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PART 3

INSTRUCTIONS FOR REPAIR

OF

KITTY HAWK AEROPLANE

In these instructions, approved methods of repair for various parts of the aeroplane structure are described and illustrated.

Units are warned against the use, for any important structural component, of any method of repair not described herein. Comments or suggestions concerning the subject matter of these instructions should be addressed, through the usual channels, to the Under-Secretary of State, Air Ministry.

The amendments promulgated in the undermentioned amendment lists have been made in this publication.

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CHAPTER 1

INTRODUCTION

Type of construction

1. The Kitty Hawk Aeroplane is of all metal construction, consisting of a semi-monocoque fuselage and full cantilever wing and empennage. The main structure is a network of bulkheads, spars, and stringers, which are covered with a thin stressed Aluminum Alloy skin. The ailerons, rudder, and elevators are of metal structure which is fabric covered. The engine mount is a welded and bolted tubular structure of X-4130 steel and is detachable from the fuselage. See Fig. 1 for major disassembly.

Types of repair

2. Damages have been divided into four groups to facilitate the classification of repair methods. The classification and general description of the various damages is as follows:

(i) Negligible damage - Small dents, holes or cracks in the sheet material requiring no addition of material or reinforcement. The dents must be bumped out, cracks stopped by a 1/8" hole at each end, and small holes rounded out to a 1/4" radius to prevent formation of cracks.

(ii) Damage repairable by patching - Holes and cracks which impair the strength of the structure but which may be repaired by the use of sheet reinforcements attached by a specified number and arrangement of rivets or bolts. Patches must be shaped and arranged in such a manner as to permit the required rivet or bolt pattern to extend completely around the damage or to the edges of the original stock. Where fittings or other structure is near the damaged area, the patches may have to be extended beyond these in order to obtain the required attachment. In many cases the damaged material must be replaced to give support to the patch and to other parts of the structure, or to obtain continuity, as in repair of the fuselage skin, this added material is designated as a filler or insert.

(iii) Damage repairable by insertion - Extensive damage requiring large inserts which may be attached by means of splices. When the damage is extensive or the presence of fittings and other structures make it difficult to use patches, the damaged material must be removed and replaced by formed inserts of the same or equivalent material, gage, and shape. Where practical, the inserts should be made to extend to the edges of the original sheet and should be attached by using the original rivet or bolt pattern. In cases where complete replacements are impractical, splices may be effected by

using patches. Patches used in splicing must be continuous along the length of the splice and of sufficient width to take the rivet or bolt pattern specified for patching on each side of the cut. Continuous patches for splices that are not straight, that is, for angles, rectangles or circles, are designated as frames. Frames are frequently used in repairing small sections of damaged fuselage skin. Where continuity is not essential, splices may be effected by overlapping the insert and undamaged material. The attachment for an overlap should be, the same in pattern as that used on one side of a patch splice.

(iv) Damage necessitating replacement - Damage to fittings, highly stressed material, and small pieces such as clips and gussets which may be easily replaced. Fittings which are cracked, sprung or nicked must be replaced. Certain portions of the sheet structure are highly stressed and cannot be successfully repaired. These must be replaced. Small sheet fittings, gussets, clips, brackets, etc. are easily duplicated and should be replaced if damaged or stretched out of shape.

3. Where a specific repair is not given it is generally permissible to assume that either the member in question or its attachment has been designed to a zero margin. Due consideration must, however, be given to the probable types of loading to which the member is to be subjected and to the eccentricities of the applied loads. Repairs for the most part consist of replacing the damaged material with material of equal strength and section properties and of attaching this material with the same type of attachment as used for the damaged piece or with sufficient attachment to permit the new piece to take its full allowable load. Care must be taken in attaching repair pieces to arrange the attachment so as not to reduce the structural efficiency of the member to which the repair piece is attached.

4. Due to the construction of the aeroplane, it is important that any repair to the skin, stringers, and bulkheads be given careful consideration. Simple operations, such as repairs to dents, small skin holes, and exterior injuries may be accomplished readily and easily, however, internal structures must be repaired by means of patches, inserts, or by splicing to reinforce the damaged sections or areas before the outer skin is attached. Caution must be exercised to maintain the original contour and to eliminate excessive increases in weight.

5. A simple procedure to follow for all repairs is: Analyze the extent of the damage to the part before proceeding to repair it, devise several methods for its repair by referring to the repair schemes in the back of the text, and with the aid of the illustrations and the book, proceed to use the most convenient and easiest method.

Extent of damage

6. The extent of damage must be carefully ascertained. Determine the path taken by every missle which enters the wings, fuselage, or control surfaces and examine the attachment of every item which has been struck. Look for damage caused by the travel of shock loads along large members. If necessary form semi-structural doors in the skin, see paragraph 7, Chapter 6, to facilitate inspection. Check particularly for the following: Dents and cracks in extrusions and fittings; elongated rivet and bolt holes, cracks and sharp cornered dents or wrinkles, and corrosion in sheet materials; and rivets which are stretched or sheared leaving their heads intact.

Support of structure during repair

7. When repair operations are being performed which necessitate the removal of structural material, care must be taken not to overload other parts of the structure. A fixture of some type must be used to brace or hold that portion of the structure being worked upon. It is essential that the damaged structure be suitably and firmly supported against distortion.

Heat treatment

8. The material used in the construction of the aeroplane is almost entirely aluminum alloy. High strength rolled sheet is used for the stressed skin, and formed sheet is used for the spars, webs, bulkheads and ribs, and extrusions for the stringers and capstrips. All replacement or reinforcement material used must have the same structural characteristics as the damaged part for which it is used. Repair stock for the assembly covered in each chapter is listed in a table at the end of the respective chapter. A list of the commonly used heat treat specifications, along with a brief description of each is given at the end of this Chapter.

The heat-treated and cold worked alloys, 17SRT and 24SRT, can stand very little bending without cracking. The strong alloys of 17S and 24S can be formed in their annealed temper and heat treated to develop the required strength before assembly. In cases, where the annealed metal is not available, it is possible to heat the metal and quench it according to regular heat-treating practice and then form it before the age hardening sets in. The forming must be completed in one hour on "17S" and twenty minutes on "24S" after quenching or the material will become too hard to work. Heat treating the strong alloys of 17S and 24S consists of heating to a temperature ranging from 940° $\pm$ 10°F. for "17S" material; and 920° $\pm$ 10°F. for "24S". Hold at the required temperature until the piece is uniformly heated throughout and quench it immediately in cold water or oil. Thus, all strong aluminum alloy bar, sheet and tube used for the aeroplane parts must be in the fully heat treated condition upon final fabrication. It is only in this condition that the material develops its maximum physical properties and resistance to corrosion. Aluminum forgings, castings, and

fittings must be replaced, as reheat-treat weakens the tensile strength of the part.

All structural steel fittings are also heat treated. These fittings must be replaced because of their respective structural and tensile strength value.

Welding

9. Repair welded aluminum tanks and petrol bag shells according to regular welding procedure. There are several ways and means of accomplishing good lasting welds if the following precautions are adhered to. However, when effecting repairs, care must be taken to eliminate the combination of slag and gas as they produce defects that have a very definite bearing on the strength and ductility of the weld and depending on their size and location can seriously endanger any welded joint. The elimination of slag and gas in the weld metal is depended largely upon proper welding procedure and a good welding operator. Nevertheless, some slag will be formed and this must be removed with emery paper.

10. When performing welds on the fuel tanks and petrol bag shells, the tip size and gas pressure for oxy-hydrogen welding should be according to the thickness of the metal. For metal 0.050"-0.064", the diameter of the orifice should be 0.065". The oxygen pressure should be 2 and the hydrogen pressure should be 1 lb./sq. in. For metal 1/8"-3/16", the diameter of the orifice should be 0.095", the oxygen pressure 3 and the hydrogen pressure 2 lbs./sq. in.

11. Only parts which were welded during manufacture may be repaired or replaced by welding. When effecting repairs to the engine mount, reference should be made to the Caution note contained in paragraph 2, Chapter 2. All welded repairs must be similar to those made on the original part; tack welding for instance must be replaced by tack welding.

Bowed tubes

12. Engine mount tubes bowed in excess of 1/600 of their length must be replaced.

Solid rivets

13. Removal of formed rivets - When removing old rivets the following precautions should be observed. Use No. 30 (.128 in.) drill for 1/8 rivets, 5/32 inch drill for a 5/32 rivet and 3/16 inch drill for a 3/16 rivet. On round head rivets, a flat should be filed on the head before drilling. Drill to a depth equal to the depth of the rivet head or slightly beyond the head and drive the rivet out

with a punch. If the rivet will not come out and the drill hole is centered in the rivet, the drill may be run partly into the shank. Care should be exercised not to elongate the rivet hole. See paragraph 29 for information concerning enlarged rivet holes. After the removal of the rivet, inspect the hole to see that particles of metal are not lodged between the sheets holding them apart.

Removal of countersunk-head rivets

14. The same procedure as followed in paragraph 13 is a good method, except that a center mark should be made on the center of the rivet head before proceeding to drill. Use a drill of the same size or slightly smaller than the rivet shank. Drill into the head of the rivet to half the thickness of the nearest plate or sheet. The head should come away on the drill in the form of a washer. If this does not happen the remainder of the rivet may be punched out with a flat-ended pin punch small enough to pass through the hole.

Fitting solid rivets

15. Solid rivets may be replaced by several methods. Press countersunk 78° rivets are used extensively on skin gage .051" and under. For skin over .051" drill countersunk 78° rivets are used. Drill countersunk rivets should never be used on thin sheets. All rivets should be a good fit in their holes. When press countersinking the sheet for a 5/32" rivet first drill with an 1/8" drill and then form with a male and female steel die. The hole is then redrilled using a No. 22 (.157") drill and the rivet is inserted and driven by hand with a moderate weight hammer.

16. Drill countersinking of the sheet offers less support against shearing of the rivet than does the press countersunk sheet. In the fabrication of drill countersunk rivets, care must be taken to be sure that the head of the rivet is flush with the surface. If the drill countersink is allowed to go too deep, the joint is weakened.

17. For rivet operations, insert the rivet from the outside, place the heading tool on the rivet head and drive the rivet. The blow should be shocked on the inside by a dolly whose distance from the member will become less as the body of the rivet becomes shorter. The counterblock of the dolly should be adjusted during clinching and head forming. Uniform and straight driving of the rivet and its body will be difficult unless the dolly is in the exact center of the rivet. Caution should be taken that the rivet does not fit too tightly as it will cause the plates to bulge and, when the rivet is not pulled tight, clinches will be formed between the plates. Also avoid closing the head too flat. Avoid material bucklings of the skin due to an apparent "bulge" between the press countersinks. See Fig. 108 for flush riveting tools.

18. When effecting repairs on the wing skin, flush type doors are recommended, because of structural value and also for access in locating any future damage that may occur in or around the vicinity. See paragraph 7 of Chapter 6.

Rivet allowance - Modified brazier heat rivet (671-D)

19. For 1/8" diameter rivet: The formed head thickness should be .047"; the diameter of the formed head should be .156"; the extruded length of the rivet, after insertion, should be 5/32".

For 5/32" diameter rivet: The formed head thickness should be .063"; the diameter of the formed head should be .203"; the extruded length of the rivet, after insertion, should be 5/32".

For 3/16" diameter rivet: The formed head thickness should be .078"; the diameter of the formed head should be .234"; the extruded length of the rivet, after insertion, should be 3/16". See Fig. 109.

Countersunk 78° rivet (673-D)

20. For 1/8" diameter rivet: The formed head thickness should be .063"; the diameter of the formed head should be .188"; the extruded length of the rivet, after insertion, should be 3/16"; the protrusion due to the press-countersinking of the metal sheets should be 1/32".

For 5/32" diameter rivet: The formed head thickness should be .063"; the diameter of the formed head should be .234"; the extruded length of the rivet, after insertion, should be 3/16"; the protrusion due to the press-countersinking of the metal sheets should be 3/64".

For 3/16" diameter rivet: The formed head thickness should be .078"; the diameter of the formed head should be .281"; the extruded length of the rivet, after insertion, should be 3/16"; the protrusion due to the press-countersinking of the metal sheets should be 1/16". See Fig. 109.

Round head rivet (AN430)

21. For 1/8" diameter rivet: The formed head thickness should be .063"; the diameter of the formed head should be .188"; the extruded length of the rivet, after insertion, should be 3/16".

For 5/32" diameter rivet: The formed head thickness should be .078"; the diameter of the formed head should be .234"; the extruded length of the rivet, after insertion, should be 3/16".

For 3/16" diameter rivet: The formed head thickness should be .093"; the diameter of the formed head should be .281"; the extruded length of the rivet, after insertion, should be 7/32". See Fig. 109.

Flat head rivet (AN442)

22. Same allowance as used for round head rivet (AN430). See paragraph 21. See Fig. 109.

Rivet clearance

23. For minimum clearances for rivet holes use the proper drill size. For example, on a 1/16" rivet size use a No. 52 (.0635); 3/32" rivet use No. 41 (.096); 1/8" rivet size use No. 30 (.1285); 5/32" rivet use No. 22 (.157); 3/16" rivet size use No. 12 (.189); 1/4" rivet size use 1/4 size drill, etc. When aligning holes of different parts, it is essential that they be dimensioned by the same method and from a corresponding datum point.

24. The method of operating the Chobert riveter is given in A.P. 1464/D.76. Read note given in Chapter 6, paragraph 7.

To calculate the required number of rivets

25. The strength of parts joined together is determined by the number and type of rivets used. To find the required number of rivets for a repair, determine the ultimate strength of the part being repaired by multiplying the cross sectional area by the ultimate tensile strength of the material. This value times the sum of one plus the margin of safety will give the minimum rivet strength required. This required rivet strength divided by the allowable unit shearing stress of the rivet material will give the total rivet cross section required. Dividing this by the area of the rivet to be used will give the number of rivets required for shear strength.

26. However, the bearing of the rivet on the sheet is often more critical than the shear strength of the rivet. Thus, tne ultimate strength of the part times the sum of one plus the required bearing margin will give the required bearing strength. This divided by the allowable unit bearing strength of the sheet material gives the required bearing area. This area divided by the thickness of the sheet and the diameter of the rivet selected finally gives the number of rivets required for bearing strength. The greater number of rivets must be used. The bearing strength of the rivet material is not considered, as tests have shown that the rivet itself does not fail in bearing.

27. The following is an example of the above procedure: If a bulb angle stringer has a cross sectional area of .053 sq. in. and the material is 24ST, its ultimate strength is .053 x 62,000 = 3285.

62,000 P.S.I. is the ultimate tensile strength of 24ST material. The required shear strength, if 671-D rivets are used, is 1.15 x 3285 = 3780 (1 + .15 is considered the margin of safety in this case). The total rivet area for A17ST rivet material is 3780 divided by 25,000 = .1512 square inch. 25,000 P.S.I. is the ultimate stress of the rivet in shear, see "ANC-5, Strength of Aircraft Elements." The area of a 3/16" rivet is .0276 sq. in. and the number required in shear would be .1512 divided by .0276 or 6 rivets.

The required bearing strength is 3285 x 1.28 = 4200 (1 + .28 is the margin of safety in this case). The allowable bearing strength of 24ST material is 90,000 lbs./sq. in. and so the bearing area needed is 4200 divided by 90,000 or .0467 sq. in. See "ANC-5 Strength of Aircraft Elements." If the metal is .040" thick, .0467 divided by .040 x 3/16 = 7 rivets. Therefore, seven 3/16 in. 671-D A17ST rivets are needed on each side of the splice or 14 rivets in all.

NOTE: Margin of Safety	Shear	Bearing
673-D	.35	.64 - .92
671-D	.15	.28

Fitting bolts

28. No steel bolts smaller than 3/16" shall be used. No commercial machine screws or bolts shall be substituted for aircraft bolts. The condition, to be obtained with standard bolts employing washers under the nuts where necessary, is that the threaded portion of a bolt must not be used to take a shear load. When replacing a bolt, the plain portion of the shank of the new bolt must be identical in length with that of the old bolt. All bolts must be suitably locked. Wherever lock wire is used, the wire must fit the hole. Care must be taken to ensure that the nuts are locked in the same manner as the original.

Enlarged holes

29. Enlarged or elongated rivet holes should be drilled for the next larger diameter rivet. Slightly elongated holes can in some cases be filled by using a longer rivet of the original diameter. Elongated holes in fittings or extrusions must not be redrilled because of the limited edge distances provided in manufacture.

Detecting the presence of cracks

30. When effecting repairs, great care must be exercised at all times to ensure that no cracks in the immediate structure remain undetected. Fine hairsize cracks in fractured sheets if undetected will open and spread under vibration. Minute cracks caused by bullet impacts should be cut away when cleaning up fractured areas for repair.

However, if any doubt exists as to the presence of a crack, the part or area should be soaked in paraffin and thoroughly dried. The application of a whiting-water or whiting-methylated spirit paste to the surface will on drying disclose the presence of a crack by a discolored mark.

Marking-off

31. When making up new part replacements of important members or fittings, care must be taken that the correct dimensions given on the drawing be marked off with crayon or soft marking pencil on the surface plate. Prevent heavy marking of the material, as deep markings or scratches may seriously weaken the material and may develop into fine hair like cracks.

Prevention of corrosion

32. All damaged surfaces should be immediately coated to prevent corrosion. Examine the metal under cracked or blistered paint. Use particular care in repairing internal structure which cannot be periodically inspected for corrosion.

33. With the exception of Alclad aluminum, aluminum covered sheets, all aluminum alloy parts are anodically treated. Steel parts, other than those made of non-corrodible sheet or stainless steel are cadmium plated. However, in addition to these primary protective treatments, one coat of zinc chromate primer and one coat of aluminized zinc chromate primer before assembly are applied to everything except the conduit system. The elevators, ailerons and rudder are coated with dope resisting paint and all parts which are liable to come in contact with acid are given two coats of acid-resisting paint. Open ended tubular and hollow parts are given a coat of primer either by filling or dipping. Closed or sealed metal tubular and hollow parts are coated with raw linseed oil forced into the parts by pressure.

34. All cuts, files or badly scratched surfaces can be treated with a zinc chromate paste Type II. Also when insulating dissimilar metals, insulate parts with a thin layer approximately 1/32" thick of zinc chromate paste Type II. Excess should be squeezed out before riveting, or on tightening the assembled parts. Form a small fillet at the edges of the joint unless this fillet is exposed to the air stream.

35. For tail surfaces, a quick drying, clear cellulose nitrate dope may be used for emergency patches on fabric-covered airfoils. This dope is applied in the same manner as semi-pigmented dope, but in drying imparts more tension to the fabric and thus requires a lesser number of coats. Cover with a semi-pigmented dope as soon as practicable to match surrounding finish. However, patches applied with this material are to be used in emergency only. Semi-pigmented dope should be used when initial time saving is not essential.

Reused steel parts

36. Steel parts which are removed and are to be reused should be treated as follows:

(i) Remove all paint, grease and oil by immersing in 20% sodium hydroxide (NaOH) 80% water solution. This may be performed at room temperature, or in a warm solution (faster), and in general should not require much more than 10 to 15 minutes.

(ii) Remove cadmium, rust and corrosion with a 60% hydrochloric acid (Muriatic) 40% water solution. This must be watched to prevent over pickling. In many cases a single momentary dip will suffice.

(iii) Replate with .0005" min. thickness, u. standard cadmium plating practice.

(iv) Cadmium plated parts (and also unplated parts), which require painting shall be chromic acid dipped for two to five minutes in a water solution at room temperature, containing 3 to 5% chromic acid, rinsed and dried.

(v) Paint.

New steel parts

37. New steel parts should be treated as follows:

(i) Clean with any approved alkali cleaner either in hot or cold solution and rinse in water.

(ii) Pickling to prepare for plating may proceed in a 25% hydrochloric (Muriatic) acid bath for 5 to 10 minutes. Steel springs shall never receive more than a momentary dip.

(iii) Plate with .005" min. thickness, using standard cadmium plating practices.

(iv) Cadmium plated parts (and also unplated parts) which require painting, shall be chromic acid dipped for two to five minutes in a water solution, at room temperature, containing 3 to 5% chromic acid, rinsed and dried.

(v) Paint.

Aluminum alloy parts

38. Aluminum alloy parts should be treated as follows:

(i) Remove paint, grease and oil by immersion in a suitable approved inhibited mild alkali cleaner, and rinse in fresh water. Cleaning may be aided by hand scrubbing. Parts excessively oily or greasy may be given a standard degrease before this alkali cleaning.

(ii) Dip for two to five minutes in a water solution, at room temperature, containing 3 to 5% chromic acid, rinse and dry. After this treatment, and before painting, parts should be handled as little as possible.

(iii) Paint.

Magnesium alloy parts

39. Magnesium alloy parts should be treated as follows:

(i) Rough sand castings or other parts which are excessively dirty or which contain imbedded bold sand etc., may be cleaned by immersing for five minutes in a 15% to 20% hydrofluoric acid (HF) 80% water solution. A satisfactory bath can be prepared by diluting one volume of technical grade 48 to 52% (HF) with two volumes of water. Wash thoroughly in cold water.

(ii) Boil casting for 45 minutes in a water solution containing 10% by weight of sodium dichromate ($Na_2Cr_2O_7$). This solution can be readily prepared by dissolving technical sodium dichromate in water in the ratio of 3/4 lbs. per gallon.

(iii) Depletion of the 10% sodium dichromate solution will be indicated by nonuniformity of coating. It can be crudely revivified by adding 1.3% or less of chromic acid. More positive control can be accomplished by adding sufficient chromic acid to bring the pH value of the bath to 4.2.

(iv) Dry in an oven and paint immediately.

SPECIFICATIONS OF MATERIALS USED FOR REPAIR

* Superseded specification
** Current specification

MATERIAL	SPECIFICATIONS	RECEIVED PHYSICAL COND. AND TENSILE STRENGTHS	REMARKS
ALUMINUM Sheet 2S 1/2 H	QQ-A-561 ** 57-151-1 *	Half Hard (AN) 16,000 P.S.I.	For general use in forming operations.
Tubing 2S 1/2 H	WW-T-783	Half Hard (AN) 16,000 P.S.I.	For electrical conduit and tube attached by welding such as filler necks.
ALUMINUM ALLOY Bars & Rods 17ST	QQ-A-351	Heat Treated (AN) 55,000 P.S.I.	Used for stressed fittings, bolts, screws and other lightweight stressed parts.
Bars & Rods, Extruded Shapes 24ST	QQ-A-354 (T) ** 57-152-5 (T) *	Heat Treated (AN) 62,000 P.S.I. Bar & Rod (AN) 57,000 P.S.I. Ext.	Used for highest stressed aluminum alloy structural fittings. Readily machined. Extrusion used for stringers.
Extruded Shapes - 24SO	QQ-A-354 (T) ** 57-152-5 (A) *	Annealed (AN) 35,000 P.S.I. As H.T. (AN) 57,000 P.S.I.	Use only where necessary because of extreme bends not possible with 24ST.
Bars, Rods, Shapes & Wires 53ST	QQ-A-331 (T)	Heat Treated (AN) 32,000 P.S.I.	May be welded.
Forgings 14ST	QQ-A-367-GR.5** 57-153-GR.5 *	Heat Treated (AN) 65,000 P.S.I.	Used wherever possible to take advantage of superior strength. For structural fittings and other forgings where maximum tensile strength, yield strength and hardness are desired.
Forgings A51ST	QQ-A-367-GR.3	Heat Treated (AN) 44,000 P.S.I.	Aircraft engine parts, etc. Good alumiliting characteristics. Used for lightly stressed forging requirements.

SPECIFICATIONS OF MATERIALS USED FOR REPAIR

* Superseded specification
** Current specification

MATERIAL	SPECIFICATIONS	RECEIVED PHYSICAL COND. AND TENSILE STRENGTHS	REMARKS
ALUMINUM ALLOY (Cont.) Casting, Sand Alcoa 43	57-72-GR.I 11311	As Cast (AN) 17,000 P.S.I.	For welded tank fittings and low strength parts. Has good welding and corrosion resistant properties. Capable of withstanding high fluid pressures.
Sheet 3S 1/2 H	QQ-A-359	Half Hard (AN) 19,500 P.S.I.	For general use in forming operations. Harder and stronger than aluminum. Equal corrosion resistance. Forming properties slightly inferior. Good welding properties, suitable for tanks, junction boxes, etc.
Sheet 24SO	QQ-A-355 (A)** 57-152-6 (I) *	Annealed (AN) 35,000 P.S.I.Max. As H.T. (AN) 62,000 P.S.I.	24SO material must be heat treated. For structural parts requiring forming. May be resistant welded. Do not torch weld.
Sheet 24ST	QQ-A-355 (T)** 57-152-6 (II)*	Heat Treated (AN) 62,000 P.S.I.	For structural parts not formed too greatly. May be resistant welded. Do not torch weld.
Sheet - Alclad 24SO	11067 (I)	Annealed (AN) 32,000 P.S.I.Max. As H.T. (AN) 56,000 P.S.I.	For structural parts that require forming more severe than that possible with 24ST Alclad. 24SO material must be heat treated. Pure aluminum coating on both sides gives maximum resistance to corrosion. Do not torch weld.
Tubing 24ST	10235 Cond. B	Heat Treated (AN) 62,000 P.S.I.	Anneal and heat treat if necessary for severe forming. For structural applications. Do not weld.
Tubing 52SO	57-187-3 Temp. A	Annealed (AN) 32,000 P.S.I. Max.	For non-structural parts; fuel, oil, instrument, hydraulic vacuum and other lines. Do not torch weld when wall thicknesses are in excess of 1/8". Do not anneal after forming.

SPECIFICATIONS OF MATERIALS USED FOR REPAIR

MATERIAL	SPECIFICATIONS	RECEIVED PHYSICAL COND. AND TENSILE STRENGTHS	REMARKS
BRASS Bar & Rod - Leaded Brass	QQ-B-611	Half Hard (AN) None Required	Free cutting material for machined parts, knobs, bushings, leaded bearings, etc.
Sheet and Strip - Low Brass	57-160	Annealed (AN) 40,000 P.S.I.	For use on radiator plates and shells only.
Tubing, Seamless	WW-T-791	Semi - Annealed (AN) None Required	Used for spacers, bushings and tubing that requires strength and corrosion resistance.
BRONZE Casting - Gun Metal Type 1, Comp. 5	QQ-B-691	As Cast (AN) 40,000 P.S.I.	High tensile structural bronze. Used for special fittings, nuts, bushings, bearings, etc., where a combination of strength casting properties and corrosion resistance is necessary.
COPPER Tubing, Seamless	WW-T-799	Annealed (AN) None Required	For fuel, water, oil and air lines, in connection with solder or flared type fittings.
Tube, Cu - Si - Bronze	57-192-1	Soft Annealed (AN) 50,000 P.S.I.	Used for oil, water, fuel and air lines.
CLOTH Cotton - Grade A	AN-CCC-C-399	80 lbs. breaking strength	For covering wings, fuselage, control surfaces, etc.
RUBBER PRODUCTS Hose - Synthetic Rubber	20-103	----------	Used in fuel, oil and coolant liquid lines in engine installations.

SPECIFICATIONS OF MATERIALS USED FOR REPAIR

MATERIAL	SPECIFICATIONS	RECEIVED PHYSICAL COND. AND TENSILE STRENGTHS	REMARKS
STEEL Carbon, low SAE 1112	None	Annealed 75,000 P.S.I. As case Hardened 150,000 P.S.I.	For machined parts carrying no load. Excellent machinability. Unsafe for vital parts.
Chrome - Moly SAE X-4140	AN-QQ-S-752	Annealed (AN) 55,000 P.S.I. to 65,000 P.S.I. As H.T. (AN) 125,000 P.S.I.	Used for all steel forgings and fittings where bar stock is required. Can be welded. Heat treats well and can be used for forgings with wide thickness variations.
Nickel Carbon, Medium SAE 2330	57-107-17	Annealed (AN) 65,000 P.S.I. As H.T. (AN) 125,000 P.S.I.	For bolts and threaded parts, fittings, bomb rack parts. Do not weld. Not for carburizing.
Chrome - Moly, Medium Carbon SAE 4130	57-136-8	Normalized (AN) 90,000 P.S.I. As H.T. (AN) 150,000 P.S.I.	Used for all stressed steel fittings and parts such as gussets, straps, plates, clamps, etc. Easily welded.
Corrosion Resisting, stainless, chrome-nickel	11068 GR.A 1/2 H	Half Hard (AN) 150,000 P.S.I.	Is slightly magnetic. For structural parts where only slight forming is necessary. For firewalls and armament spot welded parts. Do not torch weld. Not to be heat treated.
Chrome - Moly (Round) Medium Carbon X-4130	57-180-2	Normalized (AN) 95,000 P.S.I. As H.T. (AN) 125,000 to 180,000 P.S.I.	For all structural steel tubing parts. Easily welded and heat treated.
Sheet and Strip Carbon, Low SAE 1010	Commercial	Annealed 45,000 P.S.I.	Extra soft low carbon for deep drawing and non-structural parts. May be gas, arc or spot welded.
TAPE Surface Tape, Cotton Pinked	6-62	----------	Used on airfoil coverings over ribs, leading edges, trailing edges, etc.

CHAPTER 2

ENGINE MOUNT

General

1. The primary structure of the engine mount is constructed of X-4130 chrome molybdenum steel tubes which have been heat treated to a high tensile strength. The upper tube assemblies and the horizontal bearer tubes are heat treated to 150,000 p.s.i. tensile strength. The upper tube assemblies have steel fittings welded at the ends to form the joints. The horizontal bearer tubes have bolted fittings which facilitate their replacement. The lower diagonal tubes are X-4130 steel tubes heat treated to 95,000 p.s.i. tensile strength with fittings bolted to the tubes to permit quick disassembly. The engine mount truss and sway brace link assemblies are aluminum alloy 14ST forgings which are heat treated to 65,000 p.s.i. tensile strength.

2. The engine mount was originally designed for extremely accurate jigging and close hole tolerances in order to eliminate vibration. The design of the engine mount is of such a nature that it may be easily disassembled into small units and sub-assemblies for quick replacements. Figure 2 shows the complete disassembly of the engine mount and calls out the sub-assemblies in order to assist in quick identification of parts.

CAUTION: Do not under any circumstances apply torch heat to the engine mount tubes as the heat impairs the tensile strength of the material. When heat is required for a replacement, the assembly must be reheat-treated to the original tensile strength specified for the member (see para. 1)

3. Any damage to the engine mount, however slight, necessitates replacement of the damaged member. All center line of holes must be within 1/32" of the center line of the forgings and tubular members. See the Engine Mount Chart and Figure 2 for replacement of parts.

Vibration absorbers

4. For replacing the engine vibration absorbing bushings, refer to the Service and Maintenance Handbook, Air Publication 2014A, Vol. I.

Engine mount bushings

5. Bushed holes of the engine mount make it possible to maintain the desired tolerance and close fits. However, when replacing a sub-assembly of the engine mount, replace bushings, only

hen absolutely necessary. Because of the close hole tolerances, t is improbable that any appreciable wear will develop in the ushings.

longated holes

6. If any bushed hole is slightly elongated or damaged eplace the bushing and bolt according to the Engine Mount Material hart.

Engine Mount (87-22-501) Material Chart for Allison V-1710-F3R

Name and location of the part	Part number	Material	Size	Remarks
Horizontal bearer tube assembly	87-22-531 L/R			
Tube	87-22-515	X-4130 Steel	Stock - 2.525" O.D. x 2.046" I.D.	46 5/8" long
Bolt	AN73-A5	Steel	5/8" long; shank 1/8"	Coarse thread
Bolt	AN7-35	Steel	3 5/8" long; shank 3 1/16"	
Bolt	AN6-51	Steel	5 1/8" long; shank 4 9/16"	
Collar - oil cooler and prestone radiator support	87-22-530	Al. Al. 14ST	Bore - 2.501" +.002 -.000	
Fitting	87-22-516	4340 Steel	I.D. 2.502" +.002 -.000	Forging
Support - cowling to engine mount	87-29-738	Al. Al. 14ST		Forging
Upper bearer tube assembly	87-22-512 L/R			
Fitting	87-22-513	4140 Steel		Forging
Fitting	87-22-514	4140 Steel		Forging
Bushing	1001D-6-.374	4140 Steel	I.D. .375"; O.D. .5015"	.374" long
Bushing	1001D-12-.525	4140 Steel	I.D. .75"; O.D. .8765"	.525" long
Tube	87-22-512-1	X-4130	2 1/2" O.D. x .095" x 56 1/2"	Weld fittings at ends
Truss - engine mount lower	87-22-521			
Truss	87-22-520	Al. Al. 14ST		Forging
Stud	626-D-5/16-1 1/4	2330 Steel	Dia. 5/16"; 1 1/4" long	Coarse thread
Stud	626-D-5/16-1 3/8	2330 Steel	Dia. 5/16"; 1 3/8" long	Coarse thread
Bushing	1001-D-6-.370	4140 Steel	I.D. .375"; O.D. .5015"	.370" long

Engine Mount - Material Chart for Allison V-1710-F3R Cont'd

Name and location of the part	Part number	Material	Size	Remarks
Bushing	1001-D-6-.495	4140 Steel	I.D. .375"; O.D. .5015"	.495" long
Bushing	1001-D-12-.625	4140 Steel	I.D. .750"; O.D. .8765"	.625" long
Tube assembly - lower diagonal	87-22-518			
Tube	87-22-518-1	X-4130 Steel	1" O.D. x .065" x 20 3/4"	
Bolt	AN23-21	Spec. 29-59	1 5/16" long; shank 1"	
Nut	AN320-3	Steel	No. 10-32	
Washer	AN960-10	1010 Steel	13/64" I.D.; 7/16" O.D.	1/16" thick
Cotter	AN-380-2-2	Spec. (42P7D)	1/2" long; 1/16" Dia.	
Clevis	87-22-519	Al. Al. 24ST	1 1/8" Dia. x 3 3/16" Bar	
Bushing - clevis	87-22-519-2	4140 Steel	.375" I.D.; .5015" O.D.	1001-D-6-.187
Link - lower truss to fire-wall	87-22-517	Al. Al. 14ST	11.019" ±.003 long	
Bushing	1001-D-6-.250	4140 Steel	.375" I.D.; .5015" O.D.	.250" long
Washer	AN960-816	1010 Steel	33/64" I.D.; 7/8" O.D.	1/16" thick
Nut	AN320-6	Steel	3/8" Dia. of tap x 24 thds.	
Nut	AN310-12	Steel	3/4" Dia. of tap x 16 thds.	
Nut	AN310-8	Steel	1/2" Dia. of tap x 20 thds.	
Bolt	AN8-87	Steel	Shank Dia. .499 +.0000 -.0035	8 7/8" long
Bolt	AN8-86	Steel	Shank Dia. .499 +.0000 -.0035	8 3/4" long
Bolt	87-22-034-7	2330 Steel	9/16" Hex. x 1 17/32"	
Bolt	87-22-034-6	2330 Steel	9/16" Hex. x 1 25/32"	

Engine Mount - Material Chart for Allison V1710-F3R Cont'd

Name and location of the part	Part number	Material	Size	Remarks
Snubber	87-22-535	No. 14 Fabreeka	1 5/16" I.D.; 1 7/8" O.D.	.234" ± .004 thick
Snubber	87-22-534	No. 14 Fabreeka	1 1/2" I.D.; 1 15/16" O.D.	.234" ± .004 thick
Stop	87-22-533-2	4140 Steel	Ream .500"; 2 3/8" Dia.	
Stop	87-22-533-1	4140 Steel	2 3/8" Dia. x 1 1/8" Bar	
Stop	87-22-542-1	4140 Steel	Ream .500"; 2 3/8" Dia.	
Bolt	87-22-532	2330 Steel	1 1/16" Hex. x 3 3/8"	3/4" Dia.-special

CHAPTER 3

FUEL, OIL, HYDRAULIC AND COOLING SYSTEMS

Tanks

General

1. The fuel tanks consisting of a fuselage tank and two wing tanks are petrol-tight, self-sealing bags which are snuggly fitted into pressed aluminum containers, see Fig. 110. Also see Fig. 111 for wing tank installation tools. The petrol bags are fabricated by employing several layers of material which consist of an inner lining of Neoprene balloon fabric, a second layer of split steerhide, third layer of uncured Latex sheet, fourth layer of sponge rubber, fifth layer of uncured Latex sheet and an outer covering of chrome-tanned steer-hide. The inner lining of Neoprene balloon fabric consists of balloon cloth impregnated with Thiokol and cemented together with Neoprene cement to form a two ply sheet .017" thick. The self-sealing element consists of two .015" sheets of Latex gum on either side of a .250" sponge rubber sheet. The Latex sheets are protected on the outside by a .078" sheet of grained steerhide leather and on the inside by a .060" sheet of split steerhide. Bostick M-40 cement is used to attach the split steerhide to the layer, while Neoprene cement is used to attach the successive layers of the Latex gum, sponge rubber and leather. The Neoprene cement is applied to both surfaces and allowed to dry for twenty to thirty minutes. The pipe fittings, filler neck, gage fittings and inspection hole fittings are all made of molded Neoprene and have flanges which are cemented to the inside of the self-sealing bag and covered with a patch of balloon cloth. The baffles are of rubberized webbing with Neoprene flanges molded on and consist of five layers, two of duck and three of Neoprene, center and outsides. Each self-sealing bag is provided with inspection holes so as to facilitate repair. The fuselage bag has one inspection hole, whereas the front wing bag is equipped with three inspection holes and the rear wing bag has four inspection holes. The capacity of the fuel tanks is 122.83 Imperial gallons. The individual capacities are as follows: the fuselage self-sealing bag, 51.5 Imperial Gallons; the front wing self-sealing bag, 29.23 Imperial Gallons and the rear wing self-sealing bag 42.1 Imperial Gallons. All fuel bags have a 3% expansion space and are vented to the atmosphere.

The oil and coolant expansion tank are welded aluminum alloy (3S) structure. The externally Linatex covered oil tank has an expansion space of 1.2 Imperial Gallons and a normal tank capacity of 10.83 Imperial Gallons and an overload capacity of 13.33 Imperial Gallons.

The reserve hydraulic tank, located forward of the fuselage access door, is a magnesium alloy casting (Alcoa AM-260T6). The auxiliary hydraulic tank located on the forward side of the fire-wall is an aluminum alloy (3S) welded structure. The ends are castings (Alcoa No. 43.)

Classification of damage

2. When determining the type of damage to any of the tanks, the repair must be classified as one of the following:

(i) Negligible damage
(ii) Repairable damage
(iii) Damage necessitating replacement

Negligible damage

3. When effecting slight repairs to a fuel tank, it is not necessary that the tank be steamed and washed before the repair is made, however it must be kept away from heat or fire. It is necessary that the surfaces of the self-sealing bags and aluminum shells be free from grease, oil or fuel. All surface scratches, small cuts or rips on the self-sealing bags can be repaired readily by roughing up the outside steerhide and patching with strips of leather using two coats of M-40 Bostick cement and rolling down smoothly with a roller. The bag shells must be free from cracks, abrasions and sharp corners, and all small dents must be restored to shape, taking care not to stretch or crack the shell. File all sharp corners smooth.

Repairable damage

4. Self-sealing bags and shells that are damaged and necessitate repairs should be replaced and the damaged bag and shell sent to a repair depot where repairs should be effected by the following method.

Removal of a self-sealing petrol bag

5. Remove the petrol bag from the aluminum shell container. The containers or shells of the fuselage and wing tanks are (2S1/2H) aluminum and can be repaired by welding. The wing tank shells are pressed sections consisting of an upper and lower assembly which are held together to form the complete shell by means of straps. The fuselage container or shell consists of pressed sections with a bolted forward end and a riveted aft end. The shell sections are bolted together with the leather covering of the petrol bag fastened between its flanges, see Fig. 110. The fuselage container or shell is reinforced by means of straps.

Repair of petrol bag on the side which the bullet enters

6. A small clean hole, which would usually result from a bullet entering a tank, may be repaired as follows:

(i) Clean the Neoprene balloon cloth lining around the bullet hole with ethyl acetate solution to remove the zinc chromate slushing compound. Allow to dry and buff lightly where the patch will fit. Use two coats of Bostick M-40 cement on both the Neoprene fabric patch and the liner of the bag. The patch should extend at least one inch beyond the damaged area in all directions.

(ii) Brush on TL-284 zinc chromite slushing compound so that the repaired area is completely covered.

(iii) Rough up the steerhide leather on the outside of the bag with card cloth around the damaged area. Cement the leather surface with two coats of M-40 cement and allow to dry fifteen minutes.

(iv) Prepare a patch by cementing the flesh side of the steerhide leather with two coats of M-40 cement. Allow to dry, and apply the leather patch to the prepared area and hand roll thoroughly, see Fig. 112.

Repair of petrol bag on the side from which the bullet emerges

7. Any extensive damage or large tear in the bag may be repaired as follows:

(i) Repair the inner Neoprene lining in the same manner as detailed above.

(ii) On the outside leather surface draw a circle around the damaged area so that no part of the circle will fall closer than two inches to any part of the damaged area. Remove this section of the steerhide leather using benzol and a knife.

(iii) Remove the outer layer of Latex and sponge from a concentric circle having a one-half inch smaller radius than the previously removed steerhide.

NOTE: The Latex and sponge are removed simultaneously over an equal area, see Fig. 112.

(iv) Remove the inner layer of Latex from a concentric circle having a one inch smaller radius than the previously removed steerhide or a 1/2" smaller radius than the previously removed Latex and sponge.

(v) Remove any loose particles of the split steerhide.

(vi) Cut patches of steerhide, Latex sheet, sponge and split steerhide. These patches should be large enough to make a lap joint on each step of this repair except in the case of the sponge patch where a butt joint should be used instead of a lap joint. Each lap is one-half inch except the outer layer of steerhide which should lap one inch. See Figure 112. Use two coats of Bostick M-40 cement on each surface.

(vii) The bag layers should be repaired as soon as possible after damage, because the Latex gum swells at the rate of 2000% in 48 hours when saturated with 100 octane fuel. The area affected will spread rapidly and unless repaired immediately, the petrol bag may have to be scrapped.

(viii) Emergency temporary repairs made by merely patching the inside of the inner lining would prove effective where the tear does not exceed four inches, provided the aluminum shell is hammered back into shape to support the self-sealing element where it is damaged.

(ix) Bostick M-40 cement should be used to repair self-sealing petrol bags. This is a self-vulcanizing cement and tends to deteriorate if stored for long periods. It is, therefore, advisable to order supplies in small quantities as it is necessary to mix the cement with a curing fluid before use and once mixed, it starts to vulcanize rapidly. Therefore, mix only sufficient cement to do the job on hand. Never use previously mixed M-40 Bostick cement. Benzol or Toluol may be used as a cement thinner. Toluol is used in the M-40 Bostick cement.

NOTE: Both Benzol and Toluol have severe toxic effects and consequently must be used only in a location that will afford ample ventilation to protect the repair personnel from any ill effects.

Repair around fittings

8. Leaking or damaged pipe fittings may be easily repaired. Loosen the defective fitting by pouring Benzol or Toluol down the outside of the pipe so that it seeps between the flange of the fitting and the balloon cloth. The fitting when loosened, may be pushed into the bag and removed through the inspection hole. The jointing surfaces must be cleared of the zinc chromite slushing compound before applying the Bostick M-40 cement. A balloon patch should be cemented to the flange before the fitting is cemented inside the bag. Care should be exercised to work from the center out when attaching the fittings or patches so that no air will be trapped between the surfaces.

9. Materials

(i) Neoprene synthetic rubber fabric liner, Spec. 16112-A.

(ii) Benzol or Toluol cement thinner.

(iii) Uncured Latex sheet gum, Spec. 26568.

(iv) Cellular sponge, Spec. 26556.

(v) Chrome tanned steerhide, Type 1 and 2, Spec. 12028.

(vi) M-40 Neoprene cement with liquid accelerator.

(vii) TL-284 Fuller's slushing compound.

10. Tools for repair kit

(i) One set of No. 50 emery paper.

(ii) One bevel stitcher, 2" x 2-1/2" x 1/4".

(iii) One hand roller, 2".

(iv) One round handled turn-over knife.

(v) One steel knife for cutting rubber, Type 1" x 4".

(vi) Several 1" brushes for cement and slushing compound.

Repair of petrol bag shells

11. Failures in the fuel tank shells can usually be repaired by welding provided a smooth interior surface is obtained that will not injure the fuel bag. Remove the paint coatings from around the damaged area with paint remover and thoroughly wash off the surface with hot water before proceeding to repair the shell. See paragraphs 9 and 10, Chapter 1 and paragraph 16, this Chapter. Shells must be free from dirt, oil, grease, etc., before proceeding with welding operation.

Application of Linatex covering to the oil tank

12. Remove the Linatex covering of the aluminum oil tank when effecting repairs by welding. Replace the Linatex covering of the oil tank according to the following procedure.

(i) Tanks shall have one coat of primer before covering with Linatex.

(ii) Clean tank with solvent (naptha, benzol, etc.) to remove oil, grease and dirt.

(iii) Apply one coat of primer C-10. Allow to dry 1/2 hour (min.).

(iv) Apply one coat of cement L-110. Allow to dry 10-15 min. Tanks may stand for 1-2 days after cementing if necessary.

(v) Clean Linatex coat (1 side) with solvent to remove dirt, oil and grease.

(vi) Brush in well one coat Solufix No. 1. Only mix sufficient Solufix No. 1 for one day's use, as it jells rapidly on exposure to the air. Solufix No. 1 is 50% No. 1A and 50% Solufix No. 1B. Allow to dry 10-15 minutes.

(vii) Apply one coat Solufix No. 1 to tank and allow to dry 10-15 minutes.

(viii) Cement on Linatex covering working from center of sheet outward. No air should be trapped under the coating.

(ix) At joints lap 1" minimum, and clean with solvent. Brush both surfaces with Solufix No. 1, allow to dry 10-15 minutes, then roll down, beginning at the edge of the lap, using the thin roller along the lapped edge first.

IMPORTANT: Each layer must be hand rolled immediately after applying to the tank. Care should be taken to work from the center outward and no air shall be trapped between the layers.

(x) Clean the first coat of Linatex with solvent. Brush in one coat of Solufix No. 1 and allow to dry 15 minutes.

(xi) Clean the layers of Linatex for the second covering with solvent. Brush in one coat of Solufix 1, and allow it to dry for 15 minutes.

(xii) Apply the second coat of Linatex over the first, and work it down as before. No air shall be trapped between layers. Roll down the surface after application of the second coat.

(xiii) Clean the Linatex covering and the (16-3/4 oz.) duck on its proofed side. Apply to each, one coat of Solufix 1 and allow to dry 10-15 minutes.

(xiv) Apply the duck covering over the Linatex layers, pulling down hard. Work should be from the center outward.

(xv) Apply one coat of cement L-110 to the joints of duck and allow to dry 15-20 minutes; then one coat Solufix 1 and allow to dry 15 minutes. All lap joints must then be rolled down, working from the edge of the under layer out.

(xvi) The edges of all lapped joints and edges of openings for clips and fittings must be coated with cement L-110.

13. Method

(i) As the second coat of Linatex is applied, care should be taken in lapping the applied pieces so that the laps made in the first and second coverings are staggered. This gives a maximum thickness of three layers of Linatex in any one spot, and keeps irregularities in the contour at a minimum.

(ii) In applying the cements and primer, spraying may be used for applying primer C-10. The coat of cement L-110 may be applied by a dipping operation. Solufix 1 is best handled by brushing and gives the desired thin, smooth coats. Spraying of Solufix 1 is not recommended as the cement must penetrate the surface of the Linatex in order to form good joints.

(iii) Butt joints formed by cementing the clean edges of sheets with Solufix 1 have nearly the full strength of the material. It is suggested, in order to conserve material, that large scrap pieces of the Linatex be butt jointed together to procure large sheets for use as covering. These butt joints may be formed by coating each clean edge with Solufix 1, allowing to dry 10-15 minutes, then placing the edges approximately 1/32" apart on a flat surface, and hammering the joint starting from one end and working toward the other. The Linatex expands sidewise upon impact and cements, pulling the joint together. The edges must be trimmed true to match before cementing.

(iv) The duck used for the finishing coat over the Linatex is (16-3/4 oz.) cotton duck proofed on one side only with masticated or uncured rubber in order to allow cementing over Linatex with Solufix 1 cement. When doping this duck, light coats should be applied to avoid excessive strain on the fabric and the cemented joints. The tanks should stand two days after covering before doping to allow the cements to dry and cure properly.

Tools and materials required

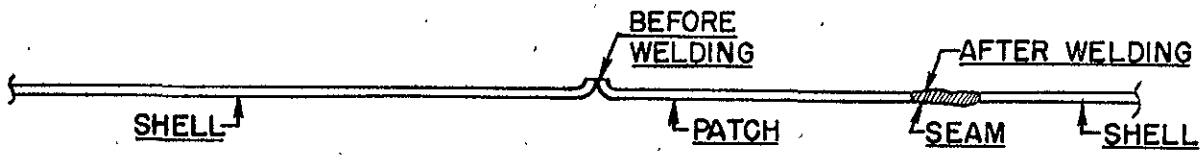
14. Linatex is used in conjunction with special cements developed for use with this product. Two tools are used in rolling down the layers after applying to the oil tank. The first, a stitcher is used in rolling down the edges of lapped joints to form a secure joint without trapped air bubbles. The second is a small roller used on the entire surface to roll down the Linatex driving out the trapped air and insuring good contact between the cemented layers.

Repair of Aluminum Tanks and Shells

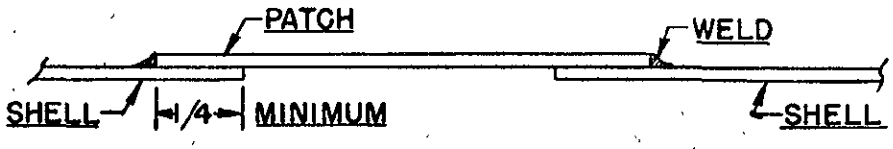
15. The coolant expansion tank, oil tank and the auxiliary hydraulic tank are of aluminum alloy (3S) construction and can be repaired by welding. Before proceeding with welding operations, the tank must be free from dirt, oil, paint, etc. and all fittings must be removed. Run a constant stream of boiling hot water entering at the bottom of the tank and letting it overflow at the top for at least one hour. Blow compressed air into the tank until all odors have been expelled.

Welding Procedure

16. When welding aluminum tanks or shells, use oxy-hydrogen flame according to instructions given in paragraph 10, Chapter I. A 5% silicon rod, or equivalent, should be used with Flux No. 22, manufactured by the United States Aluminum Company. The Flux is mixed with water to a thin paste condition and is applied on the area to be welded and also for dipping the rod. Cut all fractures round or elliptical and when these openings are closed, the tank edges should be bumped up about 1/8" and the patch to be inserted should also have up-turned edges to fit snuggly into the tank opening. The patch can then be tacked and welded in place as shown in the following sketch.



If the tank thickness of the metal is .050" or over, a lap weld patch as shown, may be used provided there is room for the repair.



Pressure test for tanks

17. Repaired tanks must pass the following internal pressure tests before being returned to service.

Wing (reserve) fuel bag	1 lb./sq.in. - unrestrained
Wing (main) fuel bag	1 lb./sq.in. - unrestrained
Fuselage fuel bag	1 lb./sq.in. - unrestrained
Oil tank	5 lbs./sq.in.
Coolant expansion tank	20 lbs./sq.in.
Reserve hydraulic tank (Magnesium alloy casting)	5 lbs./sq.in. - pressure test without valve

Damage necessitating replacement

18. Cracking or perforation of the bag shell or tank due to corrosion, or damage which by its extent or location renders the success of the repair uncertain, necessitates replacement of the tank or shell. Damage beyond repair of the self-sealing bags due to fuel saturation should also be replaced.

Coolant radiators - oil cooler

19. The coolant radiators are constructed with a core frontal area of 1.11 square feet, a cooling surface area of 147 sq. ft. and a free air area in the core of .715 sq. ft., having a minimum flow of 100 British Imperial Gallons per minute with 7 1/2 lbs./sq.in. inlet pressure and zero lbs./sq.in. outlet pressure.

20. The oil cooler, United Aircraft Product U-3385-D8S Type "11" is constructed with a frontal area of 95 sq.in. and a cooling surface of 86 sq. ft. and weighs 44.5 lbs.

Construction - coolant radiators - oil cooler

21. The coolant radiator consists of copper tubes (.006 x .230 O.D. x 12). The brass header bulkhead flanges are turned for attachment to the shell and riveted. All rivet heads or external surfaces are sealed with silver solder which is a lead base containing from 5% to 6% silver, developing a high shearing strength and having a melting point of 304° to 370°C. (581° to 698°F.)

22. The inner and outer brass shells and the valve flange casting of the oil cooler are assembled by silver soldering. The core tubes are held together, one tube to all its adjacent tubes, and the core assembly complete to the shell, by means of a lead tin solder. Tubes used are .210 dia. x .250 hex.

Cleaning before repair

23. Oil Cooler

In all cases where any type of repair work is to be done the cooler must first be drained of oil and then thoroughly cleaned. Carbon tetrachloride or trichlorethylene are the best solvents for cleaning oil coolers and should be used at elevated temperatures, approximately at the boiling points of the liquids. However, in the absence of any heating means, these solvents at room temperature will perform a satisfactory cleaning job. A 50-50 mixture of carbon tetrachloride and naptha or a mixture of carbon-tetrachloride and Sunoco Spirits may be used if desired. The solvent should be mixed as required in quantities sufficient to meet daily requirements. It is recommended that the liquid be pumped through the cooler. A hand fuel pump, transfer pump or a power driven pump may be used. The liquid should be strained as it leaves the cooler to catch any particles of hard carbon, metal, etc.. If bearing metal particles are found, the cooler should be scrapped. The interior of the cooler, after cleaning should be flushed with hot running water and steamed for not less than one-half (1/2) hour. The steam should pass downward into the internal passages with the regulator so placed that the condensate will drain freely from the bottom.

24. Coolant Radiators

A solution consisting of one to two pounds of concentrated soap to forty gallons of water makes a satisfactory cleaning solvent. After thoroughly washing the radiator, remove the soap solution and flush the exterior and interior with clean hot running water. After rinsing, steam the interior of the radiator for not less than one-half (1/2) hour. The steam should pass downward into the internal passages with the radiator so placed that the condensates will drain freely from the bottom.

Testing for leaks

25. Oil Cooler

After cleaning as described above, locate leaks by submerging the cooler in clean warm water with all openings closed and an air pressure of not more than 75 lbs./sq.in. applied. The pressure is to be applied and released slowly to prevent any strain or shock. Then mark each point where bubbles appear with a wire clip. If there is a leak in the tube, remove it as described in paragraph 28 and insert a new one by soldering it in place as described in paragraph 29. If the leak appears around the jacket, or the core face, the leak can usually be soldered without disturbing any of the assembled parts.

The same test should be made after any repairs are completed.

26. Coolant Radiators

The leak test for the coolant radiators should be conducted in the same manner as for the oil cooler except that an air pressure of not more than 10 lbs./sq.in. is to be applied.

Repair equipment required

27. The following equipment is required for the complete repair work of oil coolers and coolant radiators in accordance with this prospectus:

(i) Oxy-acetylene torch, oxygen acetylene tanks, and pressure regulator with several sizes of torch tips.

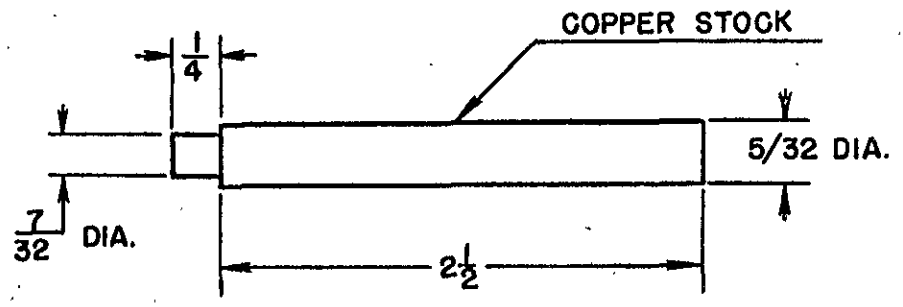
(ii) Small gas-fired furnace for heating copper soldering irons.

(iii) At least two large gas-heated soldering irons.

(iv) At least four special tube pulling irons (see Figure below).

(v) Silver solder wire approximately 1/16 inch in diameter; soft tin lead solder wire approximately 1/8 inch in diameter.

(vi) Zinc chloride flux for the soft solder and also flux for the silver solder.



SQUARE OFF END OF PLAIN SOLDERING IRON (AT LEAST A 3 LB. IRON). DRILL 3/8 INCH HOLE IN SQUARED END 1-1/4 INCH DEEP. INSERT COPPER POINT AND SILVER SOLDER TO IRON. BE SURE TO SWEAT SOLDER FULL LENGTH OF HOLE.

Repairs

28. Removing single tubes

Collapsed tubes usually will not leak but should be removed because of their effect on the heat dissipation. Instruction for repair and replacement of collapsed tubes also applies to the repair and replacement of a leaking tube. The procedure is as follows: Heat the special tube pulling irons in the gas furnace. While the irons are heating, clean the original soldered ends of the tubes to be pulled, with concentrated hydrochloric acid and swab with zinc chloride flux. The cleaning and fluxing should be done with a small hair brush or swab. With the irons hot, insert the tip of one iron into one end of the tube and the tip of the other iron into the opposite end of the tube, making sure they are in the same tube. Corresponding tube ends can be identified easily by pushing a wire through the tube and as the wire is withdrawn from the tube, insert one iron in the end from which the wire has been withdrawn and then as the wire is withdrawn from the other end, insert the other iron in that end. Then applying a pushing pressure directed toward the core face with one iron, hold the other iron against the tube with just enough pressure to keep it in place and apply a slight oscillating motion of ten or fifteen degrees to both irons. If the irons are hot enough the solder bond between the tube to be removed and the adjacent tubes will loosen almost immediately and the hex tube ends will assume a round shape and will break loose from their position in the core. Then the irons may be removed from both ends of the tube. Using a pair of pliers, pull the protruding end of the tube out through the core.

29. Replacing new tubes

To replace the new tube, first flux each end of the new tube and tin it with a lead tin solder on the hex ends only. Then take the special tube pulling iron and round up the opening in the core where the old tube was removed so that the new tube may be easily inserted in case there are any lumps of solder adhering to the opening. Next flux the openings in the core where the old tube has been removed and insert the new tube. Use a pair of sharp-nosed pliers and re-form the hexagons of the tubes adjacent to the new tubes. After re-fluxing use the standard soldering iron and solder over the face of the core with a back-and-forth motion of the iron.

30. Removing large sections of core

The above procedure applies to removing one tube or several tubes. However, if a large section of the core must be removed, it is safe to use an oxy-acetylene flame on both ends of the core to melt out large sections at one time.

31. Repair of core surface leaks

Core surface leaks may be repaired by fluxing the surface of the core at the point of leakage with a zinc chloride flux, and then using a hot iron apply a back-and-forth motion, and solder over the point of leak.

32. Repair of surface leaks between the core and shell assembly

Flux at the point of leak with zinc chloride flux and either apply an iron directly to the solder bond, and resolder at the point of leak, or use a flame on the outside surface of the shell to apply heat to the brass and using the solder wire feed the solder between the periphery of the core and the inside of the shell.

33. Leaks through silver solder bond of the shell assembly

These leaks may be repaired by the application of soft solder, using either a flame or an iron after first fluxing the point of leak.

34. Dents in shell

Large dents in the shell may be corrected by applying an air pressure of 30 to 40 lbs. to the inside of the cooler and using oxy-acetylene flame, apply heat carefully to the dent, allowing the heating of the metal with its consequent decrease in hardness to form out to the proper radius under the action of air pressure on the inside. Sharp dents can sometimes be pulled out by soldering the end of the silver solder wire to the point of the dent and pulling the shell into position.

35. Bullet holes in shell

Small holes, that is, anything corresponding to 1/4 inch in diameter or under may be patched using a piece of .040 inch or .050 inch thick brass and soft soldering over the hole. Large holes in the shell may be repaired by silver soldering provided the core is properly protected from excessive heating by the use of wet cloths. Holes in the inside shell are extremely difficult to repair and it is doubtful if the cooler can be salvaged in such cases. These remarks in regard to the holes in the cooler and the repair thereof apply only to the holes in the outside shell. However, in the hands of a skillful workman it is quite possible that bullet holes in the inside shell can be repaired. This will require considerable familiarity with cooler construction and repair work and is not recommended.

36. Bullet holes in core

If a large portion of the core has been damaged, that damaged section may be removed by using an oxy-acetylene torch as previously described under "Collapsed Tubes" and "Tube Leaks".

Cleaning after repair

37. Oil cooler

After repairing and testing, any cooler should be thoroughly flushed inside and out with hot water and steamed as specified in paragraph 23. However, any steaming operation may be omitted in case the cooler is to be installed for immediate use, but in case the cooler is to be installed for immediate use, but in this case it will be first thoroughly dried either by immersing in hot oil as outlined below or by baking it in an oven at a temperature from 121° to 135°C. (250° to 275°F.) for approximately one hour, or until all evidence of moisture has been removed. If the regulator is to be placed in stock apply the hot oil treatment to remove the moisture and cover the internal surfaces with a protective coating. This is accomplished by completely immersing the cooler in a tank of clean, light engine oil, approximately SAE 20, maintained at a temperature of 121°C (250°F) plus or minus 10°. The cooler should be agitated thoroughly until all bubbling ceases, which will indicate that the water is evaporated and the interior of the cooler is completely coated. It should then be drained and the openings closed for storage.

38. Coolant radiator

After repairing and testing, any radiator should be thoroughly flushed inside and out with hot running water and steamed as specified in paragraph 24. However, any steaming operation may be omitted in case the radiator is to be installed for immediate use.

Fuel, oil and hydraulic tubes

39. The copper and aluminum tubes of the fuel, oil, and hydraulic systems must be replaced if damaged in any way with the same type tubes as originally used.

Fuel system - self-sealing lines (tubes)

40. On the H87A-3 aeroplane, AK-721 and subsequent all fuel lines are gun fire protected, self-sealing tubes. These lines are made up of a seamless compounded inner tube, layers of self-sealing material, plies of reinforcement and a compound cover. The hose will seal completely within four minutes after damage at a temperature of minus 20°F. (-29°C.). These lines must be replaced if damaged in any way with the same type tubes as originally used. Care must be exercised when tightening clamps that they are not too tight, because the outer compound cover may be pierced and thus damage the tube.

Material for repair of fuel bag shells, radiators and piping

Part number	Description	Size	Spec.	Remarks
87-45-501-8	Shell - upper - Al. sheet (2S-1/2H)	.125" x 20" x 36 3/8"	57-151-1A (1/2H)	Fuselage shell
87-45-501-2	Shell - lower - Al. sheet (2S-1/2H)	.125" x 36 3/8" x 66"	"	" "
87-45-501-7	Shell - end - front - Al. sheet (2S0)	.125" x 27" x 29"	QQ-A-561	" "
87-45-501-3	Shell - end - rear - Al. sheet (2S0)	.125" x 27" x 29"	"	" "
87-45-501-4	Sump housing - Al. sheet (2S-1/2H)	.125" x 5" x 20"	57-151-1A (1/2H)	" "
AN510B-416-12	Screws - brass - flat head		QQ-B-611	" "
AN3-5	Bolt - steel	5/8" long, shank 1/4"	29-59 Mfg.	" "
365-1032	Nut - self locking - steel	15/64" x 3/8"	25527 Mfg.	" "
87-45-501-9	Flange head - Al. sheet (2S-1/2H)	.125" x 7" x 7"	57-151-1A (1/2H)	" "
87-45-525-37	Shell - lower - forward - Al. sheet (2S-1/2H)	.125" x 30" x 16"	57-151-1	Wing shell - rear
87-45-525-31	Shell - lower - aft - Al. sheet (2S-1/2H)	.125" x 30" x 22"	"	" " "
87-45-525-46	End - Al. sheet (2S-1/2H)	.125" x 43" x 14 1/4"	"	" " "
87-45-525-45	Shell - Al. sheet (2S-1/2H)	.125" x 22 3/4" x 48"	"	" " "
87-45-525-51	Plate - Al. sheet (2S-1/2H)	.187" x 3 1/2" x 7"	"	" " "
87-45-525-52	Plate - Al. sheet (2S-1/2H)	.187" x 5 3/4" x 4 1/4"	"	" " "
87-45-525-43	End - Al. sheet (2S-1/2H)	.125" x 43" x 14 1/4"	"	" " "
87-45-525-42	Plate - Al. sheet (2S-1/2H)	.125" x 5 1/4" x 6 1/2"	"	" " "
87-45-525-41	Shell - Al. sheet (2S-1/2H)	.125" x 22 3/4" x 48"	"	" " "
673-D-6-8	Rivet - 78° countersunk head	3/16" dia. x 1/2" long	A-17ST	" " "

Material for repair of fuel bag shells, radiators and piping Cont'd.

Part number	Description	Size	Spec.	Remarks
87-45-097-1	Fuselage - fuel shell - front - strap	.063" x 1" x 27 5/8"	57-136-8	Cr. moly. steel
87-44-569-1	Wing - rear shell - aft-inboard strap	.081" x 1 1/2" x 15 9/16"	QQ-A-35	Al. Al. 24ST
87-44-059-1	Wing - forward shell - aft-outboard strap	.064" x 2 7/16" x 18 7/8"	57-136-8	Steel sheet X-4130
87-44-058-1	Wing - forward shell - aft-inboard strap	.064" x 2 1/2" x 20 1/4"	57-136-8	Steel sheet X-4130
87-44-568-1	Wing - rear shell - aft-outboard strap	.081" x 1 1/2" x 14 7/16"	57-152-6 (II)	Al, Al. 24ST
87-44-567-1	Wing - rear shell - (front) strap	.081" x 1 1/2" x 8 3/16"	"	" " "
87-50-015	Header bulkheads - Brass	.040" thickness	57-160	Radiator - coolant system
87-50-015-9	Flange - (Bronze casting)	2" dia. x 5/16"	QQ-B-691	" " "
87-50-015-2	Tubes - Copper	.006" x .230" O.D. x 12"	WW-T-799	" " "
AN435-C4-4	Rivet - round head - copper	1/8" dia; 1/4" long		" " "
AN420-C4-4	Rivet - 90° C'sunk head - copper	1/8" dia; 1/4" long		" " "
87-50-015-1	Shell - Brass	.040" x 12 1/2" x 48"	57-160	" " "
	Note: different O.D's required.			
87-33-501-11	Tube - hydraulic system - Everdur	1/2" O.D. x .035" x 25"	57-192-1A	Cu., Si., Br., Tube
87-33-501-13	Tube - hydraulic system - Everdur	3/8" O.D. x .035" x 10"	"	" " " "
87-33-501-21	Tube - hydraulic system - Everdur	1/4" O.D. x .035" x 46 5/8"	"	" " " "
87-33-501-53	Tube - hydraulic system - Everdur	5/16" O.D. x .035" x 8 1/2"	"	" " " "

Material for repair of fuel bag shells, radiators and piping Cont'd.

Part number	Description	Size	Spec.	Remarks
87-45-525-47	Sump cover - Al. sheet (2S-1/2H)	.125" x 6" x 5"	57-151-1	Wing shell - rear
87-45-525-35	Angle - shell - lower - aft	.125" x 1 1/8" x 4 1/2"	57-151-1 (1/2H)	" " "
87-45-524-33	Shell - lower - aft - Al. sheet (2S-1/2H)	.125" thickness	57-151-1	Wing shell - front
87-45-524-34	Cover flange	.125" x 13/16" x 6 3/4"	"	" " "
87-45-524-31	Shell - lower - forward - Al. sheet (2S-1/2H)	.125" thickness	"	" " "
87-45-524-42	Sump cover - Al. sheet (2S-1/2H)	.125" x 6" x 5"	"	Weld and rivet assembly
87-45-524-41	End - upper - R.H. - Al. sheet (2S-1/2H)	.125" thickness	"	" " " "
87-45-524-40	Shell - upper - R.H. - Al. sheet (2S-1/2H)	.125" thickness	"	" " " "
87-45-524-46	Plate - upper - L.H. - Al. sheet (2S-1/2H)	.187" x 3 1/2" x 8 1/4"	"	" " " "
87-45-524-38	End - upper - L.H. - Al. sheet (2S-1/2H)	.125" x 12" x 35"	"	" " " "
87-45-524-37	Plate - upper - L.H. - Al. sheet (2S-1/2H)	.125" x 6 1/8" x 7 3/8"	"	" " " "
87-45-524-36	Shell - upper - L.H. - Al. sheet (2S-1/2H)	.125" x 24" x 38"	"	" " " "
	Note:	R.H. = Right Hand; L.H. = Left Hand		
87-47-501-11	Fin - Al. sheet (3S)	.040" x 1 1/2" x 6 1/4"	QQ-A-359 (1/2H)	Oil tank - Linatex covered
87-47-501-10	Cone	.040" x 7" x 16"	"	" " " "
87-47-501-9	Tube - Aluminum (2S)	O.D. 2 1/2" x .049" x 8 1/4"	WW-T-783 (1/2H)	" " " "

Material for repair of fuel bag shells, radiators and piping Cont'd.

Part number	Description	Size	Spec.	Remarks
87-47-501-8	Cylinder (weld assembly)-Al. (3S)	.040" x 15 3/4" x 13"	QQ-A-359 (1/2H)	Oil tank - Linatex covered
87-47-501-6	Tube - Aluminum (2S)	.049" x 2 1/2" O.D. x 20 1/4"	WW-T-783 (1/2H)	" " " "
87-47-501-4	Baffle - Aluminum Alloy (3S)	.040" x 12" x 22 1/4"	QQ-A-359 (1/2H)	" " " "
87-47-501-3	Cover - Aluminum Alloy (3S)	.051" x 16" x 48 1/2"	"	" " " "
87-47-501-2	Shell - (welded assemblies)	.040" x 16 5/8" x 54 1/2"	"	" " " "
87-50-502-8	End - Aluminum Alloy (3S)	.015" x 10 3/8" x 10 3/8"	QQ-A-359 (1/2H)	Coolant tank - expansion
87-50-502-7	Center - upper - Aluminum Alloy (3S)	.051" x 12 3/8" x 14 1/2"	"	" " "
87-50-502-6	End - Aluminum Alloy (3S)	.051" x 10 3/8" x 10 3/8"	"	" " "
87-50-502-5	Center - lower - Aluminum Alloy (3S)	.051" x 12 3/8" x 14 1/2"	"	" " "
87-50-502-9	Reinforcement - Al. Al. (3S)	.051" x 4 7/8" x 4 7/8"	"	" " "
87-50-502-11	Tube - brass tube	5/8" O.D. x .035" x 8"	WW-T-791	" " "
AN505-8-6	Screw - flat head - steel - coarse thread	3/8" long	FF-S-91 Mfg.	" " "
503-8-8	Screw - coarse thread (steel)	1/2" long	"	" " "
501A-10-10	Screw - drilled carbon steel - fine thread	5/8" long	"	" " "
AN442-6-6	Rivet - flat head - Aluminum	3/16" dia; 3/8" long	25526 Mfg.	" " " Note: Do not heat treat before using.
AN960-8-8	Washer - plain	I.D. 11/64"; O.D. 3/8"	1010 Steel	Coolant tank - expansion
87-33-011	Tank - reservoir - hydraulic - casting			Magnesium alloy - Alcoa AM-260T6
87-33-525-1	Tank - aux. hydraulic - welded	.051" x 8 15/32" x 16"	QQ-A-359	Aluminum Alloy (3S)
87-33-536	Tank - end - aux. - hydraulic		11311	Casting - Alcoa No. 43

Material for repair of fuel bag shells, radiators and piping Cont'd.

Part number	Description	Size	Spec.	Remarks
AN520-416-8	Screw - oil system	1/2" long	FF-S-91 Mfg.	Round head - fine thread
365-524	Nut - oil system - steel	11/32" x 1/2"	255-27 Mfg.	Self-locking
AN-310-4	Nut - oil system - castle	1/4" dia., 7/16" x 9/32"	29-26 Mfg.	
AN960-416	Washer - oil system - plain	17/64" I.D., 1/2" O.D.	1010 Steel	
	NOTE: Bead all tube ends, see Chapter 3 for radii bend on oil lines.			
87-44-503-6	Tube - fuel system	1/2" O.D. x .042" x 36"	57-187-3	(52SO) Aluminum Alloy
87-44-503-17	" " "	1/4" O.D. x .032" x 60"	"	" " "
87-44-503-28	" " "	3/4" O.D. x .049" x 103"	"	" " "
87-44-503-26	" " "	1" O.D. x .049" x 13"	"	" " "
87-44-503-50	" " "	1/4" O.D. x .035" x 54"	WW-T-799	Copper tube
882-4-10	Hose - fuel system	1/4" I.D. x 2 1/2" long	20-103	Hose clamp - 745-1B
882-6-10	" " "	3/8" I.D. x 2 1/2" long	"	Hose clamp - 745-1A
882-8-10	" " "	1/2" I.D. x 2 1/2" long	"	Hose clamp - 745-2A
882-12-12	" " "	3/4" I.D. x 3" long	"	Hose clamp - 745-3A
811-T-4CS	Sleeve - fuel system - solderless	11/16" long		Tube fitting
811-BT-4D	Nut - fuel system	9/16" x 37/64"		Tube fitting
	NOTE: Avoid beaded ends, and flare tube ends according to figure and table in Chapter 3			

Material for repair of fuel bag shells, radiators and piping Cont'd.

Part number	Description	Size	Spec.	Remarks
365-832	Nut - self locking - coarse thread	15/64" x 3/8"	25527 Mfg.	
365-1032	Nut - self locking - fine thread	15/64" x 3/8"	"	
AN520-10-8	Screw - round head - fine thread	1/2" long	FF-S-91 Mfg.	Carbon steel
An960-10	Washer - plain	13/64" I.D. x 7/16" O.D.	1010 Steel	
	NOTE: Stainless steel tubing spec. 57-180-3 may be used in place of Everdur. All tube ends must be flared. See table and diagram in the text. Chapter 3.			
87-46-501-1	Tube - oil system	1" O.D. x .049" x 21 1/2"	57-187-3	52S0 Aluminum Alloy
87-46-501-3	" " "	1 1/2" O.D. x .049" x 55 1/4"	"	" " "
87-46-501-10	" " "	3/4" O.D. x .049" x 21 1/2"	"	" " "
87-46-501-11	" " "	1/2" O.D. x .042" x 23"	"	" " "
87-46-501-15	" " "	1/4" O.D. x .035" x 41 1/2"	"	" " "
87-46-501-32	" " "	3/8" O.D. x .035" x 18"	"	" " "
882-24-18	Hose - oil system	1 1/2" I.D. x 4 1/2" long	20-103	Hose clamp - 745-5A
882-16-20	" " "	1" I.D. x 5" long	"	" " - 745-3A
882-12-14	" " "	3/4" I.D. x 3 1/2" long	"	" " "
882-8-8	" " "	1/2" I.D. x 2" long	"	Hose clamp - 745-2A
882-6-8	" " "	3/8" I.D. x 2" long	"	Hose clamp - 745-1A
882-4-9	" " "	1/4" I.D. x 2 1/4" long	"	Hose clamp - 745-1B
GT-1	Clamp - oil system			
GT-14	" " "			
AN3-20A	Bolt - oil system (without cotter pin)	2" long - shank 1 5/8"	29-59 Mfg.	Use with self-locking nut

CHAPTER 4

FUSELAGE

General

1. The fuselage is a semi-monocoque structure consisting of 24ST Aluminum Alloy stressed skin reinforced longitudinally by bulb angle stringers and laterally by traverse bulkhead rings. The skin and all bulkheads are spliced at the horizontal center line. The forward portion of the fuselage which forms the pilot's cockpit is reinforced with heavy upper and lower longerons. See Figure 3. Bulkhead No. 5 immediately aft of the pilot is so designed that with the armor plate installed it will support the fuselage in the event of a turnover. The bulkheads aft of Station 12 are reinforced sufficiently to enable them to take concentrated tail wheel and empennage loads.

2. Fillets are provided at the intersections of the wing and empennage with the fuselage. The wing-fuselage fillet is constructed of Aluminum Alloy sheets (24ST) which are spot-welded together and attached by means of screws. The tail fillets are composed of four sections of Alclad 24ST and are also attached by means of screws. When effecting repairs to the wing-fuselage fillet, it is important to maintain the original contour. Flush patches must be used to prevent formation of eddies in the airflow.

Classification of damage

3. When effecting any repairs on the fuselage structure, carefully examine the extent of the damage and determine a method of repair by classifying it as one of the following:

(i) Negligible damage
(ii) Damage repairable by patching
(iii) Damage repairable by insertion
(iv) Damage necessitating replacement

SKIN

General

4. Aluminum alloy stressed skin is used to cover the fuselage. Since the skin gages at the various stations have been carefully selected to give the required strength with a minimum of material, it is necessary, when effecting repairs to make all patches, inserts, and splice plates of the same gage stock as the sheet being repaired, Fig. 4. The rivets and rivet patterns to be used for each attachment or around a damaged area should be the same as in the nearest parallel skin splice or skin overlap.

Negligible damage

5. Small dents free from cracks, abrasions and sharp corners may be neglected provided the adjacent structural members are not damaged and the rivets are undisturbed. Care must be exercised when bumping out dents that the skin is not stretched or buckled otherwise it will have to be reinforced with a patch of the same gage skin or removed and repaired by an insert.

Damage repairable by patching

6. Large dents, cracks, holes, and skin abrasions are repairable by patching or splicing as illustrated in Figures 30, 31, 32, 34, 36 and 40. When effecting skin repairs, note the gage of the skin used in the damaged area by referring to Figure 4. . Figures 5 and 6 illustrate methods of repairing damages to the free areas of the skin between stringers and bulkheads. The damaged skin area should be cut away to leave a square or rectangular hole with 1/2" radii in the corners and a flush insert should be fitted in the hole and secured by an internal frame as shown in Figure 6 or by a patch as in Figure 5.

7. Skin patch repair over stringers should be repaired by the method shown in Figures 7, 30, 32, 34 and 36. The repair is similar to that described in paragraph 6 except that the repair to t stringer is effected by splicing, see paragraph 11 and 12 of this Chapter, and the internal frame must be inserted about the stringer having a 1/32" clearance at the stringer. The insert is neatly fitted in the hole and flush riveted by countersunk rivets.

8. Skin patch repair over a bulkhead is illustrated in Figures 8, 30 and 31. Remove the skin to enable the damaged area of the bulkhead to be cut away and splice in the new section of the bulkhead. Place the reinforcing frame about the bulkhead as described in paragraph 7 and fit it so that it will clear the edge of the bulkhead approximately 1/32 in. The existing countersunk holes in the bulkhead should be used as a pattern when attaching the flush patch which must be counterpunched. Avoid damaging the bulkhead when effecting repairs of this type.

Damage repairable by insertion

9. When effecting an extensive repair to the skin necessitating the insertion of all or a large part of the skin, the damaged portion of the fuselage should be supported so that the removal of the skin will not place a strain on the adjacent structure. Remove the necessary rivets taking care not to elongate or damage the rivet holes, see paragraphs 14 and 15, Chapter 1. Repair any damage to the internal structure and add splice plates where the skin sheet has been cut. Splice plates should be of the same gage and material as the damaged sheet and twice the width of the lap at the nearest parallel edge of this sheet. Form the insert

and drill the rivet holes to match the original holes in the fuselage and fittings. Remove all burrs caused by drilling and rivet the insert in place. Attach each splice plate with the same rivet pattern and rivets on each side of the cut as originally used in attaching the nearest parallel edge of the sheet. When inserting a complete skin section remove the damaged section and attach the new insert using the original rivet pattern.

STRINGERS

Negligible damage

10. Smooth isolated dents, free from cracks, abrasions and sharp corners which can be removed without excessive hammering, may be considered negligible damage. Small cracks running longitudinally and not exceeding 1" should be stopped by drilling 1/8" diameter holes at their ends to prevent spreading. File all nicks in the stringer until smooth. Nicks on the legs of the stringer should not exceed 1/4" in depth after clean up.

Damage repairable by patching

11. Use the methods shown in Figure 9 provided the cross-section of the damaged area does not exceed one half of the total cross-section of the stringer. Repair damage to the leg attaching the stringer to the skin, as shown in the upper section of Figure 9. Use a filler of .068" to pick up the skin rivets in the damaged area and a formed channel of .040" 24ST of ample length to take four 1/8" rivets at one half inch spacing in the free leg of the stringer on each side of the damaged portion in addition to the corresponding rivets in the skin. For damage to the free leg of the angle use .051" plate as shown in the lower section of Figure 9 with four 1/8" rivets on each side of the damage. A filler plate is unnecessary unless damage after cleaning up exceeds one and one half inches in length, if so it should be formed from .064" sheet and attached with 1/8" rivets at one half inch spacing.

Damage repairable by insertion

12. If the damage occurs at a bulkhead or destroys more than one half of the stringer cross section, remove the rivets which attach the damaged section of the stringer to the skin. Remove the damaged portion of the stringer by cutting it off at each end at a point midway between two of the existing rivet holes and proceed to splice the new section as shown in Figure 10. The insert material should be cut from stock of the same cross sectional area as the original stringer. The length should be sufficient to leave a maximum clearance at each end of the insert of 1/32 of an inch. Use the same stock and cut two splice pieces of ample length to take the necessary number of rivets. Attach the splice pieces to the original member and the insert with an equal length on each side of the cut and with a clearance of 1/32 of an inch between the

splice piece and the skin. Rivet the splice piece in place with 5 5/32" or 8 1/8" rivets spaced at 1/2 of an inch on each side of the insertion joint as illustrated in Figure 10. Use the existing skin rivet holes as a pattern to drill the holes in the inserted stock. Attach the skin to the inserted stock using the existing skin rivet holes.

LONGERONS

General

13. The fuselage is reinforced between the firewall and bulkhead No. 8 with upper and lower longerons, see Figures 3 and 4. The upper longeron is a formed channel with flanged legs which is reinforced with an added channel between the firewall and bulkhead No. 3 and added angles which extend from bulkhead No. 3 to bulkhead No. 6. The cabin track running from bulkhead No. 3 to bulkhead No. 8 is attached to the back of the upper longeron. The lower longeron consists of an extruded angle and an extruded "T" section (See Figure 107) which form the wing-fuselage attachment plus the heavy gusset straps which extend from the firewall completely around the edge of the lower fuselage opening. The skin on each side of the fuselage acts as a diagonal tension web between the longerons, and the bulkheads in this region act as stiffeners to keep the longerons apart. The longerons are subjected to heavy axial and bending loads and should in general be replaced if damaged.

Repair of upper longeron

14. The upper longeron may be spliced between Stations 2 and 3, 4 and 5, or 6 and 7, see Figures 3, 32, and 33, by the methods shown in Figures 11, 12, and 13. Minor damages to the legs or flanges of this longeron may be reinforced by attaching .102 gage 24ST Al. Alloy patches with 3/16" diameter rivets providing there is room to use the required number of rivets. The number of rivets to be used at each end of the damage, between the firewall and bulkhead No. 5, is one for each 1/8 inch of the length of the damage as seen in a vertical cross section of the longerons. For sections aft of bulkhead No. 5 use one for each 5/16 inch of damage. The width of the patch should be at least 25% greater than the cross-sectional length of the damage and should be formed with a flange if a corner or bent part of the longeron is damaged. Rivet the flange of the patch to the longeron.

Small damages to the back of the longeron may be neglected if after cutting away the damaged material the adjacent corners or legs are undamaged. Replace any damaged reinforcements, fittings, and gussets and use the rivet patterns given in Figure 14 to attach new sections of the cabin track.

Repair of lower longeron

15. The extruded angle which is attached to the lower edge of the fuselage may be spliced between Stations 3 and 4 as shown in Figures 15 and 32. Minor damages to this member may be patched or reinforced with 3/16 inch 24ST sheet stock attached by one 3/16" A17ST rivet at each end of the damage for each 1/8 inch length of damage as seen in a vertical cross section. The cross section of each patch should be at least 25% greater than the maximum cross section of the damage.

The extruded "T" section which is attached to the upper surface of the wing cannot be repaired. Any damage which exceeds that caused by the bolt and rivet holes in adjacent cross sections will necessitate complete replacement of this extrusion.

Any damage to the gusset straps which reinforce the lower edges of the skin above the wing should be repaired by patching with 24ST sheet of the same gage as the damaged gusset using one 3/16" A17ST rivet for each 5/16 inch of damage measured along the cross section of the gusset or 3 rows of 3/16" rivets at 1" spacing around the damage

BULKHEADS

General

16. All bulkheads are designated by numbers counting aft from the firewall, see Figure 3. Each bulkhead is spliced on the horizontal reference line. The outer flange face of the bulkheads is cut out so as to clear the stringers. Due to the variation of design, the bulkheads or formed channels are individually paragraphed. When effecting a repair to the bulkheads, follow the procedure outlined for each specific case. In general the bulkheads are accessible. However, in some cases, the location of the damage may necessitate the dismantling of surrounding fittings and the stripping of the structure. All damaged fittings, clips, gussets, etc. should be replaced. Bulkhead patches and splice plates should be formed from sheet stock of the same gage and material as the damaged bulkhead. Splice plates should be formed with flanges as channels and inserted into the bulkhead. Rivet or bolt patterns are given for each bulkhead in the paragraphs which follow. A distinction is maintained between attachment to webs and attachment to flanges.

Negligible damage

17. Small smooth isolated dents may be neglected provided the dents are free from cracks, abrasions and sharp corners, and the adjacent rivets and bolts are not disturbed. Small holes in webs which after clean up do not exceed an inch in diameter and are at least a half inch from the nearest hole, edge of sheet, or inside flange may be neglected except in bulkhead sections which are reinforced.

Cracks

18. All cracks located in any part of the bulkhead structure must be drilled at the ends to prevent them from spreading. Use a 1/8" drill, whether the crack is considered negligible or otherwise. Cracks up to one inch in length and half an inch from the inside flange or nearest rivet hole may be neglected.

Bulkhead No. 1

Bulkhead frame

19. The channel sections which form the frame around this bulkhead, Figure 16, should in general be replaced if damaged because of the low design margins and the difficulty of attaching repair material. See Figure 31.

Vertical channels

20. Minor repairs to the vertical channels may be effected in some cases by adding 24ST patches of the same gage as the damaged material. The design stresses in the flanges and in the bent material at the corners between the flanges and the back of the channels is such that the patch material must be attached with at least one 3/16" A17ST rivet above and below the damage for each 1/8" of damage measured horizontally after the damaged material has been cleaned away. For damage to the back of a channel use one 3/16" rivet above and below for each 3/16 inch of damage. The patching material should have at least 25% more cross sectional area than the horizontal cross section of the damaged material and should be formed with a flange if the corner of the channel is damaged. Use the original rivet spacing and where possible the original rivet holes in attaching all reinforcing material.

Lower cross-member

21. Minor repairs to either leg or to the back of the lower cross channel may be made using the data given in Figure 18. For more extensive damage or damage requiring the use of more than two such patches the channel should be replaced as in Figure 31.

Upper cross-member

22. The hat section forming the upper cross-member may be spliced as shown in Figure 17 to facilitate the insertion of a new section. Minor damage to a leg or flange may be patched with a .081 24ST angle attached with sixteen 3/16" A17ST rivets or four in each leg at each end of the damage plus those which are necessary in the damaged area. Use the existing rivet spacing.

Firewall stiffeners

23. Figure 19 shows a typical repair which may be used for damage to the bulb angle stiffeners in the center of the bulkhead.

Firewall

24. The stainless steel firewall sheet should be patched with .015" gage stock of the same material using two rows of 671-D-4AD rivets at one inch spacing completely around the damage for areas within the bulkhead frame and one row at 3/4 inch spacing for the area above the upper cross-member. If the required rivet pattern cannot be obtained extend the patch to the edge of the original sheet or use inserts with conveniently located splices or frames of the same material.

Fittings

25. All fittings and gussets on the firewall and also the engine mount and coolant tank supports must be replaced if either they or their attachments are damaged.

Bulkheads Nos. 1A, 2, 3, and 4

26. These bulkheads carry heavy axial loads caused by the diagonal tension in the skin between the upper and lower longerons and the distribution of the loads from the wing to the fuselage. These bulkheads are heavily reinforced and consequently cannot be readily repaired, see Figure 32. Due to their inherently low margins of safety, damage to these bulkheads or to their attachments cannot be neglected. In those cases where it appears feasible to repair minor damages instead of replacing the damaged parts the table which follows may be used to determine the number of 3/16" A17ST rivets or 3/16 steel bolts to be used above and below the damaged area. In this table data is given separately for the back and for the inside flange of each upper channel, each lower channel and each flanged reinforcement. The data for the backs of the channels applies also to the flange which is next to the skin and the data for the flanges applies to the corner or bent material at the junction of the inner flange and the back Repair each damage with 24ST sheet of the same gage as the original. Divide the width of the damage, measured horizontally after clean-up by the correct fraction of an inch as given in the table to determine the number of rivets or bolts to be used above and below the damage in attaching the repair material. Rivets should be used in preference to bolts where the number required is not excessive. If both the lower channel and reinforcement are damaged each rivet or bolt may be used to attach the patches for both by placing the patches on opposite sides so as to load the rivets or bolts in double shear.

BULKHEAD		#1A		#2		#3		#4	
3/16 Rivets or Bolts		R*	B*	R	B	R	B	R	B
Lower Channel	back	3/16	3/8	11/32	5/8	7/32	13/32	7/32	7/16
	flange	1/16	1/8	1/8	7/32	1/32	1/16	3/32	3/16
Flanged Reinforcement	back	5/32	3/8	5/16	5/8	7/32	13/32		
	flange	1/16	1/8	1/8	1/4	1/32	1/16		
Upper Channel	back	5/16	1/2	15/32	3/4	5/16	15/32	9/32	9/16
	flange	5/32	1/4	7/32	11/32	5/32	7/32	1/8	7/32

* R = Rivet Data; B = Bolt Data

Use existing holes or a minimum spacing of 3/4 of an inch for the above attachments. The stringer cut outs are reinforced by the stringer clips which are designed to reinforce the bulkheads at the cut outs. These fittings and their attachments as well as the fittings at the upper and lower ends of the bulkheads must be replaced if damaged.

Bulkhead No. 5

General

27. This bulkhead is designed to support the fuselage in the event of a "Turn Over". The fitting at the top of the bulkhead transmits the load to the skin and stringers at the top of the fuselage aft of the bulkhead and to the armor plate which is attached to this bulkhead. The armor plate through its attachment at each side and along the bottom transmits the loads into the bulkhead which in turn transmits the loads to the fuselage skin and longerons.

Upper section

28. Damage to the upper part of the bulkhead should be patched or reinforced with .064"gage 24ST Al. Alloy stock attached with 1/8 inch A17ST rivets as shown in Figures 21 and 33. Form a flange on the patch if an inside bulkhead flange is damaged. For extensive damage insert a new section or splice in new material as shown in the drawing. Damages which do not injure the flanges or the armor plate attachments may be neglected.

Lower section

29. Damage to any of the lower sections of the bulkhead will in general necessitate replacing the damaged parts, see Figure 33. Splices which may be used at the bottom of the bulkhead are shown in Figure 20. Any damage which injures a bulkhead flange, splice, armor plate attachment or any fitting to the bulkhead must be repaired using equivalent material and method of attachment. Minor dents in the armor plate may be neglected. Do not, however, neglect large

horizontal buckles as these will cause the bulkhead to collapse should the aeroplane turn over. The bolts attaching the armor plate to the bulkhead have a low margin of safety, consequently, any damaged bolts should be replaced or new bolts should be added on each side of each damaged bolt.

Turn over fitting

30. The attachment of the large fitting at the top of the bulkhead to the fuselage has a low margin of safety. If the fuselage skin is damaged directly aft of this fitting add a .040" gage 24ST patch large enough to take 3 rows of 3/16" A17ST rivets at 1 inch spacing around the damage plus all of the rivets and bolts in the fitting which are directly forward of the damage. Arrange the rivet pattern so as to use the original holes. Do not drill any additional holes in the fuselage skin immediately aft of this fitting. The stringer at the top of the fuselage which attaches to the bulkhead fitting should be spliced if damaged with a similar stringer section and at least six 3/16" A17ST rivets on each side of the splice cut.

Bulkhead No. 6 to 12

31. In general any portion of these bulkheads which is not over 2 1/2" wide between flanges may be patched or spliced by adding a flanged plate as shown in Figures 22 and 36. The plate should be of the same gage and material as the damaged portion of the bulkhead and should be shaped to fit the outer edge of the bulkhead. The flange on the inner edge should be the same as the inner flange on the bulkhead but may be formed straight. To attach the patch or splice use six 5/32" A17ST rivets for a .040" bulkhead or six 3/16" rivets for a .064" bulkhead spaced at one inch minimum in the channel web on each side of the damage or cut.

32. Minor damage to the wider portions of these bulkheads may in general be repaired by patching with a sheet of the same gage and material and two rows of 5/32" A17ST rivets completely around the damage as in Figure 23. Extensive damage may be repaired by the use of inserts; use 2 rows of 5/32" rivets along each side of the line of cut as illustrated in Figure 24. For .040" bulkheads use a maximum spacing of 1" for the rivets and on the .064" bulkheads use a maximum spacing of 3/4".

33. No. 6 and 7 have reinforcing angles at the bottom, see Figure 34. These angles may be spliced or patched by nestling a similar angle into the damaged angle and attaching with 671-D-5AD rivets in both flanges. The required number of rivets per flange on each side of the damage is five minus one fifth the number of rivets in one flange of the angle between the damage and the vertical center line of the bulkhead.

34. Exceptions to the preceding general rules are as follows:

Bulkhead No. 8: Any splice below stringer 10 requires a minimum of eight 3/16" rivets a 3/4" spacing on each side of a splice cut.

Bulkhead No. 9: Use two rows of 5/32" rivets at 3/4" spacing around any damage below stringer 11.

Bulkhead No. 10: Use three rows of 1/8" rivets at 1" spacing around any damage below stringer 11.

35. Stringer 10 is attached to bulkheads No. 7 and 8 by structural clips. Any damage to the attachment of these clips will require reinforcement or replacement of the damaged portion of the bulkhead.

All damaged gussets, clips, splices, etc. must be replaced.

Bulkhead No. 13

36. Minor damage to the upper half of this bulkhead may be repaired with .064", 24ST sheet attached by two rows of 1/8 inch rivets at 5/8" spacing completely around the damage. If the damage is near an inside flange add an equal flange to the patch plate, as shown in Figures 25, 35 and 36. A damaged inside flange may be reinforced by attaching an angle of .064", 24ST sheet to the web of the bulkhead by two rows of 1/8" rivets at 5/8 inch spacing around the damage.

37. Due to the number of fittings and reinforcements attached to the lower half of this bulkhead, any damage will in general require complete replacement of this section of the bulkhead. Figures 37 and 38 illustrate this type of repair. Any damaged channels, clips, reinforcements, or fittings must be replaced.

Horizontal bulkhead

38. The horizontal bulkhead aft of bulkhead No. 13, see Figure 35, should be patched, if damaged, with .032", 24ST Al. Alloy sheet attached with two rows of 671-D-4AD rivets at 1" spacing around the damage. Add a flange to the patch material if a lightening hole flange is damaged. Replace the bulb angle stiffeners and the fitting reinforcements if either they or their attachments are damaged.

Bulkhead No. 14

39. This bulkhead is heavily loaded and will in general require replacement if damaged. Figures 26 and 27 give data for a splice which may be used below the upper stringer cut-out. Patches of .040", 24ST Al. Alloy sheet may be used if there is room to attach

the repair stock with two rows of 5/32" rivets at 1" spacing at each end of the damage as shown in Fig. 27.

Bulkhead No. 15

40. This bulkhead may be patched or spliced at any point with a flanged plate of .032", 24ST Al. Alloy sheet and two rows of 1/8" rivets at 1 inch spacing at each end of the damage. See Fig. 28. Use a minimum of six 671-D-4AD rivets on each side of the cut in splicing this bulkhead.

Bulkhead No. 16

41. This bulkhead must be spliced or patched with .064" channels of 24ST Al. Alloy sheet formed to fit in the bulkhead channel, Figures 39 and 40. Attach the repair stock with eight 5/32" rivets on each side of the damage if it is in the upper ring of the bulkhead or use eight 3/16" rivets at three-quarter inch spacing if the damage is on the lower ring. The lower ring should be replaced if damaged extensively. See Figure 29.

Material for repair of fuselage, skin and longerons

Part number	Description	Size	Spec.	Remarks
87-21-702	Fuselage skeleton - stringers etc. (78077-8)	.770" x 9/16"	Alcoa die K-22422	Fuselage - extrusion
87-21-702-17	Fuselage skeleton - stringer longeron (78077-3)	1 5/16" x 3/4"	Alcoa die K-14652	" "
75-03-291	Fuselage skeleton - nut plate			Mfg. by Elastic Stop Nut Corp.
87-21-274	Fuselage skeleton - splice plate - channel	.040" x 3 13/16" x 3 1/8"	11067 (II)	Alclad 24ST
87-21-552	Fuselage skeleton - channel - support tab control	.064" x 5 5/8" x 9 5/16"	57-152-6 (I)	Al. Al. Sheet 24S0
87-21-562	Fuselage skeleton - splice plates stringers 2, 3, and 4 - Sta. 8	.064" x 2 1/8" x 10 5/8" .051" x 2 7/16" x 13 5/16" .081" x 2 1/8" x 11"	QQ-A-355	Al. Al. Sheet 24S0
AN24-10	Fuselage skeleton - bolt	5/8" long, shank 5/16"	29-59 Mfg.	
AN4-6	Fuselage skeleton - bolt	3/4" long, shank 5/16"	"	
AN3-5	Fuselage skeleton - bolt	5/8" long, shank 1/4"	"	
AN5-27	Fuselage skeleton - bolt	2 7/8" long, shank 2 7/16"	"	
364-428	Fuselage skeleton - nut - self-locking	13/64" x 7/16"	25527 Mfg.	Thin
365-524	Fuselage skeleton - nut - self-locking	11/32" x 1/2"	"	
671-D-4AD-4	Fuselage skeleton - rivet - solid	1/8" dia. x 1/4" long	A17ST	Modified brazier head
AN960-10	Fuselage skeleton - washer - plain	13/64" I.D. x 7/16" O.D.	1010 Steel	
87-21-530-1	Longeron - upper	.102" x 11" x 105"	11067-(I)	Alclad 24S0
87-21-530-3	Longeron - channel - upper	.125" x 6 1/2" x 15 13/16"	57-152-6 (I)	Al. Al. 24S0
87-21-530-4	Longeron - gussets - upper	.051" x 4" x 4 1/2"	"	" " "
87-21-530-11	Longeron - clip angle - upper	.125" x 1 21/32" x 2 3/4"	"	" " "
87-21-530-16	Longeron - plate - upper	.031" x 3/8" x 1 1/8"	57-136-8	X-4130 Steel
87-21-530-8	Longeron - angle - upper	.102" x 2 1/2" x 41 3/4"	57-152-6 (I)	Al. Al. 24S0
671-D-6AD-7	Longeron - rivet - solid - upper	3/16" dia. x 7/16" long	A17ST	Aluminum

Materials for repair of fuselage, skin and longerons Cont'd.

Part number	Description	Size	Spec.	Remarks
673-D-4-6	Longeron - rivet - 78° countersunk upper	1/8" dia. x 3/16" long	A17ST	Aluminum
659-D-2	Longeron - fasteners - nut plate - upper	25/64" x 1/4"	AN-QQ-P-421	1112 Steel
87-21-530-15	Longeron - block - upper	3/16" x 1/2" x 1 3/8"	60-70 Duro Comm.	Moulded Rubber
87-25-037-63	Longeron - track - upper	Alcoa die No. K-23083	57-152-5	Al. Al. 24ST
87-21-701-5	Fuselage - skin	.032" x 17 1/4" x 40 1/4"	QQ-A-355	Al. Al. 24ST
87-21-701-6	" "	.040" x 15 3/4" x 90 5/8"	"	" " "
87-21-701-11	" "	.025" x 14 1/2" x 84"	"	" " "
87-21-701-20	" "	.064" x 24 5/8" x 28 1/8"	"	" " "
87-21-701-25	Fuselage - splice plate	.051" x 5 5/8" x 5 5/8"	"	" " "
11030-S-4	Fuselage - bolt - recessed head	1/2" long	2330 Steel	100° Countersunk
1120-D-8	Fuselage - screw - modified - brazier	1/2" long	" "	recessed type head
AN23-8	Fuselage - bolt	9/16" long; 1/4" shank	29-59 Mfg.	
AN960-8	Fuselage - washer - plain	I.D. 11/64"; 3/8" O.D.	1010 Steel	
364-428	Fuselage - nut - self locking	13/64" x 7/16"	25527 Mfg.	
673-D-4-4 1/2	Fuselage - rivet - 78° countersunk	1/8" dia. x 9/32" long	A17ST	
671-D-6AD-6	Fuselage - rivet - modified brazier head	3/16" dia. x 3/8" long	"	
87-21-701-65	Fuselage - strip - durometer 40-45	1/16" x 1 5/16" x 37 1/2"	Neoprene	
87-21-568	Fuselage - skin - rear vision	.032" x 24" x 36"	11067 (I)	Alclad 24S0
S5-325	Fuselage - dzus spring			
87-21-701-67	Fuselage - filler	1/8" x 1" x 2 1/4"	Asbestos	Wire woven - Tape style No. 121

Materials for repair of fuselage, skin and longerons Cont'd.

Part number	Description	Size	Spec.	Remarks
87-21-623	Fuselage - reinforcement - skin - fuel line	.032" x 3 1/2" x 3 9/16"	57-152-6 (II)	Al. Al. 24ST
87-21-640	Fuselage - reinforcement - upper access door	.040" x 7" x 6 5/8"	57-152-6 (I)	Tail wheel oleo
915-D-00-5	Fuselage - chain	5" long	Brass	Safety
AN230-B10	Fuselage - grommet - plain	1/4" I.D.; 9/16" O.D.	Brass	
87-21-643	Fuselage - shim	.051" x 1" x 1 1/2"	57-152-6 (II)	Al. Al. 24ST
87-21-596-4	Fuselage - channel - doubler plate	.094" x 4 1/2" x 12 3/4"	QQ-A-355	Al. Al. Sheet 24S0
87-21-596-3	Fuselage - doubler plate	.081" x 4" x 44"	"	" " " "
87-21-596-2	Fuselage - doubler plate	.051" x 5" x 45"	"	" " " "
87-21-596-1	Fuselage - doubler plate	.064" x 9" x 60"	"	" " " "

Materials for repair of fuselage bulkheads and frames Cont'd.

Part number	Description	Size	Spec.	Remarks
87-21-613-4	Sta. No. 13 - ring - lower	.064" x 12 1/2" x 20 1/2"	QQ-A-355 (A)	Al. Al. 24SO
87-21-613-9	Sta. No. 13 - plate - lower	.064" x 6 7/16" x 16"	" "	" " "
87-21-613-8	Sta. No. 13 - splice plate	.064" x 5 1/4" x 10 1/8"	" "	" " "
87-21-613-10	Sta. No. 13 - doubler plate	.064" x 4 1/4" x 10 1/8"	QQ-A-355 (T)	Al. Al. 24ST
87-21-614-2	Sta. No. 14 - frame - upper	.040" x 16" x 17"	57-152-6 (I)	Al. Al. 24SO
87-21-614-4	Sta. No. 14 - frame - lower	.040" x 5" x 6"	"	" " "
87-21-615-3	Sta. No. 15 - frame - upper	.032" x 14" x 16"	57-152-6 (I)	Al. Al. 24SO
87-21-615-4	Sta. No. 15 - frame - lower	.032" x 3 1/2" x 5"	"	" " "
87-21-188-1	Sta. No. 15 - splice plate	.040" x 1 1/2" x 4 3/4"	"	" " "
87-21-190-1	Sta. No. 15 - reinforcement bracket	.040" x 2" x 2"	"	" " "
87-21-191-1	Sta. No. 15 - pulley bracket	.051" x 2 3/4" x 4 3/4"	"	" " "
87-21-616-2	Sta. No. 16 - ring upper	.064" x 10 3/4" x 15 1/2"	QQ-A-355 (A)	Al. Al. 24SO
87-21-616-4	Sta. No. 16 - ring lower	.064" x 7 3/4" x 11"	"	" " "

Materials for repair of fuselage bulkheads, and frames

Part number	Description	Size	Spec.	Remarks
87-21-608-3	Sta. No. 8 - frame - lower	.040" x 10 3/4" x 28 1/2"	QQ-A-355 (A)	Al. Al. 24SO
87-21-608-5	Sta. No. 8 - splice plate	.081" x 2 5/64" x 5 15/16"	"	" " "
87-21-608-4	Sta. No. 8 - frame - upper	.040" x 7" x 42"	"	" " "
87-21-131	Sta. No. 8 - clip - forging	5/8" x 1 15/16"	57-153 (Gr5)	Al. Al. 14ST
75-21-186-3	Sta. No. 8 - clip	.040" x 1/2" x 1 5/16"	57-152-6 (II)	Al. Al. 24ST
87-21-577	Sta. No. 8 - clip	.081" x 2 3/16" x 2 3/4"	57-152-6 (I)	Al. Al. 24SO
87-21-609-3	Sta. No. 9 - channel - upper	.040" x 7" x 37"	QQ-A-355 (A)	Al. Al. 24SO
87-21-609-4	Sta. No. 9 - channel - lower	.040" x 11" x 26"	"	" " "
87-66-582	Sta. No. 9 - bracket - pull box - Hydr. pump	.051" x 4 1/4" x 8 7/8"	QQ-A-355 (T)	Al. Al. 24ST
87-21-572	Sta. No. 9 - splice plate - lower	.040" x 6" x 11 1/2"	57-152-6 (I)	Al. Al. 24SO
87-21-610-3	Sta. No. 10 - channel - upper	.040" x 6 3/8" x 34 1/8"	QQ-A-355 (A)	Al. Al. 24SO
87-21-610-6	Sta. No. 10 - channel - upper	.040" x 4" x 4 9/16"	QQ-A-355 (T)	Al. Al. 24ST
87-21-610-4	Sta. No. 10 - channel - lower	.040" x 8 3/4" x 24"	QQ-A-355 (A)	Al. Al. 24SO
87-21-611-3	Sta. No. 11 - channel - upper	.040" x 7" x 33"	QQ-A-355 (A)	Al. Al. 24SO
87-21-611-4	Sta. No. 11 - channel - lower	.040" x 7 1/2" x 20"	"	" " "
87-21-612-3	Sta. No. 12 - channel - upper	.040" x 7" x 30"	QQ-A-355 (A)	Al. Al. 24SO
87-21-612-4	Sta. No. 12 - channel - lower	.040" x 6 1/4" x 18"	"	" " "
87-21-613-2	Sta. No. 13 - ring - upper	.064" x 20 1/2" x 26 1/8"	QQ-A-355 (A)	Al. Al. 24SO
87-21-613-5	Sta. No. 13 - channel - upper	.125" x 5 1/4" x 10"	"	" " "
87-21-613-6	Sta. No. 13 - plate - upper	.102" x 3 1/2" x 5"	QQ-A-355 (T)	Al. Al. 24ST

Materials for repair of fuselage bulkheads, and frames

Part number	Description	Size	Spec.	Remarks
87-21-604-9	Sta. No. 4 splice plate	.125" x 6 1/16" x 2 13/16"	QQ-A-355	Al. Al. 24SO
87-21-604-7	Sta. No. 4 gussett	.094" x 4 7/8" x 4 1/4"	"	" " "
87-21-605-9	Sta. No. 5 - channel - upper	.064" x 3 11/16" x 12 3/4"	QQ-A-355 (A)	Al. Al. 24SO
AN442-5AD-6	Sta. No. 5 - rivet - flat head	5/32" dia. x 3/8" long	25526 Mfg.	Do not heat treat before using.
AN24-27	Sta. No. 5 - bolt	1 11/16" long; 1 3/8" shank	29-59 Mfg.	
87-21-605-11	Sta. No. 5 - web	.064" x 6" x 12"	QQ-A-355 (A)	Al. Al. 24SO
87-21-605-21	Sta. No. 5 - channel - lower	.064" x 2 3/4" x 11"	"	" " "
659-D-15	Sta. No. 5 - nutplate - elastic nut type	1/4" high x 25/64" wide	1112 Steel	No. 8-32 threads
87-21-581	Sta. No. 5 - reinforcement - forging	3.687 ± .005" x 3/4"	QQ-A-367	14ST Al. Al.
87-21-606-4	Sta. No. 6 - frame - lower	.064" x 13 1/2" x 25"	QQ-A-355 (A)	Al. Al. 24SO
87-21-606-5	Sta. No. 6 - reinforcement	.102" x 1 1/4" x 23"	"	" " "
87-21-606-3	Sta. No. 6 - frame - upper	.064" x 11" x 40"	"	" " "
1028D-.187-.187	Sta. No. 6 - spacer - aluminum	.032" x .187" O.D. x .187" long	10235 (B)	same for Sta. 7
87-21-607-4	Sta. No. 7 - frame - lower	.064" x 14" x 27"	QQ-A-355 (A)	Al. Al. 24SO
87-21-607-6	Sta. No. 7 - reinforcement	.125" x 1 1/4" x 23"	"	" " "
87-21-607-7	Sta. No. 7 - reinforcement	.102" x 1 1/2" x 27 1/8"	"	Al. Al. 24ST
87-21-607-3	Sta. No. 7 - frame - upper	.040" x 8" x 40"	"	Al. Al. 24SO

Materials for repair of fuselage bulkheads, and frames

Part number	Description	Size	Spec.	Remarks
87-21-601-5	Sta. No. 1 - sheet - firewall	.015" x 15" x 38"	11068 (1/2H)	Steel Sheet
87-21-601-6	Sta. No. 1 - reinforcement strip	.040" x 31/32" x 12"	"	" "
87-21-601-11	Sta. No. 1 - channel	.125" x 7 3/8" x 32 15/16"	QQ-A-355 (A)	Al. Al. 24SO
87-21-601-12	Sta. No. 1 - gusset	.081" x 6 1/2" x 7 1/2"	QQ-A-355 (T)	Al. Al. 24ST
670-D-4-12	Sta. No. 1 - rivet - hollow - steel	1/8" dia. x 3/8" long	AN-QQ-P-421	Thomson
671-D-4AD-6	Sta. No. 1 - rivet - modified brazier head	1/8" dia. x 3/16" long	A17ST	
673-D-4-5	Sta. No. 1 - rivet - 78° countersunk	1/8" dia. x 5/32" long	A17ST	
87-21-601-53	Sta. No. 1 - plate	.064" x 3 3/4" x 5 5/8"	QQ-A-355 (T)	Al. Al. 24ST
87-21-601-30	Sta. No. 1 - rivet strip	.051" x 5/8" x 14"	QQ-A-355 (A)	Al. Al. 24SO
87-21-601-32	Sta. No. 1 - sealing strip	3/16" x 7/8" x 14 1/4"	Neoprene	Black Sponge
87-21-602-5	Sta. No. 2 - upper frame	.081" x 12 1/8" x 5 1/2"	QQ-A-355 (A)	Al. Al. 24SO
87-21-602-8	Sta. No. 2 - lower frame	.094" x 8 5/8" x 4 3/8"	" "	" " "
87-21-602-9	Sta. No. 2 - splice plate	.102" x 11 1/4" x 3 3/4"	" "	" " "
AN25-15	Sta. No. 2 - bolt	15/16" long; shank 5/8"	29-59 Mfg.	same for sta. 3
AN23-11	Sta. No. 2 - bolt	11/16" long; shank 3/8"	29-59 Mfg.	same for sta. 3 & 4
364-1032	Sta. No. 2 - nut - self-locking - thin	11/64" x 3/8"	25527 Mfg.	same for sta. 3 & 4
87-21-603-5	Sta. No. 3 - upper frame	.081" x 12 1/4" x 4 7/8"	57-152-6 (I)	Al. Al. 24SO
87-21-603-8	Sta. No. 3 - lower frame	.094" x 8 7/8" x 3 3/4"	"	" " "
87-21-603-9	Sta. No. 3 - splice plate	.102" x 11 1/2" x 3 7/8"	"	" " "
87-21-604-5	Sta. No. 4 - upper frame	.094" x 12 1/4" x 5 3/8"	QQ-A-355	Al. Al. 24SO
87-21-604-8	Sta. No. 4 - lower frame	.102" x 10 1/4" x 4 3/4"	"	" " "

CHAPTER 5

LANDING GEAR

General

1. No repairs are permitted to any part of the landing gear or tail wheel units, consequently all damaged parts must be replaced by standard spares. The replacement of parts may be facilitated by the use of the disassembly drawings of the Landing Gear and Tail Wheel. These drawings, Fig. 41 and 42 contain call-outs of all sub-assemblies.

Bushing

2. With regard to bushed holes in the landing gear and the tail wheel units, wear should occur only inside of the bushing and consequently only the bushing will have to be replaced. Most bushings are replaceable with standard parts and do not require re-reaming after installation. If the bushing is used with a shaft where a special tolerance between the shaft and the bushing must be held, it will be necessary to control the shaft diameter to suit the design requirements.

3. Oilite bushings cannot be reamed after installation; however, the hole may be burnished for close control of I.D. when the condition warrants.

4. In hand reaming, for diameters up to 1 inch, a tolerance of 0.001 inch should be maintained; for diameters above 1 inch, the tolerance should be 0.002 inch.

For machine reaming, the tolerance of diameters up to 1/2 inch should be ± 0.0005 inch; for diameters of 1/2 to 1 inch ± 0.001 inch, and for diameters above 1 inch, ± 0.0015 inch.

5. A rule to use for circular fits, such as shafts in bearings, or bushings in fittings is as follows: Compare the maximum dimension of the hole with the minimum dimension of the shaft and the minimum dimension of the hole with the maximum dimension of the shaft.

For example:

Hole	Shaft	
.875 ± .0015 - .001	.873 ± .000 - .002	
.8765 - .871	.0055	clearance, maximum
.874 - .873	.001	clearance, minimum

CHAPTER 6

MAIN PLANES

General

1. The wing is of all metal construction consisting of a network of spars, ribs and stringers which are covered with a thin highly stressed Aluminum Alloy skin. See Figs.43, 44 and 45

Three types of riveting are used in the fabrication of the wing. These are:

(i) Machine countersunk type where the upper sheet is machine countersunk.

(ii) Press machine countersunk type which consists of machine countersinking the lower sheet or stringer and dimpling the upper sheet by squeezing or vibrating separately.

(iii) Press countersinking where both the upper and lower sheets or the stringer are dimpled separately.

(iv) In all cases, the parts are together when drilled for the rivets, and all rivets are driven by vibration.

2. All rivets exposed to the air-stream are of the 78° countersunk, A17ST type (Curtiss Standard 673-D-AD). Internal rivets are of the modified brazier head A17ST type (Curtiss Standard 671-D-AD).

3. The main plane has a multi-spar arrangement and consists of two sections which are jointed at the center line of the aeroplane. The wing tips are detachable. The skin gages vary from .020" to .064", as shown on Figs. 44 and 45. The split trailing edge type flaps are of all metal construction, whereas the ailerons have a metal frame which is fabric covered.

Classification of damage

4. When classifying any damage on the wing, carefully examine the extent and nature of the damage before placing it in one of the following:

(i) Negligible damage
(ii) Damage repairable by patching
(iii) Damage repairable by insertion
(iv) Damage necessitating replacement

MAIN PLANE SKIN

General

5. The main plane skin is supported by five spars, ribs between the spars, and closely spaced stringers which lie between the spars and are attached to the ribs. All areas of the skin are designed to take heavy tension and compression loads. It is essential, therefore, to adequately reinforce any area of the skin which becomes damaged.

6. Table I, Fig. 46, specifies the required numbers of rivets or bolts to be used at the inboard and outboard edges of any patch or splice plate used to reinforce a damaged area. Columns 1, 2, and 3 specify the areas to which the data applies. Stations are measured in inches outboard from the center line of the aeroplane as shown by the encircled numbers on Figures 44 and 45. Column 4 gives the rivet diameter, number of rows and the spacing between the rivets to be used at each end of a given patch; along the edges which are parallel to the ribs. The same data applies to the attachment on each side of a chordwise splice. The attachment for the edges of a patch which are parallel to the spars and for spanwise splices should be the same as in the nearest attachment of the damaged skin to a spar capstrip. When, as illustrated in Fig. 47, splices are made with frames which are discontinuous at the stringers or spars, the required number of rivets inboard and outboard of the chordwise cuts should be determined from Column 5 of Table I on the basis of the overall chordwise length of the skin cut. Arrange the rivets at the spacing given in Column 4 adding an extra row on each side of the cut to take the extra rivets. Count only those rivets which attach the frame within the chordwise length of the cut.

7. Flush type structural or semi-structural doors may be formed in the skin to facilitate skin repair* and permit future inspection of internal repairs. A structural door may be formed by substituting bolts for the rivets used in attaching a skin insert to a frame or splice plates, Fig. 47. Flush steel bolts No. 1101-D which fit countersunk holes are used. These screw into self-locking nut plates No. 659-D each of which is riveted to the underside of the frame with two No. 673-D-4AD flush type rivets. The bolt patterns to be used for the chordwise attachments are given in Columns 6 and 7 of Table I, Fig. 46, while the patterns for the spanwise attachments consist of one bolt for every two rivets in the nearest attachment of the skin to a spar capstrip. Openings which do not extend beyond

* Data available at the time of this writing does not substantiate the use of blind rivets in highly stressed portions of the aeroplane. The deflection of blind rivets, even when used in the ratio of two for one standard rivet and even when pinned or formed with a solid shank, is considerably in excess of that for the standard machine formed or vibrated solid rivets. Their use produces dangerous stress concentrations due to the redistribution of loads.

two adjacent stringers may be closed with semi-structural doors requiring approximately one half the number of bolts for their attachment. The frame for a semi-structural door should be made from stock one gage heavier than the sheet being repaired and should be cut to the shape illustrated in Fig. 46. The width of the frame on each side of the opening should equal one half the width of the opening, and the length should be such as to take the required number of rivets given in Column 5 of Table 1, Fig. 46, at the spacing given in Column 4, all of these required end rivets to be placed in the two stringers and in the skin between these stringers. The washer head type of bolt No. 525-10 which is not countersunk may be used on semi-structural doors except in areas near the leading edge where their drag would be detrimental. The nut plates No. 659-D contain a fibre washer which automatically locks the screws into place. Attachment of the nut plates to stock of gage .040" or lighter, where the material must be dimpled or press countersunk to obtain flush rivet heads on the outer surface requires the use of a countersunk shim plate No. 1066-D-1 or a .064" gage strap laid along the line of bolt holes between the nut plates and the frame. This shim strap is drilled and machine countersunk for each rivet and bolt, the frame is drilled and dimpled to match, and the door is countersunk for the bolts.

Negligible damage

8. Skin dents, free from cracks, abrasions and sharp corners may be neglected. These dents should be restored to shape wherever possible to prevent their developing into cracks, using care, however, not to stretch or crack the skin in the process. Inspect all rivets near the damage to see that they have not been loosened or sheared.

9. Holes and cracks which can be cleaned up to a one inch circle are considered negligible if in .040" or lighter skin and if the edge of the cleaned up hole is at least one inch from the nearest rivet or cut-out and at least two inches measured along the span to the nearest skin splice rivets. Two such holes within ten inches of each other measured chordwise and five inches measured spanwise, however, may not be neglected. Negligible holes must be cleaned up to prevent the spread of cracks and should be plugged as in Fig. 47.

Damage repairable by patching

10. Minor damage not considered negligible may in general be cleaned up and patched by attaching a 24ST sheet of the same gage under the skin using the required number of rivets and rivet spacing as given in Fig. 46. It is preferable to place patches under the skin so that the damaged area may be inspected for the formation of cracks. For aerodynamic reasons the damaged material which is cleaned away should be replaced with a filler sheet. The

original contour may be maintained by making patches discontinuous at stringers and bulkheads, care must be taken to use the total required number of rivets per inch of chordwise damage. On the other hand, continuous patches which pass over and are attached to the stringers require less rivets and are structurally superior. Existing rivets which interfere with the attachment of a patch should be carefully drilled out and the resulting holes used in arranging the new required rivet pattern.

Damage near reinforced sections of the skin, particularly in the area between Stations 27 and 65 of the lower surface, may be patched only when sufficient attachment can be obtained by using the original rivet or bolt holes. Do not drill additional holes in any reinforced area because these areas have only the minimum required margins of safety.

Damage to the skin of the gas tank doors may be patched by using a sheet of the same gage 24ST stock which is large enough to take four rows of 3/16" rivets at 3/4" spacing along the inboard and outboard ends of the damaged area plus one row of 5/32" rivets at 1 inch spacing on the other two sides. Clean up the damaged area giving all corners a minimum radius of half an inch to prevent the formation of cracks and remove enough rivets to permit placing the patch between the skin and the stiffeners. Patches or splice plates must be made continuous across the stringers and should take 3/16" rivets in both legs of each stiffener. A filler sheet should be added to preserve the contour if the damage is located in an unfaired section of the door. The filler should be attached to the patch with a single row of 1/8" rivets at 1 1/4" spacing.

Damage repairable by insertion

11. Damage to areas which cannot be effectively patched due either to their location or to their extent may be repaired by the use of inserts. The required insert should be cut from 24ST stock of the same gage as the damaged skin. The insert should be sufficiently large to extend to the edges of the damaged sheet or to areas in which the necessary splice plates or frames may be used, see Figures 47 and 48, and its corners should be rounded off to a half inch or larger radius. Use the insert as a template in cutting away the damaged material. Make up the necessary splice plates or frames and rivet these to the skin using the data in Fig. 46.

Damage necessitating replacement

12. Damaged reinforcement plates and extensively damaged sheets of skin should be replaced with equal gage 24ST stock cut and drilled to match the damaged part. Use care in drilling out the existing rivets, see Paragraph 14, Chapter 1.

RIBS

Negligible damage

13. Cracks or holes which after clean-up have not reduced the length of the material along every cross-section of the rib by more than ten percent and which are not within half an inch of any web hole flange, structural bead, or fitting attachment may in general be considered negligible. Small, isolated dents which are at least half an inch from the nearest web hole flange or structural bead may be neglected. Sharp cornered holes should be rounded out and all dents should be bumped out and examined for cracks. All cracks should be stopped by drilling 1/8" holes at their ends.

14. Do not neglect any cracks, nicks, or holes in the landing gear attachment ribs or in the leading and trailing edge portions of the center line rib.

Damage repairable by patching

15. Minor damage not considered negligible may in general be cleaned up and patched with 24ST stock of the same gage. Refer to Figures 77 to 81. In all areas except those directly above or below a lightening hole, use the same rivets or bolts and the same spacing as in the nearest attachment of the rib to the spar web and run this pattern either completely around the damage or to the edges of the undamaged portion of the rib. In patching damaged areas above or below a lightening hole use the same gage patch with twice as many rows of the same rivets or bolts and the same spacing as in the nearest web attachment.

16. If the damage after clean-up is in the flange of a lightening hole or within half an inch of this flange, form a flange on the patch equal to the lightening hole flange and add an additional rivet at each end of the patch flange near the undamaged rib hole flange. See Fig. 49.

17. If the damage is within half an inch of a structural bead or extends across the bead, form an equal bead in the patch and add two additional rivets each side of the damage, one each side of the bead.

18. The landing gear ribs should not be patched unless the rivets or bolts used for the patch, see nearest attachment of rib to spar web, can be placed around the damage without their being closer than 1 inch to the nearest fitting attachments. If a landing gear rib or any of its fittings are in any way damaged, inspect the whole landing gear attachment structure for damage to the attachments, cracks in the fittings, and misalignment of parts.

Damage repairable by insertion

19. Damage to areas supporting fittings, to areas around which sufficient attachment cannot be obtained for patches, and to areas extensively damaged should be repaired by the use of inserts of the same gage 24ST stock. The design requirements for splice plates and their attachments or for overlap splices are the same as for patch plates, as given in paragraphs 15 to 18 of this chapter. Equal legged angles of the same gage 24ST stock 5/8" x 5/8" may be attached to an insert along the line of an original bead in lieu of forming a bead. The same angle should be used as a vertical stiffener across a space where it is undesirable to reform a flanged lightening hole, Figures 50 and 79. Attach the angle with the same rivets and pattern used for the splices.

Damage necessitating replacement

20. Damaged rib reinforcements and fittings and extensively damaged rib sections should be replaced. Use care in drilling out the existing rivets, see paragraph 13, Chapter 1.

SPARS

Negligible damage

21. Small holes in the spar webs which can be circumscribed by a 3/4" diameter circle need not be patched provided the perifery of the circle is not less than 1" from the nearest lightening hole or capstrip. The hole should be drilled or reamed to make the edges smooth.

Damage repairable by patching

22. Minor damage not considered negligible should be cleaned up and patched provided there is sufficient room to use the required rivet pattern as given in Tables A and D of Fig. 51 around the damage. Patches should be made from the same gage 24ST stock as the damaged spar web. The spar web gages are as follows:

Spar No. 1	.051" from Sta. ℄ to Sta. 89
	.040" from Sta. 89 to Sta. 205
Spar No. 2	.040" from Sta. ℄ to Sta. 133
	.032" from Sta. 133 to Sta. 205
Spar No. 3	.051" from Sta. ℄ to Sta. 205
Spar No. 4	.040" from Sta. ℄ to Sta. 57
Spar No. 5	.040" from Sta. ℄ to Sta. 205

23. When damage is near a web lightening hole, as in Figures 77 and 78, extend the patch beyond the edge of the hole, run the required rivet pattern around the damage up the edge of the hole, and add an extra rivet at each end of the pattern near the edge of the hole. If the web hole is flanged, add an equal flange to the patch

and add two extra rivets at the ends of the rivet pattern near the flanges. The flange on the patch may be formed straight and should be opposite to the web hole flange. Damaged lightening hole reinforcement rings must be replaced. Large reinforcement plates may be patched with 24ST stock of the same gage as the original member using the same method as employed for web repair. Where both web and reinforcement are damaged, place the required patches on opposite sides and rivet through the four sheets with the required rivets and pattern. Use a filler between the patches and replace all rivets which were originally in the damaged area, see Figures 77 and 79. A single patch equal in gage to the web plus its reinforcement as in Fig. 52 may be used, providing the next larger size of rivets is used and the spacing is reduced to the minimum in Table D of Fig. 51. When damage occurs near a web flange or capstrip and prevents running the required rivet pattern around the damage, extend the patch to the edge of the web and use the required number of rivets as given in Table B of Fig. 51 for the attachment to the capstrip, at each end of the damage. Run the required rivet pattern, Table A, around the damage and up to the capstrip or flange. See Fig. 52 and 53.

Damage repairable by insertion

24. Extensive damage should be repaired by splicing in new sections of the same gage 24ST stock. Splice plates for attaching the inserts to the undamaged parts of the web should also be of the same gage 24ST stock. The rivet pattern requirements are in general the same as for patches. Table C, Fig. 51 gives the minimum number of rivets to be used on each side of the cut between the capstrips. Figures 73 to 76 give capstrip and web flange repairs which are equal in strength to capstrip material including the web material in the capstrip region. When these repairs are made at a cut in the web, the web splice plate does not need to be attached to the capstrip. If, however, the capstrip or web flange is not repaired according to Figures 73 to 76, the splice plate should overlap the capstrip and should be attached with the number of rivets specified in Table B on each side of the cut, Fig. 51 Table D gives the minimum allowable spacing for rivets and should be considered in arranging all rivet patterns. Various examples of repairs to spar webs are given in Figures 51 to 61.

Damage requiring replacement

25. Damaged fittings, small gussets, and reinforcements must be replaced. Also all rivets or bolts removed in making repairs must be replaced.

STRINGERS

General

26. Several types of stringers are used in reinforcing the wing skin. Cross-sectional views are shown in Figures 62 and 63. Figure 62 shows extruded stringers with their Alcoa die numbers.

Figure 63 shows formed "Z" stringers and an extruded "Z" stringer with its alcoa die number. For reference purposes each stringer is given a number as shown in Figures 44 and 45.

Negligible damage

27. Small isolated dents, free from cracks, abrasions, and sharp corners may be neglected provided no two adjacent stringers are damaged and the skin to which the stringers are attached is not affected. All stringers should be kept as straight as possible in order to withstand compression loads.

Damage repairable by patching

28. Do not neglect any nicks or cracks in the stringers. Damage which after clean-up affects less than one half of the cross-sectional area may be reinforced by using the required patch plates and rivets as given in Figures 64, 65, 66 and 67. Damage affecting more than one half of the cross-section should be repaired according to Figures 68, 69, 70 and 71. As shown in these figures an angle may be attached to the skin next to a stringer to reinforce any damaged area located near the outboard end of the stringer. Filler pieces should be added wherever needed for the attachment of the skin or fittings.

Damage repairable by insertion

29. Extensive damage should be repaired by cutting away the damaged portion of the stringer and replacing this with an insert of the same section and material. Details for the splices to be used in attaching the insert are given in Figures 68, 69, 70 and 71 for the various sections.

Damage necessitating replacement

30. Damaged stringer reinforcements and splice plates should be replaced.

31. The short stringers supporting the lower surface of the ammunition compartment should be replaced if damaged or may be reinforced by attaching a section of similar stringers to the skin next to the damaged portion using 671-D-4AD rivets at 1" spacing and at least four rivets at each end of the damage.

Gas tank door stringers

32. Any damaged gas tank door stringers should be replaced or patched with .051" gage 24ST sheet formed to fit over the damaged stringer and long enough to take at least four 3/16" rivets at each end thru each flange or a total of eight 3/16" rivets at each end plus the original 1/8" rivets along the length of the damage.

SPAR CAPSTRIPS

General

33. Several types of capstrips are used. Cross-sectional views with Alcoa die numbers for each are shown in Fig. 72.

Negligible damage

34. Small isolated dents, free from cracks, abrasions and sharp corners may be neglected.

Damage repairable by patching

35. Do not neglect any nicks or cracks in the capstrips. Clean-up the damaged area, by rounding out the sharp corners and stopping cracks with an 1/8" drilled hole and then reinforce or patch the capstrip according to the data given in Figures 73 to 76.

36. There are four types of capstrips: an extruded angle, an extruded "J" section, an extruded bulb angle, and a formed "J" section. Each type requires a special arrangement of patch material and is covered separately in one of the above figures. The number of bolts or rivets for each repair is given on the figures according to spar number and spanwise location.

37. Care must be exercised to use the correct drill sizes when enlarging rivet holes to take the required bolts. Any looseness of the bolts will throw excessive loads on the nearby rivets, thus loosening the rivets and making them ineffective. All bolt and rivet patterns should be arranged to make use of the original holes. Do not drill additional holes or change the pattern unless the change is justified by a similar change inboard of the section in question.

38. Due to the fact that reinforcements bolted to a capstrip cannot be made as efficient as the original continuous material any partially damaged section will take its ultimate allowable load before the reinforcements or patches are loaded up. This action will inevitably cause complete failure of the capstrip at the damaged section during service. To avoid a failure of this nature, all capstrip patches and their attachments at each end of the damage, must, therefore, be made equal in strength to the strength of the original undamaged section. The repairs given in Figures 73 to 76 are designed to include the strength of the web material that acts with the capstrips.

Damage repairable by insertion

39. Extensive damage or damage which due to its location cannot be repaired by patching should be repaired by the use of an insert. Details for the splicing in of capstrip inserts are given in Figures 73 to 76.

Damage requiring replacement

40. All damaged capstrip reinforcements should be replaced.

FLAP

General

41. The skeleton aluminum alloy frame work of the split trailing edge flaps is covered with .025" Aluminum Alloy 24ST sheet. See Fig. 82.

Skin

42. Any damage to the skin should be repaired with a flush insert of .025 gage 24ST stock attached by a patch or frame of .032 gage 24ST stock. Use a single row of 673-D-4AD press countersunk rivets at one inch spacing for the attachment. Patches and frames may be discontinuous at the ribs or beam.

Rib

43. Random holes in the web of any rib which when cleaned up can be circumscribed by a circle of diameter less than one half of the depth of the rib at the damaged section may be considered negligible providing:

(i) The center of the hole is not above the center of the rib web.

(ii) The lower edge of the hole does run into the lower bend radius.

(iii) The edge of the hole is not closer than one inch in a chordwise direction, to the nearest structural hole.

44. For damage in excess of the above, see Fig. 83.

Stringer

45. Any damage to the stringers should be reinforced by adding a .040 gage 24ST "Z" section as shown in Fig. 84. This same reinforcement may be used as a splice when replacing sections of a damaged stringer.

Channel beam

46. The channel forming the main beam of the flap is heavily loaded and has low margins at the sections where the operating links are attached as well as at the ribs. All repairs are to be made with .051 gage 24ST stock fitted to the channel as shown in Fig. 85 and the specified arrangement of 671-D-4AD rivets. For minor damages to the beam use portions of the reinforcement illustrated in Fig. 85 as follows:

(i) Damage to the flange only - attach an angle with three rivets in the flange and three in the leg of the channel at each end of the damage.

(ii) Damage to the leg only - attach a "Z" section with three rivets in the flange of the channel, six rivets in the leg, and three rivets in the back of the channel at each end of the damage.

(iii) Damage to the back of the channel only - attach a channel with seven rivets through the back and three through each of the legs of the channel at each end of the damage.

For extensive damage or damage occurring in the sections which cover bearing blocks for the operative links insert new sections of channel making the splices, see Fig. 85, between ribs in the sections where there are no bearing blocks. Replace all damaged fittings, etc.

Hinge

47. Minor local damage to the flap hinge between the ribs may be cleaned up and neglected. Damage within two inches of any rib should be repaired by cutting away the damaged portion of the hinge and replacing it with a new section of standard hinge. Arrange the new insert so that its ends are at least two inches from the nearest flap rib.

AILERONS

General

48. The ailerons are light alloy, fabric-covered structures as shown in Fig. 86. To prevent their flutter at high speeds the static balance of each about its hinge axis is adjusted in manufacture by attaching a lead filled tube within the leading edge near the outboard end. Any repair which decreases the static balance; that is, makes the trailing edge fall, by more than 0.3 inch-pounds measured at the hinge axis should be compensated for by adding lead sheet to the leading edge directly in front of the repair. Use 1/8

inch or thinner lead sheet extending to within one inch of the upper and lower row of rivets in the nose beam flanges and attach with 1/8 inch countersunk blind rivets at one inch spacing and one half inch edge distance along the top and bottom edges, see Fig. 101. Cover the lead with well doped fabric extending at least two inches beyond its edges.

Mass balancing

49. The procedure for checking static balance should consist of prebalancing the aileron on its end bearings in an inverted horizontal position by attaching a small weight, in a manner similar to that employed for the elevator, as illustrated in Fig. 101. After completing the repairs replace the balancing weight at the same point, in the same manner, as the original attachment and add sufficient lead sheet to the leading edge to bring the trailing edge up to its original prebalance position.

Negligible damage

50. Smooth dents, free from cracks, abrasion, and sharp corners may be neglected provided the adjacent rivets and internal structure are intact. Do not neglect dents in the nose skin which tend to buckle when the aileron is twisted or warped by hand. Where accessible, negligible dents should be restored to shape taking care to avoid the formation of cracks.

Repairable damage

51. The nose skin may be repaired or reinforced by using external patches which extend to the upper and lower edges of the nose skin as shown in Fig. 87. The patch must cover the damage and extend to the nearest ribs. Use .025" 24ST stock for the patch and attach it with 1/8 inch solid rivets in the beam flanges and 1/8 inch blind rivets in the rib flanges. Use rivet spacing as illustrated in Fig. 87. Damage to the skin aft of the beam web should be reinforced with .025" 24ST sheet of sufficient size to take one row of 1/8" blind rivets at 1/2 inch spacing around the damage forward of the beam plus at least three of the original 671-D-4AD rivets in the beam flange at each end of the damage. Use a .025"shim between the reinforcement and beam flange where the skin is cut away and replace all original rivets. The edges of the skin patches should be well rounded to prevent their cutting through the fabric.

52. Damaged nose ribs should be replaced using the same size rivets and pattern where accessible. If blind rivets must be used, use two of the same diameter for each original solid rivet.

53. The nose beam web may be patched with .032 gage 24ST stock attached by two rows of 1/8" blind rivets arranged around the damage at one inch spacing between rivets and 3/4 of an inch between rows. See Fig. 88. If the damage is too near a flange to obtain the required rivet pattern form a 3/4" flange on the patch which is long enough to take the existing 1/8" rivets in the flange, next to the damage, plus two additional rivets at each end of the damage. If only the flange is damaged reinforce it with a .032 gage 3/4" by 3/4" 24ST angle long enough to take four of the original 1/8" rivets in the beam flange at each end of the damage plus 4 1/8" blind rivets in the back of the channel. To splice the beam use a nestled channel of .032"24ST stock with 3/4 inch flanges approximately 5 inches long and attach this splice channel with 4 671-D-4AD rivets in each flange on each side of the cut plus 3 1/8" blind rivets on each side of the cut in the web of the beam and 3 1/8" rivets at each end of the splice in the web of the channel. See Fig. 88.

54. Damage to the web of any rib aft of the main beam should be patched with .025"gage 24ST sheet using one row of 671-D-4AD rivets at 3/4 inch spacing around the damage. If the damage extends into the radius of either flange add a flange to the patch and use at least 2 671-D-4AD rivets in the rib capstrip at each end of the damage. Damage to the rib flange alone should be reinforced with a .025 gage 24ST angle formed to fit into the flange of the rib and pick up the capstrip rivets as shown in Fig. 89. Use at least two 671-D-5AD rivets through the capstrip approximately 1/2 inch apart at each end of the damage plus any existing intermediate rivets. To splice the rib use a nestled channel as shown in Fig. 89 of .025 gage 24ST aluminum alloy attached with eight 671-D-5AD rivets, four in each capstrip, two on each side of the cut. If the capstrip is damaged replace or insert a new section and splice with a strip of .032 gage 24ST using two 671-D-5AD rivets on each side of the cut at 1/2 inch minimum spacing.

55. The tab mechanism must be rigidly supported. Any damaged parts should be replaced, and any damaged supporting structure must be carefully reinforced to prevent flutter of the aileron in flight.

56. For general repair of the trailing edge refer to Fig. 90.

WING TIP

General

57. Each wing tip is attached by screws and can be easily removed. See Fig. 43 and 81. Wing tips should generally be replaced if damaged. Minor repairs may be effected using blind rivets and following the procedures outlined for repair of the fin and stabilizer. For aerodynamic reasons patches forward of Spar No. 3 should be made flush with the skin. For a general repair to the wing tip joint refer to Fig. 91.

Materials for repair of main plane skin, spars, ribs and trailing edge

Part number	Description	Size	Spec.	Remarks
87-03-521-7 87-03-521 671-D-6AD-6 81599-3-7 81599-4-8 7/8 and 8 15/16"	Rib - angles - wing attachment Rib - Al. Al. 24SO Rib - rivets - brazier head Rib - angle (K-78-K) Rib - angle (K-78-J)	.081" thickness x 1 3/4" x 2 5/8" .064" x 12 1/4" x 13 3/4" 3/16" dia. x 3/8" long 3/4" x 1/16" thick 1" x 1/16" thick	QQ-A-355 (A) " " A17ST	Spars 4 and 5 " " " " " " " " "
87-03-529-1 87-03-529-3 AN931-6-10	Rib - sta. 27 - spars 2 and 3 Rib - sta. 27 - spars 2 and 3 reinforcement Rib - sta. 27 - spars 2 and 3 grommet	.040" x 16" x 19 1/2" .051" x 2 7/8" x 3 3/4" I.D. 3/8" x O.D. 7/8"	57-152-6 (I) "	Al. Al. 24SO " " Neoprene
87-03-530-1 87-03-530-2 81599-1-17 1/8 and 19 3/8" 87-03-530-5 87-03-530-16	Rib - sta. 26 - spars 3 and 4 Rib - angle Rib - angles Rib - reinforcement Rib - reinforcement	.040" x 15" x 32 3/4" .051" x 1 3/4" x 32" 3/4" x 3/32" thickness. .064" x 2 5/8" x 2 5/8" 3/16" x 5/8" x 12 7/8"	57-152-6 (I) " 57-152-6 (II) QQ-A-354 (J)	Al. Al. 24SO " " Alcoa Die No. (K-78-C) Al. Al. 24ST " "
87-03-031-11	Rib - sta. 27 - spars 4 and 5	.040" x 11" x 13 5/16"	57-152-6 (I)	Al. Al. 24SO
87-03-535-1 659-D-15	Sheet - chassis support - inner spars 2 and 3 Anchor nut - chassis support - inner spars 2 and 3	.128" x 13 15/16" x 17 1/2" 25/64" x 11/32" x 1/4" high	QQ-A-355 (T) 1112	Al. Al. 24ST Steel

Materials for repair of main plane skin, spars, ribs and trailing edge Cont'd.

Part number	Description	Size	Spec.	Remarks
525-10-10	Screws - chassis support - inner spars 2 and 3	5/8" long; 7/32" shank	57-107-17	Washer head
365-1032	Nuts - chassis support - inner spars 2 and 3	15/64" x 3/8"	25527 Mfg.	Fine thread
AN3-5	Bolts - chassis support - inner spars 2 and 3	5/8" long; x 1/4" shank	57-152-5	
87-03-541-1	Sheet - chassis support - outer spars 2 and 3	.128" x 13 15/16" x 17 15/16"	QQ-A-351	Al. Al. 24ST
81599-1	Angles - chassis support - outer - spars 2 and 3	3/4" x 3/32" thickness		Alcoa die No. (K-78-C)
81599-3	Angles - chassis support - outer - spars 2 and 3	3/4" x 1/16" thickness		Alcoa die No. (K-78-K)
81599-6	Angle - chassis support - outer spars 2 and 3	1" x 1/8" thickness		Alcoa die No. (K-77-B)
81599-2	Angle - chassis support - outer spars 2 and 3	3/4" x 1/8"		Alcoa die No. (K-77-A)
AN960-10	Washers - chassis support - outer - spars 2 and 3	13/64" I.D.; 7/16" O.D.		Plain
87-03-618-1	Rib - inboard wheel pocket - spars 4 and 5	.040" x 7 5/8" x 9 3/4"	57-152-6 (I)	Alclad 24SO
87-03-619-1	Rib - outboard wheel pocket - spars 4 to 5	.040" x 7 7/8" x 9 5/8"	57-152-6 (I)	Al. Al. 24SO

Materials for repair of main plane skin, spars, ribs and trailing edge Cont'd.

Part number	Description	Size	Spec.	Remarks
87-03-559-1 87-03-559-3	Rib - sta. 57 - spars 2 to 3 Rib - sta. 57 - spars 2 to 3 - stiffener	.040" x 14 1/32" x 17 1/8" .040" x 2 1/4" x 1 3/8"	57-152-6 (I) 57-152-6 (II)	Al. Al. 24SO Al. Al. 24ST
87-03-560-1 87-03-560-2 87-03-560-3 to 17 87-03-560-22	Rib - sta. 57 - spars 3 to 5 Rib - sta. 57 - spars 3 to 5 - reinforcements Rib - sta. 57 - spars 3 to 5 - plates Rib - sta. 57 - spars 3 to 5 - collar	.051" x 14 1/8" x 38 1/2" .064" x 2 15/16" x 3 3/8" .032" thickness .064" x 4 7/16" x 4 7/16"	QQ-A-355 (A) " QQ-A-355 (T) "	Al. Al. 24SO " " " Al. Al. 24ST " " "
87-03-569	Rib - sta. 65 - spars 3 to 5	.051" x 4 3/8" x 35 3/4"	11067-(I)	Alclad sheet 24SO
87-03-568-1 87-03-568-3	Rib - sta. 66 15/16 - spars 2 to 3 Rib - sta. 66 15/16 - spars 2 to 3 - reinforcements	.040" x 14" x 17 1/2" .051" x 3 1/16" x 5 7/16"	11067-(I) 57-152-6-(I)	Alclad sheet 24SO Al. Al. 24SO
87-03-574-1 87-03-044-2 87-69-539	Rib - sta. 73 1/2 - spars 2 to 3 Rib - angles - 78077-4 - Alcoa die No. K-10223 Rib - angles - Alcoa die No. K-27369	.040" x 13 1/4" x 17 5/16" 11 9/16" x 9/16" x .040" thickness 1.5" x 1.188" x 11 1/2" long	11067-(I) QQ-A-354 (T)	Al. Al. 24SO Area .056 sq. in. Al. Al. 24ST

Materials for repair of main plane skin, spars, ribs and trailing edge Cont'd.

Part number	Description	Size	Spec.	Remarks
87-03-583-1	Rib - sta. 81 1/2 - spars 2 to 3	.051" x 16" x 12 7/8"	57-152-6-(I)	Al. Al. 24S0
87-03-583-4	Rib - sta. 81 1/2 - spars 2 to 3 clips	.064" x 1" x 3 1/2"	"	" " "
87-03-583-6	Rib - sta. 81 1/2 - spars 2 to 3 plates	.081" x 2 9/16" x 4 1/2"	57-152-6-(II)	Al. Al. 24ST
AN-4-6	Rib - sta. 81 1/2 - spars 2 to 3 bolts	3/4" long; 5/16" shank	57-152-5	Steel
365-428	Rib - sta. 81 1/2 - spars 2 to 3 nuts	5/16" x 7/16"	25527 Mfg.	Self-locking
87-03-584-2	Rib - sta. 81 1/2 - spars 3 to 5	.040" x 12 15/16" x 35 3/32"	QQ-A-355 (A)	Al. Al. 24S0
87-03-584-10	Rib - sta. 81 1/2 - spars 3 to 5 filler	.125" x 1 9/16" x 2 7/8"	QQ-A-355 (T)	Al. Al. 24ST
659-D-15	Rib - sta. 81 1/2 - spars 3 to 5 nutplate	25/64" x 11/32" x 1/4" high	1112	Steel
AN24-11	Rib - sta. 81 1/2 - spars 3 to 5 screws	11/16" long; 3/8" shank	29-59 Mfg.	
364-428	Rib - sta. 81 1/2 - spars 3 to 5 nuts	13/64" x 7/16"	25527 Mfg.	Self-locking - thin
87-03-604-1	Rib - sta. 100 - spars 2 to 3	.025" x 11 9/16" x 15 5/8"	57-152-6-(I)	Al. Al. 24S0
87-03-604-3	Rib - sta. 100 - spars 2 to 3 - angle	.040" x 1 1/4" x 2 11/16"	57-152-6-(II)	Al. Al. 24ST
87-03-605-1	Rib - sta. 100 - spar 3 to aux. spar	.040" x 6" x 11 1/2"	57-152-6-(I)	Al. Al. 24S0

Materials for repair of main plane skin, spars, ribs and trailing edge Cont'd.

Part number	Description	Size	Spec.	Remarks
87-03-606-1	Rib - sta. 100 - aux. spar to aux. spar	.040" x 8 1/16" x 12 1/4"	57-152-6-(I)	Al. Al. 24SO
87-03-607-1	Rib - sta. 100 - aux. spar to aux. spar	.040" x 9 21/32" x 14 3/16"	"	" " "
87-03-624-1	Rib - sta. 122 - spars 2 to 3	.025" x 10 3/8" x 14 1/2"	57-152-6-(I)	Al. Al. 24SO
87-03-624-2	Rib - sta. 122 - spars 2 to 3 - angle	.040" x 1 1/4" x 2 11/16"	57-152-6-(II)	Al. Al. 24ST
87-03-625-1	Rib - sta. 122 - spars 3 to aux. spar	.040" x 7 17/32" x 10 1/4"	57-152-6-(I)	Al. Al. 24SO
87-03-626-1	Rib - sta. 122 - aux. spar to aux. spar	.040" x 6 9/16" x 13 3/8"	57-152-6-(I)	Al. Al. 24SO
87-03-627-1	Rib - sta. 122 - aux. spar to spar No. 5	.040" x 5 15/32" x 8 5/8"	"	" " "
87-03-788-1	Rib - reinforcement - aileron drum support	.040" x 8 1/8" x 7 1/8"	57-152-6-(I)	Al. Al. 24SO
87-03-788-2	Filler	.051" x 3/4" x 3 9/16"	57-152-6-(II)	Al. Al. 24ST
87-03-788-3	Angle	.040" x 2 1/16" x 5 5/16"	"	" " "

Materials for repair of main plane skin, spars, ribs and trailing edge Cont'd.

Part number	Description	Size	Spec.	Remarks
87-03-645-1	Rib - sta. 143 - spars 2 to 3	.025" x 9 1/8" x 13 1/2"	57-152-6-(I)	Al. Al. 24S0
87-03-646	Rib - sta. 143 - spars 3 to aux. spar	.040" x 9 1/16" x 9 1/16"	QQ-A-355 (A)	Al. Al. 24S0
87-03-647-1	Rib - sta. 143 - aux. spar to aux. spar	.040" x 5 3/16" x 13 7/32"	"	" " "
87-03-647-6	Strap	.102" x 1" x 5 3/8"	QQ-A-355-(T)	Al. Al. 24ST
87-03-648-1	Rib - sta. 143 - aux. spar to spar 5	.032" x 5 3/16" x 6 11/16"	QQ-A-355-(A)	Al. Al. 24S0
87-03-649	Rib - sta. 143 - aft of spar 5	.025" x 6 5/16" x 6 1/2"	"	" " "
87-03-666	Rib - sta. 164 - spar 2 to spar 3	.025" x 8" x 12 5/8"	57-152-6-(I)	Al. Al. 24S0
87-03-667-1	Rib - sta. 164 - spars 3 to 5	.032" x 8" x 23 1/2"	11067-(I)	Alclad 24S0
87-03-667-4	Rib - sta. 164 - spars 3 to 5 - angle	.040" x 2 1/8" x 3 13/16"	QQ-A-355-(T)	Al. Al. 24ST
87-03-667-6	Rib - sta. 164 - spars 3 to 5 - angle	.064" x 1 15/16" x 3 5/8"	QQ-A-355-(A)	Al. Al. 24S0
87-03-687	Rib - sta. 185 - spars 2 to 3	.025" x 7" x 11 5/8"	QQ-A-355-(A)	Al. Al. 24S0
87-03-688-1	Rib - sta. 185 - spars 3 to 5	.032" x 6 7/8" x 21 1/4"	57-152-6-(I)	" " "
87-03-306	Ribs - sta. 185 - aft of spar 5	.025" x 5" x 5 1/4"	11067-(I)	" " "
87-03-705-1	Rib - sta. 205 - leading edge to trailing edge	.032" x 6 1/2" x 50"	11067-(I)	Alclad 24S0
87-03-705-2	Rib - angle - sta. 205 - leading edge to trailing edge	.032" x 1 3/8" x 3 1/2"	57-152-6-(I)	Al. Al. 24S0

Materials for repair of main plane skin, spars. ribs and trailing edge Cont'd.

Part number	Description	Size	Spec.	Remarks
75-03-162-1	Rib - plate - sta. 205 - leading edge to trailing edge	.051" x 1 13/16" x 3"	57-152-6-(II)	Al. Al. 24ST
75-03-187-1	Rib - reinforcement - sta. 205 - leading edge to trailing edge	.040" x 5" x 5 9/32"	57-152-6-(I)	Al. Al. 24SO
87-03-511-2	Spar No. 1 - inner	.051" x 11 1/2" x 89 1/2"	57-152-6-(II)	Al. Al. 24ST
87-03-511-3	Spar No. 1 - outer	.040" x 8 1/2" x 116 5/8"	"	" " "
87-03-511-13	Spar No. 1 - reinforcement	.064" x 5 3/8" x 5 3/8"	"	" " "
87-03-511-5	Spar No. 1 - angle	.081" x 2 1/4" x 29 1/16"	57-152-6-(I)	Al. Al. 24SO
87-03-839	Spar No. 1 - flange - lower	Alcoa die No. (K-27290)	57-152-5-(T)	Al. Al. 24ST
87-03-052	Spar No. 1 - flange - upper - outboard	.102" x 2 3/8" x 32 11/16"	11067-I	Alclad 24SO
87-03-551	Spar No. 1 - flange - lower - inboard	Alcoa die No. (K-16016)	57-152-5	Al. Al. 24ST
87-03-694	Spar No. 1 - flange - upper - outboard	Alcoa die No. (K-27291)	"	" " "
87-03-512-1	Spar No. 2 - inboard	.040" x 14 1/4" x 133 1/2"	QQ-A-355-(T)	Al. Al. 24ST
87-03-512-2	Spar No. 2 - outboard	.032" x 7 1/2" x 72"	"	" " "
87-03-812-5	Spar No. 2 - plate	.040" x 4 7/8" x 9 15/16"	"	" " "
87-03-812-12	Spar No. 2 - plate	.064" x 11 3/16" x 37 1/2"	"	" " "
87-03-812-15	Spar No. 2 - angle splice	.081" x 2 3/16" x 12"	QQ-A-355-(A)	Al. Al. 24SO
87-03-812-22	Spar No. 2 - filler	.051" x 15/16" x 2 9/16"	QQ-A-355-(T)	Al. Al. 24ST
87-03-733	Spar No. 2 - flange - upper - outboard	Alcoa die No. (K-27383)	57-152-5-(T)	Al. Al. 24ST
87-03-598	Spar No. 2 - flange - lower - inboard	Alcoa die No. (K-15004)	"	" " "

Materials for repair of main plane skin, spars, ribs, and trailing edge Cont'd.

Part number	Description	Size	Spec.	Remarks
87-03-513-2	Spar No. 3 - inboard	.051" x 15 3/4" x 111 1/2"	QQ-A-355-(T)	Al. Al. 24ST
87-03-513-3	Spar No. 3 - outboard	.051" x 10 1/2" x 95 5/16"	"	" " "
87-03-513-20	Spar No. 3 - reinforcement - sta. 180	.040" x 6" x 6"	"	" " "
87-03-513-24	Spar No. 3 - filler plate	.125" x 1" x 4"	"	" " "
87-03-513-25	" " " " "	.093" x 1" x 3 3/4"	"	" " "
87-03-513-28	Spar No. 3 - stiffener	.032" x 3 1/4" x 11 5/8"	QQ-A-355-(A)	Al. Al. 24S0
87-03-513-42	Spar No. 3 - spacer	7/16" x 3/4" x 2 3/16"	QQ-A-354-(T)	Al. Al. 24ST
87-03-514-5	Spar No. 4 - web sheet	.040" x 10 3/4" x 57 11/16"	57-152-6-(II)	Al. Al. 24ST
87-03-514-6	Spar No. 4 - top channel - middle	.072" x 3 1/2" x 28 1/2"	57-152-6-(I)	Al. Al. 24S0
87-03-514-7	Spar No. 4 - top channel - inner	.064" x 3" x 25 3/8"	"	" " "
87-03-514-8	Spar No. 4 - channel	.064" x 2 5/8" x 10"	"	" " "
87-03-514-9	Spar No. 4 - jay Section	.064" x 2 7/8" x 33 1/2"	"	" " "
87-03-514-15	Spar No. 4 - filler	.040" x 1 5/16" x 3 1/2"	57-152-6-(II)	Al. Al. 24ST
87-03-514-16	Spar No. 4 - reinforcement	.051" x 10 5/16" x 12 9/16"	"	" " "
87-03-514-30	Spar No. 4 - block	3/4" x 1/2" x 1 5/8"	QQ-A-354-(T)	Al. Al. bar 24ST
75-03-027	Spar No. 4 - lower - inner	Alcoa die No. (K-15002)	11071-T	Al. Al. 24ST
87-03-515-1	Spar No. 5 - web	.040" x 9 1/8" x 126 1/8"	57-152-6-(II)	Al. Al. 24ST
87-03-515-2	Spar No. 5 - web	.040" x 7 7/16" x 85"	"	" " "
87-03-515-5	Spar No. 5 - angle	.040" x 1 3/8" x 6 7/8"	57-152-6-(I)	Al. Al. 24S0
87-03-515-10	Spar No. 5 - angle	.040" x 1 1/4" x 48 5/8"	"	" " "
87-03-552	Spar No. 5 - lower - extrusion	Alcoa die No. (K-27394)	57-152-5-(T)	Al. Al. 24ST

Materials for repair of main plane skin, spars, ribs, and trailing edge Cont'd.

Part number	Description	Size	Spec.	Remarks
87-03-722-1	Auxiliary Spar - rear	.051" x 9 9/16" x 82 3/8" (74 1/2")	QQ-A-355-(T)	Al. Al. 24ST
87-03-722-5	Auxiliary Spar - reinforcement angle	.125" x 1 3/8" x 12 3/4"	QQ-A-355-(A)	Al. Al. 24SO
87-03-706-4	Auxiliary Spar - front	.051" x 11 1/16" x 82 11/32"	QQ-A-355-(T)	Al. Al. 24ST
87-03-706-9	Auxiliary Spar - spacer	.125" x 5/8" x 2 3/8"	"	" " "
87-03-816-4	Auxiliary Spar - front	.051" x 10 5/16" x 74 1/4" (H87-3)	"	" " "
671-D-4AD-	Rivet - same for lower - brazier head	1/8" Dia.	A-17ST	upper main plane
673-D-5-	Rivet - same for lower - 78° countersunk	5/32" Dia.	A-17ST	" " "
AN442-AD-4-	Rivet - same for lower - flat head	1/8" Dia.	A-17ST	" " "
AN430D-6-	Rivet - round head	3/16" Dia.	A-17ST	lower main plane
AN425D6-	Rivet - countersunk head 78°	3/16" Dia.	A-17ST	" " "
AN23-12A	Bolts - without cotter pin hole	3/4" long x 7/16" shank	29-59 Mfg.	" " "
365-1032	Nuts - self-locking - fine	15/64" x 3/8"	25527 Mfg.	" " "
AN960-10	Washers - plain	13/64" I.D. x 7/16" O.D.	1010 Steel	" " "
525-10-10	Screws - washer head	5/8" long, 7/32" shank	57-107-17	" " "
87-03-710-1	Main plane skin - upper - inboard - Spars 2 to 3	.064" x 20 1/2" x 122 1/2"	57-152-6-II	Al. Al. 24ST
87-03-710-2	Main plane skin - upper - outboard	.040" x 14 3/8" x 85 1/2"	"	" " "
87-03-710-36	Main plane skin - collar	.040" x 1 1/2" x 15 7/16"		" " "

Materials for repair of main plane skin, spars, ribs, and trailing edge Cont'd.

Part number	Description	Size	Spec.	Remarks
87-03-712-1	Main plane skin - upper - spars 3 to 4	.051" x 35" x 108"; .051" thickness	QQ-A-355-(T)	Al. Al. 24ST
87-03-712-4	Main plane skin - upper - spars 3 to 4	.032" x 32" x 44"	"	" " "
87-03-712-36	Main plane skin - collar	.040" x 1 1/2" x 15 7/16"	"	" " "
87-03-712-29	Main plane skin - reinforcement L.H. only	.051" x 4" x 7 3/4"	"	" " "
87-03-712-30	Main plane skin - patch - L.H. only	.040" x 6 1/2" x 12 1/2"	"	" " "
87-03-714-1	Main plane skin - upper - spars 4 to 5	.051" x 15 5/8" x 105"	57-152-6-II	Al. Al. 24ST
87-03-711-1	Main plane skin - lower - spars 2 to 3 - inboard	.051" x 20" x 97 1/2"	57-152-6-II	Al. Al. 24ST
87-03-711-2	Main plane skin - lower - spars 2 to 3 - outboard	.032" x 14 1/16" x 93 1/4"	"	" " "
1100-D-S-6	Main plane skin - lower - screw	3/8" long	1115 steel	100° countersunk
87-03-229-1	Main plane skin - lower - reinforcement - L.H.	.051" x 7 1/32" x 18"	57-152-6-I	Al. Al. 24SO
87-03-588	Main plane skin - lower - reinforcement - L.H.	.040" x 3 3/4" x 22"	"	" " "
87-03-181-1	Main plane skin - lower - plate	.032" x 12 9/32" x 20"	57-152-6-II	Al. Al. 24ST
87-03-779	Main plane skin - lower - channel splice - R.H.	.051" x 2 1/4" x 5 1/4"	QQ-A-355-(A)	Al. Al. 24SO
87-03-795-1	Main plane skin - lower - frame	.032" x 5 9/16" x 7 9/16"	QQ-A-355-(T)	Al. Al. 24ST
75-03-367-1	Main plane skin - lower - channel splice - R.H.	.051" x 2 5/16" x 5 1/2"	57-152-6-I	Al. Al. 24SO

Materials for repair of main plane skin, spars, ribs and trailing edge Cont'd.

Part number	Description	Size	Spec.	Remarks
87-03-713-2	Main plane skin - lower - inboard - spars 3 to 4	.040" x 37" x 43"	QQ-A-355-(T)	Al. Al. Sheet 24ST
87-03-713-3	Main plane skin - lower - inboard - spars 3 to 4 - reinforcement	.040" x 10 3/4" x 12 3/16"	"	" " " "
87-03-713-13	Main plane skin - lower - inboard - spars 4 to 5	.051" x 15 1/2" x 70"	"	" " " "
659-D-2	Main plane skin - lower - inboard - spars 4 to 5 - fastener	25/64" x 11/32" x 1/4" high	1112 steel	nutplate
87-03-049-1	Main plane skin - lower - inboard - spars 4 to 5 - gusset - R.H.	.064" x 2 5/16" x 6 5/16"	57-152-6-II	Al. Al. 24ST
75-03-816-2	Main plane skin - lower - inboard - spars 4 to 5 - reinforcement	.051" x 5 5/8" x 12"	"	" " "
87-03-055-2	Main plane skin - lower - inboard - spars 4 to 5 - gusset - R.H.	Forging	57-153 (Gr.5)	Al. Al. 14ST
87-03-713-18	Main plane skin - lower - outboard - spars 3 - 5	.051" x 19" x 83"	QQ-A-355 (T)	Al. Al. 24ST
87-03-713-19	Main plane skin - lower - outboard - spars 3 - 5	.032" x 23" x 128"	"	" " "
87-03-713-26	Main plane skin - lower - outboard - spars 3 - 5 - stiffeners	.040" thickness	"	" " "
87-03-713-31	Main plane skin - lower - inboard - spars 3 - 5 - reinforcement	.032" x 18 1/2" x 12 15/16"	"	" " "

Materials for repair of main plane skin, spars, ribs, and trailing edge Cont'd.

Part number	Description	Size	Spec.	Remarks
87-03-510-1	Main plane - nose skin - inboard	.051" x 42" x 101"	57-152-6-(II)	Al. Al. 24ST
87-03-510-2	Main plane - nose skin - outboard	.040" x 31 1/2" x 106 7/8"	"	" " "
87-03-510-5	Main plane - nose skin - strip	.020" x 5/8" x 12"	"	" " "
365-428	Main plane - nose skin - nuts - fine	5/16" x 7/16"	25527 Mfg.	Self-locking
365-1032	Main plane - nose skin - nuts - fine	15/64" x 3/8"		" "
87-03-510-6	Main plane - nose skin - shim	.040" x 3/4" x 6"	57-152-6-(II)	Al. Al. 24ST
87-03-510-18	Main plane - nose skin - reinforcement	.051" x 16" x 25"	"	" " "
87-03-510-19	Main plane - nose skin - reinforcement	.102" x 3 5/8" x 3 1/4"	"	" " "
659-D-7	Main plane - nose skin - nutplate - R.H.	1/2" x 1/2" x 9/32" high	1112 Steel	Elastic nut type
87-03-516-1	Trailing edge - inboard - skin - upper	.025" x 22 3/4" x 131 7/16"	57-152-6-(II)	Al. Al. 24ST
87-03-516-2	Trailing edge - inboard - skin - lower	.025" x 21 15/16" x 22 1/2"	"	" " "
87-03-516-3	Trailing edge - inboard - skin - inner	.032" x 8 1/4" x 25 3/4"	"	" " "
87-03-516-5	Trailing edge - inboard - skin - reinforcement	.125" x 27/32" x 21 29/32"	"	" " "
87-03-516-6	Trailing edge - inboard - skin - plate	.040" x 1/2" x 2 1/4"	"	" " "

Materials for repair of main plane skin, spars, ribs, and trailing edge Cont'd.

Part number	Description	Size	Spec.	Remarks
87-03-516-7	Trailing edge - inboard - skin - filler	.032" x 1 1/4" x 2 1/4"	57-152-6-(II)	Al. Al. 24ST
AN3-5	Trailing edge - inboard - bolts	5/8" long x 1/4" shank	57-152-5	Steel
659-D-15	Trailing edge - inboard - nut-plate	25/64" x 11/32" x 1/4" high	1112 Steel	Elastic nut type
87-03-516-4	Trailing edge - inboard - door	.032" x 5 1/2" x 10 5/8"	57-152-6-(II)	Al. Al. 24ST
87-03-639	Ribs - Aileron - center hinge	.032" x 5 17/32" x 5 15/16"	57-152-6-(I)	Al. Al. 24SO
87-03-532-1	Wing tip - skin - upper	.020" x 21" x 54"	QQ-A-355-(T)	Al. Al. 24ST
87-03-532-2	" " - skin - lower	.020" x 22" x 54"	"	" " "
87-03-532-3	" " - spar No. 2	.020" x 5 5/16" x 17"	QQ-A-355-(A)	Al. Al. 24SO
87-03-532-4	" " - spar No. 3	.020" x 5 5/8" x 18 3/4"	"	" " "
87-03-532-5	" " - spar No. 4	.020" x 5 3/16" x 17 7/8"	"	" " "
87-03-532-6	" " - spar No. 5	.020" x 4" x 14 7/8"	"	" " "
87-03-532-7	" " - rib	.020" x 4 3/8" x 6 1/4"	"	" " "
87-03-532-8	" " "	.020" x 4 3/4" x 10 1/8"	"	" " "
87-03-532-9	" " "	.020" x 4 3/4" x 10"	"	" " "
87-03-532-10	" " "	.020" x 4 1/8" x 9 7/8"	"	" " "
87-03-532-12	" " - spacer - top	.051" x 19/32" x 36"	QQ-A-355-(T)	Al. Al. 24ST
87-03-532-16	" " - leading edge	.025" x 1 5/8" x 32"	QQ-A-355-(A)	Al. Al. 24SO
75-03-148	" " - trailing edge	"casting"	57-72-GR-(I)	Al. Alloy
87-03-532-17; 18	" " - spacer - top and bottom	.051" x 19/32" x 10 5/8"	QQ-A-355-(T)	Al. Al. 24ST
87-03-532-14	" " - rib - sta. 206 1/2	.032" x 5 11/16" x 48"	11067-I	Alclad 24SO
670-D-4D-4	" " - rivet - hollow - Thomson	1/8" dia. x 1/8" long	17ST	Aluminum Alloy
75-03-203-1	" " - clip	.040" x 7/8" x 2 5/16"	57-152-6-(I)	Al. Al. 24SO

Materials for repair of main plane skin, spars, ribs, and trailing edge Cont'd.

Part number	Description	Size	Spec.	Remarks
87-08-501-1	Flap - skin	.025" x 22" x 125"	57-152-6-(II)	Al. Al. 24ST
87-08-501	Flap - ribs - all	.025" thickness	57-152-6-(I)	" " 24S0
87-08-501	Flap - stringers - all	.040" x 1 3/4" x —	"	" " "
87-08-501-20	Flap - reinforcement	.064" x 1 1/8" x 4 1/2"	57-152-6-(II)	" " 24ST
87-08-501-21	Flap - filler	.081" x 1/2" x 118"	"	" " "
87-08-501	Flap - angles - all	.025" thickness	57-152-6-(I)	" " 24S0
87-08-501-26	Flap - beam	.040" x 5 1/2" x 120"	57-152-6-(II)	" " 24ST
87-08-501-27	Flap - reinforcement	.040" x 1 3/4" x 2 5/8"	57-152-6-(I)	" " 24S0
1018-D-72 13/32"	Flap - trailing edge - also 20 5/8" long	11/16" x 3/16" x .035"		Alcoa die No. T-608
1019-D-22 7/8"	Flap - trailing edge - walk away	43/64" x 3/16" x .035"		Alcoa die No. T-609
75-08-024-6	Flap - hinge - outboard	1092-DB-2-57"	57-152-6-(II)	Al. Al. 24ST
75-08-011	Flap - splice - trailing edge	"Forging" - ends 43/64" x 3/16" and 11/16" x 1/8"	QQ-A-367-Gr.3	Al. Al. 51ST
75-08-024-5	Flap - hinge - inboard	1092-DB-2-57 1/8"	57-152-6-(II)	Al. Al. 24ST
75-08-013	Flap - trunnion	5/8" dia. x 2 13/16"	57-107-17	Steel bar
87-05-501-200	Aileron - nose ribs - all except -18 and -113	.025" thickness	57-152-6-(I)	Al. Al. 24S0
87-05-501-18	Aileron - nose rib - also -113 L/R	.040" x 4 23/32" x 4 1/2"	"	" " "
87-05-501-3	Aileron - nose beam - L/R	.032" x 5 1/8" x 84 1/16"	57-152-6-(II)	" " 24ST
87-05-501-4	Aileron - nose skin - L/R	.025" x 14 7/8" x 83 3/4"	"	" " "
87-05-501-16	Aileron - brace - L/R	.020" x 3 15/32" x 14 13/32"	57-152-6-(I)	" " 24S0
87-05-501	Aileron - ribs - L/R	.025" and .020" thickness	"	" " "
87-05-501-40	Aileron - trim tab - R.H.	.051" x 2" x 13 1/2"	QQ-A-359	Al. sheet 3S1/2H
87-05-501-90	Aileron - reinforcement L/R	.040" x 4 5/8" x 4 3/4"	57-152-6-(II)	Al. Al. 24S0
911-D-	Aileron - trailing edge L/R	.6" x .25" x .022"		Alcoa die No. T-483
82-03-014	Aileron - capstrip - upper and lower L/R	"Y" shape .77" x .031" thick	QQ-A-331 (T)	Al. Al. 53ST

Materials for repair of main plane skin, spars, ribs and trailing edge Cont'd.

Part number	Description	Size	Spec.	Remarks
87-05-017	Aileron - balance tube - total weight 6.$^{+.1}_{-.0}$ lbs.	3/4" O.D. x .035" x 39 1/2"	57-180-2	Steel
87-05-504	Aileron - trim tab - ribs - L.H.	.020" thickness	57-152-6-(II)	Al. Al. 24ST
87-05-504-3	Aileron - trim tab - beam - L.H.	.025" x 2 1/8" x 11 1/4"	"	" " "
87-05-504-2	Aileron - trim tab - skin - L.H.	.016" x 6 1/2" x 11 1/4"	"	" " "
87-05-504	Aileron - trim tab - angles - L.H.	.051" x 3/4" x 3 1/4"	"	" " "
87-05-504-12	Aileron - trim tab - reinforcement - L.H.	.040" x 3/4" x 1 1/2"	"	" " "
87-05-501-131	Aileron - tapping plate - L.H.	1/8" x 7/16" x 3 1/4"	"	" " "
87-05-501-137	Aileron - angle - L.H.	.064" x 2" x 2 7/16"	"	" " "
87-05-501-87	Aileron - gusset - L.H.	.020" x 1 1/2" x 1 1/2"	"	" " "

CHAPTER 7

TAIL PLANE AND FIN

General

1. The tail plane and fin are of aluminum alloy construction consisting of spars, stringers and inter-costal ribs which are covered with an aluminum alloy highly stressed skin. See Fig. 92 and 93.

TAIL PLANE

Negligible damage

2. Smooth dents, free from cracks, abrasions, and sharp corners may be neglected provided the adjacent rivets are intact, and there is good reason for assuming that the damage has not affected the internal structure. Wherever possible these dents should be restored to shape taking care to avoid cracks.

Damage repairable by patching

3. The method of repairing the nose skin is shown in Fig. 94. Attach the .051" splice plates to the undamaged skin with 1/8" solid rivets. The .051" 24ST Aluminum Alloy skin insert may be attached with Chobert rivets after the plates are in position.

4. Repair to the tail plane skin may be effected as shown in Fig. 95. For attaching the strap plates to the .020" skin use 673-D-4AD-4 rivets spaced at 3/4". For the .025" skin use 673-D-4AD-4 rivets at 1" spacing in 2 staggered rows as shown in Fig. 95. For attaching a .020" skin patch to a strap plate use two rows of Chobert D.T.D. 327 - 1/8" Dia. - countersunk rivets. For attaching a .025" skin patch, use 2 staggered rows of Chobert D.T.D. - 327 - 5/32" Dia. - countersunk rivets.

5. For flange and web repair of the spar, see Fig. 96. When effecting repairs, refer to the chart on Fig. 96 for the number and spacing of rivets. Use the existing rivet holes for the skin rivet pattern.

6. For repair over a stiffening bead of the spar use the same material, one gage higher than the damaged member, using 671-D-4AD-4 rivets as shown in Fig. 97.

7. For repair of a spar section where there are lightening holes use 24ST aluminum alloy material of the next higher gage and attach with 671-D-4AD rivets as shown in Figure 97.

8. Damage to reinforced sections of the spars should be repaired by splicing in new sections or by adding two pieces of stock on opposite sides equal in gage to the web and reinforcement. The required number of rivets in double shear is the same as given in Fig. 96.

9. For damage to any flange of the rib, patch by a bent up angle attached to the web by a minimum of three 1/8" rivets on each side of the damaged area as specified in the chart, see Fig. 98.

10. For repair of a "V" stringer, see Fig. 98. Drill and punch out the necessary skin rivets according to paragraph 14, Chapter 1. Cut away and clean the damaged area of the stringer. Insert a filler plate of the same gage material (24ST) and rivet the section as shown in the figure using three rows of 1/8" rivets on each side of the damage.

Damage repairable by insertion

11. For a "V" stringer insertion splice, refer to Fig. 98. Drill and punch out the skin rivets, cut away and clean the damaged area and insert a new section of Alclad 24ST, leaving a 1/32" clearance at each end. Splice the new section ends, using three rows of rivets on each side of the cut, leaving a rivet edge distance of 2 1/2 diameters.

Damage necessitating replacement

12. Sections of the spars between the fin and fuselage attachment fittings should generally be replaced if damaged. The webs should be spliced at least three inches outboard of the fuselage fittings. Replace all damaged gussets, fittings, etc.

FIN

Spars

13. Web and flange damage should be repaired according to data given in Fig. 96.

Reinforcement angles on spars #1, 3 and 4 should be either replaced if damaged or repaired by attaching a .025" 24ST angle over the damaged section with 1/8" rivets. Use at least 4 1/8" rivets, two in each leg of the angle, at each end of the damage.

Ribs

14. For web damage a minimum of two 1/8" rivets are necessary on each side of the damage. The flange repair should be the same as used on the tail plane, paragraph 5 of this chapter, see Fig. 96.

Stringers

15. Patch the damage with four rivets on each side of the damage. Same as the tail plane repair, see Fig. 98.

Skin patches

16. Use 1/8" rivets at 3/4" spacing around the damaged area of .020" skin; use 1/8" rivets at 1" spacing in two staggered rows for .025" skin, (see Figures 94 and 95.) For repair of the running light, see Fig. 99. Cut away and clean the damaged area. Redrill existing holes with a No. 20 drill and use D.T.D. 327 - 5/32" Dia. countersunk rivets. Replace Al. Alloy 24ST, .020" plate and lamp assembly.

Material for repair of the tail planes

Part number	Description	Size	Spec.	Remarks
87-11-501-1	Tail plane - nose skin	.051" x 20 5/16" x 68 5/8"	11067-(I)	Alclad 24S0
87-11-501-2	Tail plane - bottom skin	.025" x 10 1/8" x 66 5/16"	57-152-6-(II)	Al. Al. 24ST
87-11-501-3	Tail plane - top skin	.020" x 10 7/8" x 66 5/16"	"	" " "
87-11-501-18	Tail plane - angle	.020" x 7/8" x 3"	"	" " "
87-11-501-19	Tail plane - angle	.040" x 7/8" x 3"	"	" " "
673-D-4-4	Tail plane - rivet - 78° countersunk	1/8" dia x 1/4" long	A17ST	
671-D-5AD-3	Tail plane - rivet - modified brazier head	5/32" dia x 3/16" long	A17ST	
AN442AD-4-3 1/2	Tail plane - rivet - flat head	1/8" dia x 3.5/16" long		
87-11-512-2	Tail plane - rib	.020" x 5 1/2" x 9 3/16"	57-152-6-(I)	Al. Al. 24S0
87-11-512-8	Tail plane - rib	.032" x 4 15/16" x 7 15/16"	"	" " "
87-11-512-9	Tail plane - rib	.025" x 3 3/8" x 6 1/4"	"	" " "
87-11-512-19	Tail plane - nose	.025" x 4 1/8" x 8 3/4"	"	" " "
87-11-515-36	Tail plane - spar	.040" x 6 3/16" x 64 5/8"	57-152-6-(II)	Al. Al. 24ST
87-11-515-14	Tail plane - spar - reinforcement	.040" x 4 5/8" x 15 1/16"	"	" " "
87-11-515-33	Tail plane - spar - channel	.040" x 2 3/4" x 5 1/2"	"	" " "
87-11-515-32	Tail plane - spar - angle	.040" x 1 9/16" x 65 7/16"	"	" " "
87-11-515-11	Tail plane - spar	.032" x 6 9/16" x 64 5/8"	"	" " "
87-11-515-15	Tail plane - spar - reinforcement	.032" x 7 5/8" x 18 1/4"	57-152-6-(I)	Al. Al. 24S0
87-11-515-22	Tail plane - spar - channel	.040" x 2 3/4" x 8 1/2"	57-152-6-(II)	Al. Al. 24ST
87-11-515-16	Tail plane - spar - reinforcement	.025" x 7 7/16" x 12 5/8"	11067	Alclad 24S0
AN23-8A	Tail plane - spar - bolt	1/2" long x 3/16" shank		Without cotter pin hole
365-1032	Tail plane - spar - nut - self locking	15/64" x 3/8"		Fine thread

Material for repair of the tail planes Cont'd.

Part number	Description	Size	Spec.	Remarks
AN960-10	Tail plane - spar - washer	13/64" I.D. x 7/16" O.D.	steel	1/16" thick
75-11-011	Tail plane - stud	7/8" screw - 3/32" thickness	AN-QQ-S-762	Forging
87-11-024-2	Tail plane - reinforcement - rear	.025" x 1 3/4" x 1 3/4"	57-152-6-(II)	Al. Al. 24ST
75-11-027	Tail plane - stringer - "V" section	.025" x 3 17/32" x 49 17/32"	11067-(I)	Alclad 24SO
87-11-019-2	Tail plane - reinforcement - front	.025" x 1 3/4" x 2 1/8"	57-152-6-(II)	Al. Al. 24ST

NOTE: Tail Plane - 670 - D steel rivets or 671D-AD- rivets may be substituted for AN442AD- rivets to faciliate fabrication where machine riveting is used.

Material for repair of the fin

Part number	Description	Size	Spec.	Remarks
87-12-501-2	Fin - skin	.025" x 16 5/8" x 42 1/2"	57-152-6-(II)	Al. Al. 24ST
87-12-501-5	Fin - skin	.020" x 9 7/8" x 34 3/4"	"	" " "
87-12-501-6	Fin - reinforcement	.032" x 3 1/4" x 37 1/4"	"	" " "
87-12-501-7	Fin - reinforcement - (59036-12-12 3/4)	.025" x 1 9/16" x 12 3/4"	57-152-6-(I)	" " 24SO
87-12-501-11	Fin - conduit - tube	3/8" O.D. x .022" x 18"	WW-T-783	
87-12-501-12	Fin - nose piece - L.E.	.020" x 3 7/8" x 5 13/16"	57-152-6-(II)	" " 24ST
87-12-501-14	Fin - angles -(81599-1-1 5/8)	3/4" x 3/32" thickness		Alcoa die No. K. 78-C
87-12-501-16	Fin - filler	.020" x 3/4" x 1"	57-152-6-(II)	Al. Al. 24ST
75-12-011-16	Fin - rib	.032" x 4 1/4" x 9 1/4"	57-152-6-(I)	" " 24SO
75-12-011-17	Fin - rib	.020" x 5 7/16" x 10 7/16"	"	" " "
75-12-011-29	Fin - reinforcement	.040" x 2 1/16" x 8 1/8"	"	" " "
75-12-016-21	Fin - spar	.025" x 4 1/2" x 39 1/16"	57-152-6-(II)	" " 24ST
75-12-016-22	Fin - spar - reinforcement	.025" x 1 3/8" x 12 1/2"	"	" " "
75-12-016-31	Fin - spar	.032" x 5 1/4" x 36"	"	" " "
75-12-016-30	Fin - spar - reinforcement	.064" x 5 1/2" x 5 1/8"	57-152-6-(I)	" " 24SO
87-12-501-25	Fin - gusset- plate	.040" x 2 5/8" x 2 3/4"	57-152-6-(II)	" " 24ST
87-03-596-3	Fin - light - plate	.020" x 3 3/4" x 5"	57-152-6-(I)	" " 24SO
87-03-596-4	Fin - light - channel	.020" x 5 1/2" x 11"	"	" " "
87-12-517-1	Fin - tip - spar	.032" x 3" x 9 15/16"	"	" " "
87-12-517-3	Fin - tip - skin	.025" x 11 3/8" x 11 3/8"	"	" " "
87-12-517-5	Fin - tip - plate	.040" x 2 1/4" x 4 3/8"	"	" " "
673-D-4-4	Fin - rivet - 78° countersunk	1/8" dia x 1/4" long	A17ST	
671-D-4AD-4	Fin - rivet - modified brazier head	1/8" dia x 1/4" long	A17ST	
AN442AD-4-4	Fin - rivet - flat head	1/8" dia x 1/4" long		
AN3-6A	Fin - bolt	3/4" long; 3/8" shank	29-59 Mfg.	Without cotter pin hole

Material for repair of the fin Cont'd.

Part number	Description	Size	Spec.	Remarks
365-428	Fin - nut	5/16" x 7/16"	25527 Mfg.	fine thread
AN515-8-8	Fin - screw - round head	1/2" long	FF-S-91 Mfg.	coarse thread
AN3-5A	Fin - bolt	5/8" long; 1/4" shank	29-59 Mfg.	without cotter pin hole
AN960-10	Fin - washer - plain	13/64" I.D.; 7/16" O.D.	1010 steel	
365-1032	Fin - nut - self-locking	15/64" x 3/8"	25527 Mfg.	fine thread

CHAPTER 8

ELEVATOR AND RUDDER

Mass balancing

1. The elevator and rudder are aluminum alloy, fabric-covered structures. The static balance of each about its hinge line is adjusted in manufacture by the addition of lead weights near the leading edge. The weights added in each case are the minimum that will give satisfactory flutter control. It is important, therefore, in effecting repairs aft of the hinge line to compensate for any addition of weight. This may be easily accomplished as follows: Set the surface on its hinge bearings. Attach a sufficient length of cord to the trailing edge of the surface so that it may extend along the top part of the surface, and over the leading edge. Attach weights to the free end of the cord until the top surface assumes a horizontal position. Remove the cord and make the necessary repairs. When the repairs are complete replace the cord and weight in the same position as the original prebalanced attachment. Add sufficient lead sheet to the leading edge to return the surface to its horizontal prebalanced position. Attach the lead sheet and cover with fabric as described in paragraph 48, Chapter 6, see Fig. 101.

ELEVATOR

General

2. The elevator contains one counterweight which is installed inside of the paddle at the outboard end, forward of the center line of the hinge. This counterweight is a 2" O.D. x .058 x 5 1/8" tube filled with 3.607 pounds of lead. It is welded to webs which are riveted to the ribs, see Fig. 100. This weight is not accessible.

Negligible damage

3. One inch holes at the center of the rib webs which are at least one half inch from any other holes or the flanges may be neglected if there are no cracks.

Main beam

4. Repair flange damage, when injury does not extend more than one inch into the web, by patching with 5/8" x 1" x .032" 24ST aluminum alloy angle long enough to take three 671-D-4AD rivets in the beam web plus three of the skin rivets at each end of the damage as shown in Fig. 96, or use a repair similar to that shown in Fig. 88 with the .032" angle long enough to take four 671-D-4AD rivets through the beam flange plus at least two 1/8 inch Chobert or blind rivets through the beam web near the flange at each end of the damage.

5. Damage that is confined to the web of the beam should be patched with .032" 24ST aluminum alloy sheet attached with one row of 1/8 inch Chobert rivets at 3/4 inch spacing around the damage. If accessible use 671-D-4AD rivets at one inch spacing.

6. For complete cross-section damage, patch the member with an equivalent section as shown in Fig. 97. Use the next heavier gage if lightening holes or beads are damaged. If the section is inaccessible for riveting the web of the beam use four 671-D-4AD rivets in each flange on each side of the cut plus four 1/8 inch Chobert rivets, two near each flange in the web, on each side of the cut similar to repair illustrated in Fig. 88.

Nose skin

7. Repair is the same as for the aileron, use an external patch extending to the nearest ribs and to the edges of the nose skin, see Fig. 87.

Trailing edge

8. Repair as illustrated in Fig. 90.

Torque tube

9. Replace the entire damaged section of the tube.

Ribs

10. Rib web damage may be repaired by patching with 24ST stock of the same gage as the original material. Attach the stock with one row of 671-D-4AD rivets at 3/4 inch spacing around the damage.

11. Flange damage repairs should be effected by replacing the area and using three 671-D-4AD rivets in the web near the flange at each end of the damage to attach the patch piece in place as illustrated in Fig. 96.

12. Any damage to the extrusion, see Fig. 106, by which the fabric is attached, should be repaired by inserting a new section long enough to take at least two 1/8" rivets at a one inch minimum spacing. Splice with a .032 x 1/2" 24ST plate long enough to take two 1/8" rivets on each side of each cut.

13. Rib flanges that attach the ribs to the beam web if damaged should be replaced by a 5/8" x 5/8" angle of the same gage material. The angle should be attached to the rib by the same number of rivets as used to attach the rib to the beam web.

RUDDER

General

14. The rudder contains two counter-weights inside of the leading edge. One, made of steel bar is welded to plates which are in turn bolted to the first and second ribs above the intermediate center line of the hinge. The other, an assembly consisting of lead, three nose ribs and a channel is located above the top center line of the hinge. This assembly is integral with, and cannot be removed from, the rudder structure. See Fig. 102.

Main beam

15. Damage confined to the web and at least 5/8" from the flanges may be repaired according to Fig. 96, using 671-D-4AD rivets at 3/4 inch spacing around the damage.

16. Flange damage should be repaired by patching with an equivalent area and the same gage material, using three 671-D-4AD rivets each side of the damage. See Fig. 96.

Ribs

17. Repairs for the rudder ribs should be the same as used for the elevator rib repairs, which are discussed in paragraphs 10 thru 12.

Nose skin

18. Repair in the same manner as an aileron; use an external patch extending to the nearest ribs and to the edges of the nose skin, see Fig. 87.

Brace tube

19. This tube may be repaired by insertion of a 7/16" dia. aluminum rod attached with 1/8" rivets as in Fig. 103.

20. Refer to Fig. 104 for the Rudder Assembly locating fixture.

Material for repair of the elevator

Part number	Description	Size	Spec.	Remarks
671D-4AD-4	Elevator - rivet - brazier head	1/8" dia x 1/4" long	A17ST	
AN442AD-4-4	Elevator - rivet - flat heat	1/8" dia x 1/4" long		
1045-D-6	Elevator - bonding tab	Dia. .1285" x Dia. .113"	57-136-8	X4130 steel sheet
AN73A3	Elevator - bolt	3/8" long		
87-13-038	Elevator - beam ribs	.025" thickness	11067-(I)	Al. Al. 24S0
87-13-034	Elevator - spar - inboard end	.020" x 5 5/8" x 22 3/4"	"	" " "
87-13-033	Elevator - fairing - inboard end	.020" x 8" x 24"	"	" " "
87-13-032-21	Elevator - rib	.051" x 4 1/2" x 7"	57-152-6 (I)	" " "
87-13-032-22	Elevator - rib	.020" x 5" x 6"	"	" " "
87-13-032-25	Elevator - rib	.040" x 5" x 3 7/8"	"	" " "
87-13-032-31	Elevator - tapping plate for-32 rib	.187" x 3/8" x 1 7/8"	57-152-6 (II)	" " 24ST
87-13-026	Elevator - skin - tip	.025" x 7 1/2" x 10 1/4"	11067-(I)	" " 24S0
87-13-025-1	Elevator - shoe - elevator end	.051" x 7 1/8" x 7 3/4"	57-152-6-(I)	" " "
87-13-021-1	Elevator - skin - elevator balance	.040" x 5 1/4" x 7 1/2"	"	" " "
87-13-020	Elevator - bolt - trim tab control	5/16" Hex x 1 1/32"	57-107-17	Steel bar
87-13-018-1	Elevator - skin - nose	.025" x 15" x 60"	57-152-6-(II)	Al. Al. 24ST
87-13-016-12	Elevator - beam - main	.032" x 3 3/4" x 13"	"	" " "
87-13-015	Elevator - beam - false	.025" x 3" x 27 3/8"	11067-(I)	Alclad sheet 24S0
87-13-014-1	Elevator - plate - tapping	3/16" x 5/8" x 3 5/8"	57-152-5-(I)	Dural bar
87-13-013-3	Elevator - angles - trim tab bearing attachment	.040" x 1" x 1 3/8"	57-152-6-(II)	Al. Al. 24ST
87-13-012-1	Elevator - channel - false beam reinforcement	.025" x 1 19/64" x 2 1/8"	"	" " "
75-13-037	Elevator - spacer	3/8" x .120" x 1 1/16"	10235-(B)	Al. Al. tube 24S
75-13-025	Elevator - brace - flap false beam - trailing edge	3/8" O.D. x .035" x 8 11/16"	10235	Al. Al. tube 24ST
75-13-018-1	Elevator - gusset - flap beam - inner hinge	.025" x 1 5/8" x 2"	57-152-6-(II)	Al. Al. 24ST

Material for repair of the elevator Cont'd.

Part number	Description	Size	Spec.	Remarks
87-13-517-3	Elevator - rib	.025" x 6" x 15 7/8"	57-152-6 (I)	Al. Al. 24S0
87-13-517-5	Elevator - rib	.020" x 5 1/2" x 15"	"	" " "
	Material for repair of the rudder			
671-D-4AD-4	Rudder - rivet - brazier head	1/8" dia x 1/4" long	A-17ST	
87-14-545	Rudder - skin - tip - R.H.	.040" x 8 5/8" x 18 1/4"	11007-(I)	Alclad sheet 24S0
87-14-547	Rudder - beam - tip - rear	.040" x 4 1/16" x 6 1/16"	QQ-A-355-(A)	Al. Al. 24S0
87-14-544	Rudder - skin - tip - L.H.	.040" x 8 5/8" x 13 7/16"	11067-(I)	Alclad sheet 24S0
87-14-542	Rudder - nose cover - lower	.020" x 9 9/32" x 17 3/8"	"	" " "
87-14-534	Rudder - skin - trailing edge	.032" x 10" x 13"	57-152-6-(I)	Al. Al. 24S0
87-14-533-1	Rudder - fairing - lower	.032" x 16 1/4" x 22"	11067-(I)	Alclad sheet 24S0
87-14-531-1	Rudder - rib - diag	.020" x 7 1/8" x 13 11/16"	QQ-A-355-(A)	Al. Al. 24S0
87-14-531-3	Rudder - rib - upper	.040" x 3 3/16" x 3 3/4"	"	" " "
87-14-529	Rudder - splice - main beam	.040" x 3 1/2" x 7 7/8"	"	" " "
87-14-527	Rudder - rib - sta. 9	.040" x 3 5/16" x 16 1/4"	53-152-6-(I)	" " "
87-14-525-10	Rudder - rib - nose	.020" x 3 3/8" x 4 5/8"	"	" " "
87-14-522-5	Rudder - rib web - sta. 4	.040" x 7" x 31"	"	" " "
87-14-520-10	Rudder - rib - nose - sta. 2	.020" x 4 5/16" x 7 3/4"	11067-(I)	Alclad 24S0
87-14-518-6	Rudder - beam - lower	.020" x 5 9/16" x 8 1/4"	QQ-A-355-(T)	Al. Al. 24ST
87-14-517	Rudder - beam - tip	.040" x 3 7/16" x 11"	57-152-6-(I)	Al. Al. 24S0
87-14-516-6	Rudder - beam - inter.	.020" x 3 1/32" x 16 5/8"	"	" " "
87-14-515	Rudder - beam - lower main	.051" x 7 7/8" x 16 5/8"	"	" " "
87-14-514	Rudder - beam - main	.025" x 5 1/8" x 33 1/2"	QQ-A-355-(T)	Al. Al. 24ST

Material for repair of the rudder. Cont'd.

Part number	Description	Size	Spec.	Remarks
87-14-510-2	Rudder - plate - counterweight	.031" x 11" x 9"	57-136-8	4130 Steel
87-14-510-4	Rudder - counter weight - lead weight	6.81 lbs.	Comm.	Lead
87-14-504-4	Rudder - covering - cotton (gr.A)	60" x 4 1/2 yds.	AN-CCC-C-399	
87-14-504-5	Rudder - covering - tape surface	2 1/4" x 26 yds.	6-62	
AN503-8-6	Rudder - screw - coarse thread	3/8" long	FF-S-91 Mfg.	
365-832	Rudder - nut - self locking	15/64" x 3/8"	25527 Mfg.	coarse thread
365-632	Rudder - nut - self locking	11/64" x 5/16"	"	" "
87-14-501-9	Rudder - trailing edge (911-D-57)	.022" thickness of tube	10235-(B)	Al. Al. 24ST
87-14-501-7	Rudder - tube	3/16" O.D. x .022" x 50"	"	Al. Al. tube

CHAPTER 9

MISCELLANEOUS REPAIR

ENGINE COWL

General

1. The engine cowl consists of several sections, which are of spot-welded and riveted aluminum alloy construction, except for those portions of the cowl adjacent to the exhaust stacks which are stainless steel. The engine cowl sections are reinforced by formers which are supported by numerous fittings attached to the engine mount. The forward ends of the cowling are supported by a bulkhead which is attached to the bosses on the engine reduction gear housing. That portion of the cowl which must be frequently removed for servicing is attached with Dzus fasteners. Access doors are provided for the coolant expansion tank and starter crank.

Negligible damage

2. All small dents, free from cracks, abrasions and sharp corners, may be neglected. Larger dents should be restored to shape taking care to avoid cracking when effecting the repair.

Damage repairable by patching

3. For damage in excess of that in paragraph 2 above, use the repair data given in Fig. 105. Cut away all damaged area leaving a smooth-edged, regular-shaped hole with at least a one half inch radius in the corners. Patches must be of the same gage and material as the original construction.

Damage necessitating replacement

4. Any damaged section of the cowl which, due to its extent or location makes a repair impracticable, should be replaced.

SURFACE CONTROLS

General

5. No repairs should be made to the control mechanisms and cables. Replace, if damaged in any way by standard spares. All cables must be of the corrosion-resisting type and must be replaced if frayed, see the Cable Chart of this Chapter for replacement. If cloth is replaced on any of the control surfaces it should be attached to the ribs as shown by diagrams in Fig. 106.

Pulleys

6. Check all pulleys for proper alignment and signs of excessive wear and replace when necessary. All control pulleys are of the anti-friction bearing type and replacements must be of the same nature.

Flexible Cables (Kittyhawk)

Part No.	Title	End Fittings	Length (Inches)	Material and Spec.	Dia.	End Fitting Type and Part No.
85731	Rudder Control Cable	Spliced and Wrapped	60.0	Ex. Flex. Cable (AN-RR-C-48)	5/32	Bushing AN111-5
85731	" " "	" " "	132.625	" " "	"	" "
85731	" " "	" " "	118.625	" " "	"	" "
85731	Steerable Tail Wheel Cable	" " "	55.5	" " "	"	" "
85731	" " " "	" " "	30.500	" " "	"	" "
85731	Elevator Control Cable	" " "	59.875	" " "	"	" "
85731	" " "	" " "	99.875	" " "	"	" "
85731	" " "	" " "	62.125	" " "	"	" "
87-64-047-1	Aileron Control Cable	" " "	24.0	" " "	"	Bushing AN111-5 Bushing 75-64-055
87-64-047-2	" " "	" " "	115.688	" " "	"	Bushing AN111-5
75-64-056-1	" " "	" " "	111.0	" " "	"	Bushing AN111-5 Bushing 75-64-055
75-64-056-5	" " "	" " "	27.5	" " "	"	Bushing AN111-5
87-64-052-5	Rudder Tab Control Cable	Soldered	109.375	Flexible Cable (AN-RR-C-48)	1/16	Link 84907
87-64-052-9	" " " "	"	109.0	" " "	"	Link 84907 Turnbuckle 75-54-110
87-64-052-16	Rudder Tab Control Chain	Riveted	86.5			Link 84907 Turnbuckle 75-54-110
87-64-052-13	" " " "	"	79.75			Link 84907
87-64-052-6	Elevator Tab Control Cable	Soldered	110.5	Flexible Cable (AN-RR-C-48)	1/16	Link 84907
87-64-052-10	" " " "	"	108.25	" " "	"	Link 84907 Turnbuckle 75-64-110
87-64-052-4	Elevator Tab Control Chain	Riveted	86.0			Link 84907 Turnbuckle 75-64-110
87-64-052-19	" " " "	"	79.5			Link 84907

Material for miscellaneous repairs

Part number	Description	Size	Spec.	Remarks
1101-D-S-10	Cowl - screw - 100° countersunk	5/8" long	57-107-17	2330 steel
365-1032	Cowl - nut - self-locking	15/64" x 3/8"	25527 Mfg.	fine thread
AN960-D-10	Cowl - washer	13/64" I.D. x 7/16" O.D.	Steel	1/16" thick
AN6-21	Cowl - bolt	2 1/8" long; 1 9/16" shank	29-59 Mfg.	
AN350-6	Cowl - nut-wing	1 3/8"; 23/32"	Steel	
87-29-749-7	Cowl - former - channel - side - rear - lower	.064" x 5 1/2" x 13 3/4"	QQ-A-355-(A)	Al. Al. 24S0
87-29-749	Cowl - former - channel - side - rear - lower	.064" x 4 1/2" x 13 3/4"	"	" " "
87-29-748-5	Cowl - former - channel - side - rear - middle	.064" x 4 1/2" x 27 3/4"	"	" " "
87-29-748-8	Cowl - former - angle - side - rear - middle	.081" x 2 5/8" x 1 3/8"	"	" " "
87-29-748-7	Cowl - former - spacer - side - rear - middle	.032" x 7/8" x 1 3/4"	"	" " "
87-29-718	Cowl - duct - center and front	.051" thickness	"	" " "
87-29-718	Cowl - duct - angles	.064" thickness	"	" " "
87-29-718-21	Cowl - strip	.040" x 1/2" x 14"	QQ-A-355-(T)	Al. Al. 24ST
87-29-718-24	Cowl - duct - aft	.051" x 23" x 34"	QQ-A-355-(A)	" " 24S0
87-29-718-26	Cowl - door	.051" x 4 3/4" x 8 1/2"	"	" " "
87-29-716	Cowl - skin - side - bottom - nose	.032" thickness	11067 (I)	" " "
87-29-715-10	Cowl - skin - L.H. - weld assembly - side - rear	.032" x 22" x 25 7/8"	"	" " "
87-29-715	Cowl - skin - reinforcements - all	.040" thickness	"	" " "
87-29-706-2	Cowl - duct - rear exit - trough	.032" x 4 5/8" x 6"	QQ-A-355-(HT)	" " 24ST
87-29-706-3	Cowl - duct - rear exit - angle	.032" x 1 1/4" x 3 1/8"	"	" " "
87-29-502-2	Cooling tube - fuel pump	1 1/2" O.D. x .049" x 51"	57-187-3-(A)	" " 52S0
87-29-502-1	Cooling tube - spark plug manifold	1 3/4" O.D. x .065" x 16"	"	" " "
671-D-4AD-	Cowl - rivets - brazier head	1/8" dia-	A17ST	
673-D-4AD-	Cowl - rivets - 78° countersunk head	1/8" dia-	A17ST	
670-D-4AD-	Cowl - rivets - hollow	1/8" dia-	Al 17ST	

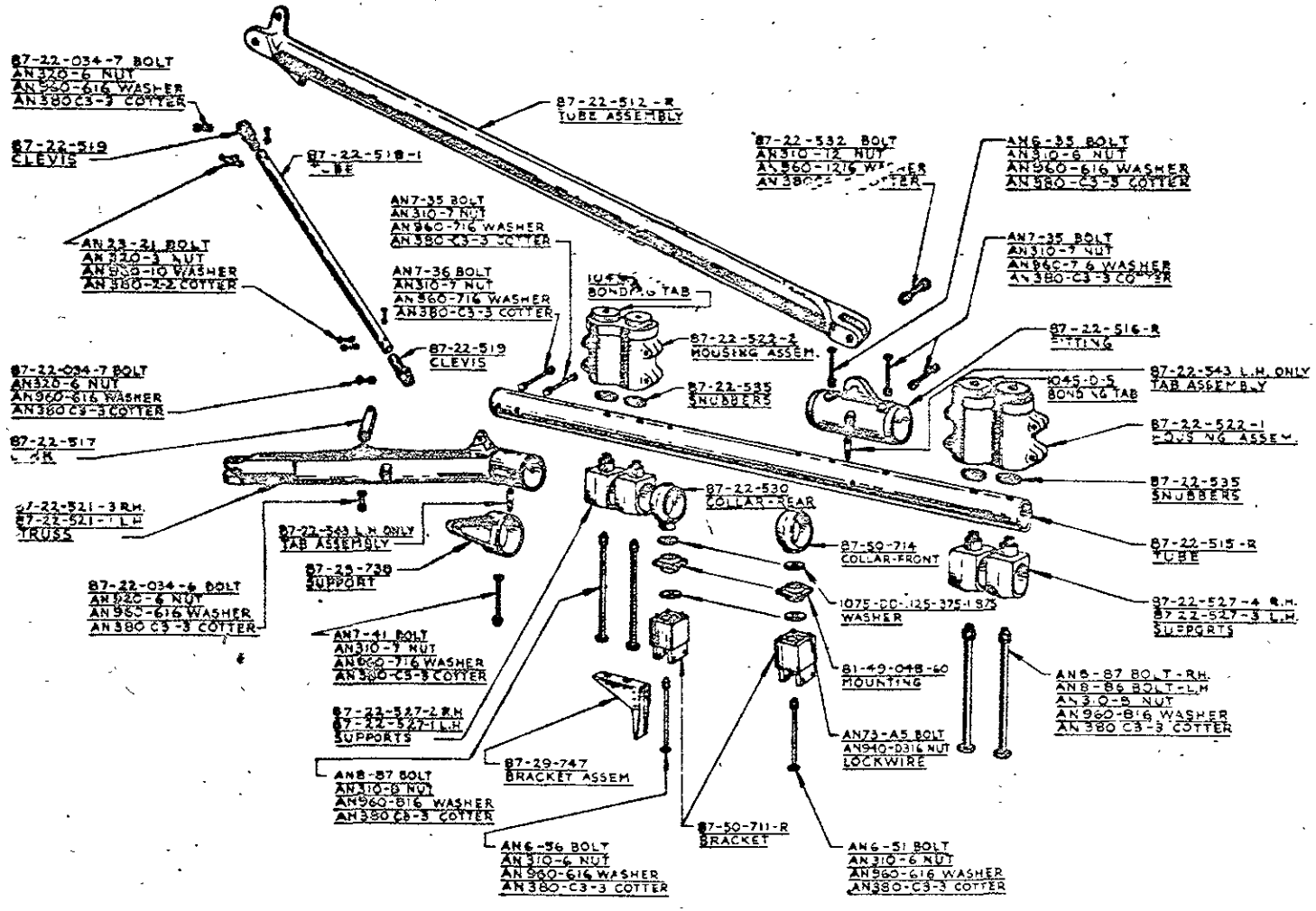
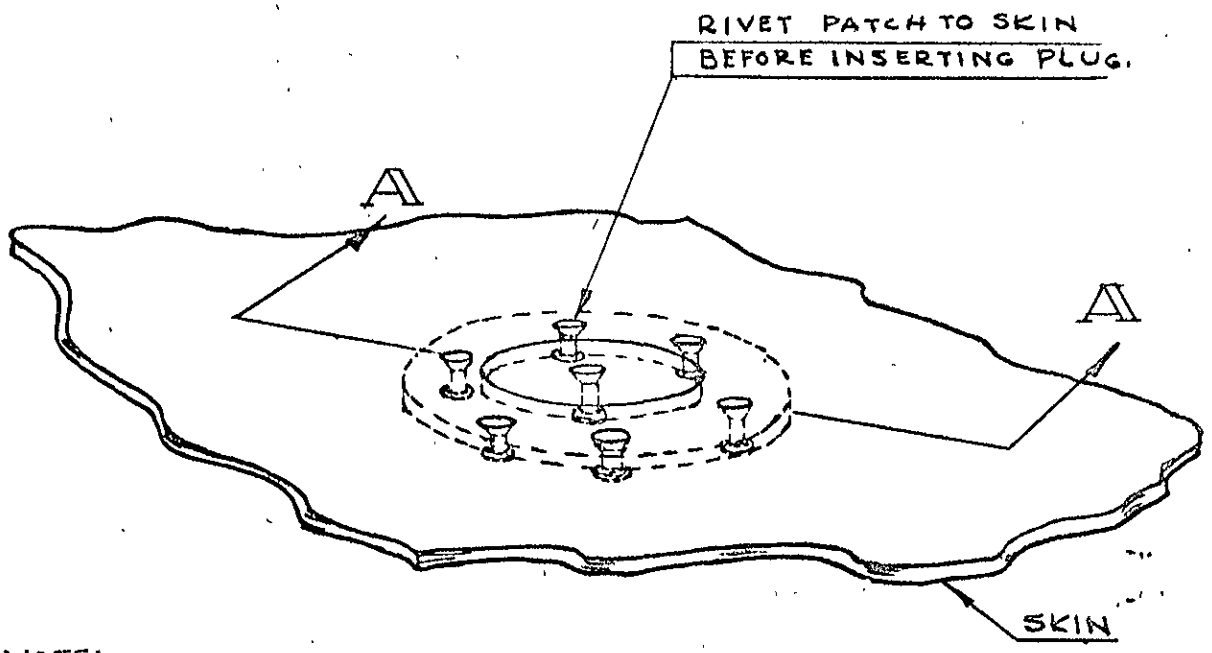
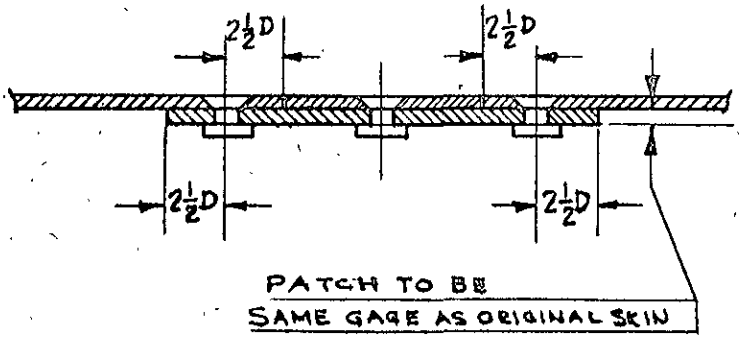


FIG. 2 ENGINE MOUNT DISASSEMBLY



NOTE:
RIVETS & PATTERN SAME AS IN NEAREST SKIN SPLICE.
FOR LARGE HOLES REFER TO FIG. 6



SECTION AA

FIGURE 5 FUSELAGE
SKIN - SMALL PATCH

NOTES:

ALL RIVETS TO BE 673-D-AD

RIVETS & RIVET PATTERN SAME AS IN NEAREST PARALLEL SKIN SPLICE OR OVERLAP.

ROUND OUT CORNERS OF CUTOUT TO ½" RAD.

RIVETS & RIVET PATTERN IN INSERT TO BE SAME AS IN SKIN & FRAME.

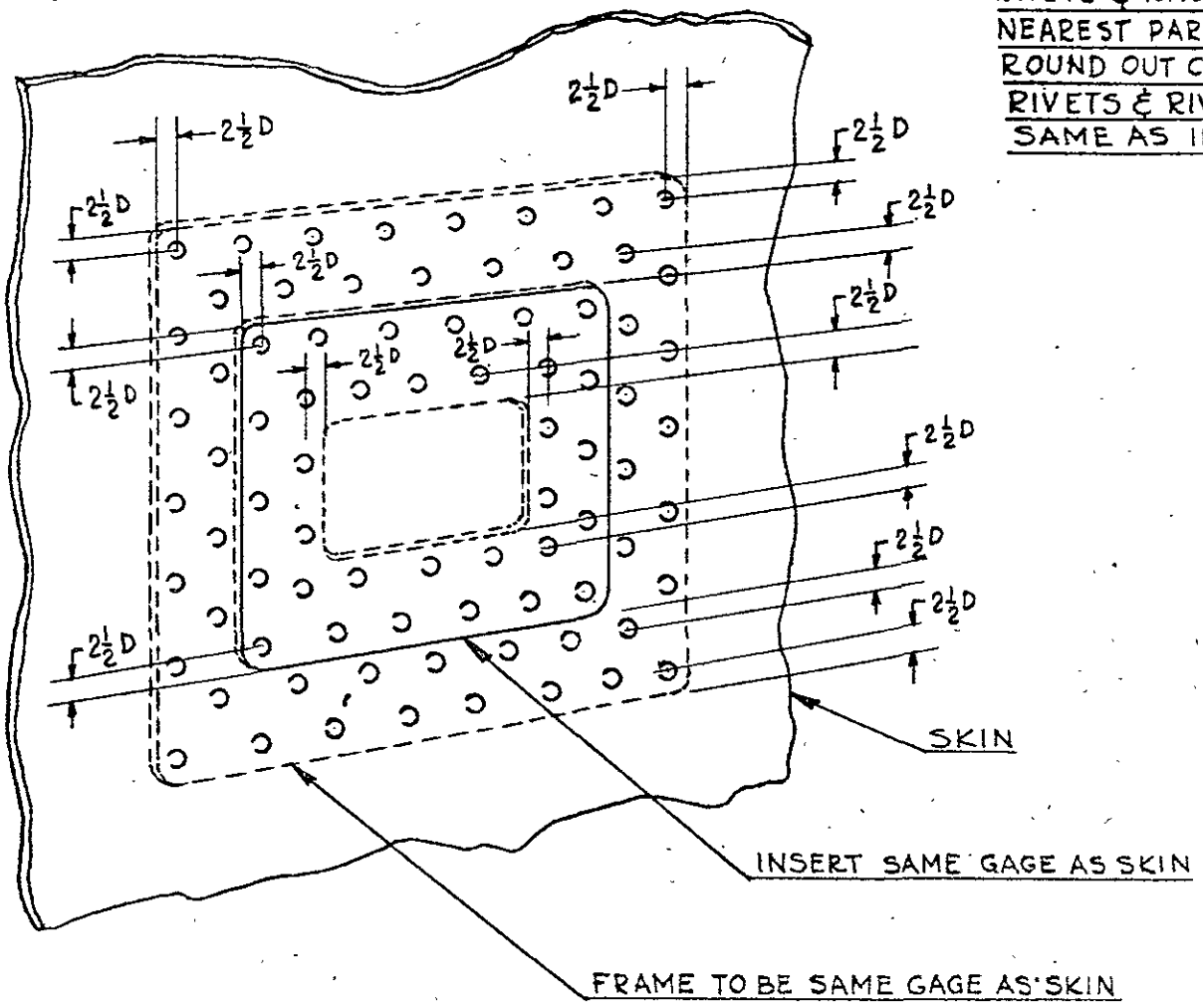
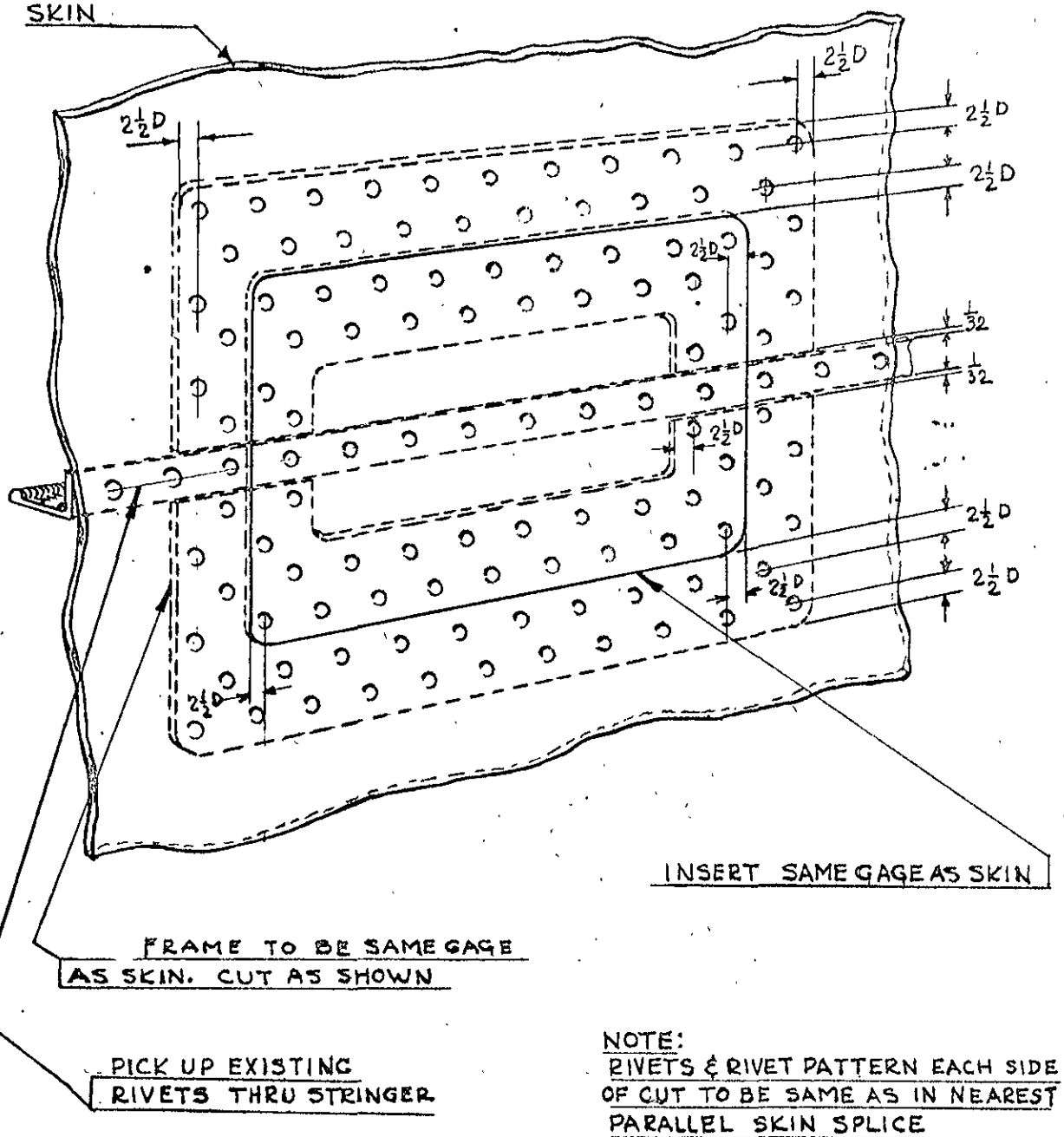


FIGURE 6 FUSELAGE SKIN INSERT



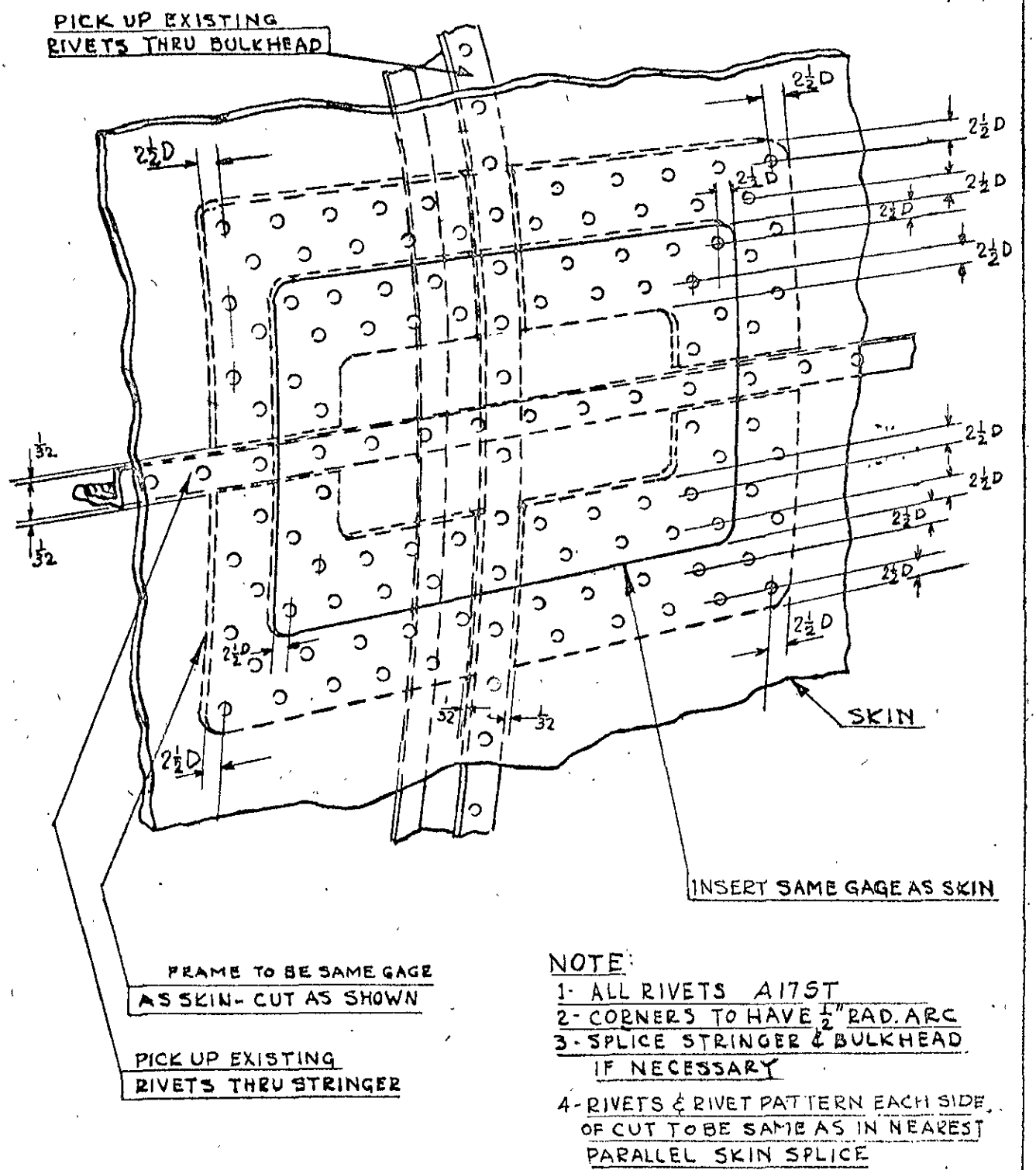
NOTE:

1- ALL RIVETS A17ST

2- CORNERS TO HAVE ½" RADIUS.

3- SPLICE STRINGER IF NECESSARY AS IN FIG. 9 OR 10

FIGURE 7 FUSELAGE - FLUSH SKIN PATCH AT STRINGER



NOTE:

1- ALL RIVETS A17ST
2- CORNERS TO HAVE ½" RAD. ARC
3- SPLICE STRINGER & BULKHEAD IF NECESSARY
4- RIVETS & RIVET PATTERN EACH SIDE OF CUT TO BE SAME AS IN NEAREST PARALLEL SKIN SPLICE

FIGURE 8 FUSELAGE- FLUSH SKIN PATCH AT BULKHEAD

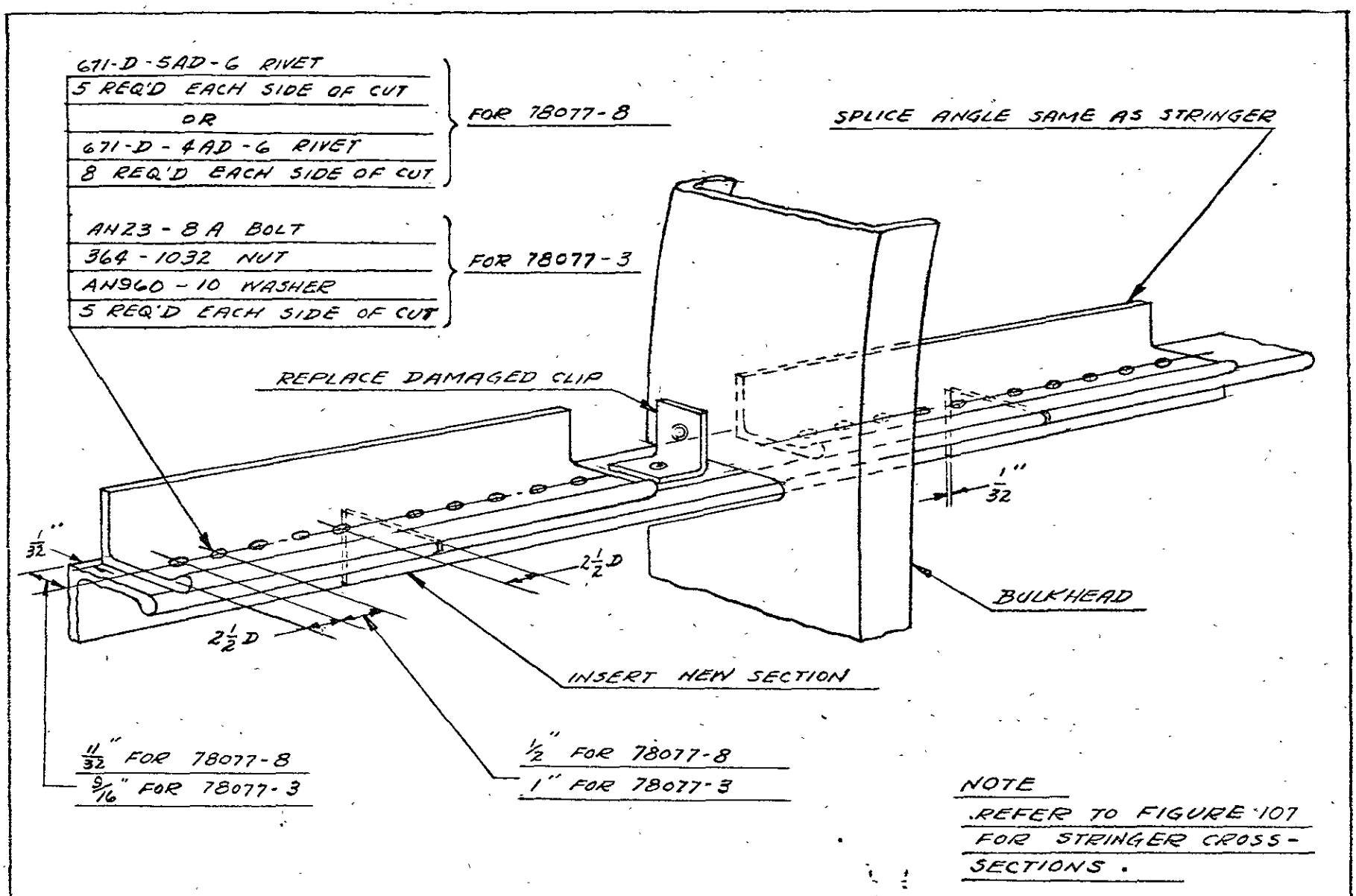


FIGURE 10 FUSELAGE-STRINGER INSERT AT BULKHEAD

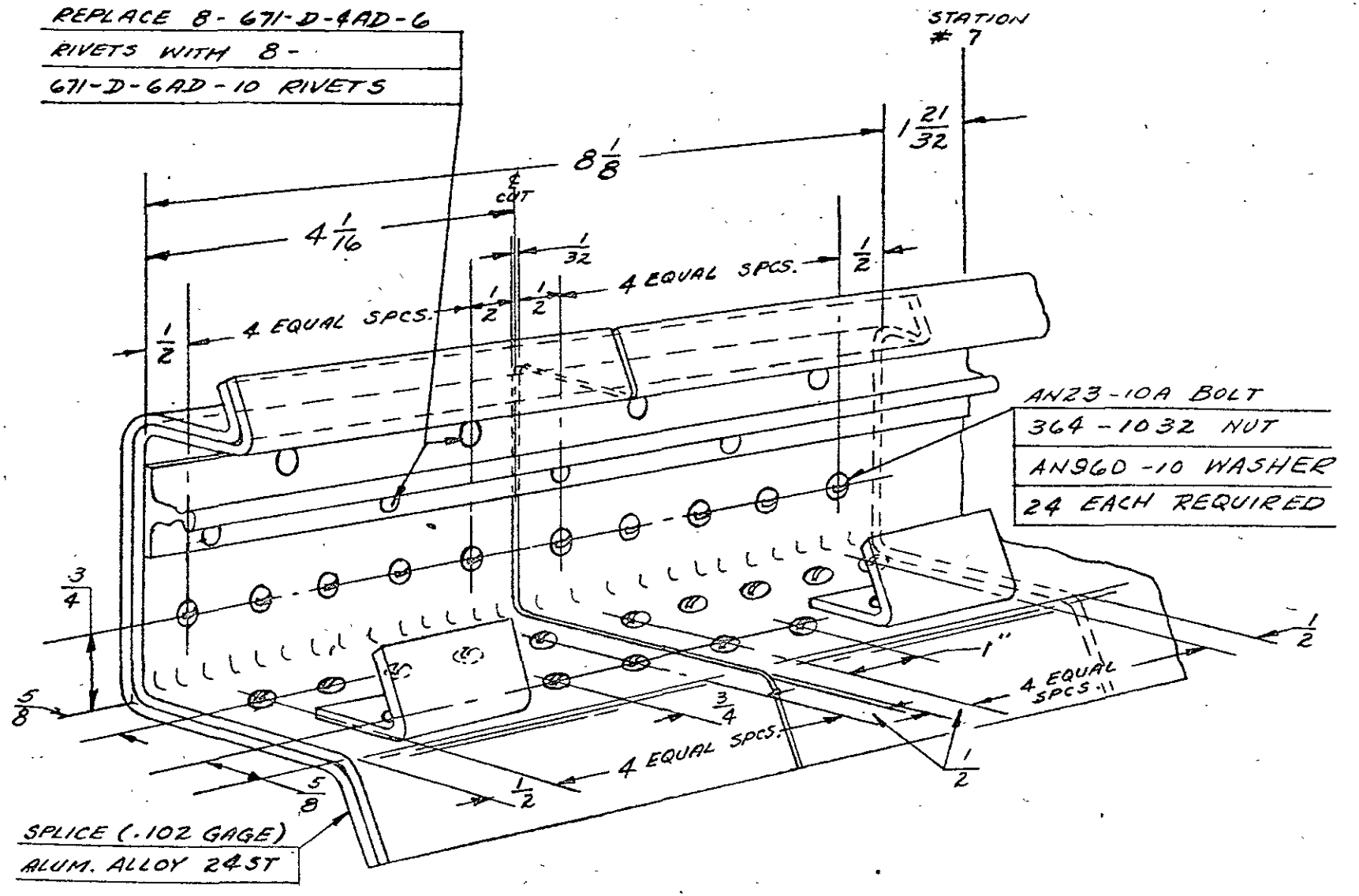


FIGURE 13 UPPER LONGERON SPLICE - STAS. 6 TO 7

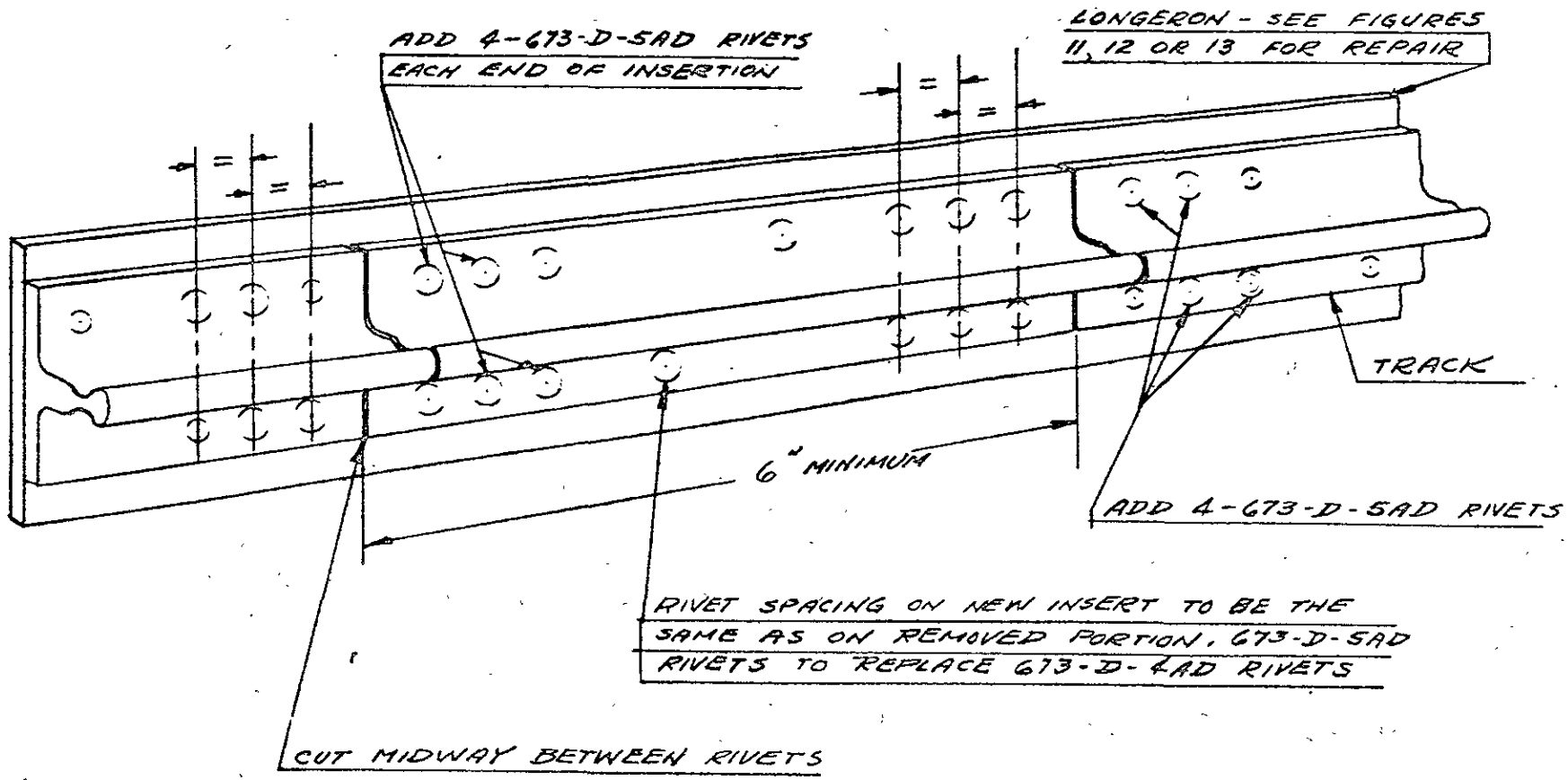


FIGURE 14 CABIN TRACK INSERT

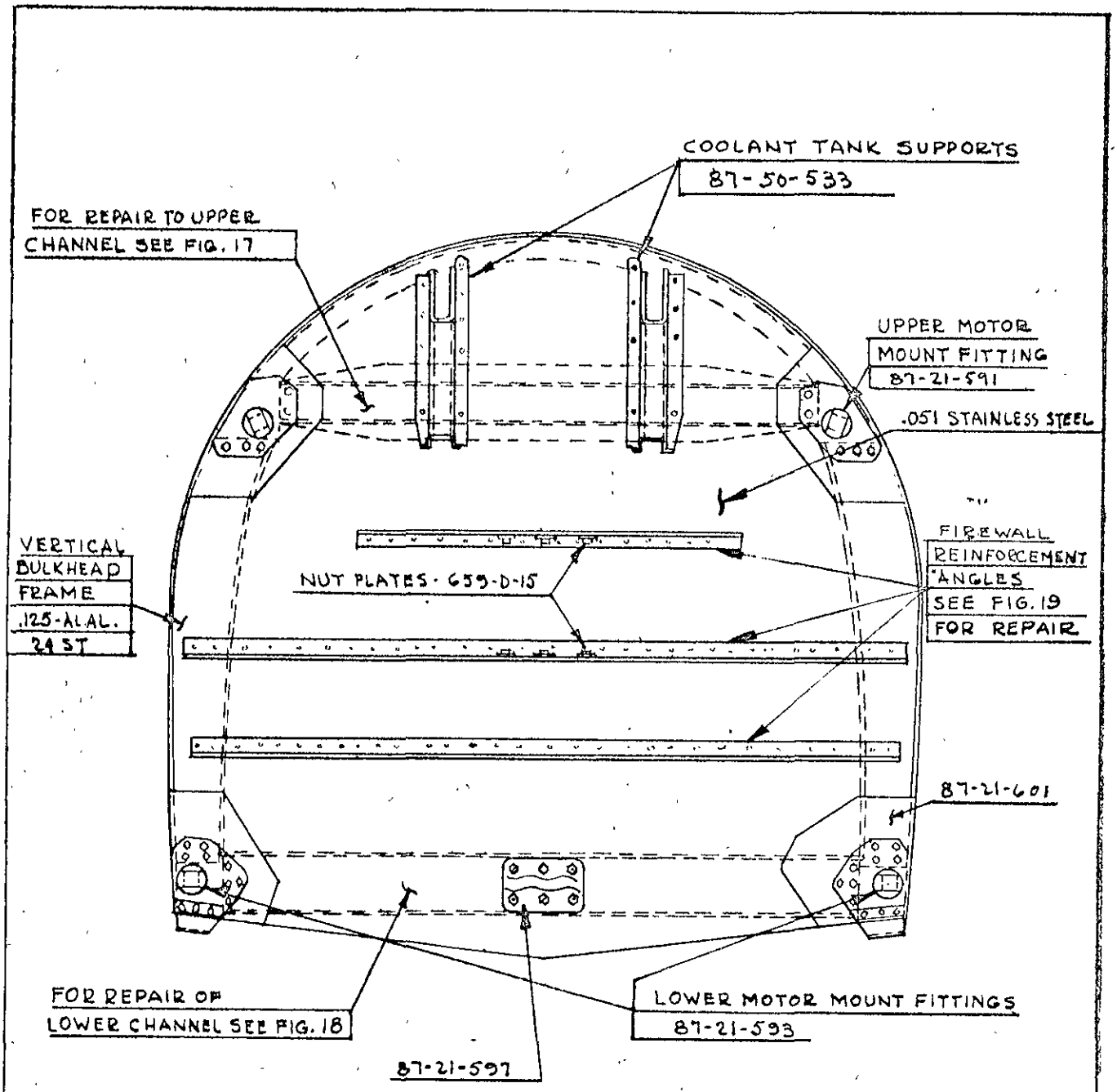


FIGURE 16 FUSELAGE - FIREWALL

11-7-41
FCD

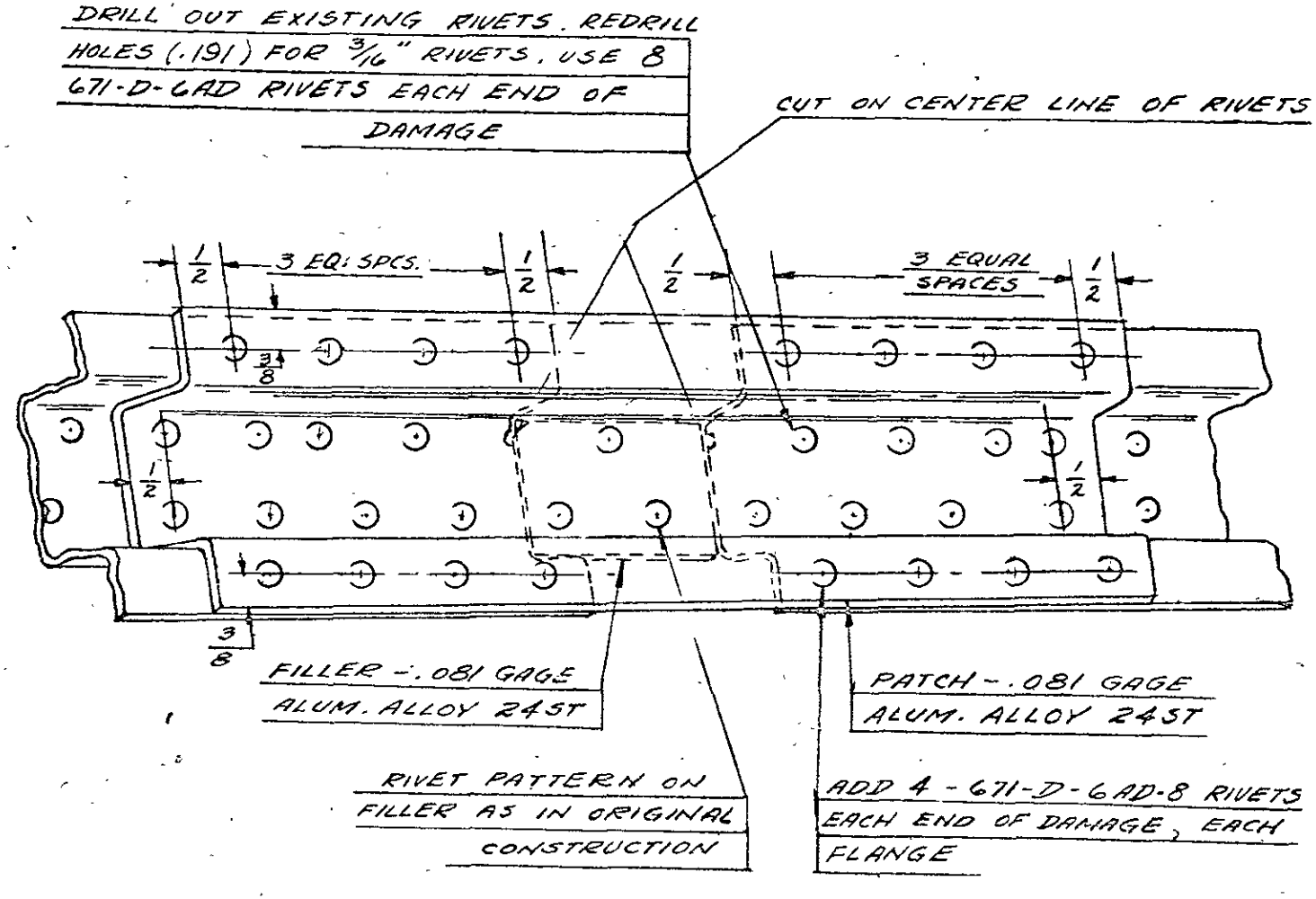
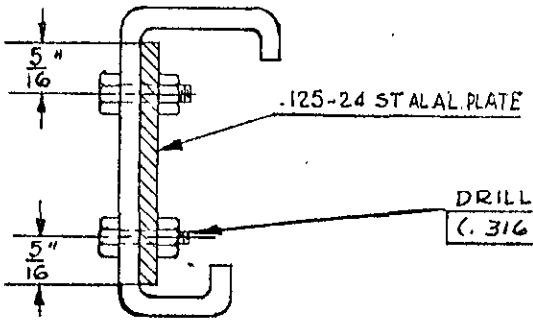


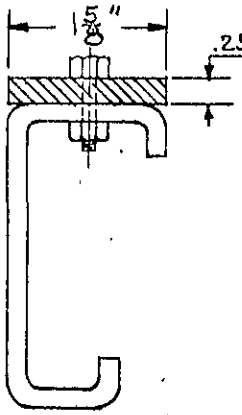
FIGURE 17 FIREWALL - UPPER CROSS CHANNEL - PATCH



ATTACH WITH 4-5/16 DIA. STEEL BOLTS ON EACH SIDE OF DAMAGE AT 1" MIN. SPACING.

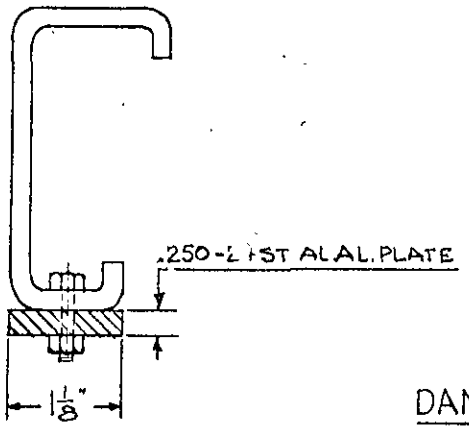
DRILL OUT EXISTING RIVETS. REDRILL (.316") FOR 5/16" BOLTS.

DAMAGE - BACK OF CHANNEL



ATTACH PLATE WITH 3-3/8 DIA STEEL BOLTS ON EACH SIDE OF DAMAGE AT 1" MIN. SPACING

DAMAGE - UPPER LEG OF CHANNEL



ATTACH PLATE WITH 3-5/16 DIA. STEEL BOLTS ON EACH SIDE OF DAMAGE AT 1" MIN. SPACING

DAMAGE - LOWER LEG OF CHANNEL

FIGURE 18 MINOR REPAIRS - LOWER CHANNEL - FIREWALL

11-11-41 PCP

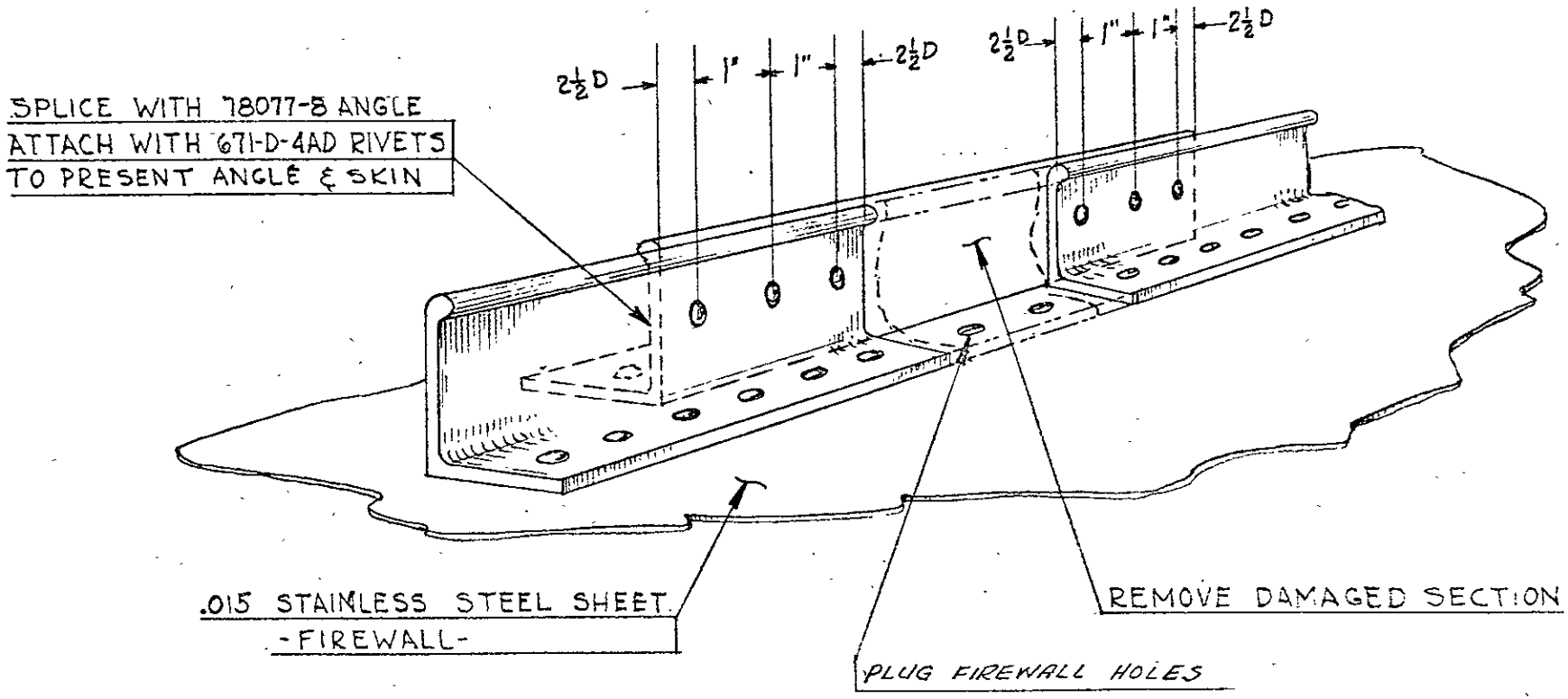
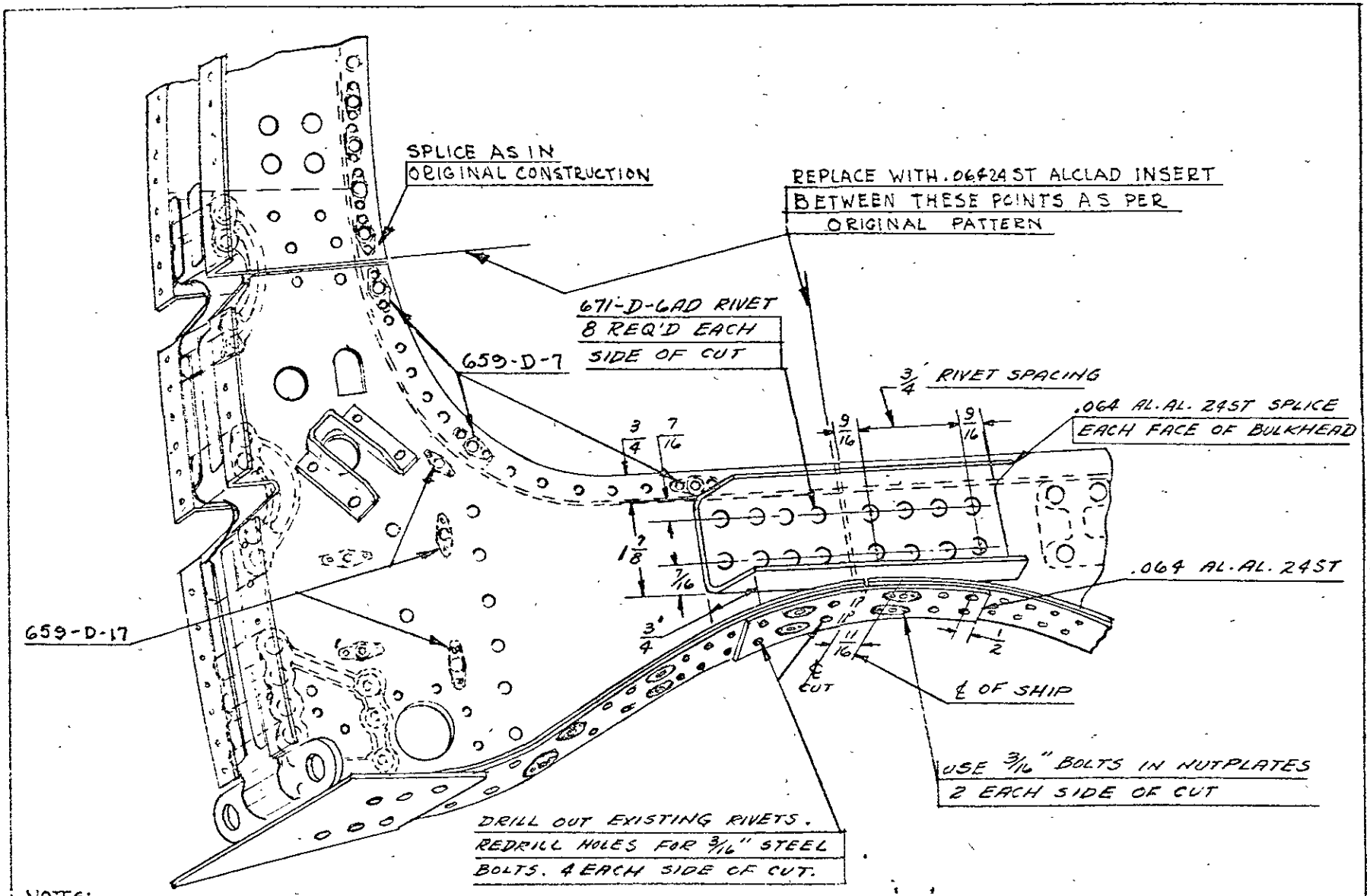


FIGURE 19 FIREWALL-REINFORCEMENT PATCH



NOTES:
REPLACE ALL FITTINGS AS PER ORIGINAL CONSTRUCTION.
LOCATE ALL HOLES AS PER ORIGINAL PATTERN.

FIGURE 20 BULKHEAD NO. 5 - LOWER - SPLICES

11-1-41

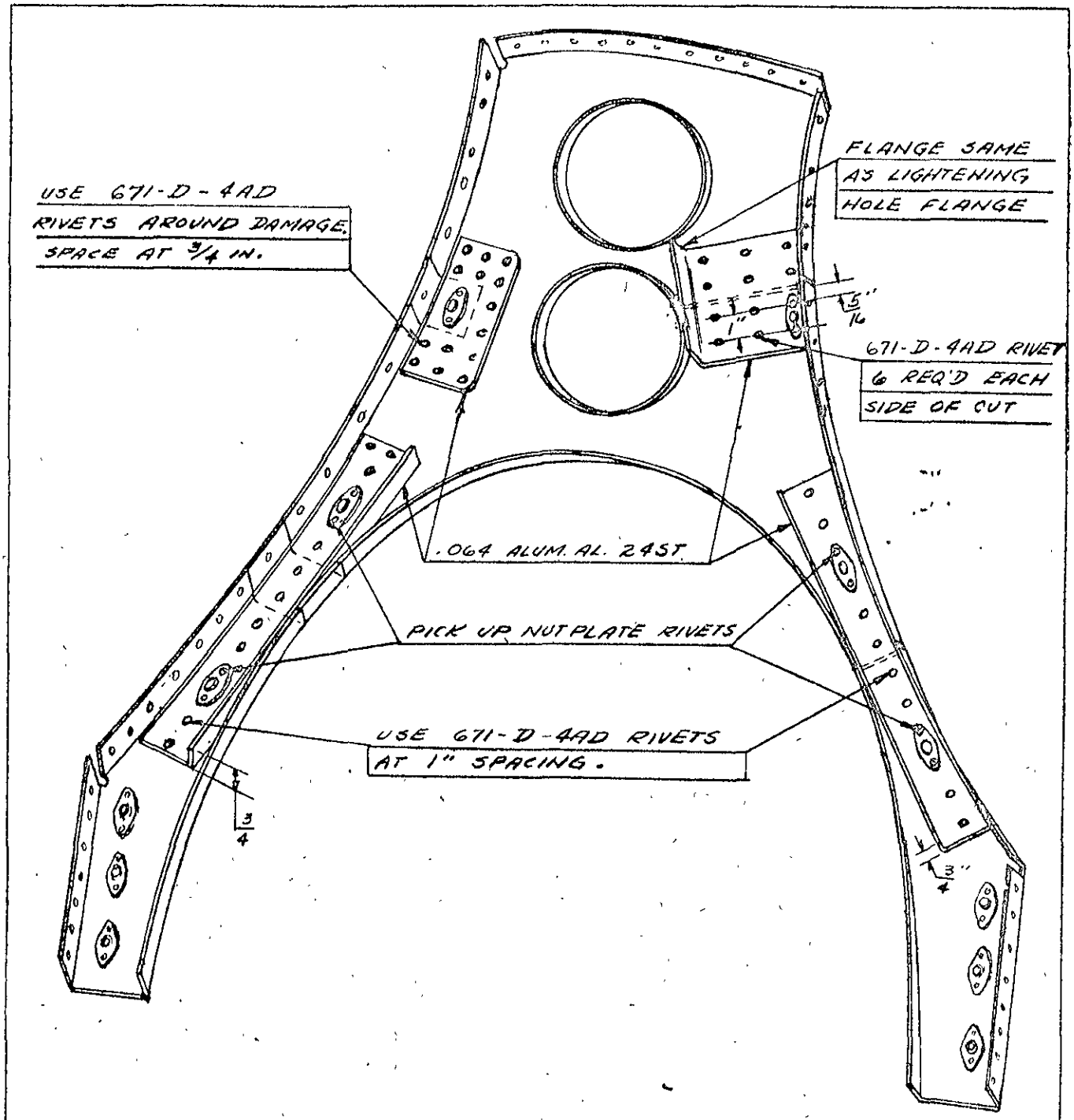


FIGURE 21 BULKHEAD NO. 5
UPPER - SPLICES & PATCHES

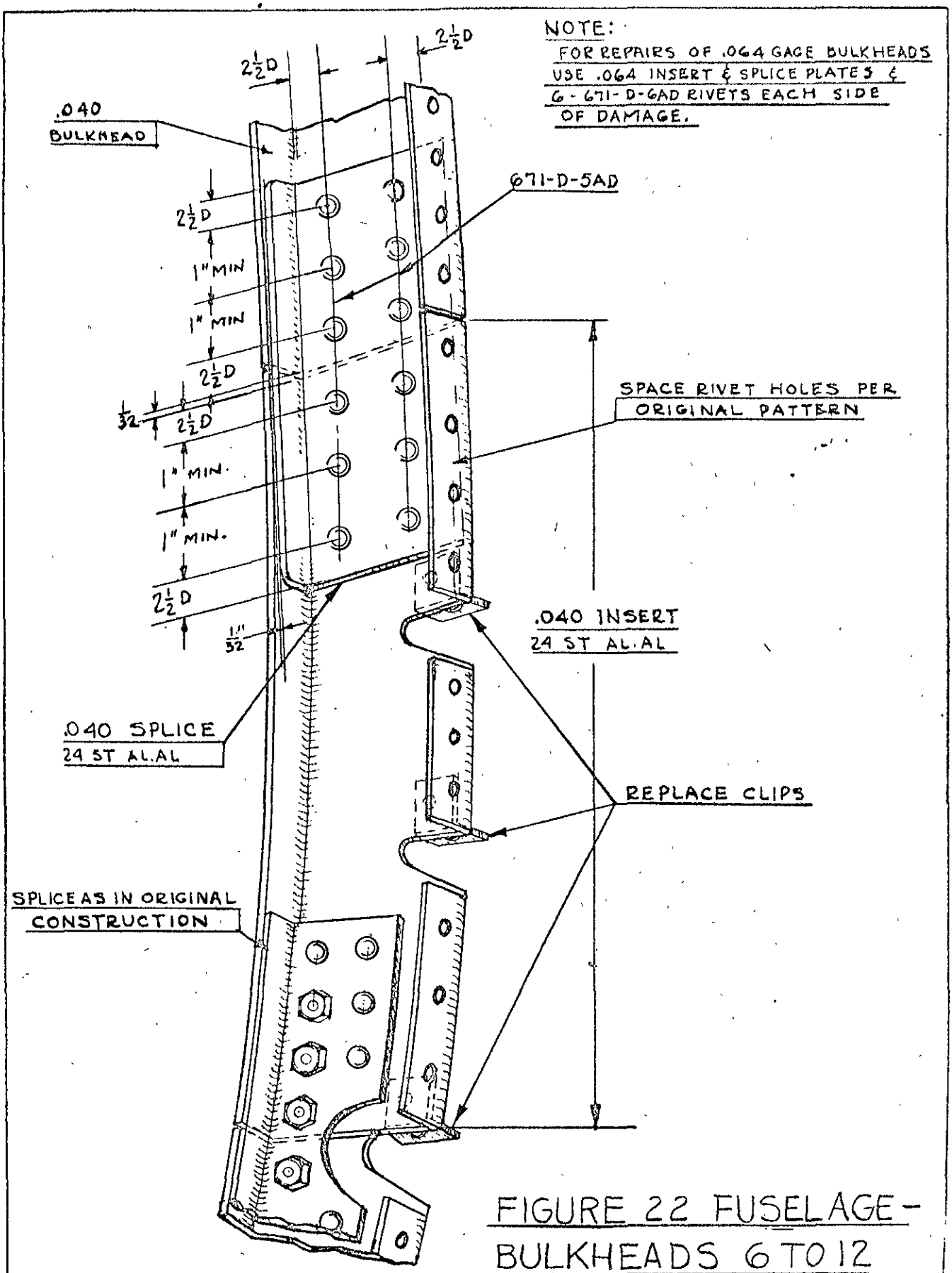
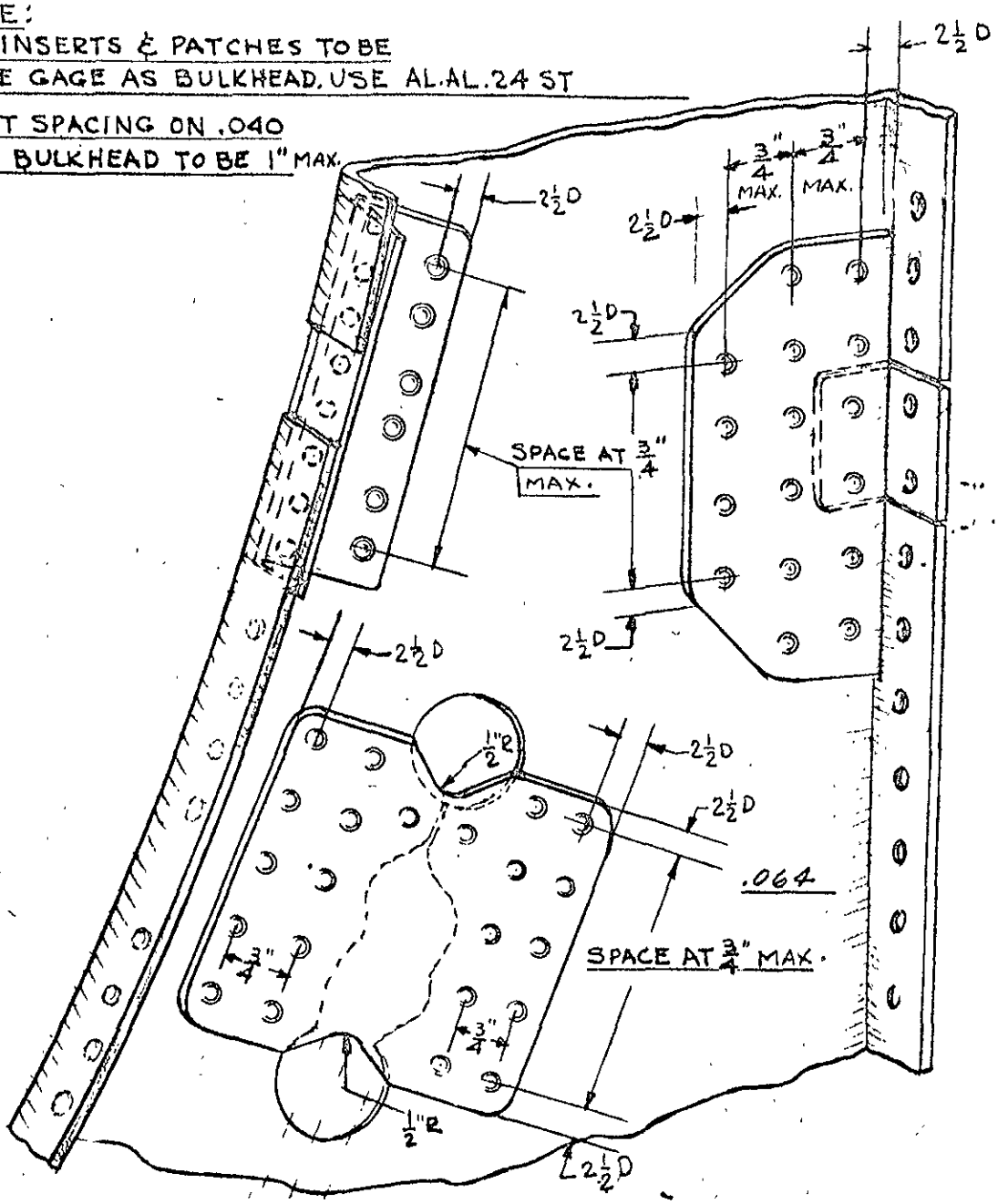


FIGURE 22 FUSELAGE - BULKHEADS 6 TO 12

NOTE:
ALL INSERTS & PATCHES TO BE
SAME GAGE AS BULKHEAD. USE AL.AL.24 ST

RIVET SPACING ON .040
GAGE BULKHEAD TO BE 1" MAX.



NOTE
ALL RIVETS 5/32" DIA. A-17ST.

FIGURE 23 FUSELAGE- BULKHEADS 6 TO 12

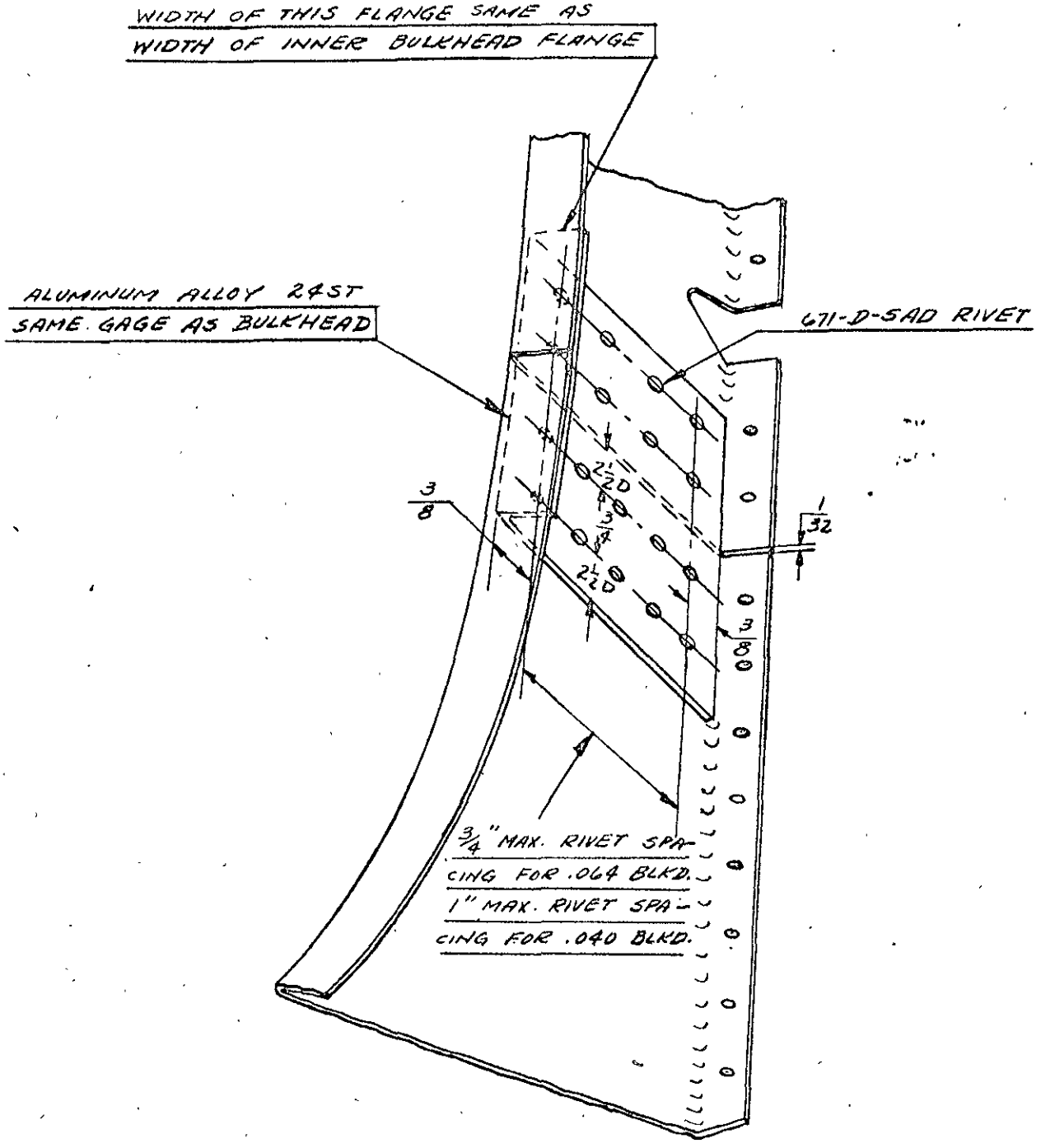
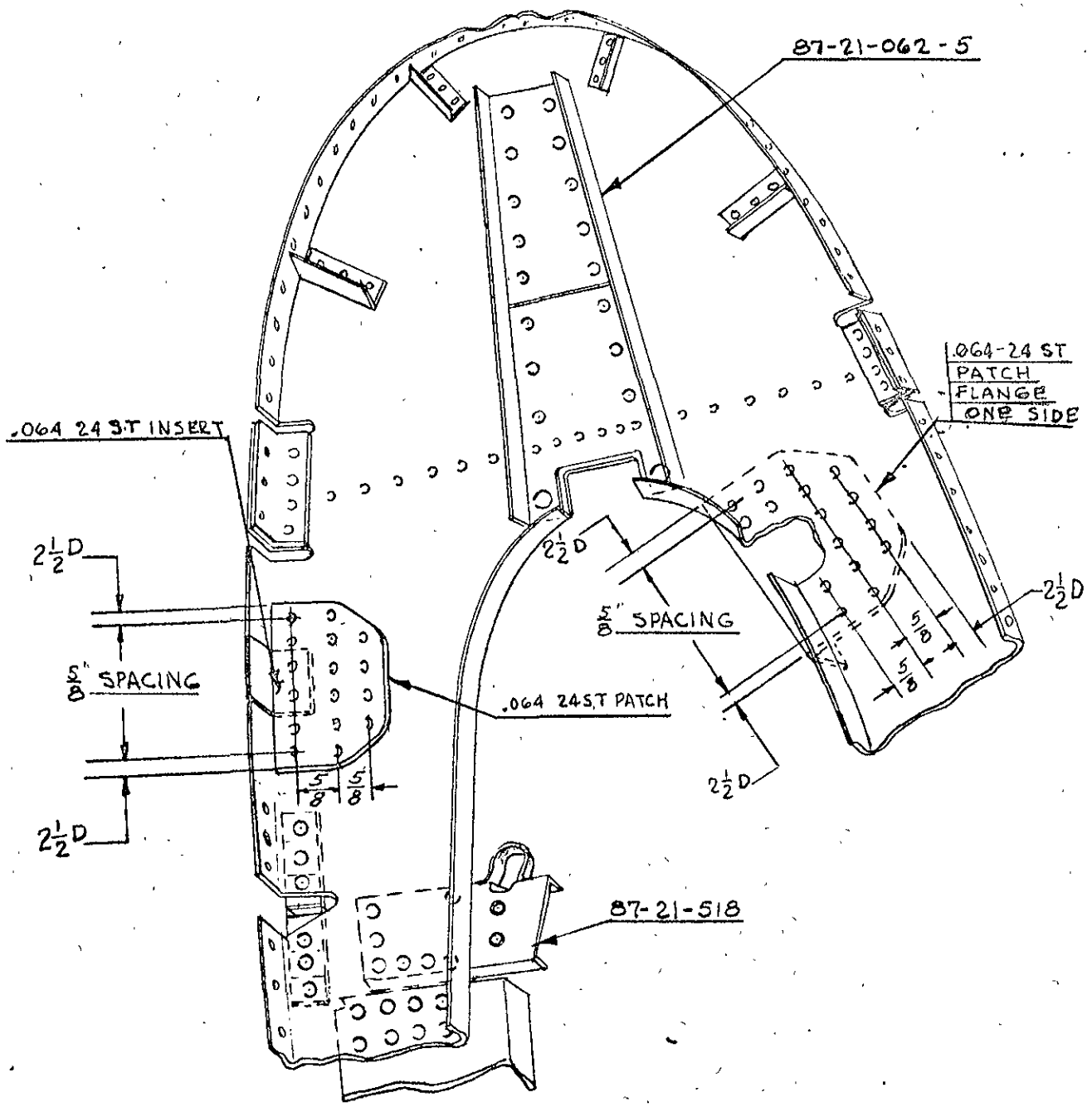


FIGURE 24 FUSELAGE - BULKHEADS 6-12



NOTES

REPLACE ALL DAMAGED FITTINGS.

USE 671-D-4AD RIVETS.

FIGURE 25 FUSELAGE - BULKHEAD NO.13

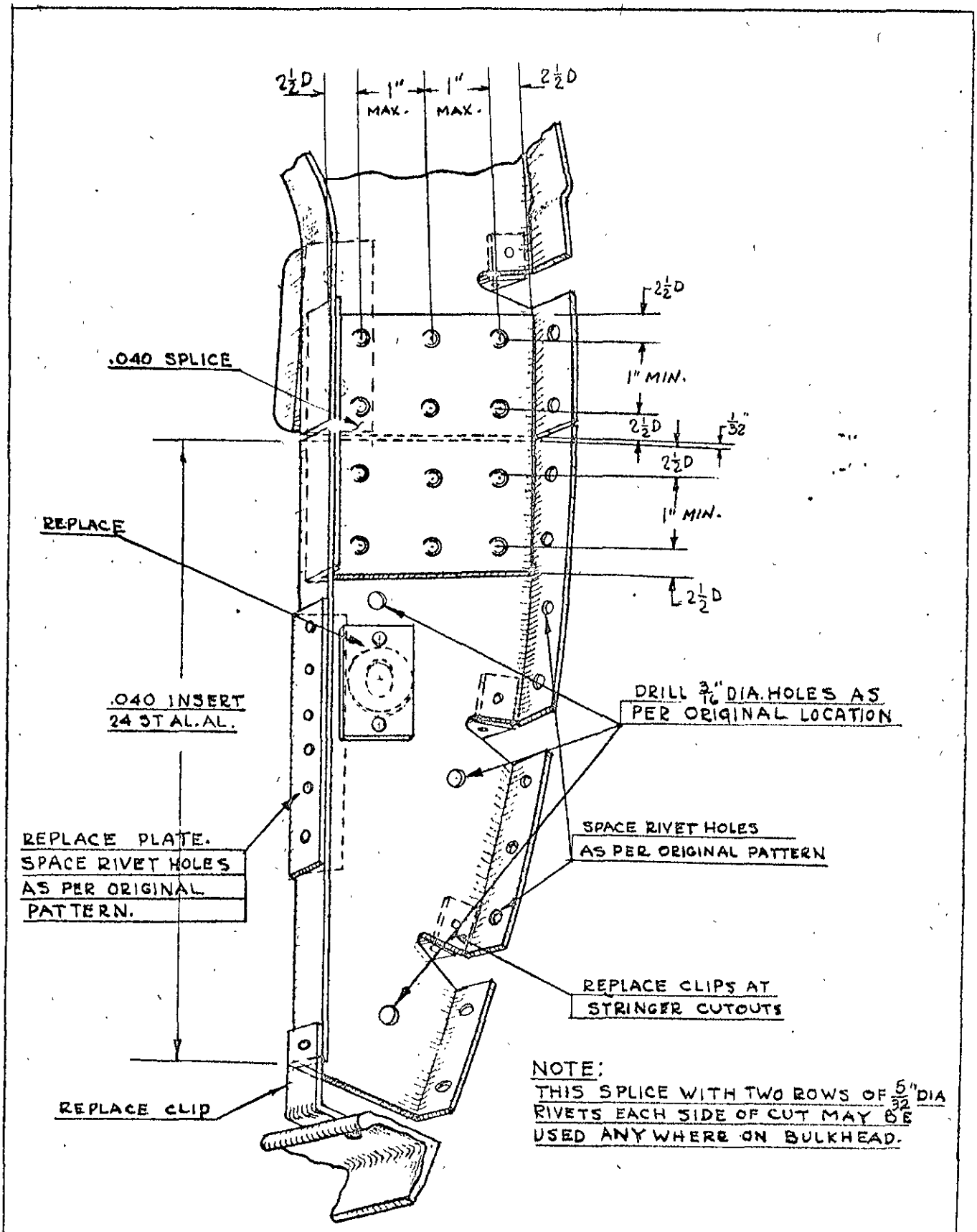


FIGURE 26 FUSELAGE BULKHEAD Nº 14

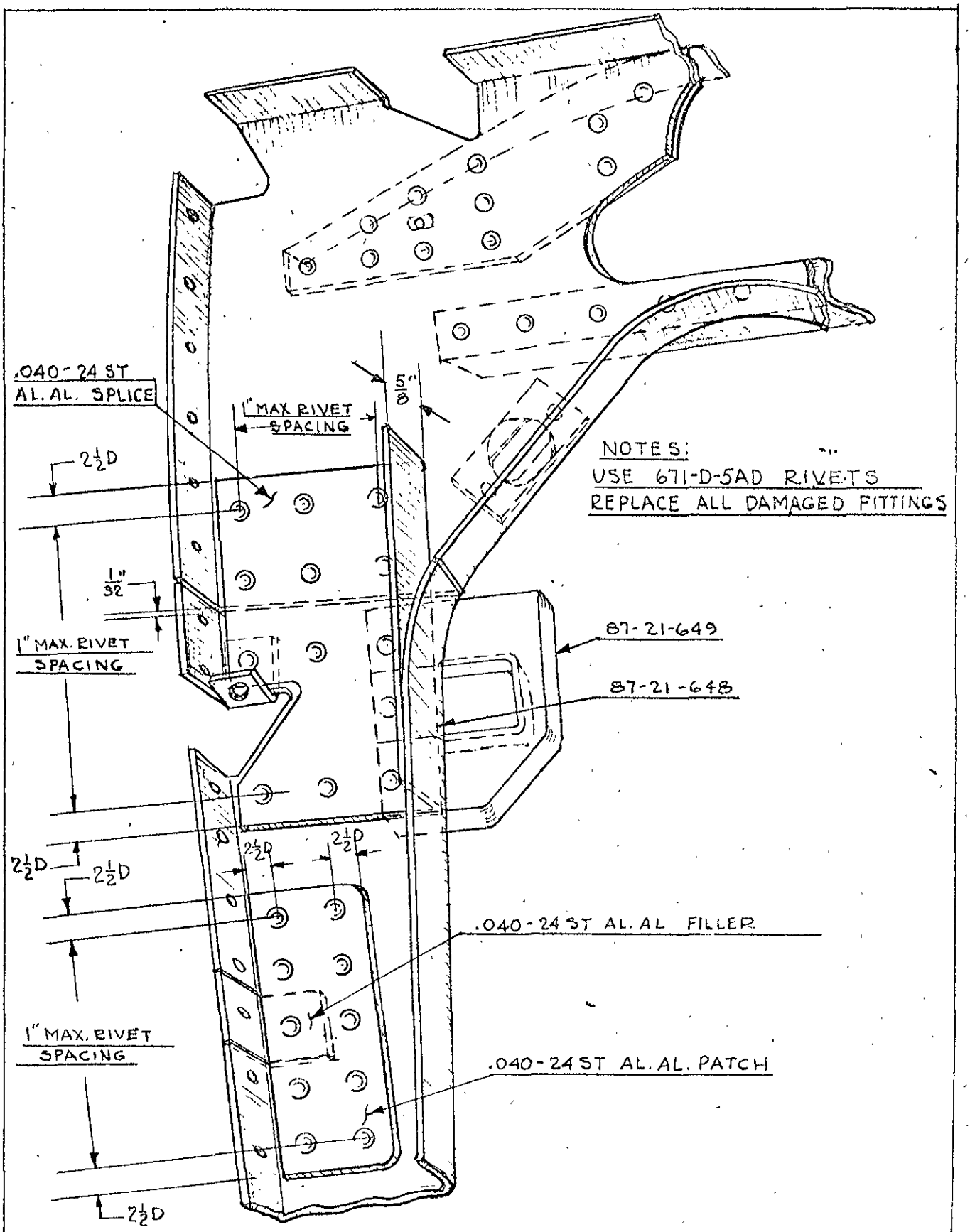
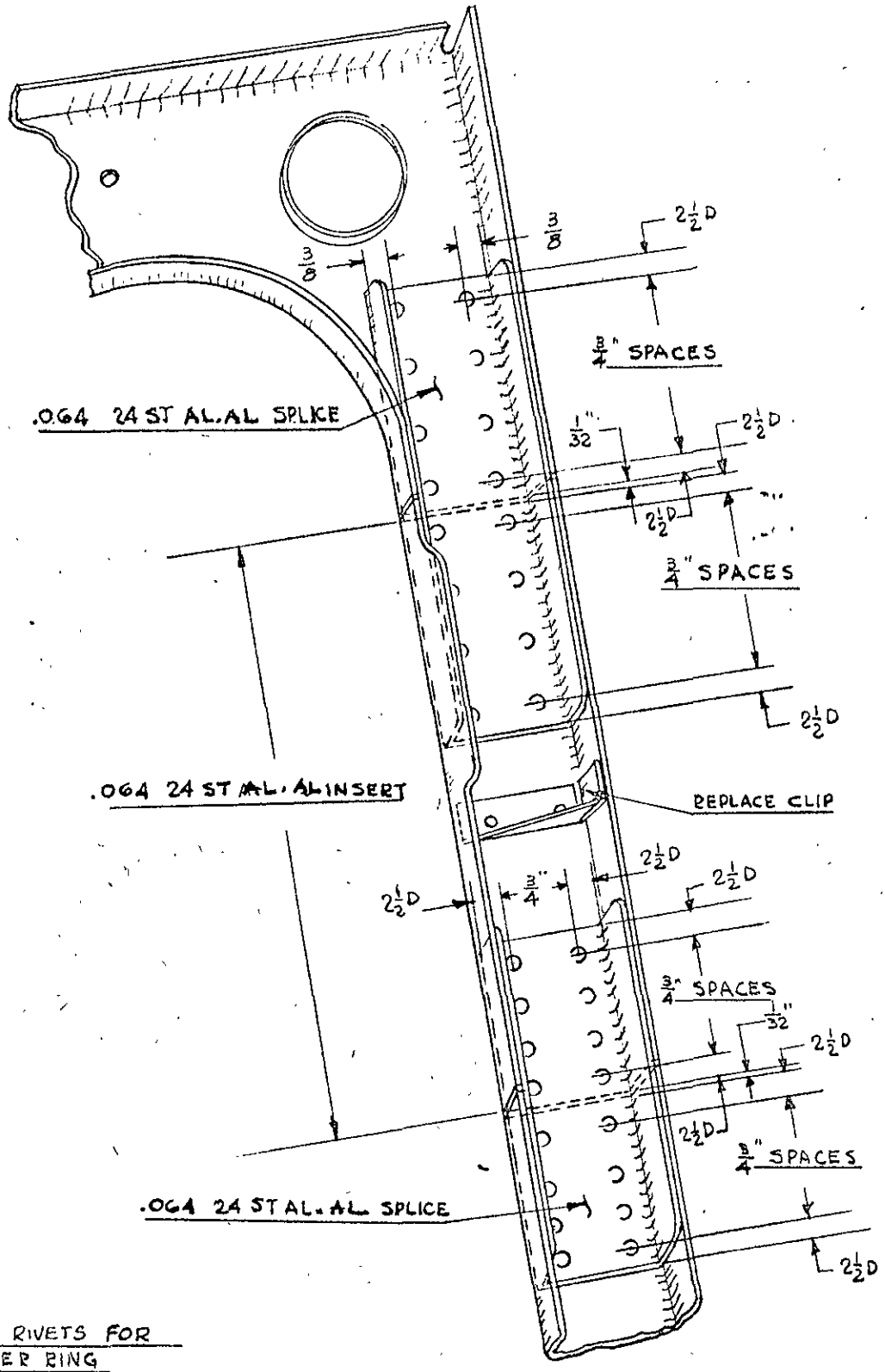


FIGURE 27 FUSELAGE-BULKHEAD NO. 14

11-15-41 Rep



NOTES

USE 671-D-6AD RIVETS FOR SPLICES IN LOWER RING

USE 671-D-5AD RIVETS FOR SPLICES IN UPPER RING.

FIGURE 29 FUSELAGE BULKHEAD NO. 16

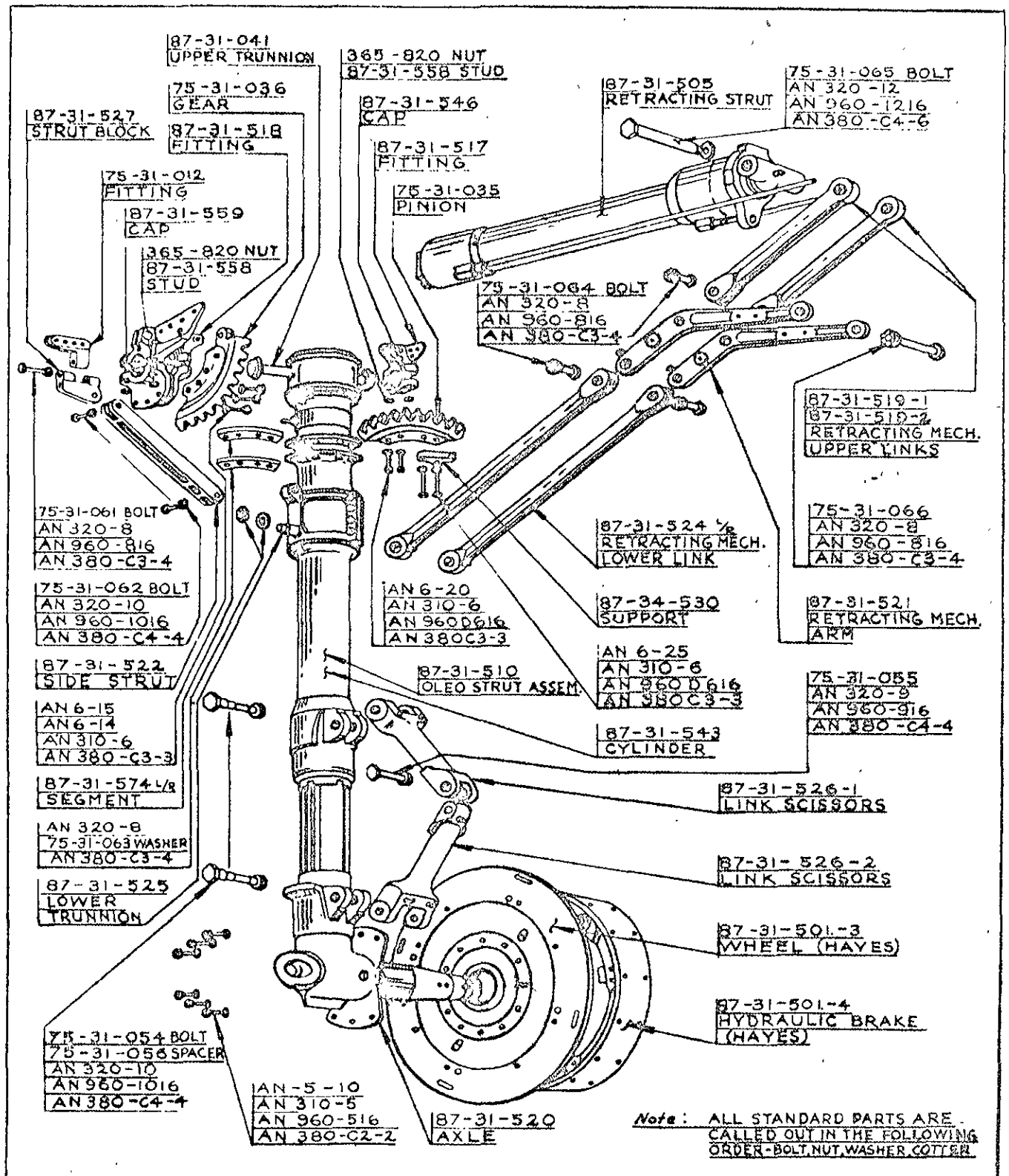
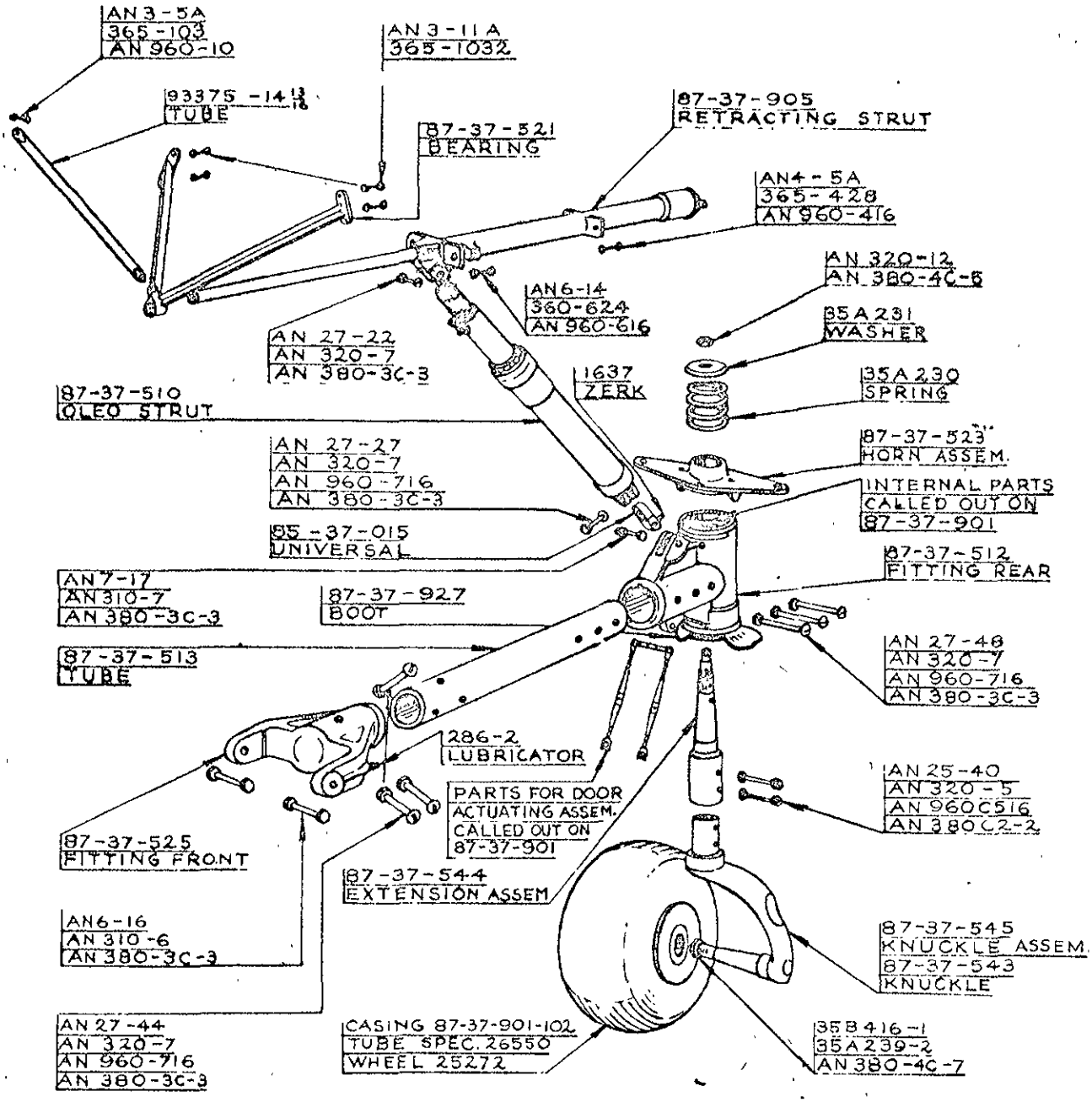


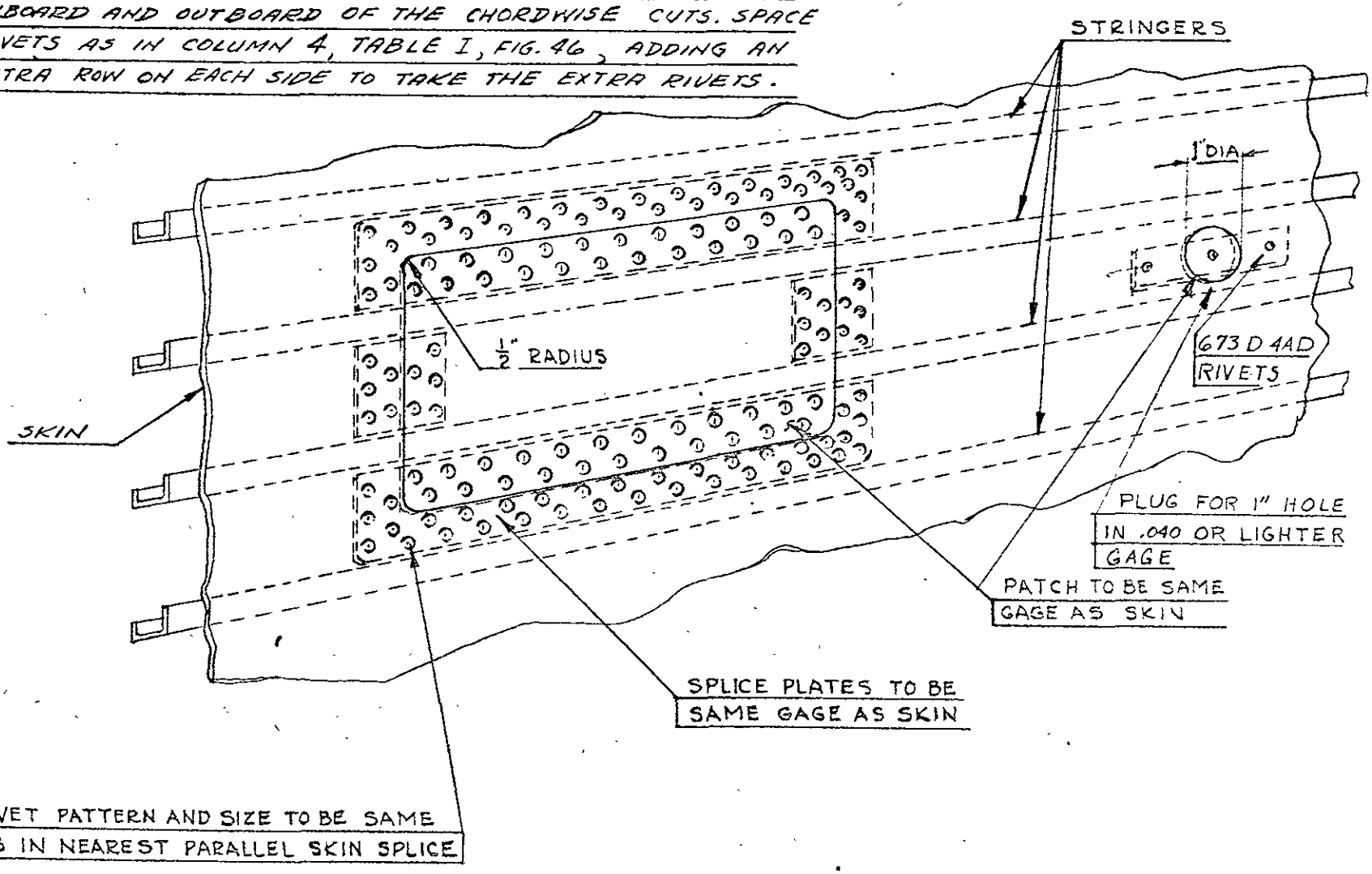
FIGURE 41 LANDING GEAR DISASSEMBLY



Note: ALL STANDARD PARTS ARE CALLED OUT IN THE FOLLOWING ORDER- BOLT, NUT, WASHER, COTTER

FIGURE 42 TAIL WHEEL DISASSEMBLY

SEE COLUMN 5 TABLE I, FIG. 46 FOR RIVETS REQUIRED INBOARD AND OUTBOARD OF THE CHORDWISE CUTS. SPACE RIVETS AS IN COLUMN 4, TABLE I, FIG. 46, ADDING AN EXTRA ROW ON EACH SIDE TO TAKE THE EXTRA RIVETS.



NOTE:
ROUND ALL CORNERS WITH ½" RADIUS ARC.

FIGURE 47 WING - FLUSH SKIN PATCH

11-A-41

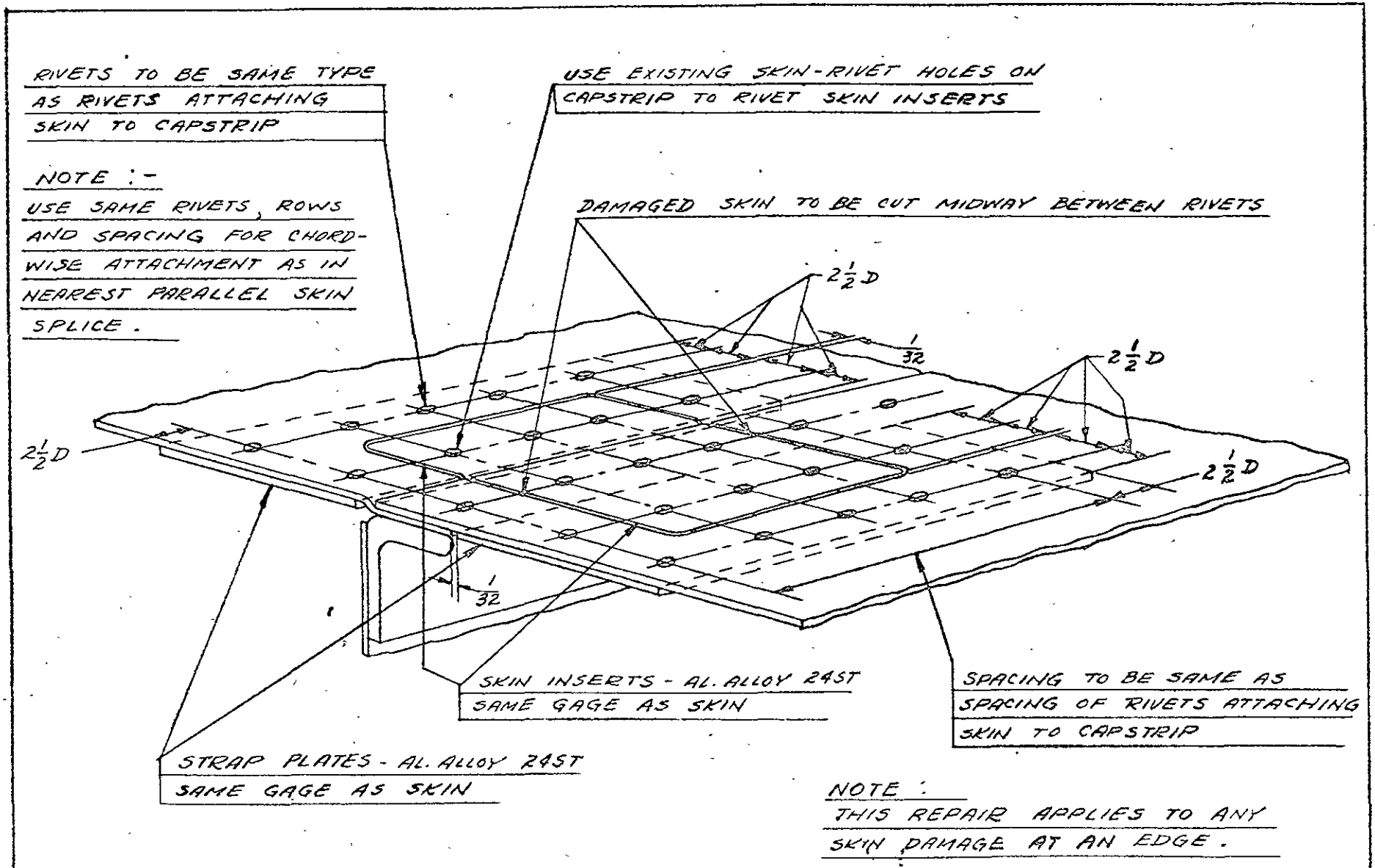


FIGURE 48 FLUSH SKIN PATCH AT OVERLAP

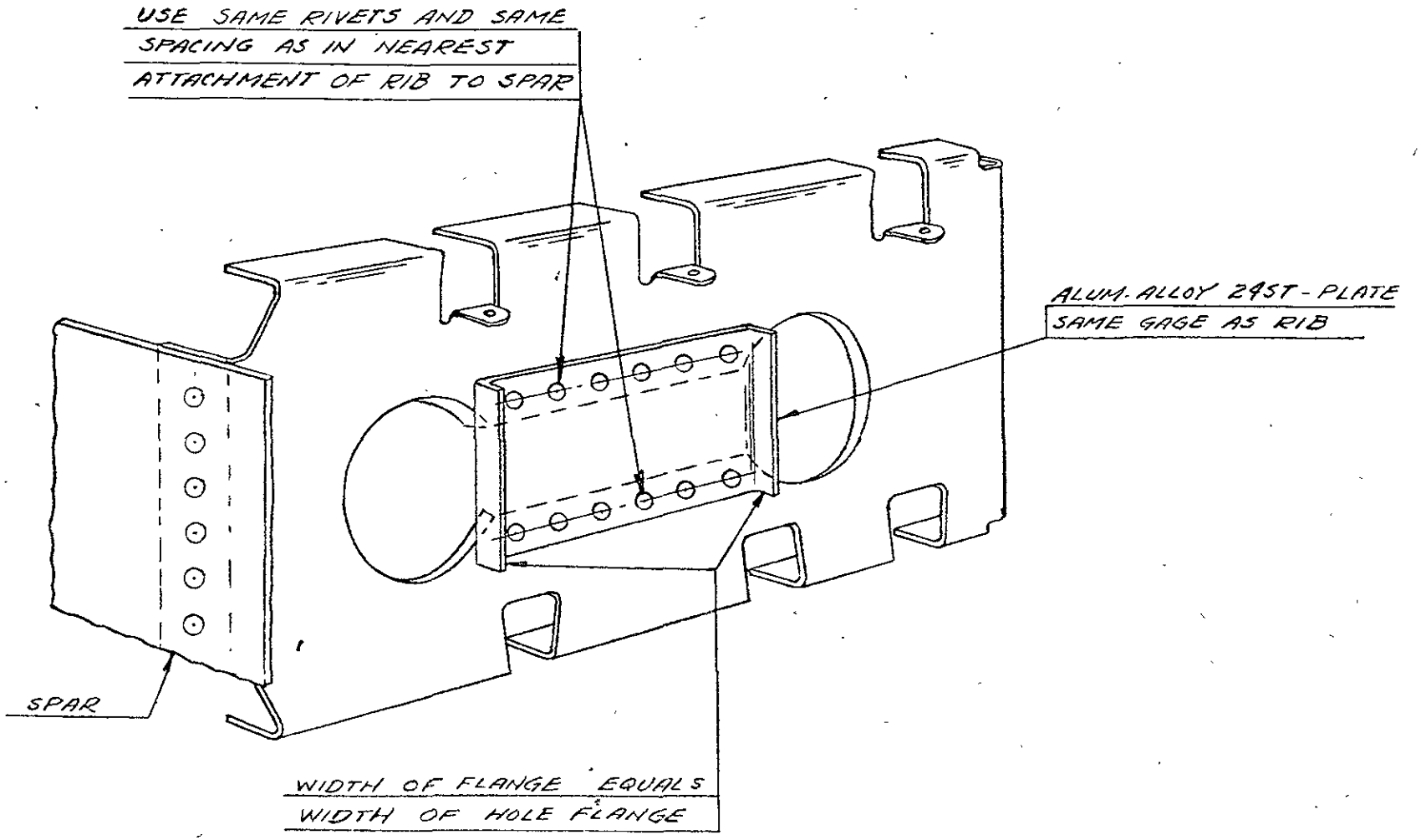


FIGURE 49 WING-RIB PATCH

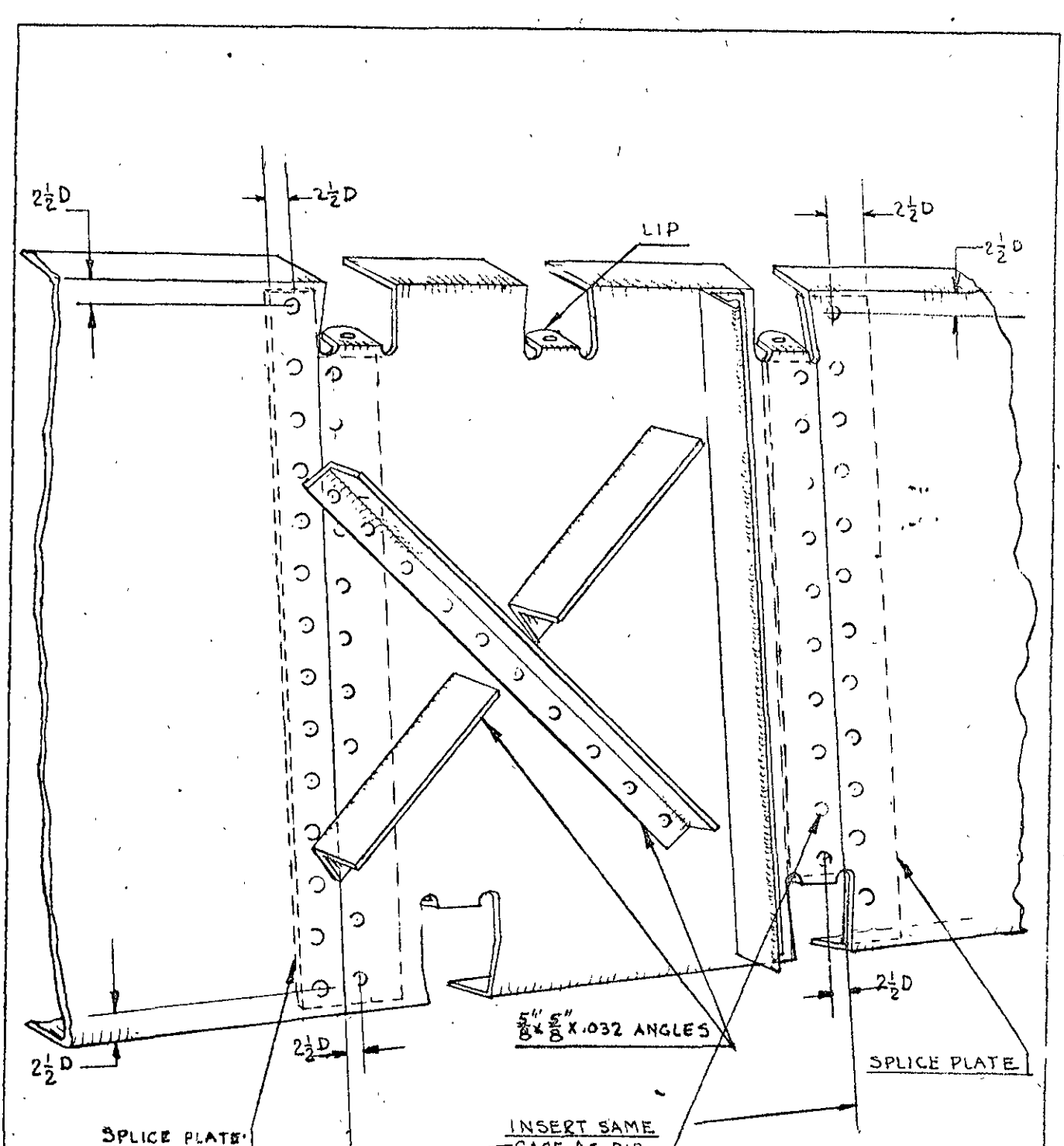
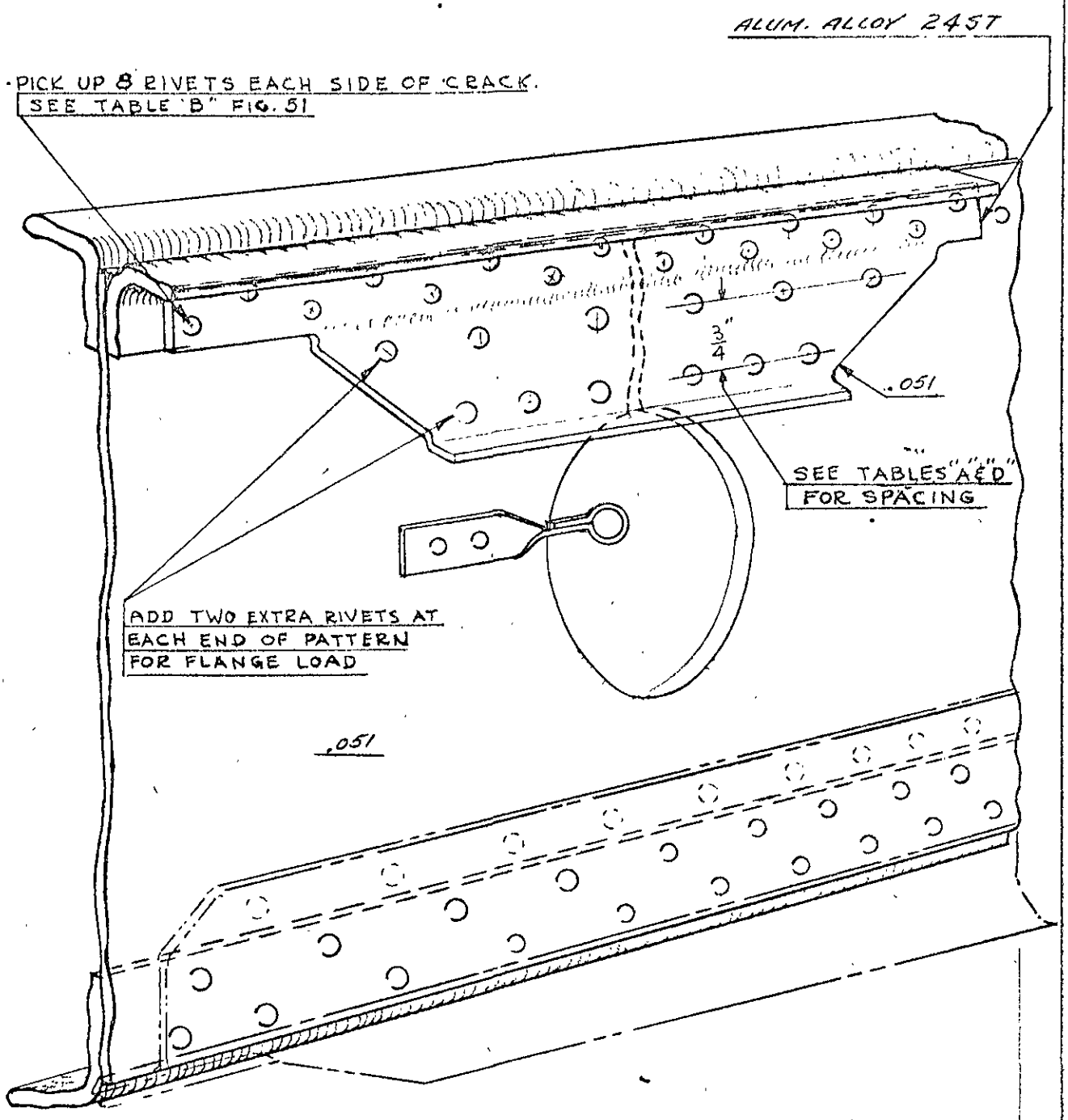
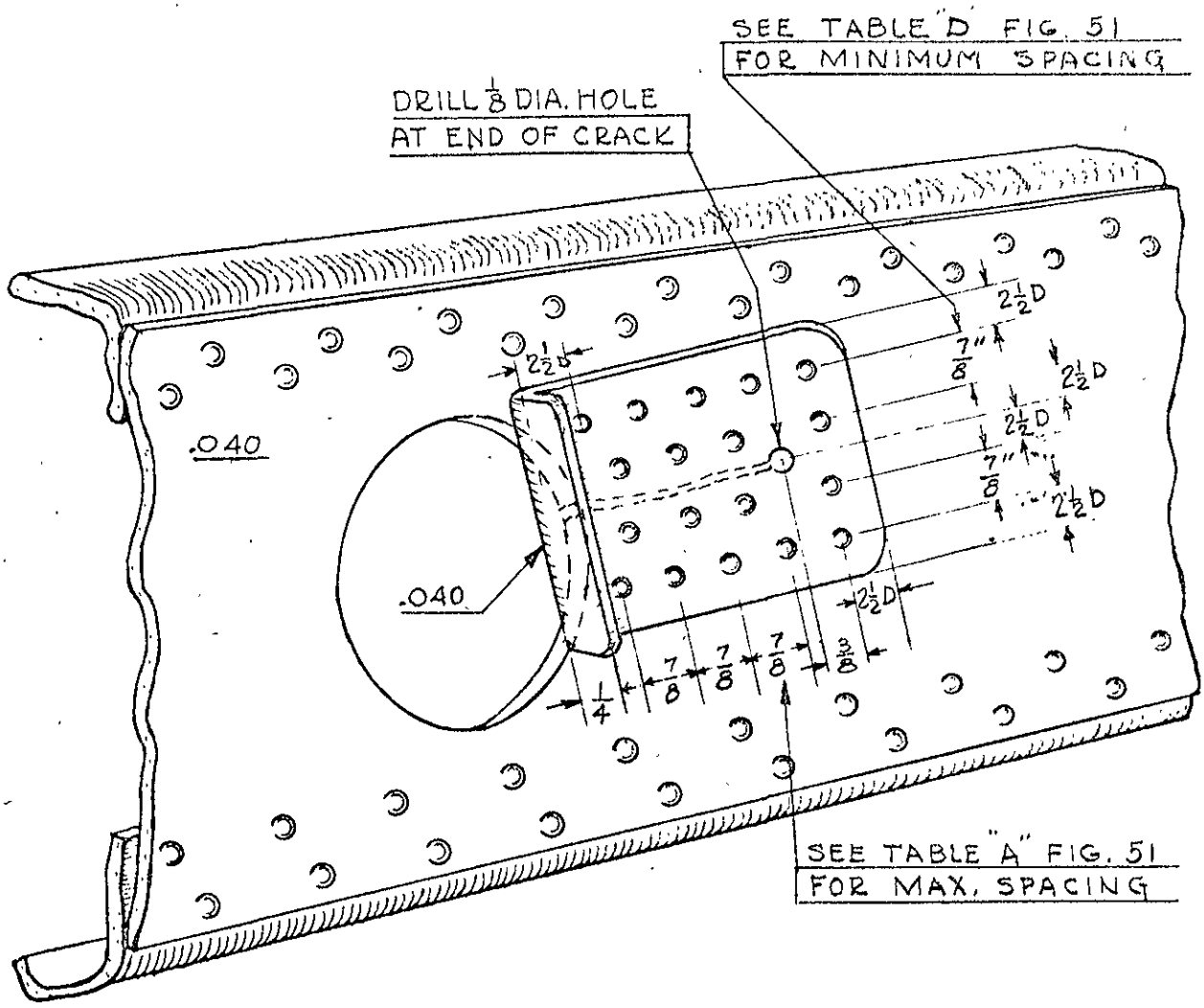


FIGURE 50 WING - RIB INSERTION



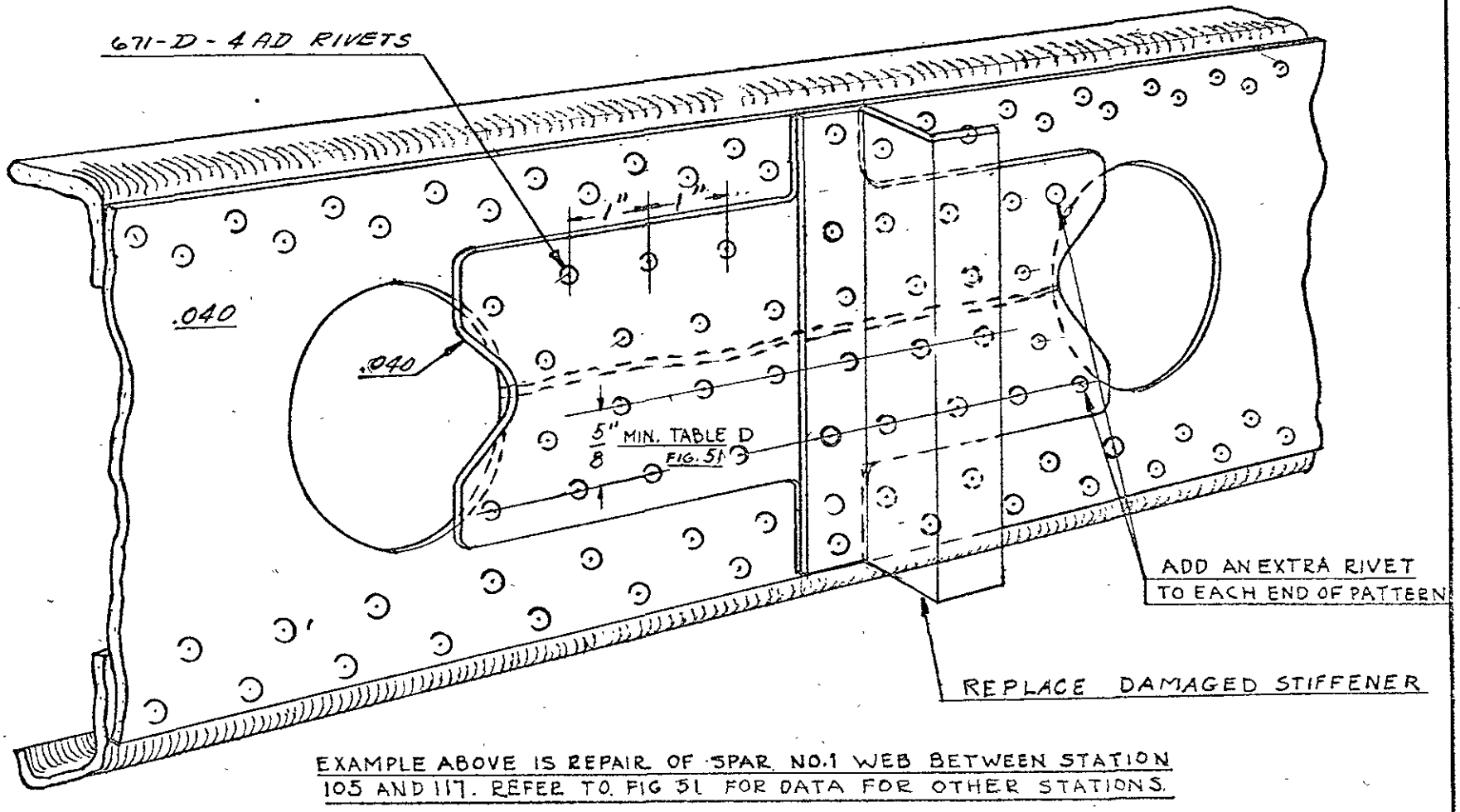
EXAMPLE ABOVE IS THE REPAIR OF SPAR NO 1 AT STATION 32
FOR OTHER STATIONS USE DATA IN FIG. 51

FIGURE 53 WING - SPAR PATCH NEAR CAP-STRIP



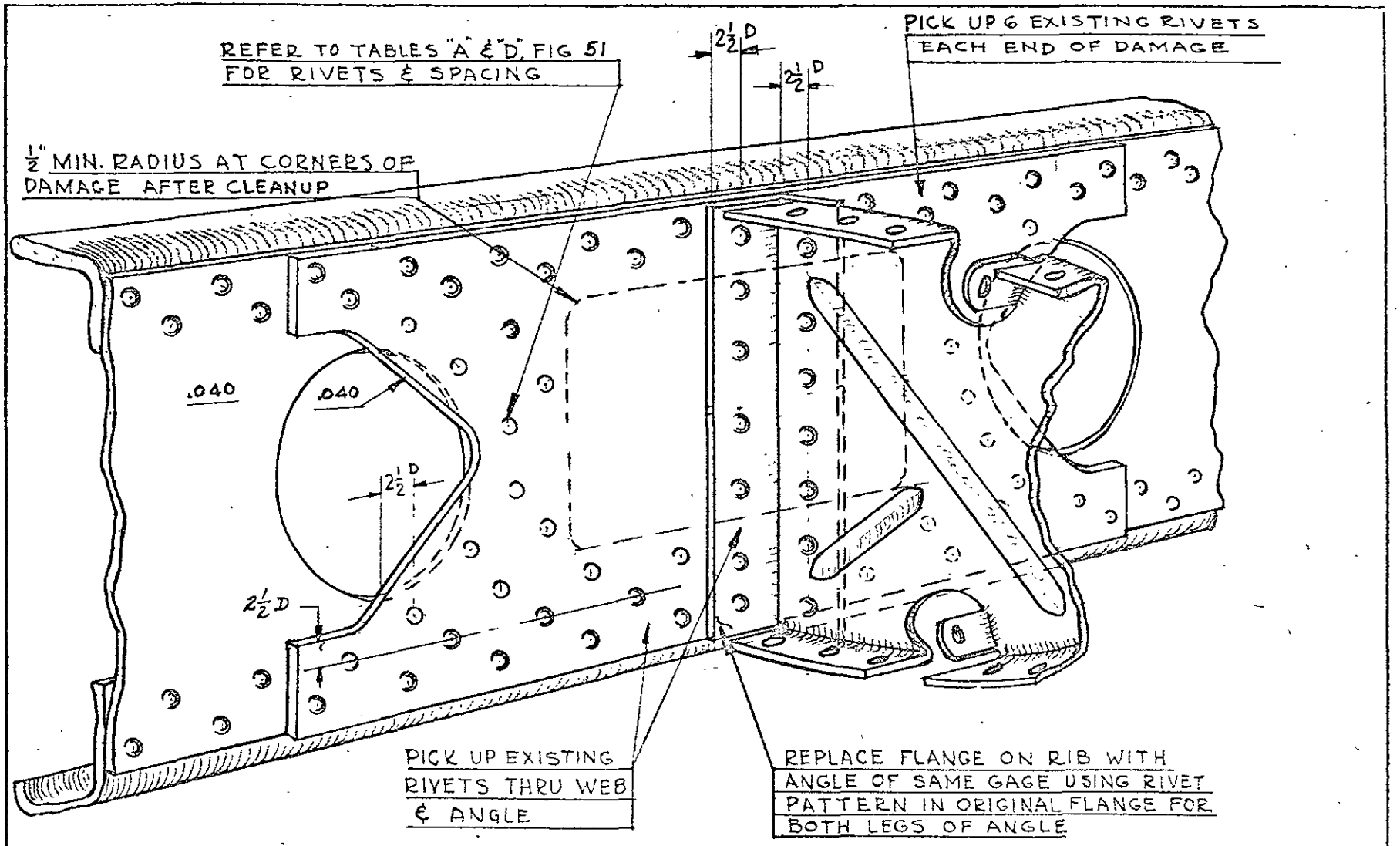
EXAMPLE ABOVE IS FOR REPAIR OF SPAR NO. 2 AT STATION 51.
FOR OTHER STATIONS USE DATA IN FIGURE 51

FIGURE 54 WING - SPAR WEB
LIGHTENING HOLE FRACTURE



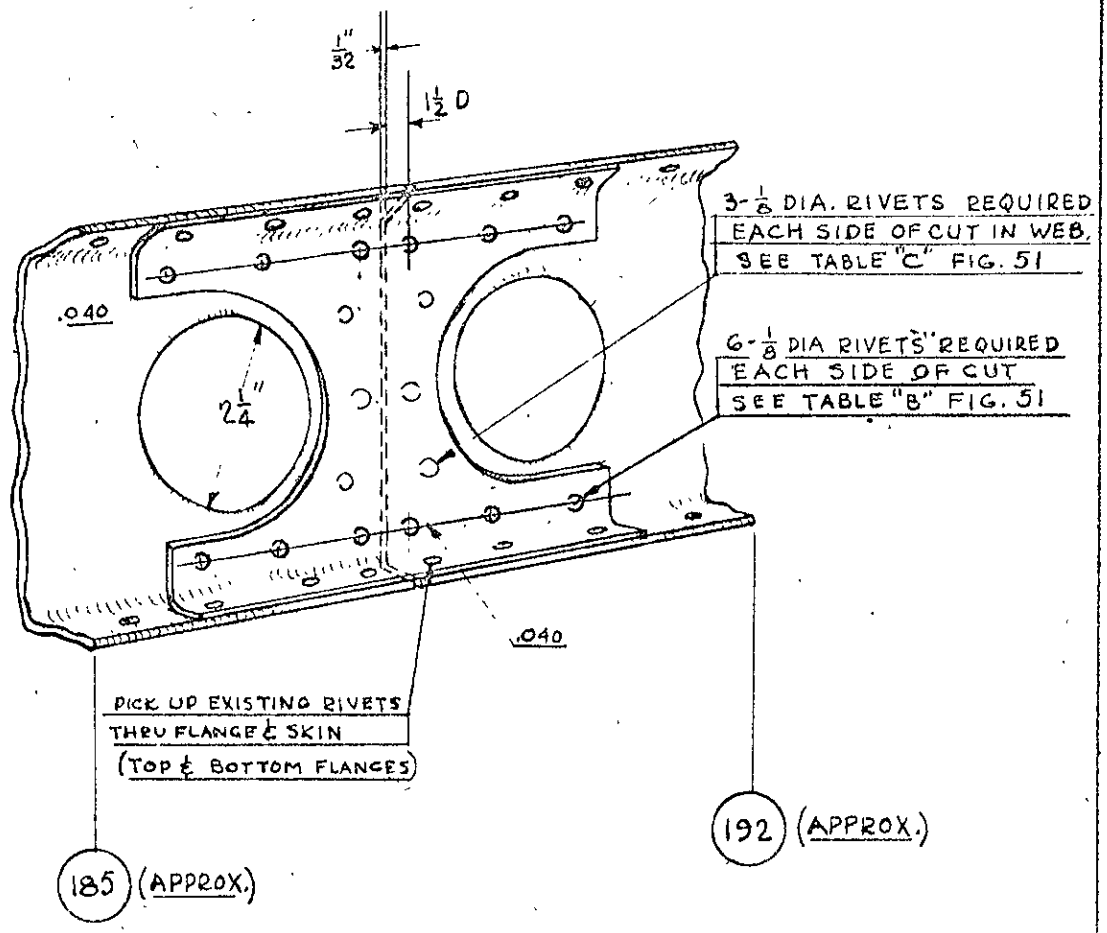
EXAMPLE ABOVE IS REPAIR OF SPAR NO.1 WEB BETWEEN STATION 105 AND 117. REFER TO FIG 51 FOR DATA FOR OTHER STATIONS.

FIGURE 55 WING - SPAR - FRACTURE BETWEEN LIGHTENING HOLES



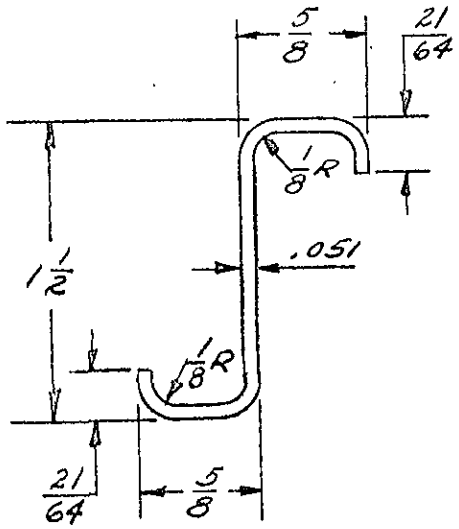
EXAMPLE ABOVE IS FOR DAMAGE TO SPAR NO. 1 STATION 117 TO 127
FOR OTHER STATIONS USE DATA IN FIGURE 51.

FIGURE 56 WING - SPAR WEB PATCH AT RIB



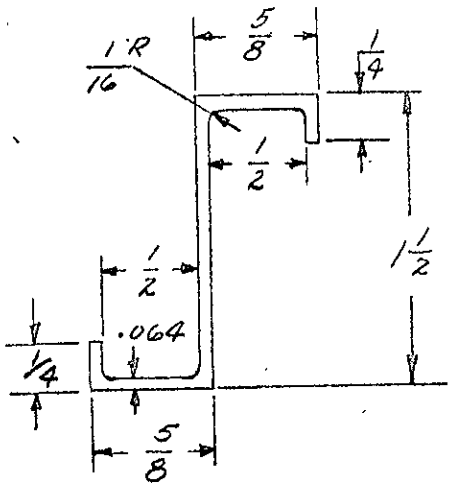
EXAMPLE ABOVE IS THE SPLICE OF SPAR NO. 1 AT STATION 188
FOR OTHER STATIONS REFER TO DATA IN TABLES OF FIG. 51

FIGURE 58 WING - SPAR WEB SPLICE - OUTBOARD END



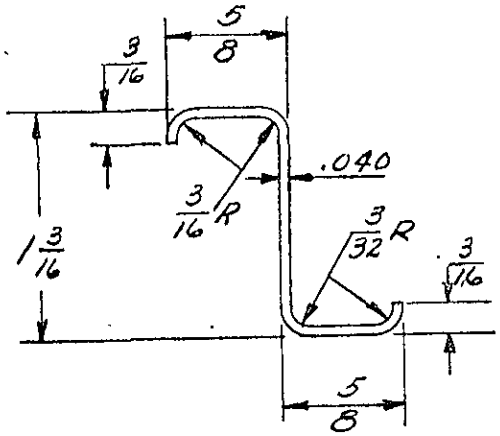
THIS STRINGER TAPER FROM 1 1/2" TO 11/16" IN 88"

87-03-691



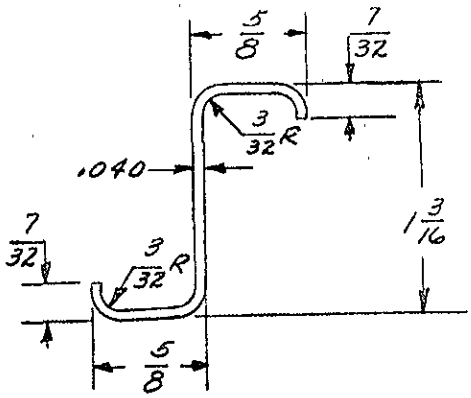
K-10274.

CURTISS NO. 84016



THIS STRINGER TAPERS FROM 1 3/16" TO 5/8" IN 65".

87-03-178A



75-03-043

FIGURE 63 WING STRINGERS - "Z" SECTION

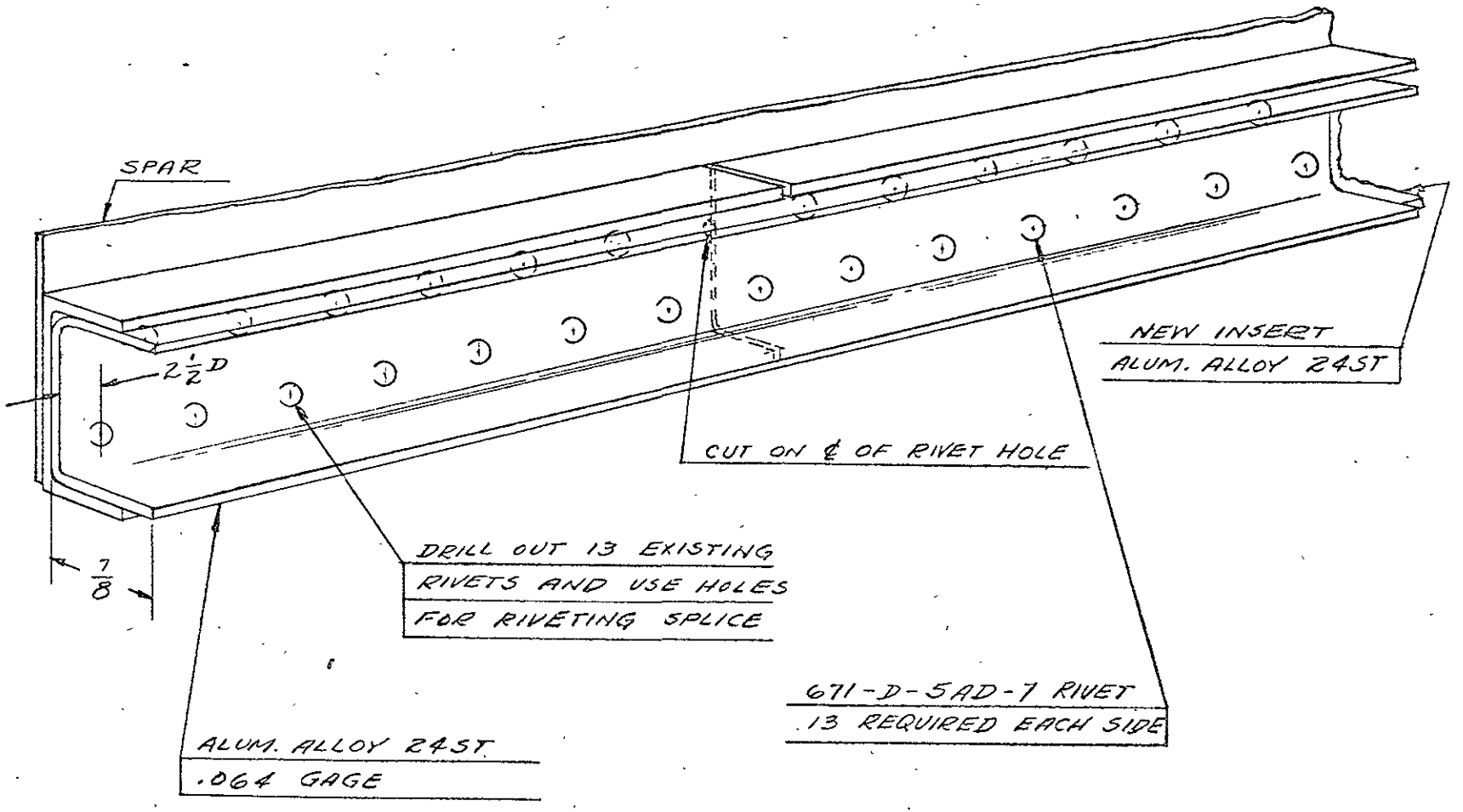


FIGURE 76 CAPSTRIP - LOWER SURFACE - REAR AUXILIARY BEAM - SPLICE

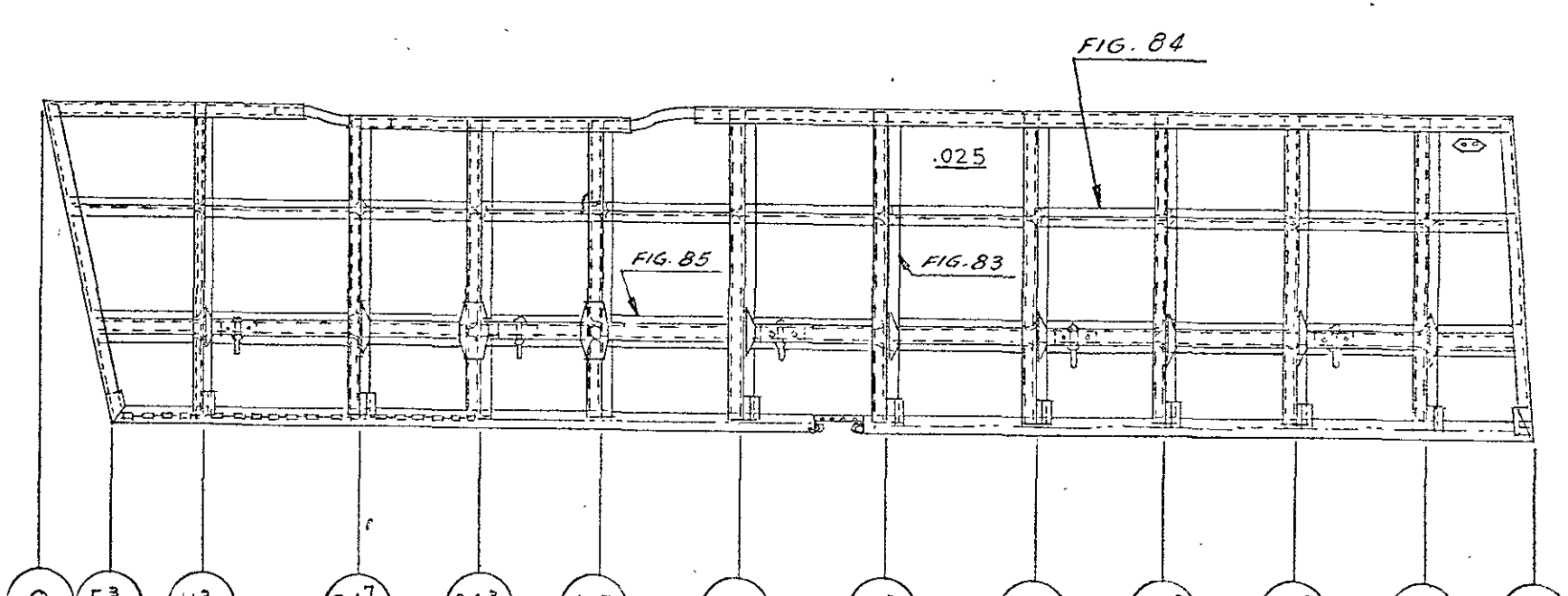
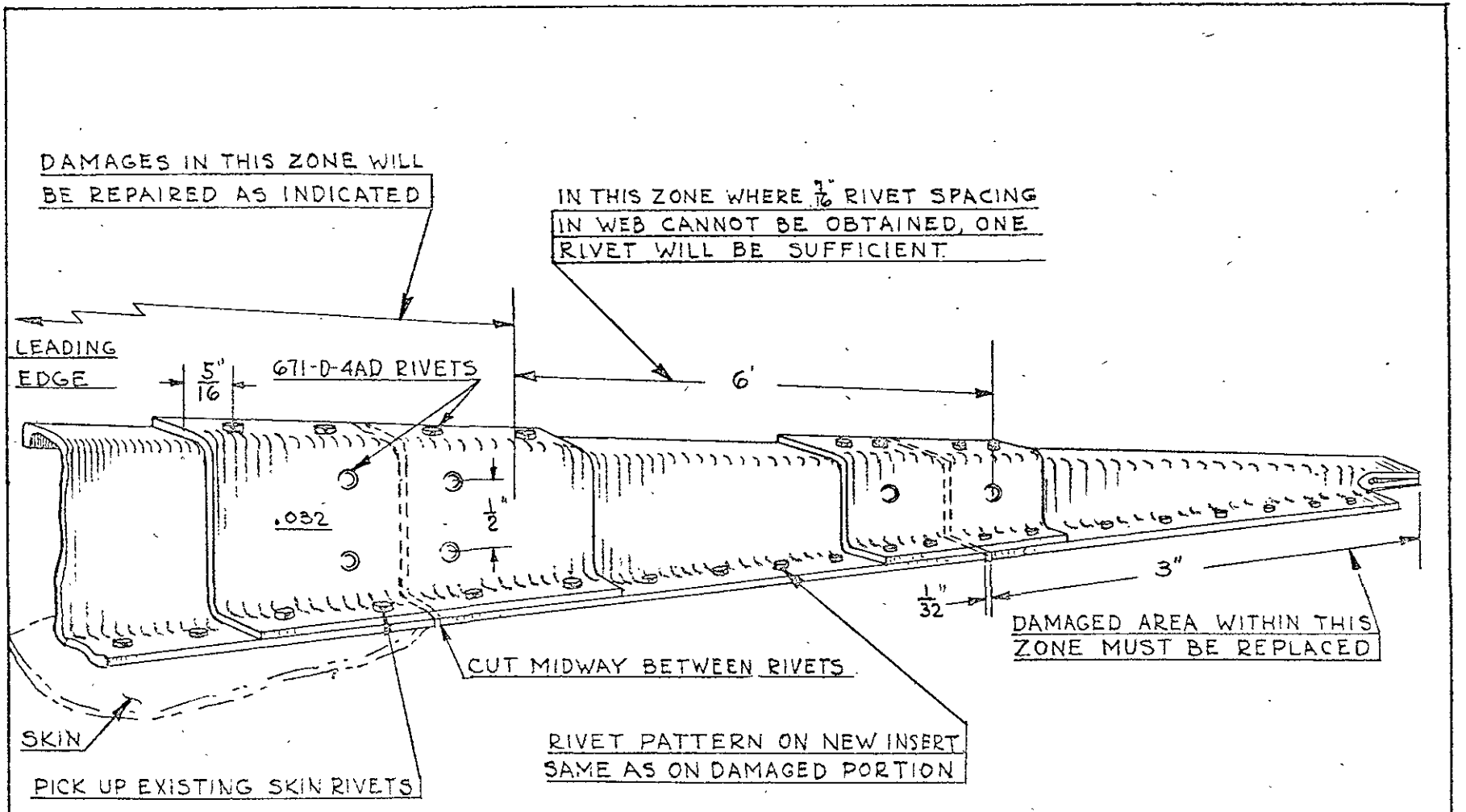


FIGURE 82 FLAP ASSEMBLY



NOTE:
INSERTS FOR EXTENSIVE DAMAGE WILL BE SPLICED ON EACH END ACCORDING TO THE ZONE WITHIN WHICH THE SPLICE IS MADE.

FIGURE 83 FLAP-RIB SPLICE

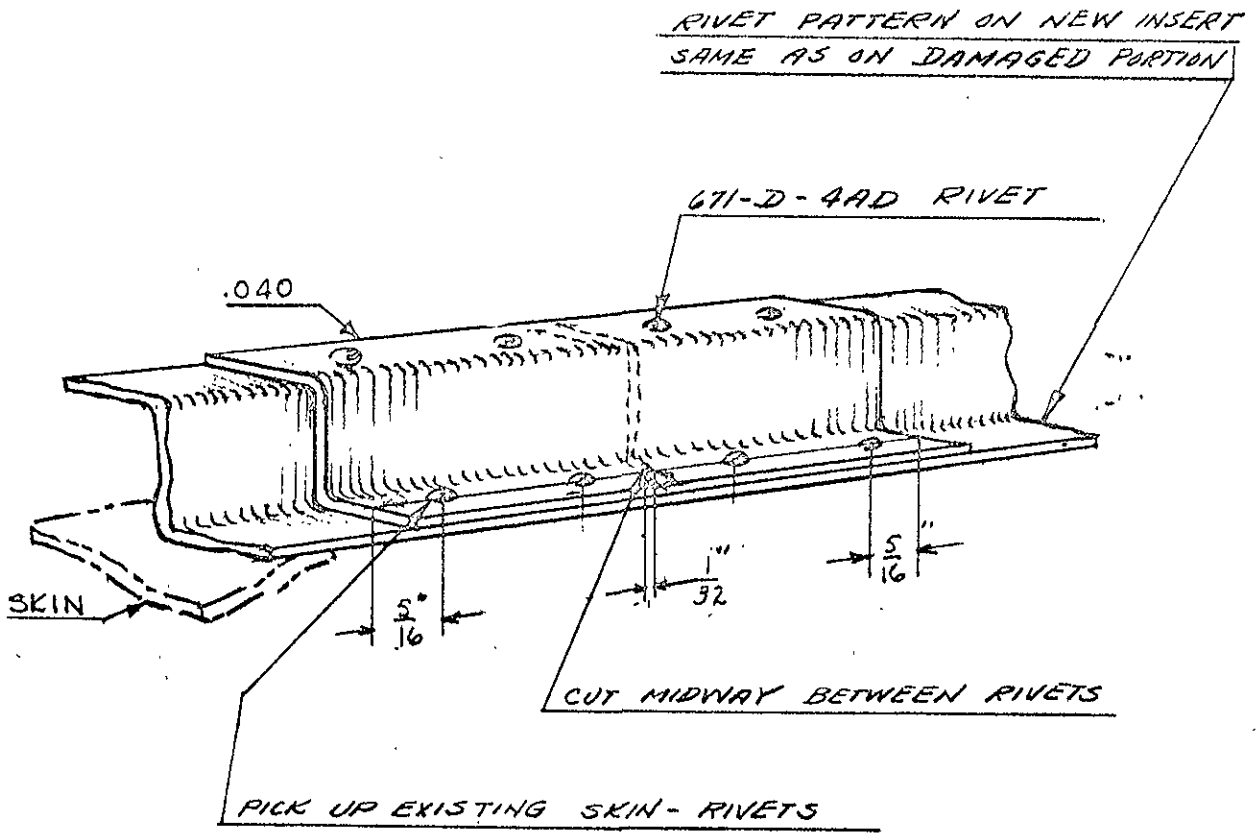


FIGURE 84 FLAP-STRINGER SPLICE

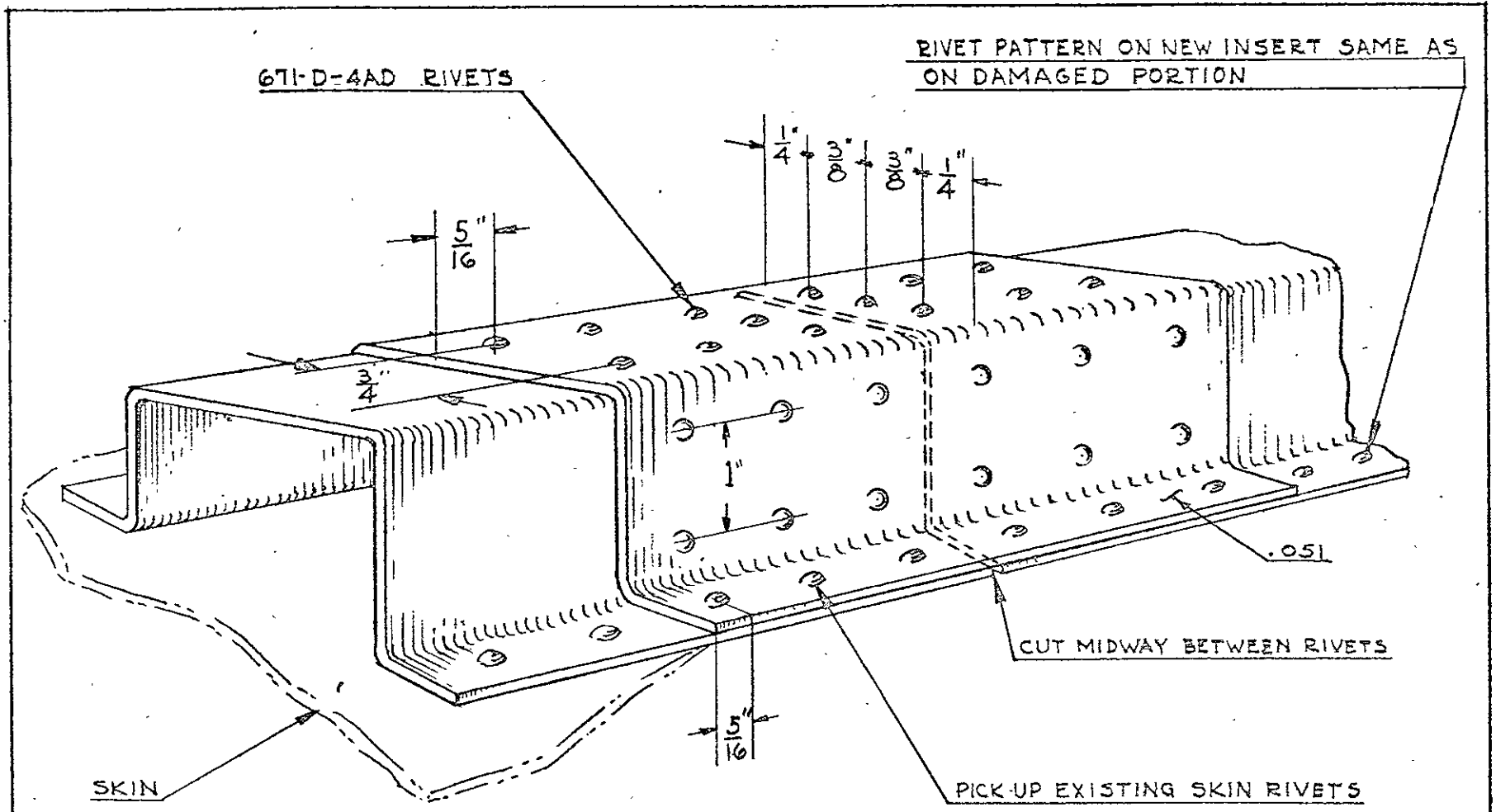


FIGURE 85 FLAP- CHANNEL BEAM SPLICE

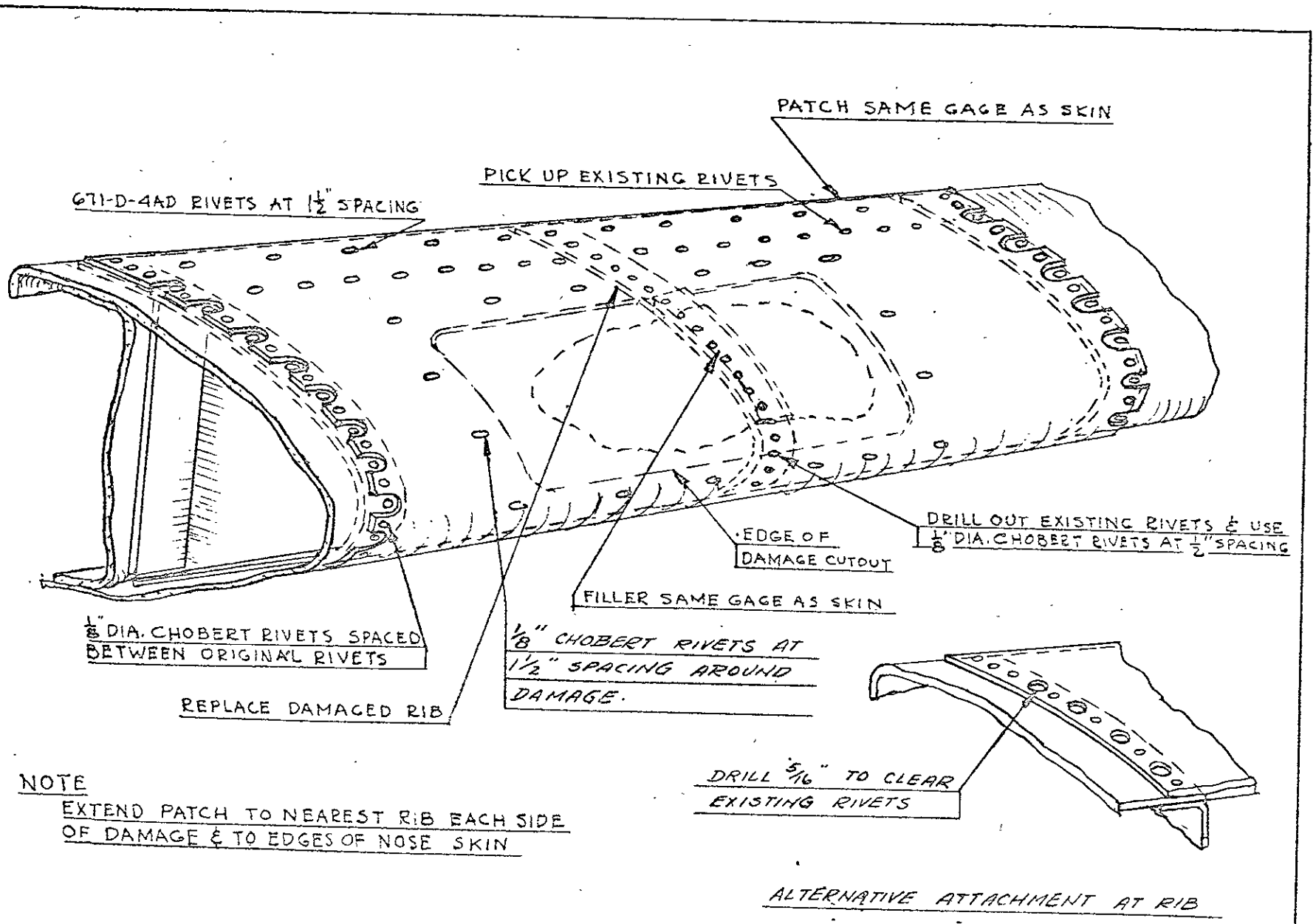


FIGURE 87 AILERON-NOSE SKIN PATCH

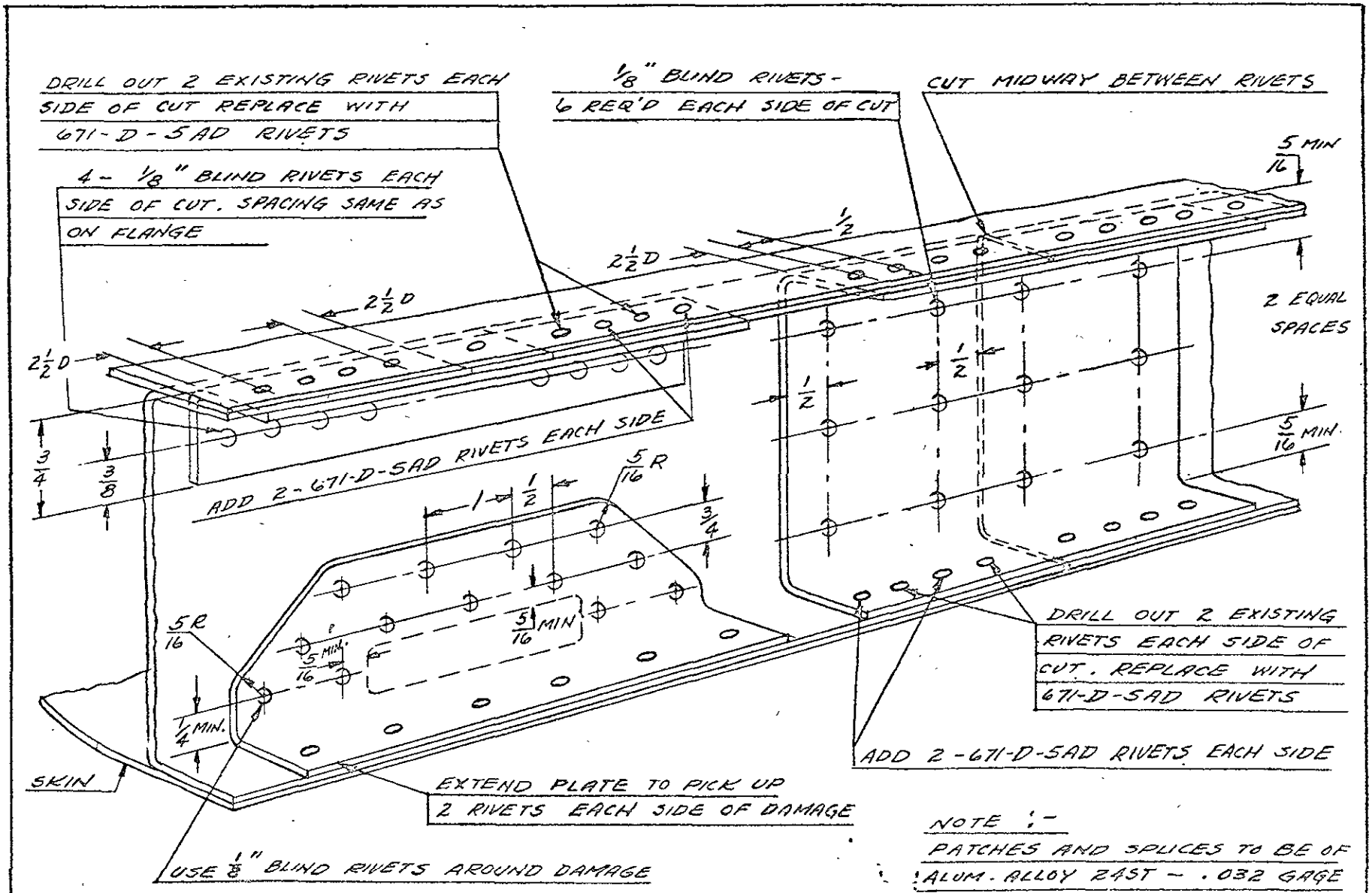


FIGURE 88 AILERON - BEAM SPLICE & PATCHES

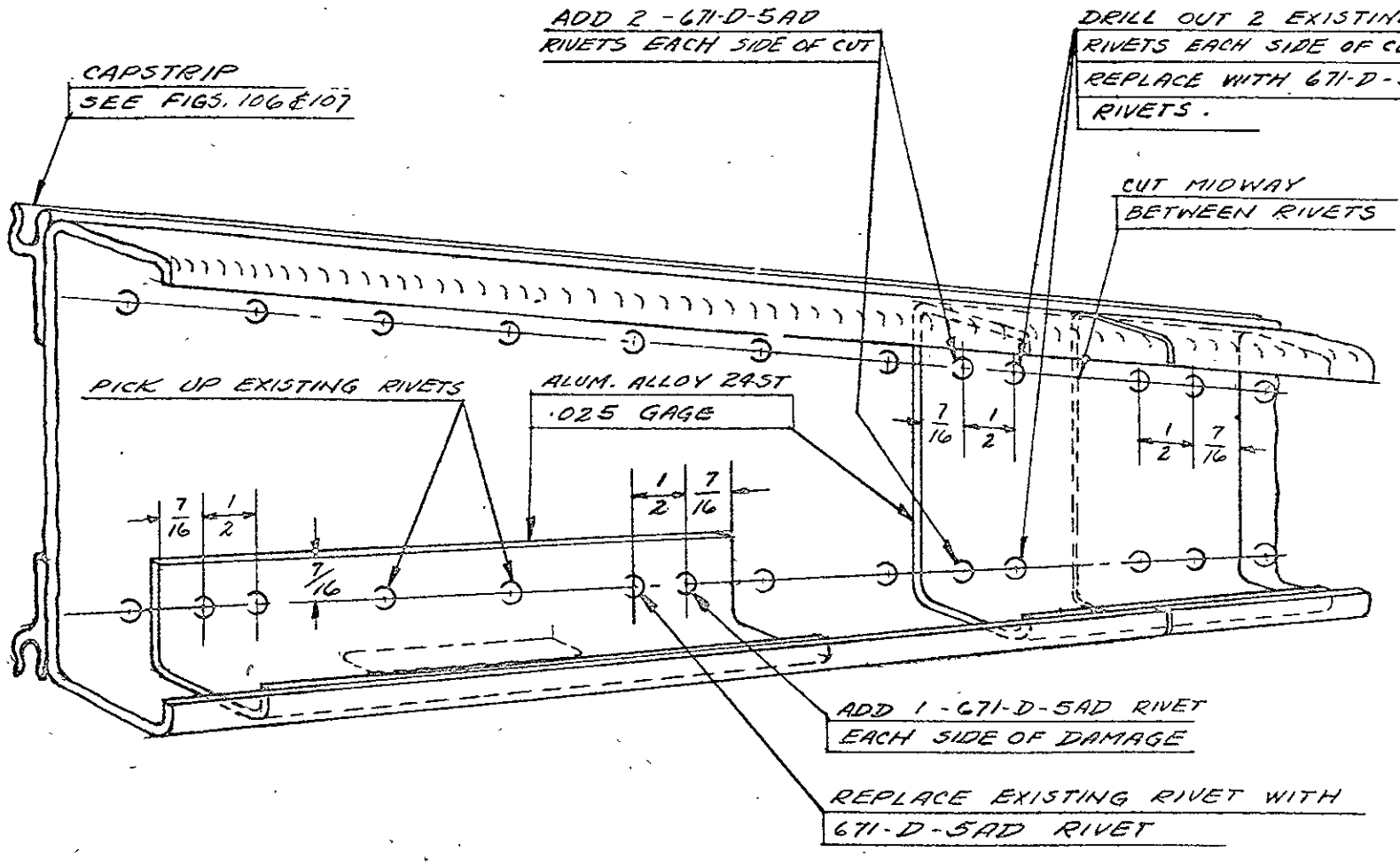


FIGURE 89 AILERON-RIB SPLICE & PATCH

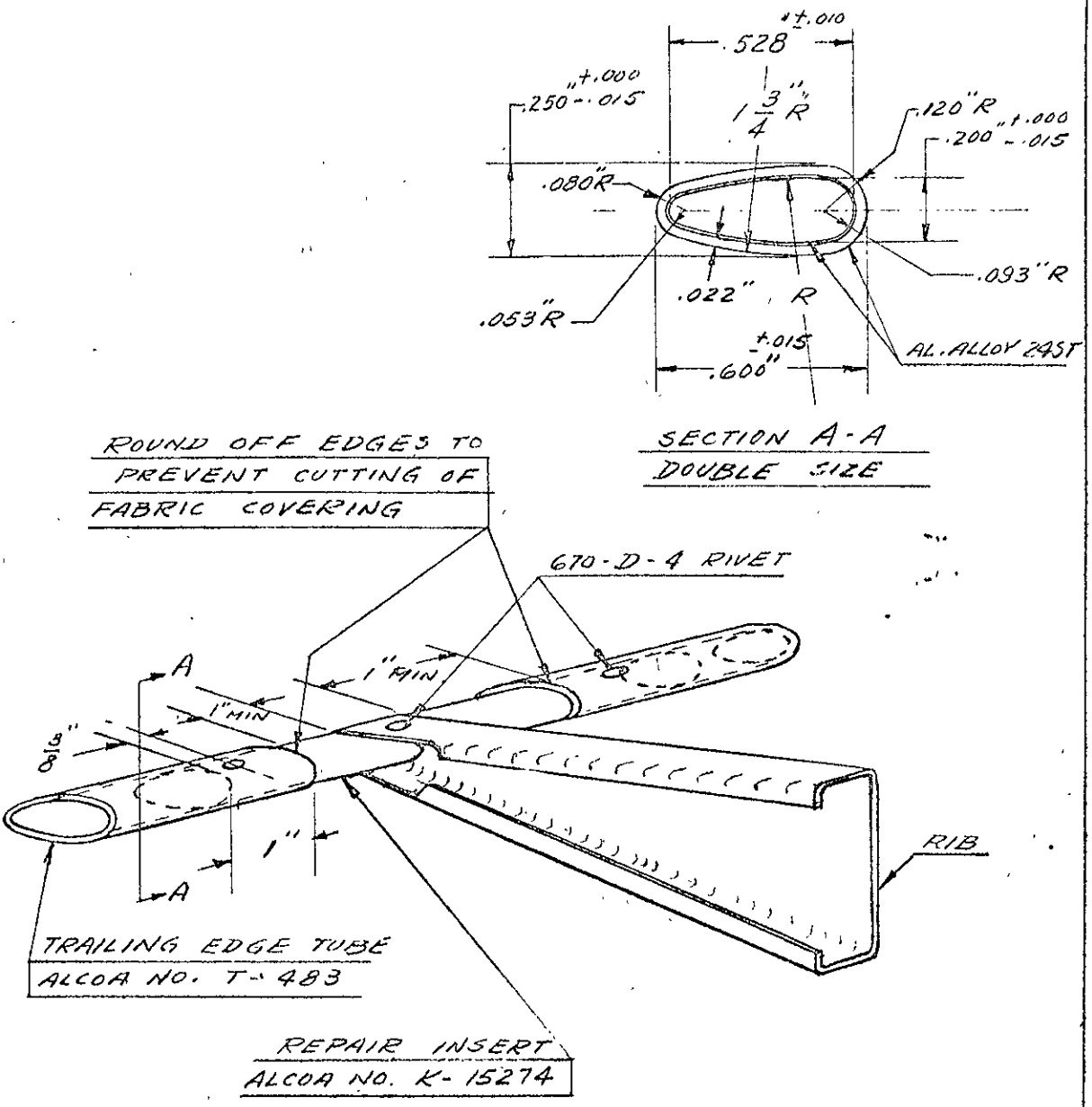


FIGURE 90 CONTROL SURFACES -
TRAILING EDGE INSERT

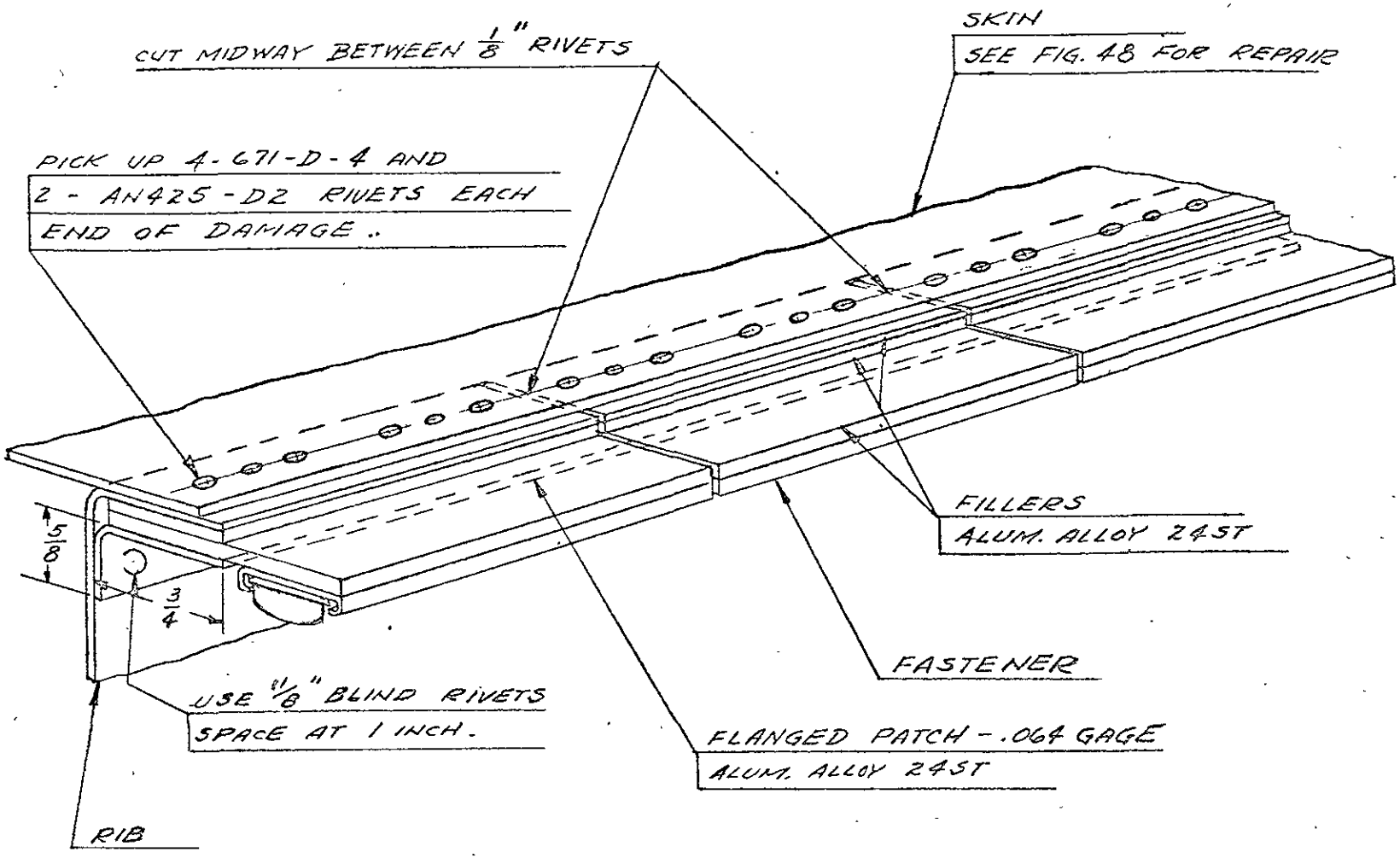


FIGURE 91 RIB - WING TIP JOINT - PATCH

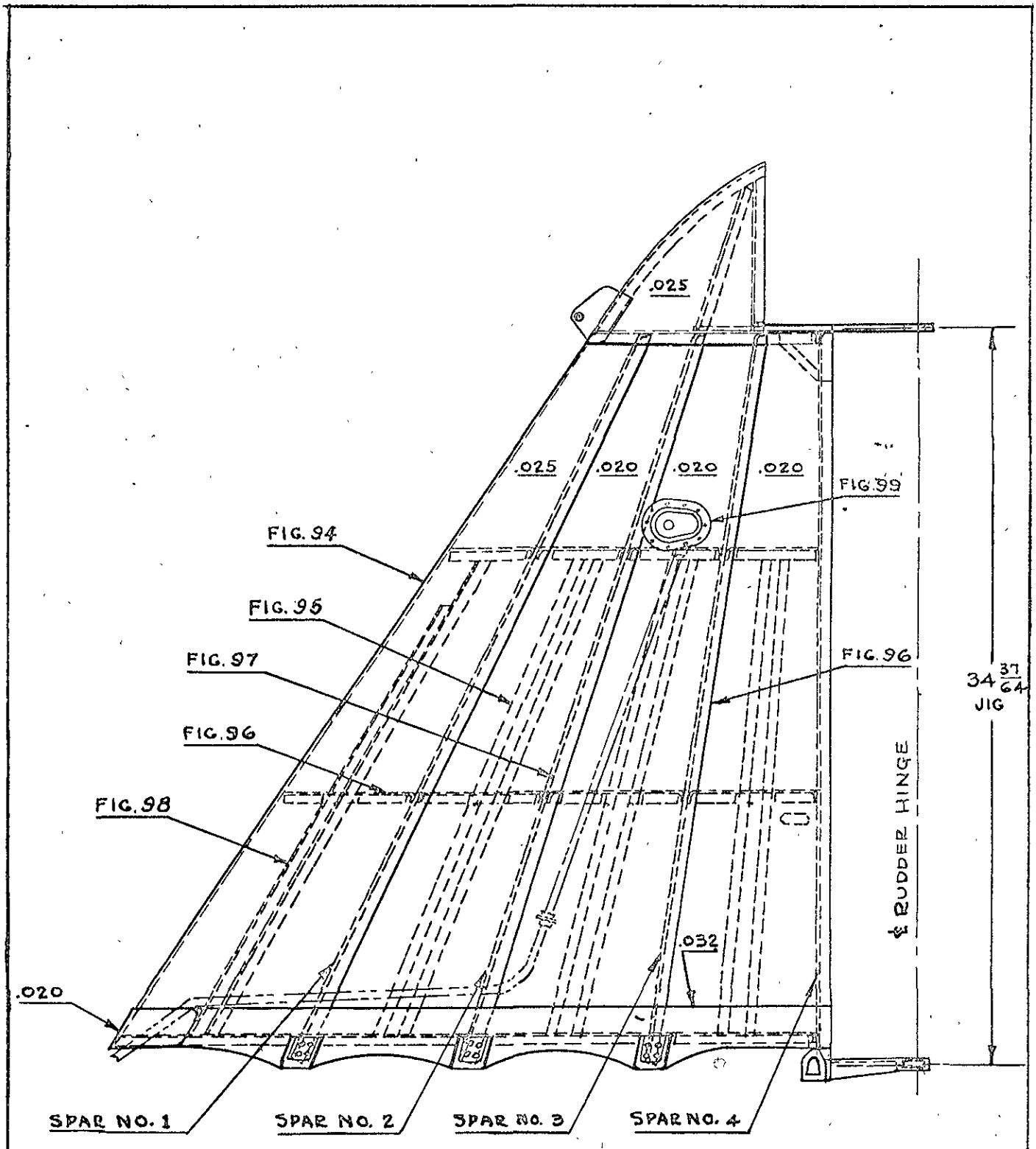
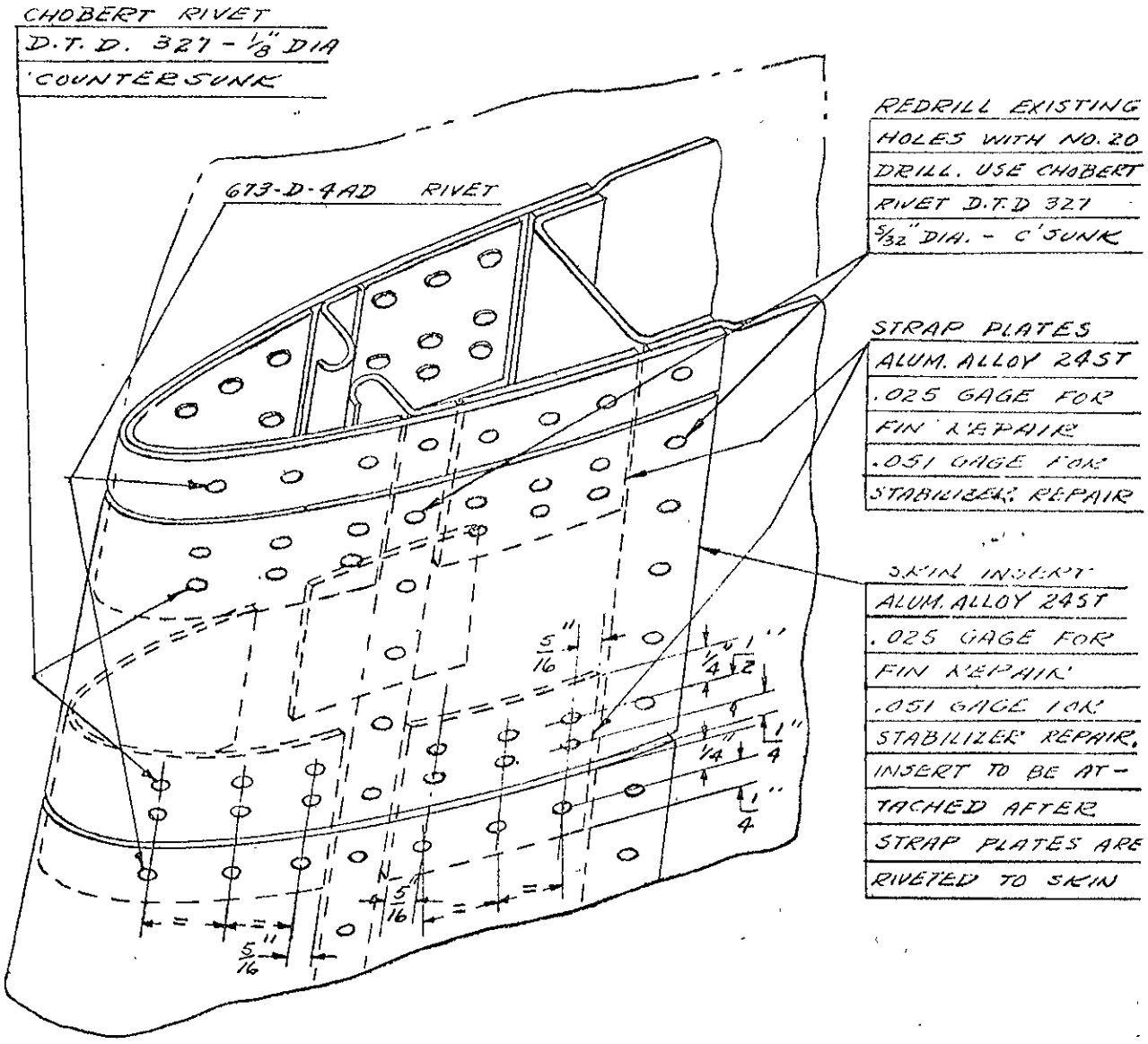


FIGURE 93 FIN ASSEMBLY

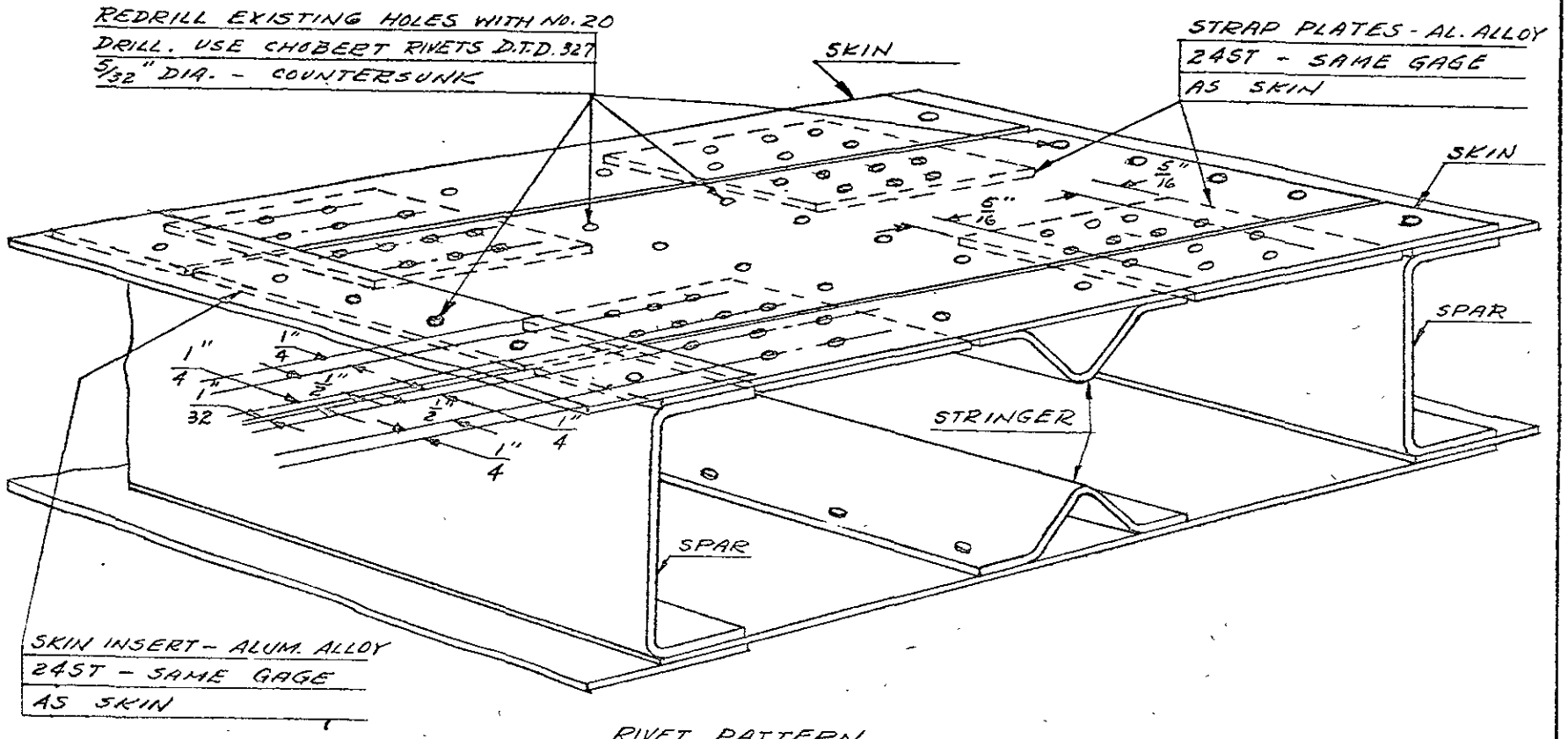


RIVET PATTERN

FIN REPAIR :- WHERE NOSE SKIN IS REINFORCED BY A "J" STRINGER USE 3 ROWS OF RIVETS EACH SIDE OF THE STRINGER AS SHOWN TO ATTACH PLATE. WHERE THERE IS NO STRINGER USE 5 ROWS OF RIVETS TO ATTACH PLATE.

STABILIZER REPAIR :- TO ATTACH PLATES USE 673-D-4AD-5 RIVETS SPACED AT 3/4" MAXIMUM.

FIGURE 94 TAIL PLANE AND FIN-
NOSE SKIN - FLUSH PATCH



RIVET PATTERN

1. TO ATTACH STRAP PLATE TO SKIN:

a) FOR .020 GAGE SKIN REPAIR USE 673-D-4AD-4. RIVETS SPACED AT 3/4". 1 ROW.

b) FOR .025 GAGE SKIN REPAIR USE 673-D-4AD-4 RIVETS AT 1" SPACING IN 2 STAGGERED ROWS AS SHOWN ABOVE.

2. TO ATTACH SKIN INSERT TO STRAP PLATE:

a) FOR .020 GAGE SKIN REPAIR USE TWO ROWS OF CHOBERT D.T.D. 327 1/8" DIA. - COUNTERSUNK RIVETS AT 3/4 INCH SPACING

b) FOR .025 GAGE SKIN REPAIR USE 2 STAGGERED ROWS OF CHOBERT D.T.D. 327 5/32" DIA. - COUNTERSUNK RIVETS AT 3/4 INCH SPACING.

FIGURE 95 TAIL PLANE AND FIN - FLUSH SKIN PATCH

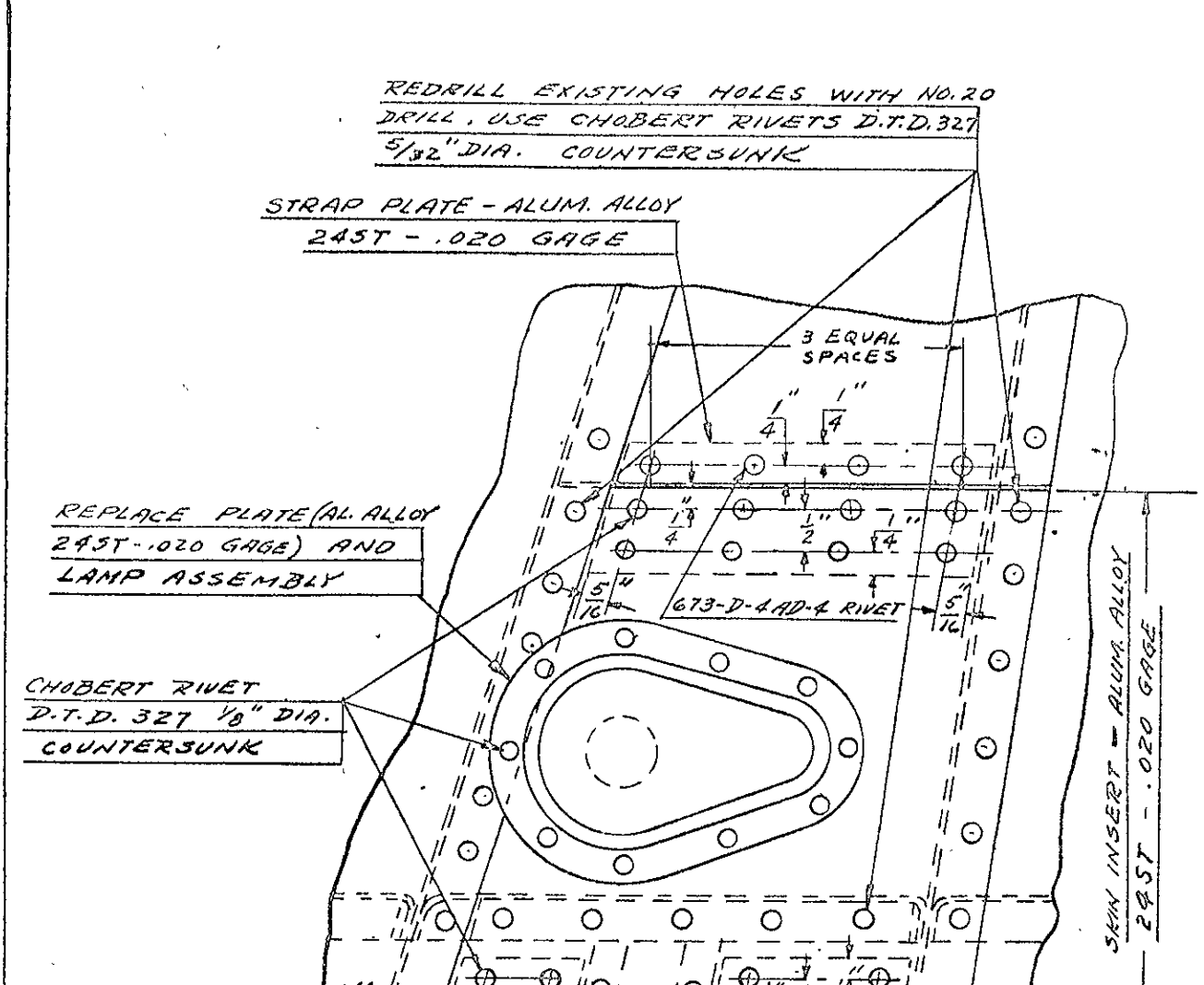


FIGURE 99 FIN-RUNNING LIGHT DAMAGE

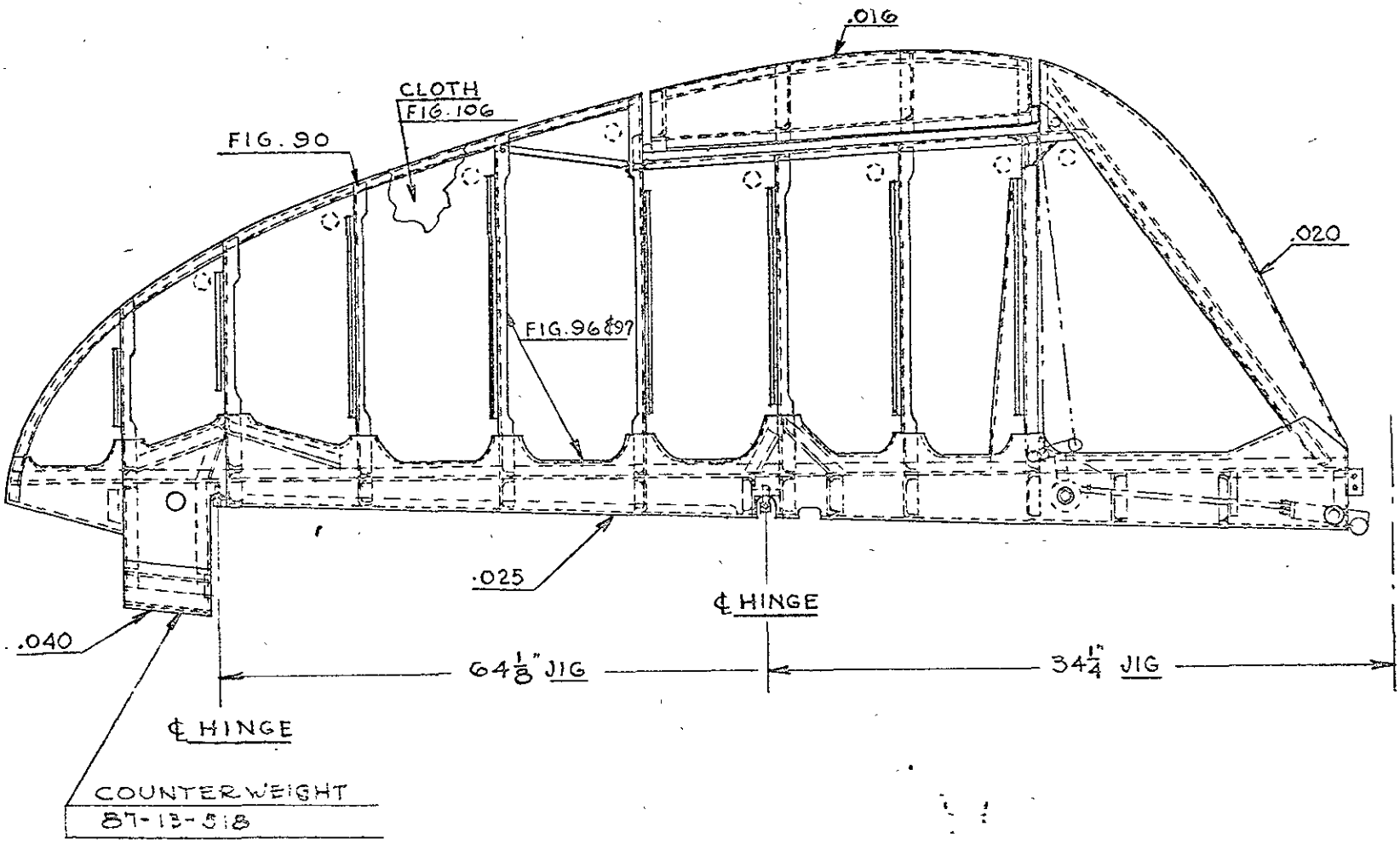


FIGURE 100 ELEVATOR ASSEMBLY

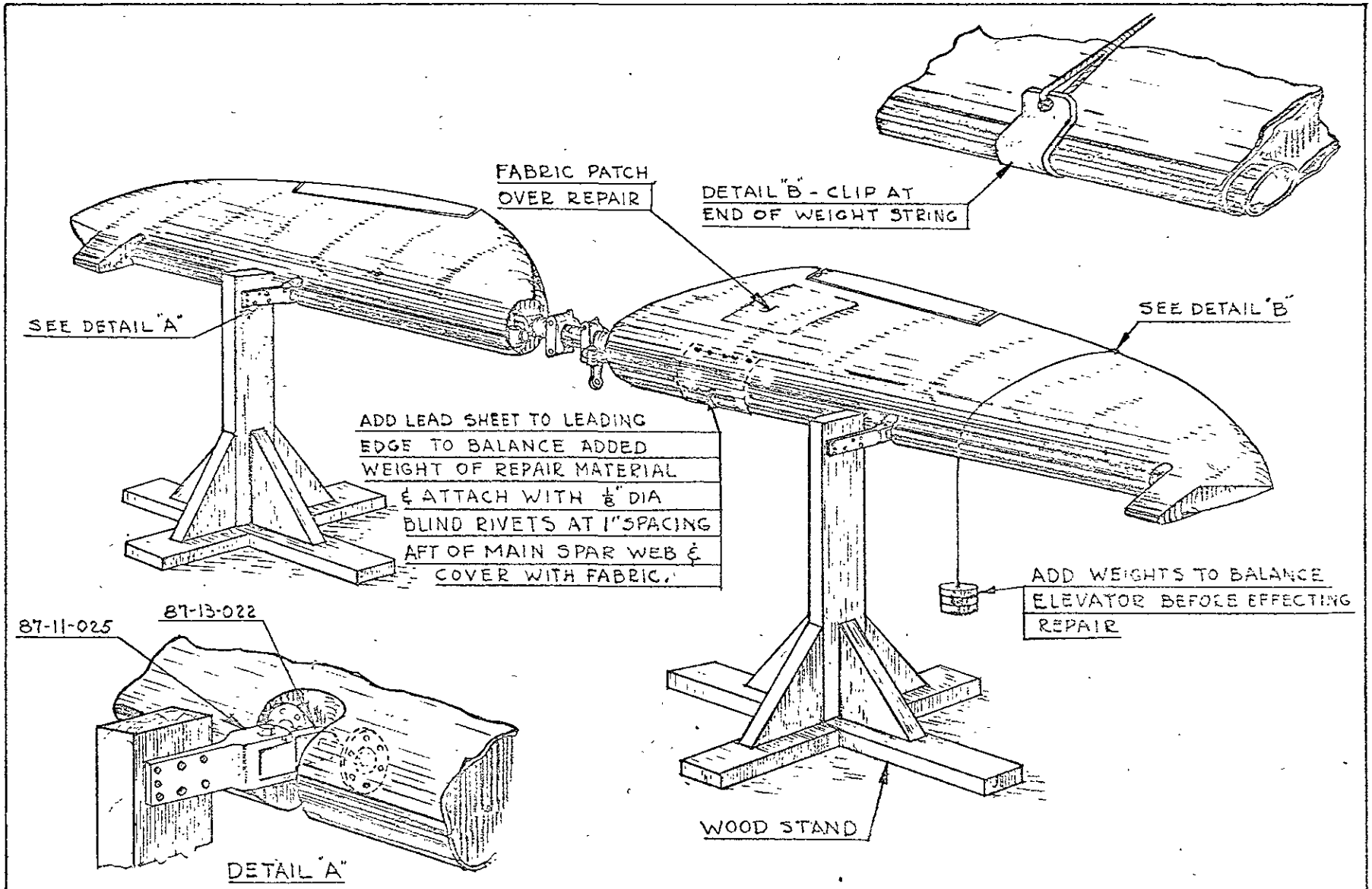
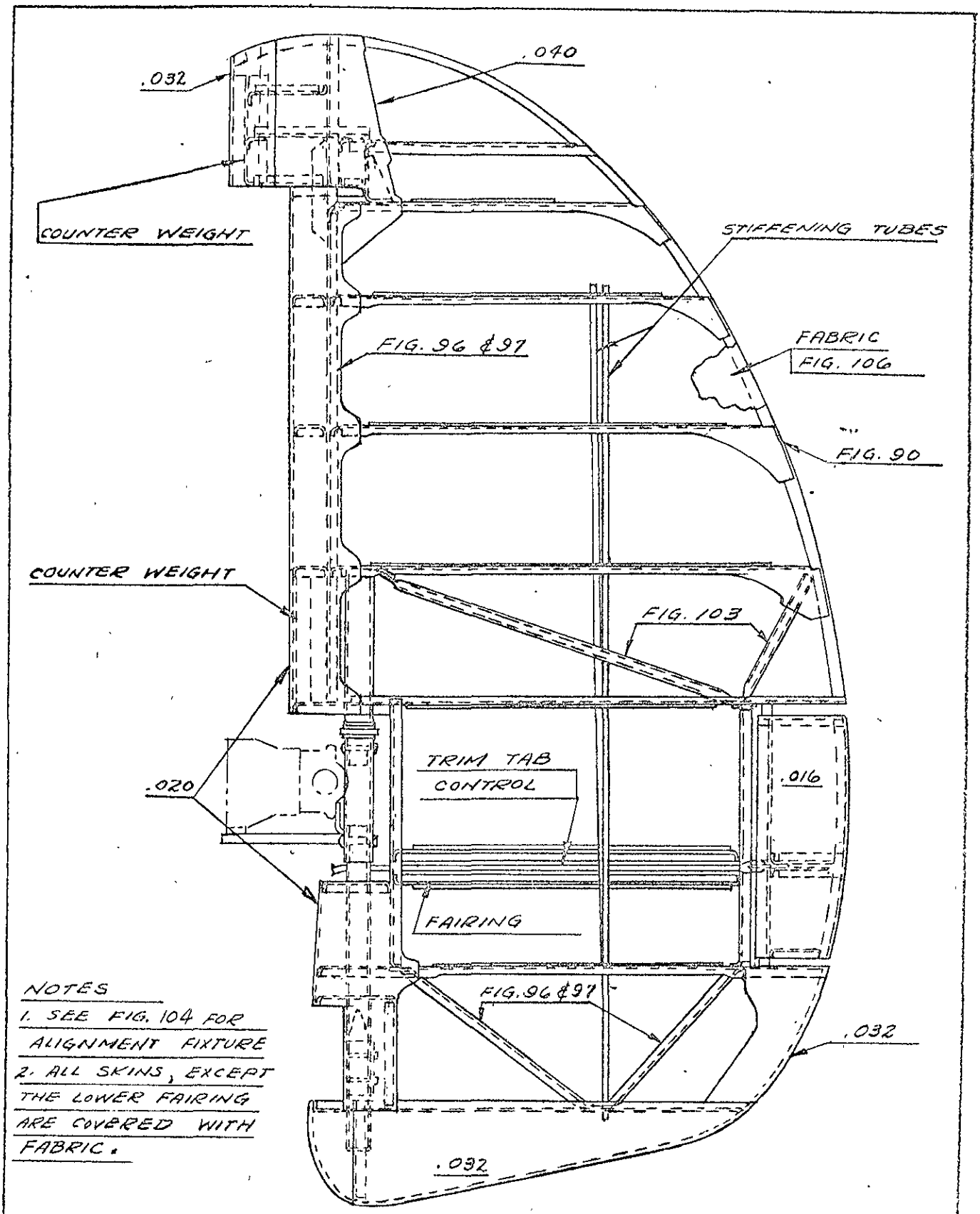


FIGURE 101 ELEVATOR-MASS BALANCE DIAGRAM



NOTES

1. SEE FIG. 104 FOR ALIGNMENT FIXTURE
2. ALL SKINS, EXCEPT THE LOWER FAIRING ARE COVERED WITH FABRIC.

FIGURE 102 RUDDER ASSEMBLY

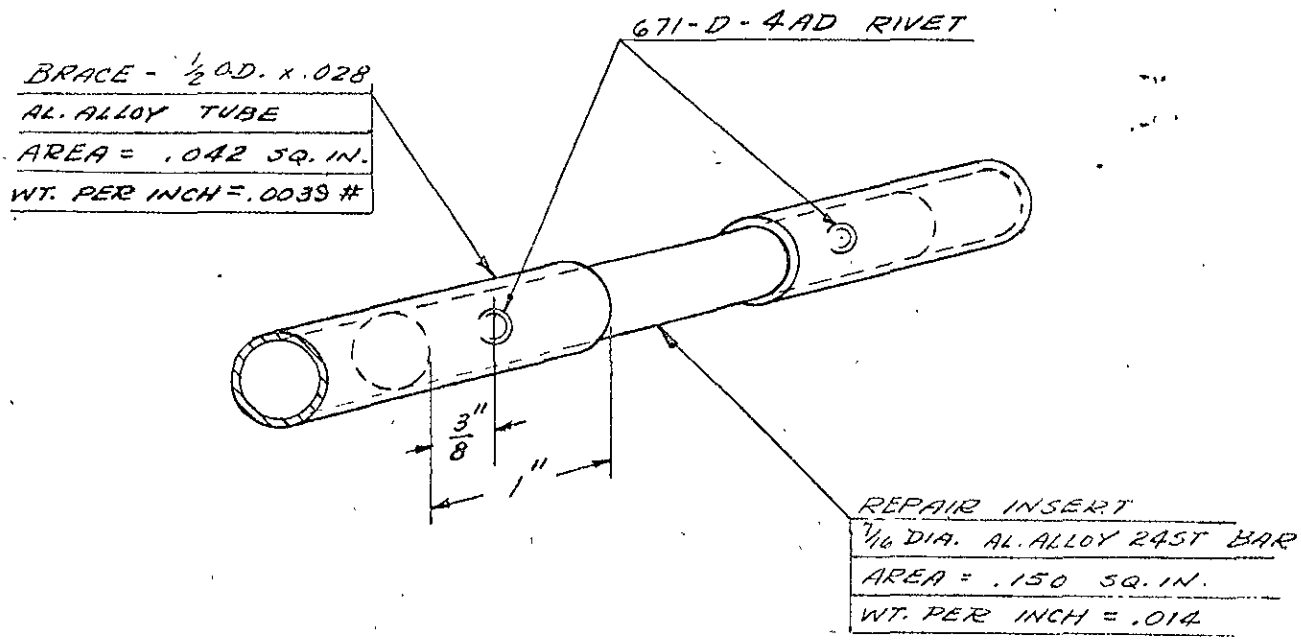


FIGURE 103 RUDDER BRACE TUBE INSERT

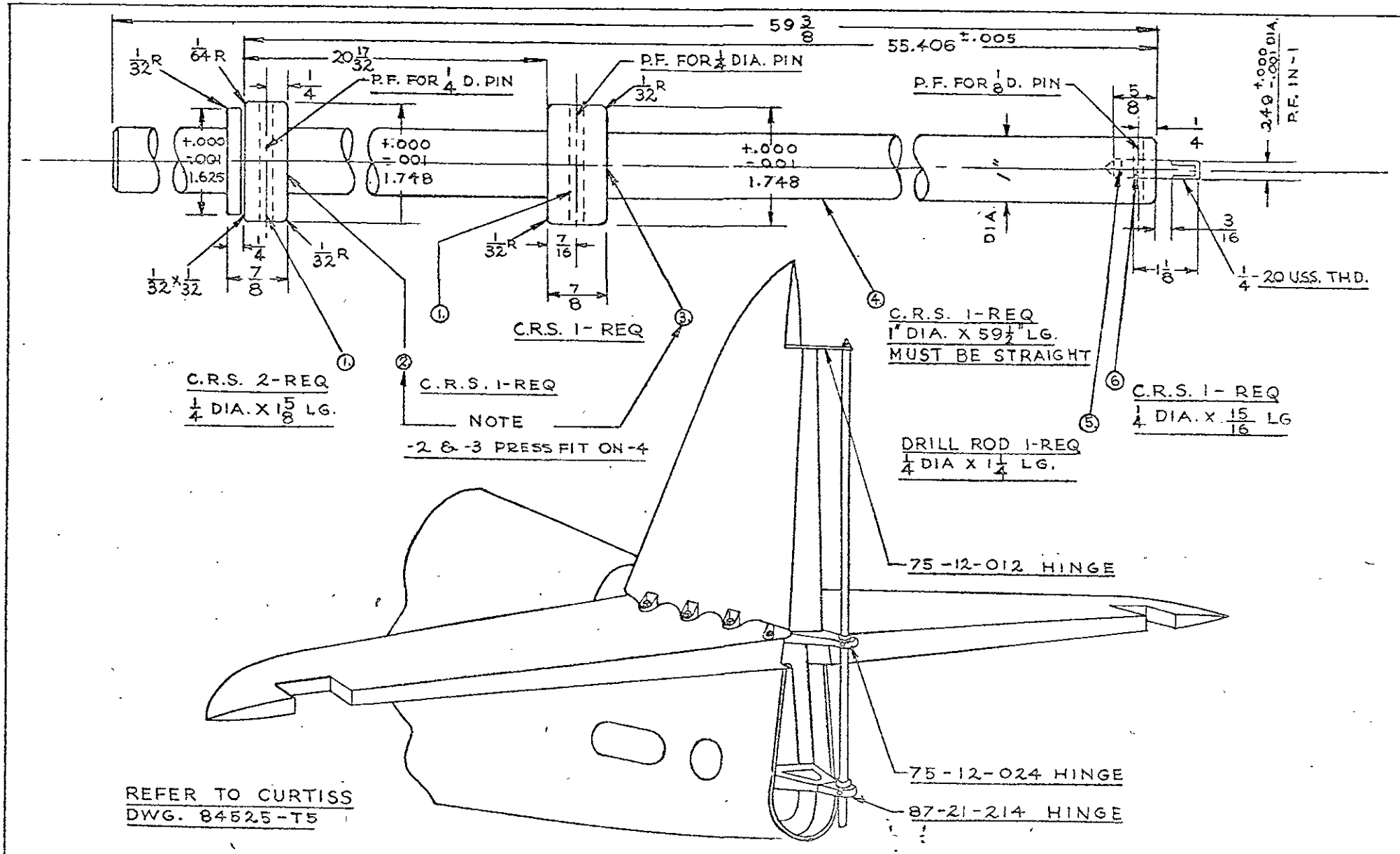
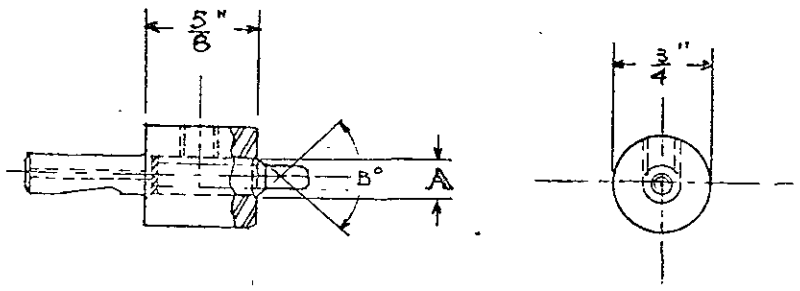


FIGURE 104 RUDDER ASSEMBLY LOCATING FIXTURE

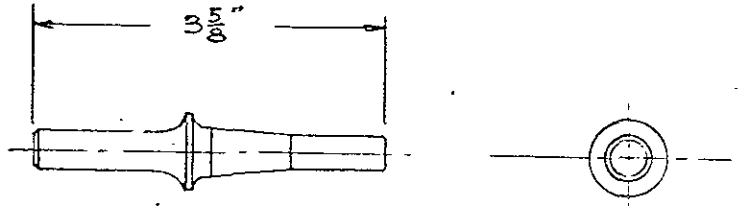


COUNTER PUNCH

TOOL Nº	RIVET	A	B°
P-9333	1/8	.213	78°
P-9221	5/32	.272	78°
P-9221	3/16	.312	78°

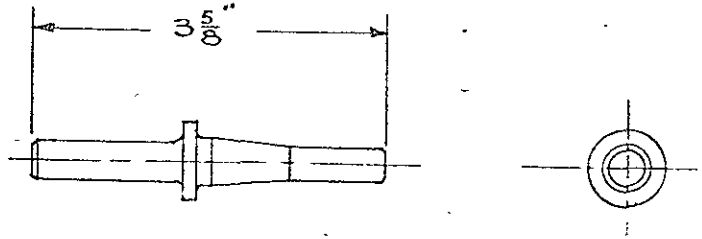
P-9058

FLUSH RIVETING TOOL - USE WITH ADAPTER



P-8429

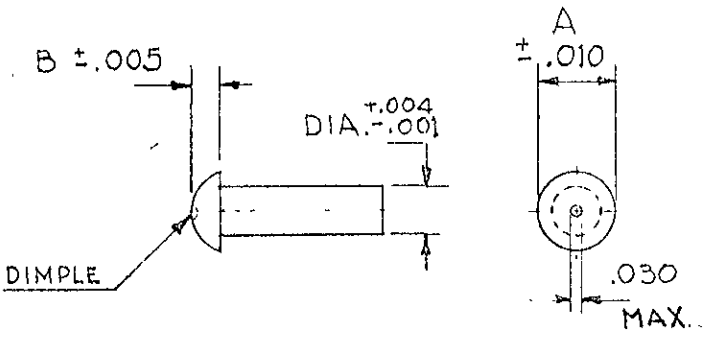
ADAPTER FOR Nº 3 CHICAGO AIR GUN



P-8505

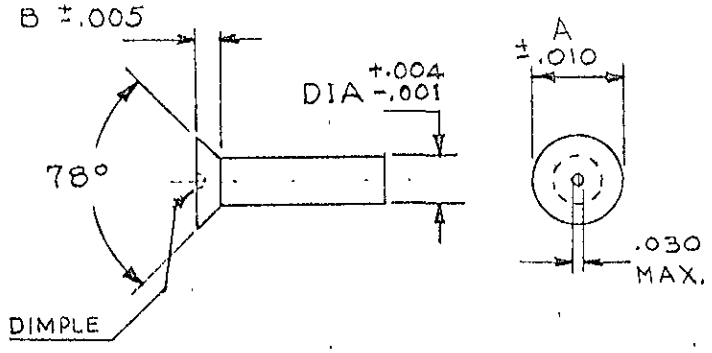
ADAPTER FOR Nº UU BOYER AIR GUN

FIGURE 108 FLUSH RIVETING TOOLS



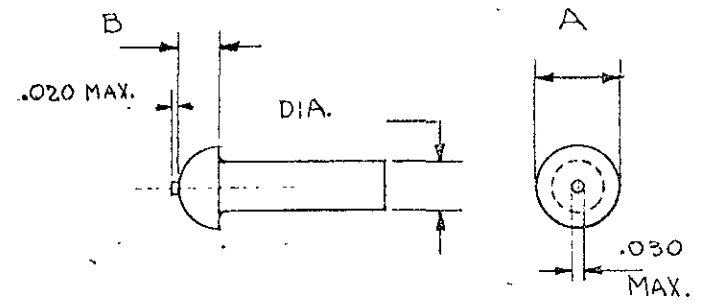
DIMENSIONS 671-D- A17ST RIVET			
DIA	1/8 = -4AD	5/32 = -5AD	3/16 = -6AD
A	7/32	17/64	5/16
B	.032	.036	.048

EXAMPLE: 671-D-4AD = 1/8 DIA RIVET



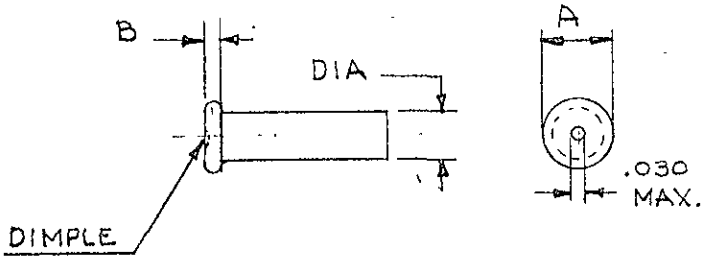
DIMENSIONS 673-D- A17ST RIVET			
DIA.	1/8 = -4AD	5/32 = -5AD	3/16 = -6AD
A	.200	.250	.300
B	.046	.058	.069

EXAMPLE: 673-D-6AD = 3/16 DIA. RIVET



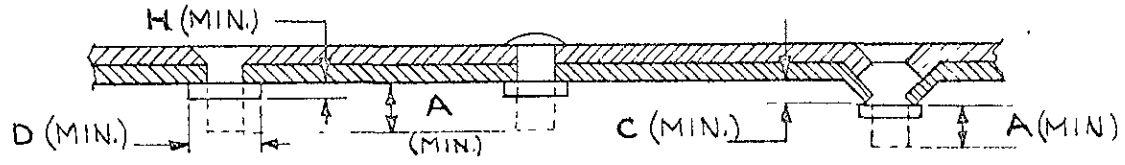
DIMENSIONS AN-430 17ST RIVET			
DIA.	1/8	5/32	3/16
A	1/4 ± .012	5/16 ± .016	3/8 ± .019
B	.094 ± .005	.117 ± .005	.141 ± .007

REFRIGERATED RIVET



DIMENSIONS AN442 A17ST RIVET			
DIA	1/8	5/32	3/16
A	1/4 ± .012	5/16 ± .016	3/8 ± .019
B	.050 ± .005	.062 ± .005	.075 ± .005

RIVET ALLOWANCES



RIVET	1/8 DIA.				5/32 DIA.				3/16 DIA.			
	H	D	A	C	H	D	A	C	H	D	A	C
671-D	.047	.156	5/32		.063	.203	5/32		.078	.234	3/16	
673-D	.063	.188	3/16	1/32	.063	.234	3/16	3/64	.078	.281	3/16	1/16
AN-430	.063	.188	3/16		.078	.234	3/16		.093	.281	7/32	
AN-442	.063	.188	3/16		.078	.234	3/16		.093	.281	7/32	

FIGURE 109 RIVET REFERENCE CHART

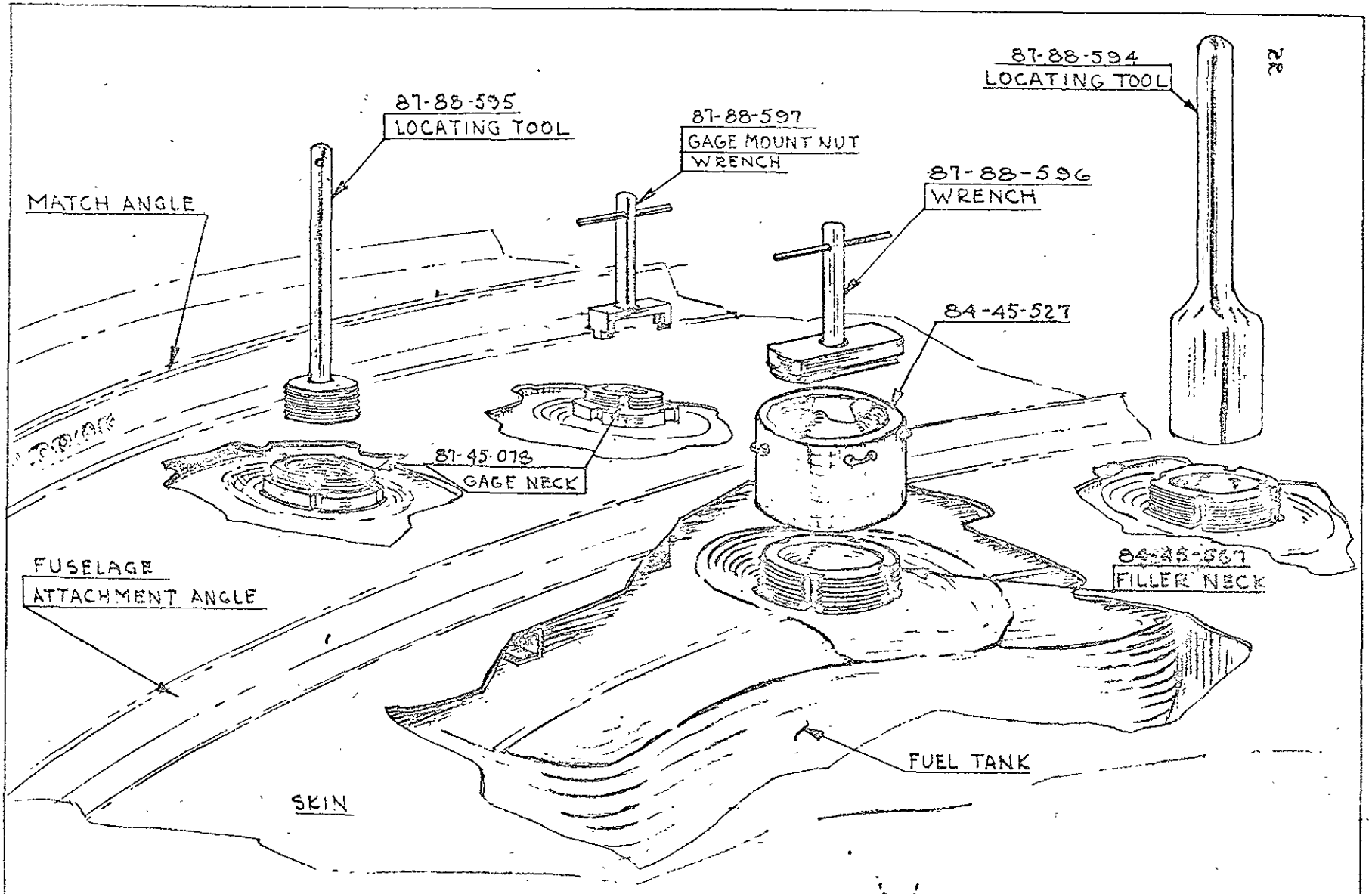


FIGURE III WING TANK INSTALLATION TOOLS