bore).

ii. Tighten the connecting rod bearing nuts **by hand-spanner** not longer than 10". The bearing will then be an accurate fit.

FITTING PF BEARINGS IN "NON-FINE-BORED" CONNECTING RODS

i. Fit the dowel peg in the bearing cap.

ii. Ensure that all parts are clean and smear the outside of the bearing shell with marking paste.

iii. Assemble the bearings in the bore of the connecting rod and tighten the connecting rod bearing nuts by hand-spanner not longer than 10".

iv. Dismantle the bearing assembly and examine the marking in the shell. This will indicate that the shell bears hardest on the horns but these must not be relieved (See Note, above).

v. To obtain overall bedding of the shell in the bore of the connecting rod, commence by filing accurately the joint faces of the cap only. The amount to be filed will probably not exceed .002" (Fig. 5).

vi. Repeat operations ii, iii, iv and v, until the marking shows that there is contact between the outside of the bearing shell and the crown of the bore of the connecting rod and cap. Scrape away high spots in the bore to obtain an even bedding.

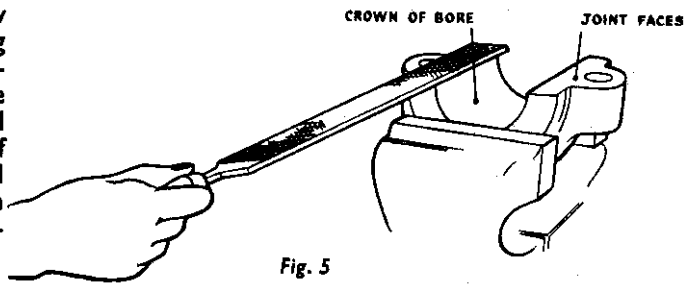


Fig. 5

IMPORTANT Take great care when filing the joint faces of the cap to ensure that when the assembly is finally tightened these faces make solid contact with the corresponding faces on the connecting rod. In all cases, the " nip " of the connecting rod cap on the bearing should be carefully checked, see Fig. 3, S.V.9 and the gap should be .0015"/.002" on one side ONLY.

WARNING

Do not scrape the white metal on the inside of the bearing or file the outside of the shell.

SPARE BEARINGS

Under-sized pre-finished bearings are available to suit reconditioned crankpins. When replacements are obtained from our works and the exact dimensions of the crankpins are known the pre-finished bearings can be bored to suit.

Replacements can be supplied in three sizes.

***i. Bored .005" undersize.**

ii. Bored .015" undersize.

iii. Bored .030" undersize.

In all cases the outside dimension of the shell is standard.

* For crankpins not worn sufficient to warrant regrinding.

NOTES

i. When once a " non-fine-bored " con-rod has been serviced strictly in accordance with these instructions it may thereafter be treated in the same way as a " fine-bored " rod.

ii. Should it be required to check the bore of the bearing, the two halves must be " nipped " together in the connecting rod to obtain a true reading.

CONNECTING ROD BOLTS

CONNECTING ROD BOLTS

All bolts must be renewed after the engine has run a number of hours as follows, or earlier if required, *i.e.*, after piston seizure.

at :— **1500 r.p.m.—4000 hrs.**
1250 r.p.m.—5000 hrs.
1000 r.p.m.—6000 hrs.

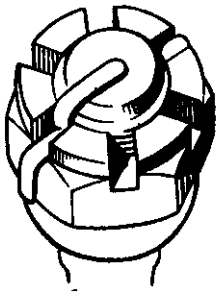


Fig. 6

CASTLE NUT AND SPLIT PIN

After tightening up the nuts, the split pins should be driven in until the heads are right inside the castellation of the nuts, and one end bent vertically, the other to be flattened over the nut. See Fig. 6

NOTE Split pins should NEVER BE USED TWICE, and replacements should be a light driving fit in the hole.

TAB WASHERS

On later engines the bolts have tab washers to lock the nuts, and it is important that the 'TAB' be bent over the flat which is machined the full width of the boss of the large end. See Fig. 7.

IMPORTANT Under no circumstances should bolts be annealed and used again. Such action is FALSE ECONOMY.

This also applies to TAB WASHERS WHICH SHOULD NOT BE USED AGAIN.

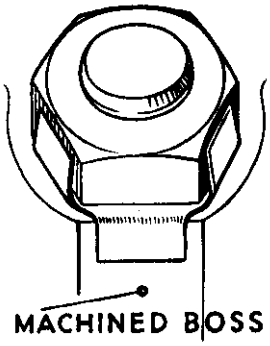


Fig. 7

SMALL END BEARINGS

SMALL END BEARING

This is a phosphor bronze bush which is a press fit in the rod. When it becomes necessary to replace, simply drive the old bush out with suitable drift or by press.

The service bush, like the large end bearing, is prefinished, consequently allowance has already been made for closure upon pressing in.

PRESSING IN

It is preferable to employ a press to ensure that the bush enters the hole at 90° in all directions to the bore of the rod. Should no press be available, use either a spigoted drift, or a draw bolt and washers. Fig. 8 gives manufacturing particulars.

IMPORTANT

The bush must enter the hole squarely.

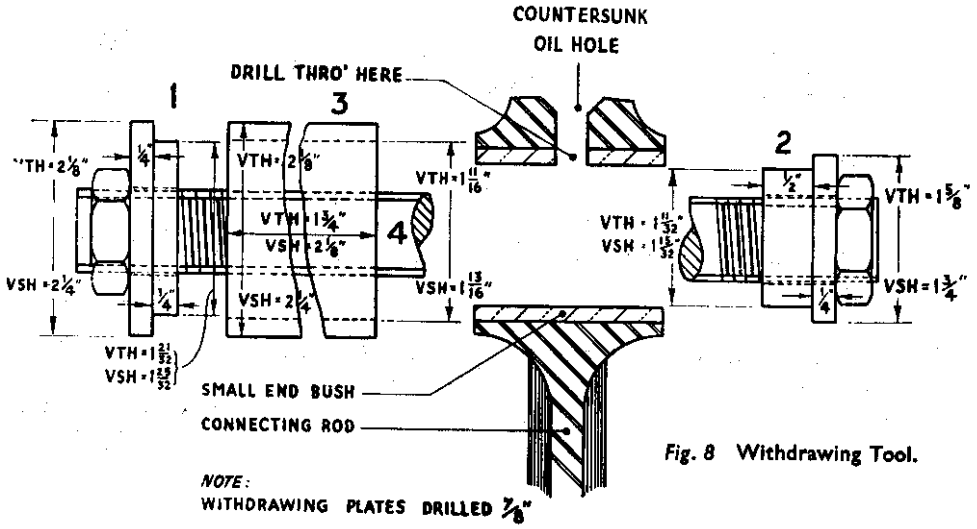


Fig. 8 Withdrawing Tool.

Item	Description	Material	No. off.
1	Withdrawing plate	E.N.3A.	1
2	Withdrawing plate	"	1
3	Tubular distance piece	"	1
4	½" B.S.P. plugging	Steel	8
5	½" B.S.P. nuts	"	2
6	¾" washers	"	2
VTO, VTH, VSO, VSH	S.E. Bearing Part No. 208.		

DRILLING

The lubrication of the small end is through the countersunk hole in the top of the rod, see Fig. 8, therefore the new bush will require drilling through the same size hole as in the old one.

Remove the burrs from the hole and the rod is ready for the piston.

DECEMBER, 1952

SV 6

CYLINDER
LINERS

CYLINDER LINERS

SV 6

CYLINDER LINERS

When it is required to remove the cylinder liner the following methods should be adopted in the order given.

In all cases the instructions assume that the cylinder heads, pistons and connecting rods have been removed, also the crankcase covers.

REMOVAL

METHOD 1

i. Turn crank so that maximum accessibility is given to the bottom of the liner at the back of the engine—this is approximately with crank 20° after top dead centre, see Fig. 1.

ii. Protect crankpin with clean rag tied on and also the bottom of the sump with brown paper against falling particles.

iii. Through the crankcase door hole at the back, give the liner a sharp blow at the point indicated in Fig. 1 and it should move—if it does, knock it up until the top flange clears the housing, when the liner may be lifted out.

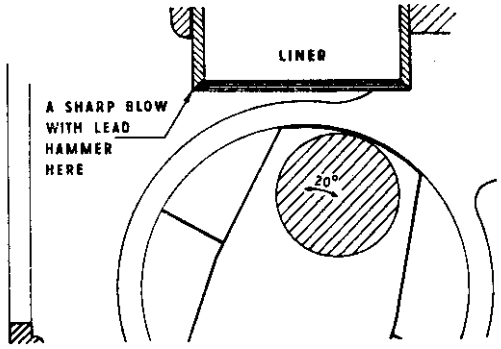


Fig. 1

Should this method prove unsuccessful, try :—

METHOD 2

i. As in i above, but see Fig. 2.

ii. As in ii above.

iii. With a wooden bar and a short piece, using the casting as a fulcrum, all as shown in sketch—Fig. 2, prise the liner out.

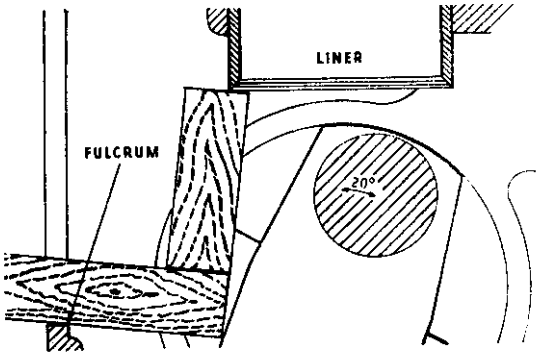


Fig. 2

Should method 2 fail, use :—

METHOD 3

i. As in method i but with crank turned about 45°.

ii. As in method 1.

iii. Assemble withdrawing gear as shown in Fig. 3, taking care to enter spigot of bottom plate into the liner at the bottom and that the sides of the bridge piece are clear of the liner at the top.

iv. Lock bottom nuts together and withdraw liner by turning draw-nut, see Fig. 4—until the liner comes clear of the bottom rubber joint rings, after which it can be lifted out by hand—see Fig. 5.

Fig. 6 gives dimensions and manufacturing particulars for liner withdrawing tool No. 39-J-482

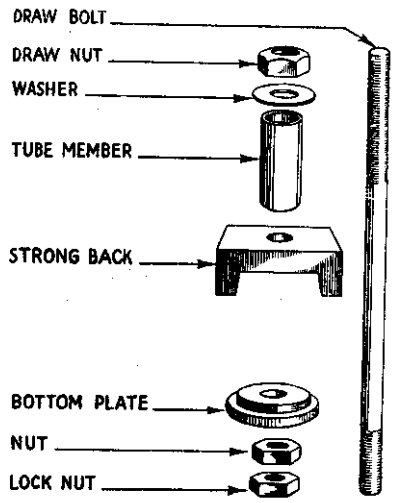


Fig. 3

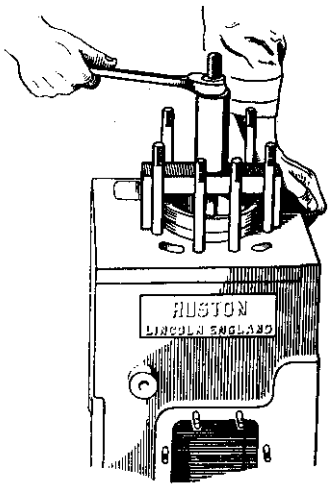


Fig. 4

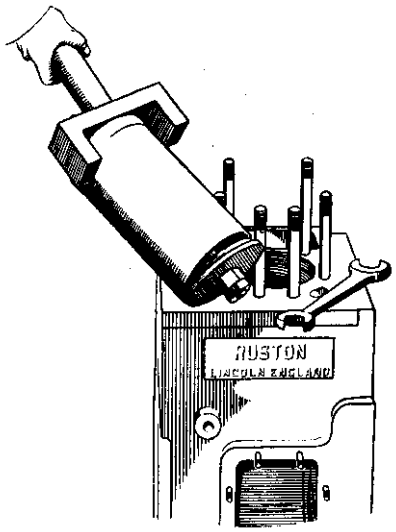


Fig. 5

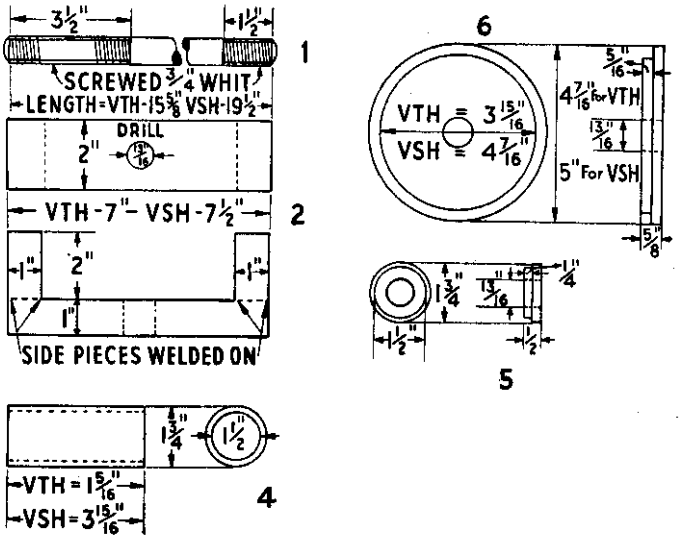


Fig. 6

Ref. No.	Description	No. off.	Material.
1	Withdrawing bolt	1	Steel E.N.3A.
2	Strong back (Thrust-plate) .. .. .. comprising 2" x 1" steel bar with side pieces welded on	1	"
4	Distance piece	1	"
5	Distance piece collar	2	"
6	Withdrawal plate	1	"
	¾" Whit. nuts	2	Stock
	¾" Whit. lock nut	1	"

Details of liner withdrawing gear. Part No. VH2. VTO, VTH, VSO, VSH engines. Tool No. 39-J-482.

CYLINDER LINERS

REPLACEMENT

i. The housing should be thoroughly cleaned, both at the top where the shoulder of the liner will rest and at the bottom where the rubber joint rings will seal the water jacket (See Fig. 7)

ii. The liner should be cleaned of its protective grease and, with a smear of engineer's marking under the shoulder, tried in the housing and rubbed round to see if it is free to revolve and if a good metal to metal joint between faces is evident.

NOTE If in doubt about this, a smear of very fine carborundum will quickly clean the faces up.

iii. Rubber rings should then be placed in the two grooves in the liner taking care to see THAT THEY ARE NOT TWISTED.

iv. Smear soft soap liberally on the rubber rings and also on the LEAD IN or TAPER of the bottom hole in the housing.

v. Although not absolutely necessary, a thin application of jointing compound on the top ledge may be made.

vi. The liner should then be PRESSED IN by HAND. The liner should not be forced in, otherwise distortion may take place.

NOTE If the liner cannot be pressed in by hand, it should be withdrawn and an examination made to see that the rubber rings have not become twisted.

vii. Finally the liner should be firmly held on its seating and the amount by which the top face of the liner is above the housing face carefully checked by means of a straight edge and feelers. See Fig. 8.

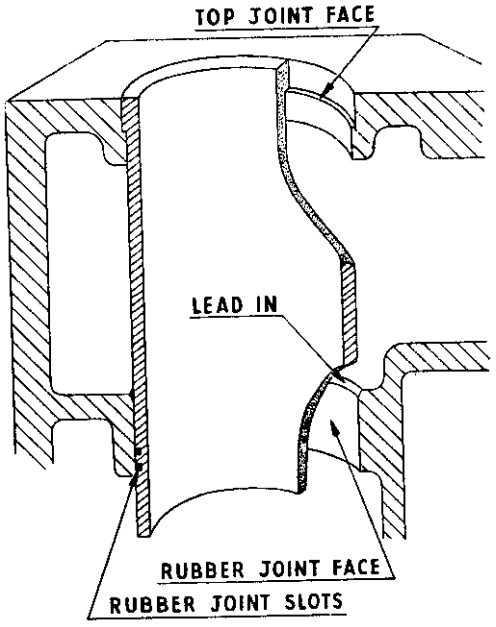


Fig. 7

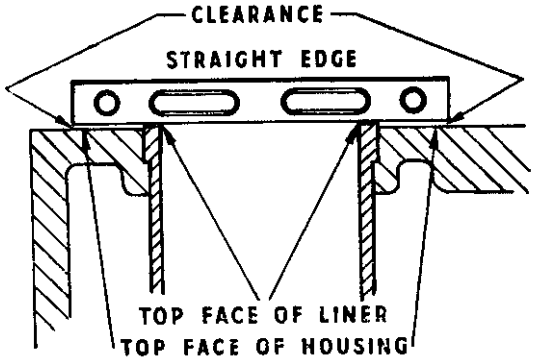


Fig. 8

IMPORTANT

To ensure a gas and water tight joint the top facing of the liner should be NOT LESS THAN two thousandths (.002") and NOT MORE THAN six thousandths (.006") above the top of the housing.

DECEMBER, 1952

SV 7

CRANKCASE OR HOUSING

CRANKCASE or HOUSING

SV 7

VALVE TAPPET BUSHES

Valve tappet bushes are a driving fit in reamered holes in the crankcase and are NOT locked in position.

The instruction assumes that the camshaft and all accessory equipment have been removed and that the housing has been laid on its side.

REMOVAL (1)

Insert the spigoted phosphor bronze drift (3) in the tappet bush (4) from top side and with steel bar (1) through the push rod guide bush (2) tap the bush through into the crankcase.

Dimensions of the phosphor bronze drift and round steel bar are given in Fig. 2.

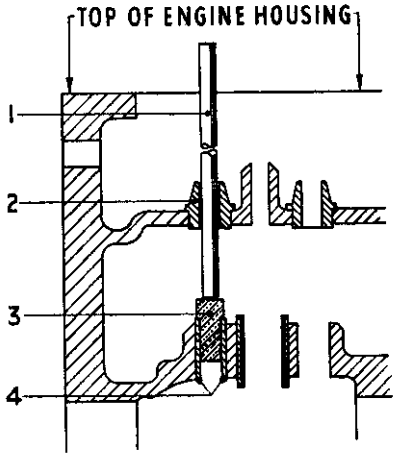


Fig. 1

REPLACEMENT

With drift (3) and bar (1) drive the bush into the hole until the lower end of the bush (4) is within approximately $\frac{1}{8}$" of being flush (level) with the casting, see Fig. 1.

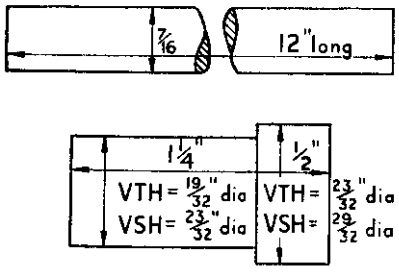


Fig. 2

ALTERNATIVELY

If it is not convenient to lift the engine from its foundation or fixing, the bushes may be removed by means of a drawbolt, complete with nuts, washers and tubular distance piece (see Fig. 3) which also gives dimensions.

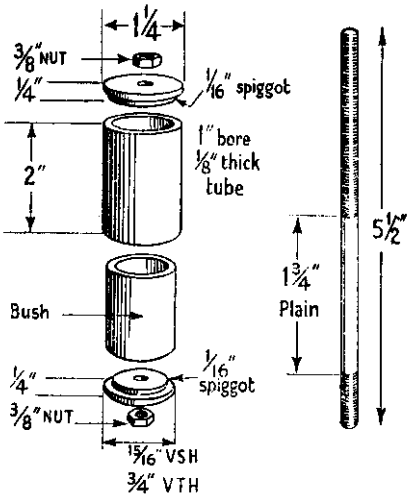


Fig. 3

REMOVAL (2)

Assemble as shown in Fig. 3, drawing the bush downwards into the crankcase. Care should be taken to ensure that the bush enters the tube piece.

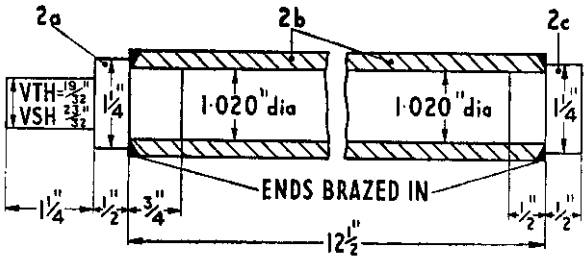


Fig. 4

REPLACEMENT

Simply reverse procedure stated in removal using either a shorter tube piece, or a longer ⅜" bolt.

Should large number of engines be serviced, it will be found convenient to remove the bushes as in (1) and to employ the drift—tool No. 8224/2.1W.—to drive the bushes in. The tool comprises a piece of steam tube with phosphor bronze ends brazed in.

Fig. 4 gives dimensions and constructional details of tool 8224/2.1W.

Fig. 5 shows a cut-away view of the housing with the bush being driven into position with tool No. 8224/2.1W.

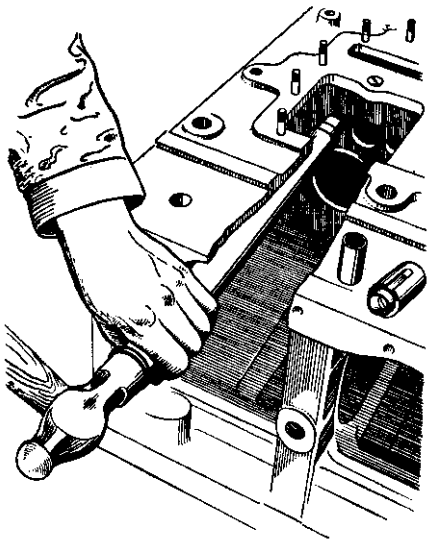


Fig. 5

IMPORTANT

The bushes are made of a special mixture of cast iron, consequently care MUST be taken to ensure that upon replacement, each bush enters the hole squarely before pressure is applied, otherwise there is a risk of the bush collapsing.

FUEL PUMP TAPPET BUSHES

The bushes are a driving fit in reamered holes in the crankcase and are located in position. The instruction assumes that the camshaft and accessory equipment have been removed and the housing laid on its side.

REMOVAL (1)

(a) Take out the countersunk headed locating screw. This is clearly shown on Fig. 10.

(b) Insert the spigoted phosphor bronze drift (3) in the bush (4) from the top side and with round steel bar (1) through fuel pump tappet rod hole (2) drive the bush into the crankcase. See Fig. 6.

For dimensions of drift and bar see Fig. 7.

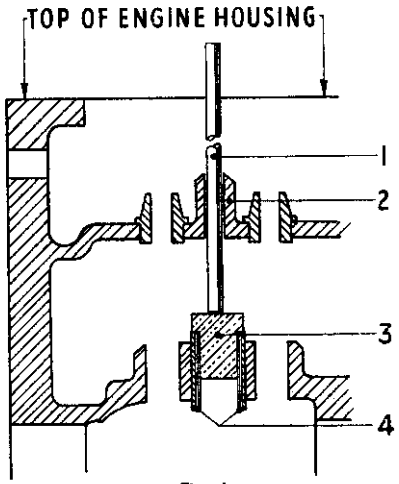


Fig. 6

REPLACEMENT

(a) Enter the bush carefully into the hole with the outside slot facing upwards and in line with the locating screw hole.

(b) Put in the locating screw so that it enters the slot for guide purposes.

(c) Using drift (3) and steel bar (1) drive the bush in until it projects evenly above and below the casting—about $\frac{1}{4}$" below.

(d) Tighten the counter sunk headed screw remembering that its only purpose is to prevent the bush from turning.

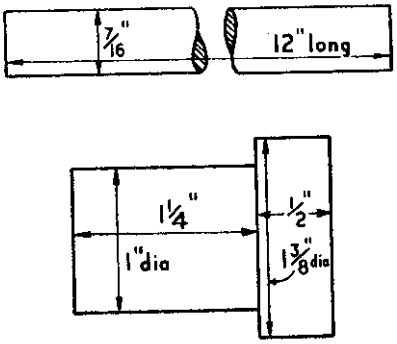


Fig. 7.

ALTERNATIVELY if the engine cannot be lifted from its fixing.

REMOVAL (2)

Using draw bolt assembly shown in Fig. 8 draw the bush out downwards, taking care to see that the bush enters the tube piece.

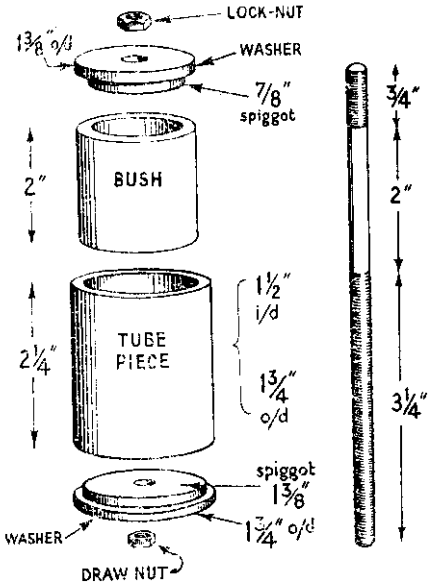


Fig. 8

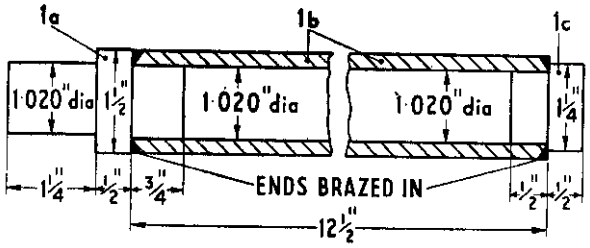


Fig. 9

REPLACEMENT

Simply reverse the procedure under removal, but using either a shorter tube piece, or a longer bolt.

Should large numbers of engines be serviced it will be found convenient to remove the bushes as in (1) and to employ drift tool No. 8224/1.IW. to drive the bushes in.

Fig. 9 gives dimensions and contructional details of the drift, tool No. 8224/1.IW. which comprises a piece of steam pipe with ends brazed in.

Fig. 10 shows a ' cut away ' view of the housing with the bush being driven into position with tool No. 8224/1.IW.

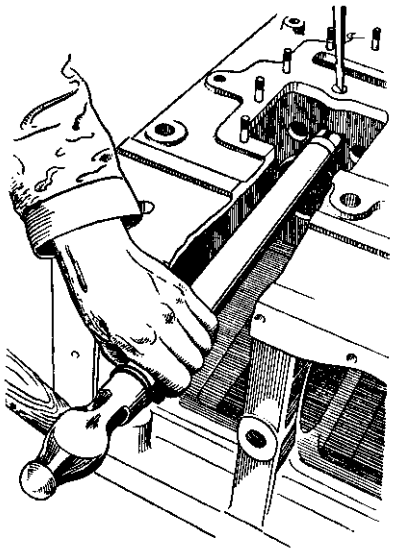


Fig. 10

IMPORTANT

The bushes are made of a special mixture of cast iron, consequently care MUST be taken to ensure that upon replacement, each bush enters the hole squarely before pressure is applied, otherwise there is risk of the bush collapsing.

LUBRICATING OIL PUMP

The gear driven gear pump is always flooded with lubricating oil, consequently rarely, if ever, requires any servicing attention. Should occasion arise to renew parts the following instructions will be found helpful.

REMOVAL

(a) Lubricating Oil Pump

i. Drain the oil from the sump, preferably whilst the engine is still warm.

ii. Remove the setscrews on the delivery side and the suction pipe altogether.

iii. Undo the three setscrews item (2) holding the pump to the housing —after which it may be taken away—see Fig. 11.

(b) Idler Wheel.

i. The end cover (gear end) and a crankcase inspection cover should be removed.

ii. With finger, or drift $\frac{3}{8}$" dia. through the hole in the crankcase press the spindle out withdrawing the wheel downwards. Fig. 11 shows drift pressing spindle out.

(c) Idler Wheel Spindle Bush

This hardened steel bush should be driven through into the wheel chamber with bronze drift.

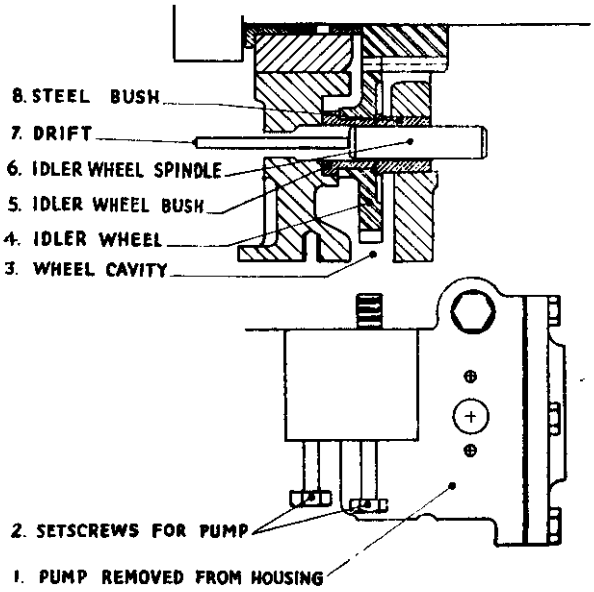


Fig. 11

REPLACEMENT

(c) Idler Wheel Spindle Bush.

Enter the new bush squarely into the hole from inside the wheel chamber, and with a pinch bar and a piece of thin wood, using the casting as a "fulcrum," tap the bush in with lever action until it will go NO further. See illustration, Fig. 12.

ALTERNATIVELY

The bush can be inserted by means of a draw bolt, nuts, washers and tube member, *i.e.*, similar to valve tappet bush sections.

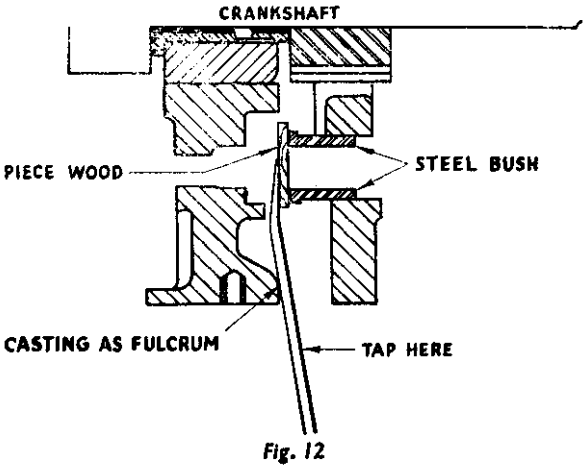


Fig. 12

(b) **Idler Wheel**

i. Enter the wheel into the cavity with boss and bush flange facing inwards. See Fig. 11.

ii. Engage teeth with those on crankshaft spurwheel and press the spindle in until the end is level with the housing face.

iii. Check end cover joint to see if damaged.

iv. The end cover may now be replaced, using sleeve, tool No. 8943 IW. see S.V. 8, Figs. 13 and 14, so as not to damage the oil seal, when pressing on to the larger diameter of the crankshaft.

v. Tighten cover into position.

vi. Replace crankcase cover.

DISMANTLING THE PUMP *(a)*

See Fig. 13.

Remove setscrews (1) with ring or tube spanner, prise the cover (2) off, taking care not to damage faces or joint (3). Turn wheel (6) until it is possible to close the split portion of the taper pin (4) then drive this out.

The gearwheel drive (5) and driving wheel (6) may now be removed.

Finally—the spindle (7) and oil gear wheel (8) may be slipped out.

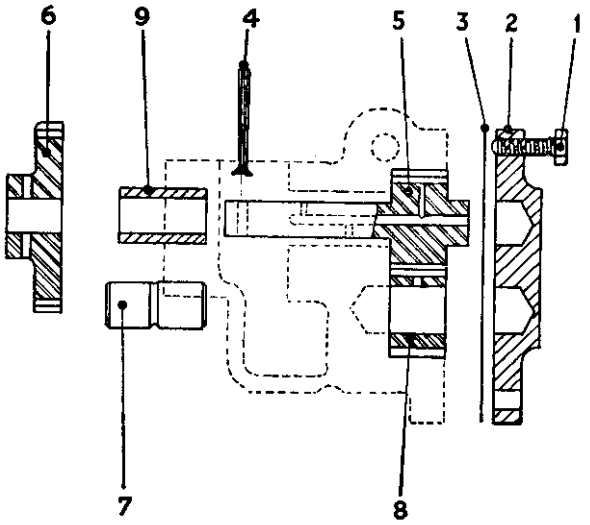


Fig. 13

REMOVAL OF THE PUMP DRIVING SPINDLE BUSH

The bush (9) is a press fit in the pump body and should therefore be drawn out.

A draw bolt arrangement similar to Fig. 3 can be utilised for this purpose.

IMPORTANT

Very special care must be exercised during the withdrawal operation to avoid damage to the inside of the pump body—otherwise the efficiency of the pump may be impaired.

REPLACEMENT OF THE BUSH

The new bush (9) should be tapped in with brass drift until the face at the driving end is level with the body of the pump.

RE-ASSEMBLING THE PUMP

Insert oil gearwheel (5) in bush (9) and thread spindle into driving wheel (6) with boss facing away from end of bush (9). Fit taper pin (4) correctly and open out the split end. Oil gear wheel (8) and pin (7) should be inserted next.

CHECKING

Without the dowel pins and the joint (3) the cover should be tried on with four screws and if it is assembled correctly it should not be possible to turn the pump easily.

After this check—remove the cover, fit the joint (3) and progressively tighten the setscrews (1) after of course fitting the two dowel pins. The pump should now revolve freely, without any appreciable end-play. The actual clearance limits are between two and three thousandths (.002″—.003″).

IMPORTANT

Loss of oil pressure is generally occasioned by excessive end clearance developing rather than wear on the teeth of the gearwheels.

REPLACEMENT

(*a*) Lubricating Oil Pump

i. Clean joint faces and check joint for soundness.

NOTE The joint must be the correct thickness, $\frac{1}{32}$″ (.031″) to obtain correct engagement of the gearwheel teeth. Ensure that the backlash is .005″/.006″.

ii. Engage driving gearwheel with idler wheel.

iii. Fit and progressively tighten the three setscrews.

iv. Replace suction pipe and joint and setscrews in the delivery side. Take care to tighten setscrews progressively and evenly to obtain an oil tight joint.

DECEMBER, 1953

SV 8

CRANKSHAFT
AND FLYWHEEL

CRANKSHAFT and FLYWHEEL

SV 8

CRANKSHAFT

REMOVAL

The instructions assume that the connecting rods, etc., have been removed.

1. **THE FLYWHEEL** (if keyed on):—

(a) By using two steel wedges in the manner indicated in Fig. 1 driving one wedge against the other between the flywheel boss and the key-head. Parallel packing should be added as required between the wedges and the boss.

Wedge Dimensions—4" long by ½"/¾" wide tapering from maximum thickness of ⅜" at one end to zero at the other.

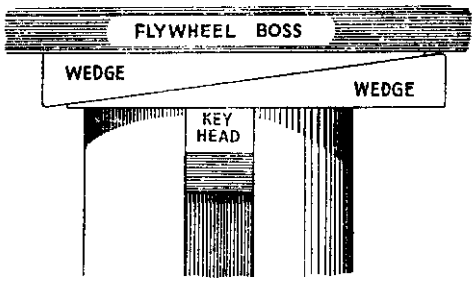


Fig. 1

(b) When a number of engines are serviced at any one time we recommend the employment of Gib head key extractor tool No. 47-J-738 as illustrated in Fig. 2 which removes keys without effort or damage to key heads.

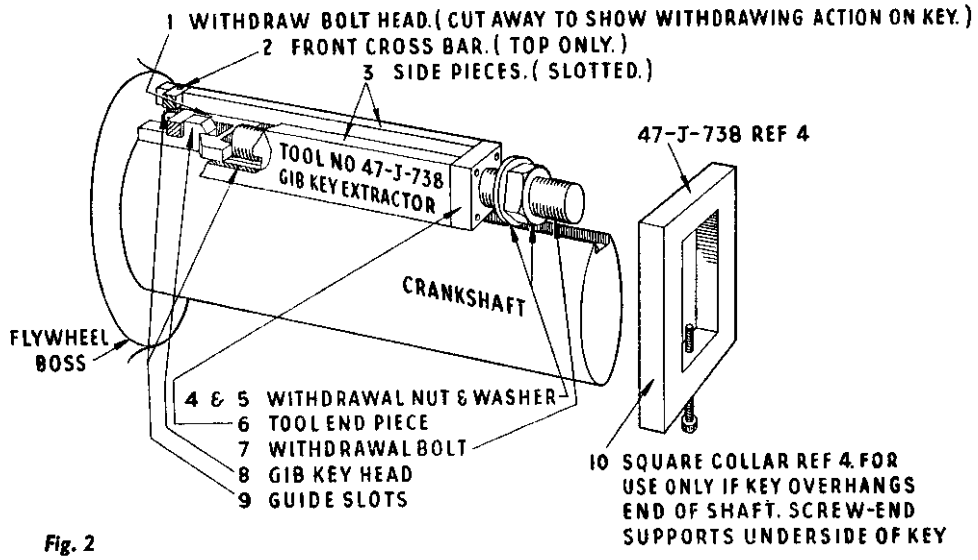


Fig. 2

i. If the key head is as shown in Fig. 2 remove item 10, the square collar, ref. 4, from the tool, and with the front cross bar (2) on top, put the tool on the shaft so that the square hole in the withdraw bolt head (1) fits on the key head (8). Tighten the nut (4) until the side pieces (3) press on the flywheel boss, after which the key can be withdrawn by turning the nut (4) with a tube spanner and a bar.

ii. When the key head projects beyond the end of the crankshaft, the collar (10) should be put on the tool with screw underneath and operation carried out as in (i) but with the screw end under the head of the key to prevent it from bending when pressure is applied.

THE FLYWHEEL (if secured by locknut) :—

i. Remove the locking wire, the three setscrews, and then the locking plate.

ii. Undo the flywheel locknut about two turns only, with a ring spanner for preference.

iii. With tool No. 3950 IW. comprising a steel bar, 2 studs with nuts and washers used in the manner indicated in Fig. 3, *i.e.*, with the lock-nut providing centre support, tighten the withdrawing nuts so that the bar is parallel with the face of the wheel; next, with a lead hammer, give a sharp blow to the centre of the bar—when the wheel should spring clear of the taper—the nut preventing the wheel from falling off the end of the shaft.

Fig. 4 gives dimensions and constructional details of flywheel withdrawing tool No. 3950 IW.

iv. Remove locknut, flywheel and woodruff key.

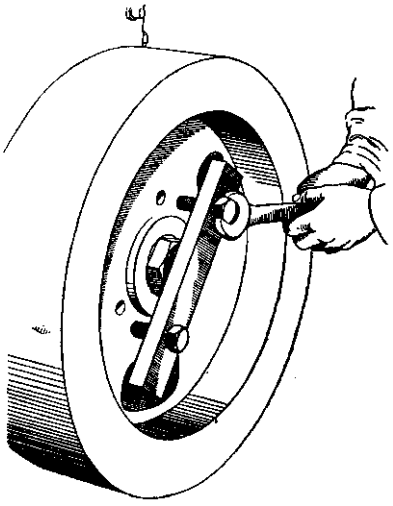


Fig. 3

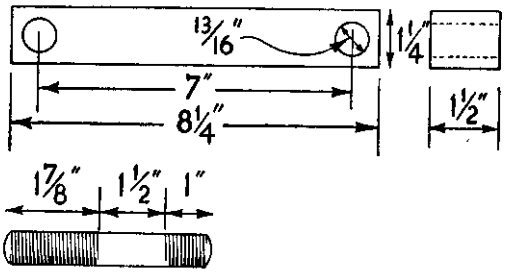


Fig. 4

2. END COVERS

Both end covers should now be removed and also the crankcase covers, and, of course, the sump.

3. BUSH BEARING

THE FOLLOWING INSTRUCTION APPLIES **ONLY** IF IT IS REQUIRED TO **EXAMINE** or RENEW THE BUSH BEARING, there being no need to remove the gearwheel, part number V.1177, in the ordinary crankshaft removal operation.

i. Assemble withdrawing tool No. 9750 IW. as shown in Fig. 5, viz:—

Screw draw studs (1) into the tapped holes in the gear wheel, put recessed plate (6) on studs, recess to face and fit on shaft and with B.S.F. screw (7) located in keyway, fit draw bar (3) next as close as possible to (6) tighten nuts evenly so that the bar is exactly at right angles to a centre line through the crankshaft.

ii. Prevent the wheel from turning by means of a block, or lead hammer between crankshaft and the housing.

iii. Draw the wheel off by screwing bolt (2) against the plate (6) using two bars, or equal, bolted on to the head of the bolt as shown in Fig. 6.

N.B. As the wheel has to be drawn all the way off the raised portion, approximate 6"—7", it is recommended that after each one inch or so, the bolt (2) be turned back and the draw bar (3) moved closer to the plate (6) thereby preventing the draw studs from twisting.

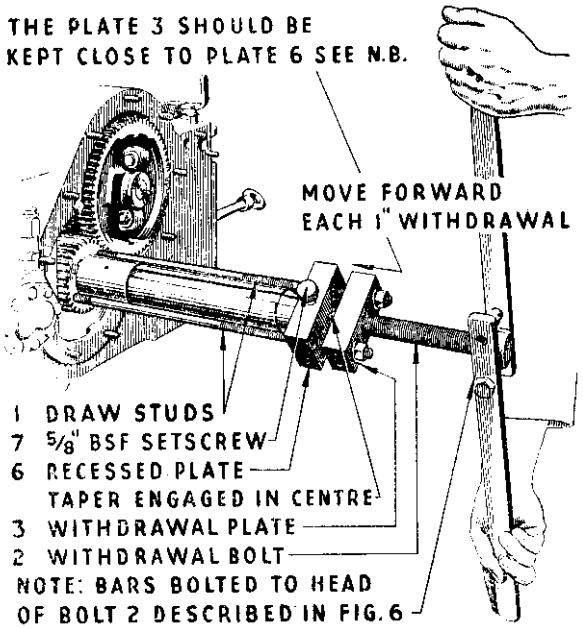


Fig. 5

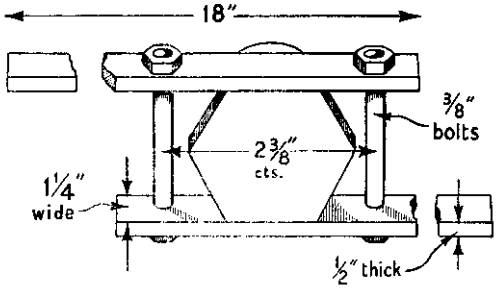
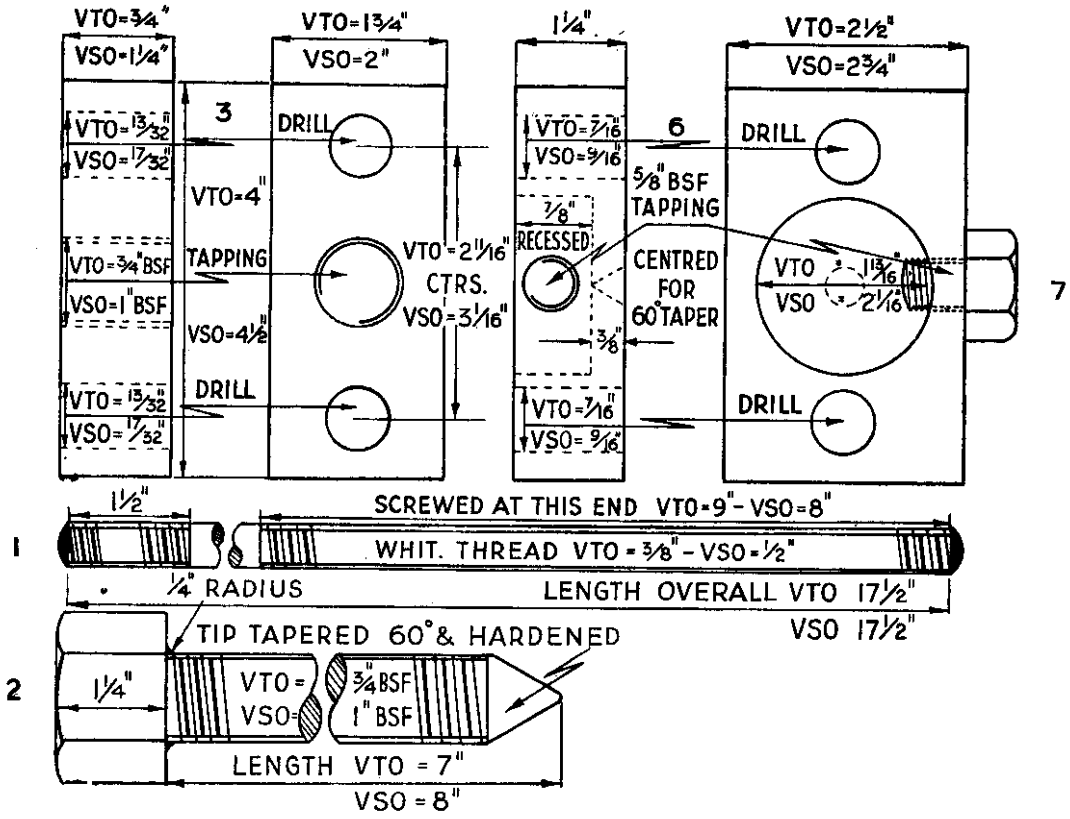


Fig. 6

SEE S.V.9, MAIN BEARINGS, REGARDING CRANKSHAFT REGRINDING.

Constructional details for the manufacture of tool 9750 IW. are given in Fig. 7.



TOOL No. 9750 IW.

Withdrawing Gearwheel from Crankshaft			Part No. V 1177
Item	Material	Description	No. off
1	EN. 16 R.	Draw Studs	Two
2	EN. 16 R.	Bolt	One
3	EN. 3 A.	Plate	One
4	Stock	Washers	Two
5	Stock	Nuts	Two
6	EN. 3 A.	Plate (recessed and centred) ..	One
7	Stock	⅜" B.S.F. Setscrew	One
VTO, VSO, VTH and VSH Engines			

Fig. 7

SEE S.V.9, MAIN BEARINGS, REGARDING CRANKSHAFT REGRINDING.

Proceed as follows to remove:—

4. The lubricating oil pipe rail.
5. The lubricating oil connection stops (1) from behind the pipe rail.
6. The bearing location stops (2) from the opposite side to the pipe rail.
7. The stops (3) from the bottom of the housing. (This applies to all except single cylinder engines).

Fig. 8 shows the stops to be removed from thrust bearing housings.

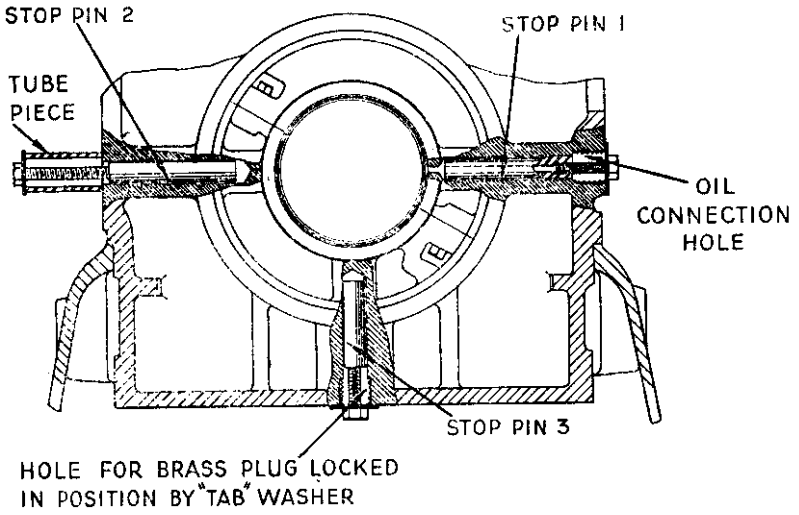


Fig. 8

Fig. 9 shows the stops to be removed from each end bearing housing on single cylinder engines. On engines of two cylinders and upwards one only stop (1) on Fig. 8, is fitted. The intermediate bearing housings on three and four cylinder engines are fitted with two stops (1 & 3), on Fig. 8. The stops on VSH engines are drilled and tapped $\frac{3}{8}$" whit. and VTH $\frac{5}{16}$" whit. and should be withdrawn by setscrew, nut and $1\frac{1}{8}$" outside diameter washer as shown. In some cases it may be necessary to use a short tube piece between washer and housing.

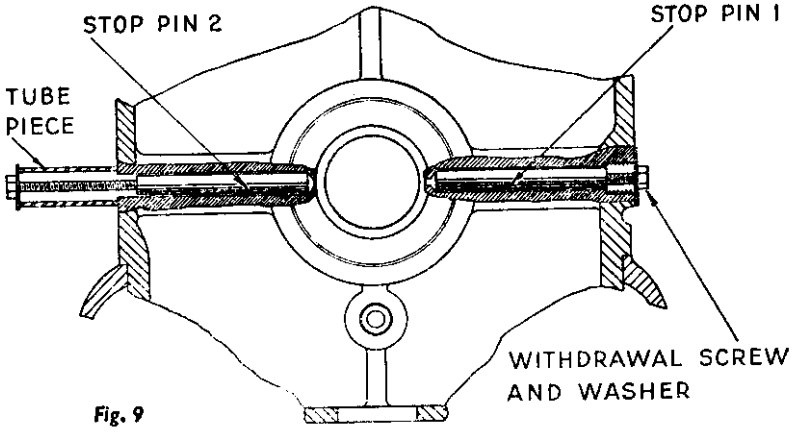


Fig. 9

IMPORTANT

Before proceeding with operation 8, it will be found helpful if lines are scribed on bearings, housings and crankcase, so that upon replacing the crank, the lines can be brought together and thus facilitate the fitting of the stops.

8. The crankshaft may now be removed, viz:—

(*a*) Support the free end of the crankshaft with sling and pulley blocks so that the shaft can move freely in line with the bore of the housing and does not sag.

(*b*) With lead hammer, or equal, knock the shaft out by blows at the gear wheel end.

(*c*) When the shaft is approximately half-way out, move the sling to the point of balance, *i.e.*, near the centre of the cranks, so that when the last bearing housing is drawn clear of the crankcase the crank can be lifted easily.

If the shaft has a screwed end (taper shaft) the use of a suitable sized piping (see Fig. 10) will assist in removal

BEARINGS SHOULD BE GIVEN ATTENTION IN ACCORDANCE WITH THE INSTRUCTIONS IN SECTION S.V.9.

CRANKSHAFT

REPLACING

This operation is a reversal of the foregoing procedure, therefore it is assumed that the crankshaft is assembled complete with bearings and slung ready for entry into the crankcase bores:

1.

(*a*) Turn bearing housings so that the countersunk holes face the holes on the side of the crankcase to which the oil pipe rail fits, *i.e.*, the one drilled through the bearing.

(*b*) Enter the crankshaft, gear wheel end first into the crankcase and gently tap into position with lead hammer, care to be taken to ensure that the oil holes are kept in line. As in removal the free end of the shaft should be supported to ensure ease of entry.

(*c*) To bring holes into line it will be found helpful to use a $\frac{5}{8}$" dia. bar tapered at one end for the VSH and $\frac{1}{2}$" dia. for the VTH.

2. Replace Lubricating oil connection stops (1) on Fig. 8, taking care that the right length of stop is used and that the tapped end faces outwards, and that it is drilled right through.

3. Replace stops (2) on Fig. 8.

4. Replace stops (3) on Fig. 8, replace brass plugs and tab washers.

FITTING NEW BEARING HOUSINGS

Should it become necessary to replace any of the BEARING HOUSINGS the following instructions should be followed:—

The bearing housings are delivered with one only hole drilled, *i.e.*, for lubricating oil location stop (1) on Fig. 8 (this is the one that is countersunk), therefore each bearing housing has to be drilled and reamered for the other stops when the crankshaft is in position in the crankcase.

VSO & VSH

The size of drill required is $\frac{11}{64}$" and reamer is $\frac{5}{8}$".

VTO & VTH

$\frac{31}{64}$" drill and $\frac{1}{2}$" reamer.

NOTE It is of course important that the hole be drilled and reamered to the same depth as the one in the housing which is being replaced.

5. Replace the pipe rail after softening the copper joint rings by raising them to blood red heat and then quenching in water.

When re-making the lubricating oil pump joint make quite certain the joint faces are in line and that the pipe flanges do not have to be sprung into position.

6. REPLACING THE GEARWHEEL

This instruction applies only when the crankshaft gearwheel (Part No. 1177) has been removed, see instruction 3 in removal.

(*a*) The crankshaft and bore of gearwheel should be cleaned of any burrs caused during removal.

(*b*) Replace the woodruff key, remember this type of key fits on the sides only, NOT ON TOP.

When removing the wheel it will have been noted that it is a tight fit on the shaft. This is to ensure that it will not come loose in service. The temperature of the wheel will therefore have to be raised to about 300°F. To obtain this we recommend that the wheel be placed in an oven, or on a hot plate, NOT IN DIRECT CONTACT WITH THE FLAMES, and leaving for 30 minutes so that the heat goes right through the wheel, but does NOT DISCOLOUR IT.

(*c*) **Next, with all possible speed,** slip the wheel on the raised portion of the shaft and with the ram tool No. 9996 IW. (see figures 13 and 15) drive the wheel on until a clearance of fifteen thousandths (.015") remains between the wheel face and bearing.

Fig. 10 shows the wheel being driven on by the ram, with the .015" feeler in position to ensure the correct clearance.

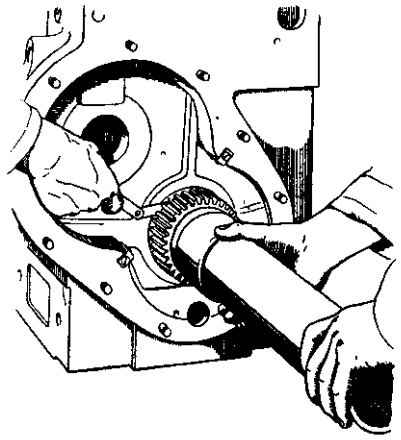


Fig. 10

7. Replace end covers, sump and crankcase doors, etc.

8. REPLACING THE FLYWHEEL

(*a*) If keyed on:—

i. Put the wheel on the shaft with the DEEPER side of the keyway facing outwards.

ii. Smear tallow fat or grease on the key and drive it in until the hammer shows signs of springing back.

(*b*) If secured by lock nut on taper:—

i. Insert woodruff key in shaft.

ii. Lift wheel and fit on taper, making certain that the key enters the keyway.

iii. Put on lock nut and tighten with ring spanner and hammer.

Prevent the wheel from turning by using a setscrew, lock nut and wooden spar in the manner indicated in Fig. 11, or by any other convenient means.

iv. Fit the locking plate, which being cut as a twelve (12) pointed star, permits the locking screw holes to be brought into line with a very small movement of the locknut.

v. Fit and tighten the three locking setscrews and thread $\frac{1}{16}$" diameter soft iron wire through the holes in the heads, bring the ends together and twist.

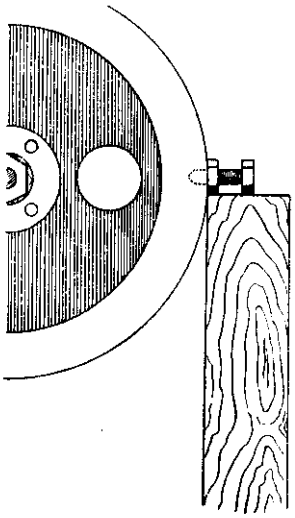


Fig. 11

FITTING NEW FLYWHEEL (Taper crank).

Should it become necessary to fit a new flywheel, the bore should be 'blued' or smeared with marking and rubbed on the taper of the crankshaft and if it is not evenly marked upon removal, then the bore should be lapped on to the taper by means of fine abrasive.

For this operation the crankshaft should be vertical with taper on top to ensure an even lapping action by using the weight of the wheel.

CRANKSHAFT OIL SEALS

The instruction assumes that the flywheel and driving gear have been removed, *i.e.*, that both ends of the crankshaft are clear.

IMPORTANT

The oil seals are a press fit in the end covers, but due to its necessary fragile construction it is not possible to remove the seal without damage, or distortion; consequently once a seal has been removed FROM THE HOUSING, IT SHOULD NOT, UNDER ANY CIRCUMSTANCES BE USED AGAIN.

REMOVAL

i. Remove end covers and place on some material, to prevent joint face damage, on bench with oil seal uppermost.

ii. Prise the seal out in the manner indicated in Fig. 12, with a wedge pointed pinch bar, or any similar pointed tool.

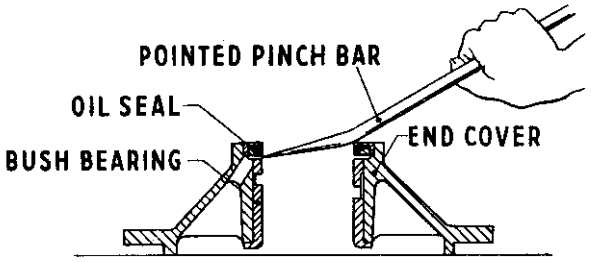


Fig. 12

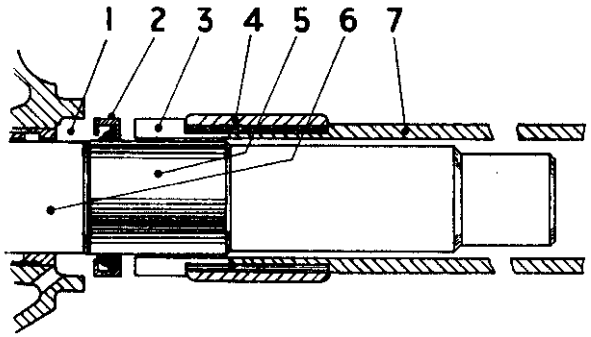


Fig. 13

FIT NEW SEAL

i. Clean end cover, removing any burrs which may have been caused during the removal operation, replace on engine and tighten into position.

ii. Refer to Fig. 13.

Press oil seal (2) on to sleeve (5) so that fabric in seal faces Non-taper end. Thread sleeve on to the crankshaft, Non-taper end first, until it butts against the raised portion of the shaft (6) then with tool No. 9996 IW., after smearing jointing compound on the rim, gently tap the seal (2) into the cavity (1) until it will go no further.

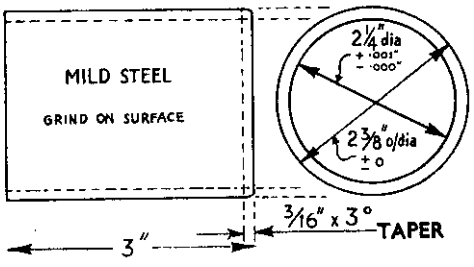


Fig. 14

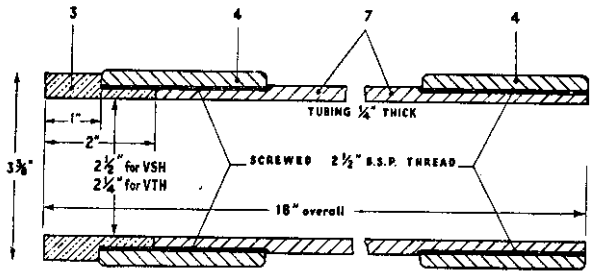


Fig. 15

Tool No. 9996 IW.

Ram for Driving Crankshaft Oil Seal In.			Part No. V 7247
Item	Material	Description	No. off
3	Phos. Bronze ..	Ram End	1
4	Steel (Stock) ..	Running Socket (2½" B.S.P.)	2
7	Steel (Stock) ..	Steam Tubing (2½" B.S.P.)	1
VTO, VTH, VSO & VSH Engines			

ALTERNATIVELY

If ram is not available, the seal may be tapped in by means of a wooden block or drift, always providing the seal does not become twisted during the operation; to avoid this tap the drift gently against the seal whilst rotating it round the shaft.

Fig. 14 gives dimensions and constructional details of the sleeve, tool No. 8943 IW.

NOTE The diameters given are for VSO/H, figures for VTO/H diameters are 2" and 2⅛" respectively, subject to the same tolerances.

Fig. 15 gives dimensions and constructional details of the ram, tool No. 9996 IW.

Fig. 16 shows the ram in use, the seal has just been tapped into position. It will be observed that no additional weight is required, *i.e.*, the weight of the ram is all that is needed to position the seal.

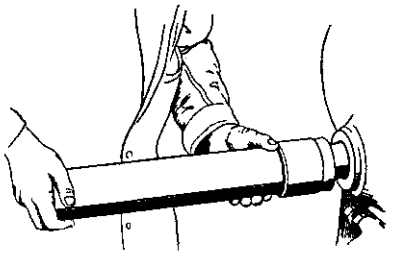


Fig. 16

SPECIAL CRANKSHAFT

AVELING BARFORD ENGINES

On the ' Barford ' road roller engines the main bearings and shaft systems are as for standard industrial types, except in regard to the size two cylinder, VSHR, viz:—

The 2VSO/H " R " engine has the flywheel fitted by taper seat and locknut instead of the usual parallel shaft and gib key.

At present, and in the two sizes of engine under review A. B. equipment incorporates 2, 3 and 4 cyl VSO/H engines, hence it will be noted that the 2 cyl. size is made to conform to the same specification as 3 and 4 cyl. sizes as regards flywheel fixing.

CONSOLIDATED PNEUMATIC TOOL CO. ENGINES

The mark 3VTO/H engines are equipped in so far as the crankshaft system is concerned on similar lines to the foregoing.

For other C.P.T. specials refer to **S.V.9 sub-section** (*d*).

CRANKSHAFT RE-GRINDING

When a crankshaft has been returned to the workshops it must be checked on all bearing journals to assess the amount of wear, and a decision taken as to the grinding necessary to clean up respective journals, having regard to the two sizes of large end and main bearings supplied to suit reduced crankshaft diameters.

THESE ARE

1st Regrind	**15 thous. (.015″)** and
2nd Regrind (maximum)	**30 thous. (.030″)**

and apply to both main bearing and large end journals.

THE IMPORTANCE OF THE FIRST CHECK FOR STRAIGHTNESS CANNOT BE TOO STRONGLY STRESSED AND MUST WITHOUT EXCEPTION TAKE PLACE BEFORE RE-GRINDING.

Failure to observe this instruction may result in the scrapping of a crankshaft which would otherwise still do many hours of useful work.

BALANCE WEIGHTS

See Sub-section (G).

CHECKING (1st)

Refer to Fig. 17

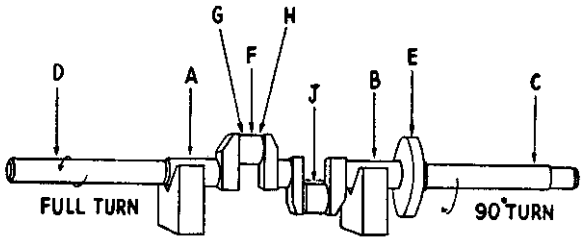


Fig. 17

i. Place the crankshaft on VEE BLOCKS in the manner shown, making sure that the surface-plate, vee blocks and journals are perfectly clean so that true readings can be taken. Surface-plate dimensions 6 feet by 3 feet approximately.

ii. With clock micrometer and stand (illustrated in Fig. 24) take readings at points A and B, i.e. directly over the vee blocks. Adjust blocks until both readings are the same, by shims or use adjustable vee blocks.

iii. Take a reading with clock micrometer at point C or at end of shaft, then at point D or opposite end of shaft, turning the shaft one complete turn, at each point, see arrow near point D.

iv. The shaft is straight only when there IS NO variation in the reading taken at any one point through ONE COMPLETE REVOLUTION of the shaft.

Crankshafts fitted into engines in our shops are straight and true throughout their length to within a limit of:—

Two thous. (.002″).

For crankshafts which have to be re-ground on account of wear, damage, or because for other reasons they are considered to be distorted, it is sufficient if, before regrinding and after DUE ALLOWANCE has been made FOR UN-EVEN WEAR, they are straight to within a limit of:—

Five thous. (.005″).

Consequently if the crankshaft is more than five thous. out of true throughout its entire length, it must be straightened on a suitable press.

STRAIGHTENING

It is difficult to state categorically the size of press required, but we estimate that a 10 ton minimum capacity press would do all that is required for VSH crankshafts.

The process of crankshaft straightening is a **highly skilled task** requiring considerable care and experience on the part of the press operator, consisting in the main of locating the points where the **deflection** begins, supporting them by vee blocks, then determining the **point of maximum deflection,** and exerting pressure on this point.

Repeat process until the shaft is straight within the prescribed limits, taking care not to damage the journals.

It is advisable to use a piece of brass sheet between the end of the press ram and the shaft.

WARNING

There are limits of bending beyond which it is **not possible** to straighten a crankshaft; for example if the bend is a purely local one in a short length of the shaft, an attempt to straighten might fail, or if successful at the time, the shaft may **revert** to out-of-true later.

RE-GRINDING

The dimensions given in the following table are for new shafts therefore after grinding, bearing and crank journals should be less .015″ or .030″ as required.

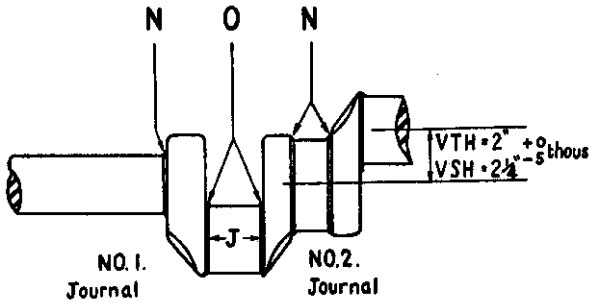


Fig. 18

Large End Journals should be ground on centres shown in Fig. 18, i.e.:—

VTO/H—2″ plus ' 0 ' minus 5 thous. (.005″).

VSO/H—2¼″ plus ' 0 ' minus 5 thous. (.005″).

relative to the crankshaft centre and the limits **must not be exceeded.**

NOTE

Maintaining the lengths of throws within machining limits is specially important on multi-cylinder engines where, due to there being a common cylinder head for two and three cylinders, it is not possible to adjust gaskets and shims individually for each line to compensate for varying lengths of crankthrow, in order to obtain correct bumping clearances.

Failure to maintain uniformity in bumping clearances in an engine may adversely effect its performance.

BEARING JOURNALS

Engine	Large End Pins	End Mains	No. 2	No. 3	No. 4
1VTO/H	$2\frac{1}{2}^{-\frac{1}{2}}_{-1}$	$2\frac{1}{8}^{-\frac{1}{2}}_{-1}$	—	—	—
2VTO/H	$2\frac{1}{2}^{-\frac{1}{2}}_{-1}$	$2\frac{1}{8}^{-\frac{1}{2}}_{-1}$	$3\frac{1}{4}^{-\frac{1}{2}}_{-1}$	—	—
1VSO/H	$2\frac{3}{4}^{-\frac{1}{2}}_{-1}$	$2\frac{3}{8}^{-\frac{1}{2}}_{-1}$	—	—	—
2VSO/H	$2\frac{3}{4}^{-\frac{1}{2}}_{-1}$	$2\frac{3}{8}^{-\frac{1}{2}}_{-1}$	$3\frac{3}{4}^{-1}_{-1\frac{1}{2}}$	—	—
3VSO/H	$2\frac{3}{4}^{-\frac{1}{2}}_{-1}$	$2\frac{3}{8}^{-\frac{1}{2}}_{-1}$	$3\frac{3}{4}^{-1}_{-1\frac{1}{2}}$	$3\frac{3}{4}^{-1}_{-1\frac{1}{2}}$	—
4VSO/H	$2\frac{3}{4}^{-\frac{1}{2}}_{-1}$	$2\frac{3}{8}^{-\frac{1}{2}}_{-1}$	$3\frac{3}{4}^{-1}_{-1\frac{1}{2}}$	$3\ ^{-\frac{1}{2}}_{-1}$	$3\frac{3}{4}^{-1}_{-1\frac{1}{2}}$

Dimensions in inches. Limits in thous. Bearings numbered from flywheel end.

REQUIREMENTS

Refer to Fig. 20

i. **Grinding machine,** with drive to give crankshaft speed of 60/70 R.P.M. and a face-plate diameter of at least 14″ to allow for a 7″ throw of the crank.

ii. **Throw blocks,** one pair, **accurately matched and preferably on fixed centres** to suit both VTO/H and VSO/H crankshafts. The blocks should be capable of receiving counter balance weights. The ends of the shaft should be protected against damage.

Fig. 19 shows three views of a typical **throw block** which will prove a good guide to manufacture. The one illustrated is suitable for one, two and four throw shafts and the same type, but with three centres, is suggested for the three throw (120°) shafts.

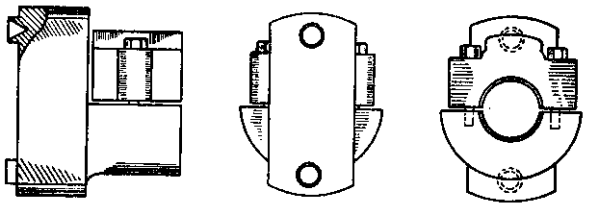


Fig. 19

iii. Make provision on the plate end for the adjustable counter balance weights.

iv. **Counter balance weights,** one pair, the weight required will, of course, depend upon the design of the blocks, but should be such as to permit any crankshaft to be revolved smoothly whilst grinding. To this end the position and amount of weight should be adjustable.

v. We use a $2\frac{1}{4}$″ wide wheel on VSO/H and 2″ on VTO/H Crankshafts, (with edges) suitably radiused.

SETTING UP

Refer to Fig. 20

Setting up the crankshaft for grinding both main and large end journals should be done with **great care.** See page 16 for adverse effects caused by incorrect setting up.

Mains

i. The crankshaft axis **AA** should revolve on the machine axis **BB.**

ii. Check with clock micrometer on grinding head by moving along the full length of the shaft, with the clock held (1) vertically and (2) horizontally.

iii. DO NOT attempt to grind until the crankshaft is parallel within the prescribed limits, making due allowances for uneven wear on the journals.

Large Ends

i. The axis of the large end journal to be ground should revolve on the machine axis **BB.**

ii. The crankshaft axis **AA** MUST be parallel and in line with both machine axis **BB** and centre line of bedplate **CC.**

iii. The ends of the shaft should be firmly held in the throw blocks which have fixed, proved centres.

iv. Check parallelism as above, i.e. with clock held (1) vertically and (2) horizontally. This should be done with crankshaft on top as shown in the illustration.

v. Turn the crank through 90° and repeat the check.

DO NOT attempt to grind until the crankshaft is parallel within the prescribed limits, making due allowances for uneven wear on the journals.

CRANKSHAFT SPEED 60/70 r.p.m. GRINDING WHEEL FOR STEEL SHAFTS.
N.B. Makers' instructions should be strictly adhered to.

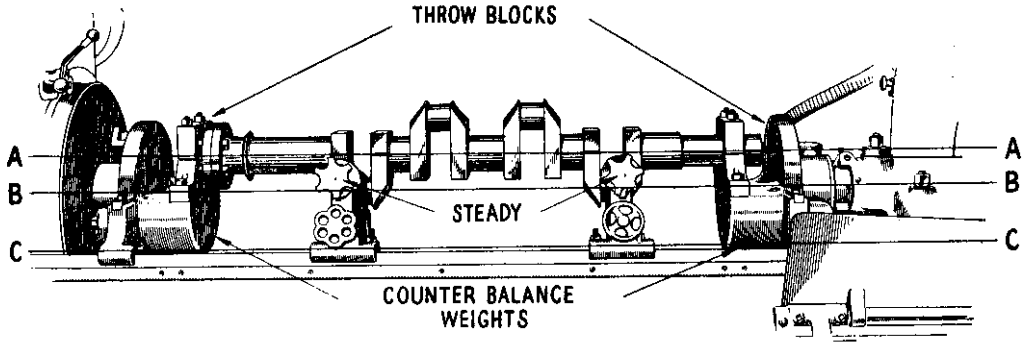


Fig. 20

NOTES

i. All oil holes to have corners broken with $\frac{1}{32}$" **radius.**

ii. All diameters to be round and parallel within $\frac{1}{2}$ **thou. (.0005").**

iii. All radii to be replaced as original shaft:—

Main bearing pins—$\frac{3}{16}$" **radius** see **N** Fig. 18

Large end pins —$\frac{1}{8}$" **radius** see **O** Fig. 18

NOTE

In each case out-of parallelism and twisting of throw blocks has been emphasised for illustration purposes.

Fig. 21 shows clearly the adverse effect of using inaccurately matched throw blocks.

The centre of the crankpin 'CP' is not parallel with the centre of the crankshaft 'AA'

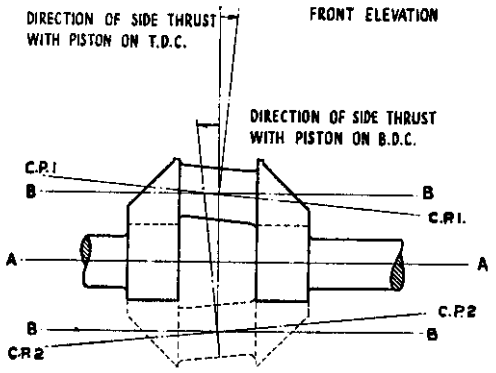


Fig. 21.

Fig. 22 illustrates how it is possible, even with accurately matched throw blocks, to set up in the machine with the blocks twisted in relation to each other.

It is therefore most important to ensure that the crankshaft centre 'AA' is in line axially with the crankpin 'CP' when in the vertical plane.

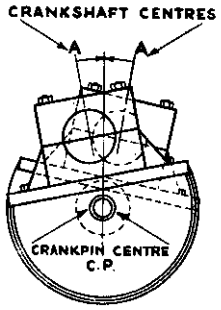


Fig. 22.

Fig. 23 shows the adverse effect of machining with twisted throw blocks.

Note that heavier pressure is created on alternate sides of the crankpin *i.e.* at half stroke downwards, on the side 'B,' and at half stroke upwards, on the side 'C.'

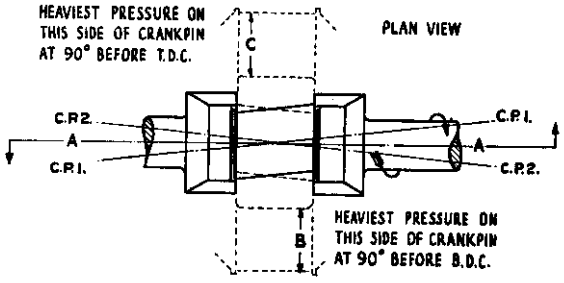


Fig. 23.

CHECKING (2nd)

Refer to Fig. 17 for 1, 2 and 4 throw crankshafts

i. Place crankshaft in vee blocks, see 1st check.

ii. Fit disc for profile check on one of the main bearing journals. See Fig. 26 for size.

iii. Set crank with large end pin to be checked on top.

iv. Check height of disc at '**E**', set clock micrometer needle at zero.

v. Check large end pin at '**F**', and the reading should be within the limits specified on Fig. 18, i.e.:—

ZERO $^{+0''}_{-.005''}$

This is a most important check—the limits must under no circumstances be exceeded.

vi. Whilst the crankshaft is in the same position check the pin for parallelism at points '**G**' and '**H**'.

vii. Turn crankshaft 90°, see right hand arrow and again check the pin at points '**G**' and '**H**'. There should of course be no variation throughout the length of the pin, within a limit of ½ thou. (.0005″).

viii. Repeat for other large end pins.

Refer to Fig. 24 for 3 throw crankshafts

The three throw crankshaft requires an additional check as follows:—

i. Place the 30° protractor, Fig. 25, firmly against the milled profile of No. 1 crank, generally as shown.

ii. Set the clock micrometer to ZERO at point '**K**' with a $\frac{3}{16}$″ (.1875″)* 'slip' or 'block' gauge between the crankshaft journal and the toe of the clock, to allow for differences in diameters. *Standard—make suitable allowance for reduced diameters.

iii. Check No. 3 pin at point '**L**' as shown and the reading obtained should **be within the limits of zero, plus 30 thous. to minus 30 thous.**

The foregoing check can be carried out by means of a disc marked out in degrees, in which case the limits would be:—

120° plus 45′ (.75°) to minus 45′ (.75°).

Check the other large end pins similarly.

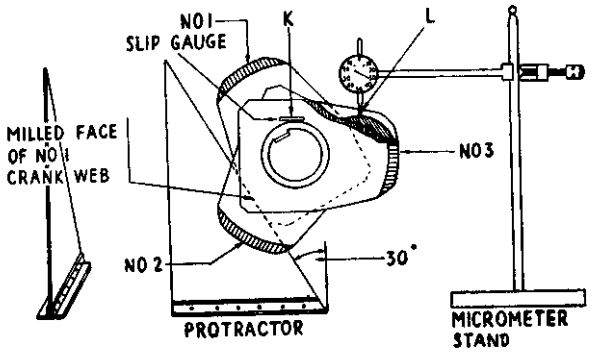


Fig. 25 *Fig. 24*

Figure 25 shows an isometric view of the 30 degree protractor from which it will be seen that it consists of a 30° angle plate rivetted between 2 angle pieces to hold it upright and enable it to be moved about on the surface-plate at will.

Refer again to Fig. 17 for all sizes

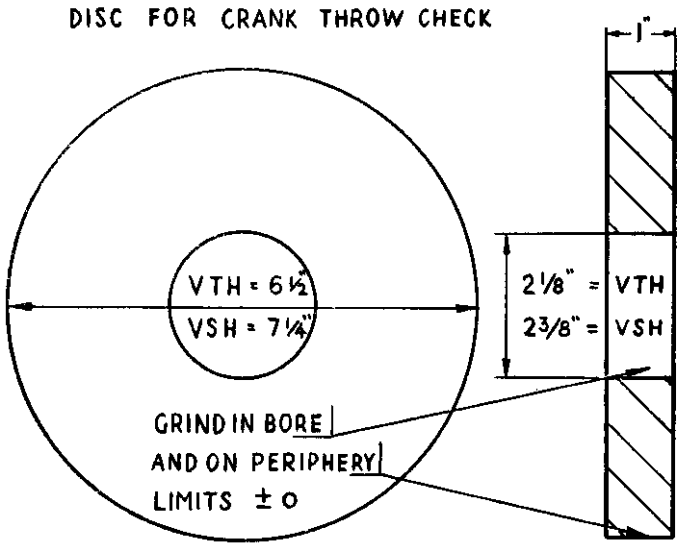
ix. Check for straightness throughout the length of the crankshaft as detailed in 1st Check on Page 12.

x. Straighten if necessary.

xi. Check dimension 'J' Fig. 17 and 18, i.e. between large end thrust faces which should be:—

VTO/H 2"±0
VSO/H 2¼"±0

Fig. 26 gives manufacturing details of the three sizes of disc required for the standard, first and second regrind crankshafts for VTO/H and VSO/H engines.



STANDARD DIMENSIONS ARE GIVEN.
1ST REGRINDS SIZE LESS 15 THOUS.
2ND REGRINDS SIZE LESS 30 THOUS.

Fig. 26

NOTES

i. The disc is not to check parallelism of large end pin and crankshaft, but to check that the stroke of the crank is within the limits allowed.

ii. Straightening is the only operation which should be undertaken, as under normal service conditions, if the crankshaft is not straight it can only be due to the shaft having sprung in the crank profiles, or on bearing pins.

iii. NO attempt should be made to heat and/or twist the crankshaft, but if it will not respond to the treatment detailed, or does not check within the limits laid down, the shaft should be replaced.

BALANCE WEIGHTS

When balance weights are fitted they must be removed before the grinding operation.

Before attempting to remove the weights read these instructions carefully.

GENERAL

Two types of setscrews are employed to secure the weights to the crank webs.

i. $\frac{5}{16}$" hexagonal head, for which special spanner tool No. 8588 I.W. is required, with a $\frac{3}{4}$" round steel bar 2' long for turning.

ii. $\frac{9}{16}$" square head requiring special spanner tool No. 4603 I.W. and the $\frac{3}{4}$" round steel bar.

Each setscrew is locked after tightening in position by a dowel pin, serrated for half its length, and driven in so that the top is just below the face of the shoulder. The corners of the hole are peened.

Fig. 27 shows a section through the balance weight with the setscrew cut-away to reveal the locking arrangement.

NOTE On early engines the lockpin was positioned at right angles to the setscrew, through the side of the balance weight, therefore if the pin hole cannot be located at the top as shown, it will be found at the side.

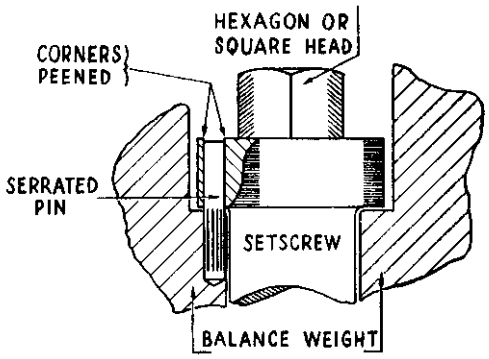


Fig. 27

REMOVAL

i. The crankshaft should be firmly secured to a bench or in a vice.

ii. Mark each weight so that it can be replaced on its correct web.

iii. With the appropriate spanner firmly fitted on the setscrew head and the bar arranged to give maximum leverage it should be possible to shear the pin.

iv. In case of difficulty drill an $\frac{1}{8}$" hole in the centre of the pin $\frac{3}{8}$" down to weaken it. This applies particularly to the old type pins see NOTE above.

REPLACING

i. Clean all parts and remove any burrs caused by shearing the pin.

ii. Replace the weight on the web from which it was removed.

iii. This is most important for **balance** purposes.

iv. Note the position of the pin-hole in the weight.

v. **Fit new Setscrews, do not use the old ones.**

vi. Tighten the setscrew with appropriate spanner and bar, **but do not over-tighten** by extending the length of the bar.

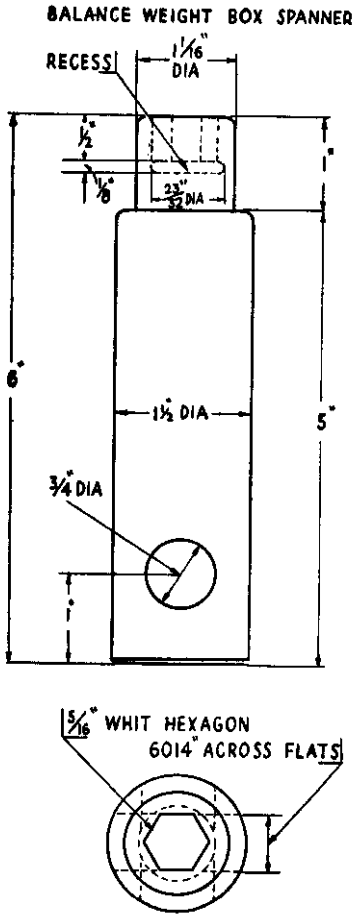
vii. Check that the drilled hole in the setscrew **does not come in line** with original pin hole. (If it does drill a **new** hole).

viii. Drill $\frac{5}{32}$" hole $\frac{13}{16}$" deep.

ix. Drive serrated pin in, see Fig. 27.

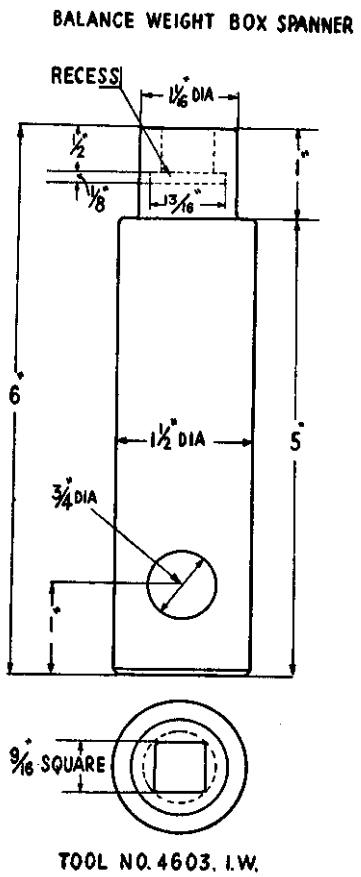
x. Peen corners of the holes as shown.

Figs. 28 and 29 give manufacturing particulars of Tools Nos. 8588 and 4603 I.W. respectively.



TOOL NO. 8588. I.W.
MATERIAL EN. 24 T.

Fig. 28



TOOL NO. 4603. I.W.
MATERIAL EN. 24 T.

Fig. 29

DECEMBER, 1952

SV 9

CRANKSHAFT
MAIN BEARINGS

CRANKSHAFT MAIN BEARINGS

SV 9

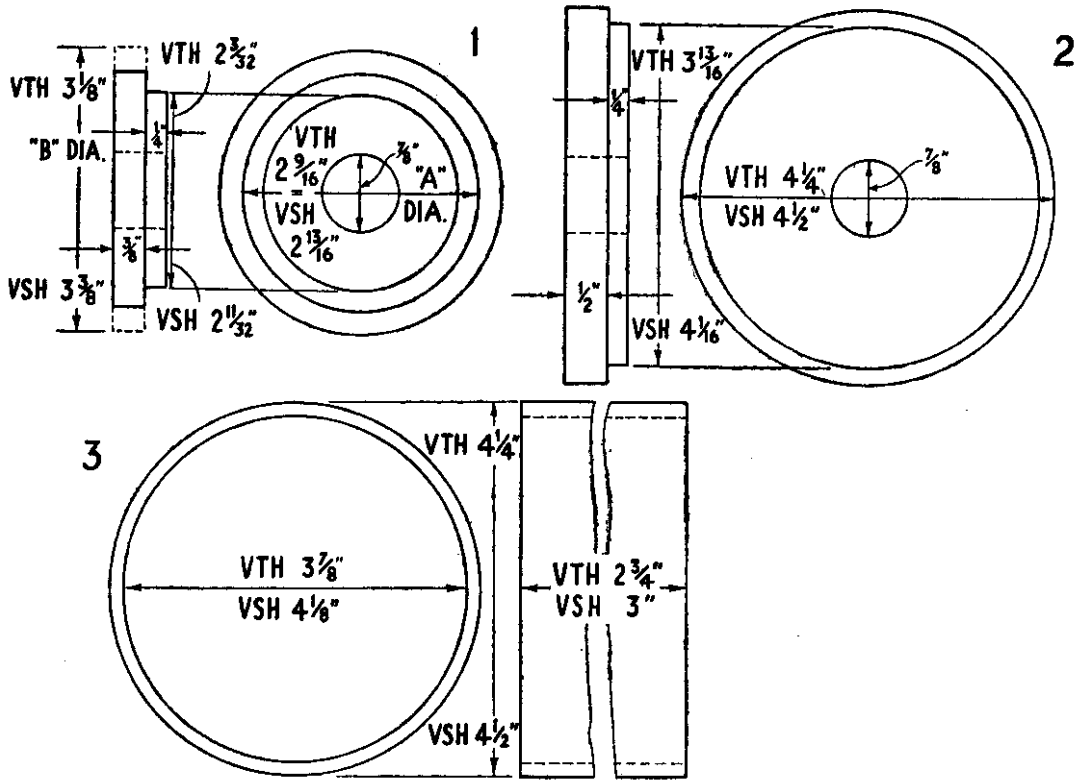


Fig. 2

WITHDRAWAL TOOL No. 3949 IW.			
Item	Description	Material	Number
1	Withdrawing Plate ..	E.N.3.A.	1 — "A" 1 — "B"
2	Withdrawing Plate ..	E.N.3.A.	1
3	Tubular Distance Piece ..	E.N.3.A.	1
4	½" B.S.P. Plugging ..	Steel	VTH 9½" long VSH 10" long
5	½" B.S.P. Nuts	Steel	2
6	¾" Washers	Steel	2
VTO, VTH, VSO & VSH		Bush Bearing Part No. V-66	

THRUST BEARINGS. Part No. V-161.

(on all multi-cylinder engines)

This is a split bearing fitting into housing part number V-6833.

i. The two halves are aligned one with the other by two fitting studs or screw bolts. To remove undo the nuts and prise the two halves of the bearing housing off the shaft.

ii. Remove the bearings and fit new ones, if necessary.

iii. Bolt the two halves together and check the overall width and scrape the flanges until the requisite end float is obtained, *i.e.*,

4—6 thous. (.004" to .006").

NOTES

1 We scrape the clearance to a gauge (Go and No-go) but if this is not available, then use the crankshaft, scraping each half separately on **one side only.** Checking finally upon assembly.

2 On single cylinder engines the thrust is taken between the two inner bush bearings (V-66) and the clearance should be adjusted to:—

3—6 thous. (.003" to .006").

3 On no account must the bearing housings be let up, although the operator should check that the housing when bolted together holds the bearing firmly. This check can be made quite readily with the aid of a set of feelers as follows:—

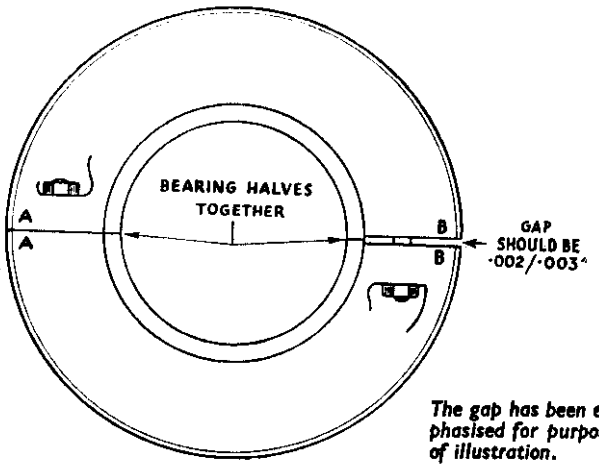
i. Fit bearings into bearing housing.

ii. Put the two halves together with the nut on **one** side finger tight so that points AA are in contact. See Fig. 3.

iii. Tighten the nut on the opposite side, also finger tight, *i.e.*, holding spanner at jaws, until the two halves of the bearing are together, as illustration. THIS will leave a gap between faces **BB.**

iv. For correctly fitting bearings the gap at BB will be **2—3 thous. (.002" to .003").**

4 When checking bores, the bearing halves should be nipped together.



The gap has been emphasised for purposes of illustration.

Fig. 3

3 and 4 Cylinder Industrial Engines only.

BUSH V-68 (in halves) fitting into
HOUSING V-64 (in halves).

This intermediate bearing requires the same fitting as V-161 except that there is NO SIDE CLEARANCE to scrape.

4 Cylinder Industrial Engines only.

BUSH V-6832 (in halves) fitting into
HOUSING V-6834 (in halves).

The only difference between this and other intermediate bearings is that it is longer and therefore the two halves of the housing are secured by 4 fitting studs and nuts instead of 2.

Repeat as for V-68 and V-64.

CRANKSHAFT MAIN BEARINGS

REGRINDS

Specially bored bearings will be supplied against order to suit crankshafts that have been reground in accordance with our recommendations.

Two regrinds are permissible, *i.e.*

i. **Size minus 15 thous.** (.015″) and
ii. **Size minus 30 thous.** (.030″).

When the crankshaft has been reground it is, of course, necessary to fit a **crankshaft gearwheel,** part No. V.1177, **which has been bored suitably undersize.**

The standard crankshaft oil seal, part No. V.7247 may, however, still be used, although the instructions given in S.V.8 sub-section (*c*) should be followed when fitting.

ORDERS for bearings and wheel should clearly state the amount by which it is proposed to regrind the crankshaft.

NOTE For crankshafts that are only slightly worn, *i.e.*, not sufficient to warrant regrinding, we can supply bearings bored :—

Size minus 5 thous. (.005″).

SPECIAL
CRANKSHAFT MAIN BEARINGS

LOCO ENGINE THRUST Part No. VL-66

This bearing is fitted on 2 and 3 cylinder VSO/H Loco engines only and is designed to withstand the axial shock loading common to LOCOMOTIVE applications.

It comprises two bush bearings VL-66, each a press fit in end cover VL-271 as shown in Fig. 4.

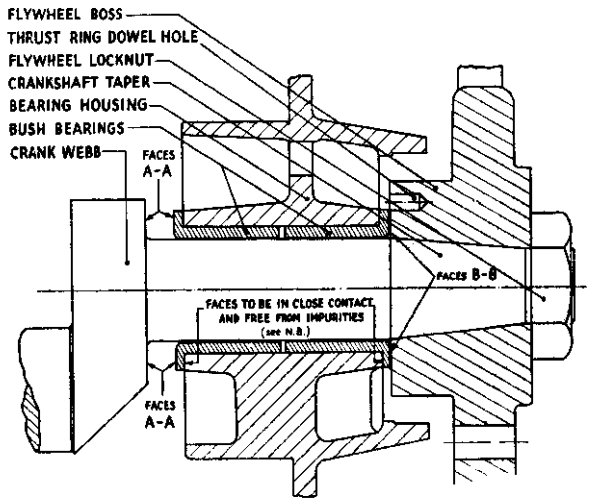


Fig. 4

DISMANTLING

Spider Coupling.

Both ends of the shaft should be cleared of accessory equipment and here it will be helpful to give a hint as to the removal of the spider coupling at the opposite end to the flywheel.

Refer to Figure 5.

The gib head (3) of the key points to the crankshaft (2) centre and the illustration demonstrates an easy means of providing necessary support to the under-side of the key, without which removal is extremely difficult.

i. Remove the bolts and the coupling disc.

ii. Assemble the wedge (4) and the retaining bar (5) using one of the bolts (6) generally as shown.

iii. Drive the key out by means of taper wedges, see Fig. 1, S.V.8.

iv. Remove the spider.

Dimensions of the parts required are given in inset on Fig. 5.

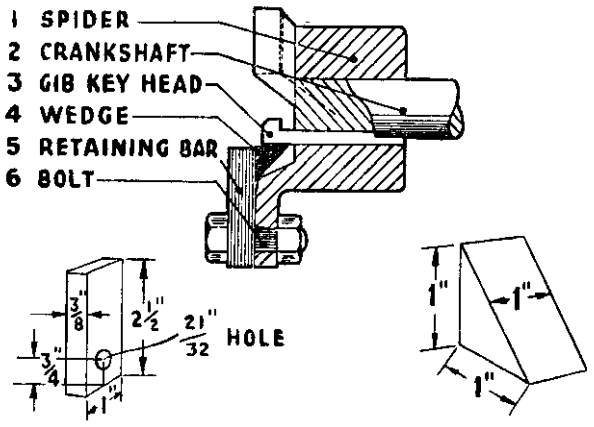


Fig. 5

FLYWHEEL

Remove per instructions given in S.V.8, sub-section (a), covering flywheels fitted on taper shaft by locknut, etc., using tool 3950 IW.

BEARING HOUSING

Remove by two $\frac{3}{8}$" dia. forcing setscrews in the tapped holes in the flange of the housing.

CRANKSHAFT

To remove see also S.V.8, sub-section (a).

OIL SEAL

The seal will have to be removed to facilitate the fitting of a new thrust plate or adjusting the end clearance thereof. See S.V.8, sub-section (c).

BUSH BEARINGS

Due to the construction of the bearing, *i.e.*, having thrust flanges at each end, the removal of one of the bushes is an operation requiring some care.

i. Try to remove **ONE** bush by driving out with a brass drift inserted in the gap between the bushes, failing this it may be necessary to split the bearing by chipping down the centre with a narrow ($\frac{1}{8}$") grooving chisel, after which the bush can easily be removed. DO NOT DAMAGE THE BORE OF THE BEARING HOUSING, DURING THIS OPERATION.

ii. Remove the other bush by means of tool No. 3949 IW. using plate 'A' (see Fig. 1).

iii. Fit new bearings with the tool, using plate ' B '.

N.B. It is important that the inner flanges of the bushes are in close contact with the faces of the bearing housing, otherwise there is a risk of excessive end float developing after the initial run. (See Fig. 4).

THRUST CLEARANCE. (End float).

This is checked whilst the crankshaft is out of the engine and it is assumed that all bearings have been removed from the shaft. It is recommended that the shaft be strapped to a bench with the end clear to receive bearing and flywheel.

i. Put the completed bearing on the shaft right way on.

ii. Remove the thrust plate and the dowel pins from the flywheel. Replace the woodruff (side fit only) key and after cleaning taper and bore, fit wheel on shaft and tighten AS IF ON FINAL ASSEMBLY.

Illustration Fig. 4 shows arrangement.

iii. The locking plate for the flywheel locknut should now be fitted.

The inset on Fig. 6 shows the locking plate machining, by means of which very little movement of the locknut is required to put the set-screw holes in line.

Try all positions before tightening the nut further.

iv. Scribe a line through the parts as shown in Fig. 6, *i.e.*, 2, 4, 5 and 6.

v. With faces BB (Fig. 4) held tightly together check the clearance between the faces AA very carefully indeed.

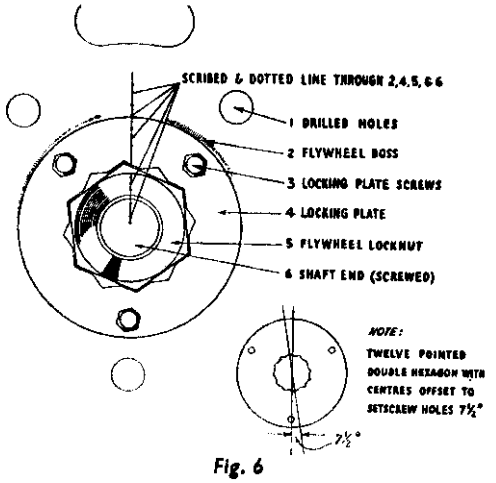


Fig. 6

THIS IS A VERY IMPORTANT CHECK, therefore exercise great care to ensure a correct figure, using, if possible, a pair of inside calipers that can be locked in any desired position.

vi. The dimension obtained with the calipers should now be checked with an 0"—1" micrometer and the plate, after dismantling the assembly, should be ground to a thickness four/six- thousandths less than the reading obtained.

e.g., **Micrometer reads .730".**
Grind plate to .726"/.724"

IMPORTANT

vii. If, after fitting new bearings as in the foregoing, the plate is found to be a thou. or two small it is possible to reduce the end-float by grinding the bore of the wheel on to the shaft.

Bear in mind that a thou. or two off the taper will permit the wheel to go further on the shaft several thousandths of an inch, and by exercising a little care much time and effort can be saved in the plate grinding operation.

FITTING NEW THRUST-PLATE

Important points to remember are:—

(*a*) Dowel pins are a push fit into the holes in the flywheel, but are an easy fit in the plate.

(*b*) The plate will only fit on the dowels one way—see key plan, Fig. 7.

(*c*) The thrust face of the plate MUST PRESENT an unbroken surface to the bearing.

(*d*) Plates should be a light driving fit on the crankshaft.

This MUST be checked when fitting as if the plate is slack on the shaft the oil seal would be rendered useless (see Fig. 7).

(e) Again the bore MUST be concentric with the periphery, as should the plate run eccentrically the efficiency of the seal would be impaired.

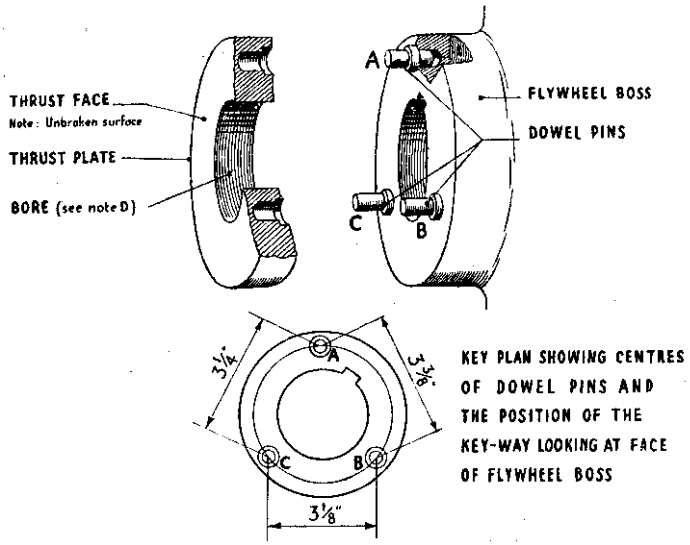


Fig. 7

PROCEED AS FOLLOWS :—

i. Scribe a line on the flywheel boss to mark the centre of the keyway in accordance with (1) on Fig. 8.

ii. Fit dowel pins in wheel and the thrust-plate over the dowels and holding it tightly against the boss scribe a line to correspond with line on wheel, extending the line when plate is removed as (2) on left hand illustration Fig. 8.

iii. Scribe a line (3) on the crankshaft taper through the centre of the keyway.

iv. Press or tap the thrust-plate on to the shaft about 1" or so further than running position; see that the two scribed lines coincide.

v. Fit the woodruff key.

vi. Put on the flywheel, tightening it lightly into position with the locknut.

vii. Tap the thrust-plate along the shaft, making certain that the dowel pins are clear in the holes, until the plate face makes contact with the fly-wheel boss.

NOTE This operation is necessary to ensure that the thrust plate fits over the dowels without pulling on the shaft, and thereby causing distortion. (See note (*d*) on page 8).

viii. Remove locknut, flywheel, woodruff key and thrust-plate.

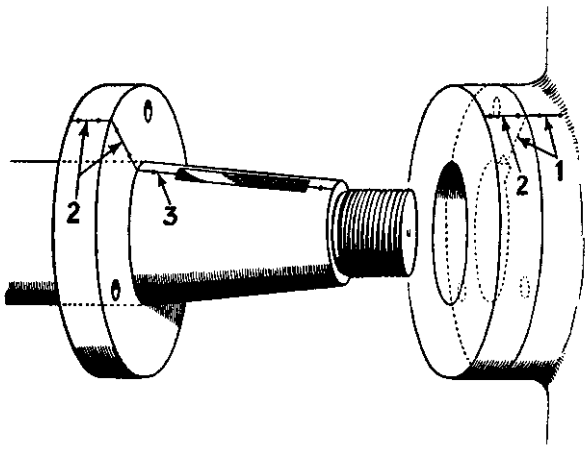


Fig. 8

COMPLETING THE OPERATION

Proceed as for Thrust Clearance.

REPLACING THE THRUST BEARING

The instructions assume that all other bearings have been fitted and that the crankshaft has been replaced in the engine in accordance with S.V. 7, sub-section (*b*).

i. Fit the bearing into the housing.

ii. Smear jointing compound on the rim and fit the oil seal. Although this seal is larger in diameter than the standard, it is a light driving fit and can be readily driven in using a piece of hard wood as a drift. Care should, of course, be taken to drive in evenly to prevent distortion. See S.V.8. sub-section (*c*).

iii. Turn the crank so that keyway is on top.

iv. Fit the thrust-plate, with the lines together, see Fig. 8, to within $\frac{1}{16}$" (approx.) of final position.

v. Insert key, replace the wheel and tighten the locknut until all lines coincide, see Fig. 6.

vi. Give a sharp blow to the locknut end of the shaft with lead hammer, or equal and check clearance finally between crank web and bearing as indicated in Fig. 9 which shows clearly in cross-section the FINAL ASSEMBLY.

vii. Finish off by fitting lockplate and threading soft iron wire through the holes in the three setscrews. Bring the ends of the wire together and twist.

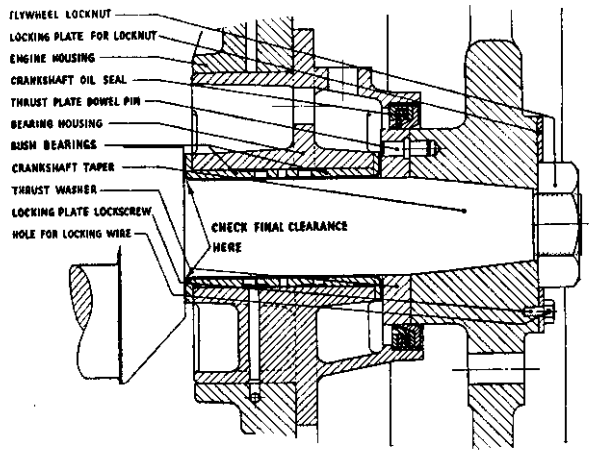


Fig. 9

NOTE

On all loco engines the standard thrust bearing is replaced by

Bearing housing (split) part No. VL-64.

Bearing bush (split) part No. V-68.

Any service attention given should be in accordance with instructions for standard thrust,

EXCEPT THAT THERE IS NO SIDE CLEARANCE TO SCRAPE.

SPECIAL
CRANKSHAFT MAIN BEARINGS

CONSOLIDATED PNEUMATIC TOOL CO. ENGINES

Two sizes of engines are fitted into C.P.T. equipment at present, viz:

1. **MARK 3 VTO or 3 VTH** to which reference is made in S.V. 8, sub-section (e).

2. **MARK 3 VSO or 3 VSH** which are fitted with a special crankshaft and bearings involving different methods in servicing, etc.

The instructions assume that the engine has been lifted from the chassis and that the clutch has been removed, so that the engine presents an appearance as the one on the left hand of the illustration, Fig. 10.

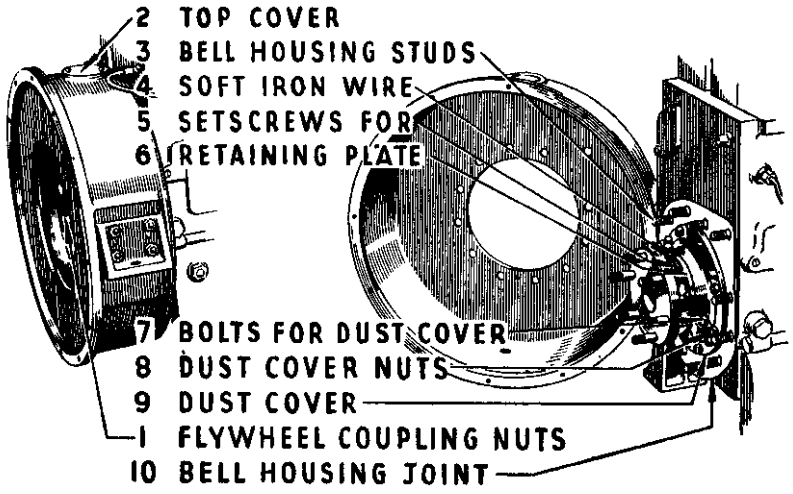


Fig. 10

DISMANTLING

The Fan Pulley.

i. Remove the starting dog from shaft at opposite flywheel end. This is merely screwed on tight and can be undone by giving a sharp blow on the end of an appropriate size of spanner.

ii. The pulley can be removed by using forcing screws in the $\frac{3}{8}$" holes provided pieces of $\frac{1}{16}$" plate are inserted between the pulley and the end cover.

iii. Remove the end cover.

The Crankshaft End Bearing Assembly

Refer to Fig. 10.

i. Remove flywheel coupling nuts (1) and spring (Kolok) washers.

ii. Remove the top cover (2) from bell housing and turn wheel to put lifting hole on top.

iii. Force the wheel off with two $\frac{1}{2}$" B.S.W. forcing screws in the tapped holes provided. Support the wheel during this operation until a lifting eye can be screwed in.

iv. Remove the bell housing, see illustration.

v. Remove the soft iron wire (4), the setscrews (5) and the oil retaining plate (6), the latter is in two halves.

vi. The two bolts (7), the nuts (8) and the dust cover (9), also in halves, to be removed.

NOTE This exposes the oil throwing arrangement which on this engine displaces the oil seal.

It is not necessary to remove the disc, but, of course, care MUST be taken in handling the crankshaft, to prevent damage to it.

vii. The crankshaft can now be removed in accordance with S.V.8 (*a*).

THE MAIN BEARING. Part No. R.71A.

This is a special split bearing bush fitting into bearing housing part No. R.6787A also split and is found only in C.P.T. engines where a flywheel coupling is shrunk on.

FITTING NEW BEARING

Follow same instructions as for other split bearings which are NON-THRUST.

RE-ASSEMBLING

i. Fit ALL the bearings on to the crankshaft.

ii. Replace the shaft. See S.V.8 (*b*).

iii. Replace gearwheel end cover, using sleeve tool No. 8943 IW. to protect the oil seal. See S.V.8 (*c*).

iv. Drive the fan pulley on and fit the starting dog.

v. Replace the dust cover (9) and tighten into position.

vi. Fit the oil retaining plate, after checking the felt washer for soundness. Thread soft iron wire through the heads of the setscrews, bring the ends together and twist.

vii. Replace the bell housing making quite certain that ALL nuts are tightened on to their ' KOLOK ' washers, and that there is no foreign matter at the back.

viii. In replacing the flywheel remember that the bolts are a " PRESS FIT " and that care must be exercised in entering the plain part of the bolts before any pressure is applied.

Both the end of the coupling and the flywheel are marked so as to avoid the possibility of replacing wrongly.

Here again the nuts should be tightened carefully with a ' Kolok ' washer beneath.

The clutch and other equipment may now be replaced.

GOVERNOR and CAMSHAFT

SV 10

REMOVING GOVERNOR LEVER

The governing of the engine speed is automatic and the parts involved rarely require attention; however, should it become necessary to service these items the following instructions will be found helpful.

DISMANTLING GOVERNOR LEVER

Refer to Fig. 1.

i. Remove front valve gear cover, governor lever cover, the small splash plate and the crankcase end cover.

ii. Remove the fuel pump link pin (1)

iii. Then the speeder spring collar (2) from the governor lever.

iv. Put fuel pump cut-out (3) in running position, or remove the assembly complete.

v. Partially unscrew the fulcrum pin (4), DO NOT remove until ready to lift the lever (5), or the governor die (8) may fall into the oil pump gears.

vi. Hold the lever (5) firmly at the top, remove fulcrum pin and lift the lever, turning anti-clockwise, see illustration, for 90° so that the governor die cannot foul the oil splash guard in the wheel cavity.

NOTE The die must clear the sleeve (6) before it can be turned, and the lever should be kept vertical or the die may still fall off.

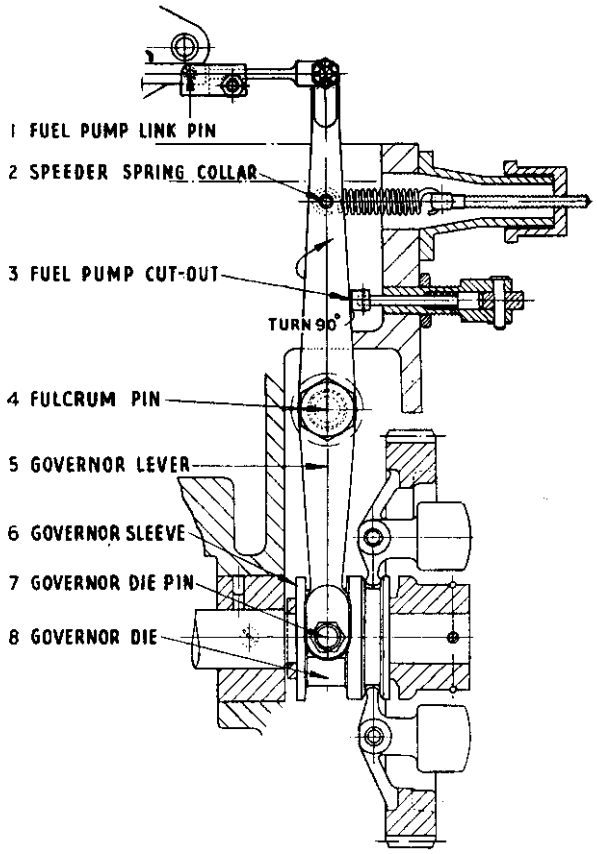


Fig. 1

REMOVING CAMSHAFT and DISMANTLING GOVERNOR

i. Remove the housing cover on the camshaft side.
ii. Tie up, or otherwise prevent fuel pump and valve-tappets from falling into the crank-case, or fouling the shaft as it is withdrawn.
iii. Remove the locating screw, see Fig. 2.
It is also shown in dotted outline on Fig. 1.
iv. The camshaft may now be withdrawn.

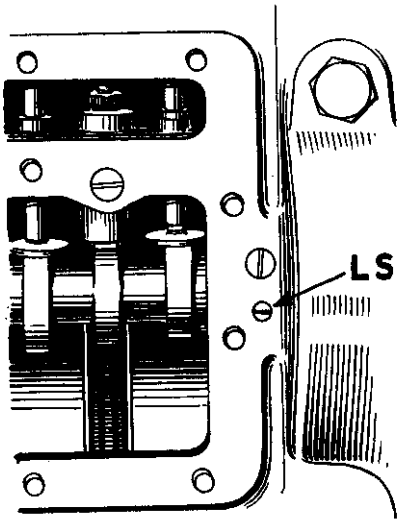


Fig. 2

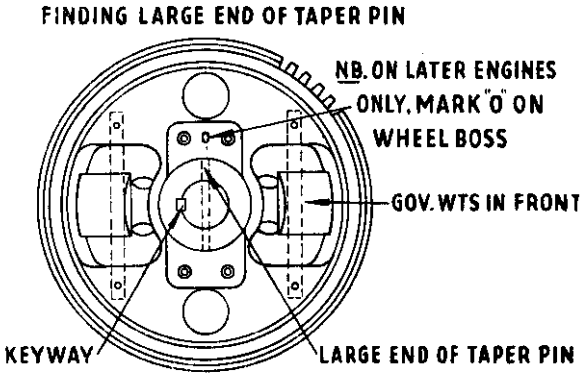


Fig. 3

REMOVING GEARWHEEL

Camshaft gearwheels are a **tight fit** on the shaft and are located by both woodruff key and taper pin. These instructions should be carefully followed to enable the wheel to be removed without damage.

i. Ascertain which is the smaller end of the taper pin. Reference to Fig. 3 will make this clear. ALL GEARWHEELS on these engines are drilled and pinned with the keyway on the left hand with the wheel boss facing front. This applies whether the pin is at right angles to the key, or at a tangent as in the case of some marine types.
NOTE On later engines the wheel has been marked with a figure "O" to indicate the LARGE END of the taper pin.
ii. Hold the camshaft firmly in vice, or on stand with clamps, so that the keyway is on the right hand when looking at the wheel. This puts the small end of the taper pin ON TOP.
iii. Remove the spring ring, and put a support under the boss of the wheel, but, of course, clear of the taper pin.
iv. Clean the boss to reveal the end of the taper pin.
v. With a pin punch, not more than $\frac{3}{16}$" dia. at reduced end, DRIVE THE TAPER PIN OUT WITH SHARP BLOWS.
Take care not to drive the pin punch against the boss, but on the end of the taper pin only.
On earlier types a split taper pin was fitted, this should be sawn off near the boss and subjected to same procedure as in the foregoing.

vi. Remove the governor weights.

vii. The wheel can be pressed off the shaft if such facilities are available. If no press, use tool No. 41-J-374.

viii. Assemble tool as shown in Fig. 4, *i.e.*, put bolts (3) through the governor weight holes, then drop backing plate (4) into position, adjust length of bolts so as to place draw bar (1) as close to the end of the shaft as possible, then draw the wheel off by turning withdrawal bolt (2).

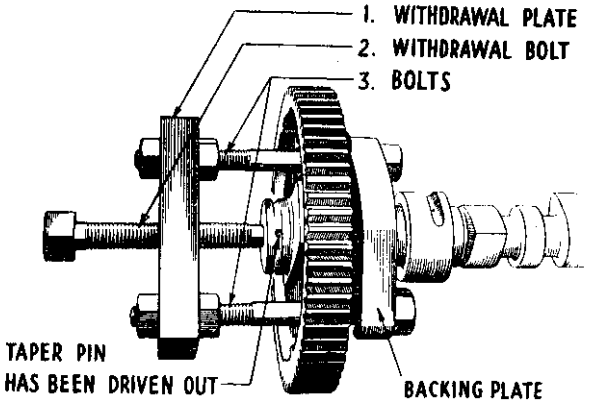


Fig. 4

Figure 5 gives manufacturing details of tool No. 41-J-374.

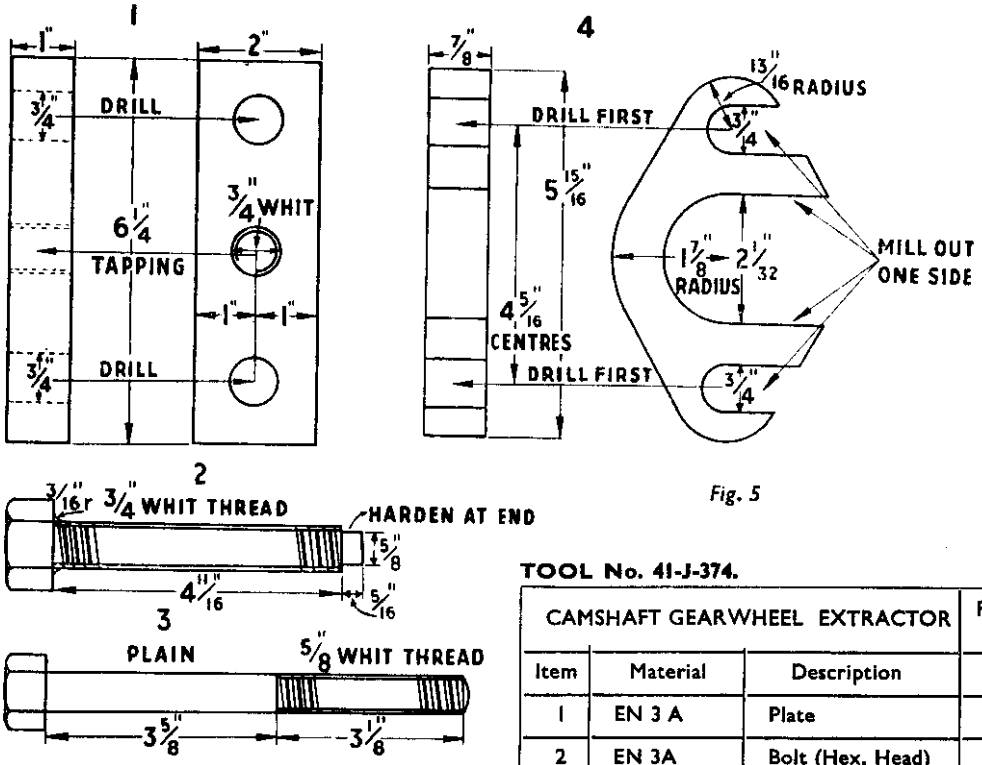


Fig. 5

TOOL No. 41-J-374.

CAMSHAFT GEARWHEEL EXTRACTOR			Part No. V-378
Item	Material	Description	No. off.
1	EN 3 A	Plate	One
2	EN 3A	Bolt (Hex. Head)	One
3	EN 3 A	Bolt (Hex. Head)	Two
4	Phos./Bronze	Withdrawal Flange	One
5	Steel	5/8" Whit Nuts	Four
VTO, VTH, VSO & VSH ENGINES			

ix. The governor sleeve, woodruff key and the camshaft bearing can now be removed.

FITTING NEW PARTS

NEW GEARWHEEL. Part No. 738

Refer to Fig. 6.

i. Fit the governor sleeve (5) as shown in Fig. 6, ensuring that it moves freely on the boss of the wheel and does not stick against face (C). Remove the sleeve.

ii. Fit weights (3) so they also are free without much side play, 3 thous. (.003") max.

iii. Then, one weight at a time, fit the weight and the sleeve, engaging weight point (E) with sleeve point (F).

iv. Ensure that the weight clears the wheel at point (A) when the sleeve (5) is in contact with face (C). Allow a minimum clearance of $\frac{1}{16}$". The weights SHOULD NOT BE ADJUSTED, but clearance made by chipping and filing the gearwheel as required.

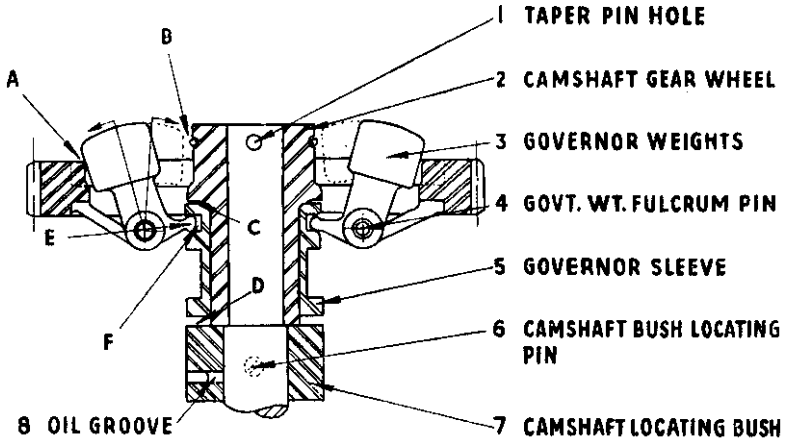


Fig. 6

v. Move the weight through the arc (AB) revolving the sleeve (5) to see that it turns freely all the time and noting that the arc of contact of the weight at point (E) is constant against the rubbing surface of sleeve at (F).

Attention is drawn to the fact that the rubbing surface of the governor arm is hardened, see governor weights, page 6.

vi. Repeat for the other weight.

vii. Check that the woodruff key is a good fit on the sides of the wheel keyway.

viii. Fit the camshaft locating bearing (7) correctly, *i.e.*, with the oil slot (8) nearest the cams.

ix. Insert woodruff key in shaft and fit governor sleeve.

x. Mark the end of the shaft to indicate the centre-line of the taper pin hole (1) and measure exactly its location relative to the shaft end.

xi. Grease the shaft and PRESS the wheel on until only running clearance is left for the locating bush, approx. 1—2 thous. (.001"/.002").

IMPORTANT

It is preferable that a press be used for this operation, although the wheel can be driven on if necessary using a spigoted phos. bronze drift for a start, then finishing with a plain drift and a 10-lb. hammer BUT GREAT CARE MUST BE EXERCISED to prevent damage to the boss of the wheel whilst it is being driven on.

The camshaft is of special cast iron consequently it is most important that the blows directed at the wheel strike it SQUARELY to prevent the possibility of the shaft breaking.

DRILLING FOR THE TAPER PIN

xii. Set the camshaft up on drill table with keyway on L.H. side (see Fig. 3) and the scribed line (note x) set vertical.

xiii. Drill and ream the hole, in accordance with note i. in "Removing Gearwheel" on page 2, for a $\frac{1}{4}$" taper pin.

Refer to Fig. 7.

NOTE After the taper reamer operation has been carried out, the hole should be carefully examined, from both ends alternatively, when if the hole presents a smooth, unbroken taper finish, the pin should be driven in tightly.

If, however, a smooth finish is NOT OBTAINED, then a size larger reamer should be used and, of course, a correspondingly larger taper pin inserted.

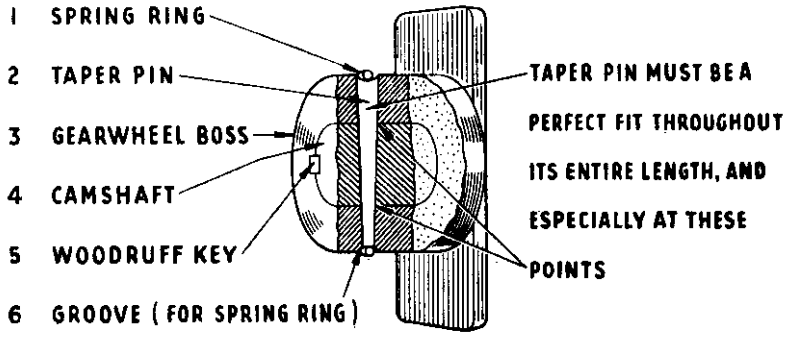


Fig. 7

Fig. 7 shows a cut away view of the shaft end. The perfect fit of the taper pin in the hole should be carefully noted.

xiv. File a groove in ends of the taper pin and fit the spring ring (1).

If split taper pin is employed, open out ends.

TEST

xv. Before replacing the camshaft carry out the following test.

Refer to Fig. 6.

(*a*) Stand the camshaft on its end, gearwheel uppermost.

(*b*) Pull weights out to point (A).

(*c*) Release weights and they SHOULD RETURN AUTOMATICALLY to point (B); ease any hard spots as required.

(*d*) Check that the weights are clear of the wheel at (A) and (B) when the sleeve (5) is at respective ends of full travel between points (C) and (D).

NEW GOVERNOR WEIGHTS. Part No. 704

Refer to Fig. 6.

Service weights supplied from works are pre-finished, *i.e.*, fitted to a standard wheel and sleeve and the LINE OF CONTACT bedded on the rubbing surfaces of weight arm end (E) and race (F) of sleeve (5).

The two weights are then perfectly balanced one against the other and the arms are hardened at (E).

Repeat procedure as detailed in notes ii, iii, iv, v and vi, and carry out the test in note xv.

NEW GOVERNOR LEVER DIE. Part No. 3376

(Camshaft in engine).

Refer to Fig. 8.

i. Give the die (5) running clearance in the sleeve race (6) approx. 1-2 thous. (.001"/ .002").

ii. Check that it is a good fit, but free to revolve on the die pin (4) without being slack.

iii. Smear thick grease on die and die pin.

iv. Set die vertical and reverse procedure in dismantling (see vi. page 1), *i.e.*, put into place so that die does not foul splash guard, turning 90° just before it enters the race in the governor sleeve.

This operation is best done before the crankcase end cover has been replaced.

It is, however, possible to remove and replace the lever and die assembly with the end cover in position although the operation requires some manipulation.

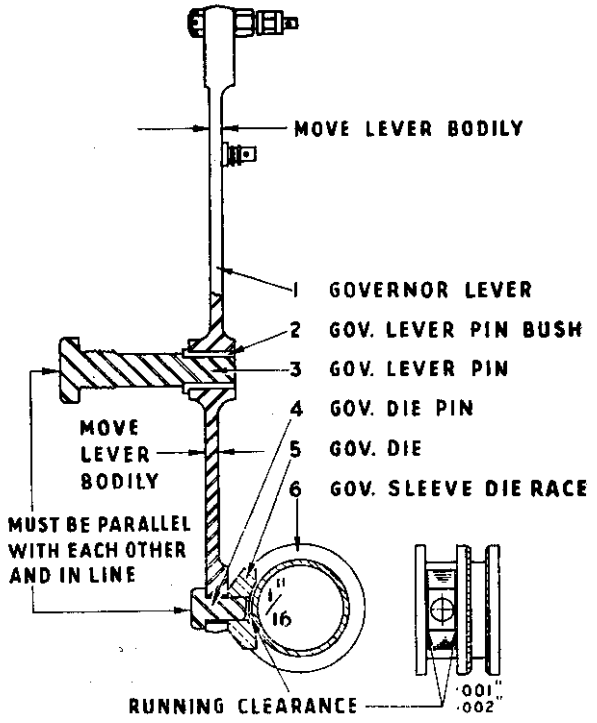


Fig. 8

v. When the die is in position, fit the fulcrum pin (3) and it should be possible to move the lever (1) bodily on the pin approximately $\frac{1}{16}$" if the correct running clearance has been given. Adjust until the required clearance is obtained. Clearance should be checked at both ends of the travel.

It will be appreciated that after a period of service it is possible for the governor lever to become slightly bent; hence if it is necessary to obtain clearance by adjusting the lever, it is important that the die pin (4) and the lever pin (3) are parallel with each other, and in line horizontally.

NEW LEVER BUSH. Part No. 7133

Renewal is seldom necessary, although if for any reason wear becomes excessive, it may be a contributory cause to erratic governing.

Simply remove the lever, drive the old bush out and replace and check that it is free on the pin before replacing the lever.

NEW CAMSHAFT. Part No. 901

Refer to Fig. 6.

Repeat procedure for gearwheel but additionally:

Check the drilling and fitting of the locating screw (6) which must be a good FIT in the bush (7), when if it does NOT LINE UP it is advisable to turn the bush only sufficient to permit the drilling of a new hole.

It is, however, MOST IMPORTANT that as much of the oil groove (8) as possible be on top.

BEFORE replacing the camshaft it is advisable to turn the pump tappet screws down to prevent damage to either shaft, or fuel pumps.

REPLACING CAMSHAFT and GOVERNOR LEVER

THE CAMSHAFT

Reverse procedure in ' REMOVAL ', see page 2.

i. Put the fitted-up shaft into the bearings in the housing, taking care that all tappets are in their correct places and held up clear of the shaft.

ii. Before meshing the gears, set the camshaft locating bush with the oil groove on top. (This makes it easier to fit locating screw).

iii. Mesh the gears correctly, *i.e.*, the one tooth on the cam shaft gear **A** marked with an " 0 " should engage between the two teeth on the crankshaft gear wheel **B** similarly marked, see Fig. 9.

iv. Bring locating screw hole into line' insert screw and tighten, see Fig. 2.

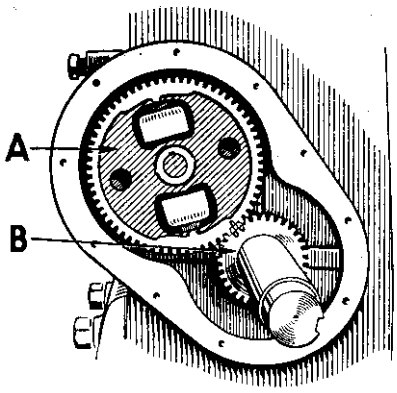


Fig. 9

THE GOVERNOR LEVER

Refer to Fig. 1.

Reverse procedure in ' REMOVAL '

i. Grease the die and the pin (to prevent it falling off) and set the die vertical.

ii. Reset fuel pump cut-out (3) Fig. 1.

This is set correctly when the pin end, which presses against the lever, has approximately $\frac{1}{16}$" clearance whilst in the ' on ' position with the engine at ' rest '.

IT IS, HOWEVER, ABSOLUTELY ESSENTIAL THAT WHEN IN THE CUT-OUT POSITION, THE FUEL PUMPS ARE NOT DELIVERING OIL.

iii. Fit the speeder spring (2) and the split pin.

iv. Replace the fuel pump link pin (1) and its split pin.

v. Finally replace small splash plate and all covers, etc., but in the case of the crankcase end cover remember to use tool 8943 IW. (see S.V.8, Fig. 13) to protect the oil seal from damage.

RESETTING THE FUEL PUMPS

CUT-OUT ADJUSTMENT Slacken the speeder gear (3), Fig. 1, so that the governor lever (5), Fig. 1, may be readily moved by hand. Its left hand position is the position for no-fuel delivery, its right hand position for full fuel delivery.

Screw the cut-out body into the engine housing, so that when the stop lever is in the " stop " position it pushes the governor lever to the extreme left position but not far enough to jam at the end of the thread.

The cut-out body should be secured into position by tightening the lock-nut, or with studs and nuts as required.

INJECTION TIMING

i. Place the fuel pump cut-out lever in the " running " position.

ii. Revolve the flywheel until the crank for the cylinder being timed is on firing top centre, with crank in this position the relative exhaust and inlet valves are closed and the fuel pump plunger lifted.

iii. Disconnect the fuel injection pipe from the pump; remove the delivery valve holder and lift out the delivery valve and spring (if fuel flows from the pump, rotate the flywheel to position where flow ceases).

iv. Replace the delivery valve holder only, and tighten it.

v. Revolve the flywheel slowly backwards until fuel commences to flow, then revolve the flywheel in the direction of engine rotation until fuel flow just ceases (wipe the top of the valve holder to check that fuel flow has definitely ceased).

vi. At this position, the fuel injection mark should be exactly in alignment with the pointer on the engine crankcase. If the marks are not in alignment adjust the fuel pump tappet setscrew until timing is accurate and ensure that the setscrew locknut is tightened after adjustment.

vii. Wash the delivery valve and spring in paraffin (kerosine).

viii. Replace the delivery valve, spring holder, and injection pipe, and prime the injection pipe as instructed in " Priming the Fuel System," see page 10.

WARNING Fuel pump tappet adjustment. A and B show respectively the marks on the fuel pump tappet just visible in the sight window at the top and bottom of the plunger stroke. These are the limits beyond which the tappet must not move after final adjustment. See S.V.11 Fuel Pumps, Fig. 23.

SETTING THE FUEL PUMP CONNECTING LINKS

Equal distribution of the fuel is essential for all multi-cylinder engines, and to ensure this the fuel pump connecting links are carefully set and marked at the works.

Should the fuel pump connecting links be taken apart the setting mark which consists of a cut on the link at ' X ', Fig. 10, should be set in line with the end of the fork ' Y '. It is important that the pumps themselves should be replaced in the original positions.

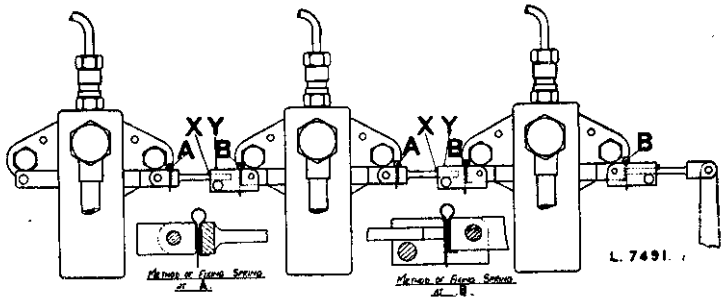


Fig. 10 Fuel pump actuating links.

If one or more new pumps or connecting links are fitted the following procedure should be observed.

i. Adjust the stop lever.

ii. Set the timing of the new pump (or pumps) in the manner laid down under the heading "Injection timing" keeping the rack rod to the right hand limit of travel while this is being done. Deal with the pump nearest to the governor first, then take each pump in rotation.

iii. Put the stop lever in the "stop" position, move the rack rod over fully to the left then move it back $\frac{1}{16}$".

iv. Lock the connecting link to the governor lever with the rack rod in this position.

v. Repeat this process for each fuel pump.

Having followed the above procedure the pumps will be in approximately correct adjustment but it is necessary now to go further and make a fine balancing adjustment to ensure that the engine load is equally shared between all cylinders.

This is carried out as follows:—

vi. Remove the exhaust manifold.

vii. Run the engine on no-load, noting the heat of the exhaust on each cylinder. Should these heats not be equal they may be corrected in the following manner:—

viii. Make fine adjustments to the length of each link as indicated by the exhaust heats. These adjustments must be very fine and subject to trial and error until the correct balance of exhaust heats is obtained.

ix. Any adjustment to the length of one interconnecting link must be counteracted by a corresponding adjustment in the opposite direction on all links to the left of the one adjusted.

x. Mark the link after satisfactory settings have been established.

NOTE Adjustment to length of links is done simply by unscrewing the link setscrew and pushing the link in or out of the fork 'Y' as required.

FUEL PUMP ACTUATING LINK SPRINGS

To give a cushioning effect to the fuel pump link system, link springs 'A' and 'B' are fitted.

To fit these disconnect each link in turn and insert the spring into the end of the fork link as at 'A' or over the end of the fuel pump rack as at 'B' and then reconnect the link pins.

PRIMING THE FUEL SYSTEM

i. See that the fuel tank is clean and filled with clean filtered fuel oil.

ii. Place fuel pump cut-out lever in the running position See (3), Fig. 1.

iii. Remove the air release plug on the top of the fuel filter, and partially unscrew the plug 'AR', Fig. 11, on each fuel pump until the vent holes are exposed.

iv. Open the fuel tank valve, and when fuel flows freely through the aforementioned vents tighten the air-release plugs.

v. Slacken the delivery pipe unions on each injector and revolve the engine until fuel appears at each union, then re-tighten.

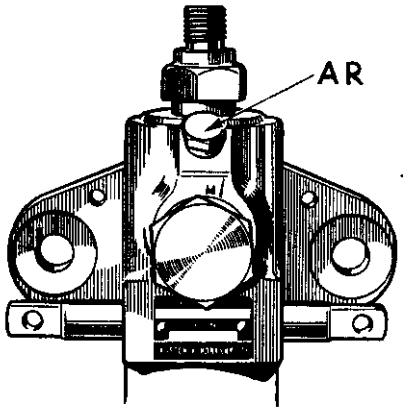


Fig. 11 Fuel Pump.

vi. Revolve engine until a creak at each injector indicates that priming is satisfactory.

vii. Empty drip-can if necessary.

viii. Replace cylinder head covers.

DECEMBER, 1953

FUEL INJECTION EQUIPMENT

SV II

INJECTION EQUIPMENT
RUSTON MARK 37 INJECTORS

The satisfactory running of an oil engine is largely dependent upon the condition of the injector through which fuel oil is injected at high pressure into the cylinder.

Maximum efficiency in operation can only be obtained if the injector is delivering the fuel oil so as to produce the most efficient combustion.

It is essential, therefore, to ensure that all injectors are kept clean and in good condition. When an injector is functioning badly the cause is generally dirt or other foreign matter.

It is wise to check the working of the injector from time to time and re-condition or replace any parts which have become worn or damaged.

To assist users to keep injectors in perfect condition special equipment has been designed for both re-conditioning and testing, as follows:—

(*a*) **Ruston Injector Re-conditioning Tools and**

(*b*) **Ruston Injector Testing Pump.**

The main feature of this equipment is the re-conditioning tools which can be used by hand, but where the number of injectors to be re-conditioned is sufficient to justify a special layout, the use of the small plant described in this manual is recommended.

DISMANTLING THE INJECTOR

As the details are dismantled they should be placed in a paraffin bath and care must be taken when more than one injector is dismantled to group the parts together to ensure that each needle valve, guide and nozzle and other components go back into their own body.

It is important to remember that absolute cleanliness is required when dismantling injectors. The bench used should be covered with either clean paper, linoleum or sheet metal (preferably lead) which can be wiped clean before commencing operations.

Do not use cotton waste, fluffy rags or lint cloth for cleaning.

Remove the injector overflow connection 12 and remove plug 9.

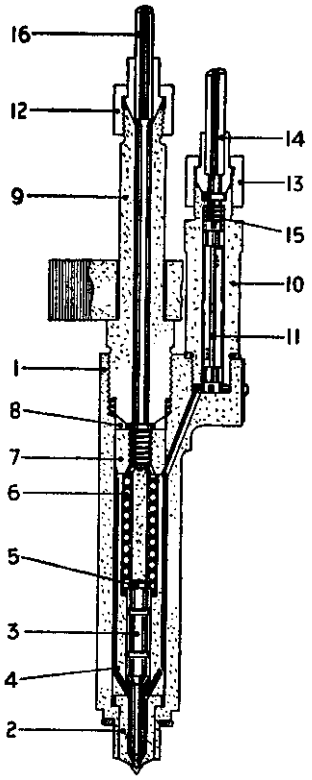


Fig. 1

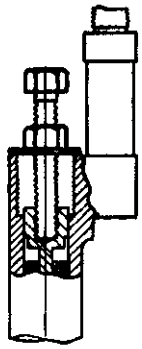


Fig. 2

1. Body.
2. Nozzle.
3. Needle valve.
4. Needle valve guide.
5. Spring washer.
6. Spring.
7. Needle valve stop.
8. Plug joint.
9. Plug.
10. Delivery connection and filter body.
11. Edge type filter.
12. Overflow connection.
13. Delivery pipe union nut.
14. Delivery pipe nipple.
15. Filter body spring.
16. Leak pipe.

Screw the Extractor Fig. 2 into the needle valve stop 7, tighten the locknut on to the extractor washer, and the needle valve stop together with the copper washer can be withdrawn.

The remaining parts can then be removed.

Should the needle 2 stick this can be easily removed by giving the nozzle a light tap, using a hollow soft copper drift.

All parts should now be well washed in clean paraffin and the injector body well rinsed out, the holes of the nozzle 2, Fig. 1, being cleaned out with the wire provided.

Any deposit of carbon around the nozzle body and bore of injector in which the nozzle fits should be removed, with tools Nos. 6764 IW. and 6765 IW.

To remove carbon from the injector body hold reamer 6764 IW. firmly in the vice as shown in Fig. 3, slide the injector on the reamer and remove the carbon with a semi-rotary movement, applying hand pressure only so as not to remove any metal from the injector facing.

Repeat as above for cleaning the bore of the nozzle hole, after substituting reamer 6765 IW.

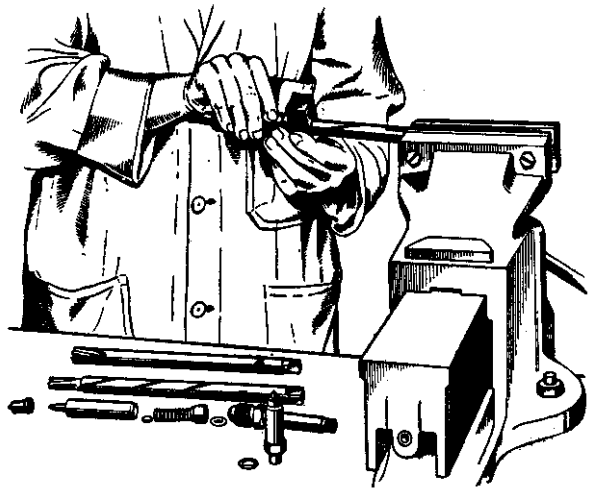


Fig. 3

Finally pour clean paraffin into the nozzle and see that all holes discharge freely.

The internal parts of the injector must not be touched with a file or coarse abrasive material.

RE-ASSEMBLING THE INJECTOR

All parts should be re-assembled direct from their immersion in clean paraffin without wiping or draining.

The needle valve should be dipped in a good quality light lubricating oil and rubbed into the guides to be sure that it is free.

MARK 37 INJECTOR. Fig. 1

i. Fit the needle valve 3 into the guide 4 and fit the nozzle 2 on the end of the needle valve.

ii. Drop the small spring washer 5 into the hole in the needle valve guide 4 and make sure that it lies flat.

iii. Place the spring 6 over needle valve stop 7 and insert spring and stop into the needle valve guide 4.

iv. Hold the injector body as shown in Fig. 4 and insert the full assembly into the injector body 1. It will be seen that by assembling the internal parts in this order, the whole assembly can be inserted into the injector body, thus avoiding the likelihood of parts being misplaced, as may occur if they are dropped into the body separately.

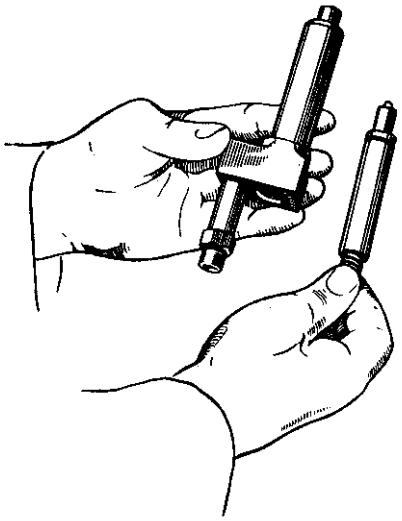


Fig. 4

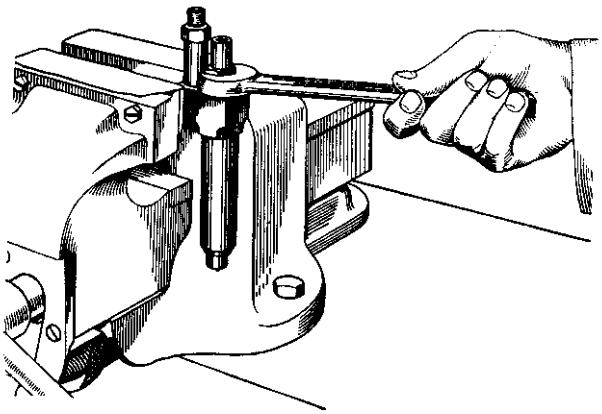


Fig. 5

v. The injector should now be held in a vice as shown in Fig. 5.

vi. Drop the copper washer 8 into position, making sure that it is approximately in the centre.

vii. Smear a little lubricating oil on the threads of plug 9 and tighten down securely.

The bore of the body, especially at the nozzle end must be kept clean to enable details to centralise themselves. Use of the tools shown in Fig. 3 ensures this and also removes any errors due to distortion of the body as well as carbon.

Care must be taken to see that the line on the nozzle is in line with the similar mark on the injector body.

IMPORTANT

If a number of injectors are dismantled together, care must be taken to see that each needle valve is returned to its own guide. **A new needle valve must never be fitted to an old guide or vice versa.**

The injector can now be tested, using the testing pump as described on page 4. **Care must be taken not to allow the spray to impinge on the hands, as the jets have been known to puncture the skin and cause skin trouble.**

INJECTOR TESTING PUMP

GENERAL USES

i. To clean the injector by pumping clean, light oil through it.

ii. To check periodically the quality of the injecting.

iii. To check the quality of the spray after the injector has been removed either for reconditioning or for fitting new parts.

By using the pump for purposes i and ii, the dismantling of the injector is reduced to the very minimum.

The pump is suitable for all sizes of injectors but different adaptor nuts are required for the various sizes and types of engines, and, of course, on the medium and large verticals a pump plunger of larger diameter is needed.

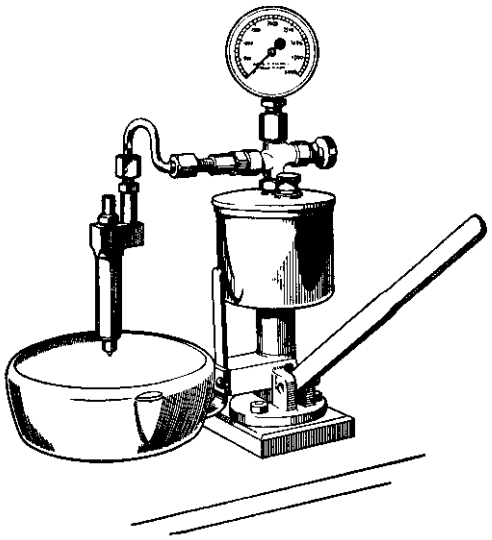


Fig. 6

METHOD OF USE

Clean, well-strained fuel oil is poured into the container and the pump is freely operated until it discharges free of air. The adaptor nut is then connected to the injector.

The necessity for using clean fuel oil, free from any foreign matter, is particularly emphasized, as the greater part of the injector wear and troubles are due to the use of unclean fuel oil.

At first, fuel oil should be forced through the injector for the purpose of cleansing with the gauge valve closed. Then gradually open the gauge valve sufficiently for the operator to be able to read a steady pressure upon the gauge.

If the gauge continues to show a reading considerably above the correct injecting release pressure, further pumping should be done with the gauge valve closed, the aim being to clean the injector in this way by the force pump until a further trial shows the gauge to read approximately the correct release pressure, as stamped on the plate attached to the injector.

A good spray should cut off without a dribble at each pump stroke and the quantity of spray from each hole should be approximately the same.

It should be noted that the gauge should not be put into action unless it is absolutely necessary.

Checking the gauge at intervals is recommended especially if the test pump is in regular use, or keep a spare gauge to use as a " Master ". Gauges must be correct.

TESTING THE SPRAY

The injector should release its charge at a predetermined pressure, viz: as stated on the injector nameplate.

The adaptor required is 64-SD-84 No. 1 Swan neck.

RE-CONDITIONING

When reconditioning an injector it is essential that the correct seating of the needle and nozzle be obtained, otherwise erratic release pressures and a sluggish cut off of the spray will result.

Do not lap needle and nozzle together, this destroys the differential angle. To replace the difference in angles use the tool kit which has been evolved for this purpose. See Fig. 7.

Each kit is packed in a neat bakelite box as illustrated.

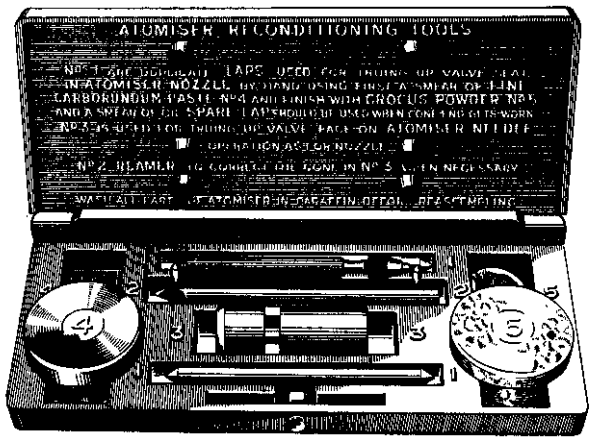


Fig. 7.

IMPORTANT **ORDER THE CORRECT KIT**

To order **THE CORRECT KIT** obtain the arrangement drawing number from the plate on the injector, then check from the following table whether **Kit A** or **A1** is required.

e.g., When VSH injector plate reads 

order Kit "A1."

ENGINE	KIT A	KIT A1	ENGINE	KIT A	KIT A1
VTO	VTO-111A VTO-111B	VTO-111C	VTH	VTO-111D	All injectors marked VTH-111 etc.
VSO	VSO-111 VSO-111A VSO-111AS VSO-111D	VSO-111B VSO-111C	VSH		All injectors marked VSH-111 etc.
VSOH		VSOH-111			

METHOD OF USE

First thoroughly clean all the parts and put them in a place free from dirt.

Should it be found that the injector needle valve or the needle valve seat in the nozzle require reconditioning, it should be carefully done to the following instructions.

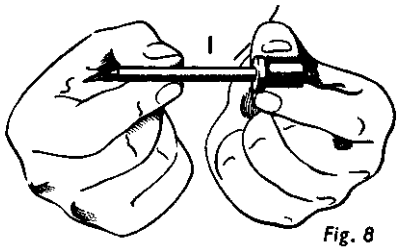


Fig. 8

RECONDITIONING THE NEEDLE VALVE SEAT IN NOZZLE

Clean the nozzle.

Smear a small quantity of the carborundum paste " 4 " on to the point of the lapping tool " 1 ", Fig. 8, and insert into the nozzle. Giving a slight hand pressure, rotate the nozzle and lapping tool until a good seating is obtained. Carefully wash the nozzle and lapping tool in paraffin. Smear lubricating oil on to the end of the lapping tool and cover the end with the fine lapping compound supplied with the reconditioning outfit. Again rotate both the lapping tool and the nozzle until the seat has a good polish.

NOTE In service lap " 1 " looses its angle and reconditioning becomes difficult, in this case correct the lap by (*a*) returning to us, or (*b*) regrinding the **sixty degree (60°) angle** on a PRECISION machine with **angle guaranteed.** In case of doubt return to us.

All laps returned to us, post paid, will be re-seated and re-posted to customer **FREE OF CHARGE.**

RECONDITIONING THE NEEDLE VALVE

Similar operations to those described on the previous page should be carried out with the needle valve. Care must be taken, before inserting the needle valve into the lap " 3 ", Fig. 10, to give it a coat of lubricating oil and only to coat the end of the needle valve with the carborundum or lapping compound through the slot in the lapping tool " 3 ".

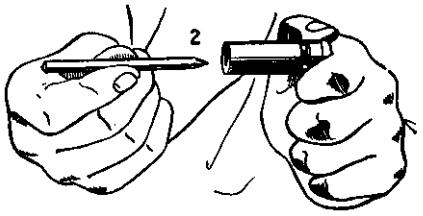


Fig. 9

RECONDITIONING THE NEEDLE VALVE LAP

After the needle valve lap has been used several times its seat may require correcting; for this purpose the seating tool "2", Fig. 9, should be used. This should be inserted into the lap and with slight pressure rotated until the seat is correct.

The operations will be facilitated if some means of rotating the laps and needle valves are available such as a small lathe, drilling machine, hand drill, etc. In such cases a similar procedure to that given in the following pages can be adopted.

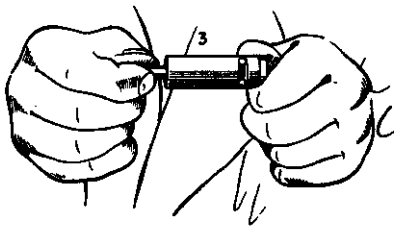


Fig. 10

SERVICE RECONDITIONING

SERVICE STATION EQUIPMENT

For Service Stations where the number of injectors to be reconditioned is sufficient to justify the lay-out of a small plant, the following equipment is recommended, and can be supplied by Ruston and Hornsby Ltd.

i. Injector Testing Pump with set of adaptors for the sizes of injectors to be serviced (when ordering give class and mark of engine to be serviced).
ii. Bench (supplied usually by Customer to drawing supplied by Ruston and Hornsby Ltd.).
iii. Motor driven self-centring chuck complete with adaptor and starting switch. Ideal spindle speed is 750 r.p.m. (when ordering state whether available current is D.C. or A.C. and give voltage; if A.C. current is used state if single or three phase and the periodicity, *i.e.*, the cycles of the supply).
iv. Vice with sheet copper or brass shields.
v. Reconditioning outfit (order correct outfit as instructed on page 6).
vi. Set of copper drifts for removing nozzles.
vii. Injector needle valve stop extractor.
viii. Edge type filter extractor.
ix. Spare nozzles, needle valve and guides supplied to special order and not included in outfit.

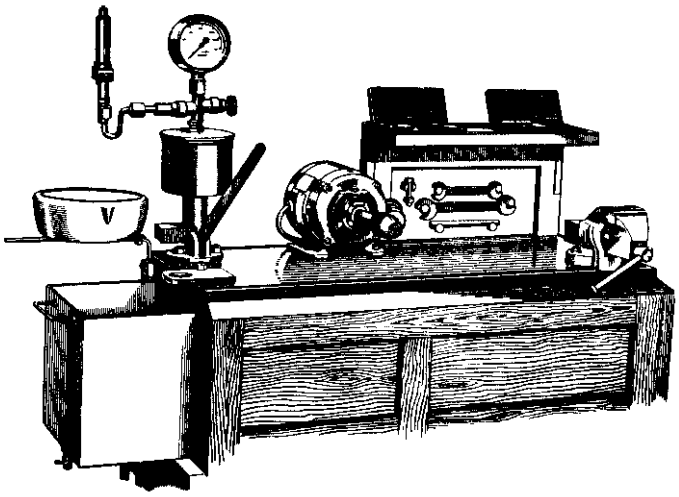


Fig. 11

Fig. 11 shows a typical service re-conditioning layout which can be supplied by Ruston and Hornsby Ltd. When ordering state voltage and whether A.C. or D.C.

In garages where a small high speed lathe or drilling machine is installed, this could be used instead of the self centring chuck shown above.

The best spindle speed is approximately 750 r.p.m.

The Ruston Injector Testing Pump is for testing the spray and checking release pressures, for while it is possible to observe the quality of the spray, etc., when injector is connected to the engine fuel pump, the finer points, such as freedom from nozzle dribble and the correct release pressure, are not so readily seen. (See Fig. 6).

Before proceeding with the re-conditioning of injectors, it is first necessary to ensure that the bench is free from all foreign matter, such as iron filings, etc. Where an existing bench is to be used a section should be covered with either sheet metal (preferably lead) or linoleum which can be wiped clean before commencing operations.

The bench should also be provided with a vice with sheet copper or brass shields in the jaws to prevent damaging the injector.

A shallow tray containing paraffin will also be required, into which the injector parts are placed as they are taken adrift.

Care must be taken to keep each injector's parts separate.

The injector testing pump should be erected on the end of the bench as illustrated in Fig. 11. In order to see whether an even spray is being ejected from all holes in the nozzle, the injector can be arranged to point upwards as shown. When the pump is being used to cleanse the injector, the latter should be pointed downwards into the tray as shown in illustration, Fig. 6.

The size of the servicing bench can be say 2 ft. 6 ins. high by about 2 ft. square, or to suit individual needs. All that is required is sufficient room to mount the motor, vice and test pump.

RECONDITIONING NOZZLES

Fit lap into chuck (Fig. 12) and smear a very small amount of No. 4 grinding compound on to the angular seat at end, taking care that the stem of the lap is free from the compound.

Place injector nozzle on lap and lightly press home. (Fig. 12).

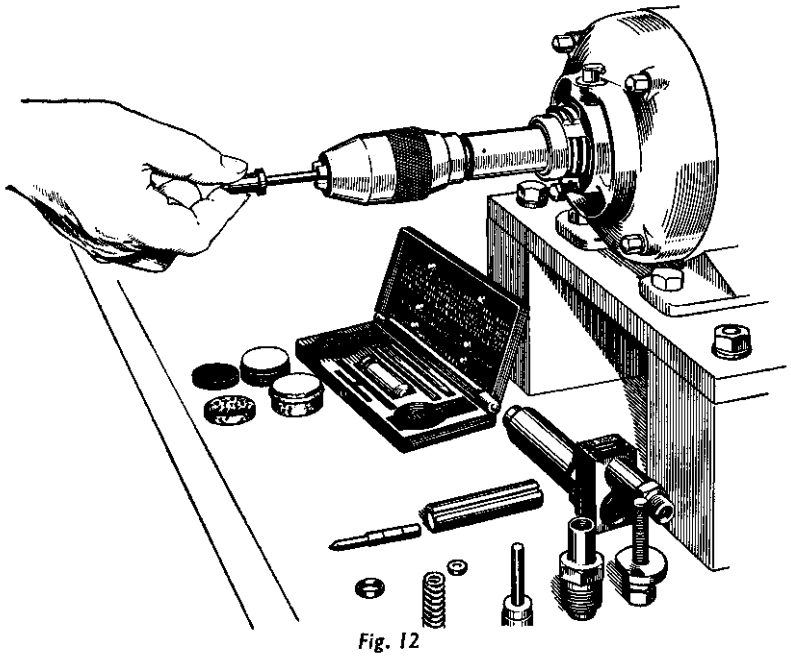


Fig. 12

To avoid scoring the seat, the nozzle should be eased back slightly every five seconds or so. Continue until marks have been removed from the seat, but no longer than necessary.

Wipe nozzle and lap clean and repeat the operation, using No. 5 lapping compound again avoiding unnecessary wear.

Wash and wipe nozzle seat, and the latter should now be free from marks and slightly polished.

As the two laps supplied are double ended they will last for a considerable time. It is a good plan to finish the lapping of the nozzle on an end set apart for finishing, and not on an end which has been used for rough grinding. These laps are made in cast iron and should be carefully handled.

TO RECONDITION THE NEEDLE SEAT

The needle should be held lightly in chuck as shown in Fig. 13.

Smear a little lubricating oil on the lapped portion of the needle and place the lapping bush (No. 3) over the needle.

A slot is made in the bush for inserting the lapping compound after the needle is in the bush. A little of the No. 5 paste should be applied with a match or wooden splinter.

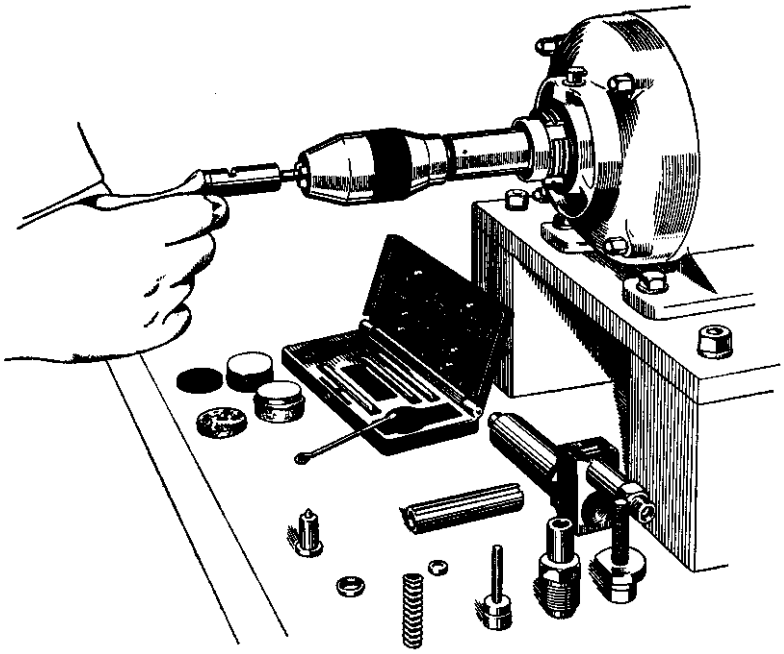


Fig. 13

It is very important that the compound does not come in contact with the lapped surface of the needle barrel, and for this reason the paste must be confined to the seat only. (See Fig. 14).

Continue this operation until the needle is free from marks, and to avoid scoring the seat ease back the lapping bush every five seconds or so as previously described.

All details, including the injector body, must now be thoroughly washed in clean paraffin.

Nozzle holes should have the wire broach passed through each hole. A small syringe will be found very useful for removing all traces of lapping compound that may be lodging in the nozzle tunnel.

If the injector is still unsatisfactory, repeat the lapping process. Usually it is only the nozzle that requires further lapping.

If the needle is found to be tight in its guide, it is probably due to a roughening of the lapped surfaces caused by dirt in the fuel oil.

Rough surfaces on the needle can be removed by polishing with a piece of soft leather on which a little No. 5 paste has been smeared, but this should not be done unless the needle is definitely sticky in its guide.

The needle should fall slowly by its own weight when perfectly clean.

All injectors are now stamped with the release pressure and it does not necessarily follow that an incorrect release pressure is due to a faulty spring. For example, low release pressure may be due to a defective seat in either nozzle or needle, and a high release pressure may be caused by the needle being too tight in its guide, or the gauge may be at fault. Check for accuracy.

After the needle valve lap has been used several times, its seat may require correcting. For this purpose a seating tool, No. 2 (Fig. 7) is used. This should be inserted into the lap, No. 3 (Fig. 7) and with a sight pressure rotated by hand until a new seat is cut into the lead lap.

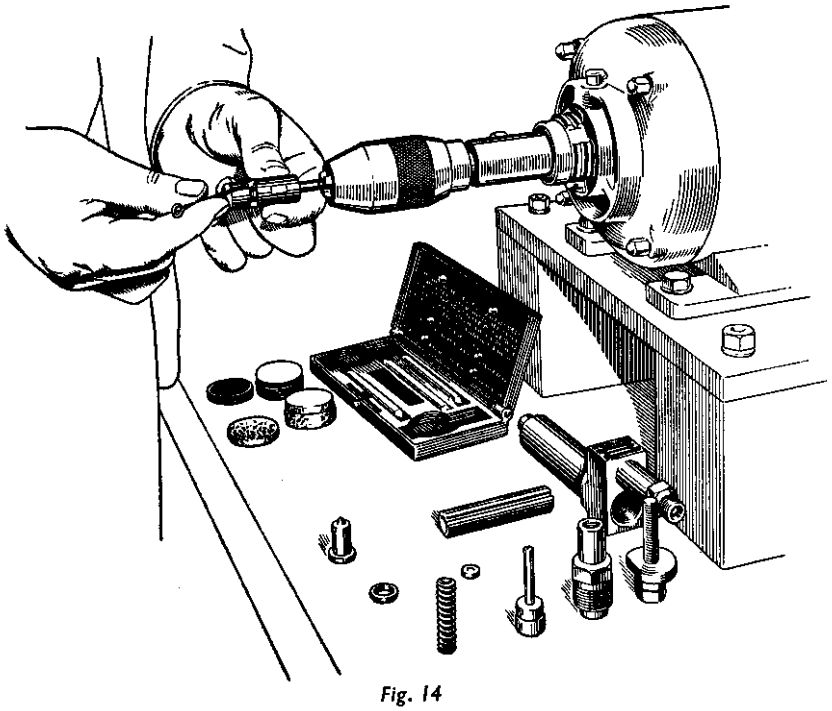


Fig. 14

MARK 37 INJECTOR SPARES

To save inconvenience and delay, Ruston Engine users are recommended to carry a small stock of Injector Spares, and these are supplied in handy form as illustrated below (Fig. 15).

SPARES

3 Nozzles
3 Needles
3 Guides

} Packed in a Bakelite box as illustrated.

IMPORTANT

A needle valve will be found inside each guide; **these two parts must always go together.**

A new needle valve must not be fitted to an old guide or vice versa.

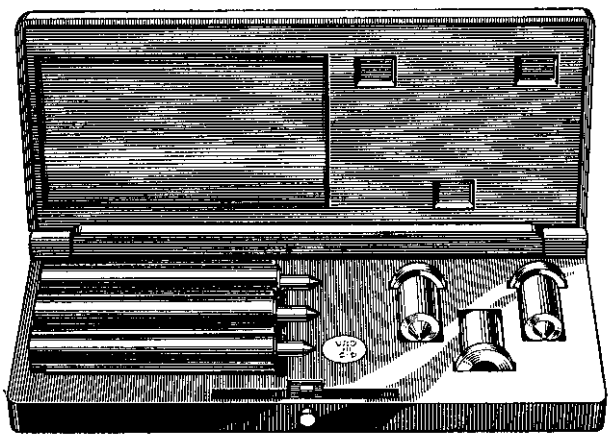


Fig. 15

INJECTION EQUIPMENT
RUSTON PUMPS MARK FPB

This sub-section fully explains the working details and servicing of Ruston Fuel Pumps.

The smooth and efficient running of modern high speed oil engines depends mainly upon the fuel injection pump. It is this which provides the engine with fuel in quantities proportional to the amount of work it is required to do. The pump must achieve this with absolute precision and timing many hundreds of times a minute, delivering the fuel in its right proportion and discharging it at high pressure through a nozzle orifice, so atomising the fuel into a form which, when delivered into the combustion chamber ignites and burns without smell or smoke.

At the lowest position of the plunger, the space in the pump barrel above the plunger is filled with fuel which flows in through two ports from the common suction chamber connecting the supply pipe from the tank. In rising, the plunger closes the two ports in the pump barrel so that the fuel is forced through the delivery valve into the delivery pipe connected to the injector, the fuel being then injected into the engine combustion chamber.

GENERAL PARTICULARS

Fig. 16 shows the pump barrel in various plunger positions, while Fig. 17 shows the fuel pump element in cross section.

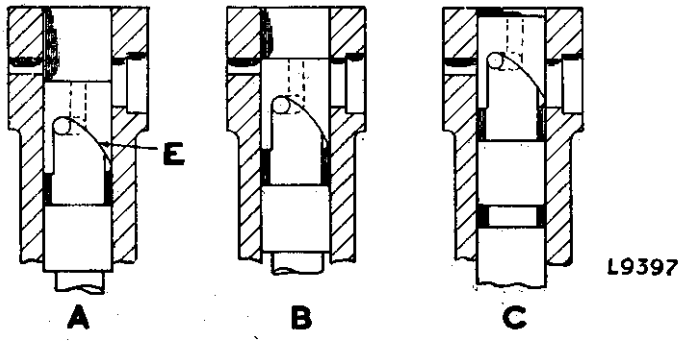


Fig. 16

Plunger Guide with Various Plunger Positions

Lowest position of plunger. Oil entering through suction port.

Plunger in position when suction ports are closed. Commencement of delivery to injector.

The suction port uncovered by the helical angle of the plunger. End of delivery stroke.

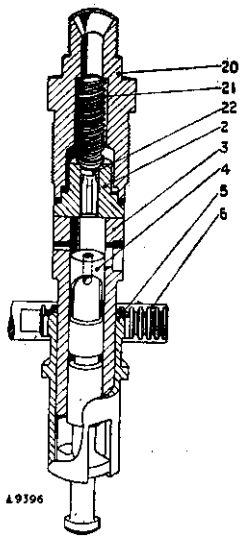


Fig. 17

Delivery of the fuel ceases immediately the helical edge of the plunger uncovers the inlet port on the right (see Fig. 17). The pressure chamber above the plunger is now in connection with the suction chamber through the vertical hole in the plunger. To control the output the plunger is rotated in its barrel by moving the control rack 6 (Figs. 17, 19 and 20) which engages in the toothed plunger operating pinion, thus varying the position of the pump stroke at which the helical edge of the plunger uncovers the inlet port and so regulates the amount of fuel pumped to the injector. The direction in which the control rack is moved to reduce the delivery is indicated by an arrow and the word " Stop ".

ANTI-DRIBBLE DEVICE

When the helical edge " E " of the plunger uncovers the port of the plunger barrel near the end of the delivery stroke, the pressure of fuel is immediately reduced so that the delivery valve at once drops on its seating, thus cutting off communication between the pump and the injector until the next delivery stroke takes place. In coming to its seat to act as a non-return valve, the delivery valve also performs the function of releasing the pressure in the delivery pipe. The valve is shown in Fig. 18.

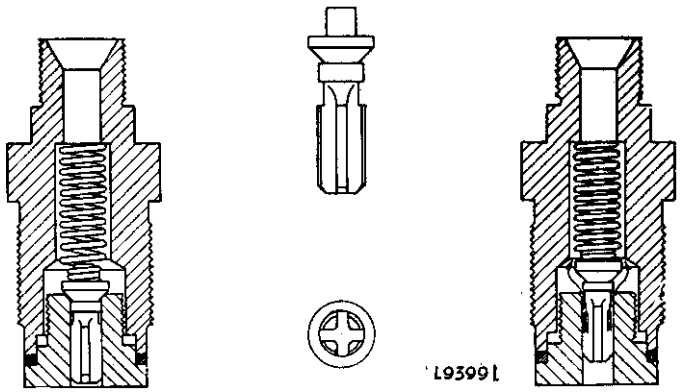


Fig. 18

When the pump is on its delivery stroke, the fuel pressure rises and lifts the delivery valve until the fuel escapes up the grooves and over the valve face to the injector. Immediately the pump plunger releases the pressure in its barrel, the delivery valve (under the influence of the spring and the pressure difference) resumes its seat. The space in the delivery pipe is thus increased by an amount equal to the volume of the small piston part of the guide before the valve actually seats itself. The effect of this increase of volume in the delivery pipe system is that of reducing the fuel pressure so that the injector needle valve can snap to its seat, the spray of fuel being instantaneously terminated into the cylinder entirely without dribble.

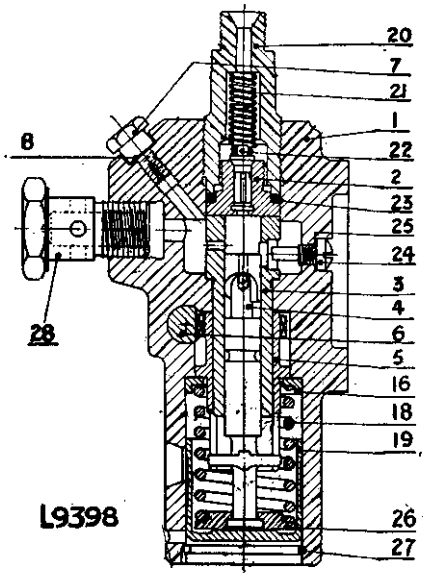


Fig. 19

KEY PLAN

1. Fuel pump body.
2. Delivery valve seat.
3. Plunger guide.
4. Plunger.
5. Plunger operating pinion.
6. Control rack.
7. Air vent plug.
8. Joint for air vent plug.
9. Nut for control rack support.
10. Skid for control rack support.
11. Slipper for control rack.
12. Washer for control rack.
13. Split pin for control rack slipper.
14. Pin for control rack.
15. Support for control rack.

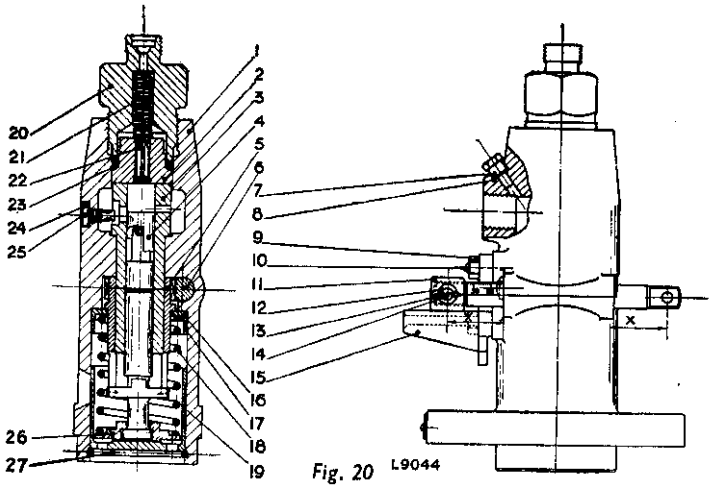


Fig. 20

16. Plunger spring retaining collar.
17. Ring for plunger spring.
18. Spring for plunger.
19. Plunger tappet.
20. Delivery pipe connection.
21. Spring for delivery valve.
22. Delivery valve.
23. Joint for delivery valve seat.
24. Locking screw for plunger guide.
25. Joint for plunger guide locking screw.
26. Plunger spring retaining collar.
27. Retaining ring for plunger tappet.

DISMANTLING THE PUMP

Strict cleanliness should be observed when preparing to dismantle the pump and the bench covered with a sheet of greaseproof paper. A number of small containers should also be provided for the various parts removed; in addition a covered container filled with clean paraffin will be needed for washing the parts.

If more than one pump is to be dismantled for cleaning it is most important that care should be taken not to mix the parts. The original parts should be retained for each pump. Special attention should be paid to the pump plunger and guide, these should not be laid down separately. To dismantle the whole pump, first remove the pipe connection 20 (Figs. 19 and 20), withdraw the delivery valve and spring 21 and 22 (Figs. 19 and 20), screw on the delivery valve seat extractor (Fig. 21) and tighten down the extractor nut to force the delivery valve seat out.

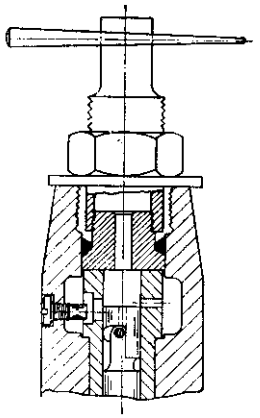


Fig. 21

The pump should then be turned upside down and pressure applied to the tappet 19 (Figs. 19 and 20). Compress the spring sufficiently to enable the service pin to pass through the hole in the pump body spigot to enable the plunger to retain the compression on the spring. Remove the plunger retaining spring 27 (Figs. 19 and 20) and remove the service pin when the internal parts of the pump can be removed (Fig. 22). If it is necessary to remove the plunger guide 3 (Figs. 19 and 20) the setscrew 24 must first be removed.

All parts should be carefully washed in petrol or paraffin, the pump barrel rinsed out and the parts carefully returned in their correct order direct, from their immersion, making sure that the plunger and guide are thoroughly lubricated with a thin, clean oil.

Should the plunger guide 3 (Figs. 19 and 20) have been removed, care should be taken when replacing this to see that the slot is opposite the hole for the set screw 24 (Figs. 19 and 20). After tightening the screw down try the pump plunger in this guide to see that it works freely. When fitting the plunger care should be taken that the locating bar correctly engages with the slots in the plunger operating pinion as indicated by the markings.

The operating rack 6 (Figs. 19 and 20) should be set so that the ends project equally as at " X " and the plunger operating pinion 5 (Figs. 19 and 20) inserted with the drill points marked on the teeth coinciding with a similar mark on the operating rack.

IT IS IMPORTANT when overhauling a pump that the internal parts are not touched with a file or other hard tools.

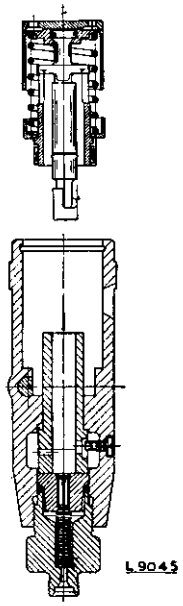


Fig. 22

SETTING THE FUEL PUMP PLUNGER

The plunger should be adjusted by the pump spill. Disconnect the fuel injection pipe and remove the delivery valve and spring, and replace the delivery pipe connection. Slightly rock the engine flywheel backwards and forwards until a position is found in which fuel just ceases to flow through the pump when the engine is being turned in a forward direction. This should be done carefully and the top of the pipe connection should be wiped clean to see that the exact position at which the fuel ceases to flow is retained at this position. The ⟶ on the flywheel, which indicates injection, should be opposite the arrow pointing on the engine crankcase. Should this not be so the fuel pump tappet should be adjusted until these conditions are obtained.

"A" and " B " (Fig. 23) shows respectively the marks on the tappet just visible in the sight window at the top and bottom of the plunger stroke.

These are the limits beyond which the tappet must not move after final adjustment.

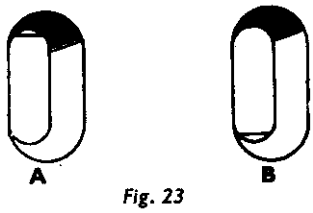


Fig. 23

FUEL PUMP TEST EQUIPMENT

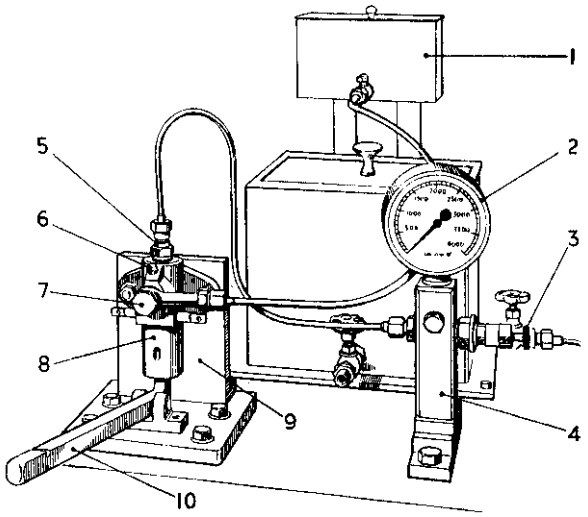


Fig. 24

1. Fuel oil supply tank.
2. Pressure gauge (graded 0—4000 lbs. per sq. in., 100 lb. divisions).
3. Release valve for test system.
4. Stand for pressure gauge.
5. Delivery connection (pump to P.G. stand).
6. Air release valve in pump body.
7. Inlet connection (supply tank to pump).
8. Fuel pump.
9. Fuel pump test bracket.
10. Test bracket operating lever.

A fabric filter should be inserted between supply tank and pump.

NOTE Construction details of the test bracket are given in Fig. 25.

DETAILED DESCRIPTION

Refer to Fig. 24

(1) The capacity of the tank is not important, the one shown holds approximately half a gallon. It should, however, be so mounted as to give a minimum head of one foot, above the pump inlet (7).

(2) The gauge should be not less than 3500 p.s.i. and have the dial marked in 100 lb. divisions.

(3 and 4) All that is required is a firm mounting for the gauge, with a suitable means for exhausting the air and, of course, provision for the connection from the pump.

(9 and 10) The test bracket and operating lever should be made to dimensions given in Fig. 25.

The items not mentioned above are covered by the test instructions.

IMPORTANT The accuracy of pressure gauges in test equipment must at all times be beyond question, constant checks should therefore be made to ensure that gauges are correct.

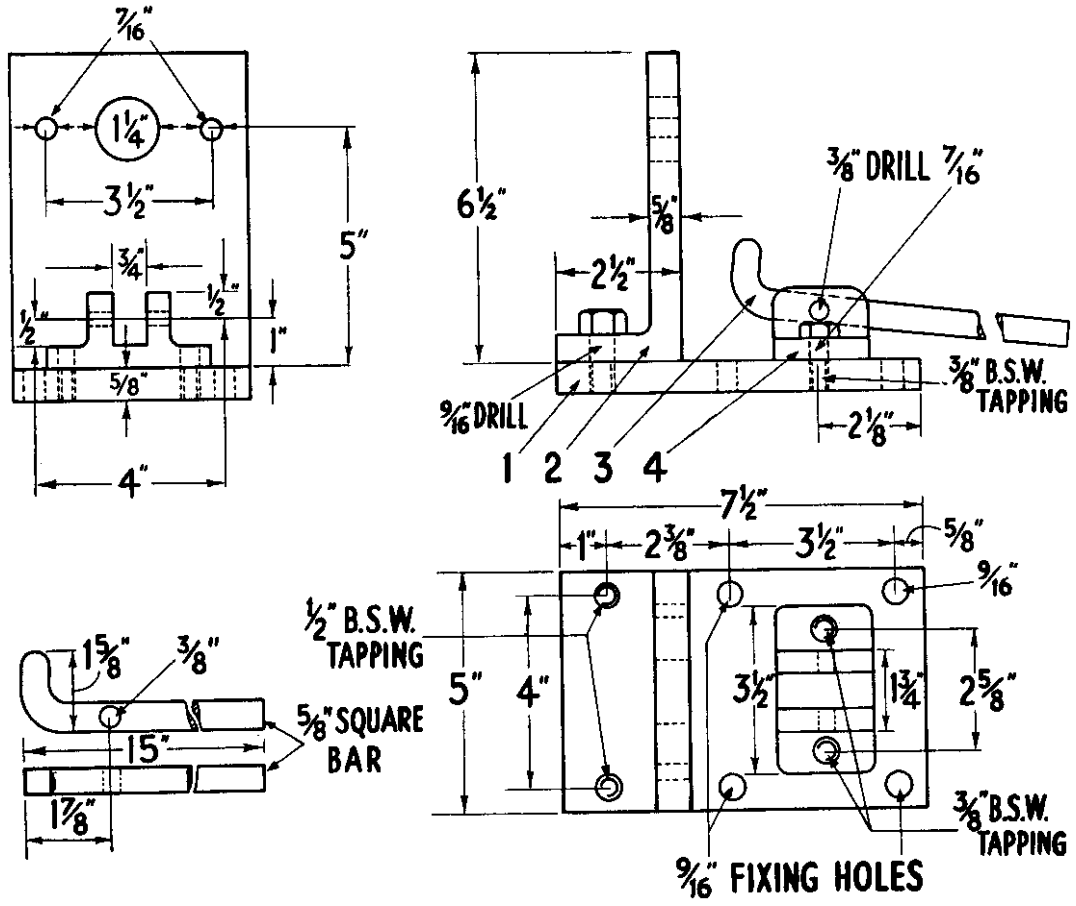


Fig. 25

FUEL PUMP TEST BRACKET

Item	Material	Description	No. off.
1	EN 3A.	Bottom Plate ⅝" thick	One
2	EN 3A.	Angle Plate ⅝" thick	One
3	EN 3A.	Lever	One
4	EN 3A.	Lever Bracket	One
*5	Steel	Lever Pin ⅜" x 2" long	One
6 & 7	Steel	Setscrews, ⅜" x 1" & ½" x 1¼"	Two each size
VTO, VTH, VSO & VSH ENGINES			

TEST PREPARATIONS

i. Mount the pump (8) on the bracket (9).

ii. Connect inlet (7) to oil supply tank (1).

iii. Connect delivery connection (5) to pressure gauge stand (4).

iv. Open tap on supply tank (1) and allow oil to flow to the pump.

v. Partially unscrew(6) and pump until all air is excluded, then tighten again.

vi. Release all the air from the delivery side through valve (3) and tighten again.

The system should now be free of air, hence make tests as under that heading.

TESTING

Prior to commencing the actual phases of the test it is essential to ensure that there are no leaks anywhere in the Test System, or on the pump or pump connections.

The Pump Rack control rod is set approximately at the ' normal running ' position for the whole of the test.

i. Operate the pump by working the lever (10). No actual test is made for ' suction ' on this type of pump as no suction valve is fitted, but the suction is proved by the ' feel ' of the pump when operating the lever.

Any defect on the suction side of the pump will be readily apparent because of the ' loose feeling ' of the lever.

The reason for this can be either, (*a*) lack of fuel in the Supply Tank (1) or (*b*) a leak on the suction side of the test system.

Any defect must be rectified before proceeding further with the test.

ii. The delivery of the pump is proved and tested by the regular increase of pressure, with each pumping stroke, indicated by the reading on the Pressure Gauge.

During the delivery test, pumping should be stopped at any pressure reading and the maximum indicated pressure noted. This pressure should remain steady, any falling back of pressure indicates either a leak on the delivery side of the test system, or a defect at the Delivery Valve, or Delivery Valve Seat.

Defective parts should be corrected or renewed.

The final phase of this test, is to check that the pump can provide fuel oil at a pressure to overcome the Injector Release.

This is as stated on the injector nameplate +100 p.s.i. The description assumes an injection release pressure of 3000 p.s.i.

iii. Operate the pump until the indicated pressure in the test system reads 2900 p.s.i.

Further operation of the lever through one pumping stroke only " must ensure " that the pressure reading is in excess of the required 3000 p.s.i.

This test proves the clearances between the pump plunger and the guide to be correct, any defect will require the checking of these parts.

NOTE This equipment does not give the accurate detailed information such as is obtained when using Hartridge or similar Test Equipment, but the results that are obtained satisfy test requirements.

CALIBRATION

This instruction concerns only those Agents who are equipped with **Hartridge** or **similar Test equipment,** for to carry out calibration tests the pump must be run at camshaft speed and fuel delivered per given number of strokes must be carefully measured in test jars.

On the early " 0 " type engines tests were made with camshaft speeds of 500 r.p.m. however, all checks are made after a given number of strokes, hence all calibration may now be carried out at 750 r.p.m.

When overhauling, the following method and calibrating figures should be used.

VTO/VTH ENGINES

Plunger size 9 m/m

Camshaft Speed	750 r.p.m.
Number of strokes for each check	100

First find Rack position where Fuel Pump is delivering 9.3 to 9.8 c/c per 100 strokes.

When this position is found lock the rack and adjust pointer if necessary to the 18 m/m mark on rack, or on later engines, the MARK which is the equivalent.

Next retard rack to the 15 m/m mark, or 3 m/m and in this position the pump should deliver 3.4 to 3.9 c/c per 100 strokes.

Next fit a standard VTH proved injector to the delivery of Fuel Pump. Reduce camshaft speed to 100 r.p.m. Bring the 16 m/m mark to the pointer, or advance 1 m/m and in this position injector should spray consistently.

Adjustment to the pointer is made by varying the thickness of the washers.

VSO/VSH ENGINES

Plunger size 10 m/m

Use exactly the same methods, camshaft speeds, and number of strokes, but the calibration figures should be as follows:—

Find rack position where pump is delivering 9.7 to 10.3 c/c.

Adjust pointer if necessary to 16 m/m mark of rack, or the MARK.

Retard rack to 13 m/m mark, or 3 m/m and delivery should be 5 to 5.5 c/c.

Reduce camshaft speed to 100 r.p.m.

Fit standard VSH proved injector. Bring the 14 m/m mark to the pointer, or advance 1 m/m and injectors should spray consistently.

IMPORTANT NOTES

i. If it is necessary to adjust the pointer on the first check this alteration to washer thickness should in NO circumstances exceed $\frac{1}{16}$".

ii. The injectors used must be proved correct in all respects before using for check.

iii. Whilst the calibration tests detailed are a very good guide to the capacity and adjustment of the pump, it should, however, be clearly understood that further adjustment may be necessary, therefore, FINAL balancing tests should be carried out on the engine. See **S.V.10 sub-section** (e).

INJECTION EQUIPMENT
C.A.V. NOZZLES AND NOZZLEHOLDERS (INJECTORS)

The satisfactory running of an oil engine is largely dependent upon the condition of the nozzle and nozzle holder through which fuel is injected at high pressure into the cylinder.

For maximum efficiency in operation, it is essential that the engine be not only provided with fuel in quantities exactly timed and proportional to the amount of work it is required to do, but also that it should receive each charge of fuel in such a condition that it can be completely consumed, without smoke in the exhaust.

All injectors MUST therefore be kept clean and in good condition. When an injector is functioning badly the cause can usually be traced to dirt or other foreign matter.

It is wise to check the working of the injector from time to time and to replace parts which have become worn or damaged.

Special equipment is available for servicing C.A.V. nozzles and holders, the proper application of which will enable users to maintain injectors in good condition.

The equipment for servicing C.A.V. injectors is similar to Ruston, except that C.A.V. injector cleaning kit should be employed.

For Service Station work, therefore, equipment generally as detailed on pages 6 and 7, Sub-Section (*a*) will be required with modifications as detailed hereunder :—

TEST PUMP

C.A.V. injectors are fitted with adaptors which contain a filter element, but the same Test Pump adaptor may be used, i.e. 6SD—84 swan neck.

SERVICING TOOLS

i. Cleaning kit ET.141 in a canvas hold-all as shown in Fig. 26 with respective tools tabulated as referred to in the text.

ii. Broaching tool, ET.426 with 2 suitable broaches, i.e. for .009" holes in VTO or .010" in VSO nozzles.

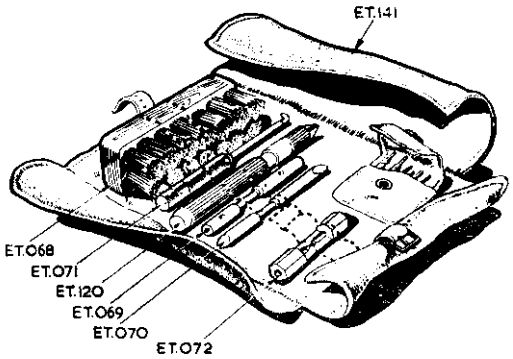


Fig. 26

Refer to Fig. 27

iii. Spanner ET.116 for nozzle cap nut.

iv. Spanner ET.117 for nozzle spring cap nut.

v. Spanner ET.119 for compression screw.

vi. Spanner ET.121 for protecting cap.

vii. Nozzle flushing device ET.427.

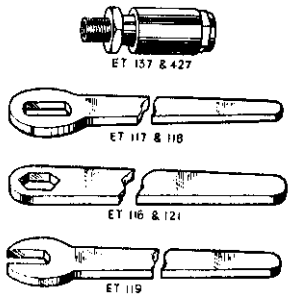


Fig. 27

CLEANING NOZZLES

Refer to Figs. 28 and 29 showing cutaway views of nozzles and nozzle holders to which special terms are applied in these instructions.

Hold injector in vice with nozzle pointing upwards.

Remove nozzle cap nut with spanner ET.116.

Examine nozzle for carbon and note if the valve lifts out freely.

Immerse it in petrol and soak a few minutes to assist cleaning.

NOTE The nozzle should be free from **all damage,** and it is important that it is not **"blued"** due to overheating.

All polished surfaces should be relatively bright without scratches, or dull patches.

It is **essential** that the surfaces 'A', 'B' and 'D' are absolutely clean, as these **must register together** to form a high pressure joint between nozzle holder and nozzle.

Clean residue from oil channel and borings, 'G.'

Scrape all carbon from valve seating with soft brass scraper ET.070.

Using body groove scraper ET.071 clear the gallery 'H' of carbon.

Spray holes should next be examined, and if these are choked by carbon, use probing tool ET.120 in conjunction with the appropriate size of cleaning wire.

VTO ... **nine thous.** (·009")

VSO ... **ten thous.** (·010")

Twelve cleaning wires are contained on carriers in the probing tool.

Insert cleaning wire into each spray hole, making sure that the end of the wire which has been ground to a 'D' shape is used, and **probe the hole thoroughly.**

If spray holes are blocked, use tool ET.426 as follows :—

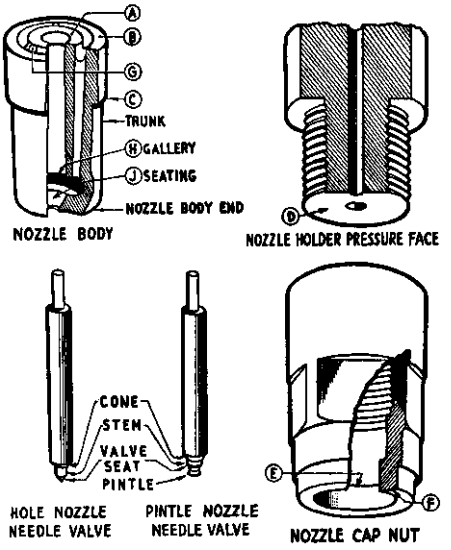


Fig. 28

Place taper point of broach against the blocked spray hole, and tap very lightly with the back of wire brush ET.068, at the same time turning the broach.

Care must be exercised, otherwise the broach may snap off, leaving a further obstruction in the spray hole.

Insert valve pin into the stem cleaner ET.072, and apply together with a rotary motion, pressing the valve hard in. Alternatively, insert cleaner in the chuck of the motor and use as above.

Brush nozzle valve gently with wire brush ET.068, paying particular attention to valve seat and cone.

Finally, assemble the nozzle into the flushing tool ET.427 and thoroughly flush through by attaching to the Test Pump, and operating the lever, to ensure that all carbon particles and foreign matter are removed from the inside. If the nozzle is not going to be used at once, smear with vaseline.

IMPORTANT

If the nozzle is " **blued** " or the seating has a dull circumferential ring indicating wear, or pitting, the complete **nozzle assembly** should be replaced.

C.A.V. state :—

> **In no circumstances must an attempt be made to lap the nozzle valve and body, as this is a specialised process and any attempt to perform this may render any subsequent effort useless.**

Unless, therefore, the Ruston agent is also agent for C.A.V., it is recommended that nozzle assemblies which will not respond to the treatment detailed herein be sent to the nearest C.A.V. depot for specialised treatment.

REPLACING NOZZLES

Absolute cleanliness must be observed, the holder and nozzle being re-assembled straight from the cleaning bath.

Hold injector in vice, nozzle face upwards.

Replace nozzle assembly and tighten cap nut with ET.116.

DOWEL PINS

Some earlier engines were fitted with C.A.V. injectors wherein the nozzle was located in the holder by a dowel pin.

Users should note that on **VTO** and **VSO** engines, i.e. where the injector enters the cylinder head vertically and sprays from the centre of the cylinder, **dowel pins are not necessary,** but, of course, if fitted should be retained, care being taken to see that it enters the hole correctly.

TESTING NOZZLES

Attach injector to the test pump, see Figure 6.

Pump fuel oil through the injector with the pressure gauge " off."

The sign of a good spray is one of fully vapourised fuel without any visible cores or jets. At the end of each pump stroke the spray should **cut-off** without any sign of dribble.

Open the valve just sufficient to permit the gauge to operate. Operate the pump until the pressure on the gauge is 150 p.s.i. below the injector release pressure as under :—

VTO Releases at	...	...	**3000 p.s.i.**
VSO Releases at	...	...	**2500 p.s.i.**

Wipe the nozzle dry and there should be no sign of drip, or weeping which will indicate the pressure tightness of the seatings. A rapid drop of the needle in the pressure gauge when the handle is released will indicate excessive leakage, not only past the seating, but also between the nozzle body and valve stem, and a reading should be taken of the time the pressure drops from 2200 to 1500 p.s.i., which should not be less than 5 seconds. To carry out the time test the release pressure should be set at 3000 p.s.i. To adjust the release pressure see page 23.

WARNING

It cannot be too strongly stressed that when a nozzle is spraying, the injector should spray into the bowl and **NOT be allowed to come into contact with the hands on account of the very great penetrating force.**

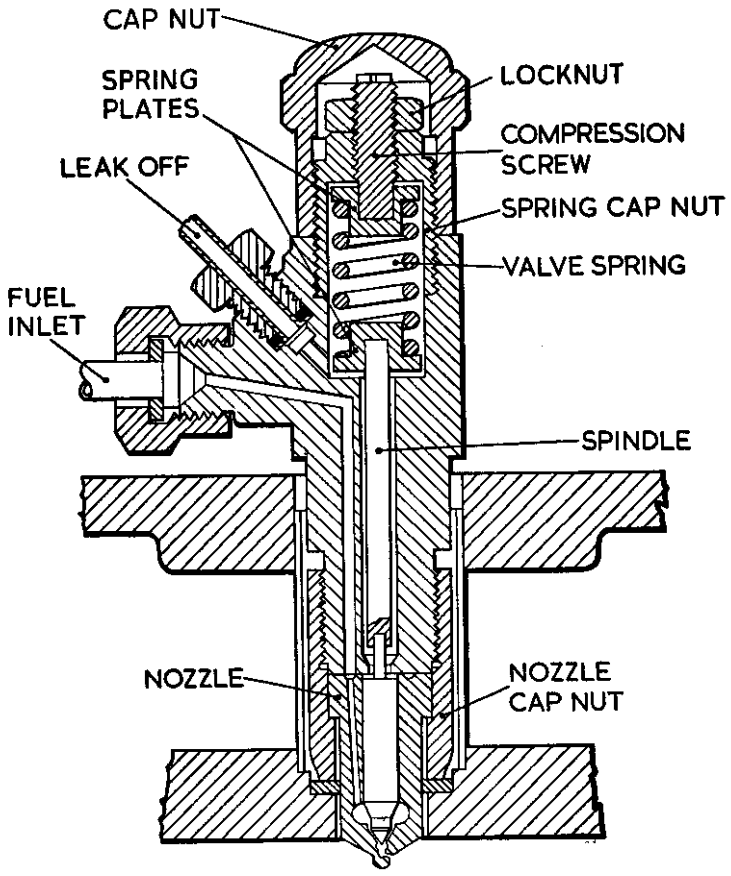


Fig. 29

NOZZLE HOLDER MAINTENANCE

The nozzle holder should be washed in clean paraffin, care being taken to protect the pressure face ' D ', Fig. 28. This face must register with the nozzle pressure surface cleanly and squarely to form a high pressure joint, and should be handled in such a way as to avoid damage to it.

Periodically it is advisable to dismantle the interior to examine the spring and spindle.

DISMANTLING

Refer to Fig. 29

Remove the nozzle cap nut and nozzle assembly.

Remove cap nut at spring end with ET.116.

Unscrew spring cap nut with spanner ET.117, take out spring plate, spring and spindle.

Thoroughly clean all parts in petrol. If any parts are damaged, replace.

RE-ASSEMBLING

Re-insert spindle, spring and spring plate, screw on spring cap nut, and tighten with spanner.

Relieve spring pressure by releasing lock nut and unscrewing adjusting screw with spanner ET.119.

Mount nozzle on nozzle holder pressure face, making sure that both surfaces are absolutely clean and undamaged, and screw on the nozzle cap nut. Tighten well, but not excessively, with spanner ET.116 ; too great a leverage may result in constriction, or distortion of the nozzle.

Reset injection pressure by means of the adjusting screw and lock nut, and test on the injector test pump.

Replace cap nut.

INJECTOR EQUIPMENT
C.A.V. PUMPS TYPE BPFIB

This sub-section explains the working details and servicing of C.A.V. fuel pumps.

The smooth and efficient running of modern high speed oil engines depends mainly upon the fuel injection pump. It is this which provides the engine with fuel in quantities proportional to the amount of work it is required to do. The pump must achieve this with absolute precision and timing many hundreds of times a minute, delivering the fuel in its right proportion and discharging it at high pressure through a nozzle orifice, so atomising the fuel into a form which, when delivered into the combustion chamber, ignites and burns without smell or smoke.

At the lowest position of the plunger, the space in the pump barrel above the plunger is filled with fuel which flows in through two ports from the common suction chamber connecting the supply pipe from the tank. In rising, the plunger closes the two ports in the pump barrel so that the fuel is forced through the delivery valve into the delivery pipe connected to the injector, the fuel being then injected into the engine combustion chamber.

GENERAL PARTICULARS

Fig. 30 shows the pump barrel in various plunger positions while Fig. 31 shows the the fuel pump element in the cross section.

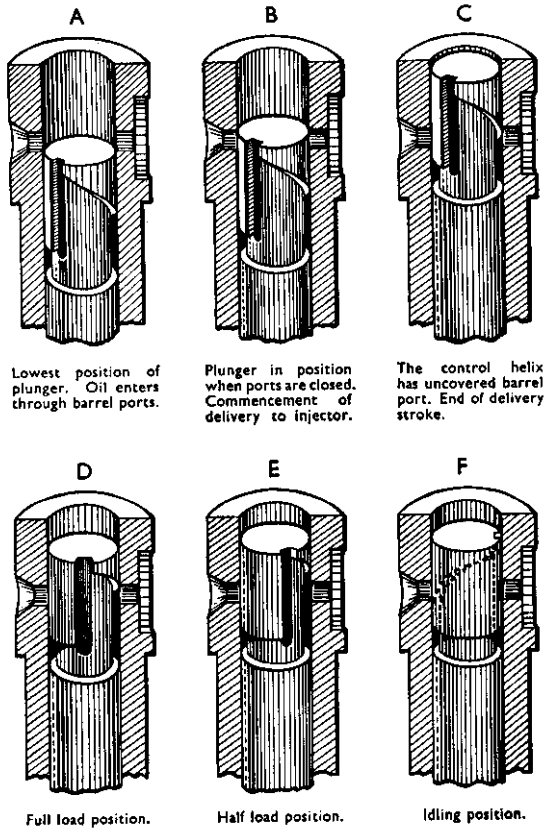


Fig. 30

Delivery of the fuel ceases immediately the helical edge of the plunger uncovers the inlet port on the right, see C, Fig. 30. The pressure chamber is now in connection with the suction chamber by way of the vertical slot in the plunger, see Fig. 31. To control the output the plunger is rotated by the control rod, or rack, see Fig. 31, which engages in a toothed plunger operating pinion, thus varying the position of the pump stroke at which the helix uncovers the barrel port and so regulates the amount of fuel pumped to the injector. The direction in which the control rod is moved to reduce the delivery is indicated by an "arrow" and the word "stop" engraved on the top of the control rod. Thus ← **Stop.**

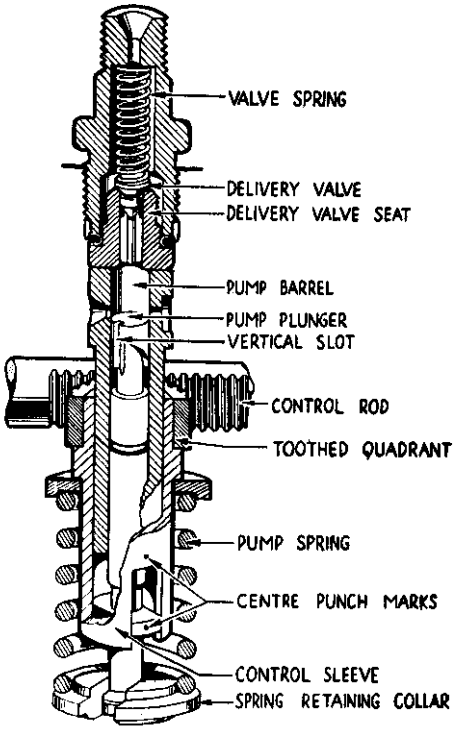


Fig. 31

ANTI-DRIBBLE DEVICE

When the helical edge of the plunger uncovers the port of the plunger barrel near the end of the delivery stroke, the pressure of fuel is immediately reduced so that the delivery valve at once drops on its seating, thus cutting off communication between the pump and the injector until the next delivery stroke takes place. In coming to its seat to act as a non-return valve, the delivery valve also performs the function of releasing the pressure in the delivery pipe. The valve is shown in Fig. 32.

When the pump is on its delivery stroke, the fuel pressure rises and lifts the delivery valve until the fuel escapes up the grooves and over the valve face to the injector. Immediately the pump plunger releases the pressure in its barrel, the delivery valve (under the influence of the spring and the pressure difference) resumes its seat. The space in the delivery pipe is thus increased by an amount equal to the volume of the small piston part of the guide before the valve actually seats itself. The effect of this increase of volume in the delivery pipe system is that of reducing the fuel pressure so that the injector needle valve can snap to its seat, the spray of fuel being instantaneously terminated into the cylinder entirely without dribble.

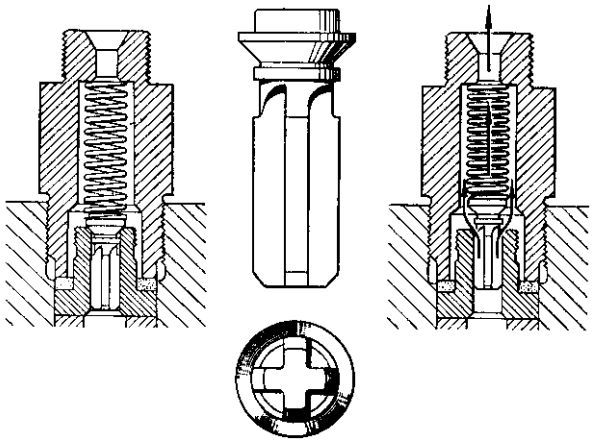


Fig. 32

KEY PLAN

1. Housing.
2. Lockplate stud.
3. Lockplate nut.
4. Fuel inlet nipple nut.
5. Spring washer.
6. Lockplate.
7. Locking pin and joint.
8. Plunger guide.
9. Spring ring.
10. Pump element (plunger and barrel).
11. Spring plate, upper.
12. Helical spring for plunger.
13. Spring plate, lower.
14. Lockplate washer.
15. Delivery valve and seating.
16. Delivery valve spring.
17. Delivery valve holder.
18. Joint for delivery valve holder.
19. Delivery nipple nut.
20. Regulating sleeve.
21. Regulating toothed quadrant.
22. Clamp screw.
23. Control rod.
24. Tool for extracting delivery valve.

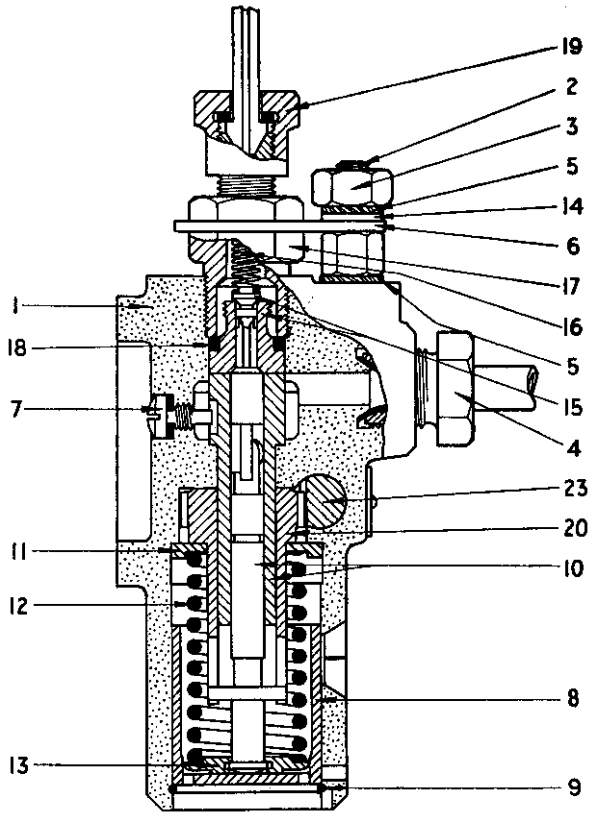


Fig. 33

DISMANTLING

When preparing to dismantle pumps, the bench on which the work has to be done should be thoroughly cleaned (particular care being taken that all iron filings, dirt, grit, etc., have been removed) and a number of small clean containers, for the various parts of the pumps, provided. It is also advisable to have a thoroughly clean vessel available with a supply of fresh paraffin for washing the parts. In dismantling the pump, the parts of each pump element should be kept entirely separate, a specially important point being to take care that the pump plungers are never fitted except into the barrels with which they originally worked (i.e. the same pump plunger and its barrel should always work together as a pair). In overhauling pumps, the **pump plunger or its barrel should never at any time be touched with a file or other hard tools.** Should these parts be damaged they should be replaced. The delivery valve and its seating should also **be kept together as a pair always** and should **never be ground in with grinding powder of any kind,** as this will ruin them entirely. If, when they are cleaned and rubbed together, trouble is still experienced, the pair should be replaced from spares.

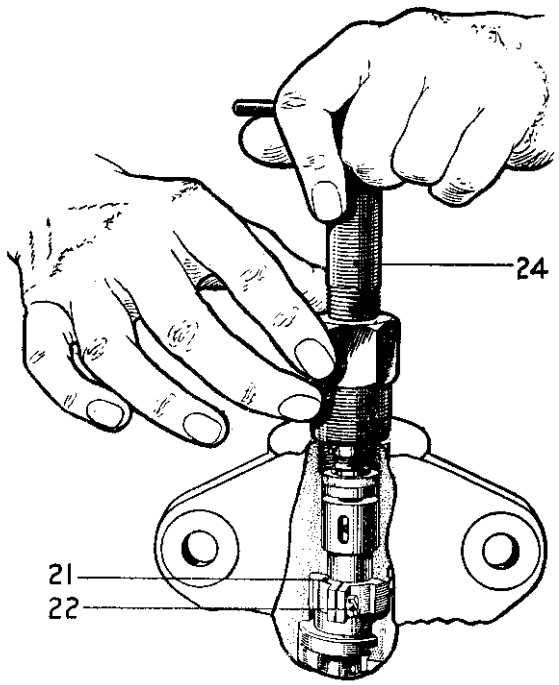


Fig. 34

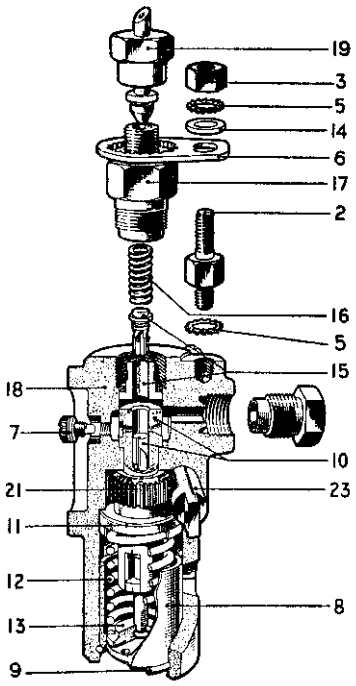


Fig. 35

Turn the pump upside down and push the plunger guide 8, Fig. 33, up until a service pin can be inserted into the dowel hole provided in the spigot of the pump flange, when it will be an easy matter to remove the spring ring 9. On removing the service pin, the plunger guide 8, lower spring plate 13, plunger spring 12, and the plunger 10 can then be easily withdrawn.

Reverse the pump, remove the delivery valve holder lockplate, unscrew the delivery valve holder 17, withdraw spring 16 and delivery valve 15. The valve seating, and its joint 18 can now be removed by means of the special lifting tool 24, Fig. 34.

To remove the pump barrel 10, unscrew the locking pin 7 and push the barrel from below by means of a clean fibre or soft brass bolt.

RE-ASSEMBLING

In re-assembling the pumps, great care should be taken that all joints and other parts are entirely clean. These should be (1) rinsed in clean paraffin, (2) allowed to drip, (3) smeared with a little lubricating oil, and finally brought together entirely **without the use of cottonwaste or rags.**

Refit the barrel carefully, taking care that the slot in it is opposite the hole for locking screw 7. Tighten down locking screw 7 after making sure that its joint is in place.

Refit valve seating 15 with joint 18, place cleanly and securely in position. Place delivery valve and its spring 16 in position. Fit delivery valve holder 17 with its joint 18 in place and screw down tightly.

Insert from below regulating sleeve 20 with toothed quadrant 21 and make it mesh with regulating rod in such a way that the slots marked by a centre punch B and the clamp cheeks of the quadrant are pointing towards the front.

NOTE

Some quadrants are marked as indicated by arrows A in Fig. 36.

Insert upper spring plate 11 and plunger 10 fitted with lower spring plate 13 and spring 12 into the pump barrel, taking care that the lug on the lower end of the plunger is fitted into the slot in the regulating sleeve 20 for which it is marked.

Insert plunger guide 8 and push up until a service pin can be fitted through the hole provided in the flange spigot, so that the spring ring 9 may be fitted into its groove,

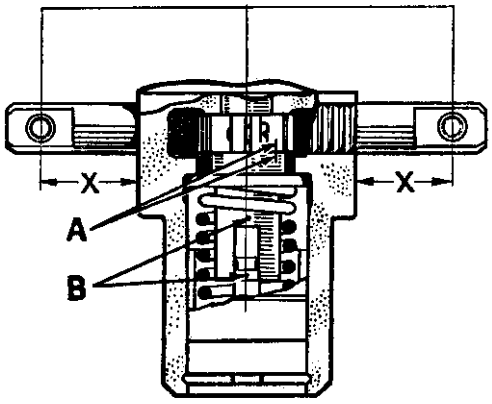


Fig. 36

Replace the lockplate assembly (if fitted) should it have been necessary to remove the control rod 23; upon replacement it is in correct adjustment when the pin holes project evenly as at " X " on either side of pump housing 1 with the clamp cheeks of the toothed quadrant facing outwards, see Fig. 36.

SETTING THE FUEL PUMP PLUNGER

The plunger should be adjusted by the pump spill. Disconnect the fuel injection pipe and remove the delivery valve and spring, and replace the delivery pipe connection. Slightly rock the engine flywheel backwards and forwards until a position is found in which fuel just ceases to flow through the pump when the engine is being turned in a forward direction. This should be done carefully and the top of the pipe connection should be wiped clean to see that the exact position at which the fuel ceases to flow is retained at this position. The ⚡ on the flywheel, which indicates injection, should be opposite the arrow pointing on the engine crankcase. Should this not be so the fuel pump tappet should be adjusted until these conditions are obtained.

"A" and " B ", Fig. 37, shows respectively the marks on the tappet just visible in the sight window at the top and bottom of the plunger stroke.

These are the limits beyond which the tappet must not move after final adjustment.

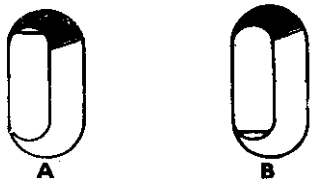


Fig. 37

DECEMBER, 1953

SV 12

STARTING
EQUIPMENT

STARTING EQUIPMENT

SV 12

C.A.V. STARTERS

Two types of starters are fitted to the engines, each conforming to the general description given and requiring servicing attention as detailed under respective headings.

NON-AXIAL TYPE

The Non-Axial Starter (Fig. 1) is a simple series-wound motor fitted with a special pinion gear for easy engagement with the teeth on the engine flywheel rim.

The drive is of the " Bendix " type. The actual shock of engagement being absorbed through a large section coil spring.

Particulars of rotation, voltage, etc. will be found engraved either on the yoke or nameplate fixed to the machine.

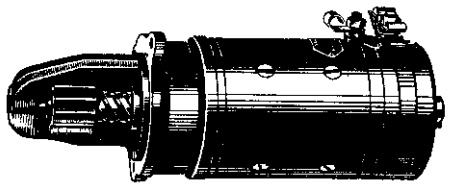


Fig. 1.—C.A.V. Non-Axial Type Starter

AXIAL TYPE

On this starter, (Fig. 2) the armature with shaft moves axially in its bearings and engages the pinion with the teeth on the flywheel rim. Its engagement is POSITIVE and SILENT, and the risk of damage due to engine backfire or faulty meshing of the pinion with the teeth on the flywheel rim is reduced to a minimum. The armature with shaft is held in a disengaged position by means of a coil spring fitted inside the shaft at the commutator end, the armature being thus kept out of complete register with the pole shoes.

The field winding of this machine consists of main series, auxiliary series and auxiliary shunt windings. When the starter switch is operated, a small current passes through the auxiliary windings, causing the armature to rotate slowly.

Simultaneously, the magnetic field set up pulls the armature forward, which brings the pinion E Fig. 10. gently into mesh with the engine flywheel teeth. This movement of the armature also causes the tripping disc E1 Fig. 10. to operate the tripping lever which releases the contacts of the solenoid switch and so completes the main circuit. The full current from the battery then flows through the armature and series field winding, and the motor exerts its full torque on the engine. In " Axial " starters with straightforward windings, directly the engine gets under way, the motor current is greatly reduced, the magnetic field is decreased in power, the tension of the spring overcomes the force exerted by the magnetic field and the pinion automatically disengages.

An important feature of the C.A.V. "Axial" starter is that even if the starter switch be kept pressed after the engine has fired, the starter will not again engage with the teeth on the fly-wheel rim but will continue to run free until the switch is released, when it will come to rest.

Another very special feature of axial starters is a unique overload device, preventing damage occurring due to engine backfire.

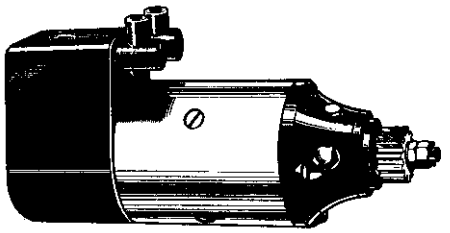


Fig. 2.—Axial Type Starter

This is a simple screw and spring-loaded clutch arrangement which has a slipping torque about three times the lock torque of the starter, but is below shearing strength of the pinion teeth. This device is a positive safeguard against the teeth of the pinion being sheared, due to excessive load.

GENERAL STARTER INSTRUCTIONS

Mounting

After removal for general overhaul the pitch-line clearance should be checked upon replacement to ensure that it is between the limits of ·015″ to ·025″ (·40 – ·65 m/m), see Fig. 3. This gives a back-lash, between the teeth, of ·018″ to ·022″ (·45 – ·55 m/m).

Points to remember

It is possible to withdraw the commutator end cover and inspect the brushes without removing the starter from the engine.

The terminals are accessible and where they are not directly exposed to oil or moisture.

Use the rubber terminal protecting covers.

Lubricators are accessible and above the horizontal centre line of the starter.

That starters are securely clamped in position, and that the fixing straps or clamps do not foul the terminals.

That the rotation of machines is taken when looking on the drive end (i.e., the end opposite to the commutator).

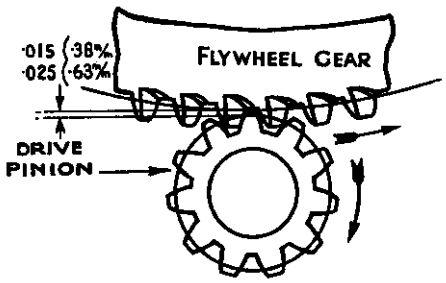


Fig. 3.—Flywheel Clearance

BRUSH GEAR MAINTENANCE

Inspect the brushes at regular intervals.

See that the brushes are free in their guides and that their flex leads are perfectly clear for movement.

Where spiral fibre insulation is provided for the brush flexes, see that it has not become burnt or charred, thus creating the danger of short circuits.

Positive and negative brush holders and brushes must be insulated from one another. Test by means of a lamp as used for testing field coils and other insulation. It is not necessary to remove the brushes from their holders when testing, provided that they are all lifted from the commutator before commencing the test.

If removed, take care to replace so that the bedding curvature of the brush face will accurately conform with the commutator periphery.

On insulated return machines the brush gear should be insulated from the rest of the machine.

The brushes should be well "bedded", i.e., they should be worn to the commutator periphery. If not, wrap a strip of very fine glass or carborundum paper firmly around the commutator and with the brush or brushes in position rotate the armature by hand in the normal working direction of rotation until the correct brush shape is obtained. See Fig. 4.

Test if brushes are free in their guides, see Fig. 5. Clean all carbon deposit away with petrol, or substitute and, if necessary to ease the fit, lightly polish the sides of the brush with a smooth flat file.

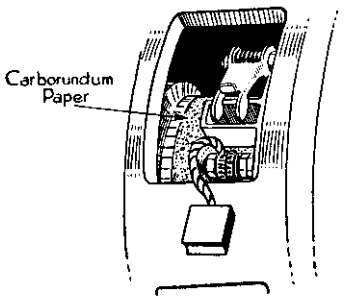


Fig. 4.—Method of Bedding Brushes

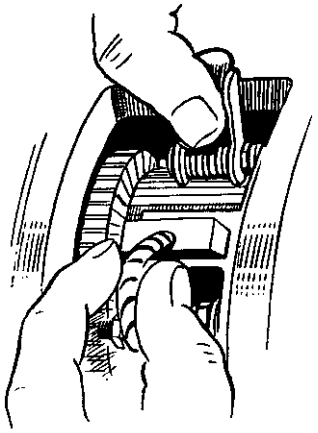


Fig. 5.—See that Brushes are free in their Guides

See that the brushes have not worn so that the trigger or spring is no longer providing effective pressure. Replace if necessary.

Test the brush spring pressure (see below) by means of a spring balance hooked under the spring trigger or spring tips. See Fig. 12, page 8. Adjust pressure by twisting spring into different slots.

It is essential that replacement brushes are the same grade as those originally fitted to the machine. To make sure of this, specify C.A.V. genuine spares.

Starter Brush Spring Pressures

Bendix (" non-axial ") type ... ... **24-32 ounces.**
Axial type ... ... **32-40 ounces.**

ARMATURE MAINTENANCE

The commutator surface must be clean and free from uneven discoloration. There should be no deposit bridging gaps between segments.

Clean with very fine grade glass or carborundum paper, **not emery cloth.** In cases where it is in a very bad pitted condition, set up on a lathe and skim. A very light cut should be made, where possible with a diamond tool, to provide a high quality finish.

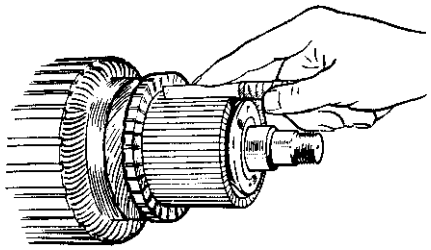


Fig. 6.—Undercutting Commutator Mica

After turning, " undercut " the mica insulation between commutator bars to a depth of $\frac{1}{32}$in. (·8 mm.) below the surface of the copper, care should be taken to remove the full width of mica and to leave nothing to project above the copper. An old hack-saw blade with a reinforced back makes a serviceable tool for this operation. See Fig. 6.

Armature coils can be tested for continuity or short circuits by mounting the armature on a block and connecting the commutator to an ordinary car battery through the medium of two brass or copper brushes mounted at an angle of 90° to each other. Contact is then made to any two adjacent commutator bars by means of hand spikes which are connected direct to a milli-volt meter. See Fig. 7.

A variable resistance should be included in the battery circuit capable of carrying the full output of the battery and adjusted to give 2 volts or less on the armature. The armature is then rotated until every commutator bar has been tested, the reading on the milli-volt meter in each case should read approximately the same ; any big variation indicating a fault in the coil connected to one of the commutator bars under test. A reduction in the milli-volt reading will generally be found due to a short circuit while an increased reading will indicate either an open or a faulty connection.

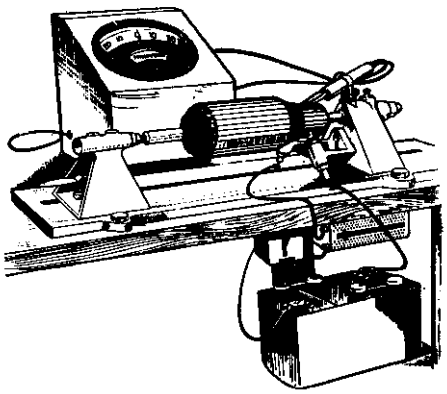


Fig. 7.—Suggested arrangement of apparatus forTesting Armature Coils

NOTE If the armature is found to be faulty and the agent is not also a C.A.V. agent, then it should be returned to the nearest C.A.V. Service Station for rewinding.

All the foregoing tests and many others can be made with a "growler" armature tester, of which there are a number of efficient makes on the market. In cases of difficulty in obtaining write C.A.V. Ltd., Acton, London, W.3, who will gladly advise a source of supply.

FIELD COILS

These can be simply tested when in position for short circuits to the yoke and poles by means of hand spikes connected to a mains supply and in series with a lamp of suitable voltage positioned on the live side of the system. One spike should be applied to the end of the winding and the other to the yoke at a suitable position where it is free from enamel and insulation. If the lamp does **not** light, then the insulation is intact. Take care to first remove all other connections to the coils and to insulate any bare ends.

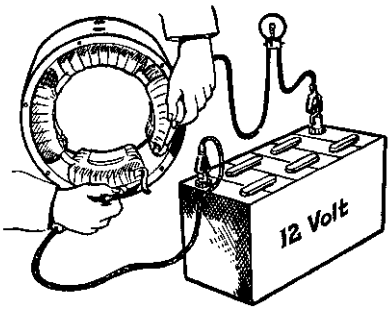


Fig. 8.—Checking Field Coils

Internal shorts can be traced by means of an ohmmeter. As the resistance of the coils should be within 6% of each other, the most satisfactory method is to compare for excessive variation the resistance of the suspected coil with each of the remaining individual coils in the set.

It will generally be found that the total resistance of main starter field coils will be from ·001 to ·003 ohms approximately per set.

AXIAL STARTER INSTRUCTIONS

Type C.A.V. BS5-H.

Setting In the idling position the face of the geared ring on the flywheel should be $\frac{1}{8}$" (3·2 mm.) from the engaging face of the starter pinion. The full travel of the armature, with its shaft is $\frac{31}{32}$" (24·6 mm.).

Tools To facilitate dismantling, the tools shown in Fig. 9 may be obtained direct from C.A.V., or their agents. The tools are numbered and respective applications are referred to in the following text.

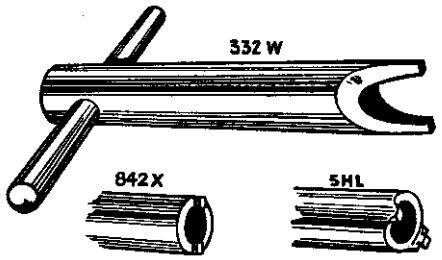


Fig. 9.—Axial Type Starter Dismantling Tools

DISMANTLING

Refer to Fig. 10

Section 1

(*a*) Remove nuts or screw A1 and take off commutator end cover.

(b) Remove nut Y on plunger by means of a box spanner.

(c) Remove screws X securing brush tags, and lift brushes in their boxes and secure by wedging with brush springs.

NOTE Brushes should not be removed from holders except for replacement or bedding purposes.

(d) Remove driving end shield screws or fixing bolts A and after freeing end shield from yoke gently slide out end shield and armature complete.

Section 2

(a) Remove screws R, U & T securing positive terminal connector main field coil ends and auxiliary field connection to switch.

(b) Remove nut on S.O.L. terminal and take off switch connection Q and also the screw and flex connected to negative terminal.

(c) Remove fixing nut and take off switch without connections.

Section 3

(a) Remove pole screws G and take off field coils. Pole pieces are marked 1, 2, 3 and 4 to correspond with numbers on the C.E. of the yoke, and when re-assembling care should be taken to ensure that the coils are replaced in the same positions.

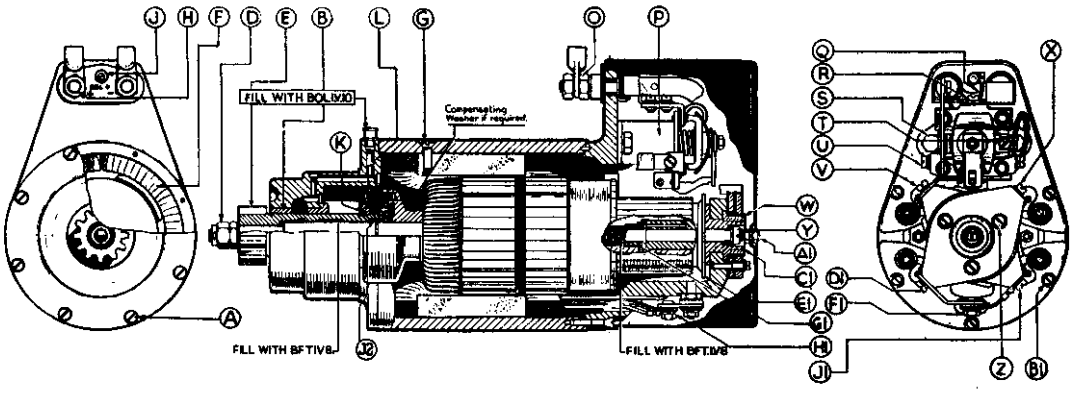


Fig. 10.—Section through BS6 Type Axial Starter

A—Driving end shield fixing screw.
B—Driving end bearing.
D—Pinion nuts.
E—Pinion.
F—Field coils.
G—Pole screws.
H—Main positive terminal.
J —Solenoid terminal.
K—Clutch sleeve.
L—Clutch pressure spring.
O—Main terminal nuts.
P—Solenoid switch.
Q—Solenoid terminal connection.
R—Main positive terminal connector screw.
S—Solenoid switch fixing screws.
T—Solenoid connector screw (BS6).
U—Field coil connector screw.
V—Main negative terminal connector screw.
W—Commutator end bearing insulator bush.
X—Brush tag screw
Y—Plunger nut (exterior).
Z—Brush-holder fixing screw.
A.1—Commutator end-cover fixing nut.
B.1—Commutator end-shield fixing screw.
C.1—Commutator end bearing.
D.1—Brush-holder connector screw.
E.1—Trip plate.
F.1—Connector fixing nut.
G.1—Plunger nut (interior)
H.1—Field coil connector nut.
J.1—Negative connector screw.
J.2 —Pinion spring.

Section 4

(a) Hold armature securely and remove nuts D in front of pinion and then withdraw pinion and driving end shield together.

(b) Do not remove pinion from end shield unless the former is to be replaced, as difficulty will be experienced in getting the thread on the sleeve past the felt lubricating pad.

(c) Take out pinion spring J2.

(d) Withdraw clutch and pressure plates from housing M Fig. 11.

Section 5

(a) To remove armature spring and plunger, undo nut G1 by means of tool No. 5HL Fig. 9 and withdraw the plunger.

NOTE The armature must not on any account be stripped beyond details shown above, and should any trouble arise with this component it must be returned to C.A.V. Ltd. for replacement or repair.

Section 6

COMMUTATOR END SHIELD AND BRUSHGEAR

(a) Remove 3 screws fixing complete Brush Gear Ring.

NOTE If any part of this riveted assembly needs replacement it should be returned to C.A.V. Ltd. for repair, or a complete new assembly fitted.

(b) Remove main positive H and solenoid J terminals.

NOTE Nothing else must be taken off the commutator end shield beyond this point, and should any part of this assembly need replacing, it should be returned to C.A.V. Ltd.

Section 7

RE-ASSEMBLING AND GREASING

Reverse the order of dismantling.

RENEWING PARTS

Section 8

TO REPLACE PINION E

(a) Dismantle as shown in Sections 1 and 4 only.

(b) See that the new pinion has the same number of teeth as the old member, and check to part number which will be found on front face of pinion.

(c) See that the pinion spring J2 is not damaged and has not lost compression.

(d) See that there are no burrs on thread of pinion and test same with inner race of clutch K for smoothness of action. Any sticking of these parts will cause clutch to slip.

(e) Refill inside of pinion with grease, BFTIV8.

(f) See that the small initial pressure springs L are in position.

NOTE The large diameter end of the spring L must be inserted in the clutch race hole.

(g) Re-assemble according to Sections 1 and 4 reversed. Make sure pinion nuts D are up against the shoulder on the shaft before replacing split pin. In order not to damage the felt lubricating pad, it should be lifted by one finger from the inside of the casting, at the same time as the pinion is inserted and twisted in the direction corresponding with the spiral of the pinion thread.

(h) After nuts are tightened there should be little endway movement of pinion.

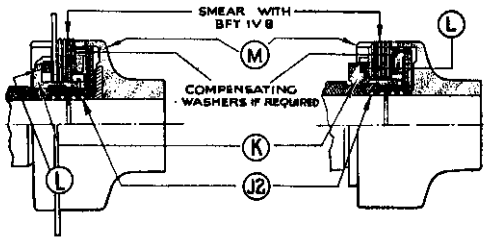
(j) It should be noted when turning the pinion by hand on machines fitted with single step clutches that the clutch should slip only when the pinion is turned in the opposite direction to the normal starter rotation. It is possible, however, to slip the two step clutch in either direction, owing to the drive not being fully taken up until the armature has moved a certain distance towards the engaging position.

Section 9

TO REPLACE CLUTCH

(a) Dismantle as shown in Sections 1 and 4 only.

(b) Individual new parts of clutch must not be put in unless facilities exist for testing the slipping torque of the clutch, as shown in Fig. 13. When no such facilities exist and parts of the clutch want replacing, then a complete new clutch interior should be purchased from C.A.V. Ltd., already tested, or if desired, the armature can be returned complete with pinion for the new parts to be fitted. Care should be taken to insert the clutch plates alternatively bronze and steel. Commence by inserting a bronze plate into the housing in order that the last one will be steel to take the pressure of the small springs.



Two Step Clutch — Single Step Clutch

Fig. 11.

(c) Re-assemble clutch according to sections 1 to 4 reversed, and smear lightly all parts with BFTV8 grease.

Section 10

TO CHANGE COMMUTATOR END BEARING C1.

(a) Dismantle as shown in Sections 1, 2 and 6 only.

(b) Assembled C.E. shield and bearing should be returned to C.A.V. Ltd., for replacement as these components are machined together. No attempt whatever should be made to machine or re-face the bearing faces, as this will cause sloppiness and uneven running of the starter.

(c) Smear bearing surfaces well with BFTIV8 grease and re-assemble according to Sections 1, 2 and 6 reversed.

Section 11

TO CHANGE DRIVING END BEARING B

(a) Dismantle as shown in Sections 1 and 4 only.

(b) If this part needs replacing, the assembled driving end shield should be returned to C.A.V. Ltd. for replacement.

(c) Re-assemble according to Sections 1 and 4 reversed, and fill driving end lubricator with oil BOLIV10.

(d) Care should be taken when replacing pinion in the bearing that the felt lubricating wick is not damaged. See Section 8(g).

Section 12

TO CHANGE SOLENOID SWITCH P

(a) Remove commutator end cover and dismantle according to Section 2 only, with the exception that there will be no need to remove main negative terminal and connector, as the connection to sweating tag can be unsoldered and re-soldered for new switch.

(b) The switch is designed and made to outlast the starter, and with proper care it will do so, but should it become damaged so that it is impossible to repair or adjust according to details given in the general instructions section it should be returned to C.A.V. Ltd. for repair.

(c) Re-assemble according to Section 2 reversed and replace commutator and cover.

Section 13

TO CHANGE FIELD COILS F

(a) Dismantle as shown in Sections 1, 2 and 3.

(b) Notice that the auxiliary coils are always assembled on poles Nos. 1 and 3, and care should be taken to ensure that the field windings are assembled in their correct positions.

(c) Re-assemble according to Sections 1, 2 and 3 reversed. For maintenance details refer to details given in the general instructions section.

PERIODICAL EXAMINATION OF AXIAL STARTERS

POINTS TO LOOK FOR

Section 14

BRUSH SPRING PRESSURES

Pressures of brush springs should be checked with a spring balance, see Fig. 12, and these should be **32-40 ozs.**, taken at the point of contact with the brush.

If spring pressures are not within the specified limits, the spring should be replaced.

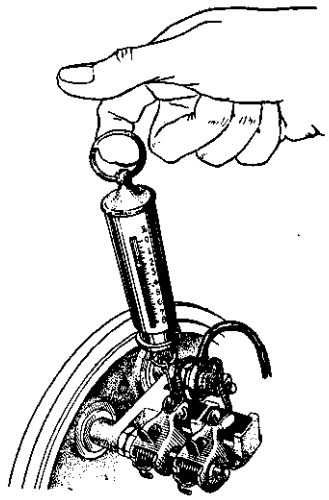


Fig. 12.—Checking Brush Spring Pressures

Section 15

CLUTCH

Where facilities exist, the clutch should be tested for slipping torque (or overloading point) and this should be between 80 and 100 lb. ft. If it is found to be below these figures, the clutch should be examined for wear, and worn parts replaced. See Fig. 13.

Take care to insert the plates as explained in Section 9 (b), and illustrated in Fig. 11.

Section 16

ARMATURE

The commutator should be clean and free from uneven discoloration. For maintenance details, see separate section.

The bearing bush inside the armature at the commutator end should be replaced if showing any signs of wear. A special tool is required for extracting and inserting this bush, particulars of which can be obtained direct from C.A.V. Ltd., Acton.

NOTE

When assembled the clutch must be adjusted to slip at 100—115 lb. ft. torque and tested about 10 times; after this, the clutch should be adjusted to slip at 80—100 lb. ft.; if clutch slips with less than 80 lb. ft. torque a compensating washer must be interposed between the clutch plates and the back ring. These washers are made in two thicknesses, ·1 and ·15 mm., and one or more should be used as required. See Fig. 11.

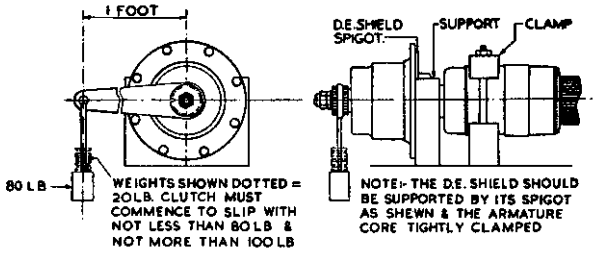


Fig. 13—Clutch adjustment for Axial Type Starters.

Section 17

PINION TEETH

If teeth of pinion appear badly worn or damaged, the pinion should be changed, see Section 8.

Before replacing the starter into service, inspect flywheel, as damaged teeth will quickly damage new pinion. Also see that solenoid switch plunger is not sticking or the contacts burnt.

Section 18

COMMUTATOR END BEARING

The commutator end bearing should be examined for wear or sloppiness and if found to be worn it should be returned to C.A.V. Ltd., complete with the commutator end shield as given in Section 10.

Section 19

CONNECTIONS

Make sure all connections (internal and external) are thoroughly tight and clean, as the successful working of the starter depends on this.

NON-AXIAL STARTER INSTRUCTIONS

MAINTENANCE

Very little attention during service is necessary with the starter, but in order to provide the maximum life and trouble-free running, the following points should be inspected at periods depending on the service conditions :—

(a) **Armature** The commutator should be examined approximately every 6 months. For full particulars of armature maintenance refer to General Instructions Section, page 3.

(b) **Drive** The screwed sleeve should be cleaned with paraffin and lubricated with thin machine oil, so that the pinion is perfectly free in travel. The pinion teeth must not be damaged or worn. Where a light pinion return spring is fitted, see that its efficiency has not become impaired.

(c) **Brush Gear** Examine the brushes approximately every 6 months. For full particulars of maintenance refer to General Instructions Section pages 2 and 3. See that the band cover is correctly replaced after brush inspection.

(d) **Terminals** Keep all nuts spanner tight and clean. Where rubber caps are fitted to cover the terminals they should not be dispensed with when connecting the cables. Remember they are supplied as a safety factor.
Polarity of the terminals is not important except on machines with solenoid switches mounted directly on the yoke, when terminal markings should be strictly adhered to.

(e) **Lubrication** Unless a greaser is provided no attempt should be made to oil or grease the bearings, as there is a danger of the properties in the self-lubricating type of bearing becoming affected.
When lubrication is provided for, use a soft grease as for general lubrication.

(f) **Bearings** When wear occurs, bearings should be replaced ; no attempt should be made at re-boring. Unless facilities exist for extracting bearings, it is advisable to return the complete end-shield to the nearest C.A.V. Depot in order that accurate replacement may be carried out.

SOLENOID STARTER SWITCHES

(IN AXIAL STARTERS ONLY)—Type BBNFA

The BBNFA solenoid starter switches are simple two-step units **incorporated with axial type starters.** At the first step the switch completes the circuit to the shunt and auxiliary field windings, allowing a small current to pass, sufficient to give the starter armature its axial movement and thus gently but firmly engaging the pinion with the teeth on the fly-wheel. When this has taken place the second circuit is completed, allowing the main current to flow and the starter to develop its maximum power.

OPERATION

Refer to Fig. 15

When the starter button is pressed the magnetic field set up in the switch winding draws in the armature C until the first contact is closed and the catch F rests on the step in the trigger E. This position is held until the trigger is lifted by the trip plate on the armature during its travel and thus allows the second contact to close and the main current to pass.

DISMANTLING

Section I

(a) Remove nut G after freeing from locking plate H, take off catch holding plate L and trigger catch F and it will then be found that bridge piece M, flat spring K and insulating bush J can be withdrawn. The earlier types of BBNFA switches were fitted with a single spring washer and where this is found to be the case a new locking plate should be fitted.

(b) Care should be taken when the trigger E is released through removing the catch F that the trigger spring D is removed, otherwise it will fall out and become lost.

(c) Note the position of the washers P and R, as the thin ones are used for adjustment purposes, as explained in the assembling instructions. The thick washer N acts as a spigot for the return spring B.

(d) Remove spring B.

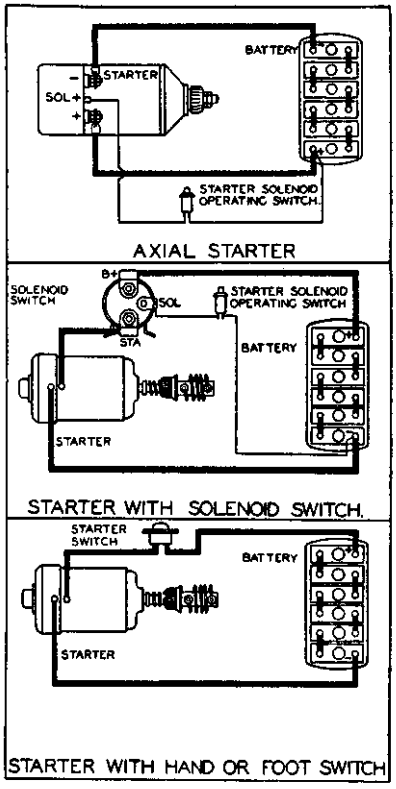
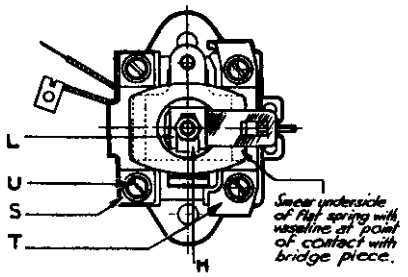


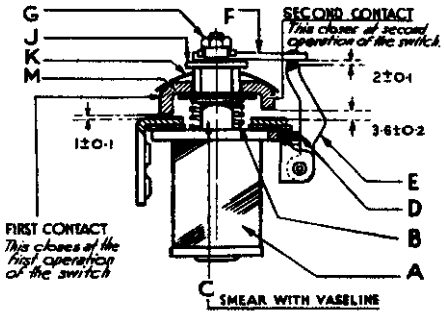
Fig. 14.—Theoretical Circuits for Axial and Non-Axial Type Starters

For Wiring Diagrams see Sub-Section (g) page 22, Figs. 27 and 28.

(e) The fixed contacts can be removed by extracting the fixing screws U. Do not omit the insulating bush or washer when replacing.



FRONT VIEW OF SWITCH



SECTION THROUGH CONTACTS

Fig. 15

MAINTENANCE

Section 2

(a) If moving contact M is dirty, clean with spirit or very fine carborundum paper.

(b) If moving contact M is badly burnt or pitted, re-face. Take care that both faces are kept to the angle shown in Fig. 16, and that they are on the same plane. This is most important, as if the faces are uneven poor contact will result and the whole operation will have to be repeated after a short time. **Not more than $\frac{1}{64}$ in. (.4 mm.)** must be removed from the faces of the contacts and in the unlikely event of this not being enough a new bridge piece should be fitted.

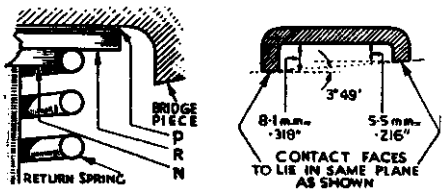


Fig. 16.—Arrangement of Packing Washers and Machining Dimensions of Bridge Piece

(c) If fixed contacts S and T are dirty, clean as for 2a.

(d) Should fixed contacts S and T be badly burnt or pitted, it is recommended that they be replaced, unless facilities are available for accurate re-facing by milling or turning. If re-facing is undertaken, **not more than $\frac{1}{64}$ in. (.4 mm.)** must be removed from the surface, as in the case of moving contacts.

As new fixed contacts are supplied in an unmachined state, care must be taken to face them when in position on the switch and before placing the switch in service. See Fig. 17.

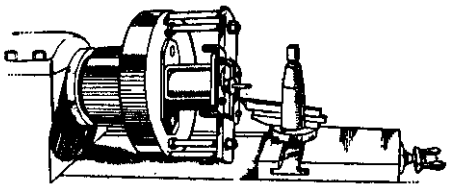


Fig. 17.—A Simple Fixture for Holding the Switch in a Lathe for Turning the Contacts.

(e) **Do not use a file or coarse grit on either the fixed or moving contacts.**

(f) Check the pressure of return spring B. It should be as follows when compressed to a length of $\frac{1}{2}$ in. (12·7 mm.), and if not within these limits a new spring should be fitted.

3 lb. 3 oz. ± 5 ozs.

(g) Check the pressure of trigger spring D. It should be replaced if not within **6 to 10·5 ozs.** when compressed to a length of $\frac{7}{32}$ **in. (5·6 mm.).**

(h) See that insulating bush J is a nice easy fit in bridge piece M and has not distorted through heat from exterior sources, etc.

(j) In the event of the winding becoming broken or damaged, the complete switch should be returned to nearest C.A.V. agent for repair as the stirrup A surrounding the coil is riveted to the main plate and should not be removed.

(k) Lightly smear the plunger C at the point of entry into the switch body with vaseline, also at the point of contact between the bridge piece and the flat spring. Apply the vaseline sparingly to avoid excess getting on to the contact faces.

RE-ASSEMBLING

Section 3

Assemble switch according to Section 1 reversed, but note the following points :—

(a) **Air Gaps** If any re-facing of the contacts has been carried out it will be necessary to re-adjust the contact air gaps by removing one or more of the adjusting washers P, but do not remove either washers R and N. The adjusting washers P are made in the following thicknesses : ·004, ·008 and ·012 ins. (0·1, 0·2 and 0·3 mm.), and the number varied until the air gaps given on Fig. 16 are obtained.

(b) It is advisable to fit a new locking plate H for the armature nut G, as the efficiency of the switch will be impaired unless the nut is kept perfectly tight.

TEST DATA

Section 4

When the switch is finally assembled the following tests should be made with the switch in a horizontal position.

(a) Force to overcome return spring in "OFF" position

$3\frac{1}{4}$ lb. ± 10 ozs.

(b) Force to overcome total spring pressure in " ON " position

$15\frac{1}{2}$ lb. $\begin{matrix}+\ 2\text{ lb.}\\ -\ 1\text{ lb.}\end{matrix}$

(c) Force to overcome spring tension of trigger applied at peak of tripping face whilst switch is in "OFF" position.

9 oz. $\begin{matrix}+\ 1\frac{1}{2}\text{ ozs.}\\ -\ 2\text{ ozs.}\end{matrix}$

(d) The switch must operate on both contacts at :

7·0 $\begin{matrix}+\ 0{\cdot}7\text{ volts}\\ -\ 1{\cdot}0\end{matrix}$

(e) All switches should be given a test of a few seconds duration at twice the normal voltage, to ensure that the trigger operation is satisfactory. Any faulty assembling or rounding off of the step will cause the catch to slip.

SOLENOID STARTER SWITCH

(FOR NON-AXIAL STARTERS ONLY)

GENERAL

The type S.O.L. Solenoid starter switch, Fig. 18, eliminates the heavy voltage drop that is liable to occur in the starter cable and reduces considerably the chances of cable fracture and consequent expenditure. The Solenoid switch is mounted on the starter panel.

CONSTRUCTION

The main pressed steel body houses the operating solenoid coil, main fixed contacts, and the moving contact with its operating plunger. The plunger is free to move through the centre of the operating coil bobbin and together with the moving contact is kept in the "OFF" position by means of a small coil spring.

The main heavy terminals, complete with cable sockets and tags, are mounted on the end of the body, together with a small terminal for solenoid operation.

All terminals are carefully insulated from one another by rigid insulating strips.

OPERATION

The terminal marked S.O.L. is connected to the hand-operated push switch, the opposite side of the switch being connected to the battery feed. As one side of the solenoid winding is also internally connected to terminal S.O.L. and the opposite end of the winding to the live main terminal, the circuit is completed immediately the push switch is operated. The energising field set up in the windings as the result of the completed circuit forces plunger against the spiral spring and compresses it until the moving contact has bridged the fixed contacts, in which position it is firmly held until the push switch is released. The bridging of the main contacts allows the main current to flow through the starter.

MAINTENANCE

Beyond the following points the actual maintenance of the S.O.L. switch is negligible :—

Keep the terminals and the surface on which they are mounted perfectly free from dirt, damp or oil.

Keep the terminal nuts well tightened.

Take care not to twist the cable sockets so that they jam against the small insulation cap, otherwise there is a danger of distorting the plunger bearing, with a consequent sticking of the plunger action.

Remove occasionally the screwed cap and plunger, smear the brass stem of the plunger with vaseline and replace.

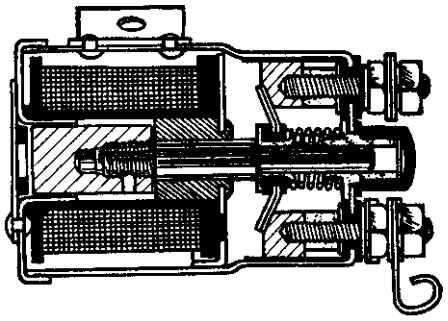


Fig. 18

STARTER SWITCH

All starters are fitted with this type SS5 switch, Fig. 19, which closes the circuit and sets into operation the solenoid switches in both axial and non-axial starter.

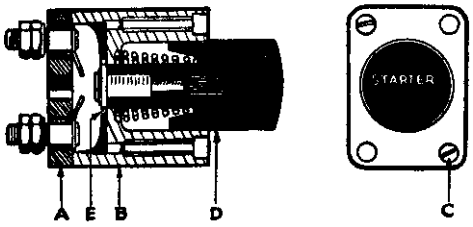


Fig. 19

DON'T—

—Attempt to re-bore the poles or re-machine armature core, as this will upset the engaging action of the starter.

—Use other than proper brushes, as incorrect grades will mean excessive sparking, resulting in bad commutator surface and pitting.

—Use lubricants other than those mentioned unless they have been submitted to C.A.V. Ltd., or their agents, for approval. Incorrect lubricants will cause excessive bearing wear.

—Damage armature core when holding it for torque test of clutch, as short circuits in the windings may occur or the air gap between poles and armature may be affected.

—Bend or damage switch tripping plate E1 on armature, otherwise the timing of the pinion engagement will be altered.

—Let oil or dirt come in contact with the commutator, since this will cause short circuits between the commutator bars, uneven brush wear, a bad commutator surface and breakdown of insulation.

—Be over enthusiastic with lubricant in the driving end lubricator. Oiling is very necessary, but if excessive, saturated windings will result and cause premature breakdown of the insulation.

C.A.V. DYNAMOS

Dynamos are used in conjuction with a regulator and cut-out to operate on the compensated voltage control system.

With the compensated voltage control system there is automatic adjustment of the charging rate in relation to the condition of the battery. Once a dynamo has exceeded cutting-in speed, the output voltage is kept slightly in excess of the back pressure of the battery irrespective of any variation in speed. In addition the excess voltage of the dynamo is made greater as the battery becomes discharged and less as the battery becomes more fully charged.

The dynamo is flange mounted and is complete with combined regulator and cut-out mounted directly on the yoke (see Fig. 20).

MOUNTING

The arrow marked on the regulator cover should always be in the vertical position. There should be no gap between flange and face to which it is bolted. When replacing, after removal, care should be taken to progressively and evenly tighten the flange fixing bolts to prevent distortion.

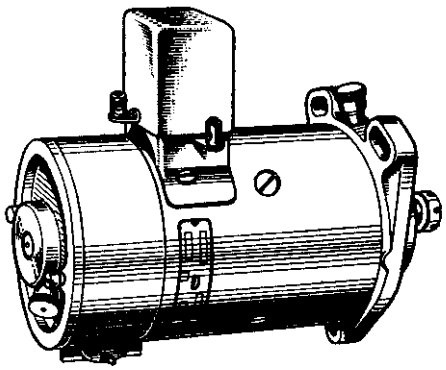


Fig. 20.—C.A.V. 4½-in. dia. Dynamo with combined regulator and cut-out unit mounted on the yoke

TESTING

When the machine is received in a new condition, it can be safely assumed that all necessary adjustments and tests have been made in order that it may be used in conjuction with the particular set specified. If, after a period of service, it is desired to check the performance, the following simple tests should be applied :—

First remove each cable from its terminal. Connection should then be made between the end of the field coil and brushes that are not already directly connected.

Clip the leads of a moving coil type voltmeter, having a suitable range, to the two large main dynamo terminals. Run the dynamo and gradually increase its speed until a reading of 6·5 volts is registered. Do not, however, exceed a dynamo speed of 1300 r.p.m.

If the voltmeter remains at zero check the dynamo brush gear and internal connections.

A very low reading throughout a speed rise indicates a possible faulty field winding, whilst a low reading may mean that the armature winding is faulty.

BRUSH GEAR

As instructed Sub-Section (a) pages 2 and 3, except the brush pressure which should be :—

10-16 ounces.

ARMATURE

As instructed Sub-Section (a) pages 3 and 4.

FIELD COILS

As instructed Sub-Section (a) page 4.

MAINTENANCE

As for starters but additionally, see that the connections from the terminals underneath the Regulator platform to the brush holders are secure.

COMBINED REGULATOR AND CUT-OUT

The dynamo is fitted with C.A.V. Type "BG" combined Regulator and Cut-out, which is mounted on the yoke as shown in Fig. 20.

Before proceeding with the setting of the Regulator in accordance with the following instruction, it is necessary to know the minimum open circuit Regulator voltage setting, which is indicated by the last group of figures in the type number stamped on the Regulator Base, e.g. BG.1-150. As the last figure in this group is decimal and a tolerance of plus 0·5 and 0·2v. is allowed for the 12v. and 6v. machines respectively, the minimum voltage setting in this particular example, being a 12-volt machine, will be 15·0. The Cut-out voltage is set at 1·5 to 4v. below the minimum Regulator setting in the case of the 12-volt machine, and from 1 to 2·5v. for the 6-volt machine.

Electrical settings should be carried out with the dynamo running at 1,000 r.p.m.

ADJUSTMENTS

Refer to Fig. 21

(A) Cut-out Mechanical Setting

1. Slack-off screws AA, attaching flat spring to the armature frame.
2. Insert 0·01" feeler between the armature and frame.
3. Press down the armature on to core and back against feeler so that the feeler is gripped firmly.
4. Tighten screws AA holding the flat spring.
5. Set air gap between armature tip and core from 0·035" to 0·037" when contacts are open. This can be adjusted by bending strip AB.
6. Set contact gap from 0·012" to 0·014" when they are open, by bending contact strip.

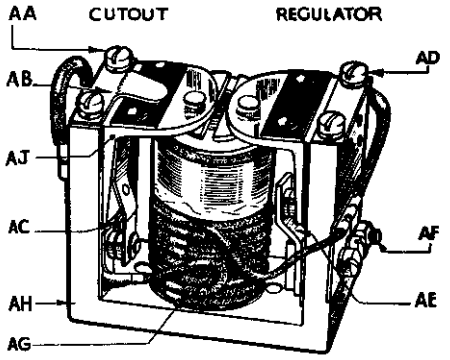


Fig. 21.—The B.G. Regulator

(B) Cut-out Electrical Setting

This is carried out by bending the brass strip AC which is in contact with the cut-out auxiliary spring.

(C) Regulator Mechanical Setting

1. Slack off screws AD attaching armature flat spring to frame.
2. Insert a feeler 0·005" thick between armature and frame.
3. Press down armature on to core and back against feeler so that the feeler is firmly gripped.
4. Tighten screws AD attaching armature to frame.
5. Set air gap between armature tip and core from 0·020" to 0·025" when the contacts are closed. This adjustment can be made by bending the fixed contact bracket AE.

(D) Regulator Electrical Setting

1. Connect a moving coil voltmeter across regulator terminals + and —.
2. Run the dynamo at 1,000 to 1,500 r.p.m. with all connections to battery, lights and other accessories removed.
3. Adjust regulator voltage by screw AF until required figure, as determined by the type formula, is recorded on the voltmeter.

USEFUL DATA

Dynamo

Type	D45, E26
Volts	12
Yoke diameter ins.	4·5
Yoke weight, lbs.	19·25
Cutting-in-speed (C.I.S.)	750
Maximum output :	
Amps.	10
R.p.m.	1000
Lamp load :	
Amps	7·5
R.p.m.	950
Fuse :	
Type	32 S.W.G. tinned copper
Capacity (amps)	22

Greasing : half a turn of grease-cup (when fitted) once a month.

STARTER BATTERIES

The battery employed is a lead-acid 6 volt starter battery, either "Young" (type R/E.4 or 3HB15L) or "Crompton" (type 3HB15L). Two batteries are connected in series to give 12 volt starting. A 12" insulated connector is used for this purpose.

SPECIAL FEATURES

Plates

Special design of both positive and negative plates ensures maximum life and starting power. Grid design ensures a uniformly pasted plate, which retains the active material in close contact with the grid under the most arduous service conditions.

Separators

"Young" Batteries:—Selected Port Orford cedar or other approved wood, treated to remove harmful impurities.

"Crompton" Batteries:—Synthetic "Dri-stor" micro-porous separators; virtually indestructible and not affected by acid.

Inspection of each individual separator is carried out before use to ensure that it is free from any defect which might affect the service life of the battery.

Connector Bars

Of low electrical resistance lead of ample cross-sectional area.

Vent Plugs

Of polystyrene, permitting the escape of gas without loss of electrolyte.

Container

Of moulded hard rubber (ebonite), designed to give the maximum of service under most arduous conditions.

Moulded Lids

Of hard rubber (ebonite) or bakelite.

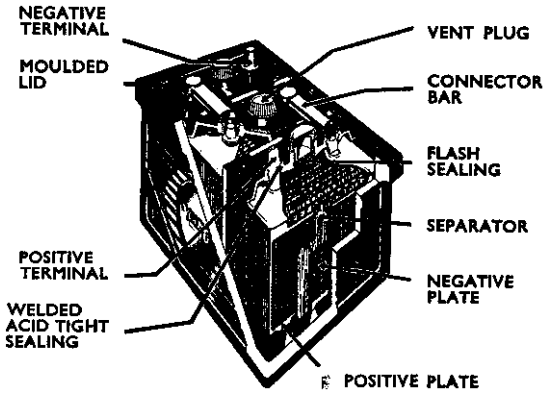


Fig. 22

Sealing

"Young" Batteries: — When batteries leave the factory they are "flash" sealed under the vent plug aperture in the lid; this, together with the fusing of the lead pillars with the lead inserts in the moulded lid hermetically seals the cell and retains moisture in the separators. Batteries may thus be stored in this condition safely up to two years in a temperate climate and one year in tropical climates; they should be charged within that time but if this has not been done they should be opened and re-separated before being put into use.

" Crompton " Batteries:—With " Dri-stor " separators there is no need to retain moisture as the separator is dry on insertion. These batteries are flash sealed only to protect from dust and the sealing may have been drilled to allow the escape of air expansion in the process of manufacture. " Crompton " batteries may safely be stored dry for an indefinite period.

Fig. 22 gives a cross-section of the battery with the respective parts clearly indicated as referred to in the text.

PROCEDURE FOR THE FIRST CHARGE

Filling

The "Flash" seal in each lid should be broken by firm pressure of the finger ; the seal will fall into the cell, but this has no effect on performance or life, and should be allowed to remain.

Each cell should then be filled with pure accumulator sulphuric acid purchased from a recognised source, and of specific gravity of 1340 in temperate climates and 1300 in tropical climates for " Young "; and 1260 in temperate climates and 1220 in tropical climates for " Crompton." At this stage the level should be $\frac{1}{2}$" (12·7 mm.) above the tops of the separators.

Soaking Time

The battery should now stand for a minimum of 8 hours and a maximum of 12 hours; in tropical climates a full 12 hour period should be allowed. **It is important that these limits are strictly observed.** Excessive soaking causes excessive sulphation, necessitating a longer first charge and impairing the life of the cell. On the other hand insufficient soaking does not allow the acid to complete its work on the plates and similar results follow.

Charging

The battery should then be charged at 7 amps for a MINIMUM period of 48 hours. (See below for ascertaining the actual completion of charge.) The charging rate of 7 amps must not be exceeded during first charge, but may be reduced, in which case the minimum period must be proportionately extended.

Temperature

The temperature is observed from a special thermometer inserted in a cell and left there during charge. See Fig. 23. The internal temperature should never be allowed to rise above 110° F. (43° C.) in temperate climates and 125° F. (52° C.) in tropical climates. If necessary, discontinue charging or reduce the current to allow the battery to cool down.

Maintaining the level of electrolyte

If the level falls to the tops of the separators during charge, it should be restored by the addition of distilled water ; **on no account should acid be added** at this point.

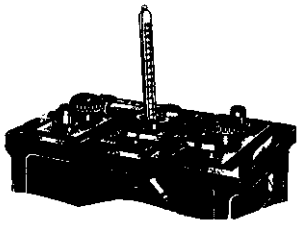


Fig. 23

How to determine completion of charge

The end of the first charge is indicated by cell voltages and specific gravity readings becoming constant whilst gas is freely discharged from the plates. When charging at the specified charging rate, the voltage and specific gravity attain a maximum value ; hourly readings on a cell over a period of 3 to 4 hours should therefore be identical.

Until both these factors give constant readings the charge is incomplete, and the battery should be given a further charge until constant readings are obtained. Irreparable damage will be caused to a battery which is put into service when its initial charge is incomplete owing to the unchanged sulphate on the plates generating more sulphuric acid during normal charging and increasing the concentration of the electrolyte to a point where it does permanent damage.

On the other hand, excessive charging either in rate or period is detrimental to the plates.

The voltage readings must be taken whilst the battery is still being charged. Readings taken when the battery is disconnected from the charger i.e. on " open " circuit, are valueless. End-of-charge cell voltage should be a minimum of 2·5 volts.

Specific gravity readings are taken with the normal battery hydrometer and an adjustment made for temperature. The hydrometer should be held vertically at eye level and no pressure whatever exerted on the rubber bulb whilst readings are being taken, see Fig. 24. Full charge sp. gr. at 60° F. (16° C.) in temperate climates is 1·280 and in tropical climates 1·240. If, in spite of constant readings, these figures cannot be obtained it will be necessary to adjust the electrolyte to the required figure, but this **must only be done** when the voltage reading is above the minimum of 2·5, and is constant, otherwise damage will result.

Fig. 24

If the specific gravity is too low, draw off a quantity of electrolyte and replace with sulphuric acid of specific gravity 1·350 to 1·400, or if the specific gravity is too high, draw off a quantity of electrolyte and replace with distilled water. In both cases continue charging for about an hour to allow complete mixing of the electrolyte and again determine the specific gravity. Once the electrolyte has been adjusted to the correct working specific gravity, it will never again be necessary unless there has been accidental loss of electrolyte through leakage or spillage. In this case, the battery **must be fully charged BEFORE the adjustment is made,** otherwise permanent damage will result.

NOTE The **final height** of the electrolyte should be $\frac{1}{4}$" **above** the separators.

NORMAL CARE AND MAINTENANCE

Cleanliness

A film of dust or dirt combined with atmospheric humidity or spillage of electrolyte on the top of the battery will cause a small but steady discharge. This, combined with the normal discharge through internal local action (which is a normal feature of any lead-acid battery) is sufficient to impair performance. If as a result of this, or indeed for any other cause, the battery is made to work in a slightly discharged state for any length of time a loss of capacity will follow.

The top of the battery should be cleaned regularly, and left as dry as possible. The connections should be free of corrosion and care taken to see that the lugs make clean contact with the posts ; dirty connections mean increased resistance and low performance.

Normal bench charging

The level of the electrolyte should be restored with distilled water, NOT acid.

The battery should be charged at 8 amps. If completely discharged it should be left on for 15 hours ; if it is only partially discharged it will need a proportionately shorter period.

The procedure for determining peak of charge is the same as with a first charge, viz. : constant voltage and gravity readings. If the battery gases freely before the expiration of 15 hours these readings should be commenced immediately and the battery taken off if they are satisfactory. At the conclusion of a 15 hour charge a normally discharged battery will be completely recharged, and this state should be checked by voltage and gravity readings. Charging should always be discontinued after the charge is complete, as proved by readings, and in any case if the internal temperature reaches 110° F. (43° C.) in temperate or 125° F. (52° C.) in tropical climates.

Adjustment of the specific gravity

It has been previously stated that normally this is not necessary in service. If however, at the end of a bench charge the electrolyte, though giving constant readings, is low in specific gravity, it must be adjusted as described for the first charge. It is again **stressed that this must only be done when the battery is fully charged.** It should be adjusted to 1·280 at 60° F.

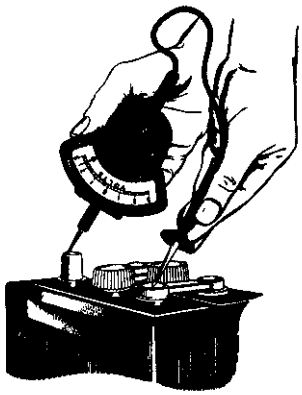


Fig. 25

The cell-testing voltmeter

The type recommended is that with a scale 3-0-3 volts. It consists of the voltmeter itself with one contact spike rigidly attached and the other on the end of a flexible cable. Fig. 25 shows a typical meter in use.

Voltage readings are only useful when taken on charge (or discharge). The end of charge cell voltage of a fully charged cell at 60° F. should be between the minimum of 2·5 volts and 2·75 volts.

Maintenance whilst unused

A battery which is not to be used for a long time should be recharged at the normal (15 hour) rate every two months.

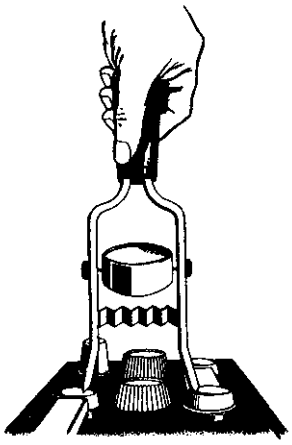


Fig. 26

Testing for Capacity

To prove whether or not a cell is holding its charge a voltmeter in parallel with a resistance is used, see Fig. 26. The load on the cell will quickly reduce voltage if any fault is present or if the cell is at the end of its useful life. It is evidenced by the needle of the voltmeter " creeping " back to zero.

Repair of Batteries

Should serious damage be caused to a battery for any reason, the repair of it should be put in the hands of Crompton Parkinson Ltd. Agents or the nearest battery specialist.

WIRING DIAGRAMS

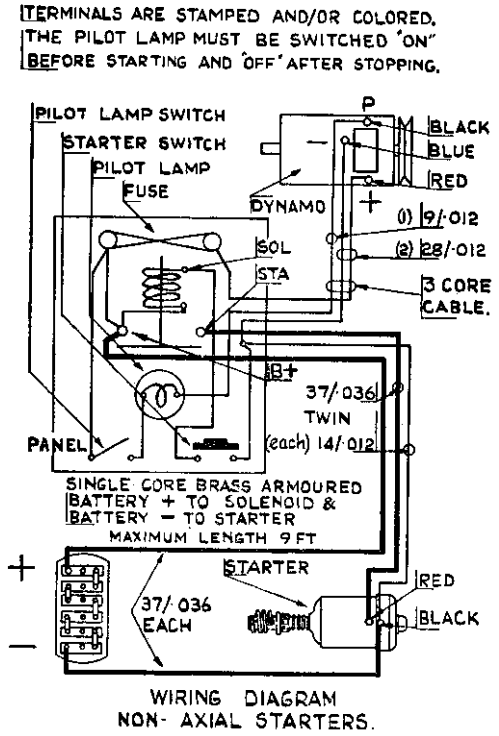


Fig. 27

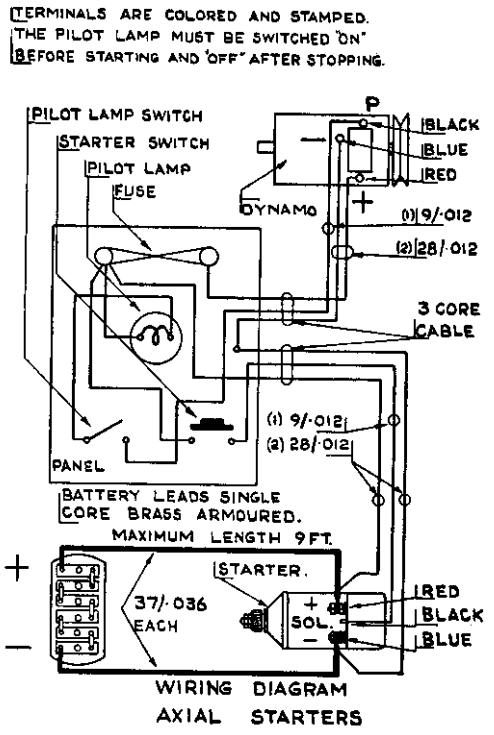


Fig. 28

IMPORTANT

Maximum lengths of 37/.036 cable given in the diagrams **should not be exceeded.**

If therefore site conditions necessitate lengths in excess of 9 feet, we recommend that the size of cable **be increased proportionately.**

PILOT LAMP

To indicate that the battery is being re-charged and must be switched " **ON** " before starting, and " **OFF** " after stopping.

REPLACEMENT

Bulbs should be: **2·5 volts—·2 amperes.** ....

CHECKING FAULTS

Bulb will not light:—

1. Apply 12 volts across the holder.
2. Replace bulb with one known to be correct.
3. Check resistance in holder for open circuit.

If necessary obtain and fit complete new lamp holder.

DECEMBER, 1952

SV 13

ENGINE
DATA

ENGINE DATA

SV 13

TECHNICAL DATA

ENGINE MARK		1VTO	2VTO	1VSO	2VSO	3VSO	4VSO
B.H.P. (Maximum Working Load)		5	10	7.5	15	22.5	30
R.P.M.	Max.	1000	1000	1000	1000	1000	1000
No. of CYLINDERS		1	2	1	2	3	4
BORE	ins. mm.	4 101.6		$4\frac{1}{2}$ 114.3			
STROKE	ins. mm.	4 101.6		$4\frac{1}{2}$ 114.3			
PISTON DISPLACEMENT	cu. ins. cc.	50.2 823		71.6 1172			
PISTON SPEED	feet/min. metres/sec.	667 3.38		750 3.81			
B.M.E.P. at 1,000 r.p.m.	p.s.i. kgs./cm²	78.8 5.55		8.3 5.81			
COMPRESSION PRESSURE	p.s.i. kgs./cm²	490 34.3		470 32.9			
FIRING PRESSURE	p.s.i. kgs./cm²	850 59.6		825 57.9			
INJECTION PRESSURE	p.s.i. kgs./cm²	2500 176.5		3000 210.9			
BRAKE THERMAL EFFICIENCY	%	31.7		33.1			

BEARING DIMENSIONS ins.							
MAIN	dia. × length	$2\frac{1}{8} \times 4\frac{1}{8}$	$2\frac{1}{8} \times 4\frac{1}{8}$	$2\frac{3}{8} \times 4\frac{5}{8}$	$2\frac{3}{8} \times 4\frac{5}{8}$	$2\frac{3}{8} \times 4\frac{5}{8}$	$2\frac{3}{8} \times 4\frac{5}{8}$
CENTRE	dia. × length		$2\frac{1}{2} \times 1\frac{3}{8}$		3 × $1\frac{1}{2}$	3 × $1\frac{1}{2}$	3 × $3\frac{1}{2}$ 3 × $1\frac{1}{2}$
THRUST	dia. × length	Main	Main	Main	Main	3 × $1\frac{1}{2}$	3 × $1\frac{1}{2}$
LARGE END	dia. × length	$2\frac{1}{2} \times 2$	$2\frac{1}{2} \times 2$	$2\frac{3}{4} \times 2\frac{1}{4}$	$2\frac{3}{4} \times 2\frac{1}{4}$	$2\frac{3}{4} \times 2\frac{1}{4}$	$2\frac{3}{4} \times 2\frac{1}{4}$
SMALL END	dia. × length	$1\frac{3}{8} \times 1\frac{11}{16}$	$1\frac{3}{8} \times 1\frac{11}{16}$	$1\frac{1}{2} \times 1\frac{7}{8}$	$1\frac{1}{2} \times 1\frac{7}{8}$	$1\frac{1}{2} \times 1\frac{7}{8}$	$1\frac{1}{2} \times 1\frac{7}{8}$

NOTES

The **BHP** figures are based on 12 hour rating.

Piston Speeds are given at maximum **R.P.M.** (piston speed varies as r.p.m.).

Outer Bearings for 3 and 4 cylinder **VSO/H,** are 2″ dia. × $4\frac{3}{8}$″ long, but are only supplied when specially required for belt drives.

ENGINE MARK		1VTH	2VTH	1VSH	2VSH	3VSH	4VSH
B.H.P. (Maximum Working Load)		7.5	15	11	22.5	34	45
R.P.M.	Max.	1500	1500	1500	1500	1500	1500
No. of CYLINDERS		1	2	1	2	3	4
BORE	ins. mm.	4 101.6		$4\frac{1}{2}$ 114.3			
STROKE	ins. mm.	4 101.6		$4\frac{1}{2}$ 114.3			
PISTON DISPLACEMENT	cu. ins. cc.	50.2 823		71.6 1172			
PISTON SPEED	feet/min. metres/sec.	1000 5.07		1125 5.71			
B.M.E.P. at 1,500 r.p.m.	p.s.i. kgs./cm^2	78.8 5.55		81.2 5.68	83 5.81	83.7 5.86	83 5.81
COMPRESSION PRESSURE	p.s.i. kgs./cm^2	475 33.3		460 32.2			
FIRING PRESSURE	p.s.i. kgs./cm^2	850 59.6		850 59.6			
INJECTION PRESSURE	p.s.i. kgs./cm^2	2500 176.5		3000 210.9			
BRAKE THERMAL EFFICIENCY	%	31.7		33.1			

BEARING DIMENSIONS ins.							
MAIN	dia. × length	$2\frac{1}{8} \times 4\frac{1}{8}$	$2\frac{1}{8} \times 4\frac{1}{8}$	$2\frac{3}{8} \times 4\frac{5}{8}$	$2\frac{3}{8} \times 4\frac{5}{8}$	$2\frac{3}{8} \times 4\frac{5}{8}$	$2\frac{3}{8} \times 4\frac{5}{8}$
CENTRE	dia. × length		$3\frac{1}{4} \times 1\frac{3}{8}$		$3\frac{3}{4} \times 1\frac{1}{2}$	$3\frac{3}{4} \times 1\frac{1}{2}$	$3 \times 3\frac{1}{2}$ $3\frac{3}{4} \times 1\frac{1}{2}$
THRUST	dia. × length	Main	Centre	Main	Centre	$3\frac{3}{4} \times 1\frac{1}{2}$	$3\frac{3}{4} \times 1\frac{1}{2}$
LARGE END	dia. × length	$2\frac{1}{2} \times 2$	$2\frac{1}{2} \times 2$	$2\frac{3}{4} \times 2\frac{1}{4}$	$2\frac{3}{4} \times 2\frac{1}{4}$	$2\frac{3}{4} \times 2\frac{1}{4}$	$2\frac{3}{4} \times 2\frac{1}{4}$
SMALL END	dia. × length	$1\frac{3}{8} \times 1\frac{11}{16}$	$1\frac{3}{8} \times 1\frac{11}{16}$	$1\frac{1}{2} \times 1\frac{7}{8}$	$1\frac{1}{2} \times 1\frac{7}{8}$	$1\frac{1}{2} \times 1\frac{7}{8}$	$1\frac{1}{2} \times 1\frac{7}{8}$

NOTES

The **BHP** figures are based on 12 hour rating.

Piston Speeds are given at maximum **R.P.M.** (piston speed varies as r.p.m.).

Outer Bearings for 3 and 4 cylinder **VSO/H**, are 2" dia × $4\frac{3}{8}$" long, but are only supplied when specially required for belt drives.

OPERATING DATA

		VTO and VTH		VSO and VSH			
Sump Capacity.	No. cyl.	One	Two	One	Two	Three	Four
	Gls.	½	1	¾	1¾	2½	4
	Ltrs.	2.28	4.54	3.40	7.94	11.37	18.18

Water outlet temp. °F. 160
°C. 71.7

NOTE Temperature should not exceed 180°F. (82.2°C.).

Lub. Oil working press. p.s.i. 15
kgs/cm² 1.1

Lub. Oil minimum press. p.s.i. 8
kgs/cm² 0.56

Fuel Oil consumptions. (Figures given are at max. speeds)	VTO	VTH	VSO		VSH
			1 & 2 cyls.	3 & 4 cyls.	
Full Load.					
Lbs./B.H.P./Hr.	.48	.44	.46	.45	.42
Pt./B.H.P./Hr.	.436	.40	.418	.409	.382
Grms./B.H.P./Hr.	218	200	209	204	191
¾ Load					
Lbs./B.H.P./Hr.	.49	.46	.48	.46	.44
Pt./B.H.P./Hr.	.445	.418	.436	.418	.40
Grms./B.H.P./Hr.	222	208	218	209	200
½ Load.					
Lbs./B.H.P./Hr.	.56	.54	.52	.50	.495
Pt./B.H.P./Hr.	.51	.491	.472	.454	.45
Grms./B.H.P./Hr.	254	245	236	227	225

The figures quoted are those obtained when using fuel to B.S.S. 209 (1947) Table A. and are guaranteed to a tolerance of 5% for VTH and VSH engines and 2½% on VTO and VSO.

Lubricating oil consumption.
(Figures given at max. speed)

	VTO		VTH	
No. cyls.	One	Two	One	Two
Pints/engine/hr.	.018	.036	.027	.054
Litres/engine/hr.	.010	.022	.015	.035

	VSO				VSH			
No. cyls.	One	Two	Three	Four	One	Two	Three	Four
Pints/engine/hr.	.027	.054	.081	.108	.040	.081	.120	.160
Litres /engine/hr.	.015	.035	.046	.063	.023	.046	.068	.091

The figures quoted refer to the amount of new, or make-up oil required per engine, after the first filling, providing the correct grade of oil is used. They are subject to a tolerance of 10%.

SERVICE DATA

Bumping clearance Piston top/cyl. head.	.035″ ± .0025″ (.89 m/m. ± .06 m/m).	
Valve timing.	Air valve opens	5° before T.D.C.
	Air valve closes	25° after B.D.C.
	Exhaust valve opens	45° before B.D.C.
	Exhaust valve closes	10° after T.D.C. (VTO and VTH). 5° after T.D.C. (VSO and VSH).
	Injection begins	25° before T.D.C.

VTO/VTH ENGINES

Details between which wear occurs	*Designed Max. and Min. Clearance*	*Maximum allowable Clearance*	*Remarks*
Crankshaft, end journal, *to* Main Bearing, end	.0025″ to .0035″ (.064 m/m .089 m/m)	.006″ (.152 m/m)	Max. ovality of journals .003″ (.076 m/m)
Crankshaft, intermediate journal, *to* Main Bearing, Intermediate	.002″ to .005″ (.051 m/m .127 m/m)	.007″ (.178 m/m)	Min. clearances may be reduced .0005″ (.012 m/m) by 'Nip' when fitting bearings.
Crankshaft End Float	1 Cyl. Engine. .002″ to .007″ (.051 m/m .178m/m) Multi Cyl. Engine .003″ to .005″ (.076 m/m .127m/m)	.015″ (38 m/m) .010″ (.254m/m)	
Crankpin, *to* Large End Bearing	.0015″ to .004″ (.038 m/m .102m/m	.006″ (.152 m/m)	Max. ovality of crankpin .003″ (.076 m/m). Min. clearance may be reduced .0005″ (.012 m/m) by 'Nip' when fitting bearings.
Cast Iron Piston Liner, *to* Piston Body	.004″ to .0055″ (.102 m/m to .14 m/m)	Max. Liner wear .015″ (.38 m/m)	The Liner wear is more important because piston body wear is usually negligible.
Alloy Piston Liner, *to* Piston Body	.0045″ to .013″ (.114 m/m .33 m/m Piston oval and tapered)	Max. Liner wear .015″ (.38 m/m)	See **Note ii.**
Gudgeon Pin Boss, *to* Gudgeon Pin	Cast Iron: .0005″ to .0015″ (.012 m/m .038 m/m) Alloy: .0005″ (.012 m/m) interference to .0005″ (.012 m/m) clearance	.003″ (.076 m/m) .0015″ (.038 m/m)	
Gudgeon Pin, *to* Small End Bush	.0015″ to .0025″ (.038 m/m .064 m/m)	.004″ (.102 m/m)	
Piston Ring Groove (Pressure) *to* Piston Ring	.001″ to .003″ (.0254 m/m .076 m/m)	.008″ (.203 m/m)	Grooves can be opened out for overwidth rings. See S.V.4 (*b*).
Piston Ring, gap in position	.010″ to .015″ (.254 m/m .38 m/m)	.030″ (.76 m/m)	Always check gap on unworn portion of Liner.
Piston, scraper rings	**Similar to Pressure Rings.**		

VTO/VTH ENGINES (continued)

Details between which wear occurs	Designed Max. and Min. Clearance	Maximum allowable Clearance	Remarks
Camshaft, to Camshaft Locating Bearing	.0015" to .003" (.038 m/m .076 m/m)	.005" (.127 m/m)	
Camshaft and Lubricating Oil Pump Drive Gears	.002" to .005" (.051 m/m .127 m/m)	.020" (.51 m/m) or if gears are excessively noisy.	
Inlet and Exhaust Valve stems, to Valve Guides	.003" to .004" (.076 m/m .102 m/m)	.008" (.203 m/m)	
Valve Rocker Bushes, to Valve Rocker Fulcrum Pins	.0005" to .002" (.012 m/m .051 m/m)	.008" (.203 m/m)	
Valve Tappet Stems, to Valve Tappet Guides	.0015" to .003" (.038 m/m .076 m/m)	.008" (.203 m/m)	With early type crankcases renew at .005" (.12 m/m) if oil is pumping excessively.
Fuel Pump Tappet Sleeve, to Fuel Pump Tappet Bush	.002" to .0035" (.051 m/m .089 m/m)	.008" .203 m/m	With early type crankcase renew at .005" (.12 m/m) if oil is pumping excessively.
Lubricating Oil Pump Body	.004" to .0075" (.102 m/m .19 m/m) Dia. Clearance	.012" (.30 m/m) Dia. Clearance	Backlash not critical but renew gears, if badly pitted or rough.
Lubricating Oil Pump Gears	.002" to .005" (.051 m/m .127 m/m) End Clearance	.007" (.178 m/m) End Clearance	

VSO/VSH ENGINES

Crankshaft, end journal, to Main Bearing, end	.003" to .0038" (.076 m/m. .096 m/m)	.006" (.152 m/m)	Max. ovality of journals .003" .076 m/m. Min. clearance may be reduced .0005" .012 m/m by 'Nip' when fitting bearings.
Crankshaft intermediate Journal, to Main bearing, intermediate	.003" to .0055" (.076 m/m .14 m/m)	.007" (.178 m/m)	
Crankshaft End Float	1 Cyl. Engine .002" to .007" (.051 m/m .178 m/m) Multi Cyl. Engine .004" to .005" (.102 m/m .127 m/m)	.015" (.38 m/m) .012" (.30 m/m)	
Crankpin, to Large End Bearing	.0015" to .004" (.038 m/m .102 m/m	.006" (.152 m/m)	Max. ovality of crankpin .003" (.076 m/m). Min. clearance may be reduced. 0005" (.012 m/m) by 'Nip' when fitting bearings.
Cast Iron Piston Liner, to Piston Body	.00425" to .00575" (.108 m/m .146 m/m)	Max. Liner wear .015 (.038 m/m)	The Liner wear is more important because piston body wear is usually negligible.
Alloy Piston Liner, to Piston Body	.006" to .014" (.152 m/m .35 m/m) Piston oval and tapered	Max. Liner wear .015" (.38 m/m)	See **Note ii.**
Gudgeon Pin Boss, to Gudgeon Pin	Cast Iron: .0005" to .002" (.012 m/m .051 m/m) Alloy: .0005" (.012 m/m) interference to .0005" (.012 m/m) clearance	.0035" (.089 m/m) .002" (.051 m/m)	

VSO/VSH ENGINES (*continued*)

Details between which wear occurs	*Designed Max. and Min. Clearance*	*Maximum allowable Clearance*	*Remarks*
Gudgeon Pin, *to* Small End Bush	.0015″ to .0025″ (.038 m/m .064 m/m)	.004″ (.102 m/m)	
Piston Ring Groove (Pressure), *to* Piston Ring	.001″ to .003″ (.025 m/m .076 m/m)	.008″ (.203 m/m)	Grooves can be opened out for overwidth rings.
Piston Ring, gap in position	.011″ to .016″ (.28 m/m .41 m/m)	.030″ (.76 m/m)	Always check gap on unworn portion of Liner.
Piston, scraper rings	**Similar to Pressure Rings.**		
Camshaft, *to* Camshaft Locating Bearing	.0015″ to .003″ (.038 m/m .076 m/m)	.005″ (.127 m/m)	
Camshaft and Lubricating Oil Pump Drive Gears	.002 to .008″ (.051 m/m .203 m/m)	.020″ (.51 m/m) or if gears are excessively noisy.	
Inlet and Exhaust Valve stems, *to* Valve Guides	.0035″ to .005″ (.089 m/m .127 m/m)	.010″ (.254 m/m)	
Valve Rocker Bushes, *to* Valve Rocker Fulcrum Pins	.0025″ to .005″ (.063 m/m .127 m/m)	.010″ (.254 m/m)	
Valve Tappet Stems, *to* Valve Tappet Guides	.0015″ to .003″ (.038 m/m .076 m/m)	.008″ (.203 m/m)	With early type crankcases renew at .005″ (.12 m/m) if oil is pumping excessively.
Fuel Pump Tappet Sleeve, *to* Fuel Pump Tappet Bush	.002″ to .0035″ (.051 m/m .089 m/m)	.008″ (.203 m/m)	With early type crankcases renew at .005″ (.12 m/m) if oil is pumping excessively.
Lubricating Oil Pump Body	.004″ to .0075″ (.102 m/m .19 m/m) Dia. Clearance	.012″ (.030 m/m) Dia. Clearance	Backlash not critical but renew gears if badly pitted or rough.
Lubricating Oil Pump Gears	.002″ to .005″ (.051 m/m .127 m/m) End Clearance	.007″ (.178 m/m) End Clearance	

NOTE

(i) To the skilled mechanic, for whom this manual has been produced, the condition of bearing surfaces, etc., will indicate almost as much as measured wear, when the question of estimating the life of worn parts arises.

(ii) Owing to the complex sections of pistons and varying designs, it is not possible to give definite figures of clearances between piston and liner, but it is found that the piston bodies only wear to a little extent, the rejection of pistons being normally due to excessive ring groove wear.

DECEMBER, 1952

SV 14

SERVICE TOOLS
AND INSTRUCTIONS

SERVICE TOOLS INDEX and INSTRUCTIONS

SV 14

SERVICE TOOLS

Section	Fig. No.	Description	Tool No.
S.V 2.			
Cylinder Head	* 2	Valve spring de-pressor	
	7	Valve guide drift	8224/3 IW.
	11	Reamer for two diameters	42-J-252
	11	Groove cleaning tool (VTH)	42-J-223
	11	Groove cleaning tool (VSH)	42-J-225
	11	Ball expander (VTH)	42-J-224
	11	Ball expander (VSH)	42-J-226
	11	Parallel expander	46-J-40
	13	Reamer for two diameters	See above 42-J-252
	13	Groove cleaning tool (VTO)	53-J-56
	13	Groove cleaning tool (VSO)	37-J-377
	13	Ball expander (VTO)	53-J-57
	13	Ball expander (VSO)	37-J-381
	13	Parallel expander	37-J-629
	14	Cutters for valve seat inserts	52-J-317 50-J-709 52-J-318 52-J-319
S.V.3			
Piston and Conn. Rod	* 2	Piston ring clip	
S.V.4			
Piston Rings	2	Ring expander (*not supplied by R. & H.*)	
	* 3	Ring blades	
S.V.5			
Conn. Rod	* 1	Dummy shaft for large end	
	* 3	All items for conn. rod check are available in most workshops.	
	* 8	Small end withdrawing bolt assembly.	
S.V.6.			
Liners	6	Liner withdrawing gear	39-J-482
	* 8	Straight edge	
S.V.7			
Housing	* 2	Phos. Bronze drift and bar for valve tappet bush	
	* 3	Bush withdrawal bolt assembly	
	4	Special drift for valve tappet bush	8224/2 IW.
	* 7	As 2 but for fuel pump tappet bush	
	* 8	As 3 but for fuel pump tappet bush	
	9	As 4 but for fuel pump tappet bush	8224/1 IW.

Section	*Fig. No.*	*Description*	*Tool No.*
S.V.8			
Crankshaft	* 1	Wedges for removing flywheel key	
	2	Gib key extractor	47-J-738
	4	Flywheel removing bar (fitted on taper)	3950 IW.
	* 6	Bars for clamping on drawbolt head	
	7	Crankshaft gearwheel extractor	9750 IW.
	14	Sleeve for fitting oil seal	8943 IW.
	15	Ram for driving oil seal and crankshaft gearwheel	9996 IW.
	*23	Disc for checking crank throw	
	25	Spanner for hexagon head balance weight setscrew	8588 IW.
	26	As 25 but square head	4603 IW.
S.V.9			
Main bearings	2	Withdrawal and fitting gear for bearing bush, Part No. 66	3949 IW.
	* 5	Removal gear for gib key in spider	
S.V.10			
Governor and Camshaft	5	Camshaft gearwheel extractor	41-J-374
S.V.11			
Injection equipment	3	Reamers for injector body (2)	6764 & 5
	6	Injector testing pump	Order per Instructions
	7	Injector service equipment	Order per instructions
	11	Test bench	Order per instructions
	24	Fuel pump test rig	Supplied to suit individual requirements, or can be made up from the information given.
	25	Test Bracket.	
	26	Injector cleaning kit in canvas holdall	from C.A.V. or Agent.
	27	Set of injector spanners	
	33	Pump delivery valve extractor	
S.V.12			
Starting equipment	7	Armature test apparatus	from C.A.V. or Agent.
	9	Axial starter tools	

*** All tools thus marked can be readily made in your own workshops from the descriptions given, or obtained locally.**

INSTRUCTIONS FOR ORDERING SERVICE TOOLS

Service tools bearing numbers given in column 4, in sub-section (*a*) can be purchased from Ruston and Hornsby Ltd.

When ordering state :—

1. Class of engine to be serviced.
2. Tool number.
3. Number of each tool required.

e.g.:—

Tools are required for replacing the injector tubes in the cylinder heads.

Order as follows:—

Supply for VSH engines **one set**
42-J-252 ref. 2.
42-J-225 ref. 1.
42-J-226
46-J-40

IMPORTANT Reference should always be made to the text to ensure that the tools ordered are suitable for the range of engines to be serviced, for instance VTO tools are not always suitable for VTH engines.

Printed in England

NOTES

NOTES

NOTES

NOTES

NOTES

NOTES

NOTES

NOTES