

Chapter 28A

IMPELLER

RENEWALS, RECONDITIONING, REPAIR, AND SALVAGE

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THIS CHAPTER, which is applicable to the impeller, contains instructions for reconditioning and repairing worn or damaged components, and for replacing unserviceable parts by serviceable standard parts. Instructions for dismantling and re-assembling these components are not given unless they are an essential part of the repair or renewal. Reference should be made to chapters 17, 23, 24, 33, or 34, as appropriate, for further information on dismantling or reassembling individual items before, or after, repair or renewal.

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 to The Service Department of The de Havilland Engine Company.

IMPELLER, REPAIR OF DAMAGED VANES

Ghost, All Marks

T.R.357 issue 6—Mod. 1080

INTRODUCTION

Damaged impeller vanes may be repaired by blending the damaged area into the surrounding surface, provided that the damage can be repaired within the limits specified in this chapter; these limits are indicated in a series of diagrams (Fig. 1, 2, 3, 4, 6, 7, and 9) and tables (A, B, and C). If damage to the leading edge of one or more vanes is greater than that which may be repaired by blending, the impeller may be repaired by cutting back the leading edge of all the vanes; this operation is called cropping. Extensive scurfing to remove corrosion may affect impeller vane frequency; the precautions to be observed are explained on page 5 under removal of extensive corrosion.

TOOLS AND EQUIPMENT

The following tools and equipment will be required.

<i>Tool No.</i>	<i>Description</i>
T.79435	Scurfing stand with an adjustable and counter-balanced base plate to hold the impeller at the most convenient working angle.
T.76768	Three-point lifting sling.
Standard	Power-driven flexible drive unit.
Standard	Rotary file.
T.76755	Polishing tool for use when blending extensive areas.
Standard	Spindle to carry abrasive strip.
T.78704	Extension to be used in conjunction with spindle when scurfing on the surface of the impeller back plate between the vanes.
T.78083	Turning mandrel on which the impeller can be mounted between centres for cropping, and bushes which adapt the mandrel to standard size, or oversize, to suit the diameter of the impeller bore.
T.75003	Six bolts $\frac{1}{2}$ in. B.S.F.
T.79688	Six bolts 0.007 in. oversize
T.79689	Six bolts 0.010 in. oversize
T.79690	Six bolts 0.015 in. oversize
T.79691	Six bolts 0.020 in. oversize
T.79692	Six bolts $\frac{9}{16}$ in. B.S.F.
Standard	Lathe capable of swinging at least 36 inches diameter.
Standard	Turning tool.
T.78770	Gauging mask
T.74310	Caliper gauge

Used with turning mandrel when centre shaft studs have been removed.

GENERAL

On receipt of the impeller which is to be repaired, check its part number and serial number against the accompanying documents.

Before repairing an impeller, the Rockhard lacquer must be removed, and the impeller subjected to crack detection by an approved dye-penetrant process such as Ardrex 996; chapter 17, page 21a.

Whilst blending and polishing, the operator should wear a gauze and cotton-wool mask. An adjustable dust extractor, and a very good, adjustable light should be provided.

TABLE A

LEADING EDGE OF IMPELLER VANES PERMISSIBLE DEPTH OF REPAIR BY BLENDING

To be used in conjunction with Fig. 1 and 2

<i>Vane stations, Fig. 1.</i>	<i>MAXIMUM DEPTH (d) (Measured in plane of vane)</i>	
	<i>Provided that not more than 8 vanes require repair</i>	<i>Where more than 8 vanes require repair</i>
A	0.060 in.	0.060 in.
B	0.080 in.	0.060 in.
C	0.100 in.	0.060 in.
D	} see also Fig. 2	0.120 in.
E		0.160 in.

TABLE B

DELIVERY TIP OF IMPELLER VANES LIMIT OF REPAIR BY BLENDING

To be used in conjunction with Fig. 3

<i>Description</i>	<i>Limit</i>
Number of vanes which may be repaired	One only
Maximum depth of repair	0.500 in. at leading edge of delivery tip

Revised by Amendment No. 138
June, 1958

TABLE C
SIDE OF IMPELLER VANES
LIMIT OF REPAIR BY BLENDING

To be used in conjunction with Fig. 4

Description	Limit
Number of vanes which may be repaired	Any one or more, up to all 19
Maximum number of repairs per vane	4
Relationship of adjacent damage on one side of a vane	There must not be any overlap between the extremities of adjacent blended regions
Relationship of damage on one side of a vane to damage on the opposite side of the same vane	There must not be any overlap between the extremities of any blended region on one side of a vane and any blended region on the opposite side of that vane
Maximum depth of blended indentation (d on Fig. 4)	Depth must not exceed one quarter of the initial thickness of the vane at the point of damage (T on Fig. 4)
Blending radii	Must not be greater than ten times nor less than six times the depth of the blended indentation
Blending of lesser damage in the area immediately adjacent to greater damage	Permissible provided that the depth of the lesser damage is not more than one-third the depth of the greater damage

BLENDING

For repair by blending, the impeller should be mounted on scurfing stand T.79435, Fig. 5.

1. Release the two clamps which are on either side of the scurfing stand, move the circular wooden base plate until it is horizontal, and re-tighten the clamps.
2. Remove the wing nut, washer, and wooden locating block from the top of the locking bar which is attached to the centre of the base plate.
3. Using three-point lifting sling T.76768, lower the impeller, rear face downwards, onto the stand so that the locking bar passes through the impeller bore. Ensure that the bell-mouthed end of the impeller bore locates accurately over the wooden locating block on the base plate, and that the rear face of the impeller rests evenly on the four wooden rollers.
4. *Pivot removed.* Pass the locating block, smaller internal diameter downwards, over the locking bar. Place the washer on the top of the block so that its raised centre diameter

locates in the larger internal diameter of the block.

Pivot in situ. Pass the locating block, larger internal bore downwards, over the locking bar and locate it about the pivot. Place the washer on top of the block so that its raised centre diameter locates in the smaller internal diameter of the block.

5. Refit the wing nut to secure the impeller and check that the impeller is free to rotate on the four wooden rollers.

Taking each damaged vane in turn, make a general visual examination of the damage, and, by reference to the illustrations and the associated text and tables, decide the best method of blending each damaged area. Release the two side clamps on the stand, and tilt the impeller until it is in the most convenient position for blending. Tighten the wing nut to prevent the impeller accidentally rotating during the blending operation. The sub-paragraphs which follow indicate methods of blending various types of damage; in all instances, the aim should be to remove as little metal as possible consistent with forming the required radii.

1. *Initial blending of deeper indentations.* Use a suitable power-driven flexible drive unit fitted with a rotary file.
2. *Blending comparatively large areas.* Use the power unit in conjunction with polishing tool T.76755, fitted with an abrasive disc having a grade of grit appropriate to the depth of the damage or corrosion.
3. *Blending local indentations and restoring radii.* Use the power unit in conjunction with a spindle and a 12 in. length of 1 in. abrasive strip, having a grade of grit appropriate to the depth of damage; wind the abrasive strip around the end of the spindle as indicated in the inset on Fig. 5.
4. *Blending damage on the surface of the impeller back plate between the vanes.* It may be necessary to use extension T.78704 in conjunction with the spindle.
5. *Final polishing of all blended and repaired areas* must be done with the spindle wrapped with a fine grade abrasive strip, and must be continued until all traces of scratches have been removed.

DAMAGE AT ROOT OF LEADING EDGE, Fig. 6.

Damage at the root of the leading edge of an impeller vane, at the point where the leading edge is radiused into the impeller hub, may be repaired by blending within the limits indicated on Fig. 6. This repair may be applied to any one or more vanes up to all 19. The maximum permissible depth of the perpendicular cut-back is controlled by the distance from the impeller centre line (axis) at which the perpendicular cut runs out of the leading edge, and this distance becomes progressively less according to the extent to which the

impeller has been cropped. Therefore, before commencing this repair, check whether the impeller has been cropped, and if so, the extent of cropping. When applying this repair, remove as little material as possible consistent with complete rectification of the damage, so that the maximum amount of material remains for future repair; that is, keep the point at which the perpendicular cut runs out of the leading edge as close to the impeller hub as possible.

CROPPING

If the leading edge of one or more vanes is damaged beyond the limits specified in Table A, all the vanes must be cropped by machining their leading edges. To ensure that the maximum amount of material is left for future repair, the depth of machining must be limited to the minimum which will remove the deepest indentation. If cropping to the maximum angle indicated on Fig. 7 will not remove all traces of damage, reference should be made to the appropriate inspection authority.

1. Measure the bore of the impeller, Fig. 8. By reference to Table D, select the mandrel bush which will fit the impeller bore; each bush is marked to show whether it is for standard, or for one of the four oversizes.

TABLE D

BUSHES FOR TURNING MANDREL T.78083

Impeller Bore	Use Bush marked
2.5250 + .0005 in.	Standard
2.5350 + .0005 in.	T.R.222-1 (0.010 in. oversize)
2.5450 + .0005 in.	T.R.222-2 (0.020 in. oversize)
2.5550 + .0005 in.	T.R.222-3 (0.030 in. oversize)
2.5650 + .0005 in.	T.R.222-4 (0.040 in. oversize)

2. Place the selected bush, chamfered end first, on the larger of the ground diameters of mandrel T.78083, and align the small hole in the bush with the threaded hole in the mandrel. Secure the bush by screwing the 2 B.A. socket-headed screw into the mandrel. Ensure that the head of this screw does not project above the external diameter of the bush.
3. *Centre shaft studs and dowels removed.* Pass the mandrel into the impeller bore from the rear. Align the offset hole in the mandrel back plate with the corresponding offset hole in the impeller. By reference to Table E, select six bolts which will fit the threaded holes in the impeller, and secure the mandrel to the impeller by means of these bolts; *all the holes in the impeller may not be the same size, check each individually.*

TABLE E

BOLTS FOR TURNING MANDREL T.78083

For Stud Hole	Use Bolt
Standard	T.75003
0.007 in. oversize	T.79688
0.010 in. oversize	T.79689
0.015 in. oversize	T.79690
0.020 in. oversize	T.79691
$\frac{9}{16}$ in. B.S.F.	T.79692

Centre shaft studs and dowels in situ. Pass the mandrel into the impeller bore, so that the offset stud in the impeller rear face is aligned with the corresponding offset hole in the back plate of the mandrel. Secure the mandrel by tightening each of the six captive nuts on its back plate on to the adjacent studs in the rear face of the impeller.

4. Attach a carrier to the end of the mandrel which protrudes from the back plate, and mount the impeller between centres in a lathe, Fig. 8. Alternatively, the back plate end of the mandrel may be gripped in a chuck and the opposite end of the mandrel supported by the back centre.
5. Using a dial test indicator, check the rear face of the impeller for swash and eccentricity at the stations specified in chapter 38, and ensure that it runs true within the limits. Similarly, check the pivot or the front end of the impeller hub.
6. Mount the tool, cutting edge downwards, on the tool slide, Fig. 8.
7. Rotate the impeller slowly, by hand, and identify the vane, if any, whose leading edge projects the most. Set the cross slide so that the tool can be traversed parallel to the leading edge of this vane. If the angle at which the cross slide is set, is equal to, or greater than, the maximum cropping angle, Fig. 7, and runs out at the point where the leading edge is radiused into the hub, it is probable that the impeller has been cropped to the greatest permissible extent already and reference should be made to the appropriate inspection authority before proceeding.
8. When the results of the foregoing checks are satisfactory, set the cross slide to a slightly greater angle than that found by Op. 7 but less than the maximum cropping angle. Try to select the smallest angle which will enable all traces of damage to be machined away but will at the same time leave the maximum amount of metal for future repair.
9. Set the lathe so that it will run at about 36 r.p.m. in the opposite direction to its normal direction of rotation, as indicated by the arrow on Fig. 8.
10. Start the lathe and commence to feed the tool by hand; to minimise the possibility of removing too much metal, or setting-up machining stresses, only a very light cut (about 0.008 in.) should be taken. Do not remove more metal than is essential to clean up the deepest indentation, and do not exceed the maximum cropping angle indicated on Fig. 7; take care to ensure that metal is not removed from that portion of the vane which lies within 0.430 in. of the impeller hub.
11. Remove the impeller from the lathe, and remove the mandrel.

12. Mount the impeller on the scurfing stand, as described on page 3.
13. Restore the radius along the whole of the leading edge of each vane by blending (as indicated by Sections W-W, X-X, Y-Y, and Z-Z on Fig. 7). Polish all newly machined surfaces until a smooth, scratch-free finish is attained.

AFTER BLENDING OR CROPPING

After the impeller has been repaired by blending or cropping, reconditioning must be completed as follows.

1. Remove the anodic film by vapour blasting as described on page 9.
2. If necessary, scurf and polish to remove any traces of corrosion exposed by the initial stage of vapour blasting—refer to removal of extensive corrosion below.
3. Check the thickness and frequency of each impeller vane as described in chapter 27B, pages 3 and 5.
4. Clean the impeller by repeating the final stage of vapour blasting.
5. If this is the first time that the impeller has been repaired, lightly stamp T.R.357 adjacent to the existing part number.
6. Re-anodise the impeller as described on page 12.
7. Apply Rockhard lacquer to the front face of the impeller.

REMOVAL OF EXTENSIVE CORROSION AND ITS EFFECT ON VANE FREQUENCY

Alterations made to the general thickness of an impeller vane may affect its fundamental vibra-

tion frequency, and it is important to avoid causing undesirable low frequency characteristics in a reconditioned impeller. As a guide, an impeller vane can be divided, by eye, into three zones of approximately equal axial length, Fig. 9, and when scurfing the vanes to remove extensive corrosion, the following points should be borne in mind.

1. If the middle region, zone 2, has to be scurfed extensively, zones 1 and 3 should be thinned to a similar extent.
2. If the scurfing is confined to zone 1 or 3, these zones can be thinned individually, without any corresponding thinning of either of the other zones.
3. If it is necessary to scurf an extensive area in the root region, the area radially outboard of that region must be thinned to a similar extent.
4. In any zone, except in small areas which have been blended within the limits given in Table C, the vane thickness after scurfing must not be more than 0.040 in. below the nominal thickness, which is indicated on gauging mask T.78770 and measured with caliper gauge T.74310; chapter 27B, page 3.

RECORDING

When the impeller has been reconditioned satisfactorily, a clear record must be made of the work which has been done.

DYNAMIC BALANCING

Dynamic balancing of the main shaft assembly, including the impeller, is a standard part of the reassembly and is described in chapter 33A, pages 11 and 21.

PAGES 6, 7, 8, 9, AND 10

Pages 6, 7, and 8 have been withdrawn as the information previously given on these pages is now included on pages 2 to 5 inclusive. In effect, the folding sheet bearing Fig. 1 to 9 replaces these three pages.

As a result of the introduction of revised pages 1 to 5 inclusive, **the following handwritten amendments should be made on pages 9 and 10.**

Page 9. Delete the first 9 lines at the top of the left-hand column.

Page 9, Vapour Blasting, 15th and 19th lines, alter "Fig. 8" and "Fig. 9" to read Fig. 8a and Fig. 9a.

Fig. 8 on page 9. Re-number Fig. 8a.

Fig. 9 on page 10. Re-number Fig. 9a.

See jpeg image

for fig 1 to 9

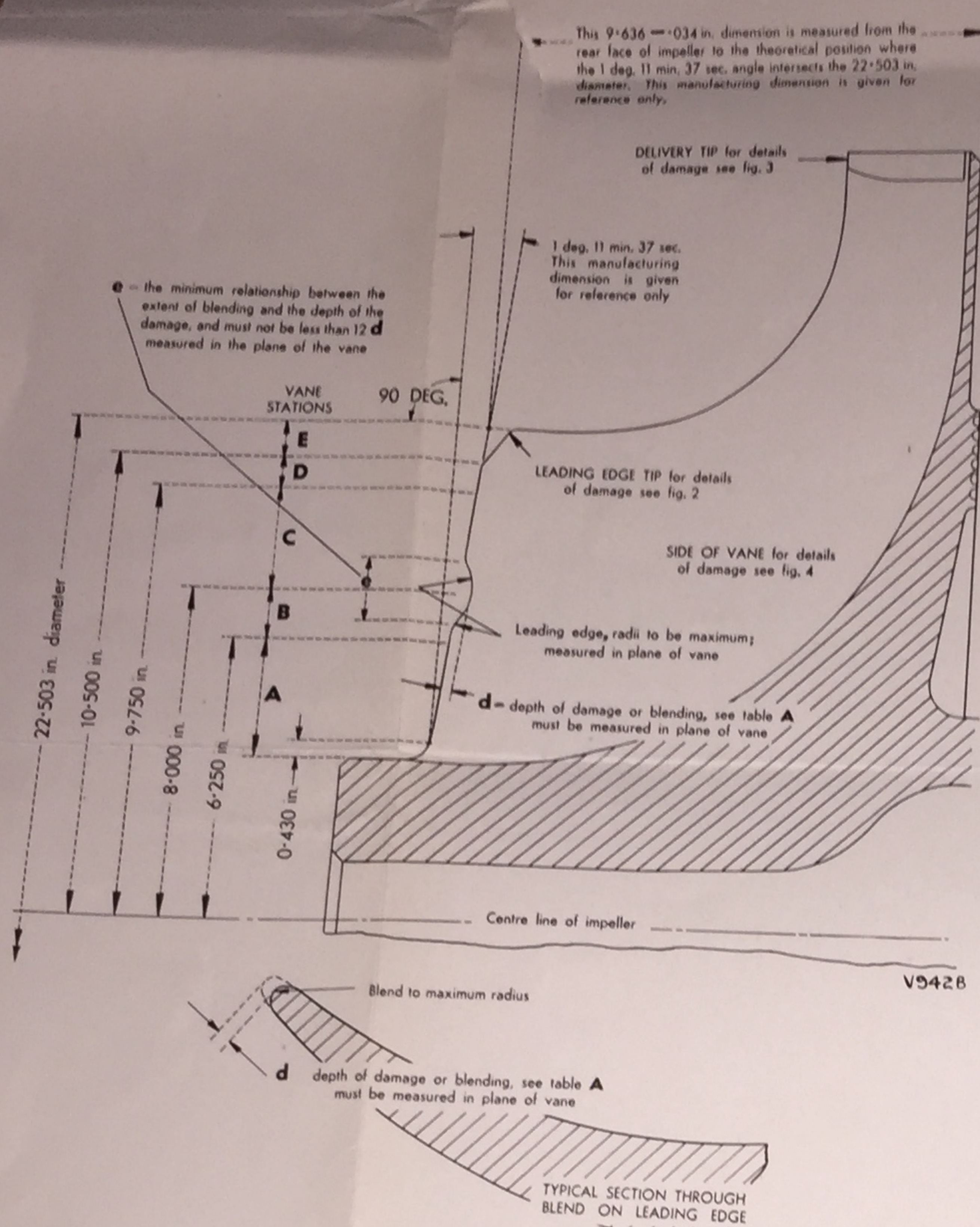


Fig. 1 Damaged impeller vane showing stations at which repairs by blending are permissible

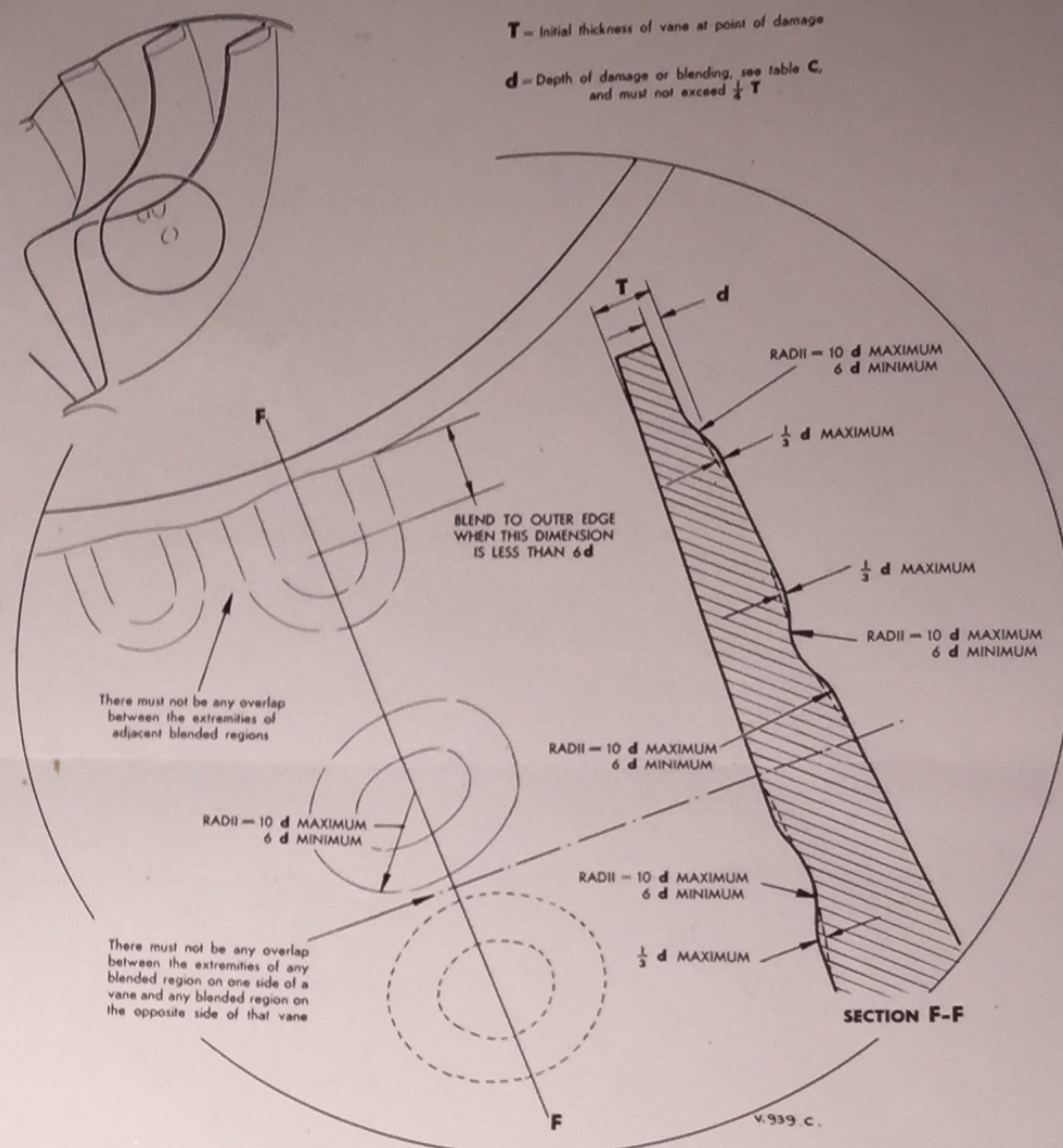


Fig. 4 Rectification of damage on side of vane, see table C

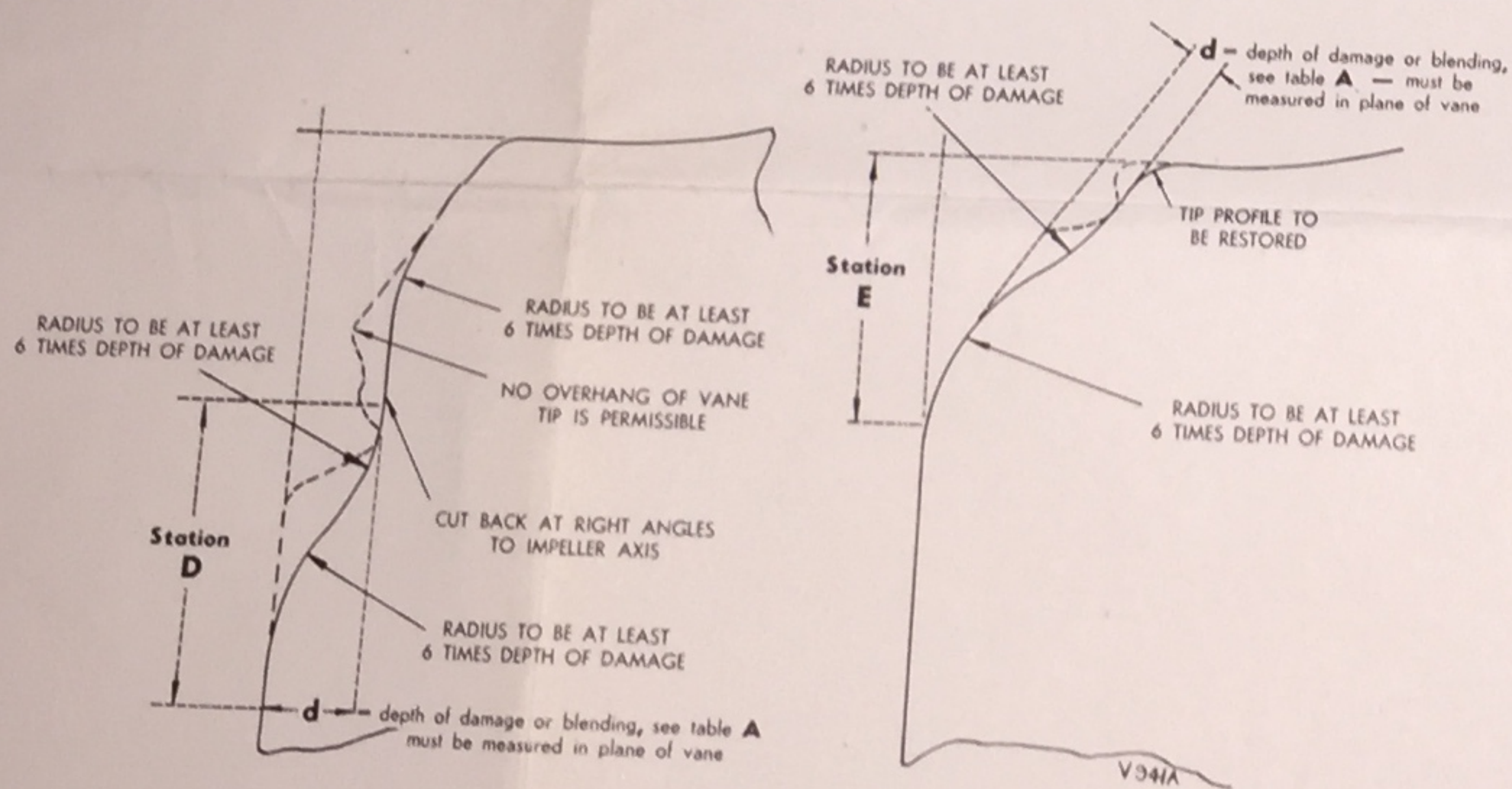


Fig. 2 Examples of rectification at tip of leading edge; stations D and E on Fig. 1, see also table A

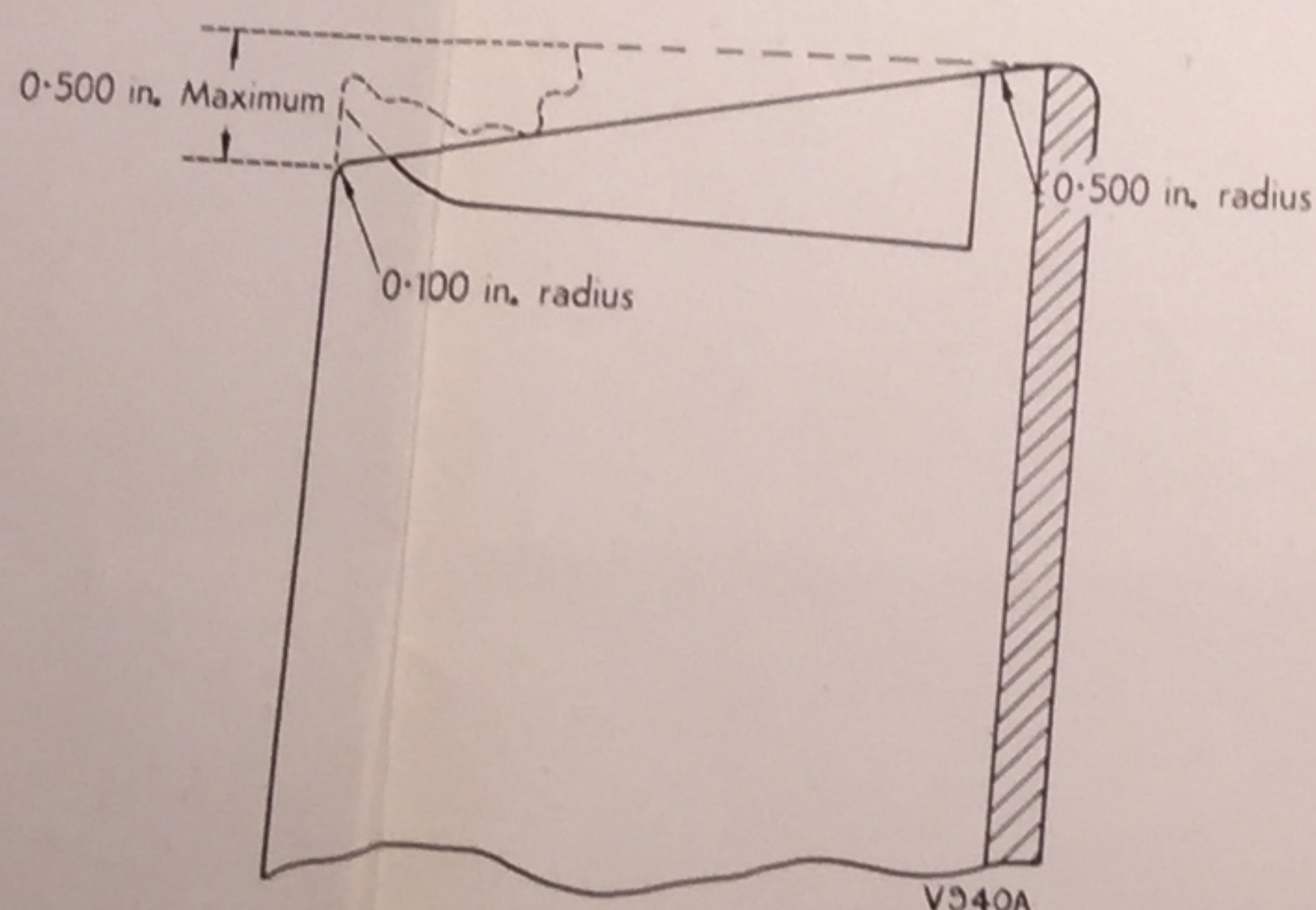


Fig. 3 Rectification at delivery tip, permissible on one vane only

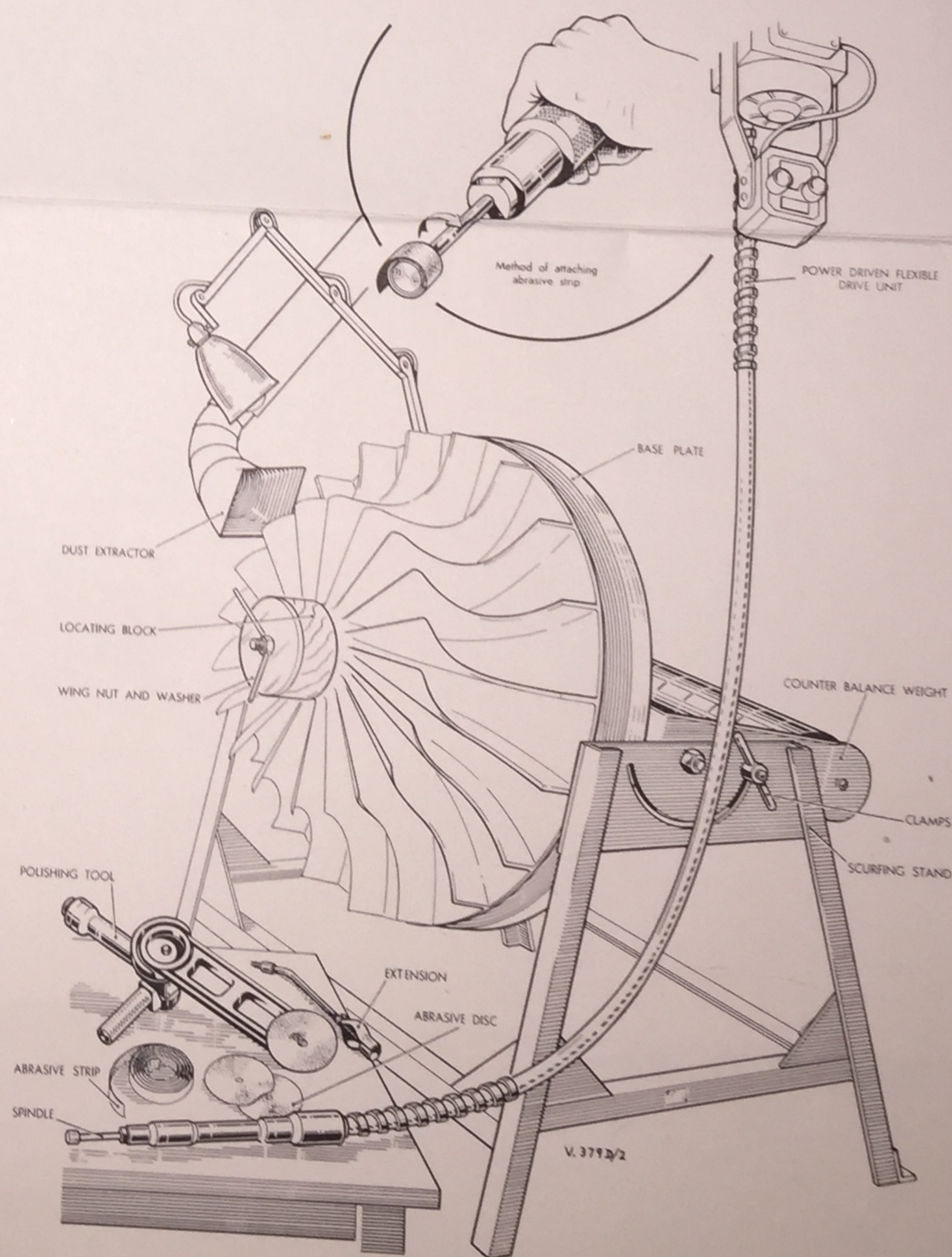


Fig. 5 Impeller attached to scurfing stand and equipment required for blending and polishing damaged vanes

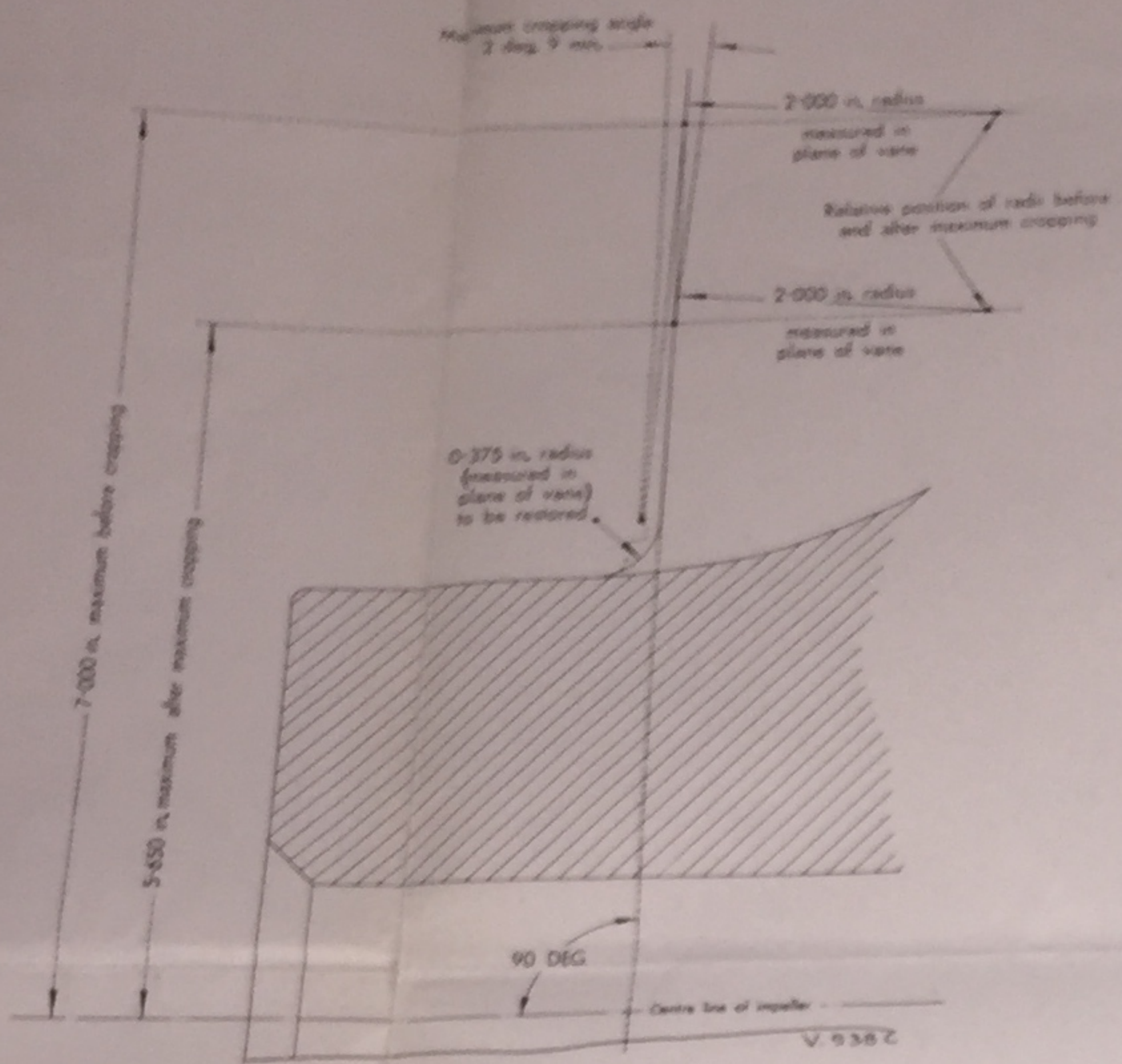


Fig. 6 MAXIMUM rectification of damage to the root of the leading edge

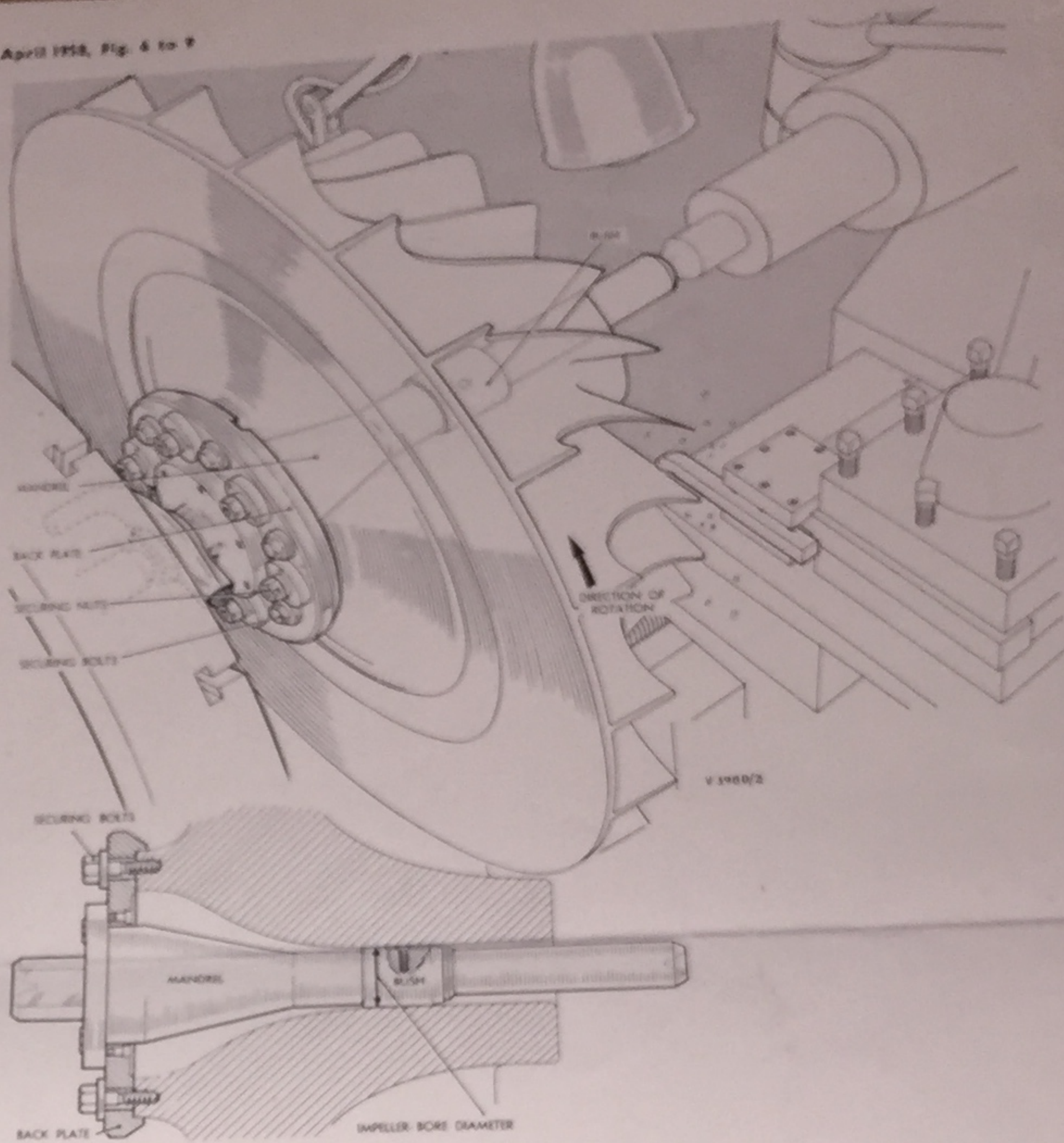


Fig. 8 Cropping impeller vanes

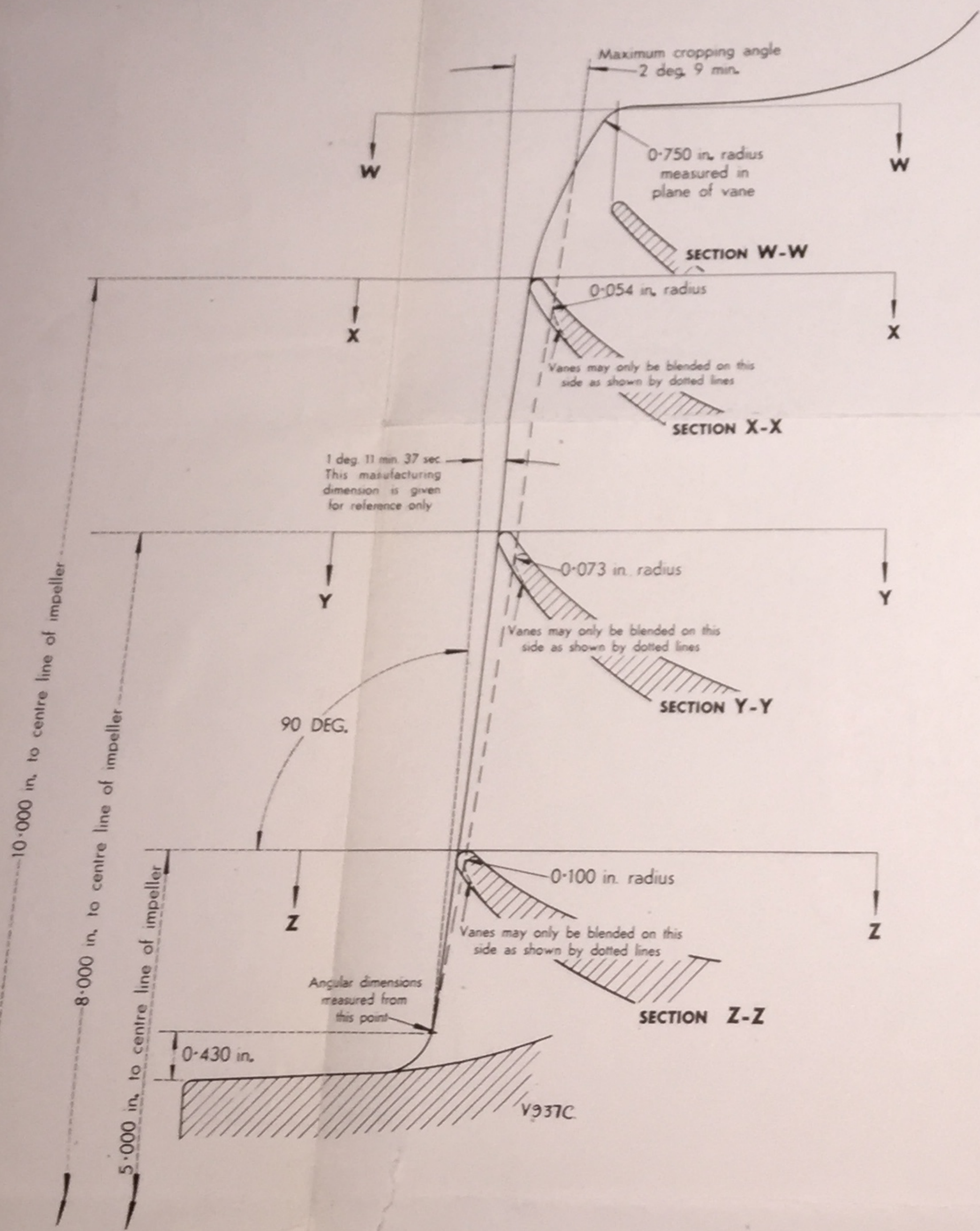


Fig. 7 Limits of repair by cropping leading edge of vane

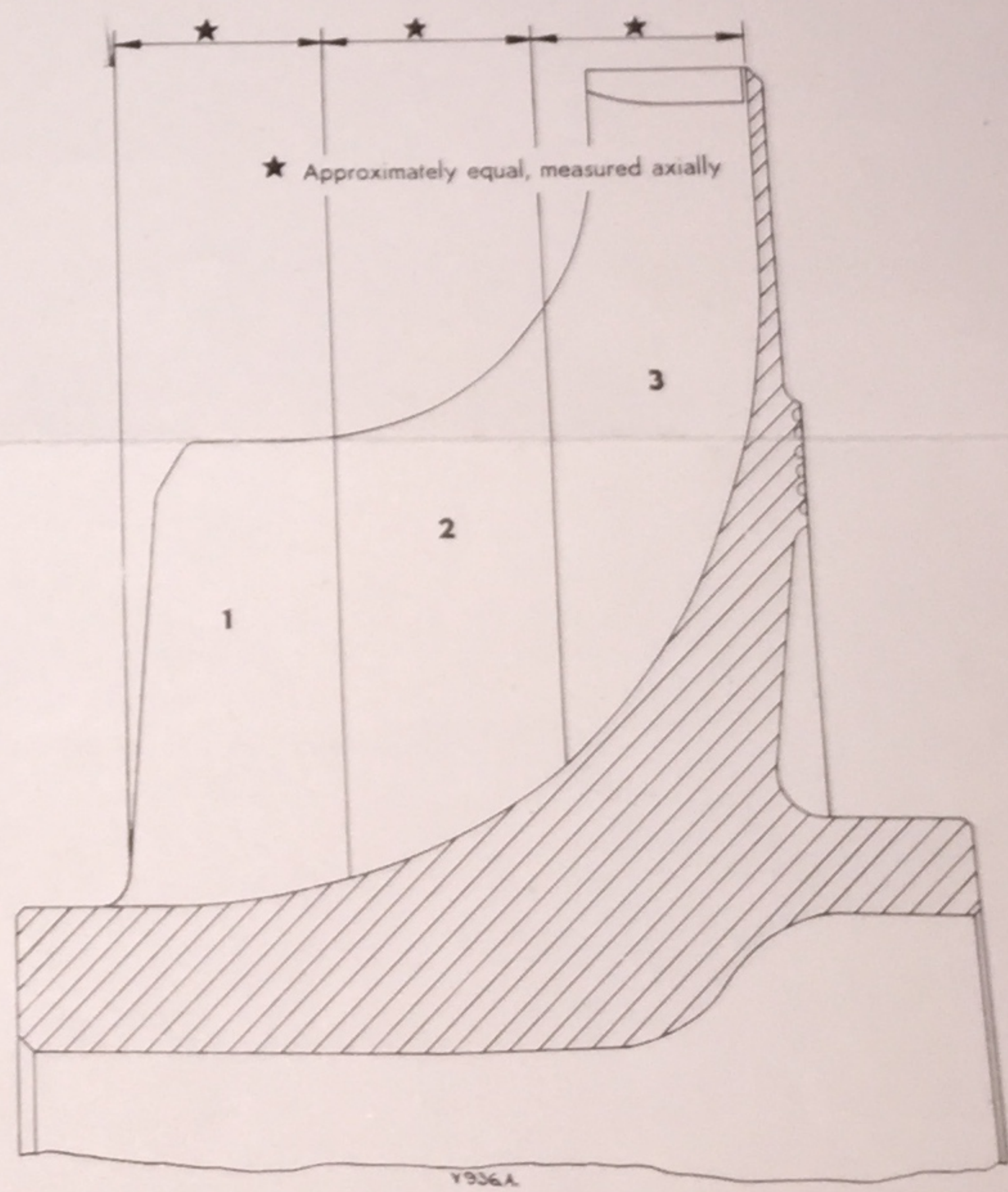


Fig. 9. Diagram indicating the three zones referred to in para. 12.

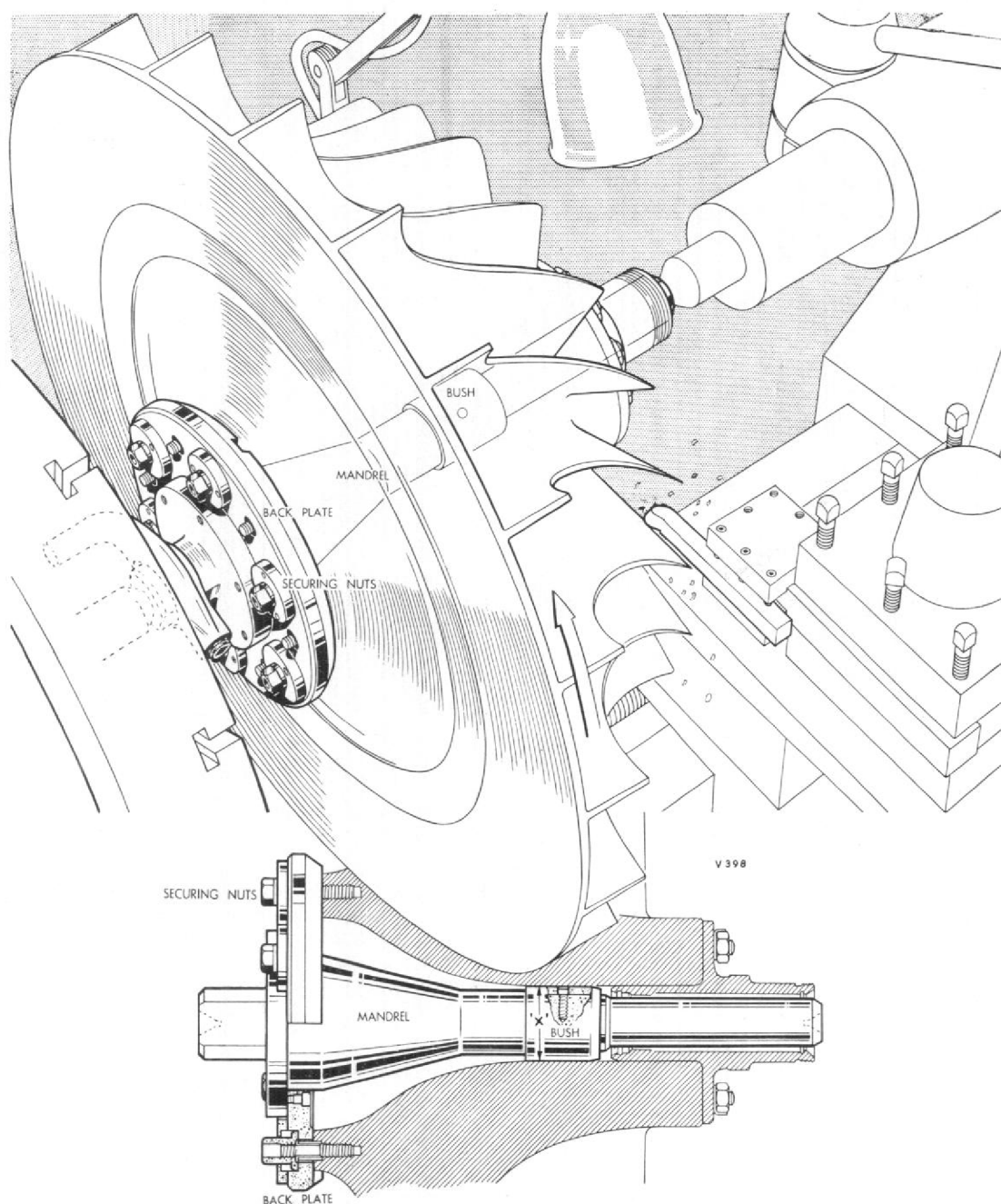


Fig. 6. Impeller loaded between lathe centres for cropping the vanes. The lower sectioned view shows the assembly of turning mandrel T.78083 to the impeller.

Fit the appropriate bush to turning mandrel T.78083 and lock by screwing in the 2 B.A. cap screw. Assemble the turning mandrel to the impeller as shown in Fig. 6, and secure by screwing the six nuts in the back plate on to six existing $\frac{1}{2}$ inch B.S.F. studs in the impeller rear face, ensuring that the offset stud in the impeller aligns with the offset nut in the back plate.

If the studs, dowels, and pivot have been

removed, use mandrel T.76756 for a standard impeller bore, or, T.77375 and the appropriate size of bush from those listed:—

Diameter 'X' in inches	Use bush Part No.
2.5350 + .0005	T.77376 (.010 o/size)
2.5450 + .0005	T.77377 (.020 o/size)
2.5550 + .0005	T.77378 (.030 o/size)
2.5650 + .0005	T.77379 (.040 o/size)

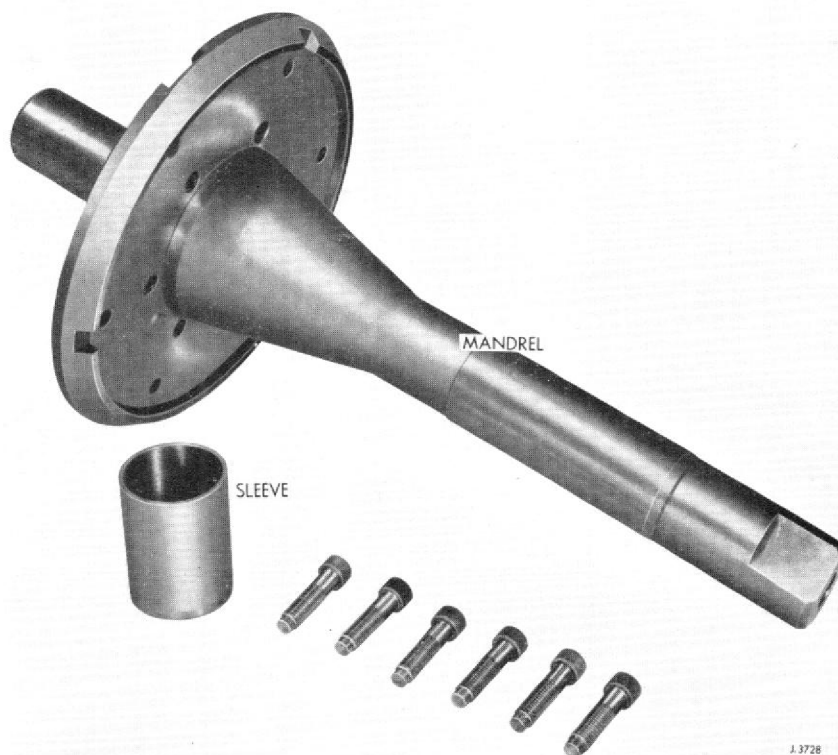


Fig. 7. Turning mandrel, with bush and special screws, used as an alternative to mandrel T.78083 (Fig. 6) when the studs, dowels, and pivot have been removed from the impeller.

Fit the appropriate bush to mandrel T.77375; assemble to the impeller, as for mandrel T.78083 (Fig. 6), and secure by selecting and screwing six special screws into the stud holes in the rear face, Fig. 7.

Stud hole size	Screw Part No.
Standard $\frac{1}{2}$ inch B.S.F.	T.76761
0.007 inch oversize	160320
0.010 inch oversize	160321
0.015 inch oversize	160322
0.020 inch oversize	160323

Load the complete assembly to a suitable centre lathe having sufficient face plate swing for this purpose (Swift, type 16 L S or similar), for turning between centres. Attach a suitable carrier pin to the end of the mandrel protruding from the back plate (Fig. 6). Secure the end of the carrier pin to the face plate or chuck to provide the drive. Rotate the impeller and check for concentricity. Fit a suitable tool to the tool slide (Jessop Saville Arkweld No. 1, H/S tip, 11 degree top rake, or similar). Set the tool slide to feed in along the leading edge of the highest vane at the angular dimension required, and test for accuracy. Selection of the highest vane—when the vanes have been previously rectified—is particularly important, as the leading edge of one or more vanes may vary in height and profile. Select a rotational speed

of 100 r.p.m. with the impeller rotating opposite to the normal direction of rotation; start up, and commence to feed in by hand. Cut the vanes to the required depth, which as already specified, must be to the depth of the deepest indentation and not exceeding a maximum depth of 0.250 inch in the plane of the vane at the tip of the leading edge or an angular dimension of 2 deg. 9 min. To obviate any possible damage, excess machining, or machining stresses, a very light cut (not exceeding .008 inch) should be taken and the depth of machining checked periodically. On completion, remove the assembly from the lathe and dismantle the turning mandrel from the impeller.

Sides of vanes

The maximum depth of blended indentation must not exceed $\frac{1}{4}$ T where "T" is the initial thickness of the vane at the point of damage.

Where "d" is the given depth, the radius of the blend must not be less than 6 d, and dimension "G" (see Section F-F, Fig. 3) must be less than 6 d.

Delivery tip of vanes

One vane only may be blended at the delivery tip, and the depth of blending must not exceed

the maximum of 0.500 inch indicated at the top right of Fig. 3.

On completion of all blending operations, proceed with operation 4 et seq. (page 2) by referring to the page or chapter specified.

When operations 1 to 11 have been completed, etch T.R.357 adjacent to the existing part number. Make an entry in the appropriate record book of the engine.

VAPOUR BLASTING, IMPELLER

(D.H. Process Specification: No. 140/1, September, 1955)

Vapour blasting is a finishing operation applied to the impeller after any rectification of damaged vanes which has resulted in partial, or extensive, removal of the protective anodic film. This process, which will produce a uniform finish, must be applied following the removal of the Rockhard lacquer and before re-anodising. With the exception of certain small areas of the impeller which will be masked, the whole of the impeller must be vapour blasted, regardless of the extent of rectification carried out, as the anodic oxidation process cannot be applied over the original anodic film; therefore, the whole of the original film must be stripped by vapour blasting. Provided that the special masks illustrated in Fig. 8 are used, all the studs, dowels, and the pivot may be left in situ throughout the process. If these masks are not available, then the masks, fibre plugs, and rubber bung illustrated in Fig. 9 must be fitted to the impeller after the studs, dowels, and pivot have been removed. At the first sign of wear or perishing of the rubber sealing surfaces incorporated in the masks, the rubber

sealing must be renewed or the mask concerned replaced by a serviceable mask.

This operation consists, essentially, of projecting a jet of water in which a suitable abrasive is suspended, on to the impeller. The operation is carried out in three distinct stages, using coarse, medium, and fine grades of abrasive in turn. Alternatively, a two stage process may be applied using the abrasives specified on page 10. For convenience, each stage is applied in a separate blast cabinet, charged with the appropriate grade of abrasive. A single blast cabinet may be employed for the complete process, provided that, after each stage, the cabinet is completely drained and thoroughly washed free of the preceding grade of abrasive before it is charged with the next grade. If this is done, the liquid and abrasive removed from the cabinet should be retained in a suitable container, until required for further use. Although the use of a single cabinet may appear, initially, to be more economical, it is rendered somewhat prohibitive by the time consumed in changing the grade of abrasive.

The normal plant (Fig. 10), which is supplied by Abrasive Developments, Limited, is of unit construction and consists of: a loading platform, blast cabinet No. 1 and water-wash bay, blast cabinet No. 2 and water-wash bay, blast cabinet No. 3 and water-wash bay, and an unloading platform. The impeller is supported on a special turn-table, which is mounted on wheels running on a pair of rails which extend through the plant, thus minimising the need to man-handle the impeller from one stage to the next. A mobile lifting tackle, slung from a rail above the plant, will facilitate the loading and unloading of the impeller, and also assist in turning

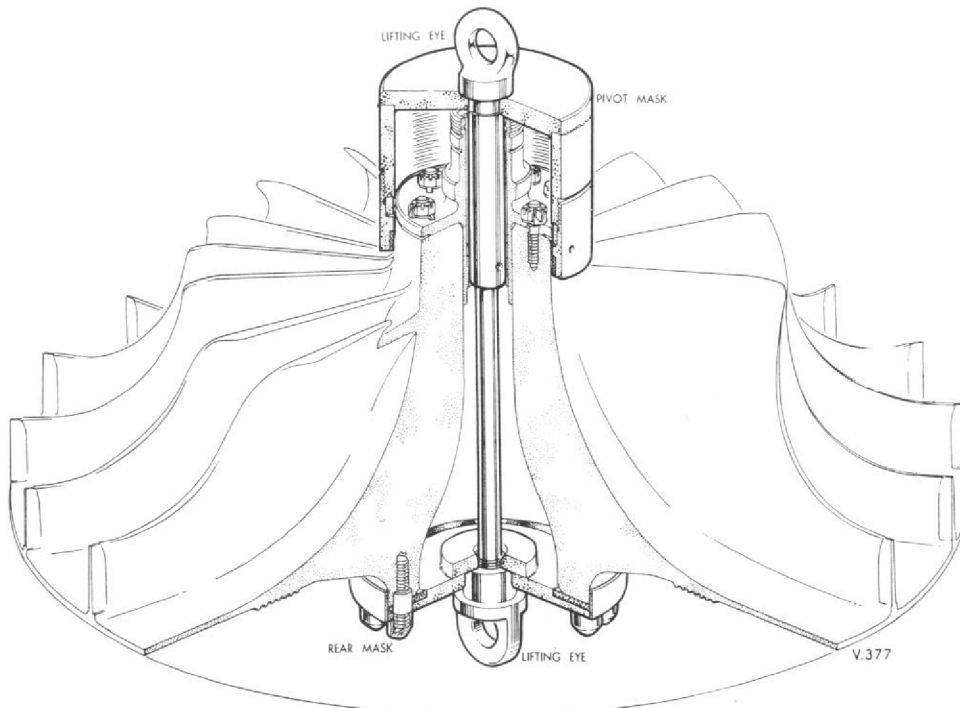


Fig. 8. Assembly of vapour blast masks to the impeller when the studs, dowels, and pivot are in situ. The labyrinth grooves are protected by the mask shown in Fig. 9.

the impeller over in order to vapour blast its rear face.

Each blast cabinet is equipped with an air-operated window wiper and water spray, a manually controlled air-pressure valve, an air-pressure gauge, a water hose-pipe, an air-operated piston-type pump, a pump control valve, an internal header tank, fluorescent lighting, and a fume-exhausting duct. If the plant is to be operated in a cold climate, each cabinet should be provided with submerged steam coils, or an immersion heater, to counteract the chilling of the operator's hands during blasting.

To ensure that the abrasive remains suspended in the liquid, agitation is provided, at the lowest part of the sump, by water spilling from the header tank overflow pipe. In the cabinet charged with the coarse grade of abrasive, this means of agitation may prove insufficient, and a supply of compressed air, introduced at the lowest point of the sump in this particular cabinet, may be used to provide more violent agitation. During blasting, the water is automatically kept in a clean condition by the water from the window-spray, which flows into the sump; any excess water in the sump draining away through the sump overflow pipe.

In the blast gun, compressed air is fed through the nozzle shroud and the water carrying the abrasive is fed through the nozzle centre. As, therefore, the abrasive mixture is not accelerated until after it has left the blast gun nozzle, wear at the nozzle tip is negligible.

The operator, wearing heavy rubber gloves and apron, stands outside the cabinet with his hands

inserted through a pair of rubber sleeves fitted in the front of the cabinet, so that he can apply and control the process as required, observing the progress of the operation through the window provided.

The abrasive mixture should consist of one part, by volume, of the appropriate grade of 'Uniblast' which is supplied by The Universal Grinding Wheel Company, or 'Blastyte' which is supplied by Tilghams & Company, Limited, to two parts, by volume, of tap water to which has been added three fluid ounces per gallon of potassium dichromate to discourage the formation of rust within the blasting equipment—that is 28 pounds of abrasive to 10 gallons of water containing 30 fluid ounces of potassium dichromate; this being the capacity of the sump in each cabinet.

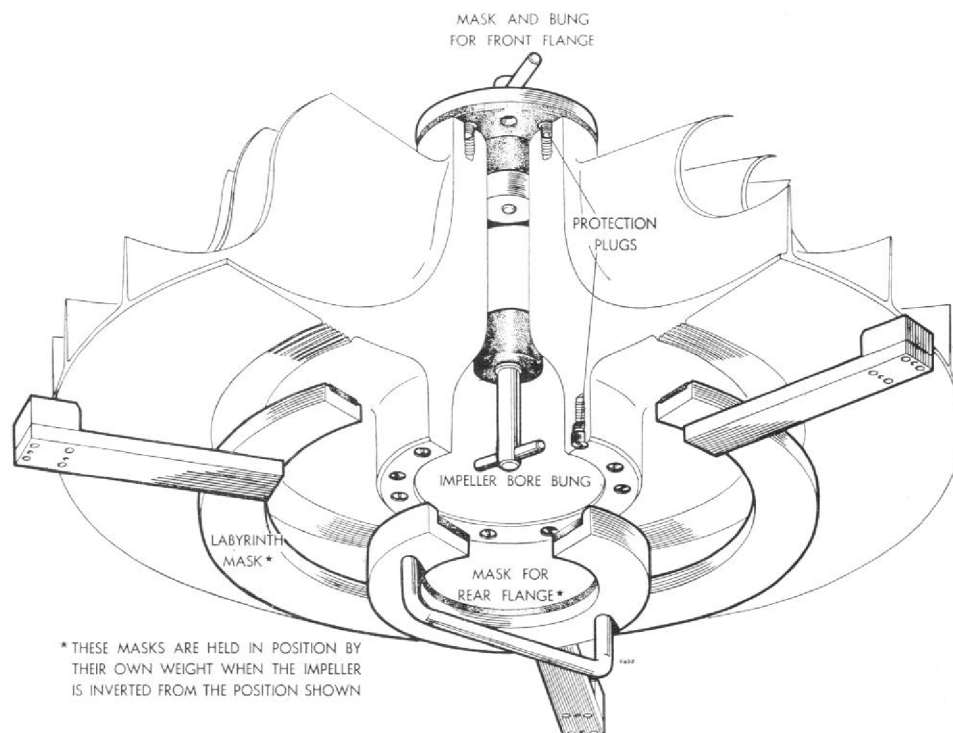
The correct grades of abrasive to be used when vapour blasting a Ghost impeller are:—

Cabinet	Abrasive grade	'Uniblast'*	'Blastyte'*
No. 1	Coarse	60-80	4
No. 2	Medium	80-120	6
No. 3	Fine	400 F.V.B.	D

* Alternative brands of abrasive

As an alternative to the above three stage process, a two stage process may be applied, using Brown Bauxilite 100 abrasive followed by Blastyte D.

When the plant is fully charged with abrasive and water and is in continual use, test samples of the abrasive mixture issuing from the blast gun nozzle—without the air blast—should be taken once a week. The test sample, which should be contained in a 2000 cc. measuring glass, should be stood



* THESE MASKS ARE HELD IN POSITION BY THEIR OWN WEIGHT WHEN THE IMPELLER IS INVERTED FROM THE POSITION SHOWN

Fig. 9. Assembly of vapour blast masks to the impeller when the studs, dowels, and pivot have been removed.

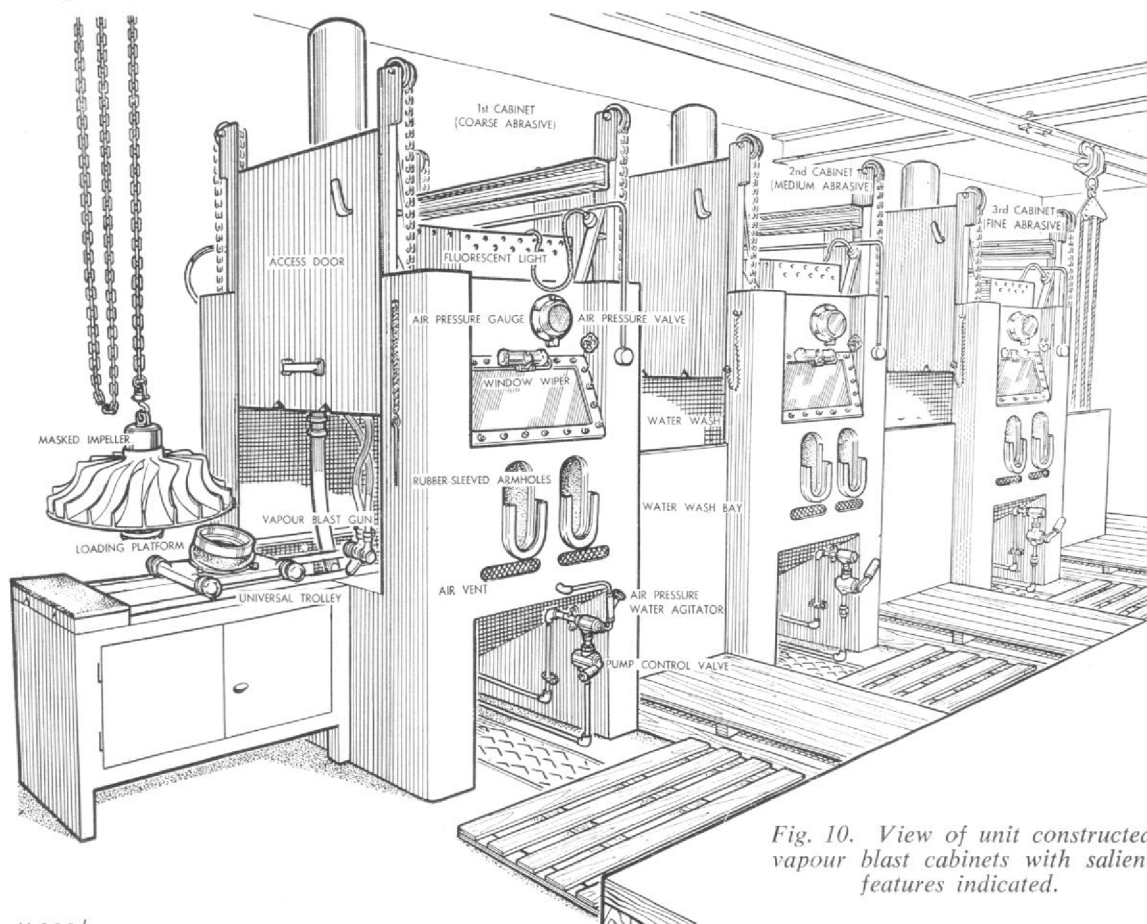


Fig. 10. View of unit constructed vapour blast cabinets with salient features indicated.

V.322/1

to allow the abrasive to settle. If the fines, or broken abrasive, exceed 10% by volume, the abrasive in the cabinet concerned should be renewed.

In the following detailed description of the procedure for vapour blasting an impeller in preparation for re-anodising, it is assumed that the cabinets are empty; normally, of course, they will be charged with abrasive and water and, therefore,

some of the operations described will be unnecessary. All rectification of impeller vane damage must be completed, and all traces of Rockhard lacquer removed before the impeller is passed for vapour blasting.

Screw lifting eye T.72476 on to the pivot, or, if the pivot has been removed, use three-point lifting sling T.76768; degrease the impeller in the vapour of a trichlorethylene vapour degreaser, and then transfer and secure it to cradle trolley T.76578 (Fig. 11).

If the studs, dowels, and pivot are to be left in situ, assemble mask T.78049 over the pivot, passing the mandrel down through the pivot bore (Fig. 8). Assemble mask T.78048 to the rear face in correct relationship to the offset stud. Tighten by screwing the lifting eye on to the threaded end of the mandrel. The labyrinth grooves must be protected by mask T.76763 placed over the grooves and held in position by its own weight when the impeller is in the inverted position.

If the studs, dowels, and pivot have been removed, fit twenty-two fibre plugs T.76759 into the centre shaft and pivot stud holes in the impeller (Fig 9). Unscrew the handle of pivot mask T.76755 until the rubber sleeve will enter the impeller bore; press the flange firmly down on to the face of the impeller; hold the extension, and

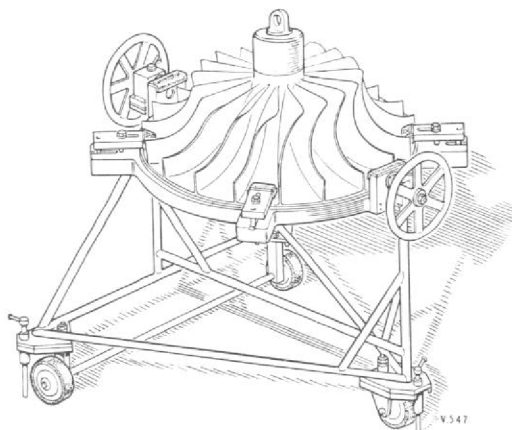


Fig. 11. Impeller clamped on cradle trolley T.76578.

at the same time screw down the handle until the rubber sleeve is compressed, thus sealing the impeller bore against ingress of grit during the process. Seal the opposite end of the bore by firmly inserting bung T.76760. When the impeller rear face is ready for vapour blasting, the labyrinth grooves and the rear face of the spigot must first be protected by placing in position labyrinth mask T.76763 and mask T.76757; these masks are held in position by their own weight only.

Commence by filling the sump in No. 1 cabinet with ten gallons of tap water containing the quantity of potassium dichromate specified already. Open the main valves controlling the supply of water and compressed air to the cabinet. Turn on the pump priming valve—usually situated at the rear of the cabinet—until water trickles from the blast gun nozzle. Start the pump, by opening the valve situated at the top right of the front panel.

Pour 28 pounds of either of the alternative coarse grade abrasives specified down the sump chute, just in front of the flow of water issuing from the blast gun nozzle.

Transfer the impeller from the cradle trolley to universal trolley T.78046 on the loading platform of No. 1 vapour blasting cabinet. Mark the rotatable part of the turn-table, to indicate the commencement and completion of vapour blasting and thus ensure that the operation will not be repeated on an area which has been vapour blasted already. Push the trolley carrying the impeller into the cabinet and close the access door. Turn on the window water-spray and wiper. Hold the blast gun firmly and turn on the air supply.

Commence vapour blasting the unmasked area of the impeller front face, starting at the marked point and turning the table as necessary until the marked commencing point is reached again. The extent of the application of this process will be arrived at through experience, and if any doubt exists the impeller should be washed and inspected periodically during vapour blasting. Patchy removal of the anodic film indicates insufficient agitation of the abrasive mixture and/or that the pumping rate is too fast.

When the first stage of vapour blasting is considered to be satisfactorily completed, turn off the air supply to the blast gun, and wash off the abrasive adhering to the impeller by means of the water hose situated inside the cabinet. Open the second access door and pull the trolley carrying the impeller out of the cabinet into the wash bay. Thoroughly wash off any remaining abrasive and inspect; the impeller should have a uniform matt finish. It is not uncommon for the initial stage of vapour blasting to expose further evidence of corrosion not previously visible; if this occurs, the impeller may be transferred to scurfing stand T.76767 or T.78731 and resurfaced to remove the corrosion in accordance with the method described in T.R.357.

If inspection is to be carried out at any stage between the vapour blasting operations, immerse the impeller in boiling water and dry off with an

air blast. The impeller must not remain in a dry state for more than three hours because of the risk of corrosion. Protective treatment, such as direct dewatering in 'Dicks ILO No. 5 oil' or drying and coating with temporary rust preventative—a mixture of lanolin and white spirit—to British Specification D.T.D.121D, should be applied if the impeller is delayed between vapour blasting operations. These protective treatments confer protection for periods of up to six days and one month respectively.

Invert the impeller on the universal trolley, and if the pivot has been removed, place labyrinth mask T.76763 over the grooves, and mask T.76757 over the rear face of the impeller spigot. If the pivot is in situ and masked as previously specified, it will only then be necessary to mask the labyrinth grooves, before vapour blasting the unmasked area of the impeller rear face. These masks are held in position by their own weight only. Return the impeller to the cabinet and close the access door. Hold the blast gun firmly, turn on the air supply, and repeat the vapour blasting on the rear face of the impeller. On completion wash off the adhering abrasive, remove the impeller from the cabinet, and finally wash off in the wash bay.

Repeat the foregoing sequence of operations in No. 2 and subsequently in No. 3 cabinet, using the appropriate grade of the abrasive specified.

On completion of the final inspection, carry out dimensional checks and if necessary, frequency checks (see chapter 27). If a delay exceeding three hours is envisaged, apply protective treatment as described above.

RE-ANODISING, IMPELLER

Conforms to British Specification D.T.D.910B, Part 2

Equivalent D.H. Process Specification: No. 113/3, September, 1951

This anodic oxidation process provides the impeller with a corrosion-resisting surface which is in all respects identical with the finish of a new impeller. Partial, or extensive, removal of the original anodic film, during the rectification of vane damage, cannot be replaced locally but necessitates the complete removal of the remaining anodic film by vapour blasting, which leaves the impeller in a raw state ready for re-anodising. The anodic process also facilitates flaw detection of the impeller which is normally carried out in order to detect any cracks that may have developed during service. Before applying this process, and immediately following the dimensional and if necessary frequency checks, the impeller must be cleaned by a re-application of the vapour blast process with the fine grit.

Provided that the special masks are used, it is permissible to re-anodise an impeller without removing the studs, dowels, and the pivot. The method of protecting these steel components from the deleterious effects of the chromic acid used in the process, is illustrated by the sectioned assembly

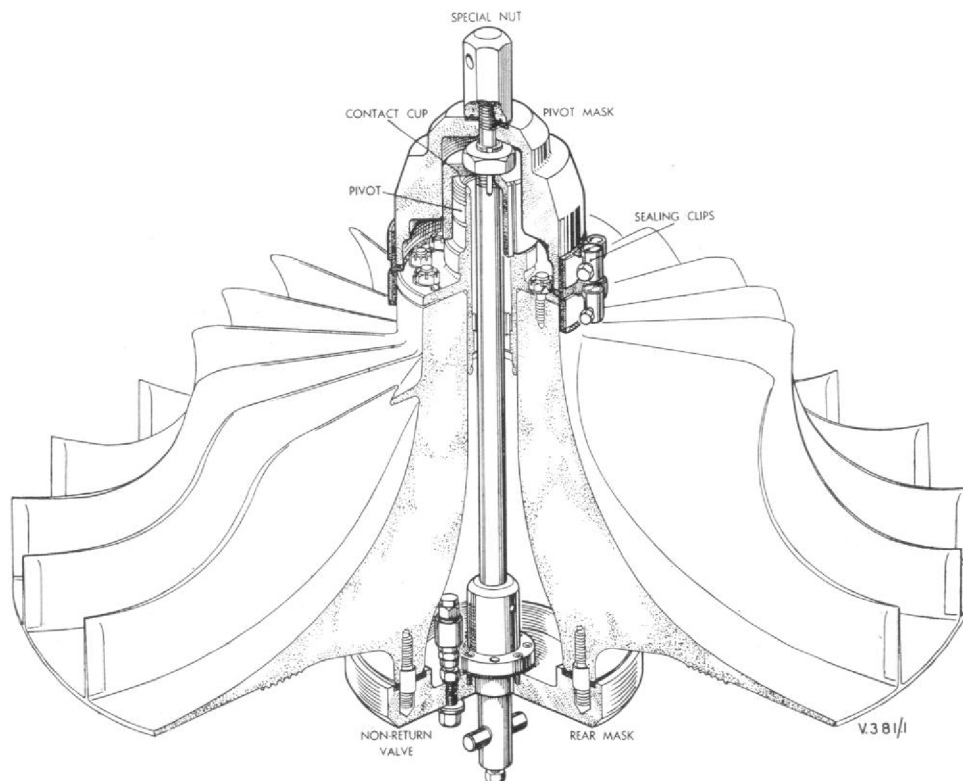


Fig. 12. Assembly of anodic masks to the impeller.

view of the masks and impeller in Fig. 12. The rubber seals incorporated in the masks must be rigidly inspected at frequent intervals, and at the first sign of wear or perishing, the seals must be renewed, or the masks returned to the manufacturer for reconditioning.

The composition of the electrolyte must be: chromic acid 2 to 6% by weight in distilled water. The electrolyte should be maintained at a temperature of 104 ± 4 deg. F. (40 ± 2 deg. C) during re-anodising.

The chromic acid electrolyte should be contained in a mild steel tank which should be equipped with steam heating coils, cooling coils, and a suitable fume extractor. Efficient, but not violent agitation of the electrolyte, either by air or mechanical means, is essential.

The cathodes must be composed of stainless steel sheet, to British Specification D.T.D.171, securely attached to the cathode rail to prevent movement during agitation of the electrolyte.

Tanks, containing cold water and warm water, will be required for washing and rinsing purposes, and, also, a tank containing a solution of 'Zonax' and water—6 to 8 oz. of 'Zonax' to each gallon of tap water—which must be maintained at a temperature just below boiling point.

The method of suspending the unmasked impeller in the electrolyte is illustrated in Fig. 13. The fixture consists of two individual tools—the grab T.75868 and the mandrel T.75869—which combine to hold the impeller at an angle. The mandrel plate is bolted to the rear face of the impeller by means of a slave set of $\frac{1}{2}$ in. B.S.F. duralumin bolts. The components of this fixture should be inspected periodically, as the arms of the grab, and the bolts in the mandrel, tend to corrode after extensive use. The impeller is suspended in the tank containing the electrolyte by resting the cutaway section of the three arms of the grab on two brass bars set across the tank, these bars providing the necessary electrical contact. Before each re-anodising operation, the contact areas of the fixture—holes, pins, bolts—which are immersed in the electrolyte during the process, must be cleaned free of anodic film by polishing with emery cloth.

The method of suspending the masked impeller in the electrolyte, is by means of grab T. which is hooked on to the end of the mandrel protruding through the rear anodic mask. The other end of the grab is hooked over the two brass bars across the tank (Fig. 14). It should be noted, that this grab must not be immersed in the electrolyte, and during the process the level of the liquid must therefore not extend above that indicated in

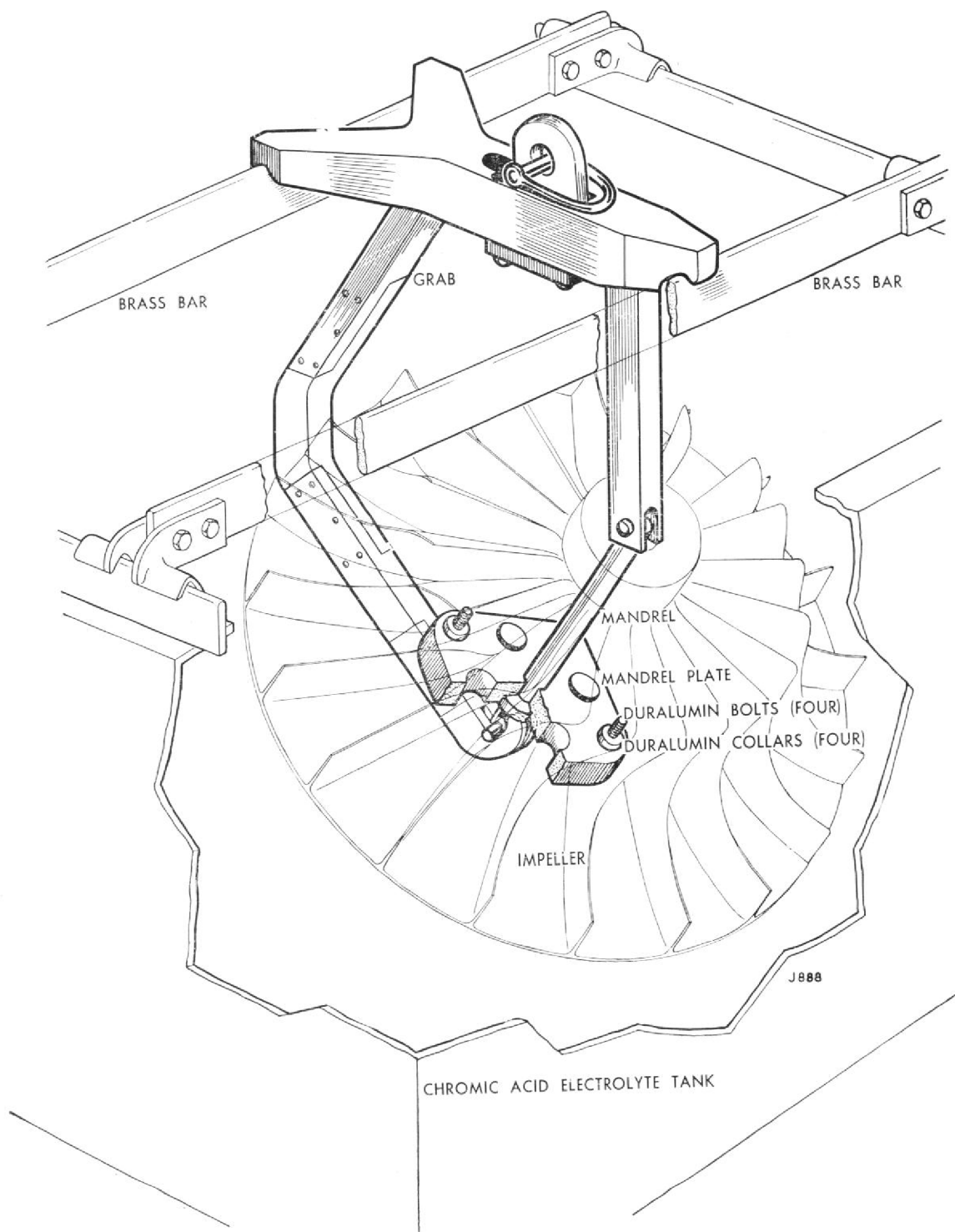


Fig. 13. Method of suspending the impeller in the electrolyte, using grab T.75868 and mandrel T.75869.

Fig. 14. The components of the masks with extensive use may become corroded, therefore, they should be inspected at periodic intervals.

A metal cradle will be required on which the impeller may rest on completion of the process.

The points at which the impeller will contact the cradle must be covered with a non-absorbent material; such as rubber or plastic. These points must be perfectly dry before the impeller is placed on the cradle. The use of a cradle made of wood, or any other absorbent material, should not

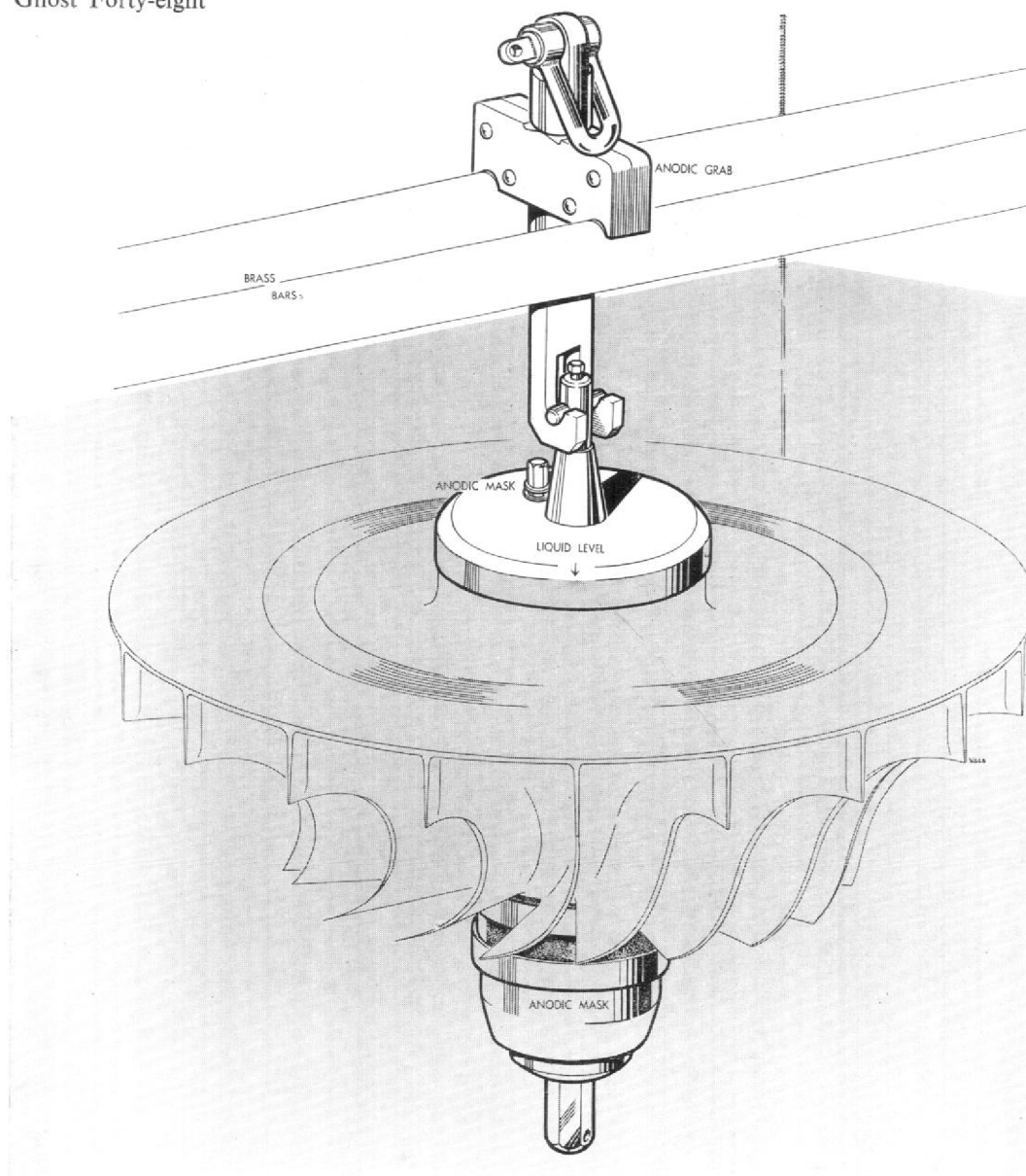


Fig. 14. Method of suspending a masked impeller in the electrolyte, using grab T.78705.

be considered, as the contained moisture would set up corrosion at the points where the impeller touched the cradle. Alternatively, one of the low trolleys used during the Rockhard lacquer process (Fig. 15) may be utilised.

To re-anodise an impeller proceed as follows:

Clean the impeller by re-applying the vapour blast process with the fine grit as described in the preceding pages. From this stage onwards it is imperative that clean rubber gloves are worn when handling the impeller, as finger marks—being greasy—will have a detrimental effect on the finished anodic film.

Screw lifting eye T.72476 on to the pivot, and using a suitable hoist, place and secure the impeller on to cradle trolley T.76578; remove the lifting eye. If the pivot has been removed, use three-point lifting sling T.76768 to move the impeller.

If the studs, dowels, and pivot are to be left in situ; assemble mask T.78050 to the rear face of the impeller in correct relationship to the offset hole. Fit contact cup T.78051 to the pivot and secure with the hexagon nut (refer to Fig. 12). Assemble mask T.78052 over the pivot and screw the special nut on to the threaded end of the mandrel; carefully check the alignment and seating of the masks and then tighten the special nut. Tighten the two clips around the impeller hub and mask. Connect up an air-line to the non-return valve in the rear mask and pressurise the assembly to 10 lb. per square inch. Immerse the assembly in a tank of cold water and check thoroughly for evidence of leaks. If the assembly is air tight, lift from the tank, remove the air-line and refit the blanking union to the non-return valve, leaving the assembly pressurised.

If the studs, dowels, and pivot have been

removed; fit mandrel T.75869 to the impeller as illustrated in Fig. 13, bolting the plate of the mandrel to the rear face of the impeller using the four collars and a slave set of $\frac{1}{2}$ in. B.S.F. duralumin bolts; if the threaded holes in the impeller have been tapped oversize, in accordance with one of the approved repair schemes, the corresponding oversize slave bolts must be used. Assemble grab T.75868 to the mandrel as shown in the same illustration.

Transfer the assembly to the 'Zonax' tank and immerse it for approximately five minutes. Thoroughly swab the impeller to remove all traces of surface blemishes. Transfer the assembly to the tank containing cold water, immerse it, and wash off all traces of the 'Zonax' solution. Suspend above the cold water tank and allow the water to drain off the impeller.

Transfer the assembly to the tank containing the chromic acid electrolyte and position the resting points of the grab on the two brass bars placed across the tank; the impeller should be completely submerged (Fig. 13 and 14). Gradually increase the voltage, in steps of not more than 5 volts, during the first 15 minutes, up to 40 volts; maintain this voltage for a further 20 minutes; gradually increase the voltage, during the next 5 minutes, to 50 volts, and then maintain this voltage for a further 5 minutes; total time 45 minutes.

On completion of the foregoing process, remove the assembly from the electrolyte tank, and immerse it in the cold water tank. Remove the assembly from the cold water tank, and lower it slowly into a tank containing hot water at a temperature of 98 deg. C. **Immediately** immersion is complete, remove the assembly from the

tank; longer immersion will wash the chromic acid out of any cracks, and thus make difficult their subsequent detection. Heat retained in the assembly will be sufficient for drying, and under no circumstances may an air blast be used for this purpose, owing to the difficulty of ensuring that the air is clean and dry; water which may remain in any of the pivot stud holes must be removed with clean, absorbent rag.

Having ensured that the table and clamps of cradle trolley T.76578 are perfectly clean and dry, attach the impeller to the cradle and carefully clamp to secure. The table will require to be in the inverted position to receive a masked impeller. Dismantle the grab, and mandrel, and if the masks are fitted, release the air pressure by unscrewing the two clips around the impeller hub, then remove the masks.

Using lifting eye T.72476 attached to the pivot, or three-point sling T.76768, transfer the impeller to the special cradle specified on page 14, or alternatively, use one of the low trolleys shown in Fig. 15. Place plastic protection cover T.78732 over the impeller.

Note: If the impeller is to be Rockhard lacquered on completion of the anodic process, it is absolutely essential that it is kept completely free from any contact with oil, grease or similar substances.

Allow the impeller to stand for not less than

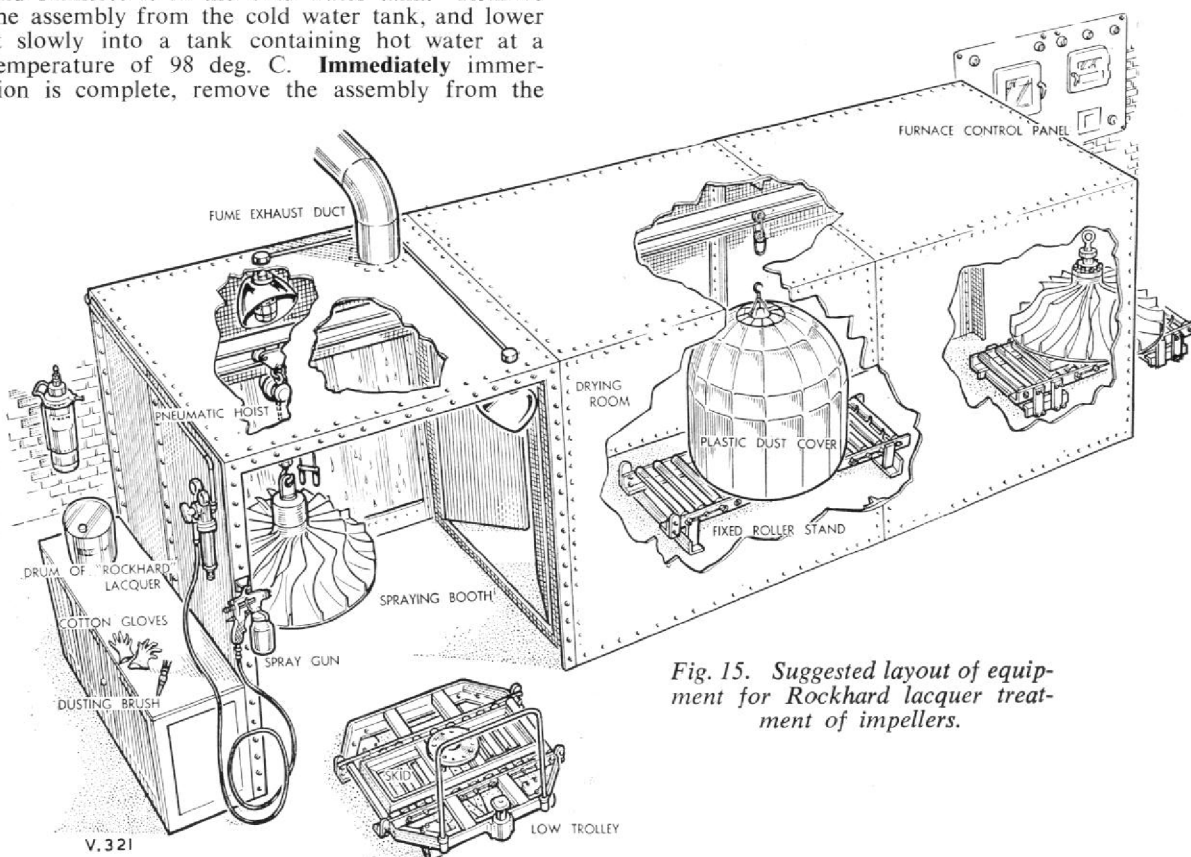


Fig. 15. Suggested layout of equipment for Rockhard lacquer treatment of impellers.

24 hours and then inspect for cracks—preferably in full daylight, or, alternatively, in artificial light of a bluish colour. The presence of cracks will be revealed by the staining effect produced by the chromic acid trapped in the cracks.

Immediately the impeller has been passed by the inspector, apply the Rockhard lacquer process described below.

ROCKHARD TREATMENT, IMPELLER

D.H. Process Specification: No. 177/1 November, 1954

This process will provide the impeller with a thin adherent coat of lacquer, which, when stoved at the recommended temperature, will provide good resistance to abrasion. The process will be repeated in order to provide a double coat of lacquer, both coats being applied to the impeller boss and vanes but not the rear face.

As the low flash point of the lacquer can present a fire hazard, CO₂ or foam fire-extinguishing equipment must be provided in an accessible

entry of particles of water or oil into the spray, which, if permitted, would have a detrimental effect on the lacquer coat. It is also most essential that the freshly anodised surface of the impeller is completely free from oil, grease, or similar substances. Clean gloves manufactured from cotton or similar material must therefore be worn when handling the impeller during the process.

The spraying booth must be equipped with a suitable fume extractor, a pneumatic hoist, and good lighting. The floor, if constructed of concrete, should be treated with a suitable solution that will prevent the formation of dust, or, alternatively, the floor should be sprayed with water prior to application of the process. All doors and windows must be closed, and currents of air reduced to a minimum.

A suggested layout showing the equipment required is illustrated in Fig. 15. The amount of handling equipment and the area allocated will of course vary with the quantity of impellers to be processed per day. A special type of electrically heated furnace will be required to stove (heat) each coat of lacquer.

A separate drying room as depicted in Fig. 15 is not essential to the process. Provided that the area to be utilised is dust-free and the covers are used, the impellers may be air-dried in a convenient position adjacent to the furnace.

The lacquer to be used must be 'Rockhard 444/19' fifteen second No 4 Ford cup at 25 deg. C. To provide a colour contrast with the anodic surface of the impeller, blue dyed lacquer 444/162 may be used. Application of the lacquer will be by spraying at a pressure of 30 lb. per sq. in.

To ensure optimum adhesion, the process must be applied immediately following the twenty-four hour waiting period and subsequent inspection for cracks after the impeller has been vapour blasted and re-anodised.

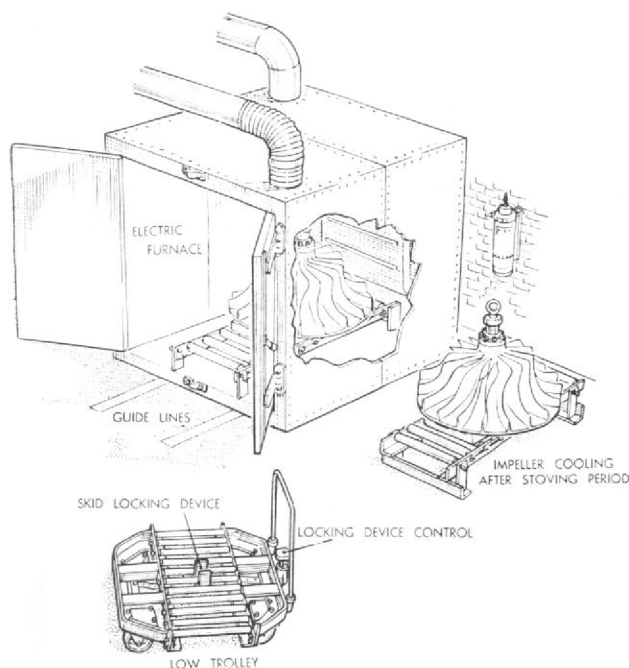
The procedure for applying the process is as follows:—

If the studs and pivot have been removed. Fit slave pivot 122196 to the impeller and secure it with two slave set screws T.75003.

Place mask T.78734 over the slave or original pivot and screw lifting eye T.72476 on to the pivot. Transport the impeller to the spraying booth and hoist it to a convenient height by means of the pneumatic hoist.

Using a clean and dry soft-bristled brush of a suitable size, methodically and carefully brush the whole surface of the hub and vanes—even though this may appear unnecessary. Any metal part of the brush must be covered with cloth or rubber to obviate any risk of scratching the anodic film.

Fill the container of the spray gun with 'Rockhard 444/19' or blue lacquer 444/162, and set the air pressure feed to 30 lb. per sq. in. Spray



position adjacent to the spraying booth and furnace, and normal fire precautions applicable to inflammable areas must be exercised in the building.

The presence of dust during application of the process, will seriously impair the efficiency of the coat—which is approximately 0.0005 inch thick—strict attention must therefore be paid to cleanliness and the necessity of conducting the process in a dust-free atmosphere. Similarly, it is essential that the supply of compressed air to the spray gun is thoroughly filtered, to preclude

one side of each vane in turn and then repeat on the opposite side of each vane; spray between the vanes, around the impeller hub and the periphery, and finally the edge of each vane; the rear face will not require spraying. Carefully inspect to ensure that complete coverage has been achieved, especially on the leading edge and concave face of the vanes, and the floor of the impeller.

Lower the impeller on to the skid on the trolley, and transport to the adjacent drying room. Place the plastic cover in position and allow the lacquer to air dry for not less than 15 minutes.

Remove the plastic cover and transport the impeller and skid into the electrically heated furnace. Heat the impeller to a temperature within the range of 180 to 205 deg. C. and maintain at this temperature for a period of not less than 75 minutes. *Under no circumstances must the temperature of the impeller be allowed to exceed 205 deg. C.* It should be noted that the impeller has considerable mass, and will therefore require a period of approximately 2 hours to attain the desired temperature.

After the prescribed stoving period has elapsed, remove the impeller from the furnace, place it on the skid on the trolley and allow to cool to room temperature.

Apply a second coat, repeating each operation in the specified sequence, and again paying strict attention to cleanliness and the necessity of applying the process in a dust-free atmosphere.

As it is difficult to obtain furnace capacity of the required degree of cleanliness combined with adequate temperature control, the impeller, after application of the lacquer, may be heated in the temperature range of 120 to 160 deg. C. for a minimum period of 60 minutes in a dust-free furnace. After the prescribed cooling period has elapsed, the second coat of lacquer may be applied, and the impeller again heated at the same temperature and for a minimum of 60 minutes. This treatment will harden the lacquer sufficiently to resist damage by dust. The impeller may then be transferred—with or without intermediary cooling—and stoved at the prescribed temperature.

IMPELLER, OVERSIZE CENTRE SHAFT DOWELS

T.R. 111 issue 4—Mod. 311

This repair may be applied to all Ghost impellers and centre shafts.

Impellers and centre shafts in which dowels have become loose or damaged may be repaired in accordance with these instructions. Any individual dowel hole, or any required number up to all twelve holes, may be repaired.

SEQUENCE OF OPERATIONS

1. Remove the damaged centre shaft dowel and

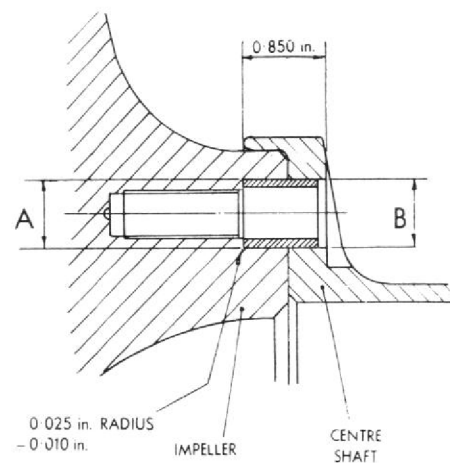


Fig. 16. Dimensions and details for repair of centre shaft dowel holes.

Diameter 'A' in Inches	Diameter 'B' in Inches	Oversize Dowel Part No.	Oversize in Inches
0.6975 +.0005	0.6995 +.0005	MR25358/1-10	0.010
0.7075 +.0005	0.7095 +.0005	MR25358/1-20	0.020
0.7175 +.0005	0.7195 +.0005	MR25358/1-30	0.030

its stud. Remove two other diametrically-opposite studs and dowels for locating the reaming fixture.

2. If a replacement centre shaft is being assembled to an impeller having a larger dowel hole, use reaming fixture T.76587 with slave bolts T.76588, nut and washer assemblies T.76589, reamer stock T.70699, and the appropriate locating pins and reamers to enlarge the affected hole in the centre shaft sufficiently to be line reamed in conjunction with the mating hole in the impeller. Remove the reaming fixture.
3. Assemble the centre shaft to the impeller. Assemble reaming fixture T.76587 to the centre shaft and locate with two suitably sized locating pins. Using the reamer stock and appropriate roughing and finishing reamers, line-ream the defective hole to the smallest diameter 'A' that will rectify the damage.
4. Assemble three extractors, T.76657, to the centre shaft at points equidistant around the flange, and draw the centre shaft evenly off the impeller.
5. Position reaming block T.76640 (standard holes) or T.76583 (oversize holes) on the open end of the centre shaft, with the appropriate hole (of T.76583) in alignment with the hole to be reamed. Using reamer T.76660, T.76584, T.76585 or T.76586 for standard size, 0.010, 0.020 or 0.030 inch oversize holes, respectively, ream the hole in the centre shaft flange to the appropriate diameter 'B'.

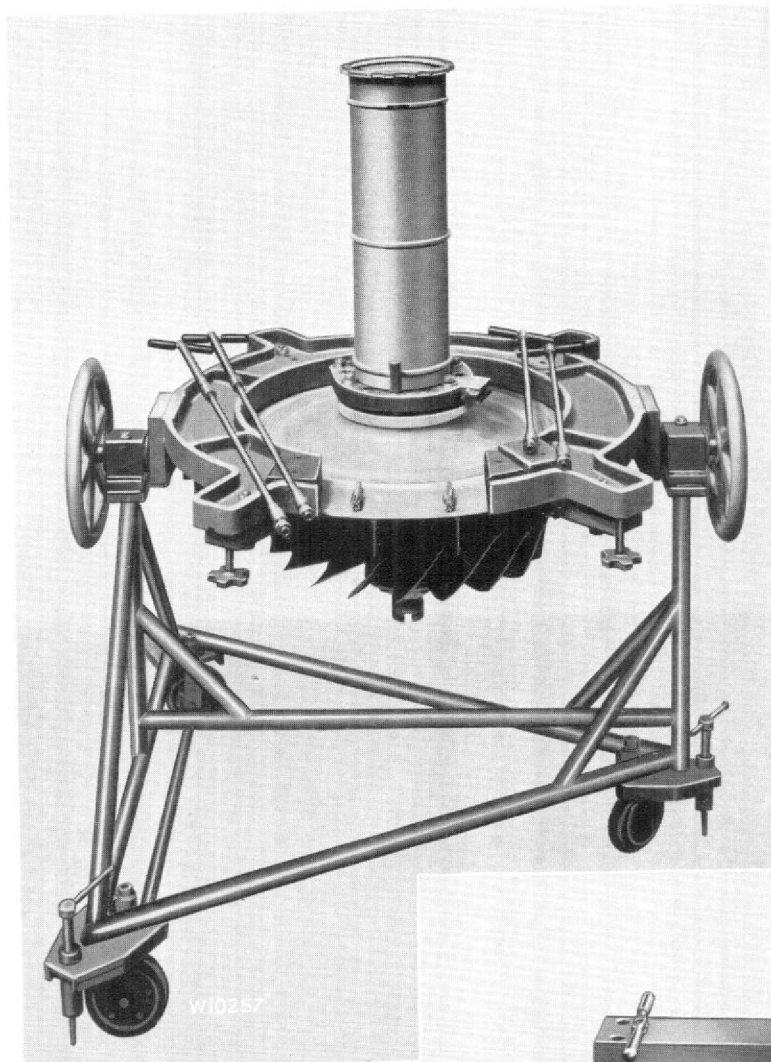
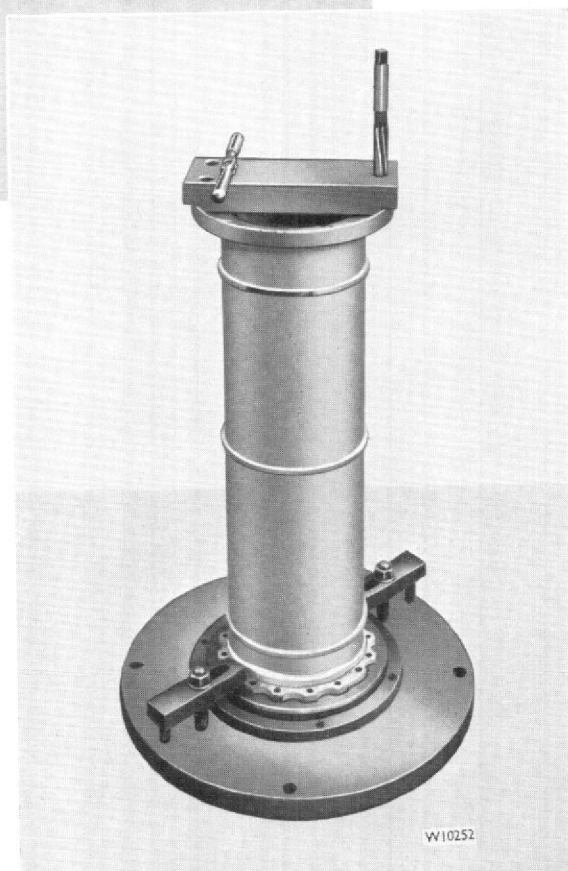
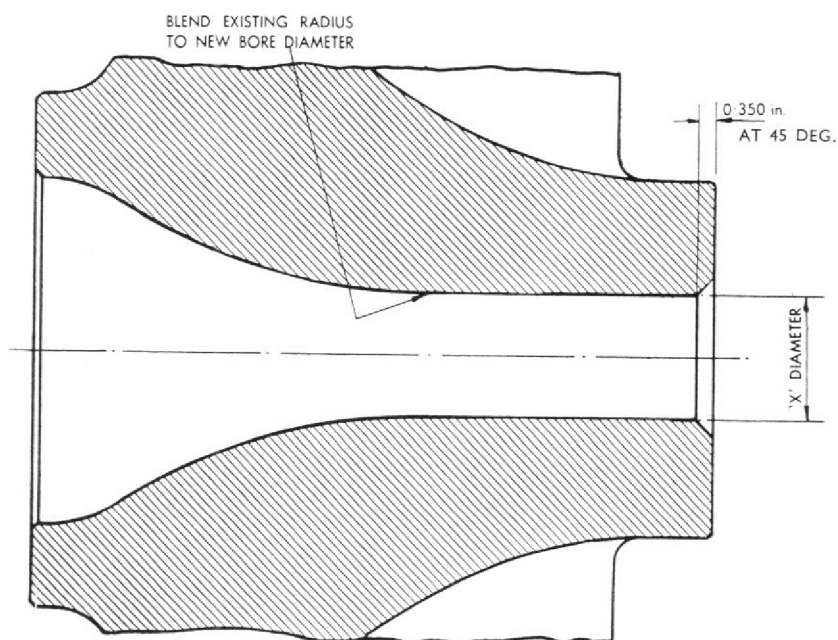


Fig. 17. Impeller and centre shaft clamped to cradle trolley T.76578, and reaming fixture T.76587 assembled ready for line-reaming the dowel holes.

6. Check the reamed bore with the small bore gauge and appropriate setting ring as before.
7. Fit the requisite oversize dowel.
8. Lightly stamp T.R.111 on both components adjacent to the existing part numbers and make an entry in the appropriate record book of the engine.

Fig. 18. Centre shaft clamped to floor fixture T.72403, and reaming block T.76583 in position for reaming a rectified dowel hole to the appropriate diameter 'B'.





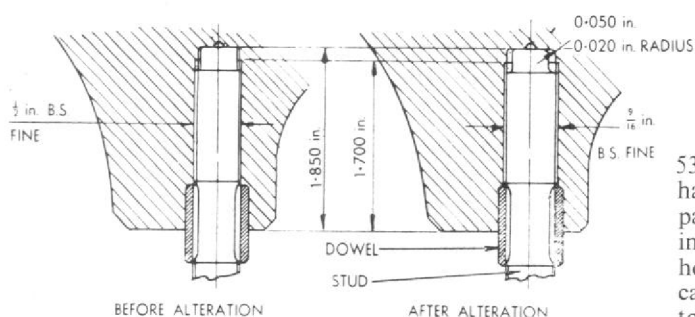
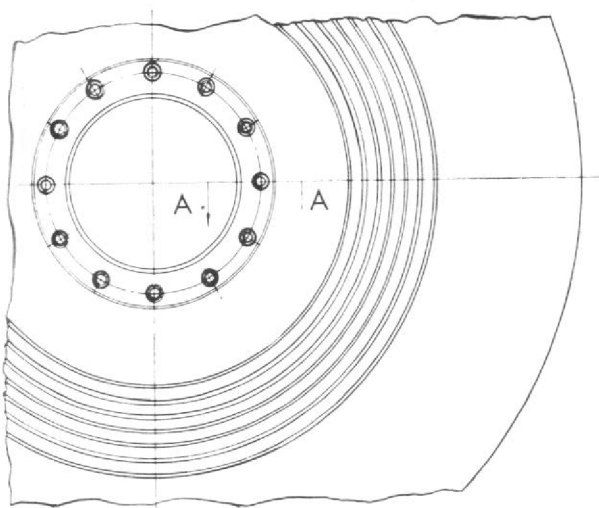
<i>Diameter 'X' in Inches</i>	<i>Oversize Pivot Part No.</i>	<i>Oversize in Inches</i>	<i>Identification No.</i>
2.5350 + .0005	MR606500-10	0.010	TR222-1
2.5450 + .0005	MR606500-20	0.020	TR222-2
2.5550 + .0005	MR606500-30	0.030	TR222-3
2.5650 + .0005	MR606500-40	0.040	TR222-4

IMPELLER BORE T.R. 222 issue 7—Mod. 311

This repair may be applied to all Ghost impellers.

Impellers in which the bore has become dam-

aged may be rectified by machining the bore to the smallest diameter 'X' that will eliminate the damage, and fitting the appropriate oversize pivot. When this repair has been carried out, lightly stamp the appropriate identification number adjacent to the existing part number. Make an entry in the record book of the engine.



PART SECTION A - A

OVERSIZE CENTRE SHAFT STUDS T.R. 133 issue 5—Mod. 751

This repair may be applied to all Ghost impellers.

Impellers in which centre shaft stud holes have become damaged may be repaired in accordance with these instructions. Any individual hole, or any required number up to all twelve holes, may be repaired.

This repair scheme should only be used where rectification to T.R.253 would prove insufficient, and it should be noted that T.R.133 cannot be applied where T.R.253 has already been carried out.

SEQUENCE OF OPERATIONS

1. Remove the existing centre shaft stud and its dowel.
2. Locate drill jig T.76787 on the impeller face, using the three locating nuts screwed on to three existing equidistant studs. Drill the defective $\frac{1}{2}$ inch B.S.F. hole $\frac{3}{4}$ inch diameter by 1.850 inch deep, using drill T.76784.
3. Thread the hole $\frac{9}{16}$ inch B.S.F. by 1.700 inch deep, using taper tap T.76785 followed by plug tap T.76786.

4. Counterbore $\frac{9}{16}$ inch diameter by 0.050 inch deep.
5. Remove any burrs and sharp edges, blow out the hole with compressed air and check the thread with a John Bull small bore gauge used in conjunction with a $\frac{1}{16}$ inch B.S.F. (effective diameter) mandrel and ring screw gauge T.76795.
6. Fit an oversize stud, Part No. 49972.
7. Refit the existing dowel, or an oversize dowel in accordance with T.R.111.
8. Lightly stamp T.R.133 adjacent to the existing part number and make an entry in the appropriate record book of the engine.

OVERSIZE PIVOT STUDS T.R.134 issue 6—Mod. 751

Any impeller (Ghost 48 Mk. 1, 48 Mk. 2, or 53 Mk. 1) in which the pivot stud holes, Fig. 19, have become damaged beyond the scope of T.R.254, page 24, may be repaired in accordance with these instructions. This repair may be applied to any one hole, or to any number up to all ten holes, but cannot be applied to any hole where rectification to T.R.254 has been carried out already.

The following tools will be required.

Tool No.	Description
T73130	Setting ring, 0.4830 in. diameter, for use in conjunction with John Bull Intercheck small bore gauge
T76768	Three-point lifting sling
T76783	Drilling jig, which enables pivot stud holes to be located correctly
T76784	Special drill $\frac{3}{4}$ in. diameter
T76785	Taper tap $\frac{9}{16}$ in. B.S.F.
T76786	Plug tap $\frac{9}{16}$ in. B.S.F.
T78447	$\frac{9}{16}$ in. ring screw gauge for use in conjunction with mandrel and small bore gauge
Standard	Tap wrench
Standard	John Bull Intercheck small bore gauge
Standard	John Bull $\frac{1}{16}$ in. B.S.F. mandrel
Standard	$\frac{9}{16}$ in. diameter flat-bottom drill

On receipt of the component which is to be repaired, its part number and serial number should be checked against the accompanying documents.

These instructions assume that the pivot and studs have been removed from the impeller, as described in chapter 24A.

To carry out this repair proceed as follows..

1. Use three-point lifting sling T.76768 to place the impeller, pivot face uppermost, on to the work table of a radial drilling machine. Securely clamp the impeller to the table.
2. Remove all burrs from the edges of the tapped holes and blow out the holes with compressed air.
3. Ensure that the locating surfaces of the drilling jig, and all other tools, are perfectly clean and

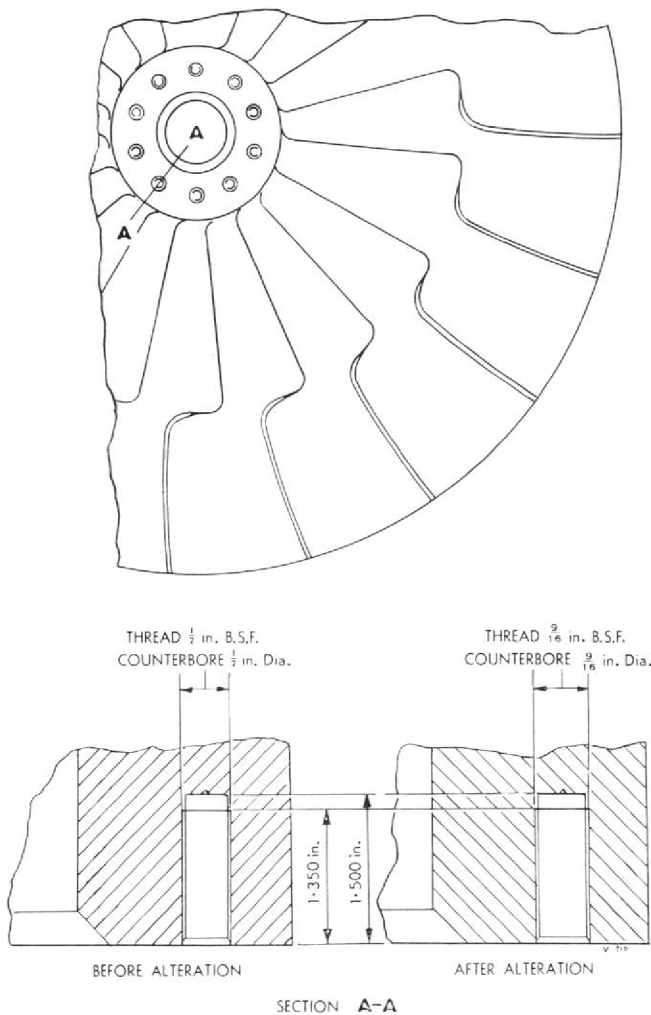


Fig. 19. Section of impeller showing oversized pivot stud holes.

free from any damage which might prevent their accurate seating.

4. Place drilling jig T.76783, Fig. 20, flange downwards, in position on the pivot face so that the offset hole in the flange of the jig is aligned with the corresponding offset stud hole in the pivot face. Ensure that the stepped end of the large locating bush, which is fitted into the jig, and which is free to move in a vertical plane, locates accurately in the bore of the impeller. To provide for accurate seating of the bush, steps are ground on it to sizes which cover standard, and four oversizes of impeller bores, and, therefore, the bush will enter only up to the step which corresponds to the diameter of the impeller bore.
5. Secure the jig in position, using two slave bolts of sizes appropriate to the stud holes into which the bolts are to be fitted; if possible, select holes which do not require to be repaired. There are two bolts of each size, covering $\frac{1}{2}$ inch B.S.F. standard, 0.007 inch, 0.010

inch, 0.015 inch, and 0.020 inch oversize, and $\frac{3}{16}$ inch B.S.F. standard respectively; the size is stamped on each bolt.

6. Select the drill locating bush having the smaller internal bore, 0.485 inch diameter and insert it into the hole in the jig which is aligned with the stud hole which is to be repaired.
7. Using $\frac{3}{4}$ inch diameter special drill T.76784, drill out to the depth specified on Fig. 19.
8. Remove the drill locating bush, blow out the hole, and use setting ring T.73130 in conjunction with a John Bull Intercheck small bore gauge to check the diameter of the hole.
9. Insert the drill locating bush having the larger internal bore, 0.595 inch diameter into the hole in the jig, and use a $\frac{3}{8}$ inch diameter flat-bottom drill to counterbore the stud hole to a depth of 0.050 inch.
10. Apply operations 6, 7, 8, and 9 to each of the other holes which has to be repaired.
11. Remove the drilling jig, blow out the holes, and using a tap wrench with taper tap T.76785, and plug tap T.76786, rethread the stud holes to the depth specified on Fig. 19.
12. Remove any burrs from the edges of the holes, blow out the holes, and check the threads using the small bore gauge in conjunction with a $\frac{3}{8}$ inch B.S.F. mandrel and ring screw gauge T.78447.
13. Should it be necessary to carry out this repair to either one, or both, of the stud holes which were used to secure the drilling jig in position, the jig must be refitted, as described in operations 4 and 5, but using two alternative holes, with the appropriate slave bolts. Operations 6 to 12 should then be applied to the damaged holes.
14. If this is the first time that this repair has been applied, lightly stamp T.R.134 adjacent to the existing part number on the impeller. In all cases record the exact holes in the engine log book.

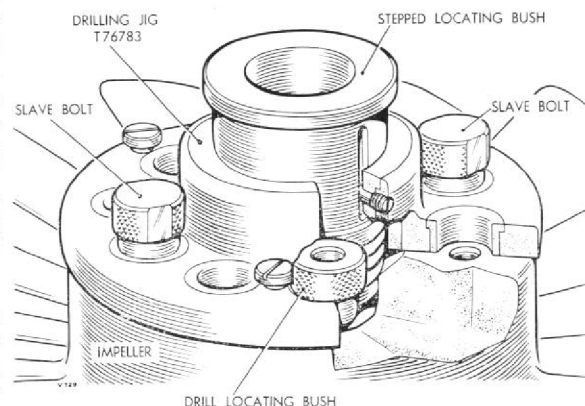
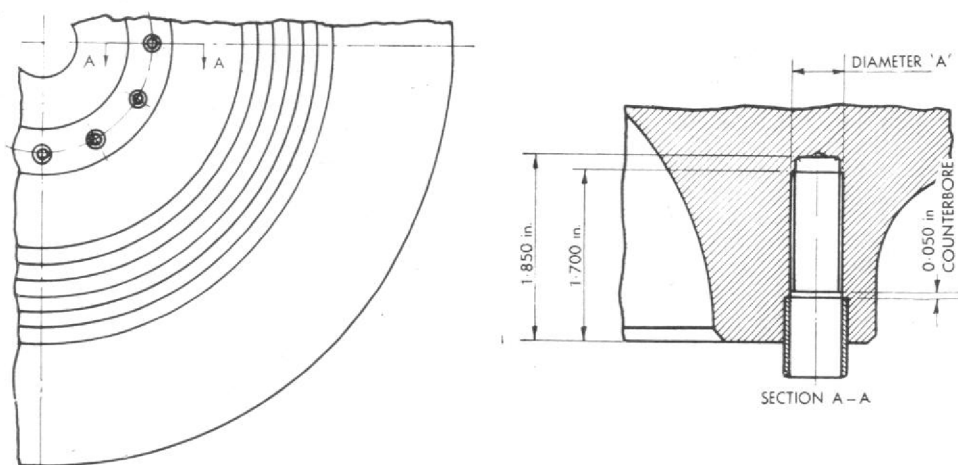


Fig. 20. Drilling jig in position on impeller.



Thread Diameter 'A' in Inches by 16 T.P.I.	Thread Effective Diameter in Inches	Counterbore Diameter in Inches	Oversize Stud Part No.	Oversize in Inches
0.507	0.4670 ± .0033	$\frac{17}{32}$	MR96724-7	0.007
0.510	0.4700 ± .0033	$\frac{17}{32}$	MR96724-10	0.010
0.515	0.4750 ± .0033	$\frac{17}{32}$	MR96724-15	0.015
0.520	0.4800 ± .0033	$\frac{17}{32}$	MR96724-20	0.020

OVERSIZE CENTRE SHAFT STUDS T.R. 253 issue 4—Mod. 311

This repair may be applied to all Ghost impellers.

Impellers in which centre shaft stud holes have become damaged may be repaired in accordance with these instructions. Any individual hole, or any required number up to all twelve holes, may be repaired.

SEQUENCE OF OPERATIONS

1. Remove the existing stud and dowel. Remove any burrs and blow out the hole with compressed air.
2. Rethread the defective stud hole to its full depth and to the smallest permitted oversize that will rectify the damage, using the appropriate taper and plug taps.
3. Remove any burrs, blow out the hole and check the thread with a John Bull small bore gauge used in conjunction with a $\frac{1}{2}$ inch B.S.F. (effective diameter) mandrel and ring screw gauge T.76794.
4. Enlarge the counterbore to the diameter and depth specified.
5. Enlarge the bore of the dowel which is to fit over the stud to 0.540 inch diameter. Check the bore using a small bore gauge with setting ring T.76793.
6. Fit the modified dowel, using dowel punch T.76796 with guide T.76797. If necessary, an oversize dowel should be fitted in accordance with T.R.111.
7. Fit the appropriate oversize stud.
8. Lightly stamp T.R.253 adjacent to the existing part number and make an entry in the appropriate record book of the engine.

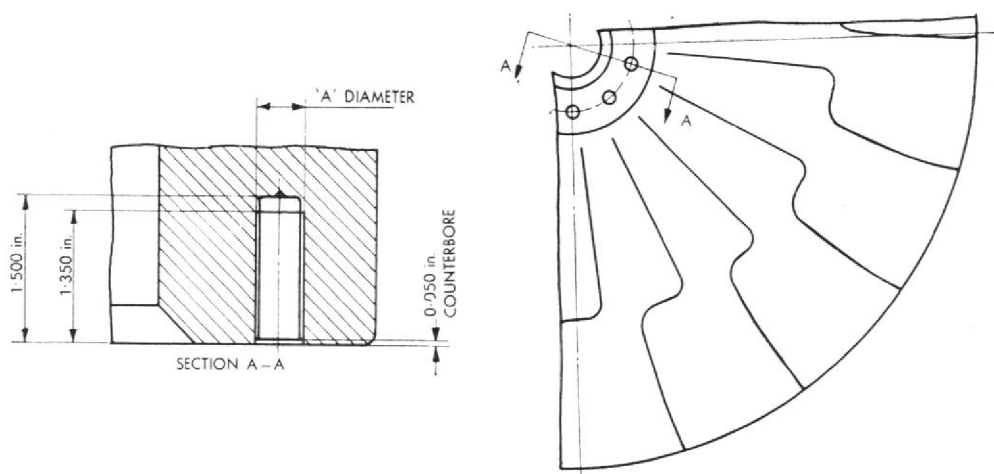


Table Showing Sizes of Stud Holes with Relevant Taps and Studs.

Thread dia. 'A' in inches by 16 T.P.I.	Thread effective dia. in inches	Taper Tap	Plug Tap	Oversize Stud Part No.	Oversize in inches
0.507	0.4670 + 0.0033	T.76775	T.76779	MR96723-7	0.007
0.510	0.4700 + 0.0033	T.76776	T.76780	MR96723-10	0.010
0.515	0.4750 + 0.0033	T.76777	T.76781	MR96723-15	0.015
0.520	0.4800 + 0.0033	T.76778	T.76782	MR96723-20	0.020

Fig. 21. Pivot stud holes in impeller.

OVERSIZE PIVOT STUDS T.R.254 issue 4—Mod. 311

Any impeller (Ghost 48 Mk. 1, 48 Mk. 2, or 53 Mk. 1) in which the pivot stud holes have become damaged may be repaired by fitting oversize studs. This repair may be applied to any one hole, or to any number up to all ten holes.

The following tools will be required.

Tool No.	Description
T76578	Impeller cradle trolley
T76768	Three-point lifting sling
T76775	Taper tap 0.007 in. oversize
T76776	Taper tap 0.010 in. oversize
T76777	Taper tap 0.015 in. oversize
T76778	Taper tap 0.020 in. oversize
T76779	Plug tap 0.007 in. oversize
T76780	Plug tap 0.010 in. oversize
T76781	Plug tap 0.015 in. oversize
T76782	Plug tap 0.020 in. oversize
T76794	$\frac{1}{8}$ in. ring screw gauge
Standard	Tap wrench
Standard	John Bull Intercheck small bore gauge
Standard	John Bull $\frac{1}{8}$ in. B.S.F. mandrel
Standard	$\frac{1}{8}$ in. diameter flat-bottom drill

On receipt of the component which is to be repaired, its part number and serial number should be checked against the accompanying documents.

These instructions assume that the pivot and studs have been removed from the impeller, as described in chapter 24A.

To carry out this repair proceed as follows.

1. Use three-point lifting sling T.76768 to transfer the impeller, pivot face uppermost, to cradle trolley T.76578. Using the four clamps which are fitted to the trolley, secure the impeller to the trolley, Fig. 22.

2. Remove all burrs from the edges of the tapped holes, and blow out the holes with compressed air.
3. Using a John Bull Intercheck small bore gauge in conjunction with a $\frac{1}{8}$ inch B.S.F. mandrel and ring screw gauge T.76794, check the threads in the defective stud holes to estimate the oversize to which each hole must be enlarged. If any of the holes are so damaged that they cannot be repaired within the limit of the fourth oversize, as shown in the table below Fig. 21, reference should be made to T.R.134, page 21, but T.R.134 cannot be

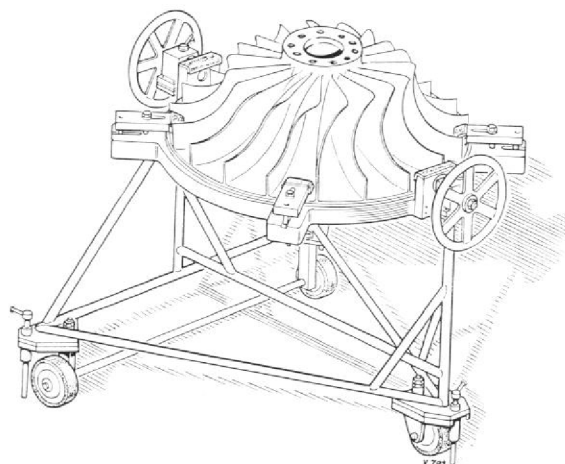


Fig. 22. Impeller clamped on cradle trolley T.76578.

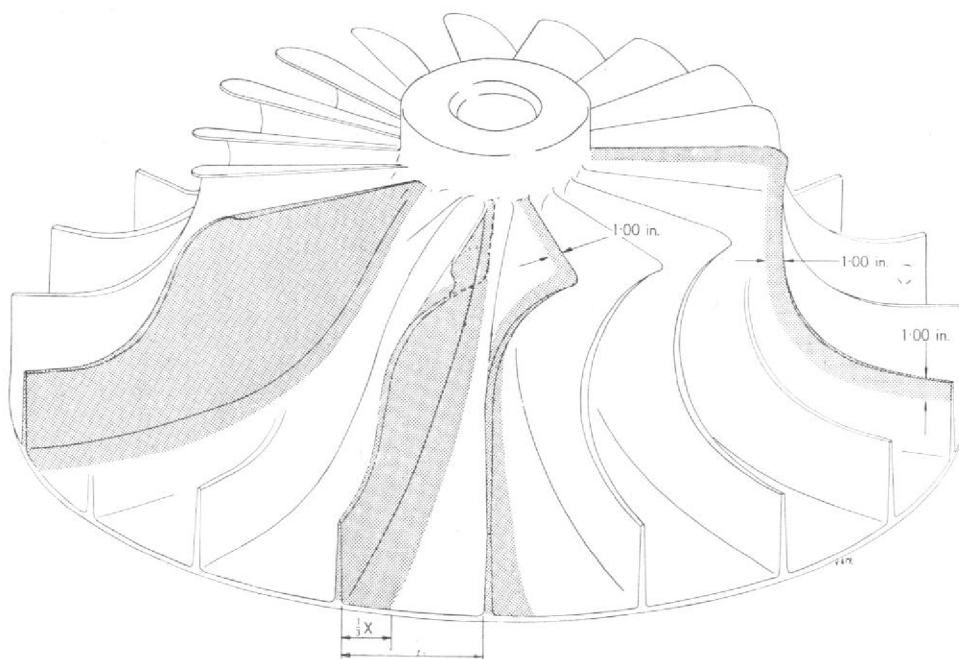


Fig. 23. Areas on the impeller shown dotted, to which cold-setting lacquer may not be applied.

applied to any hole to which T.R.254 has been applied already; see also chapter 32, page 3, "Repair Identification".

4. Refer to the table, and select the smallest oversize that will rectify the damage in the stud hole which is to be repaired. Using a tap wrench, and the appropriate taper and plug taps, of those listed in the table, rethread the stud hole to its full depth.
5. Using a standard $\frac{1}{8}$ inch diameter flat-bottom drill, enlarge the counterbore to a depth of 0.050 inch.
6. Remove any burrs from the edge of the tapped hole, blow out the hole, and check the thread using the John Bull Intercheck small bore gauge in conjunction with the mandrel and the ring screw gauge.
7. Apply operations 4, 5 and 6 to each one of the other holes which has to be repaired.
8. If this is the first time that this repair has been applied, lightly stamp T.R.254 adjacent to the existing part number on the impeller. In all cases record the exact holes and oversize in the engine log book.

ROCKHARD LACQUER
T.R. 396 issue 1—Mod. 1186

Ghost impellers on which the coat of Rock-hard lacquer has been broken, and parent metal

exposed, as a result of correcting out-of-balance during dynamic balancing, may have these areas protected by the application of cold-setting lacquer. Similarly, imperfections or other exposed areas in a newly-applied lacquer coat, may also be treated. It is not permissible to apply the cold-setting lacquer to the areas shown dotted in Fig. 23, nor may this repair scheme be applied at any place other than an overhaul base.

SEQUENCE OF OPERATIONS

1. Using 73 octane petrol, methylated spirits (industrial), or benzene, thoroughly clean the affected area.
2. Thoroughly mix equal volumes of Gittings and Hill lacquer 115/16 and 115/17; add 15 per cent of thinners 375/455 and again mix thoroughly. This mixture will provide a good brushing consistency with a final resin thickness of approximately 0.015 to 0.020 inch. It should be noted that the pot-life of this mixture is about 5 hours.
3. With a brush apply one coat only of lacquer to cover the affected area. Allow to air-dry at room temperature for a minimum period of 3 hours before handling.
4. No identity marking of the impeller is necessary, but an entry should be made in the appropriate record book of the engine.

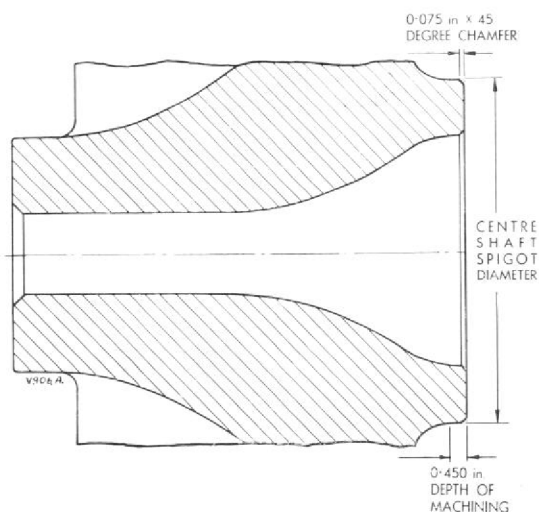
IMPELLER, UNDERSIZE CENTRE-SHAFT
SPIGOT

T.R. 201 issue 3—Mod. 751

For Information Only

If the number T.R.201 is found on a Ghost 48 Mk. 1, 48 Mk. 2 or 53 Mk. 1 impeller, adjacent to the normal part number, that impeller has an undersize centre-shaft spigot.

The degree of undersize is indicated by the suffix 1, 2, or 3 following the T.R. number, and such impellers can be fitted only to modified centre shafts having a corresponding undersize recess in the front flange—see table below.



*Impeller centre-shaft
spigot undersize diameter :
inches*

*Impeller
identification*

*Use with
centre shaft
Part No.*

10.367 - .001
10.357 - .001
10.347 - .001

T.R.201-1
T.R.201-2
T.R.201-3

M.R.94811-10
M.R.94811-20
M.R.94811-30

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