T-057 Inspection Limits and Repair

Engine Application(s):		Allison 250-C30, C30L, C30M, C30P, C30S, C30R, C30R/3, C30G, C30G/2, C30R/1
Compliance:		When diffuser is removed at overhaul.
Notes:		Refer to OEM's published data for installation, engine operation, and disassembly.
Revisions:	N/C	Dated: 7/17/01 Initial Release.
	A	Dated: 7/19/04 Added Percussion Stud Welding and Compressor Diffuser Repair Scheme for Damaged Vanes Specifications.
	B	Dated: 9/01/09 Updated from EXTEX to TIMKEN.
	C	Dated: 2/04/16 Updated Timken to EXTEX Engineered Products.

CONDITION	REPAIR LIMIT	METHOD	INSPECTION
Stud thread damaged or broken	None	Cut off stud close to plate, center on location and spot face 0.281 - 0.313 Dia. maintain 0.070 min plate thickness. Percussion weld new stud.	Proof test each replaced stud to 2000 lbs. centered and pulled against a 0.313 - 0.320 Dia hole.
Crack in plate	None	Weld repair using AMS 5825 filler wire. If weld exceeds 0.5 inch, stress relieve at 1060-1090℉ for 4 hours.	FPI
ID snap diameter	10.202 Max.	Restore Dia by electroless nickel plate per AMS 2405 or chrome plate per AMS 2406. Machine to size.	Measure ID 10.200 - 10.201
OD	13.595 Min	Restore Dia by electroless nickel plate per AMS 2405 or chrome plate per AMS 2406. Machine to size.	Measure OD 13.605 - 13.595
OD flange thickness	0.596 Min	Machine to provide for 0.010 - 0.015 thick metal spray. Spray with METCO 450 or equivalent and machine. Maintain 0.070 min base plate metal thickness.	Measure thickness 0.598 - 0.596
Missing Pin	None	Replace pin	
Damaged or eroded leading edges of vanes.	Nicks or damage 1/16 max depth on LE and 1/8 depth on TE.	Repair by (1) leading edge inserts (2) weld build up. 1) Install new vane leading edge inserts. 2) Weld repair vane leading edges.	FPI Airflow repaired assembly and mark new area on part in accordance with OEM instructions. Extex *recommended* flow values: 0.07088 - 0.07427 per passage with the average of all passages falling between 0.07190 - 0.073525.
Plate Flatness	None	Remove studs, grind surface and re-install studs if required to maintain flatness requirements.	Measure flatness 0.005 Max

Percussion Stud Welding

1. SCOPE: This specification details the procedure for percussion stud welding of carbon and low-alloy steels, corrosion and heat resistant steels and alloys, and nickel-base alloys.

2. PROCEDURE:

2.1 Equipment: Shall consist of a suitable source of electrical energy, a suitable welding head, and a means of reliably controlling and indicating the magnitude of the current and the welding force unless gravity operated.

2.1.1 The force and current controls shall operate so that no force is applied until the proper current is attained between the stud and workpiece. The current flow shall be stopped before the force is removed.

2.1.2 The equipment shall be provided with adequate means for indicating, either directly or indirectly, the settings for each variable which must be controlled to produce reproducible quality welds. The degree of accuracy of all controls shall be as required to consistently produce quality welds meeting all requirements of this specification.

2.1.3 Each group of percussion stud welders shall be provided with testing equipment suitable for accurately determining the tensile strength of representative percussion stud welds. All testing apparatus shall be accurate with ± 2% of the indicated reading. Machines which are not accurate within the above limits may be used only with a calibration curve or chart which shall be permanently displayed on or near the machine. All testing apparatus, portable or not, shall be checked for accuracy at intervals not to exceed 6 months.

2.2 Preparation of Parts:

2.2.1 Surfaces of parts to be welded shall be free from objectionable films such as oxides, scale, ink, grease, dirt, or other foreign materials detrimental to the weld quality.

2.2.2 Parts to be welded shall be fixtured commensurate with good production practice to reduce distortion to a minimum within acceptable limits and to allow accurate placement of welded studs.

3. WELD CHECK TESTS:

3.1 Proof test all studs to 2000 lbs centered in and pulled against a 0.315 diameter hole.

3.2 Replacement of Studs: If either the stud or stud weld is defective, a stud may be replaced using the original weld schedule and post weld thermal treatment.

3.2.1 A stud may be removed by machining or grinding and another stud welded in it place.

3.2.2 If the base material is damaged, the part may be locally weld repaired in the stud weld area, prior to the replacement of a new stud, using filler metal similar to the base metal.

3.2.3 The replaced stud weld and affected area shall meet quality requirements of 4.

4. QUALITY REQUIREMENTS:

4.1 Appearance: All percussion stud welds shall be free of excessive flash or expulsion and any effect from the welding cycle on the usable portion of the stud or the opposite side of the base plate.

4.2 Welds shall be free of any defects which would indicate that they had been made with faulty or dirty studs, improperly prepared surfaces, or excessive penetration into the base materials.

4.3 External Defects: Excessive expulsion of metal and external cracks are unacceptable.

4.3.1 The opposite side of the base material shall show no effects from the percussion stud weld operation such as melt through, pits, or cracks. Bulging shall not exceed 0.005 in (0.13mm) or 10% of material thickness, whichever is less.

4.3.2 When indicated by metallograpic examination, weld defects such as porosity, cracks, lack of fusion, or voids are acceptable if the maximum extent of the defect does not exceed 10% based on the stud diameter, or does not extend to within 15% of the stud outside diameter.

4.3.3 When examined metallographically, weld penetration shall not exceed 0.015 in. (0.38 mm) or 10% of the thickness of the base material, whichever is greater.

5. REJECTIONS: Any part containing percussion stud welds not conforming to the requirements detailed herein will be subject to rejection.

6. APPROVED SOURCES: Percussive Stud Welding Equipment, manufactured by KSM Division, Omark Industries, Inc., 301 New Albany Road, Moorestown, New Jersey, 09057 is approved for use under requirements of this specification.

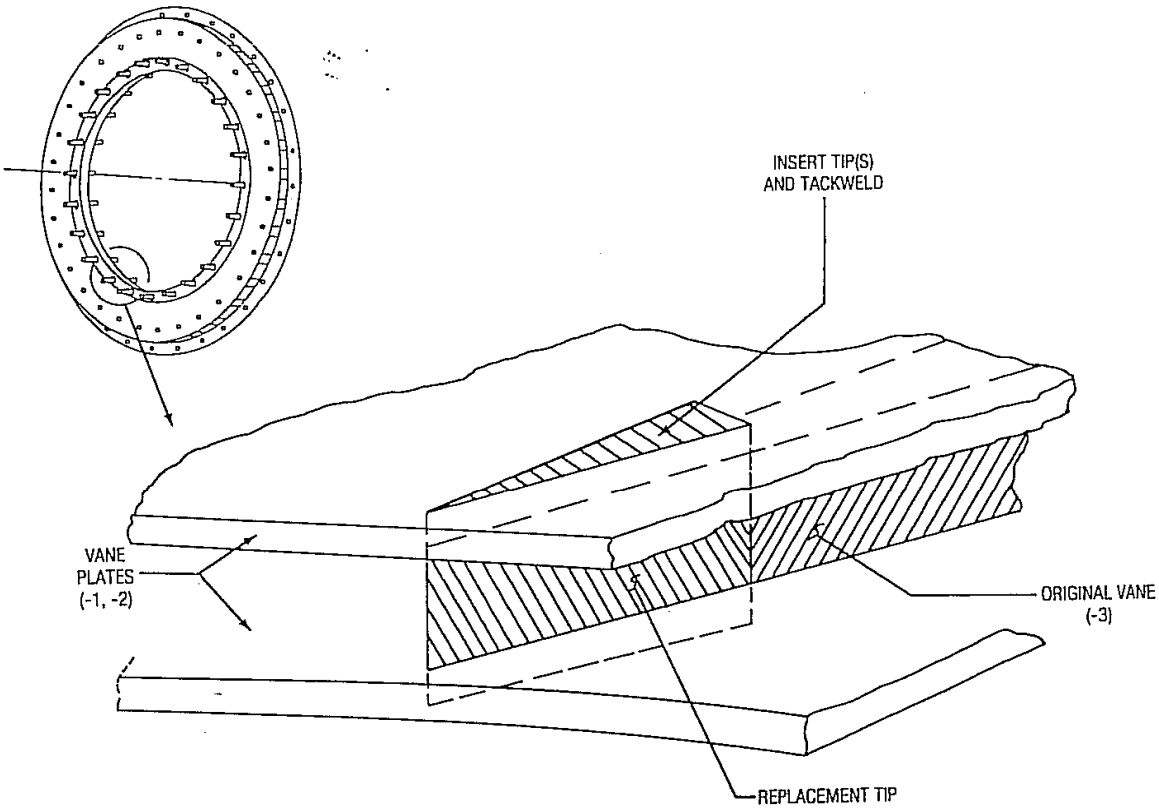
Compressor Diffuser Repair Scheme for Damaged Vanes

Occasionally damage to the vane leading edges from foreign object ingestion, corrosion, or other causes will occur that is in excess of the stated rework limits and requires diffuser rejection.

The following rework procedures (1, 2, and 3) can be used to salvage some of those diffusers which otherwise would be scrapped.

I. Procedure No. 1 – Installing a New Leading Edge Section of the Vane by Plug Welding and Back Brazing.
Series III (C28) and Series IV (C30) only.

A. This procedure is accomplished by inserting a new leading edge section of the vane (see Figure 1).



Compressor Diffuser

Figure 1.

B. The inserted vane section is installed by profiling a slot through the front and rear plates (dash 1 and dash 2 details) to the size of the vane insert.

C. The vane insert is plug welded to the plates and back brazed. The butt joint where the insert joins to the original vane is also brazed. The braze joints are not structural but serve primarily as closure for the joints and to smooth the flow path.

D. The vane insert is made from AMS 5604 or AMS 5643. The insert profile is the same as the dash 3 vane except the overall length of the insert shall be no less than 0.5000 in. or not more than 0.900 in. long and the insert width shall be such as to engage each plate with the ends recessed in the plates, reference Procedure No. 1, paragraph F.5.a and b.

E. The slots in the plates are formed by the E.D.M. Process used to remove the leading edge section of the damaged vane. The slots shall be located within 0.002 in. of the true position relative to the adjacent vanes. This should match to the profile of the original vane and remove most of the original braze joint.

F. Detailed procedure for replacing vane tips is as follows:

NOTE: Processing and/or machining of restored surfaces shall be controlled by the latest print requirement for the detail involved.

1. REMOVE STUD – Studs in line with damaged vanes must be removed. Remove stud by cutting straight across stud near the diffuser plate. Care should be taken so as not to nick or cut into flange.

2. E.D.M. – Remove vane tip to specified length.

3. DEBURR – Around E.D.M. openings in plates.

4. DEGREASE.

5. ASSEMBLY – Fit vane(s) in slot(s):

   a. OPEN AREAS – Vane insert ends to be 0.020 inch below outside plate faces (Reference sketch in Figure 2).

   b. STUD AREAS – Vane insert ends to be 0.050 inch below outside plate faces (Reference sketch in Figure 2).

6. TACKWELD – Laser beam tack one end of vane(s) insert to each plate (2 tacks).

7. BLEND – Rotary file outside face of plates to permit access to weld joint (UN-TACKED END FIRST). Reference Figure 2.

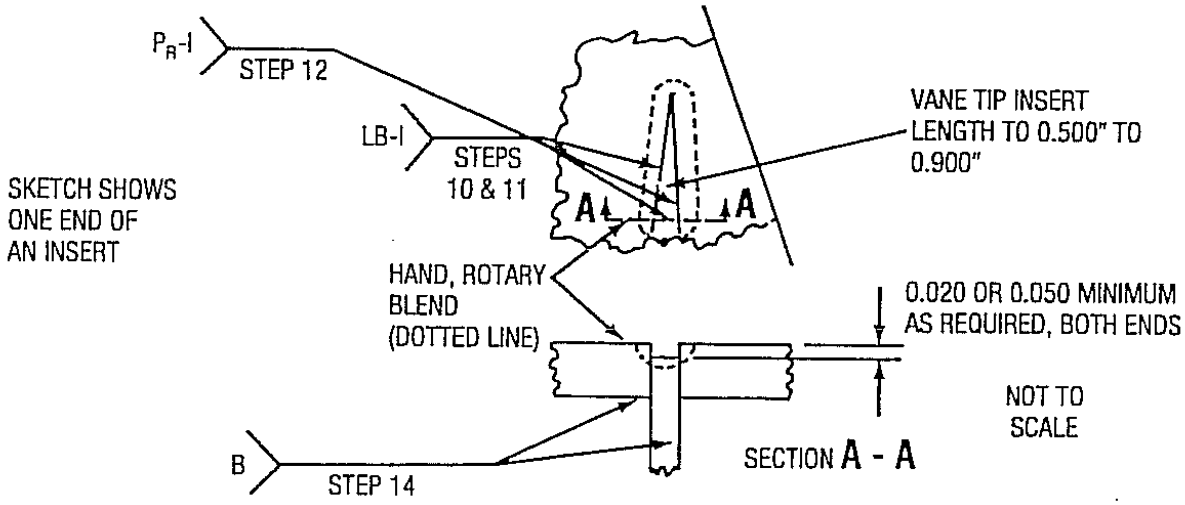
8. TACKLEWELD – Laser beam tack second end of vane insert to each plate (2 tacks) – end blended in Step 7.

9. BLEND – Repeat Step 7 on second end of insert.

10. FUSION PASSES – Laser beam weld fusion pass (NO FILLER) – 1 pass down each side and across butt with original vane on outside face of plates.

11. FILL PASSES – Laser beam weld fill pass (AMS 5825 FILLER) – 1 pass down each side and across butt with original vane on outside face of plates.

12. FILL PASS – Gas Tungsten – arc weld fill all insert ends complete to slightly convex weld face. AMS 5825 FILLER. Use argon backup in diffuser flow path. All weld joints shall meet Class II requirements per previous attachment.

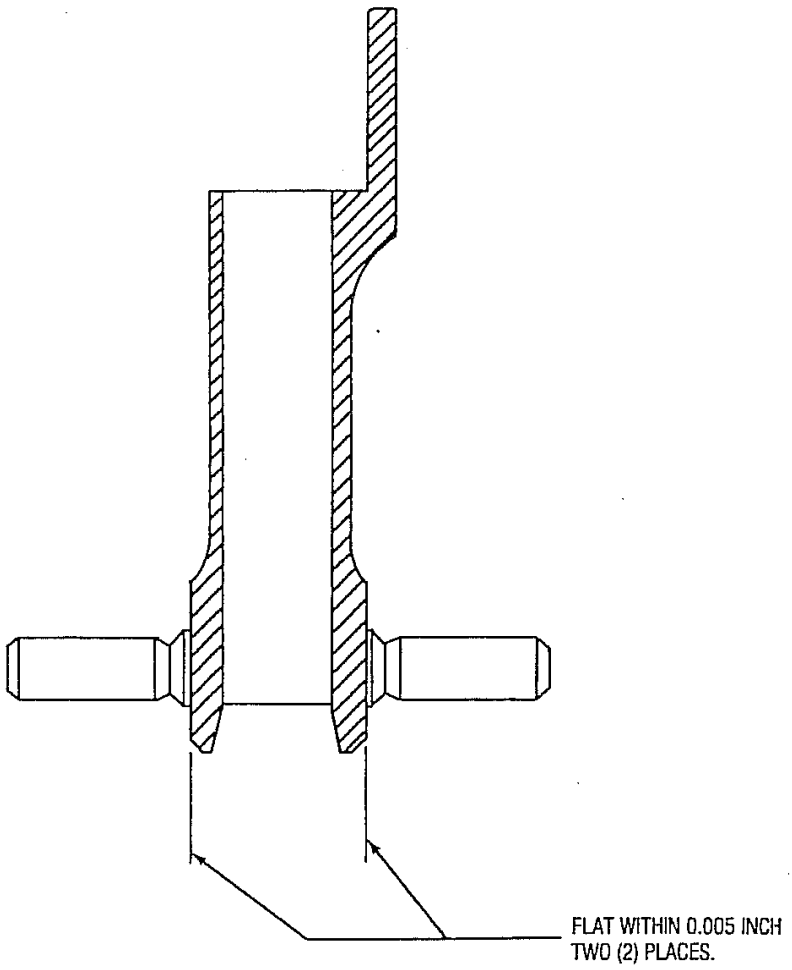


Vane Insert End

Figure 2.

13. SONIC CLEAN.

14. BRAZE – Back Braze inserts to side plates and at butt interface with original vane using oxyacetylene torch locally. Keep heat input to a minimum by allowing cooling period or skip brazing around diffuser if many inserts are involved. Use AMS 4769 (Easy-Flow 45) filler and AMS 3410 flux. Braze joints shall be crack free and visually smooth.



Compressor Diffuser Flatness Check

Figure 3.

15. BLEND WELDS – Blend flush to diffuser plate. Care is to be exercised so as not to nick or cut into flange.

16. CLEAN – Remove flux.

17. INSPECT – Check flatness of both surfaces show in Figure 3.

18. FPI

19. REPLACE STUD –

    a. Center on location of replacement stud and spot face 0.281-0.313 inch diameter on diffuser plate, maintain 0.070 inch minimum plate thickness.

    b. Percussion weld stud per attached procedure.

    c. Proof test replaced stud to 2000 lbs. Centered in and pulled against a 0.310-0.320 inch diameter hole.

20. PRECIPITATION HEAT TREAT – Vacuum or a protective atmosphere, 1060° to 1090 ℉, four hours.

21. FPI

22. INSPECT – Check flatness of both surfaces shown in Figure 3.

23. All dimensions and throat area requirements of the vane passages shall conform to the current blueprint after repair.

24. Air flow all repaired Diffuser Vane Assemblies.

25. Remove old area value and etch new area on Diffuser Vane Assembly per blueprint.

26. Identify reworked diffusers by adding the letter “R” following the serial number to indicate a repaired diffuser.

II. Procedure No. 2 – Installing a New Leading Edge Section of the Vane by Furnace Brazing. Series III (C28) and Series IV (C30) only.

A. Detailed procedure for replacing vane tips by Furnace Brazing is as follows:

1. Remove studs (48 places) on Forward and Aft side by cutting straight across diffuser plates. Care should be taken so as not to nick or cut into plates.

2. Remove damaged vane tips by E.D.M. Deburr around E.D.M openings in both plates.

3. Assemble replacement tips into diffuser (see sketch in Figure 1) by resistance tack welding into place.
4. Furnace braze per AMS 2671, except do not exceed 2040℉. Then cool to room temperature. Within two hours after reaching room temperature, cold treat for 2 hours at –100℉.

5. Precipitation heat treat for 4 hours at 1060-1090℉ in a vacuum or a protective atmosphere.

6. Blend new replacement insert and braze joint to match existing vane. Do not damage new insert or existing vane. Maintain 0.0001 inch radius on leading edge per Figure 4.

7. Visual inspect braze joints. Cracks in the filler metal are not permissible. Minor surface porosity on the external fillet of filler metal is permissible provided it does not extend into the joint between the mating surfaces.

   EXTERNAL BRAZE APPEARANCE – Continuous ring, line, or stain of braze alloy at exposed extremities of the joint, or at both ends of the joint when exposed at two ends.

8. FPI per ASTM E 1417. Cracks in the filler metal are not permissible. Minor surface porosity on the external fillet of filler metal is permissible provided it does not extend into the joint between the mating surfaces.

   EXTERNAL BRAZE APPEARANCE – Continuous ring, line, or stain of braze alloy at exposed extremities of the joint, or at both ends of the joint when exposed at two ends.

9. Ultrasonic inspect braze joint per AMS 2670.

   EXTERNAL BRAZE APPEARANCE – Continuous ring, line, or stain of braze alloy at exposed extremities of the joint, or at both ends of the joint when exposed at two ends.

   MINIMUM BOND PERCENTAGE – 80

   INTERNAL BRAZE JOINT CLEARANCE – Continuous bond of solid braze alloy from extremities of the joint extending between the mating surfaces a distance of 20% of the engagement or overlap of the pieces or 1.5 times the thickness of thinnest piece being joined whichever is less.

10. Replace studs –

    a. Center on location of replacement stud and spot face 0.281-0.313 inch diameter on diffuser plate, maintain 0.070 inch minimum plate thickness.

    b. Percussion weld stud in place per attached specification.

    c. Proof load each replaced stud to 2000 lbs. Centered in and pulled against a 0.310-0.320 inch diameter hole.

11. Inspect the following dimensions:

    a. Check
        - I.D. 10.200-10.201 in.
        - O.D. 13.595-13.605 in.
        - Drop 0.458-0.454 in. (C28), 0.537-0.533 in. (C30)
        - Flange Thickness 0.469-0.467 in. (C28), 0.538-0.546 in. (C30)
        - Maintain flatness (See Figure 3)
        - Bolt hole pattern
        - Stud location
        - Timing pin location

    b. If O.D. flange thickness or drop exceeds requirement, metal spray with METCO 450 and machine. Maintain 0.070 in. minimum base metal thickness on diffuser plates.

    c. If outer bolt hole location is found off, relocate per drawing.

    d. If I.D. is oversized, repair by
        Option 1 – Dalic NI brush plate with AMS 5825 to 0.004 inch maximum thickness per side.
        Option 2 - Dabber (GTAW) weld with AMS 5825 filler rod. Stress relieve/age the diffuser at 1060°-1090°F for 4 hours after welding.

12. Air flow all repaired diffuser vane assemblies on a correlated rig.

13. Remove old area value and etch new area on diffuser.

14. Identify reworked diffusers by adding the letter “R” following the serial number to indicate a repaired diffuser.

III. Procedure No. 3 – Repairing a Damage Vane Leading Edge by Building Up With Weld Material (See Figure 4). Series II (C20), Series III (C28) and Series IV (C30).

A. Detailed Procedure

1. Hand dress any material which has been deformed by the impact to provide a smooth contour.

2. Build up the leading edge with weld.

    a. Use argon shield with backup plates as necessary to prevent burn through during welding

    b. Use restraining clamps for fixtures to prevent diffuser flange warpage during welding.

c. Use filler rod, AMS 5825.

3. After welding, stress relieve at 1060°-1090°F fo r four hours in a vacuum or a protective atmosphere.

4. Hand dress vane to give a 0.007 inch radius leading edge and straight sides. (See Figure 4).

5. FPI.

6. Check Flatness of both surfaces shown in Figure 3.

7. Air flow all vane passages on Series III (C28) and Series IV (C30) diffuser vane assemblies. Measure vane passage dimensions (repaired only) on Series II (C20) diffuser vane assemblies.

8. Remove old area value and etch new area on Diffuser Vane Assembly.

9. Identify reworked diffusers by adding the letter “R” following the serial number to indicate a repaired diffuser.

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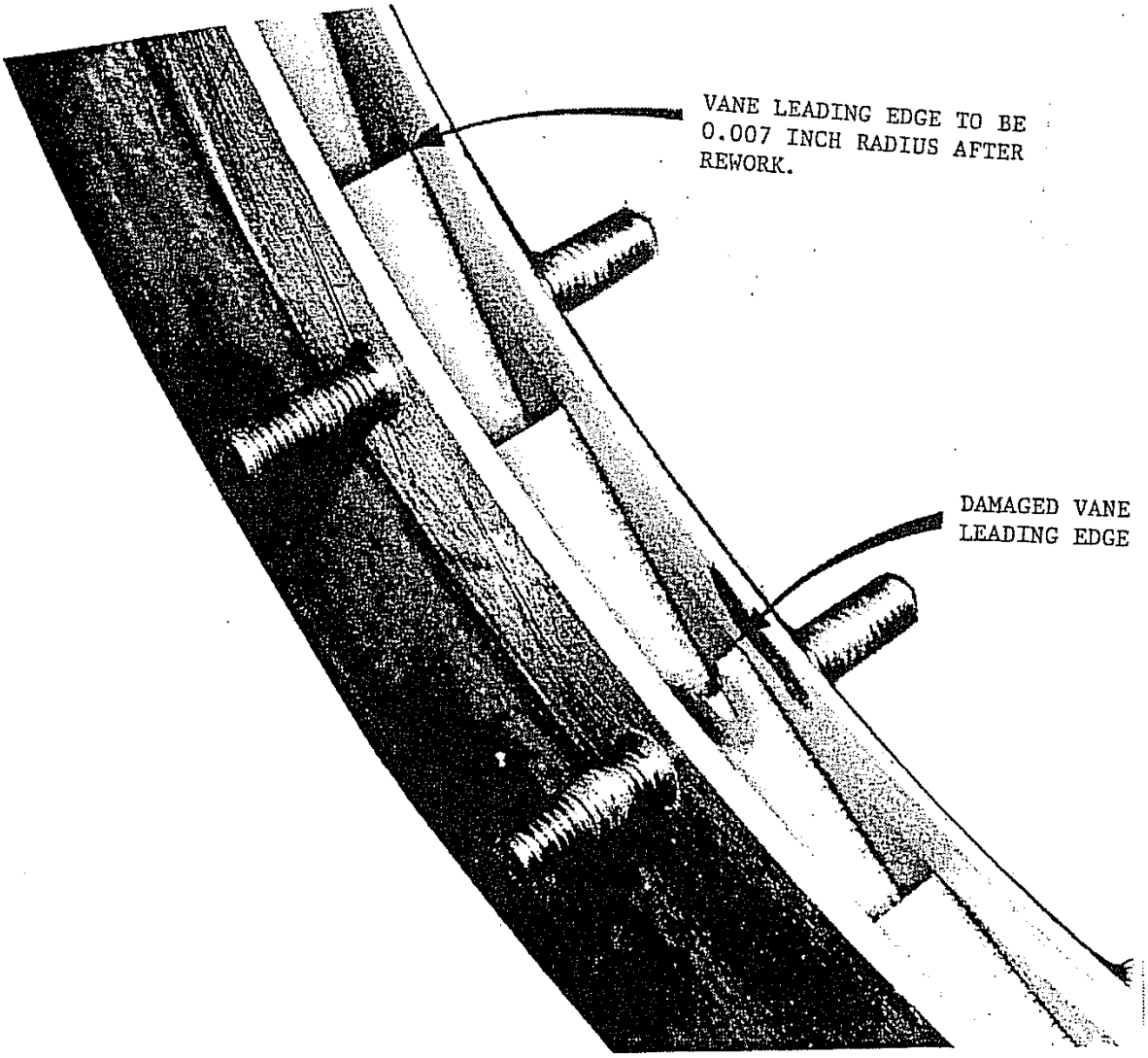

Compressor Diffuser Vane Foreign Object Damage

Figure 4.