

Chapter 28B

CENTRE SHAFT, EXTENSION SHAFT, REAR BEARING, AND HUB SHAFT, RENEWALS, RECONDITIONING, REPAIR, AND SALVAGE

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THIS CHAPTER, which is applicable to the centre shaft, extension shaft, rear bearing, and hub shaft, contains instructions for reconditioning and repairing worn or damaged components, and for replacing unserviceable parts by serviceable standard parts. Instructions for dismantling and reassembling these components are not given unless they are an essential part of the repair or renewal. Reference should be made to chapters 23, 24, 33, or 34, as appropriate, for further information on dismantling or reassembling individual items before, or after, repair or renewal. The information given in chapter 32, must also be read in conjunction with all repairs dealing with the fitting of "Cross" wire inserts to damaged or worn threaded holes.

Most of the repair information contained in this chapter is based on the manufacturer's turbine repair (T.R.) schemes and process specifications, and, in each instance, the relevant drawing (T.R.) number or specification number followed by its issue number, is quoted; turbine repair schemes are introduced under the cover of a modification and this modification number is quoted also. After any repair or renewal has been completed, an entry should be made in the appropriate record book of the engine in accordance with British Air Registration Board Inspection Procedures, Section ML,

Leaflet 1-1. Refer also to the instructions on page 3 of chapter 32 entitled "Repair Identification".

It should be noted, that these repairs and renewals must only be carried out under the supervision of an Inspection Organisation approved for such repair work by the British Air Registration Board, or an equivalent authority, or under the supervision of an appropriately licensed engineer. It is assumed also that personnel possessing the requisite skill and experience will be employed and that the recommended tools and equipment will be used.

Normally, where special tools and equipment are available for carrying out the renewals and repairs described in this chapter, they are listed at the beginning of the relevant repair instructions and are referred to in the text as they are used. In some cases, even though no list is given, the tools are referred to in the text as they are used. Where special tools are not mentioned, reference should be made either to the relevant Part and Section of the separate publication entitled "de Havilland Gas Turbine Tools and Equipment for Servicing and Overhaul", or to The Service Department of The de Havilland Engine Company.

CENTRE SHAFT, EXTENSION SHAFT, AND HUB SHAFT

The twelve 0.6895 in. holes in the front flange of the centre shaft are initially drilled 0.6835 in. and are finally reamed to size with the centre shaft assembled to the impeller. If, therefore, it is necessary to renew either the impeller or the centre shaft, it will be necessary to fit oversize centre shaft dowels in accordance with T.R.111. Similarly, the sixteen 0.3750 in. holes in the rear flange are initially drilled undersize, and are finally reamed to size with the extension shaft assembled to the centre shaft. If, therefore, it is necessary to renew either of these components, it will be necessary to fit oversize bolts in accordance with T.R.221. Whenever a centre shaft is renewed, it will be necessary to dynamically balance it, complete with the extension shaft, rear bearing, and hub shaft, as described in chapter 33A. Likewise, the eight plain turbine disc bolt holes in the hub shaft and the disc are honed 0.565 in. with these two components assembled together, and, therefore, the renewal of either component will necessitate the fitting of oversize turbine disc bolts in accordance with T.R.225 or 266, which are dealt with in chapter 28C.

REAR BEARING

Although the rear bearing housing is made in two parts—the housing and the casing—they are shrunk together and cannot be separated once they have been assembled. The grooved bronze bush, which is fitted at the extreme forward end of the rear bearing housing to form a labyrinth seal, the bronze bush, immediately forward of the roller bearing which acts as a safety bearing, and the sealing housing, which contains a second bronze bush also acting as a safety bearing, are all bored to final diameter after assembly into the rear bearing housing and cannot, therefore, be renewed individually. If, therefore, any of these items are damaged they must be renewed as described in the following paragraphs.

REMOVING SAFETY BEARING FROM SEALING HOUSING

1. Position the sealing housing on pot fixture T.78039 with the flange of the bronze safety bearing downwards.
2. Insert the mandrel of extractor T.78038 through the sealing housing, into the centre hole bored in the pot fixture base, so that the shoulders of the six extractor segments rest on the peened end of the bearing, Fig. 1. The extractor is provided with a collar which screws on to a larger, threaded portion of the mandrel; resting on the collar is a tapered plug which forces six segments in or out within the limits of slots in the segments; a spring-loaded spider carries six dowels located in the slots of the segments, these dowels function as limit stops and locate the six segments laterally. Screwing the collar towards the press head of the mandrel will force the

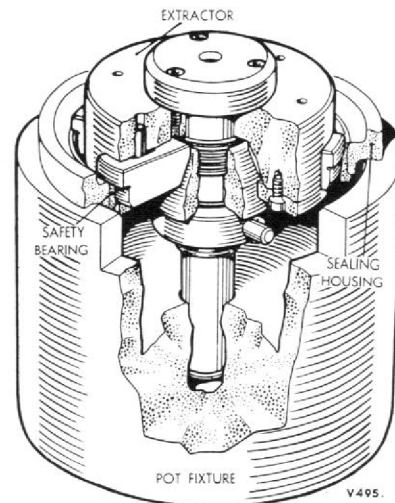


Fig. 1. Pressing safety bearing out of sealing housing with extractor T.78038 and pot fixture T.78039.

tapered plug to push the six segments outwards and vice-versa. The tool can thus be adjusted, within limits, to suit the diameter of the component to be extracted.

3. Place the pot fixture on a suitable press and press the safety bearing out of its housing.
4. Remove the extractor, the sealing housing and the extracted bearing from the pot fixture.

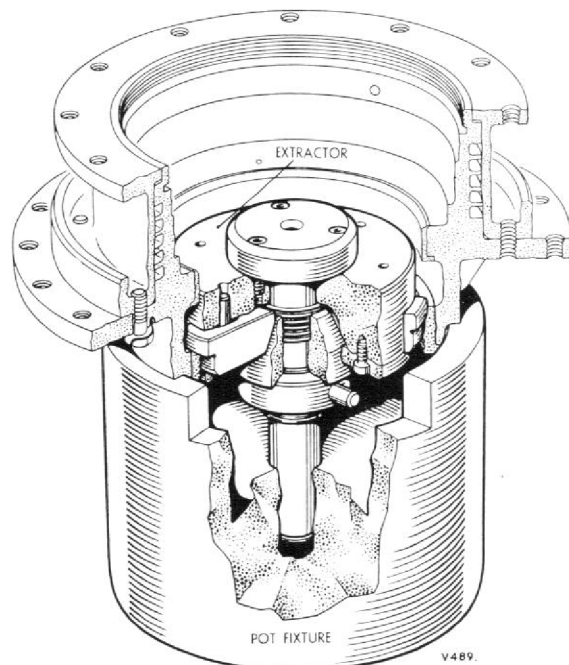


Fig. 2. Pressing labyrinth bush out of rear bearing housing with extractor T.78038 and pot fixture T.78039.

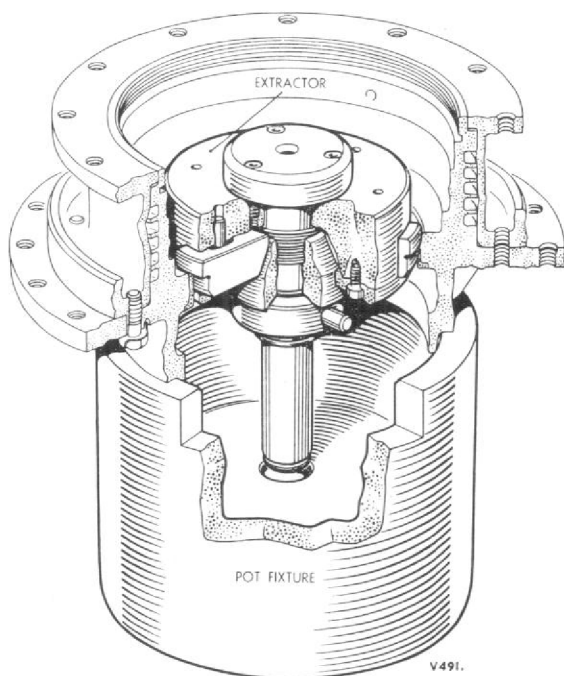


Fig. 3. Pressing safety bearing out of rear bearing housing with extractor T.78038 and pot fixture T.78039.

REMOVING LABYRINTH BUSH, AND SAFETY BEARING FROM REAR BEARING HOUSING

1. Cut the locking wire securing the labyrinth bush retaining screws; unscrew and remove the labyrinth bush retaining screw and the locking screw; mark the housing with chalk or soapstone in line with the retaining screw hole and the half-moon shaped recess in the flange of the labyrinth bush to act as a guide when pressing in the new bush—on page 4, Op. 3.

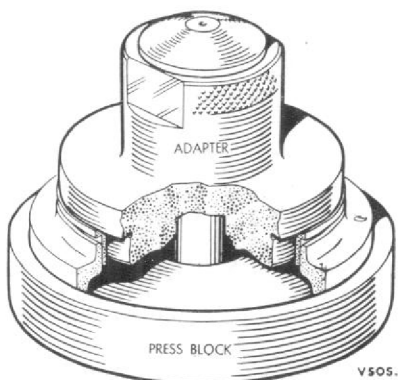


Fig. 4. Pressing safety bearing into sealing housing with adapter T.78131 and press block T.78130.

2. Unscrew the collar of the extractor to allow the six segments to pass through the bore of the labyrinth seal bush and insert the body of the extractor through the bore until the shoulders of the segments are between the labyrinth seal bush and the bronze safety bearing in the rear bearing housing; screw up the collar until the segments press lightly on the bore and the shoulders rest on the inner end of the labyrinth bush.
3. Locate the mandrel of the extractor in the centre hole of the pot fixture and press out the labyrinth bush, Fig. 2.
4. Remove the extractor and the extracted labyrinth bush from the pot fixture; repeat the operation to press the safety bearing out of the rear bearing housing, Fig. 3.

PREPARING SEALING HOUSING, AND REAR BEARING HOUSING FOR NEW BUSH AND SAFETY BEARINGS

1. Using a scraper, remove all burrs and sharp edges from the sealing housing and the rear bearing housing and from the new components which are to be fitted, and thoroughly clean off all swarf.
2. Using setting ring T.78138 and a 2 to 6 in. bore gauge check the bores of the two safety bearing housings; ensure that they are $4.3275 + .0015$ in.
3. Using setting ring T.78139 and a 2 to 6 in. bore gauge check the bore of the labyrinth bush housing and ensure that it is $4.550 + .001$ in.

FITTING NEW SAFETY BEARING INTO SEALING HOUSING

1. Position the sealing housing on press block T.78130 with the larger diameter resting in the counterbored recess of the tool.
2. Smear a new safety bearing with acid-free tallow and position it on adapter T.78131 with the flange of the safety bearing adjacent to the adapter.
3. Pass the adapter over the centre mandrel of the press block, Fig. 4; press the bearing into the sealing housing; remove the adapter and the sealing bearing housing from the press block.
4. Using a hammer and punch T.78132 lock the bearing by peening in six equally spaced positions. The peening punch is provided with an elongated point and should be used so that the major axis of the point is radial to the bush being peened; a flat is machined

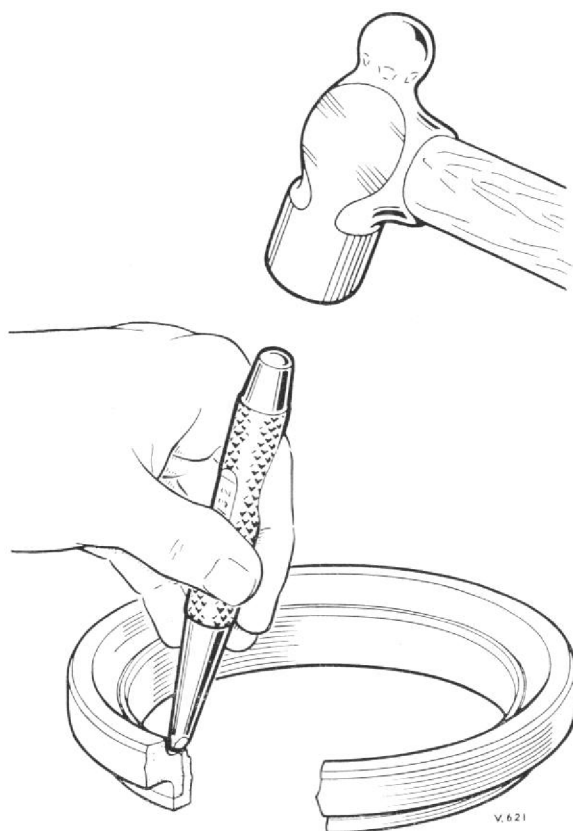


Fig. 5. Using a hammer and peening punch T.78132 to lock the safety bearing in the sealing housing.

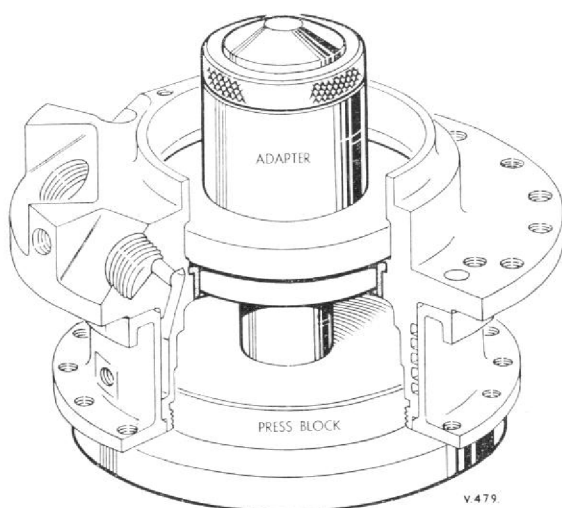


Fig. 6. Pressing safety bearing into rear bearing housing with adapter T.78131 and press block T.78134.

on the knurled body of the punch to act as a guide, Fig. 5.

FITTING NEW SAFETY BEARING, AND LABYRINTH BUSH INTO REAR BEARING HOUSING

1. Position the rear bearing housing on press block T.78134, the smaller flange downwards, and press the new safety bearing into the rear bearing in a similar manner to that described on page 3; remove the adapter from the rear bearing housing. (Fig. 6.)

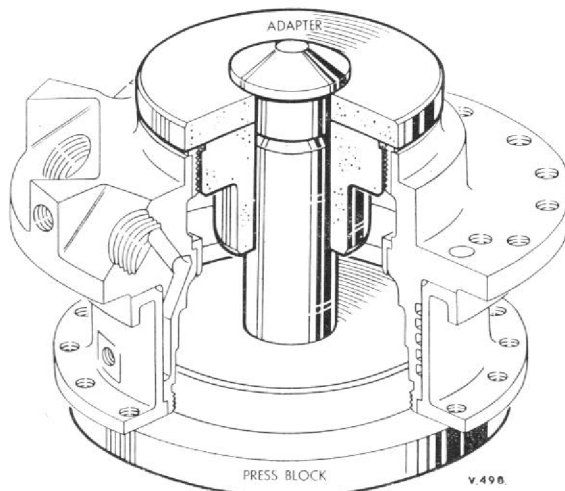


Fig. 7. Pressing labyrinth bush into rear bearing housing with adapter T.78133 and press block T.78134.

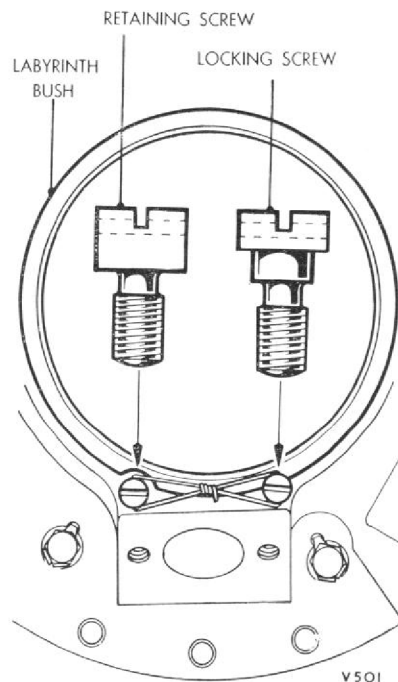


Fig. 8. Labyrinth bush retaining screws and method of wire locking.

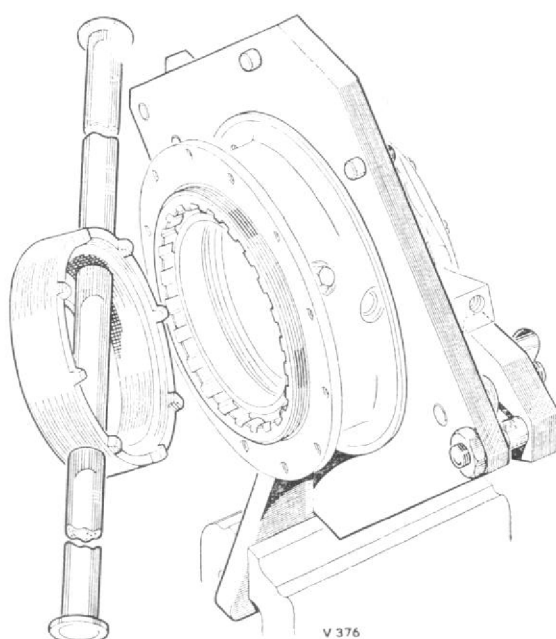


Fig. 9. Vice block T.76557 and spanner T.76556.

2. Using a hammer and punch T.78132 peen the safety bearing in a similar manner to that described at the end of page 3.
3. Return the rear bearing housing to the press block. Smear the new labyrinth bush with acid-free tallow and position it in the housing so that the half-moon recess in the flange lines up with the marked 2 B.A. threaded hole for the locking screw; place adapter T.78133 over the centre mandrel of the press block and into the bore of the bush, Fig. 7, ensuring that the half-moon recess is still in line with the marked 2 B.A. threaded hole (refer to page 3), press the bush fully home; remove the adapter and housing from the press block.
4. Place the rear bearing housing on the bench with the labyrinth bush upwards; screw the retaining screw into the marked screw hole—the head of the screw locates in the half-moon recess; the locking screw, provided with a plain shoulder deep enough to allow the underside of the head to clear the flange of the labyrinth bush, is screwed into the other 2 B.A. threaded hole which is approximately 1.8 in. from the retaining screw close to the edge of the bush flange, Fig. 8. Using 22 S.W.G. (0.028 in.) stainless steel wire, lock the two screws by passing the wire through the holes drilled in the heads of both, in a figure of eight, and twisting the ends together.

PREPARING REAR BEARING HOUSING FOR BORING

1. Mount vice block T.76557 in a vice and clamp the rear bearing housing to the vice block (Fig. 9).

2. Assemble dummy distance bearing T.78135, followed by the sealing housing; the $\frac{1}{4}$ in. drilling in the periphery of the sealing housing must align with the locking bolt hole in the rear bearing housing (Fig. 10).
3. Using a slave tab washer (Part No. 601424) screw in the sealing housing locking bolt; tighten the bolt but do not lock.
4. Using a slave locking washer (Part No. 27388), screw the externally threaded ring nut into the bearing housing and use spanner T.76556 to tighten the nut; do not lock the nut. The tab which projects outwards from the locking washer must engage in the notch cut in the periphery of the sealing housing. Remove the housing from the vice block.

BORING NEW LABYRINTH BUSH AND SAFETY BEARINGS

1. Secure the spigot of fixture T.78136 in the chuck of a centre lathe. Mount a dial test indicator on a scribing block, or other suitable tool, and place the scribing block on the lathe saddle so that the dial test indicator can be positioned with its stylus inside the bore of the fixture. Turn the chuck, complete with the fixture, through at least one revolution and ensure that the bore runs true to within 0.0005 in.; if necessary, adjust the position of the fixture in the chuck until the required degree of accuracy is attained.
2. Ensure that the fixture and the rear bearing

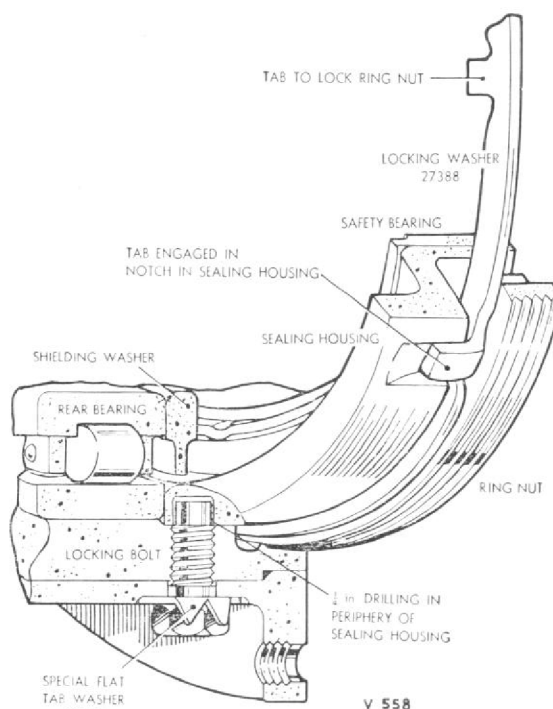


Fig. 10. Sealing housing locking bolt.

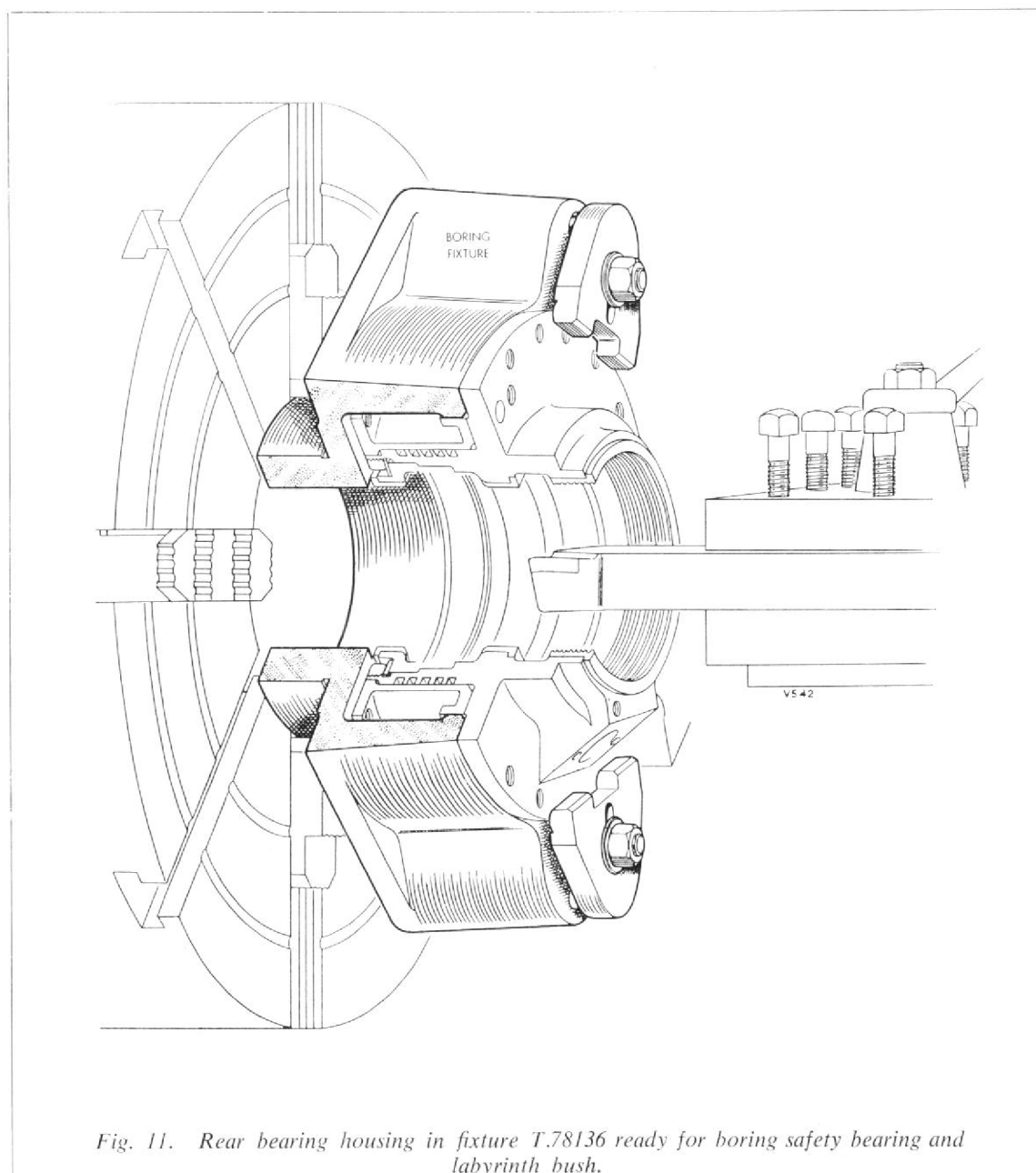


Fig. 11. Rear bearing housing in fixture T.78136 ready for boring safety bearing and labyrinth bush.

housing are absolutely clean; turn the head-stock spindle until one of the three clamps is at the bottom and assemble the housing to the fixture with the labyrinth bush towards the tailstock and the two oil cooling pipe bosses at the top; tighten up the three $\frac{1}{2}$ in. B.S.F. clamping nuts, Fig. 11.

3. With a suitable boring-bar mounted in the lathe tool post, bore the two safety bearings to the new diameter given in the Schedule of Fits, Clearances and Repair Tolerances, and the labyrinth bush to 4.203 - .002 in.; use setting ring T.74106 and a 2 to 6 in. bore gauge to check the progress of the boring operation; when completed satisfactorily, with-

draw the boring tool clear of the housing and remove the housing from the fixture. Using a scraper remove burrs and wipe the housing absolutely clean.

4. Using checking mandrel (group) T.78140 check the concentricity of the safety bearings and the labyrinth bush with the main bearing housing. Ensure that the mandrel and the two adapters are scrupulously clean and smear the mandrel with thin oil. Using a hide-faced hammer lightly drive the adapter provided with a $\frac{1}{4}$ in. B.S.F. locking screw and marked "labyrinth end", boss first, on to the mandrel and secure it by screwing in the grub-screw

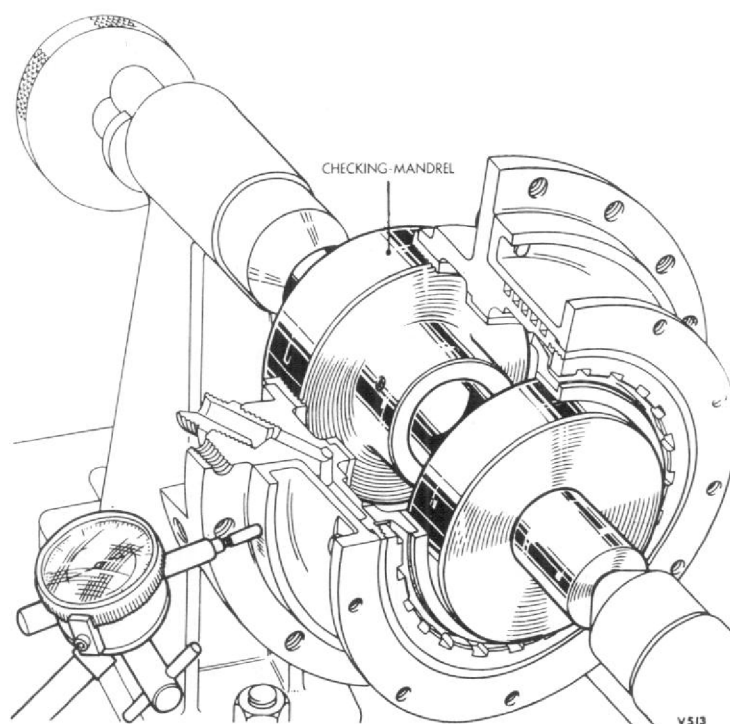


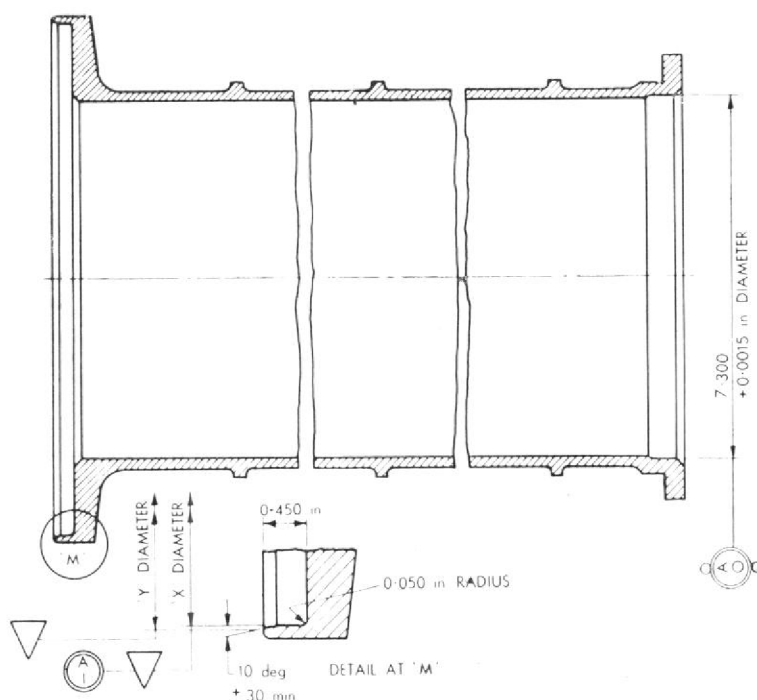
Fig. 12. Checking concentricity of safety bearings and labyrinth bush.

which locates in the dimple provided on the mandrel for this purpose. Pass the mandrel and the adapter through the rear bearing housing from the labyrinth bush end and locate the adapter in the labyrinth bush bore. With the hide-faced hammer lightly drive the second adapter, boss first, on to the mandrel and push it into the outer safety bearing. Both adapters are made with tapered peripheries to take up manufacturing tolerances and the mandrel is centred at both ends.

5. Mount the mandrel between centres; using a dial test indicator with the stylus resting on the 7.624 - .002 in. diameter spigot of the

housing check the concentricity, Fig. 12; the bore should be concentric relative to the spigot within 0.001 in., i.e., a total dial indicator reading of 0.002 in.

6. Remove the dial test indicator; remove the assembly from between the centres and dismantle the checking mandrel group. Unscrew and remove the sealing housing locking bolt with its tab washer. Use spanner T.76556 to unscrew the ring nut; remove the locking washer and the sealing housing; remove the dummy bearing. Wrap the rear bearing housing and the sealing housing in waxed paper to protect them from damage and foreign matter.



Centre Shaft Part No.	Diameter 'X' in Inches		Diameter 'Y'
	Table 'A' in Inches	Table 'B' in Inches	
94811	10.386 + .002	10.375 + .001	10.400
M.R.94811-10	10.376 + .002	10.365 + .001	10.390
M.R.94811-20	10.366 + .002	10.355 + .001	10.380
M.R.94811-30	10.356 + .002	10.345 + .001	10.370

(Refer to chapter 32 for interpretation of machining symbols)

CENTRE SHAFT, DAMAGED IMPELLER- SPIGOT RECESS T.R. 204 issue 3—Mod. 751

This repair may be applied to all Ghost centre shafts.

Centre shafts in which the recess of the impeller spigot has been damaged or worn, may be rectified in accordance with this repair.

SEQUENCE OF OPERATIONS

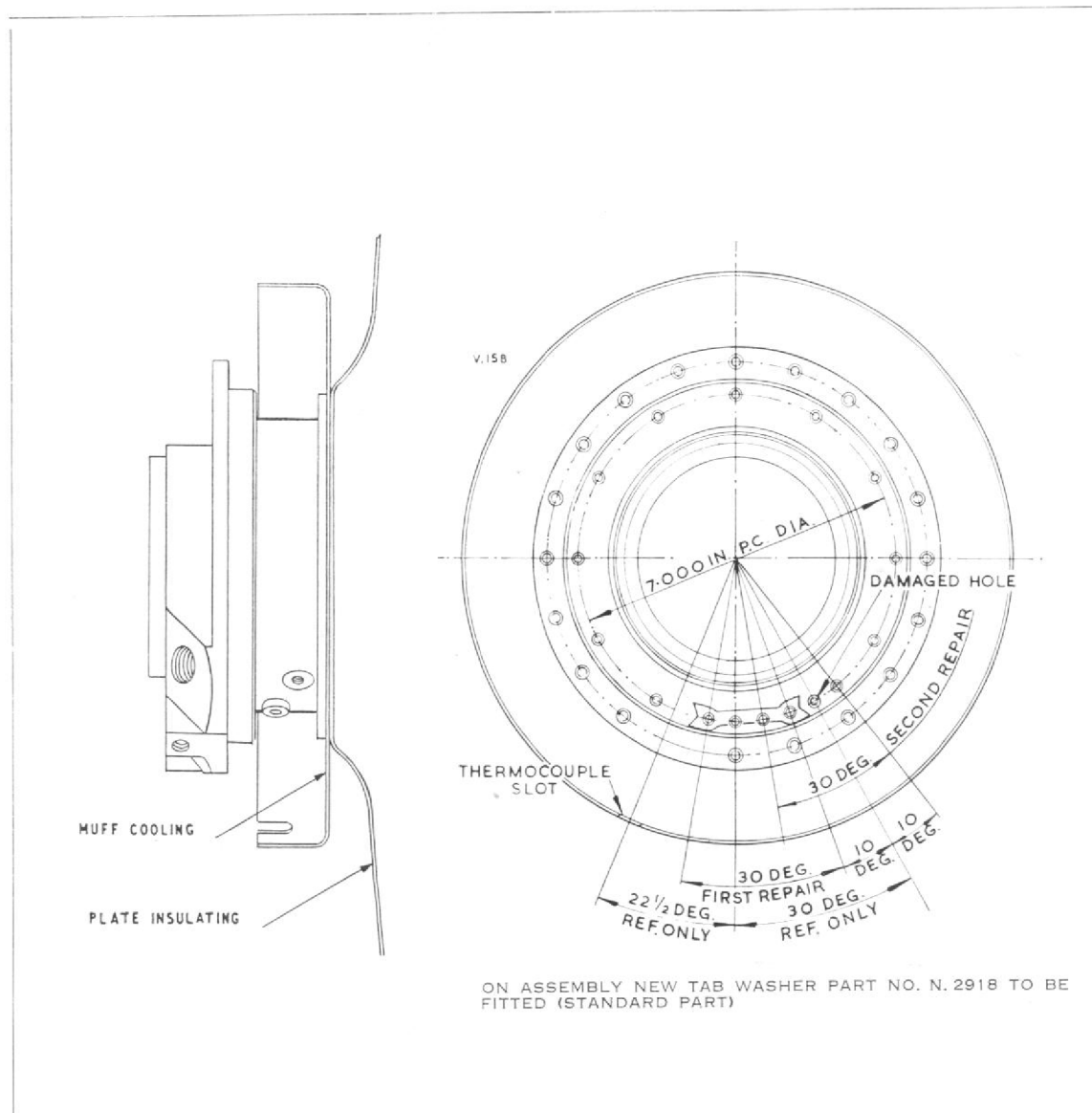
1. Machine diameter 'X' indicated in the sketch, to the applicable dimension given in table 'A'.

2. Build up diameter 'X' by Fescolising to a thickness of 0.010 + .002 inch in accordance with D.H. Specification 134.

3. Machine diameter 'X' to the applicable dimension given in table 'B' and radius the corner to 0.050 inch.

4. Machine diameter 'Y' to the relative dimension given in the table, and maintain an angle of 10 degrees $\pm$ 30 minutes as shown in the sketch.

5. Lightly stamp T.R.204 adjacent to the existing part number and make an entry in the appropriate record book of the engine.



REAR BEARING HOUSING, DAMAGED THREADED HOLES T.R. 327 issue 1—Mod. 900

This repair may be applied to all Ghost rear bearing housings.

Rear bearing housings in which any of the 12 threaded holes in the rear flange have become damaged may be rectified in accordance with these instructions.

SEQUENCE OF OPERATIONS

Note: When applying this repair, care must be taken to ensure that no foreign matter enters the housing.

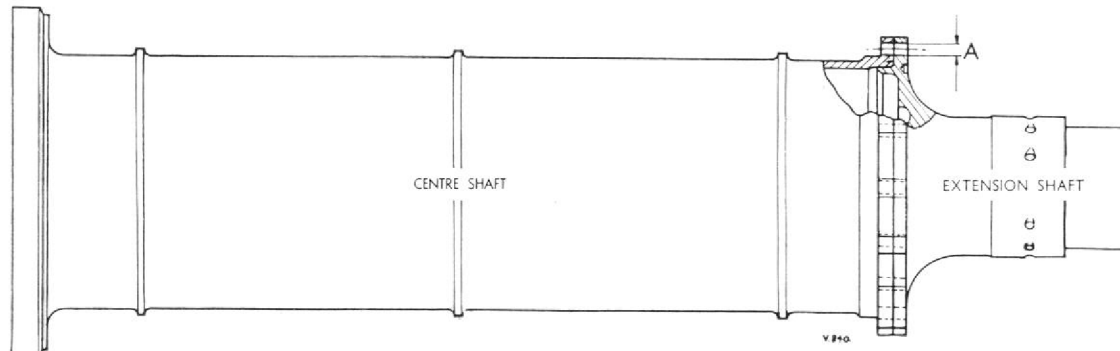
1. Fit the muff and insulating plate to the flange and bolt in position as shown in the sketch.

2. Mark off and drill two new holes $\frac{1}{8}$ inch in diameter through to dimension shown.
3. Remove insulating plate and muff.
4. Thread the holes in the flange $\frac{1}{4}$ in. B.S.F. right through.
5. Counterbore $\frac{1}{8}$ in. diameter by 0.030 in. deep.
6. Open out the new holes in the muff and insulating plate to $\frac{9}{32}$ in. diameter.
7. Weld up the old holes in the muff and insulating plate and blend the filler rod on each component flush with both sides.
8. Lightly stamp T.R.327 adjacent to the existing part number and make an entry in the appropriate record book of the engine.

CENTRE AND EXTENSION SHAFTS, OVERSIZE BOLTS
ALSO RENEWAL OF EITHER OR BOTH SHAFTS

T.R.221 issue 2 (Ghost 48 Mk. 1 and 48 Mk. 2)—Mod. 311

T.R.403 issue 1 (Ghost 53 Mk. 1)—Basic Standard.



Diameter 'A' in inches	Bolt Part No. Ghost 48Mk.1 & 2 T.R.221	Bolt Part No. Ghost 53Mk.1 T.R.403	Size in inches
0.3750 + .0005	25356/2	602884	Standard
0.3850 + .0005	MR25356/2-10	MR602884-10	0.010 oversize
0.3950 + .0005	MR25356/2-20	MR602884-20	0.020 oversize
0.4050 + .0005	MR25356/2-30	MR602884-30	0.030 oversize

Fig. 13. Bolt holes in centre shaft and extension shaft.

Centre and extension shafts in which the mating bolt holes have become damaged may be repaired by fitting oversize bolts, as indicated in the table below Fig. 13. This repair may be applied to any one or more holes as required. This repair must be applied also when either the centre shaft or the extension shaft is renewed. If both shafts are renewed, these instructions must be followed, but all sixteen holes should be reamed to the standard size, and standard bolts fitted.

The following tools will be required.

Tool No.	Description
T70746	Reamer wrench
T70748	Hand reamer 0.375 in. diameter
T70752	Hand reamer 0.380 in. diameter
T70753	Hand reamer 0.385 in. diameter
T70757	Hand reamer 0.390 in. diameter
T70758	Hand reamer 0.395 in. diameter
T70762	Hand reamer 0.400 in. diameter
T70763	Hand reamer 0.405 in. diameter
T72401	Centre stud for pressing the extension shaft into the centre
T72402	Thrust unit shaft
T72403	Floor fixture
T76641	Reaming jig which enables the bolt holes to be located accurately
T76726	Setting ring 0.375 in. bore
T76727	Setting ring 0.385 in. bore
T76728	Setting ring 0.395 in. bore
T76729	Setting ring 0.405 in. bore
T78826	Three locating bushes 0.3603 in. bore
T78827	Three locating bushes 0.3100 in. bore
T79243	Three locating pins 0.3095/0.3745/0.3845 in. diameters
T79244	Three locating pins 0.3095/0.3845/0.3945 in. diameters
T79245	Three locating pins 0.3585/0.3745/0.3945 in. diameters
T79246	Three locating pins 0.3585/0.3845/0.3945 in. diameters
T79247	Three locating pins 0.3585/0.3945/0.4045 in. diameters
T79248	Three locating pins 0.3095/0.3585 in. diameters
T79249	Three locating pins 0.3095/0.3945 in. diameters
T79251	Drill bush 0.3908 in. bore
Standard	John Bull Intercheck small bore gauge
Standard	Four $\frac{1}{16}$ in. B.S.F. bolts
Standard	$\frac{1}{16}$ in. diameter drill
Standard	$\frac{1}{16}$ in. diameter drill

On receipt of the components which are to be repaired, their part numbers and serial numbers

should be checked against the accompanying documents.

REPAIR OF HOLES IN AN EXISTING ASSEMBLY

The operations described under this heading apply to the repair of holes in an existing assembly. The sequence of operations assumes that each pair of mating holes are the same size, even though all sixteen pairs may not be the same size as each other due to the previous application of this repair to individual pairs of holes, and that no hole is less than the standard diameter quoted in the table beneath Fig. 13. If any one of the damaged holes has been enlarged already to the largest oversize, the component affected must be renewed, as no further repair is permissible. Proceed as follows.

- Engage the recess in the impeller flange of the centre shaft over the spigot on floor fixture T.72403, and clamp the flange to the fixture by tightening the two $\frac{1}{2}$ inch Whitworth nuts, Fig. 14.
- Use a John Bull Intercheck small bore gauge in conjunction with the appropriate setting ring, of those listed below, to measure each

Use setting ring	For bolt holes
T.76726	Standard
T.76727	0.010 inch oversize
T.76728	0.020 inch oversize
T.76729	0.030 inch oversize

damaged hole in both the centre shaft, Fig. 15, and the extension shaft, and estimate the

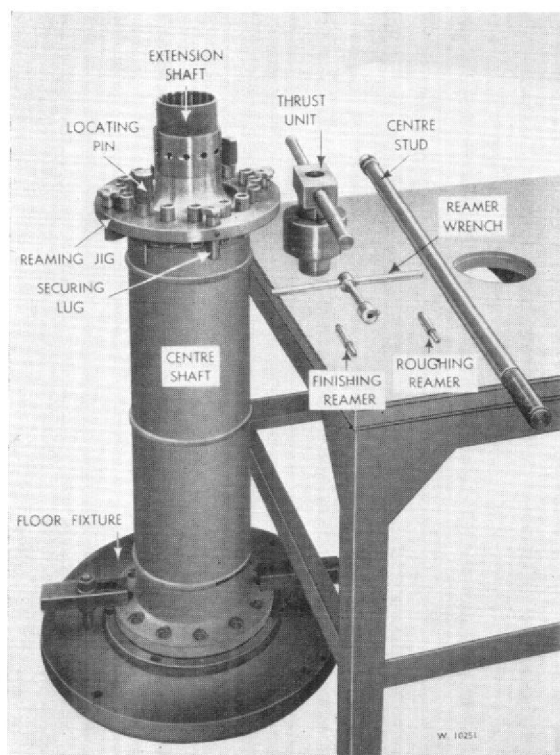


Fig. 14. Centre shaft in position on floor fixture, and tools used.

smallest oversize which will rectify the damage. Make a note of the diameter of each hole, so that this information is available to assist when selecting the locating pins, and reamers, to use in the subsequent operation.

3. Ensure that the spigot on the extension shaft, the bore of the centre shaft, and the mating faces of the flanges are clean and free from burrs, or any damage which might prevent the two shafts fitting together correctly. Lightly smear the spigot with a thin film of acid-free tallow, to reduce the likelihood of picking-up or scoring. Position the extension shaft on the centre shaft so that the sixteen bolt holes are aligned. One of these bolt holes is not equidistant between its neighbours and, therefore, there is only one position in which all sixteen holes will align.

Operations 4, 7, 8, and 9 are illustrated diagrammatically in Fig. 16, reading from left to right—overleaf.

4. To ensure correct alignment of the bolt holes during the next operation, by reference to the note made during operation 2, select three suitable locating pins, from those listed below, and fit them in three approximately equally spaced holes, Fig. 16.

Use locating pins	For bolt holes
T.79243	Standard
T.79244	0.010 inch oversize
T.79247	0.020 inch and 0.030 inch oversize

5. Pass the dogged end of centre stud T.72401 down through the shafts, and secure it to the floor fixture by means of the bayonet type coupling.
6. Screw thrust unit T.72402 on to the threaded end of the centre stud, so that the spigot on the thrust unit enters the bore of the extension shaft, and screw down the unit until the extension shaft is fully home in the centre shaft. Use a 0.0015 inch feeler to check that the mating flanges are in contact at all points around the circumference. Remove the thrust unit, the centre stud, and the locating pins.
7. Place reaming jig T.76641 over the extension shaft, hand nuts uppermost, and align the unequally spaced fixed bush in the jig with the corresponding bolt holes in the flanges of the shafts.
8. Select three suitable locating pins, from those listed in operation 4, and fit them in three approximately equally spaced holes, so that the largest diameter locates in the fixed bush of the reaming jig, refer to Fig. 16. Unless more than thirteen of the holes require rectification, the locating pins should be inserted into holes which do not require repair. Turn the four clamps on the jig so that the securing lug of each will bear on the flange of the centre shaft, and tighten the four hand nuts to secure the jig in position, refer to Fig. 14.
9. Taking each damaged hole in turn; select the smallest reamer, from those listed overleaf, which will remove any material from the hole, i.e., the appropriate roughing reamer. Using reamer

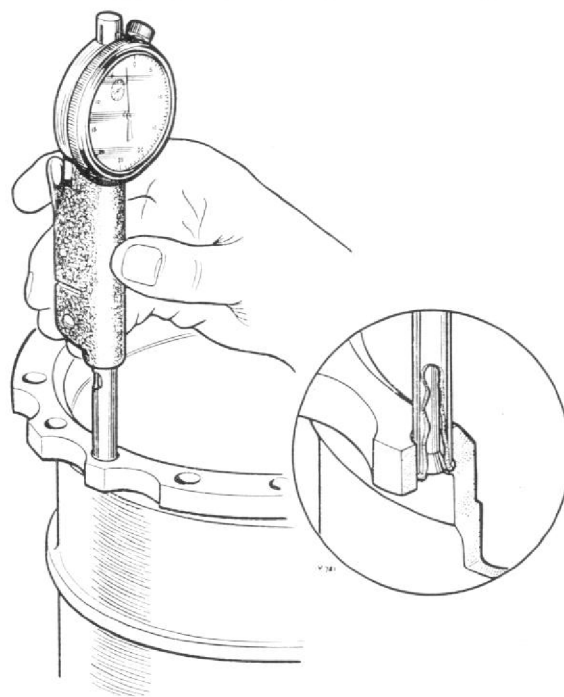


Fig. 15. Using John Bull Intercheck small bore gauge to measure damaged holes in centre shaft flange.

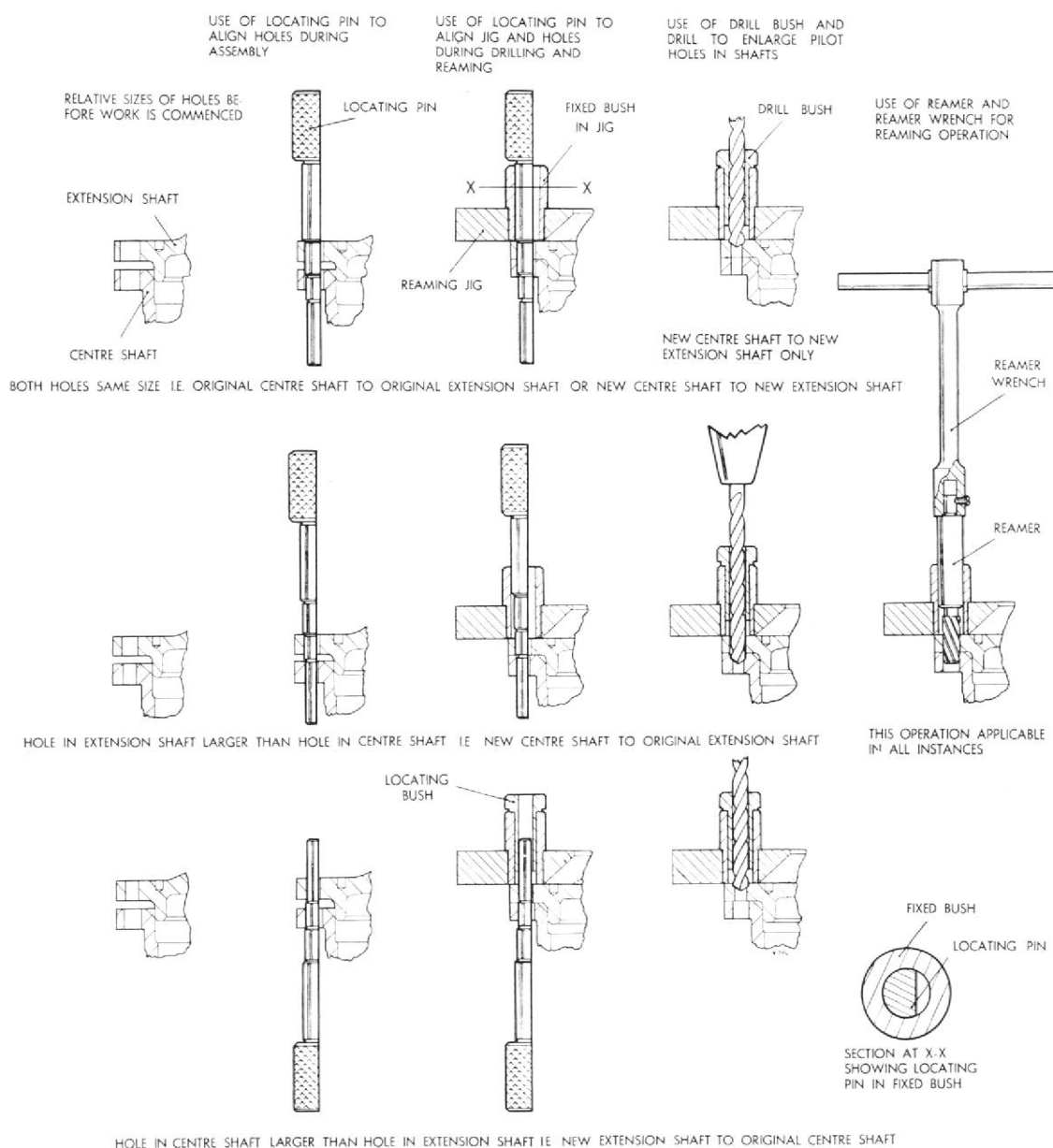


Fig. 16. Diagram showing sequence of operations.

wrench T.70746, in conjunction with the selected reamer, ream the hole, Fig. 16; repeat this operation using the corresponding finishing reamer. Inspect the reamed hole, and use the John Bull Intercheck small bore gauge, in conjunction with the appropriate setting ring (refer

Use reamer	To produce bolt holes
T.70752 (roughing)	0.010 inch oversize
T.70753 (finishing)	
T.70757 (roughing)	0.020 inch oversize
T.70758 (finishing)	
T.70762 (roughing)	0.030 inch oversize
T.70763 (finishing)	

to list at end of operation 2), to measure the reamed hole. Ensure that all traces of damage have been eradicated, and that the diameter of the hole is within the limits specified in the table below Fig. 13. If necessary, repeat this operation, using the next larger size roughing and finishing reamers, until satisfactory conditions are achieved.

- If more than thirteen holes are affected, having rectified the thirteen holes, select three suitable locating pins, from those listed in operation 4, and fit them in three approximately equally spaced rectified holes, so that the largest diameter locates in the fixed bush. Remove the original three locating pins, and rectify each damaged hole as described in operation 9.

11. When each damaged hole has been repaired satisfactorily, remove the locating pins, release the four clamps, and remove the reaming jig.
12. Screw four standard $\frac{5}{16}$ inch B.S.F. slave bolts into the four tapped extractor holes in the extension shaft flange. Using a suitable spanner, alternately tighten the four bolts a little at a time until the extension shaft is released from the centre shaft.
13. Remove the centre shaft from the floor fixture.
14. Lightly stamp T.R.221 (48Mk.1 or 48Mk.2), or T.R.403 (53Mk.1), adjacent to the existing part number on each component, and make a record in the engine log book of exactly which holes have been repaired, and their sizes.
5. As operation 5 for the repair of an existing assembly.
6. As operation 6 for the repair of an existing assembly.
7. As operation 7 for the repair of an existing assembly.
8. Select three suitable locating pins, from those listed in operation 4, and fit them in three approximately equally spaced holes, so that the largest diameter locates in the fixed bush of the reaming jig. Turn the four clamps on the jig so that the securing lug of each will bear on the flange of the centre shaft, and tighten the four hand nuts to secure the jig in position.
9. Taking each hole in turn, but omitting the three in which the locating pins are fitted, select the drill bush, from those shown below, which is appropriate to the size of the bolt hole in the extension shaft, and insert the bush into the jig. Refer to the table and, using the drill indicated, drill through the pilot hole, Fig. 16. When the thirteen accessible holes have been drilled, remove the drill bush.

RENEWING THE CENTRE SHAFT

Where a new centre shaft is to be fitted to a used extension shaft, the holes in the centre shaft, being pilot size, will be smaller than those in the extension shaft. Replacement centre shafts are supplied with the sixteen bolt holes pilot drilled to $0.310 - .002 + .010$ inch diameter, i.e., nominally 0.065 inch undersize. Some early replacement shafts were supplied with the sixteen holes drilled to $0.359 - .002 + .010$ inch diameter, and, where one of these shafts is being fitted, operation 9, in this paragraph, may be unnecessary. If any one of the bolt holes in the used extension shaft flange has been enlarged already to the largest permissible oversize, a new centre shaft cannot be fitted to it. Operations which are identical with those described for the repair of holes in an existing assembly contain a cross-reference to that operation. The procedure is as follows.

1. As operation 1 for the repair of an existing assembly.
2. As operation 2 for the repair of an existing assembly, but there is no need to measure the holes in the replacement centre shaft.
3. As operation 3 for the repair of an existing assembly.
4. To ensure correct alignment of the bolt holes during the next operation, refer to the note made during operation 2, and select three locating pins, from those listed below. Fit the pins in three approximately equally spaced holes, so that the smallest diameter locates in the pilot hole in the centre shaft flange, and the second smallest diameter locates in the hole in the extension shaft flange.

Pilot holes in centre shaft	Use locating pins	For bolt holes in extension shaft
0.310 inch	T.79243	Standard
	T.79244	0.010 inch oversize
	T.79249	0.020 inch oversize
0.359 inch	T.79245	Standard
	T.79246	0.010 inch oversize
	T.79247	0.020 inch oversize

Use drill bush	Use drill	For bolt holes in extension shaft
T.78826	$\frac{23}{64}$ inch diameter	Standard
T.78826	$\frac{23}{64}$ inch diameter	0.010 inch oversize
T.79251	$\frac{25}{64}$ inch diameter	0.020 inch oversize

10. As operation 9 for the repair of an existing assembly.
11. As operation 10 for the repair of an existing assembly, but, before reaming the remaining three holes, use the appropriate drill bush, and drill, as described in operation 9 above.
12. As operations 11, 12, 13, and 14 for the repair of an existing assembly.

Whenever the centre shaft has been renewed, it is necessary to dynamically balance it, complete with its extension shaft, rear bearing, and hub shaft, as described in Chapter 33A, page 29.

RENEWING THE EXTENSION SHAFT

Where a new extension shaft is to be fitted to a used centre shaft, the holes in the extension shaft, being pilot size, will be smaller than those in the centre shaft; this involves a change of method in the use of the locating pins. Replacement extension shafts are supplied with the sixteen bolt holes pilot drilled to one of two sizes, as described for the centre shaft. Similarly, if any one of the bolt holes in the used centre shaft flange has been enlarged already to the largest permissible oversize, a new extension shaft cannot be fitted to it. Operations which are identical with those described for the repair of holes in an existing assembly contain a cross-reference to that operation. The procedure is as follows.

1. As operation 1 for the repair of an existing assembly.

2. As operation 2 for the repair of an existing assembly, but there is no need to measure the holes in the replacement extension shaft.
3. As operation 3 for the repair of an existing assembly.
4. To ensure correct alignment of the bolt holes during the next operation, refer to the note made during operation 2, and select three locating pins, from those listed below. Fit the pins in three approximately equally spaced holes, so that the smallest diameter locates in the pilot hole in the extension shaft flange, and the second smallest diameter locates in the hole in the centre shaft flange. For this purpose it will be necessary to insert the locating pins upwards through the centre shaft flange into the extension shaft flange, as shown in the bottom row of diagrams in Fig. 16; to permit this to be done, the locating pins have a flat machined on one side to clear the main body of the centre shaft.

<i>Pilot holes in extension shaft</i>	<i>Use locating pins</i>	<i>For bolt holes in centre shaft</i>
0.310 inch	T.79243	Standard
	T.79244	0.010 inch oversize
	T.79249	0.020 inch oversize
0.359 inch	T.79245	Standard
	T.79246	0.010 inch oversize
	T.79247	0.020 inch oversize

5. As operation 5 for the repair of an existing assembly.
6. As operation 6 for the repair of an existing assembly, but do not remove the three locating pins.
7. As operation 7 for the repair of an existing assembly
8. Select three locating bushes, from those listed below, and fit them into the fixed bushes in the reaming jig, so that the bore of each bush fits over the small diameter of one of the locating pins. Turn the four clamps on the jig so that the securing lug of each will bear on the flange of the centre shaft, and tighten the four hand nuts to secure the jig in position.

<i>Use locating bush</i>	<i>For pilot holes in extension shaft</i>
T.78826	0.359 inch diameter
T.78827	0.310 inch diameter

9. Taking each hole in turn, but omitting the three in which the locating bushes and pins are fitted, select the drill bush, from those shown below, which is appropriate to the size

<i>Use drill bush</i>	<i>Use drill</i>	<i>For bolt holes in centre shaft</i>
T.78826	$\frac{23}{64}$ inch diameter	Standard
T.78826	$\frac{23}{64}$ inch diameter	0.010 inch oversize
T.79251	$\frac{25}{64}$ inch diameter	0.020 inch oversize

of the bolt hole in the centre shaft, and insert the bush into the jig. Refer to the table and, using the drill indicated, drill through the pilot hole. When the thirteen accessible holes have been drilled, remove the drill bush.

10. As operation 9 for the repair of an existing assembly.
11. As operation 10 for the repair of an existing assembly, but, before reaming the remaining three holes, use the drill bush and drill as described in operation 9 above.
12. As operations 11, 12, 13, and 14 for the repair of an existing assembly.

RENEWING BOTH SHAFTS

Where both shafts are being renewed, three alternative conditions may exist: the pilot holes in both shafts may be the same size, either 0.310 inch diameter or 0.359 inch diameter; the pilot holes in the extension shaft may be larger than those in the centre shaft, 0.359 inch and 0.310 inch respectively; or the pilot holes in the extension shaft may be smaller than those in the centre shaft, 0.310 inch and 0.359 inch respectively.

In the first instance (both pilot holes the same size), the procedure is as described for the repair of holes in an existing assembly, except for the following.

1. Omit operation 2.
2. For operation 4 and operation 8 use the following locating pins.

<i>Use locating pin</i>	<i>For pilot holes</i>
T.79243	0.310 inch
T.79245	0.359 inch

3. For pilot holes having a diameter of 0.310 inch. Immediately after operation 8, use drill bush T.78826 and the $\frac{23}{64}$ inch diameter drill, as described in operation 9 of the instructions for renewing the centre shaft.
4. Proceed as described in operations 9 and 10 of the instructions for the repair of an existing assembly, but use standard size reamer T.70748.
5. Do **not** stamp the relevant T.R. number on either component, unless, as a result of unsatisfactory reaming, it has been necessary to enlarge one or more holes to one of the oversizes.

In the second instance (pilot holes in extension shaft larger than those in centre shaft), the procedure is similar to that described for renewing the centre shaft, except for the following.

1. Omit operation 2.
2. For operation 4 and operation 8 use locating pins T.79248.

3. Proceed as described in operations 10 and 11, but use standard size reamer T.70748.
4. Do **not** stamp the relevant T.R. number on either component, unless, as a result of unsatisfactory reaming, it has been necessary to enlarge one or more holes to one of the oversizes.

In the third instance (pilot holes in extension shaft smaller than those in centre shaft), the procedure is as described for renewing the extension shaft, except for the following.

1. Omit operation 2.
2. For operation 4 use locating pins T.79248.
3. Proceed as described in operations 10 and 11, but use standard size reamer T.70748.
4. Do **not** stamp the relevant T.R. number on either component, unless, as a result of unsatisfactory reaming, it has been necessary to enlarge one or more holes to one of the oversizes.

Whenever both shafts have been renewed, it is necessary to dynamically balance the centre shaft, complete with its extension shaft, rear

bearing, and hub shaft, as described in chapter 33A, page 29.

REASSEMBLING

At the completion of any of these repairs, a label should be tied to one of the shafts giving details of the sizes to which each of the sixteen holes have been reamed, and stating the correct standard or oversize bolts which must be fitted at reassembly.

EMERGENCY REPAIRS

Where, in an emergency, it is required to produce a serviceable assembly by fitting together a used centre shaft from one engine and a used extension shaft from another, provided that neither shaft has had any one bolt hole enlarged to the largest permissible oversize, this can be effected by applying the principles of the repair procedures described already, and selecting suitable locating pins to fit the holes in the shafts. Whenever the holes in the centre shaft are larger than those in the extension shaft, it will be necessary to insert the locating pins upwards through the centre shaft flange into the extension shaft flange; in these instances, the reaming jig must be located by fitting locating bushes T.78827, or T.78826, into the fixed bushes in the jig, so that the bore of the locating bushes fits over the small diameter of the locating pins.



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