

Chapter Sixteen

COMBUSTION CHAMBERS, SERVICING AND MAINTENANCE

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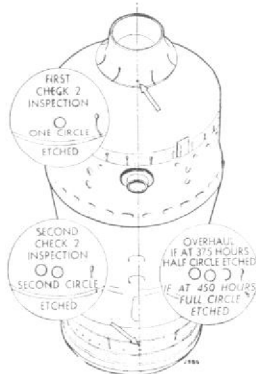
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THIS CHAPTER contains instructions for examining, removing, dismantling, inspecting, reassembling, and refitting the combustion chambers. Except where specifically stated in the text, the information given in this chapter is applicable to both the type 4 and the type 5 combustion chambers, and, therefore, covers both the Ghost 48 Mk. 1 and the Ghost 48 Mk. 2. The type 4 and type 5 combustion chambers must not be mixed on the same engine; type 4 combustion chambers must not be used on the Ghost 48 Mk. 2 but type 5 combustion chambers may be used on both marks. Detailed instructions for carrying out repairs are contained in chapter 30. The general information contained in chapter 5 should be referred to as necessary. Cleaning instructions are given in chapter 25.

RECORDING LIFE OF FLAME TUBES

Where it is required to record the approximate life of individual flame tubes, the following method of marking is recommended. On the completion of one inspection period, etch a circle, about $\frac{3}{16}$ inch in diameter, on the flame tube head snout and on the rear muff in line with one of the interconnector sleeves; as illustrated.



On completion of the second inspection period, etch a second pair of circles on the flame tube.

On flame tubes which have completed an engine life of 375 hours etch a pair of half circles in addition to the two pairs of full circles etched previously. When the overhaul life has been extended to 450 hours etch a full circle instead of a half circle. The principles of this recommendation can be applied whatever the approved overhaul life.

EXAMINATION IN SITU

At the specified periods, the combustion chambers must be examined externally, as thoroughly as possible without removing them from the engine. This examination should cover the whole of each outer casing. Cracks may occur in the inboard surface of the outer casings and, since cracks in this region can be neither seen nor felt on an installed combustion chamber, this examination must be supplemented by feeling around the outer casing of each combustion chamber, for air leaks, whilst the engine is running at approximately cruising r.p.m. Pay particular attention to the welding in the region of the rear joint ring, discolouration by gas streaks extending from the weld indicates partial breakdown of the weld; sooty marks on the centre casing also indicate leaks from the combustion chambers. Similarly, with the engine running at about 3000 r.p.m., check the joints between the diffuser casing rear cover and the expansion chambers, and between the expansion chambers and the outer casings. Leakage at

either of these points should be rectified by fitting new sealing washers.

Joint	Seal	Remarks
Between diffuser casing rear cover and expansion chamber.	Pre-mod. 794, silicone rubber sealing ring, Part No. 48714.	The Coopers mechanical joint type seal must not be fitted to the pre-mod. 794, (grooved) rear cover.
	Mod. 794, Coopers mechanical joint type seal, Part No. 96078.	
Between expansion chamber and outer casing.	Pre-mod. 1134, Klingerit sealing washer, Part No. 91752.	
	Mod. 1134, Coopers mechanical joint type seal Part No. 600331.	

REMOVAL AND DISMANTLING FOR COMPREHENSIVE EXAMINATION

Combustion chambers, burners, etc., are numbered in a clockwise direction when the engine is

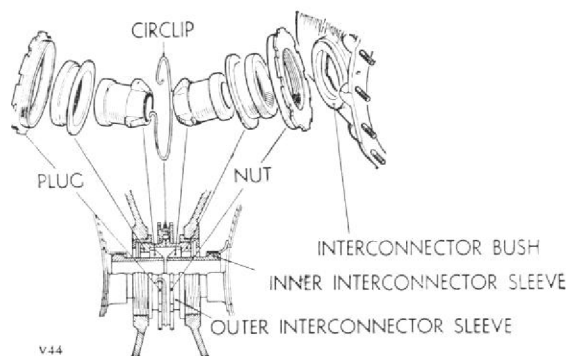


Fig. 3. Combustion chamber interconnector, on early engines only the nut and plug were locked with wire.

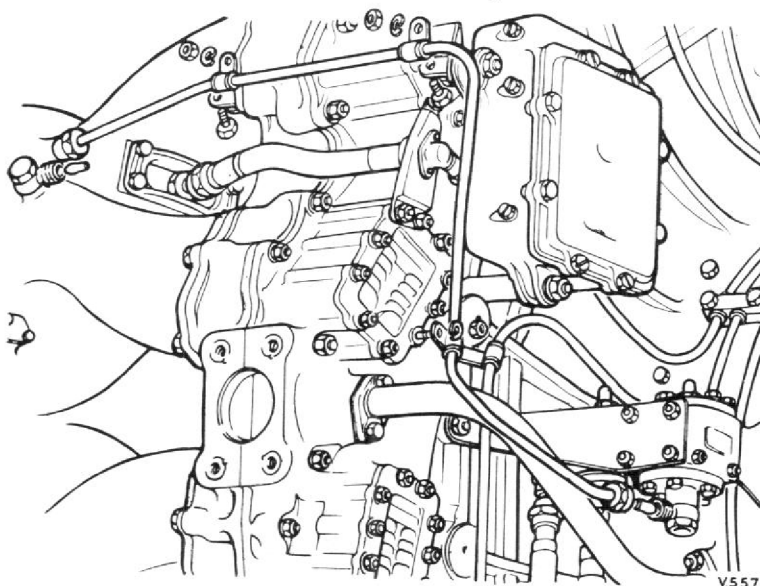


Fig. 1. Ghost 48 Mk. 1. Rigid air pressure pipe between No. 9 combustion chamber and air-fuel ratio control, mod. 1139.

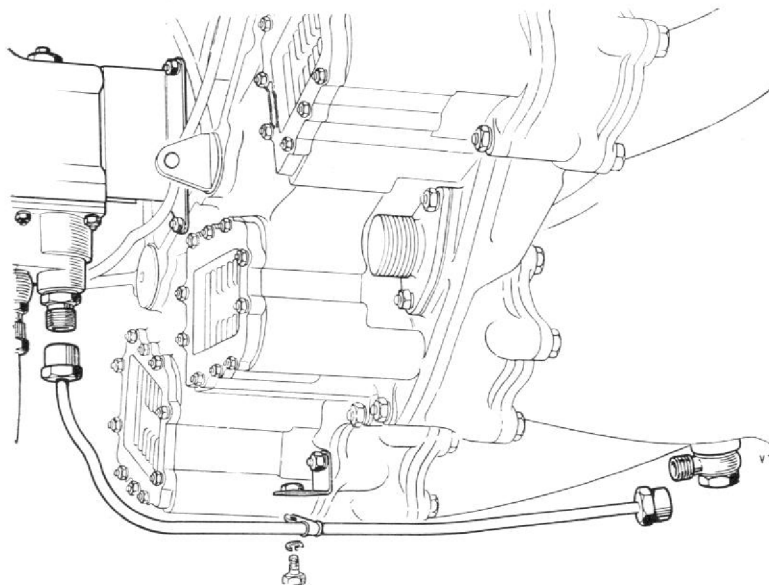


Fig. 2. Ghost 48 Mk. 2. Rigid pipe between No. 5 combustion chamber and air-fuel ratio control unit; air pressure.

viewed from the front. The number of the combustion chamber is cast on the diffuser casing. It is desirable to keep the components from each assembly in sets so that upon reassembly, flame tubes and head assemblies are refitted in their original expansion chambers and outer casings. All ten combustion chambers are not identical, and the differences will be summarized in chapter 1 when the revised, final copy is published.

Assuming all ten combustion chambers are to be removed, proceed as described in the following paragraphs. If the engine has been removed from the aircraft and mounted on a strip and assembly stand, the combustion chambers are most conveniently removed with the engine in a vertical position with its rear end uppermost. It is advisable to remove the combustion chambers in pairs, starting with those on either side of the stand arms. In Venom aircraft, combustion chambers No. 3, 4, 8, and 9 cannot be removed unless the engine has been removed from the airframe.

Commence either by removing the burners as described in chapter 14 or by disconnecting the flexible burner feed pipe from each burner (Ghost 48 Mk. 1) or removing the burner connection (Ghost 48 Mk. 2); in the latter instance each combustion chamber will be removed complete with its burner.

Remove the igniter plugs (Ghost 48 Mk. 1) or the torch igniters (Ghost 48 Mk. 2) from No. 3 and 10 combustion chambers, as described in chapter 15.

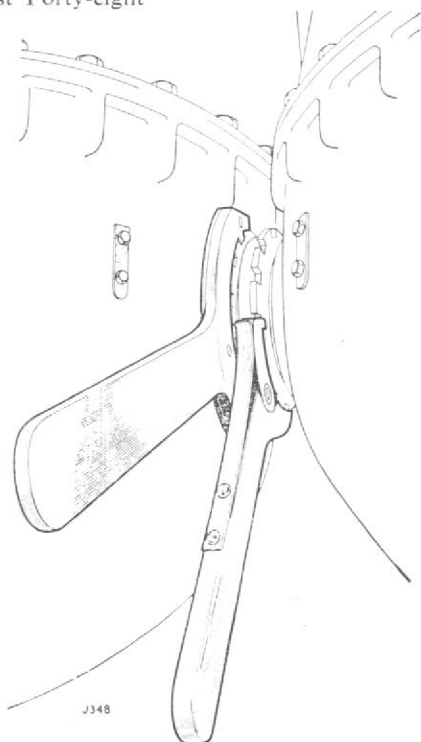


Fig. 4. Using Cee spanner T.72178 and claw spanner T.72170 to unscrew the nut from the interconnector plug.

Ghost 48 Mk. 1 pre-mod. 1139. Cut the locking wire and unscrew the union nut at each end of the rigid pipe which connects the air-fuel ratio control banjo on No. 8 combustion chamber to the rear of No. 16 diffuser bolt. Remove the pipe.

Ghost 48 Mk. 1 mod. 1139. Cut the locking wire and unscrew the union nut at each end of the rigid pipe which connects the air-fuel ratio control to banjo on No. 9 combustion chamber. Release the three clips securing the pipe and remove the pipe.

Ghost 48 Mk. 2. Cut the locking wire and unscrew the union nut at each end of the rigid pipe which connects the air-fuel ratio control to the banjo on No. 5 combustion chamber. Release the clip at the centre of the pipe and remove the pipe.

Remove the ten $\frac{1}{4}$ in. B.S.F. plain nuts, spring washers and plain washers which secure the combustion chamber fuel drain assembly to No. 4, 5, 6, 7, and 8 combustion chambers. Carefully draw the drain assembly off the studs in the combustion chamber expansion chambers; there is a Klingerit washer on each drain boss.

Remove the ten interconnector nut circlips and, using spanners T.72178 and T.72170, unscrew the slotted nut from the slotted interconnector

plug, which is between each adjacent combustion chamber. In some instances, it may be found more convenient to use the second claw spanner T.72170 instead of Cee spanner T.72178.

From this stage removal of each combustion chamber is identical and, therefore, the removal of one only is described.

Using swivel spanner T.74280 slacken off the $\frac{1}{4}$ in. B.S.F. plain nuts which secure the two entry flanges of the expansion chamber to the diffuser casing rear cover. Using swivel spanner T.74279 as necessary, remove the five $\frac{5}{16}$ in. B.S.F. bolts, spring and plain washers which also secure each expansion chamber entry flange to the diffuser casing rear cover.

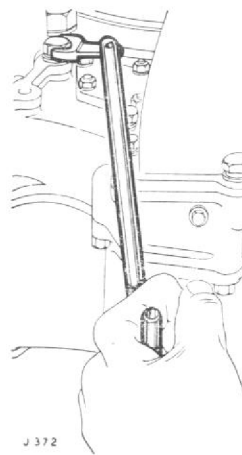


Fig. 5. Using swivel spanner T.74279 to unscrew one of the combustion chamber bolts.

Ease the combustion chamber away from the face on the diffuser casing rear cover; its rear end will slide into the nozzle ring. Gently draw the expansion chamber outwards until its entry flanges are just clear of the diffuser casing and withdraw the rear end of the combustion chamber from the nozzle ring. Blank off the apertures in the diffuser casing rear cover by fitting blanking plates T.72764.

On early engines only, where mod. 115 has not

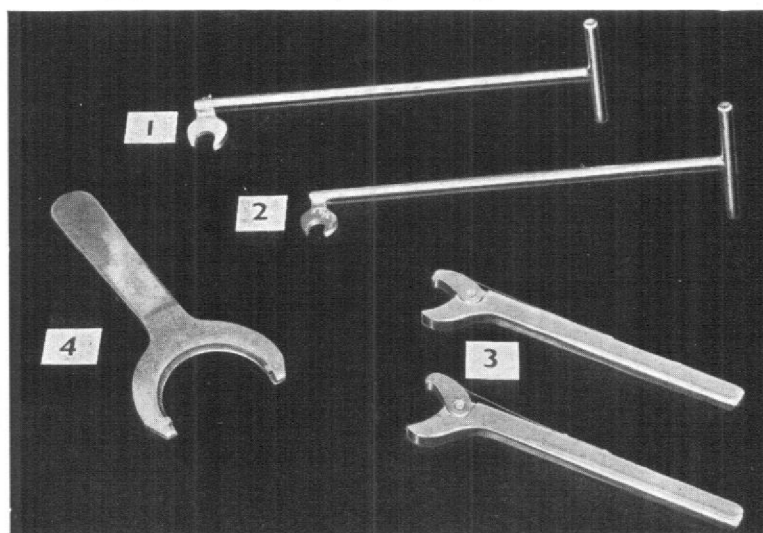


Fig. 6. Combustion chamber spanners.

1. $\frac{1}{4}$ in. Whitworth swivel spanner, T.74279, for combustion chamber set-bolts.
2. $\frac{3}{16}$ in. Whitworth swivel spanner, T.74280, for combustion chamber nuts.
3. A pair of claw spanners, T.72170, for combustion chamber interconnectors, and oil tank fillers.
4. Cee spanner, T.72178, for combustion chamber interconnectors.

Fig. 7. Type 4 combustion chamber components when mod. 293 has been embodied; Ghost 48 Mk. 1 only.

1. Expansion chamber.
2. Locating plug joint washer.
3. Locating plug.
4. Igniter plug mounting adapter.
5. Joint washer used with igniter plug mounting adapter.
6. Klingerit sealing washer.
7. Flame tube and head assembly.
8. Outer casing.
9. Outer casing front flange; four segments.
10. Pair of sealing rings.

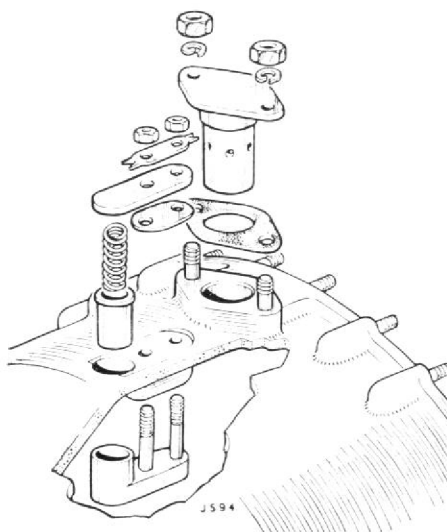
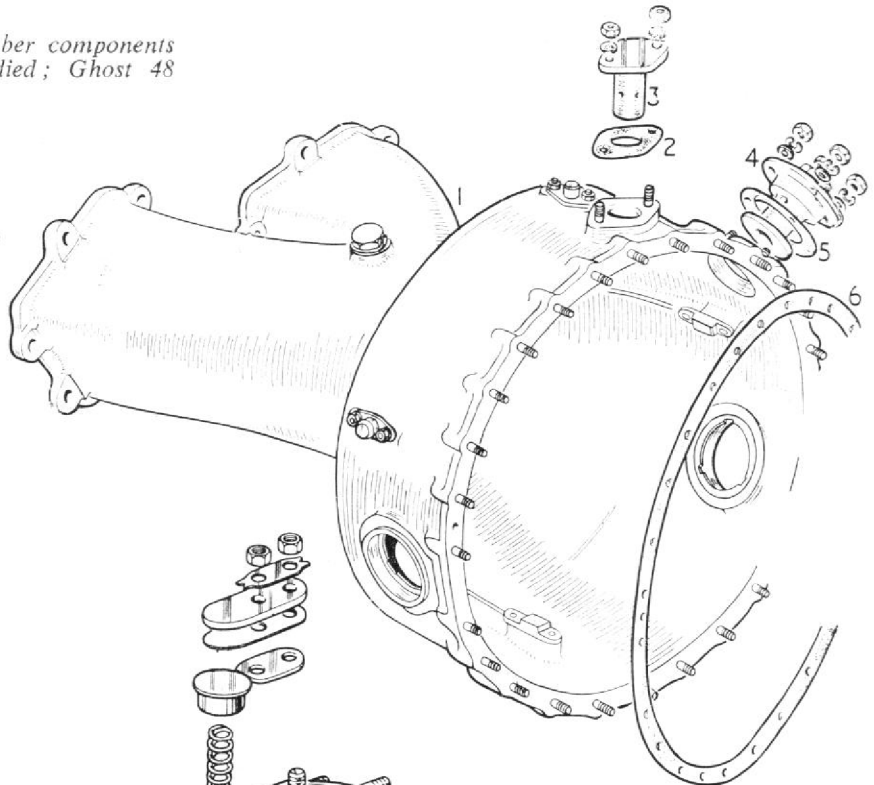


Fig. 8. Locating plug, and offset spring-loaded plunger assembly, Ghost 48 Mk. 1 only pre-mod. 293 for type 4 flame tubes.

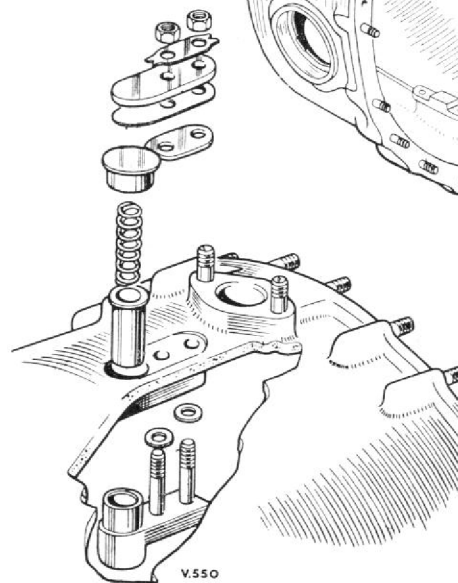


Fig. 10. Off-set spring-loaded plunger assembly, mod. 743, for type 5 flame tubes in pre-mod. 293 type expansion chambers showing bush and sealing washer introduced by mod. 1113 to reduce leakage.

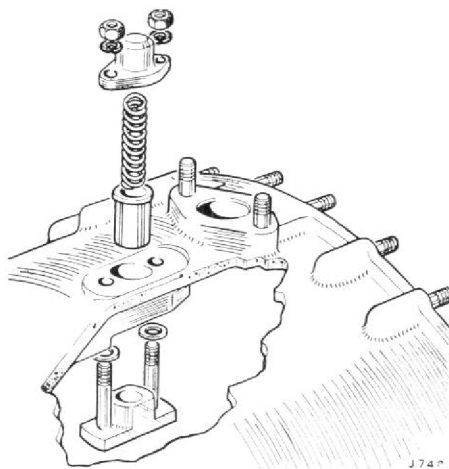


Fig. 9. Central spring-loaded plunger. Ghost 48 Mk. 1 only, when mod. 293 has been embodied for type 4 flame tubes.

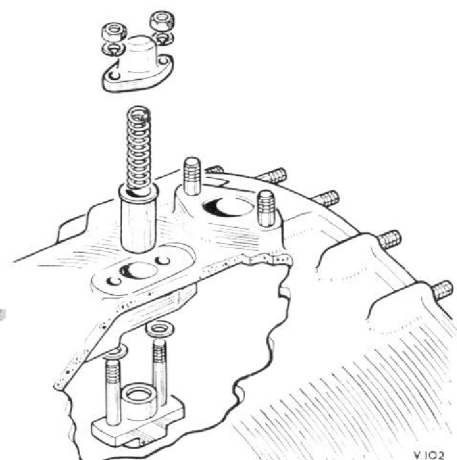
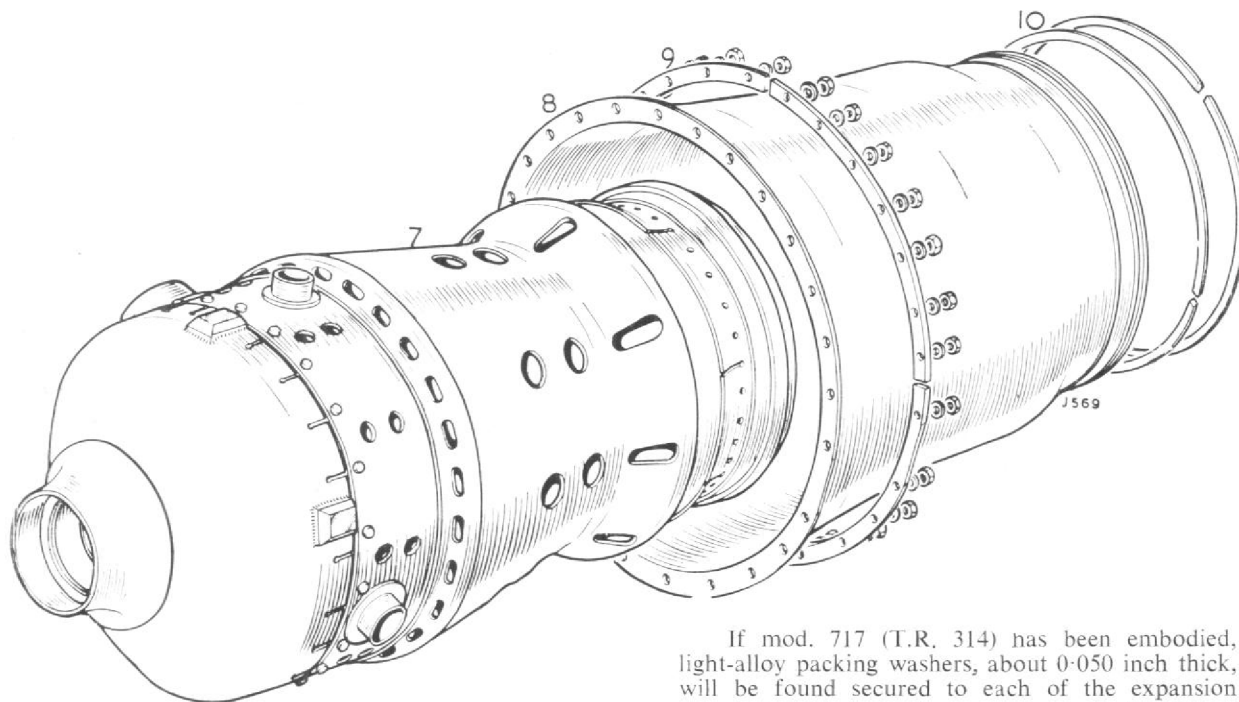


Fig. 11. Central spring-loaded plunger assembly, mod. 712, for type 5 flame tubes in mod. 293 type expansion chambers.



been embodied, there will be shims between the diffuser casing rear cover and the expansion chamber. These shims ensure correct positioning of the pre-mod. 115 outer casing in the discharge nozzle and must, therefore, be retained and secured to the relevant expansion chamber for refitment at reassembly.

If mod. 717 (T.R. 314) has been embodied, light-alloy packing washers, about 0.050 inch thick, will be found secured to each of the expansion chamber inlet faces by two countersunk screws; these packing washers should be ignored and regarded as an integral part of the expansion chamber.

As each combustion chamber is dismantled, its principal components should be kept in a set to avoid the interchange of components between the individual combustion chambers.

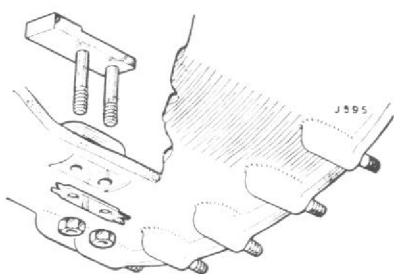


Fig. 12. Off-set locating plate for type 4 flame tubes, Ghost 48 Mk. 1 only pre-mod. 293.

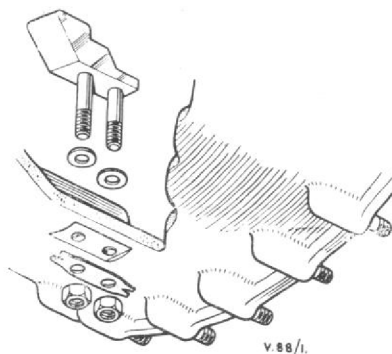


Fig. 14. Off-set locating block, mod. 743 for type 5 flame tubes in pre-mod. 293 type expansion chambers.

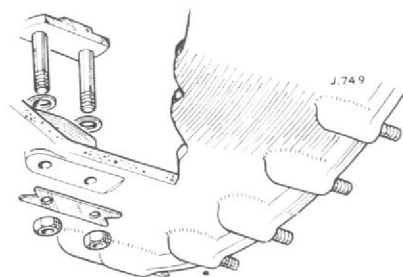


Fig. 13. Central support pad, Ghost 48 Mk. 1 only, when mod. 293 has been embodied for type 4 flame tubes.

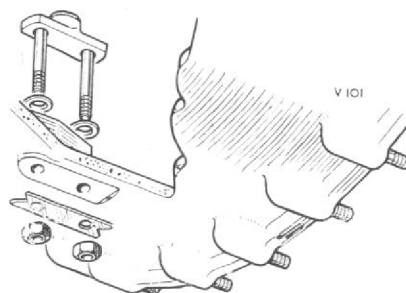


Fig. 15. Central support pad, mod. 712, for type 5 flame tubes in mod. 293 type expansion chambers.

Ghost 48 Mk. 1 only.
Two of the combustion chambers are fitted with an igniter plug mounting adapter, and this adapter should be removed thus. Remove the four 2 B.A. plain nuts, spring and plain washers, and withdraw the igniter mounting adapter from the expansion chamber: there is a Klingerit joint washer under the adapter flange.

If the burner is still in position in the combustion chamber, it should be removed as described in chapter 14.

Carefully ease one of the outer interconnector sleeves, complete with the

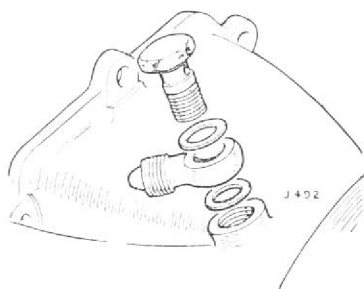


Fig. 16. Air-fuel ratio control banjo on No. 9, mod. 1139, (Ghost 48 Mk. 1) or No. 5 (Ghost 48 Mk. 2) combustion chamber.

nut or the plug, out of the bush in the expansion chamber, simultaneously withdrawing the inner interconnector sleeve from the sleeve which is welded to the flame tube; the detail parts of the interconnector assemblies can then be separated for examination. Repeat these operations to remove the second interconnector.

Remove the twenty-six 2 B.A. plain nuts and 'Cross' type spring washers which secure the outer casing to the expansion chamber. Take off the four segments of the outer casing front flange, and carefully draw the outer casing off the studs in the expansion chamber and off the flame tube. Remove the Klingerit sealing washer from the rear face of the expansion chamber. The pair of sealing rings situated at the rear of the outer casing may be handled in the same way as the piston rings of a reciprocating engine. Unscrew the two $\frac{1}{4}$ in. B.S.F. plain nuts which secure the locating plug in the expansion chamber, remove the spring washers and withdraw the locating plug and Klingerit joint washer. Ease the flame tube and head assembly out of the expansion chamber.

If it is required to renew any of the expansion chamber details, these components may be removed as follows.

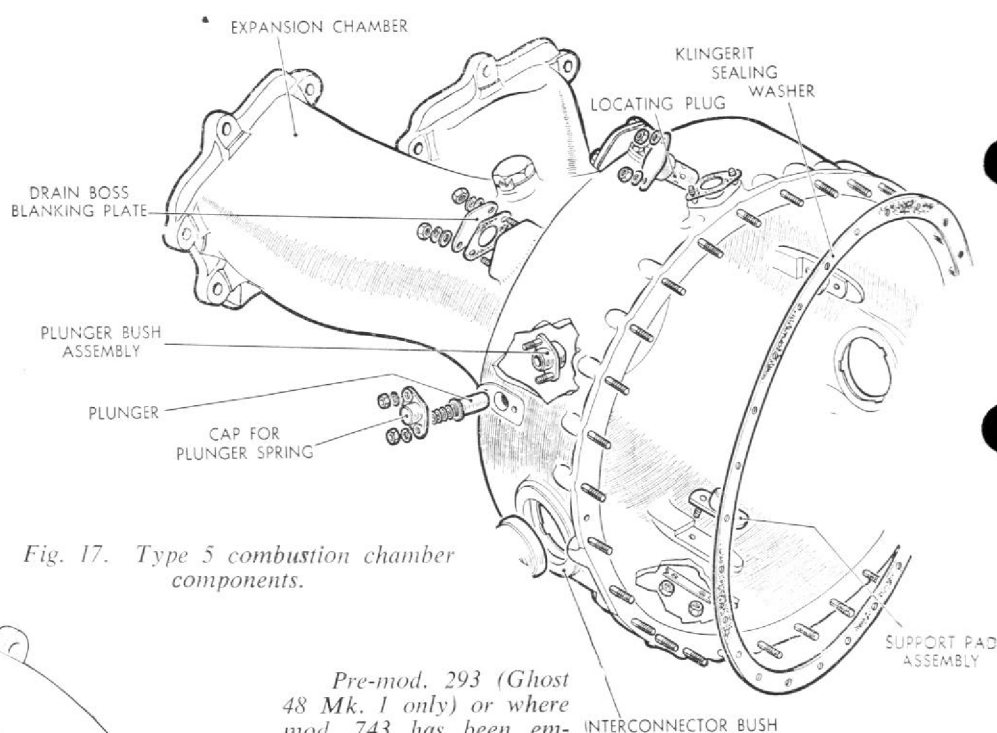
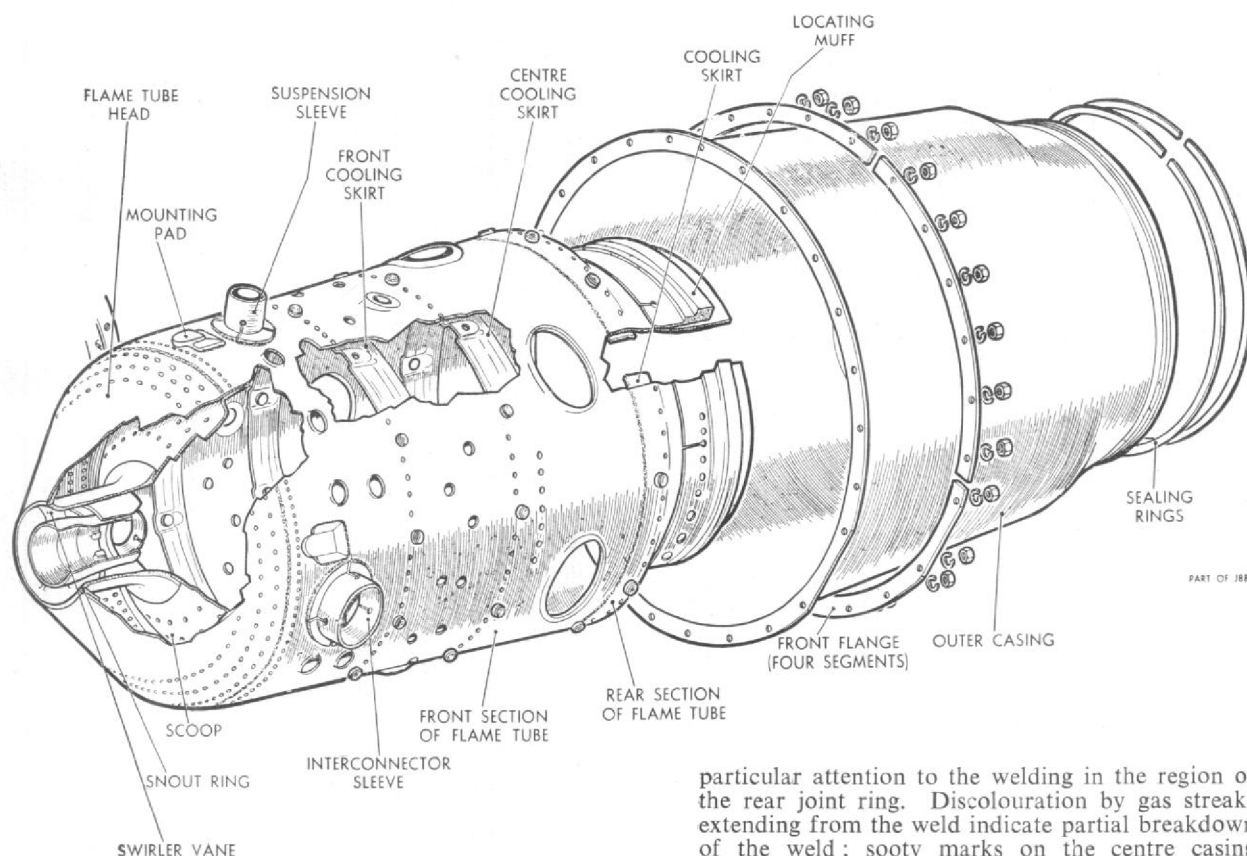


Fig. 17. Type 5 combustion chamber components.

Pre-mod. 293 (Ghost 48 Mk. 1 only) or where mod. 743 has been embodied. Release the locking tabs and unscrew the two 2 B.A. plain nuts which secure one of the two locating plates, or blocks. The locating plate, or block, complete with studs can then be removed from the inside of the expansion chamber; repeat these operations to remove the second locating plate, or block. Release the locking tabs and unscrew the two 2 B.A. plain nuts which secure one of the two spring plunger assemblies. Remove the tab washer, supporting plate, and shim from the outer ends of the studs. The spring and plunger can then be withdrawn; the support block can then be removed from the inside of the expansion chamber. The second spring plunger assembly can be removed in a similar manner. *Where mod. 1113 has been embodied,* remove also the flanged bushes and the sealing washers. It is unlikely to be necessary to remove any of the remaining detail parts but in any case the procedure will be obvious upon inspection of the parts concerned. The two interconnector bushes, and the four burner holder face ferrules and dowels are not supplied as spares separately and must not, therefore, be disturbed.

Where mod. 293 (Ghost 48 Mk. 1 only), or 712, has been embodied, the two locating plates are replaced by two support pads. The method of removing these pads is similar to that described for the plates except that there are plain washers on each of the studs between the inner surface of the expansion chamber and each support pad; as the design of the expansion chamber has been changed to accommodate these support pads, unmodified and modified parts are not interchangeable. Similarly, the two spring-loaded plunger assemblies are different also, and should be dismantled thus. Unscrew the two 2 B.A. plain nuts which secure either of the two spring-loaded locating plunger assemblies. Lift off the spring



washers and the spring cap. The spring and plunger can then be withdrawn, and the plunger bush removed from the inside of the expansion chamber; there are plain washers on the studs between the inner surface of the expansion chamber and the plunger bush. The second plunger assembly can be removed in a similar manner. Un-modified and modified parts are not interchangeable.

CLEANING

Combustion chamber components should be cleaned in accordance with the instructions contained in chapter 25.

EXAMINATION

Klingerit, and Coopers mechanical, sealing and joint washers, and tab washers, will normally be replaced by new parts at each reassembly of the combustion chamber. Outer casing sealing rings, and expansion chamber locating springs, and other small detail parts if in any way unserviceable should be changed for new parts.

The combustion chamber components should be thoroughly examined internally and externally for any signs of distortion, cracking, or opening of welded seams. Pay particular attention to the periphery of all air holes, sleeves, stubs, and bosses. Check the flanges of the expansion chamber and the flange at the front end of the outer casing for distortion; using a surface plate and marking blue if this equipment is available.

Carefully examine the outer casing, paying

particular attention to the welding in the region of the rear joint ring. Discolouration by gas streaks extending from the weld indicate partial breakdown of the weld; sooty marks on the centre casing indicate leaks from the combustion chambers also. Slight bulging of the outer casing from the rear ring, coupled with gas streaks, suggests imminent failure of the weld. Check also by trying to insert a 0.0015 inch feeler between the outer casing and the joint ring. Any outer casing which is defective in these respects must be repaired before being refitted to an engine.

In the following paragraphs an attempt has been made to indicate the extent of 'wear' which may be found after a period of running and to give some guidance in classifying 'serviceability' upon routine examination by defining the extent of damage, distortion, cracking and general 'wear' which may be endured by a flame tube without the risk of impairing its performance or reliability for a further period of service in an engine. It is, of course, only possible to indicate quite broadly the points to be inspected and the defects likely to be encountered. Each instance must be considered in the light of the particular circumstances, hours run, etc., and the final decision as to the serviceability of each component must rest on the individual's experience and knowledge of gas turbine engines of this type. Where a background of this experience is missing, frequent reference should be made to an experienced specialist.

It will be appreciated that flame tubes, if they are to be refitted after inspection, must be serviceable until the next period specified in the Maintenance Schedule and if it is desired to deviate from the following inspection standard, approval must be obtained from the engine manufacturer.

The points referred to in the paragraphs which

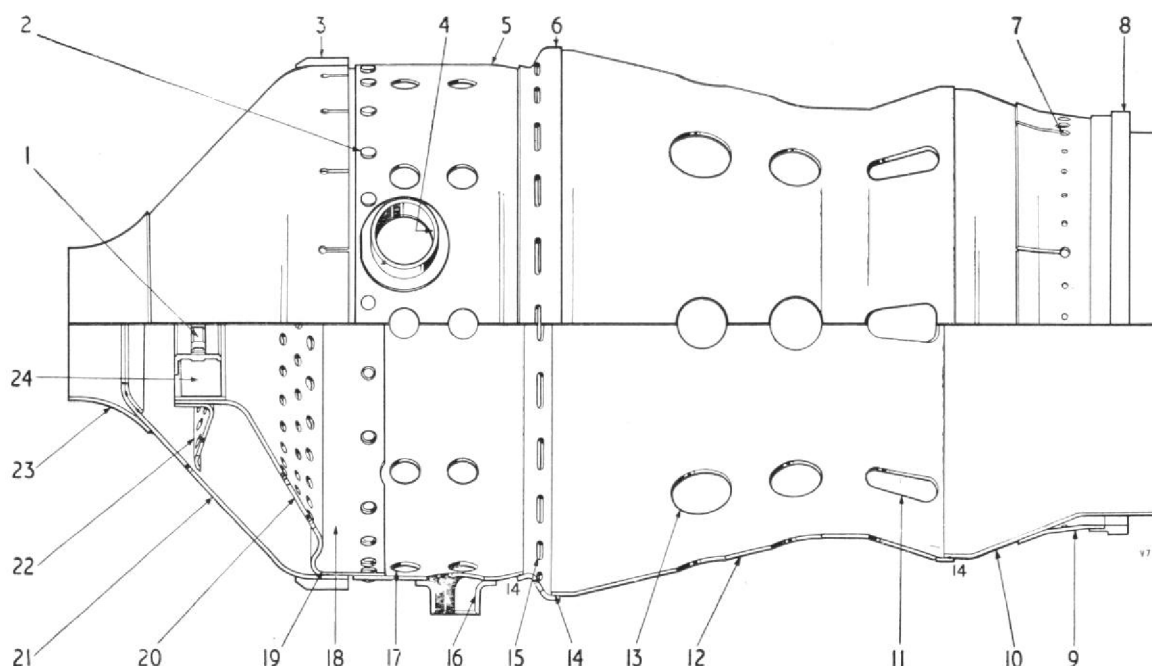


Fig. 18. Diagram of type 4 flame tube (Ghost 48 Mk. 1 only) to enable the location of possible defects to be identified.

- | | | |
|---------------------------------------|----------------------------------|----------------------------|
| 1. Burner locating lands | 10. Rear section | 18. Flame tube head |
| 2. Rivets securing head to flame tube | 11. Sector-shaped windows | 19. Circumference of flare |
| 3. Mounting pads | 12. Centre section | 20. Flare |
| 4. Interconnector sleeve | 13. Secondary air holes | 21. Scoop |
| 5. Primary section | 14. Circumferential welds | 22. Grid |
| 6. Shoulder piece | 15. Oval holes in shoulder piece | 23. Snout |
| 7. Keyhole slots in extension piece | 16. Suspension sleeve | 24. Swirler |
| 8. Locating ring | 17. $\frac{5}{8}$ inch air holes | |
| 9. Extension piece | | |

follow can be identified by reference to Fig. 18, 19, and 20 as applicable, and the numbers given in parenthesis refer to Fig. 18 and 20.

Points applicable to both type 4 and type 5 flame tubes

Wear may occur on the burner locating lands (1) in the inner sleeve of the swirler. Such wear is acceptable for further service.

Wear may occur on the mounting pads (3). Such wear is acceptable for further service.

Internal wear may be found in the interconnector sleeves (4), suspension sleeve (16) and, where applicable, igniter plug sleeve. Such wear is acceptable provided that it does not exceed half the original thickness of the metal. Wear in excess of this limit may be rectified by fitting new sleeves in accordance with the instructions given in chapter 30.

Cracks may be found around the keyhole slots (7) in the extension piece which carries the locating ring at the rear of the flame tube. No cracks can be accepted in this region without minor rectification, which consists of drilling a $\frac{1}{8}$ inch diameter hole at the end of each crack.

No cracking of the locating ring (8) at the rear

end of the flame tube can be accepted, repair to such damage is not practicable. Normal wear on the outer diameter of this locating ring is acceptable.

Cracks in the flame tube skin adjacent to the interconnector sleeves, suspension sleeve and, where applicable, igniter plug sleeve cannot be accepted

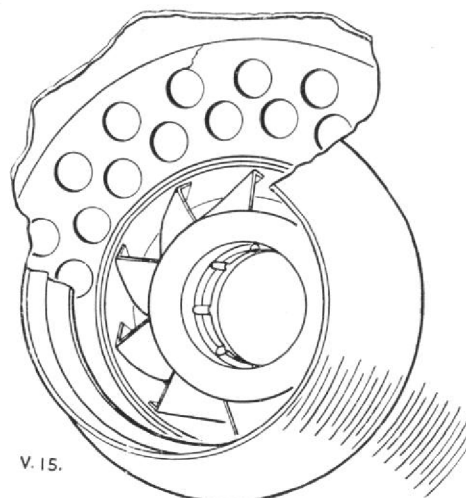


Fig. 19. Grid in type 4 flame tube head, Ghost 48 Mk. 1 only.

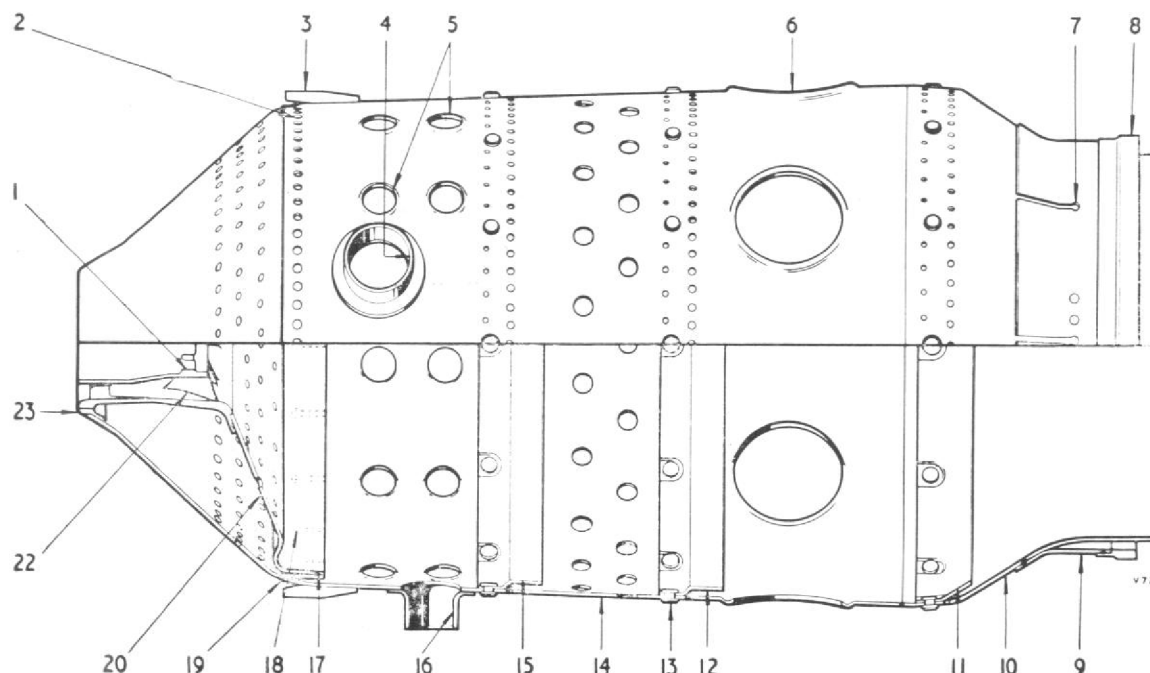


Fig. 20. Diagram of type 5 flame tube to enable the location of possible defects to be identified.

- | | | |
|--|--|---|
| 1. Burner locating lands | 7. Keyhole slots in extension piece | 15. Front cooling skirt |
| 2. Skin cooling holes | 8. Locating ring | 16. Suspension sleeve |
| 3. Mounting pads | 9. Extension piece | 17. Weld between flare and scoop |
| 4. Interconnector sleeve | 10. Rear section | 18. Keyhole slots in scoop |
| 5. Large air dilution holes in forward portion of flame tube front section | 11. Rear cooling skirt | 19. Weld between scoop and flame tube front section |
| 6. Large dilution ports in rear portion of flame tube front section | 12. Centre cooling skirt | 20. Flare |
| | 13. Rivet—twelve secure each cooling skirt | 21. Scoop |
| | 14. Front section | 22. Swirler |
| | | 23. Snout ring |

for further service without rectification. Within limits, these cracks may be repaired by argon-arc welding and, the maximum permissible lengths and numbers of cracks which may be repaired, and the method of repair, are given in chapter 30.

The locating plugs tend to wear on the shank and may be burnt at the end. New locating plugs should be fitted if there is the slightest doubt about their serviceability.

Wear on the fixed support blocks may be accepted up to a depth of 0.010 inch. Support blocks worn beyond this limit may be rectified in accordance with the instructions contained in chapter 30.

The inner and outer interconnector sleeves, nuts, plugs, and other detail parts will, normally, be serviceable.

Points applicable to type 4 flame tubes only (Fig. 18)

The flanges through which the flame tube and head are riveted together may distort between the rivets (2). Such distortion can be rectified by

normal sheet metal working without difficulty but is generally accompanied by the pulling away of a number of the rivets which will require rectification by hot riveting in a similar manner to that described in chapter 30.

Cracks may occur in the flare (20). Small cracks, up to a length of $\frac{1}{8}$ inch, may be accepted for further service but cracks which connect one hole to another are not acceptable.

Cracks may be discovered in the circumference of the flare (19) immediately behind the locating pads which are welded to the outside of the flame tube head. To examine this region, direct a light on to the interior of the flame tube head and examine each locality in turn by looking through the diametrically opposite air holes in the primary section. Two cracks not exceeding $\frac{1}{8}$ inches long, or one crack not exceeding $2\frac{1}{2}$ inches long, may be accepted for further service.

Cracks which occur from the outer row of holes in the grid (22, and Fig. 19), are acceptable provided that: not more than two holes are affected; the affected holes are not adjacent; there is one crack only from each affected hole; the cracks run from the periphery of the holes towards

the edge of the grid. This part of the flame tube head is inaccessible for repair.

Short cracks up to $\frac{5}{16}$ inch long, running from the $\frac{5}{8}$ inch diameter air holes (17) in the front cylindrical section may be accepted for further service without rectification.

Cracking around the oval holes (15) in the shoulder piece cannot be accepted for further service without rectification.

Distortion of the main conical centre section (12) of the flame tube, unaccompanied by cracking, may be removed by normal sheet metal working without difficulty.

Cracks from the sector-shaped windows (11) cannot be accepted for further service without rectification.

Cracks in the circumferential welds (14) cannot be accepted for further service without rectification.

Points applicable to type 5 flame tubes only (Fig. 20).

Cracks may occur between the skin cooling holes (2) which are adjacent to the mounting pads. Small cracks in this vicinity are acceptable.

Cracks up to a maximum length of $\frac{1}{8}$ inch from the large air dilution holes (5) in Fig. 20, in the forward part of the flame tube, can be accepted for further service without rectification. Distortion of the sheet-metal without cracking in the vicinity of these dilution holes may also be accepted.

No cracks can be accepted from the large dilution ports (6) in the rear portion of the flame tube front section. Any cracking discovered in this region may be repaired by argon-arc welding.

Carefully examine each of the three cooling skirts (11, 12 and 15) paying particular attention to the corners of the bends where these skirts are joggled to form the recesses around the rivets which secure them to the flame tube. Cracking of these skirts cannot be accepted without rectification which is a job for a fully-equipped repair depot. At the same time check each of the twelve rivets (13) which secure each cooling skirt; loose rivets may be replaced by hot riveting as described in chapter 30, T.R.346.

The skirt of the flare which is inside the combustion chamber immediately behind the junction between the flame tube head and the front section of the flame tube should be examined both visually and by feel. When examining this part of the flame tube assembly, the following point should be looked for.

- (1) Bulging of the flare skirt forward of the attachment weld (17) between the flare and the scoop. This can be identified either by the slight shadow cast by any bulge or by feel. Very slight bulging up to say 0.050 inch is acceptable for further running provided that no cracks are discovered.

- (2) Circumferential cracking around the weld (17) referred to in sub-para. 1. No defects of this nature are acceptable.

- (3) Cracking of the flare skirt, particularly near the keyhole slots (18) in the scoop, running into the flare. No defects of this nature are acceptable.

- (4) Small cracks in the flare (20) up to a length of $\frac{1}{8}$ inch may be accepted for further running but cracks running from one hole to the next are not acceptable. The limits, and method, of repair are described in chapter 30.

It is not considered practicable to repair any of the defects detailed in the foregoing sub-paragraphs except at a fully-equipped repair depot.

Circumferential cracks may occur around the weld (19) which secures the scoop to the front section of the flame tube, and particular attention should be paid to the areas in the vicinity of the four mounting pads. No damage of this nature is acceptable for further service without rectification. Cracking in this region may be repaired by argon-arc welding.

Cracks may occur in the flame tube skin adjacent to the mounting pads. Such cracking is unlikely, but where found, cannot be accepted for further service. These cracks may, however, be repaired by argon-arc welding.

REASSEMBLY AND REFITTING

Commence by reassembling the expansion chamber using new detail parts wherever necessary. Ensure that the four ferrules and dowels are secure in the burner holder face and that the two interconnector bushes and the various studs are correctly fitted and secure; any interconnector bush which shows signs of looseness or is unscrewed must be retightened securely using inserter tool T.76396; where mod. 772 has been embodied, the interconnector bushes are locked by dowels.

When assembling the fixed locating plates, pads, or blocks, and the spring-loaded plunger assemblies, reference should be made to Fig. 21 to ensure that the correct parts are fitted, having regard to the type of flame tube to be fitted and the modification standard of the expansion chamber.

Pre-mod. 293 (Type 4, Ghost 48 Mk. 1 only).
Refit the two locating plates inside the expansion chamber. Place a new tab-washer (Part No. N.3712) over each pair of studs and screw on the four 2 B.A. plain nuts; lock these nuts. Refit the two support blocks inside the expansion chamber and insert the plungers and springs from the outside. Place a shim, supporting plate, and new tab-washer (Part No. N.3712) over each pair of studs and screw on the four 2 B.A. plain nuts; lock these nuts.

When mod. 743 and 987 have been embodied.
Place a washer (Part No. N.1180) over each of the locating pad studs and refit the two pads inside the expansion chamber. Place a new tab-washer

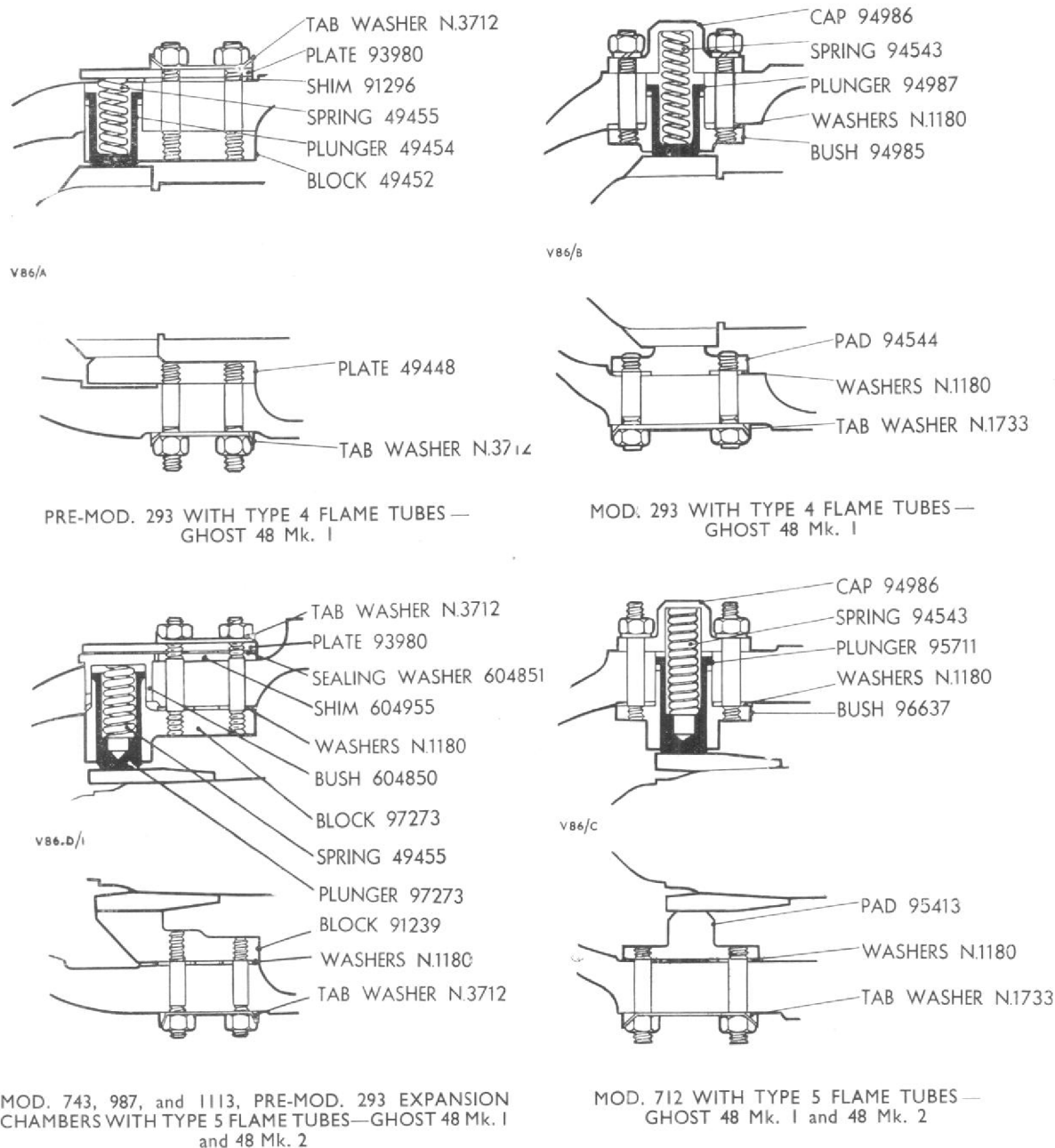


Fig. 21. Expansion chamber assembly details.

(Part No. N.3712) over each pair of studs and screw on the four 2 B.A. plain nuts; lock these nuts. Place a washer (Part No. N.1180) over the studs on each of the two guide blocks and re-fit the blocks inside the expansion chamber and insert the plungers and springs from the outside. Place a shim, supporting plate and new tab-washer (Part No. N.3712) over each pair of studs and screw on the four 2 B.A. plain nuts; lock these nuts.

When mod. 743, 987 and 1113 have been embodied. Place a washer (Part No. N.1180) over each of the locating pad studs and re-fit the two pads inside the expansion chamber. Place a new tab-washer (Part No. 3712) over each pair of studs

and screw on the four 2 B.A. plain nuts; lock these nuts. Place a washer (Part No. N.1180) over the studs on each side of the guide blocks and re-fit the blocks inside the expansion chamber. Place the plungers in the blocks and insert the springs in the plungers. Place the flanged bushes over the springs, plungers and blocks, and shims (Part No. 604955) over the two pairs of studs. Fit the sealing washers over the studs followed by the plates and tab-washers (Part No. N.3712). Screw on and tighten the four 2 B.A. plain nuts; lock these nuts.

When mod. 293 or mod. 712 has been embodied. First, place one of the special plain washers on each of the studs in the two support pads. Refit

the two support pads inside the expansion chamber, place a new tab washer (Part No. N.1733) over each pair of studs, and screw on and lock the four 2 B.A. plain nuts. Place one of the special plain washers on each of the studs in the two plunger bushes. Refit the two plunger bushes inside the expansion chamber, and insert the plungers and springs from the outside. Place a spring cap and two spring washers over each pair of studs, and screw on and tighten the four 2 B.A. plain nuts.

Continue reassembling either type of expansion chamber as follows. Using new joint washers (Part No. N.1085), refit the banjo and banjo bolt to the boss in the appropriate expansion chamber—refer to Fig. 22 and 23. Using new tab washers (Part No. N.2925) screw the plug into the boss in the other nine expansion chambers; lock the banjo bolt or plug. Using new Klingerit

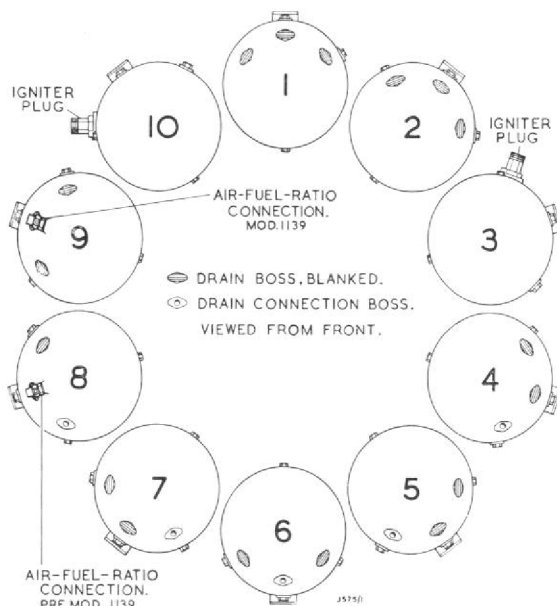


Fig. 22. Diagram of Ghost 48 Mk. 1 combustion chambers showing location of drain bosses, blanks, igniter plug mountings, and air-fuel ratio control connection.

washers (Part No. 25287) refit the drain boss blanking plates as follows:—three each on expansion chambers No. 1, 2, and 9; two each on expansion chambers No. 4, 5, 6, 7, and 8; leave the remaining bosses un-blanked for connection to the drain—refer to Fig. 22 and 23 as appropriate. Secure each blanking plate by refitting the plain washers, spring washers and $\frac{1}{4}$ in. B.S.F. plain nuts.

Position a new Klingerit sealing washer (Part No. 91752) on the rear face of the expansion chamber. Push the flame tube and head assembly into its individual expansion chamber carefully aligning the interconnector and locating plug sleeves on the flame tube with the appropriate openings in the expansion chamber. Place a new Klingerit joint washer (Part No. 25279) over the locating plug studs and insert the locating plug, ensuring that it enters the suspension sleeve on the flame tube correctly.

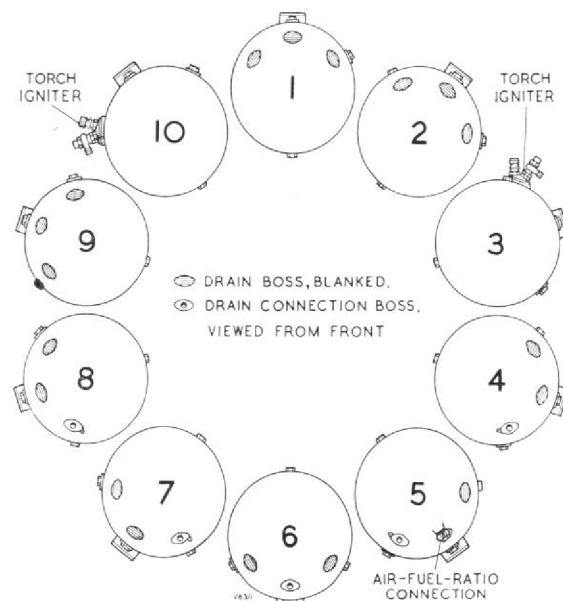


Fig. 23. Diagram of Ghost 48 Mk. 2 combustion chambers showing location of drain bosses, blanks, torch igniters and air-fuel ratio control connection.

Secure the locating plug by refitting the two spring washers and $\frac{1}{4}$ in. B.S.F. plain nuts.

Ghost 48 Mk. 1 only. The igniter mounting adapters for type 4 and 5 combustion chambers are not identical and, since they are physically interchangeable, care must be taken to ensure that the correct mounting adapter is fitted. Different igniter mounting adapters are required for pre-mod. 966 Lodge type L.H.101/1 and mod. 966 K.L.G. type K.H. 102 or mod. 1157 Lodge type L.H.102 igniter plugs. Pre-mod. 966 igniter mounting adapters can be modified in accordance with Part 3 of mod. 966. Adapters which have been salvaged in this way can be identified by 15 mm. etched on the upper face of the flange. The table at the end of this paragraph identifies the Part No. of the adapter relative to the igniters and combustion chamber type. The type 4 adapter projects 1.440 inch and type 5 projects 1.710 inch below the flange mounting face; see Fig. 24. When reassembling combustion chamber No. 3 or 10 place a new Klingerit joint washer (Part No. 26010) on the igniter mounting face and insert the adapter ensuring that its inner end enters the sleeve on the flame tube correctly; secure the adapter by refitting the four plain and spring washers and the 2 B.A. plain nuts.

Igniter plug	Part No. type 4 combustion chambers	Part No. type 5 combustion chambers
Lodge type L.H. 101/1	91727	96382
K.L.G. type L.K. 102 or Lodge type L.H. 102	600966	600965

Assemble the outer casing to the expansion chamber and refit the four outer casing front flange segments. Secure the outer casing by refitting the twenty-six spring washers and 2 B.A. plain nuts. The two sealing rings should not be fitted in the groove at the rear end of the outer casing until immediately before the combustion chamber is re-assembled to the engine, because they spring out of position unless held in place.

If desired, the burner can now be reassembled to the combustion chamber, checking its protrusion as described in chapter 14. If it is impossible to obtain the required burner protrusion, the swirler may have moved from its original position in the flame tube head—this may be checked and rectified as described in chapter 30.

Place the nut or plug as appropriate over the outer interconnector sleeve, insert the inner interconnector sleeve into the outer sleeve, and carefully insert the sleeves into the sleeve on the flame tube and the bush in the expansion chamber. Repeat to reassemble the second interconnector.

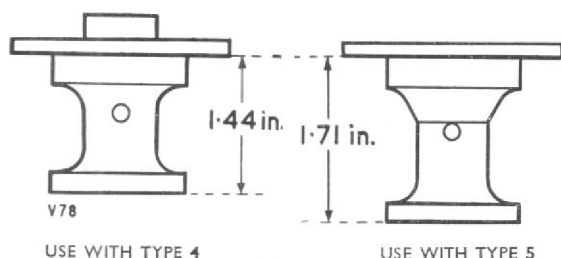


Fig. 24. Igniter plug mounting adapters, Ghost 48 Mk. 1.

To reassemble the combustion chamber to the engine proceed as follows.

Pre-mod. 794, remove each blank in turn from the diffuser casing rear cover and examine the condition of the sealing ring groove in the diffuser casing rear cover; remove the old sealing ring and any dirt from both groove and face. A new silicone rubber sealing ring (Part No. 48714) should be used. Having ensured that the face on the diffuser casing rear cover and the blanking plate are perfectly clean, smear the face on the rear cover with grease, grease the new sealing ring, and position it in the groove in the rear cover face. Temporarily refit the blanking plate, securing it and the sealing ring by means of the plain and spring washers and the $\frac{1}{4}$ in. B.S.F. plain nut on the stud in the rear cover.

Where mod. 794 has been embodied, the silicone rubber sealing rings are replaced by Coopers mechanical joint type seals and there are no sealing ring grooves in the diffuser casing rear cover. No attempt must be made to use the Coopers mechanical joint type seals in conjunction with the earlier, grooved, rear cover. Having removed the blanking plates and ensured that the face on the diffuser casing rear cover is perfectly clean, position new Coopers mechanical joint type seals (Part No. 96078) on the rear cover.

Ensure that the two entry flanges on the expansion chamber are perfectly clean and free

from damage which might prevent an air-tight joint being made. Ensure that the interconnector details are correctly positioned in the combustion chamber. Ensure that the bore in the nozzle ring is perfectly clean. Refit the two sealing rings in the groove at the rear end of the outer casing, and smear them with graphite and oil. On early engines, where mod. 115 has not been embodied, ensure that the original shims are refitted between the diffuser casing rear cover and the expansion chamber; if necessary check the positioning of the outer casing in the discharge nozzle and adjust the shimming as necessary.

Position the gaps in the two sealing rings on the outer portion of the combustion chamber but do not have the two gaps in line. Carefully insert the rear end of the combustion chamber into the correct bore in the nozzle ring, and gently compressing the sealing rings, slide the end of the combustion chamber into the nozzle ring and its front end into position on the diffuser casing.

Pre-mod. 794, as soon as the two blanking plates on the diffuser casing rear cover are held by the combustion chamber, unscrew the $\frac{1}{4}$ in. B.S.F. nuts on the two studs until the slotted hole in each expansion chamber entry flange can be slipped between the plain washer and the blanking plate.

During these operations attention must be paid to the sealing rings at the rear of the combustion chamber as they can be displaced easily; however, with reasonable care no difficulty should be experienced. Care should also be taken not to damage adjacent interconnectors; ensure that the interconnector nuts and plugs are correctly paired so that they can be coupled up when the combustion chambers are all assembled.

Pre-mod. 794, when the combustion chamber is in position, withdraw the two blanking plates ensuring that the rubber sealing rings are not displaced.

Place a spring and a plain washer on each of the $\frac{5}{16}$ in. B.S.F. bolts and screw the bolts through the five holes in each expansion chamber flange into the diffuser casing. Using swivel spanners T.74280 and T.74279 as necessary, progressively and evenly tighten the two $\frac{1}{4}$ in. B.S.F. plain nuts and the ten bolts.

When all ten combustion chambers have been correctly fitted, it is most important to make a check to ensure that all twenty blanking plates have been removed. Couple up each of the adjacent interconnectors, using spanners T.72178 and T.72170 to screw the slotted nut into the slotted plug. Lock each nut and plug by fitting the ten interconnector nut circlips.

Place a new Klingerit washer (Part No. 25287) on the drain boss on No. 4, 5, 6, 7 and 8 combustion chamber expansion chambers. Carefully position the drain assembly on the studs in the expansion chambers and secure the drain assembly by fitting the ten plain and spring washers and $\frac{1}{4}$ in. B.S.F. nuts.

Ghost 48 Mk. 1 pre-mod. 1139. Refit the rigid pipe between the banjo on No. 8 combustion cham-

ber and No. 16 diffuser bolt and the air-fuel ratio control unit. Wire-lock the union nut at each end of this pipe. Refit the two igniter plugs into No. 3 and No. 10 combustion chambers. Reconnect the ignition leads from the high energy ignition units.

Ghost 48 Mk. 1 mod. 1139. Refit the rigid pipe between the banjo on No. 9 combustion chamber and the air-fuel ratio control unit. Wire-lock the union nut at each end of this pipe and re-secure the three clips. Refit the two igniter plugs into No. 3 and 10 combustion chambers. Reconnect the ignition leads from the high energy ignition units.

Ghost 48 Mk. 2. Refit the rigid pipe between the banjo on No. 5 combustion chamber and the air-fuel ratio control unit. Wire-lock the union nut at each end of this pipe and re-secure the clip. Refit the two torch igniters into No. 3 and 10 combustion chambers. Reconnect the ignition leads from the high energy ignition units and the fuel supply pipes connecting the Tee-piece to the two torch igniters.

COMBUSTION CHAMBER DRAIN (Fig. 25)

To remove the combustion drain valve for cleaning or examination, proceed as follows. Cut the locking wire, and unscrew the two union nuts which couple the flexible drain pipe assemblies to either side of the drain valve. Remove the two $\frac{1}{4}$ in. B.S.F. plain nuts, and spring and plain washers, from the studs in the drain boss on No. 6 combustion chamber. Carefully draw the drain valve and rigid pipe unit off the studs; there is a Klingerit joint washer between the drain valve and the boss on the combustion chamber expansion chamber.

When it is required to remove the complete drain valve and flexible drain pipe assembly, as for instance when removing the combustion chambers, either cut the locking wire and unscrew the union nuts which couple the flexible pipes to combustion chambers No. 4, 5, 7 and 8 and remove the two nuts and washers from the studs in No. 6 combustion chamber or remove the ten $\frac{1}{4}$ in. B.S.F. plain nuts and spring and plain washers from the studs in the five combustion chambers. In the first instance the four flanged drain connections will remain attached to combustion chambers No. 4, 5, 7 and 8, and in the second instance the flanged connections will come away attached to the flexible pipes.

To dismantle the fuel drain release valve, having disconnected the flexible pipes from the unions in the top portion of the drain valve body, proceed thus. Remove the two 2 B.A. plain nuts, spring and plain washers, and half-inch bolts which fasten the flanged end of the rigid pipe to the bottom portion of the drain valve body; there is a joint washer between the flange on the pipe and the drain valve body. Unscrew the four 2 B.A. plain nuts from the bolts which clamp the two portions of the drain valve body together. Remove the spring and plain washers, and the four one-inch bolts and plain washers. Separate the top and bottom portions of the drain valve body and remove the disc valve and spring.

Thoroughly wash all these parts in clean kerosene. Examine the disc valve for flatness; apply a thin film of marking blue and check the contact area with the valve seating. If necessary, lightly lap the two parts together. Thoroughly wash the parts to remove any traces of the lapping medium and dry with a jet of compressed air. Ensure that the valve spring and other parts are serviceable, and that all pipes and passages are clear. If either of the unions is loose, it should be tightened and locked with a new tab washer (Part No. N.4497).

Put the disc valve in the recess in the top portion of the drain valve body and place the spring on the centre of the valve. Position the bottom of the drain valve body over this sub-

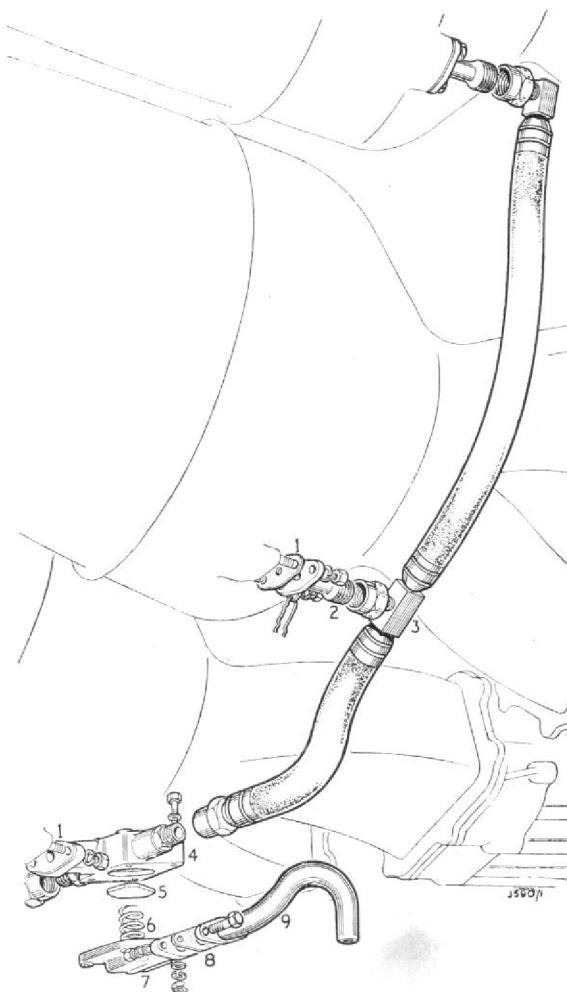


Fig. 25. Combustion chamber drain.

1. Klingerit joint washers
2. Flanged drain connection
3. Flexible drain pipe assembly
4. Top portion of drain valve body
5. Disc valve
6. Valve spring
7. Bottom portion of drain valve body
8. Joint washer
9. Rigid drain pipe

assembly so that the valve spring enters the recess in the bottom portion and the bolt holes align correctly. Place a plain washer on each of the one-inch bolts and, holding the two portions of the valve body together against the action of the spring, insert the four bolts so that the bolt heads will be nearest to the combustion chambers when the unit is on the engine, and refit the remaining plain washers, and the spring washers and plain nuts.

When the necessary equipment is available, the drain valve should be pressure tested. The fluid to be used for this purpose is aviation kerosene to specification D.Eng.R.D.2482, and the kerosene must pass through a fabric or fine mesh gauze filter before being allowed to enter the valve. The supply pressure for testing must be capable of variation between zero and 50 lb. per sq. in. Blank off two of the inlets to the drain valve and connect the third to the pressure line. Apply a gradually increasing pressure to the drain valve until the valve closes; a small seepage of kerosene may still come from the outlet. The pressure at

which the valve closes must not be greater than 35 lb. per sq. in. After the valve has closed, increase the pressure to 50 lb. per sq. in. and maintain this pressure. Examine the joints and ensure that no leakage occurs. Using a graduated vessel, measure the seepage past the valve. The amount should not exceed 2 c.c. per minute with the inlet pressure maintained at 50 lb. per sq. in. Gradually reduce the pressure to zero and observe the pressure at which the valve opens; this should not be greater than 5 lb. per sq. in.

Refit the rigid pipe unit to the drain valve assembly, using a new joint washer (Part No. 92623) if the original washer is in any way unserviceable. Refitment of the drain valve and flexible pipes to the engine is practically a direct reversal of the removal instructions given already. If any of the Klingerit joint washers (Part No. 25287), which form the joint between the drain valve or drain connections and the drain bosses on the combustion chambers, are unserviceable, new washers should be used.

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